Scream Machines!

Imagination & Engineering

For many people, there is only one reason to go to an amusement park. The roller coaster. Some people call it the "scream machine," with good reason.

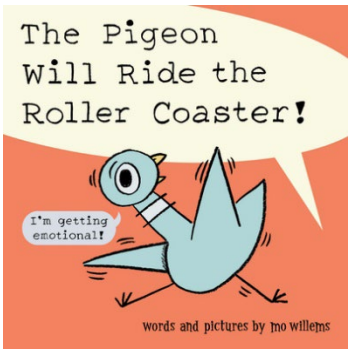
Have students explain their roller coaster experiences. Encourage students to describe:

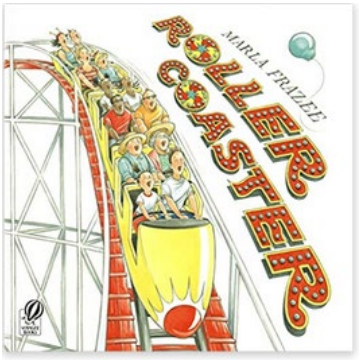
- **How fast they went**
- **How high they went**
- **How far they went**
- **How long the ride lasted**

Ask questions, such as the ones below, to stimulate discussion. Write a list of phrases that describe students' experiences and responses on the board.

- **What do you remember most about your first roller coaster ride? What do you like (dislike) about roller coaster rides? (*Give students time to share their personal experiences. You may wish to list student responses in two columns on the board labeled Likes and Dislikes*.)**
- **How fast do you think roller coasters go? Why would one roller coaster go faster than another? (Help students see that the coaster's height, especially the height of the first drop, is the key factor affecting maximum speed.)**
- **About how long do you think a roller coaster ride lasts? Why would some roller coaster rides last longer than others? (*Guide students to see that the height of the coaster and the length and steepness of the track may all influence the duration of the ride*.)**

Let's Ride Along!





Tip: Read along, too! Buckle up for twists, turns, and emotional loop-de-loops as Pigeon gets ready for his first roller coaster ride. Then have students compare and contrast Pigeon's story to the girl's experience in Marla Frazee's *Roller Coaster*. If you don't have physical copies you can also find read-alouds on YouTube. Ex. Pigeon and Roller Coaster. *Have students Compare and contrast the text to the audio, video, or multimedia version of the text, analyzing each medium's portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).*

Give students (especially those who have a never ridden a coaster) a first person point of view by watching one or more videos Ride Kingda Ka—the world's tallest roller coaster. See if you can stomach the Iron Gwazi POV. Then find additional amazing POV views of rides such as those by Theme Park Review on YouTube at @ThemeParkReview, @CoasterForce, and others such as 10 Inversion Roller Coaster, or 10 virtual roller coaster rides for at-home thrills.

Note: Please review ALL videos before showing them to your class for appropriateness of content. Be aware some rides have flashing lights and rollercoaster riders often use colorful language!

Every Roller Coaster at Six Flags Fiesta Texas! Front Seat POV!

71K views • 11 days ago

Boardwalk Bullet Roller Coaster! Kemah Boardwalk, Texas! Multi Angle Onride POV

42K views • 1 month ago

Let's Ride Expedition Everest at Walt Disney World's Animal Kingdom! Front Seat Roller...

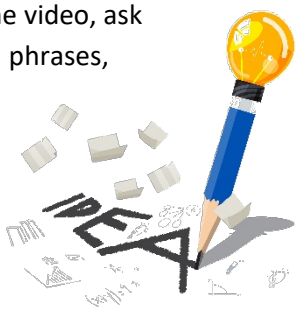
44K views • 1 month ago

Pipeline: The Surf Coaster! SeaWorld Orlando 2023 Roller Coaster!

Every Roller Coaster at SeaWorld San Diego! Front Seat POV!

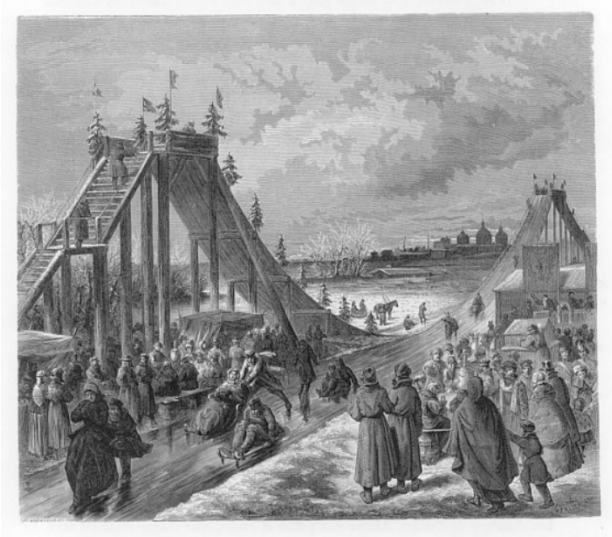
Every Roller Coaster at Silver Dollar City! Front Seat POV! Branson Missouri Theme...

Write that Down! Writing Prompt Ideas



Watch the POV videos of roller coasters. As students are watching the video, ask them to jot down words, phrases, images, or sounds that reflect the experience of riding a roller coaster or thrill ride. (For example, my stomach dropped, sky- ground- sky-ground, like a rocket, intense, weightlessness, a blur, adrenaline rush, boom, flying, thrust, shoot out like a volcano, suspended, screams, zero g, loops, 360-degree view of the park, twists, double barrel.)

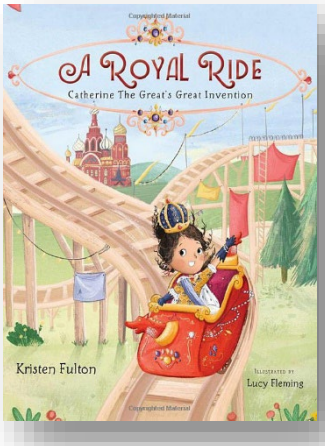
Finally, have students use their notes to make up a poem, short story, song, rap, or other creative piece describing the experience of a roller coaster or other thrill ride. They might describe a specific ride, the experience of riding a roller coaster, or an imaginary ride of the future. Would they feel like the characters in the stories we read?



A Royal Ride!

The history of roller coasters reflects a constant search for greater and more death-defying thrills. But really, the inspiration for the modern roller coaster is a very simple ride found in any playground: the slide. ***Ask students how many of them have ever been sledding, or gone down a giant slide, like those sometimes at a county fair. What do they think it would be like riding a giant ice cube down one?***

As an introduction and to access prior knowledge read the award winning nonfiction book: *A Royal Ride: Catherine the Great's Invention* by Kristen Fulton and Lucy Fleming. (Buy it here or find a read-aloud on YouTube.) Then have students compare and contrast that version with the article Catherine the Great Put Rollers on the World's First Coaster by Joel Mears at Wired Magazine and this article by Stefan Andrews for The Vintage News. What is similar in all of them? What is different?



The Russian ice slides built for (and designed by?) Empress Catherine were tall wooden structures with ice frozen over a long sloping ramp. These slides would often rise seventy or eighty feet and the ramps stretched for hundreds. A staircase led up to the launch area, where riders mounted a sled made of either wood or ice. The ice sleds were simply a block of ice with a straw mat, adding some protection between the freezing ice and the riders' bottoms. ***Have students ever sat down on snow or ice? What happens after a bit?*** They looped a length of rope through a hole drilled in the block so that sliders had something to hold on to.

Once riders sat on their blocks, all it took was a shove and off they went! Occasionally, bumps were added at the end of the slide to introduce a bit more excitement. At the very end, riders plowed into a pile of sand, which slowed them down, a technique based on the principle of friction.

They built slides in parallel pairs but facing opposite directions. One ramp ended near the stairs of the second slide, so riders could spend the day going back and forth down the slides. Later, more elaborate wooden sleds were built with iron runners to increase the speed and intensity of the ride. ***Why do students think that they kept trying to make the rides faster? What other ways could they have used? Grease? Steeper hills? Would students pay to go down these slides?***

While they thoroughly enjoyed the ice slides all over Russia, there were some safety issues. Sliding down an ice ramp on a block of ice offered very little in the way of control. ***How would students have made it so that people wouldn't fall off? Could you freeze a rope onto the block to hang on to?***

One solution slide owners came up with was to offer guides familiar with the wily ways of the sleds to help riders navigate safely to the bottom: for a small fee, of course. However, it wasn't until the French picked up on the ice slides and tried building their own that a safer system was invented.

The French businessman that brought the ice slides to France must've thought he had hit the entertainment jackpot, but he quickly found out that his country was not quite cold enough to keep the slides totally frozen. The resultant mushy ride inspired the next step in the evolution of the roller coaster, which was to put wheels on the sleds, and thus, no more ice.

However, accidents were still just as much of a problem as they were with the ice slides. That's when the idea for a track was finally hit upon. ***Ask students, how might a track have made it any safer****?*

In 1817, Les Montagnes Russes a Bellevilles (The Russian Mountains of Bellevilee), a ride that locked the sleds' wheels into a track, became the world's first roller coaster. In that same year, The Aerial Walk, a coaster ride that featured a heart-shaped track, was also unveiled. The two tracks of this ride would fan out from the launch tower and meet again at the lift hill. It was these two rides, with their cars firmly locked onto a guiding track, which set the stage for all roller coasters to come. The next move toward today's modern roller coasters would be made across the Atlantic in the United States.

Write that Down! Writing Prompt Ideas

Catherine the Great is being led by a procession of mounted guardsmen, towards the temporary 80-foot-tall 'ice mountain.' A vast crowd waits below, watching their Empress in awe, their hats off and some bow their heads. She sits in the carved ice boat on the pile of hay and grips the rope and looks at you. It's your job to send careening down the slope, a fifty degree drop on packed ice and snow. What happens?

Listen Up! Why do we like getting scared?

Have students work on those auditory skills and take a listen to this podcast episode at brainson.org. *As always, please pre-listen to all podcasts to ensure appropriateness for your students' ages and sensitivities.*

Haunted houses, roller coasters, bungee jumping - what is it that makes us like being scared?

Spooky stuff may make you cover your eyes in fright, but many of us peek through our fingers to get another glimpse. Why are we drawn to things that make us jump?

In this episode, we'll find out how fear can actually be fun. We visit a scientist who helps design haunted houses for ultimate scares, chat with an author who writes ghost stories about how he crafts the creepy crawlies, and play a rousing game of Name That Phobia!

brains on!

Watch this! Why is being scared so fun?

Now, have students compare what they learned from the scientists behind Brains On and see if it agrees with this TedEd lesson by Margee Kerr. As always, please pre-watch all videos to ensure appropriateness of content for your students' ages and sensitivities. If you don't feel it's appropriate, skip parts, mute it, or don't show it.

"At this very moment, people are lining up somewhere to scare themselves, be it with a thrill-ride or a

horror movie. In fact, in October 2015 alone, about 28 million people visited a haunted house in the US. But you might wonder: What could be fun about being scared? Margee Kerr examines the biology and psychology behind what makes fear so fun."

Discuss: What did students learn that was similar between the two resources? What did students learn that was different? Did they agree with one more than the other? Do they like being scared?

Note: While high-speed loop-to-loop coasters and haunted houses are commercial hits of the 20th and 21st centuries, people have been scaring themselves and each other since the birth of the species. This has occurred through all kinds of methods such as storytelling, jumping off cliffs, and popping out to startle each other from the recesses of some dark cave. And we've done this for reasons other than fun: inciting fear is very effective at building group solidarity, teaching the next generation about what to fear and how to survive, and to control behavior. For a more comprehensive history of how we've scared ourselves, students can check out SCREAM: Chilling Adventures in the Science of Fear.[1]

Write that Down! Writing Prompt Ideas

Write an "I Can't Ride a Roller Coaster Today!" Poem

Here's a type of poem that absolutely anybody can write, even if you're sure that you have no idea how to write a poem. That's because it's a poem full of excuses! You won't even have to think up a title for this poem, since you can use the very first line as the title.

The key to success in writing this type of poem is to let your imagination go wild. Your poem might start off with an ordinary excuse, but as the poem goes on, the excuse can get crazier and crazier.

Here are a few different first lines you could use to begin your poem:

- I can't ride a roller coaster.
- I must ride a roller coaster.
- I don't know how to ride a coaster.
- I despise riding roller coasters.
- I want to ride a roller coaster.
- My mom said to ride a roller coaster.

So, let's begin! Try using this as your first line: "I can't ride a coaster today."

Now, choose a very ordinary excuse for why you can't possibly ride a coaster right now. For example, you might decide to say that you can't ride a coaster because you don't have a ticket to get on the ride.

[1] https://ed.ted.com/lessons/why-do-we-like-to-scare-ourselves-margee-kerr#digdeeper

Next, think of a really outrageous reason why you don't have a ticket. What if it was because your backpack had been set on fire? Here's how your poem might start:

I can't ride a coaster today.
You'll think that I'm a liar,
but my ticket went up flames.
My backpack is on fire!

That's a good start. Now the reader of your poem will be wondering how in the world your bookbag was set on fire. In the rest of the poem, you can tell the story of how it happened. Perhaps a fire-breathing dragon wandered into the amusement park. Maybe aliens blasted it with a laser. Maybe you accidentally dropped it in a volcano. Your poem could end up being as long or short as you want, depending on how long it takes to tell your outrageous story.

Be sure to end your poem with a line or two that reminds the reader how impossible it is for you to ride a coaster today!

It's fun to use rhymes to make this type of poem. Often, thinking of rhyming words can help to suggest crazy things that might happen next in the poem. But it's also okay to use free verse (a type of poetry without end rhymes). A free verse poem could start with the words "I can't ride a roller coaster because…" and then list all the reasons it's impossible. End the poem with a line stating that it is obviously impossible to ride a roller coaster right now.

Additional ideas:

Option One:

What's the craziest phobia you can think of? There's probably a name for it! Like, Optophobia: Fear of opening one's eyes. Or, a little nervous about going to Grandma's house? Syngenesophobia: Fear of relatives.
What do you think would help you get over a fear?

Option Two:

People across the globe enjoy engaging in thrilling and scary activities. How do you think culture influences engagement with thrills and chills? Besides physical injury, what are the consequences of this type of engagement?

Standards:

K

- W.K.7. Take part in shared research and writing projects.
- RI.K.9. With prompting and support, identify basic similarities in and differences between two texts on the same topic (e.g., in illustrations, descriptions, or procedures).
- RI.K.8. With prompting and support, identify the reasons an author gives to support points in a text.
- RL.K.9. With prompting and support, compare and contrast the adventures and experiences of characters in familiar stories.
- RI.K.2. With prompting and support, identify the principal topic and retell key details of a text.
- RL.K.10. Actively engage in group reading and listening activities with purpose and understanding.
- SL.K.2. Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- RL.K.3. With prompting and support, identify characters, settings, and major events in a story.
- RI.K.3. With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
- RI.K.4. With prompting and support, ask and answer questions about unknown words in a text.
- RI.K.5. Identify the front cover, back cover, and title page of a book.
- RI.K.6. Name the author and illustrator of a text and define the role of each in presenting the ideas or information in a text.

1

- W.1.7. Take part in shared research and writing projects.
- W.1.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- RL.1.9. Compare and contrast the adventures and experiences of characters in stories.
- SL.1.2. Ask and answer questions about key details in an oral, digital, or visual text.
- RL.1.3. Describe characters, settings, and major events in a story, using key details.
- RL.1.2. Retell stories, including key details, and demonstrate understanding of their central message or lesson.
- RI.1.2. Identify the main topic and retell key details of a text.
- RL.1.1. Ask and answer questions about key details in a text.
- RL.1.7. Use illustrations and details in a story to describe its characters, setting, key ideas, or events.
- RI.1.6. Distinguish between information provided by pictures or other illustrations and information provided by the words in a text.

- RL.1.6. Identify who is telling the story at various points in a text.
- RI.1.9. Identify basic similarities in and differences between two texts on the same topic.

2

- W.2.7. Take part in shared research and writing projects.
- RL.2.6. Acknowledge differences in the points of view of characters.
- SL.2.2. Recount or describe key ideas or details from a text read aloud or information presented orally.
- RL.2.5. Describe the overall structure of a story, including describing how the beginning introduces the story and the ending concludes the action.
- RI.2.6. Identify the main purpose of a text, including what the author wants to answer, explain, or describe.
- RL.2.7. Use information gained from the illustrations and words in a print or digital text to demonstrate understanding of its characters, setting, or plot.
- RI.2.9. Compare and contrast the most important points presented by two texts on the same topic.
- RL.2.3. Describe how characters in a story respond to major events and challenges.
- RI.2.3. Describe the connection between a series of historical events, scientific ideas or concepts
- RL.2.1. Ask and answer such questions as who, what, where, when, why, and how to show an understanding of key details in a text.

3

- W.3.7. Conduct and take part in short research projects that build knowledge about a topic.
- SL.3.2. Determine the main ideas and supporting details of a text read aloud.
- RL.3.4. Determine the meaning of words and phrases as they are used in a text, distinguishing literal from nonliteral language.
- RL.3.1. Ask and answer questions to show understanding of a text, referring explicitly to the text as the basis for the answers.
- RL.3.3. Describe characters in a story (e.g., their traits, motivations, or feelings) and explain how their actions contribute to the sequence of events.
- RI.3.2. Determine the main idea of a text; recount the key details and explain how they support the main idea.
- RI.3.3. Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.
- RL.3.7. Explain how specific aspects of a text's illustrations contribute to what is conveyed by the words in a story (e.g., create mood, emphasize aspects of a character or setting).
- RI.3.7. Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why, and how key events occur).

- RI.3.9. Compare and contrast the most important points and key details presented in two texts on the same topic.
- RL.3.3. Describe characters in a story (e.g., their traits, motivations, or feelings) and explain how their actions contribute to the sequence of events.
- 7.Inq.3 Maintain a science notebook that includes observations, data, diagrams, and explanations.

4

- W.4.7. Conduct and take part in short research projects that build knowledge through investigation of different aspects of a topic.
- RL.4.6. Compare and contrast the point of view from which different stories are narrated.
- RI.4.3. Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
- RL.4.1. Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- RI.4.2. Determine the main idea of a text and explain how it is supported by key details; summarize the text.
- RL.4.3. Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text (e.g., a character's thoughts, words, or actions).
- RL.4.4. Determine the meaning of words and phrases as they are used in a text, including those that allude to significant characters found in mythology (e.g., Herculean).
- RI.4.5. Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.
- RL.4.7. Make connections between the text of a story or drama and a visual or oral presentation of the text, identifying where each version reflects specific descriptions and directions in the text.
- RI.4.7. Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

5

- W.5.7. Conduct and take part in short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- RI.5.3. Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.
- RL.5.2. Determine a theme of a story, drama, or poem from details in the text, including how characters in a story or drama respond to challenges.
- RL.5.3. Compare and contrast two or more characters, settings, or events in a story or drama, drawing on specific details in the text (e.g., how characters interact).
- RL.5.1. Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

- RL.5.4. Determine the meaning of words and phrases as they are used in a text, including figurative language such as metaphors and similes.
- RL.5.6. Describe how a narrator's or speaker's point of view influences how events are described.
- RI.5.6. Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent.
- RL.5.7. Analyze how visual and multimedia elements contribute to the meaning, tone, or beauty of a text (e.g., graphic novel, multimedia presentation of fiction, folktale, myth, poem).

6

- W.6.7. Conduct and take part in short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- W.6.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- RL.6.9. Compare and contrast texts in different forms or genres (e.g., stories and poems; historical novels and fantasy stories) in terms of their approaches to similar themes and topics.
- RL.6.1. Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- RI.6.3. Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes).
- RL.6.2. Determine a theme or central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.
- RL.6.5. Analyze how a particular sentence, chapter, scene, or stanza fits into the overall structure of a text and contributes to the development of the theme, setting, or plot.
- RI.6.6. Determine an author's point of view or purpose in a text and explain how it is conveyed in the text.
- RL.6.7. Compare and contrast the experience of reading a story, drama, or poem to listening to or viewing an audio, video, or live version of the text, including contrasting what they "see" and "hear" when reading the text to what they perceive when they listen or watch.
- RI.6.7. Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
- RL.6.9. Compare and contrast texts in different forms or genres (e.g., stories and poems; historical novels and fantasy stories) in terms of their approaches to similar themes and topics.
- RI.6.9. Compare and contrast one author's presentation of events with that of another (e.g., a memoir written by and a biography on the same person).
- RL.6.4. Determine the meaning of words and phrases as they are used in a text,
    - a) including figurative and connotative meanings;
    - b) analyze the impact of a specific word choice on meaning and tone.

7

- RI.7.8. Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
- RI.7.9. Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
- RI.7.6.a) Determine an author's point of view or purpose in a text.
- RI.7.7. Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium's portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).
- RL.7.4. Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of rhymes and other repetitions of sounds (e.g., alliteration) on a specific verse or stanza of a poem or section of a story or drama.
- RL.7.1. Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- RL.7.3. Analyze how particular elements of a story or drama interact (e.g., how setting shapes the characters or plot).
- RL.7.9. Compare and contrast a fictional portrayal of a time, place, or character and a historical account of the same period as a means of understanding how authors of fiction use or alter history.
- RI.7.9. Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
- RI.7.3. Analyze the interactions between individuals, events, and ideas in a text (e.g., how ideas influence individuals or events, or how individuals influence ideas or events).
- W.7.7. Conduct and participate in short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- RI.7.9. Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- RI.7.7. Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium's portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).
- RI.7.8. Trace and evaluate the argument and specific claims in a print or digital text, assessing whether the reasoning is sound, and the evidence is relevant and sufficient to support the claims.
- RL.7.6. Analyze how an author develops and contrasts the points of view of different characters or narrators in a text.
- RL.7.2. Determine a theme or central idea of a text and analyze its development over the course of the text; provide an objective summary of the text.

- RL.7.1. Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
- RL.7.3. Analyze how particular elements of a story or drama interact (e.g., how setting shapes the characters or plot).
- RI.7.3. Analyze the interactions between individuals, events, and ideas in a text (e.g., how ideas influence individuals or events, or how individuals influence ideas or events).

8

- W.8.7. Conduct and participate in short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- RL.8.5. Compare and contrast the structure of two or more texts and analyze how the differing structure of each tex t contributes to its meaning and style.
- RI.8.9. Analyze a case in which two or more texts provide conflicting information on the same topic and identify where the texts disagree on matters of fact or interpretation.
- RI.8.7. Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.
- RL.8.6. Analyze how differences in the points of view of the characters and the audience or reader (e.g., created through the use of dramatic irony) create such effects as suspense or humor.
- RI.8.6. Determine an author's point of view or purpose in a text and analyze how the author acknowledges and responds to conflicting evidence or viewpoints.
- RL.8.4. Determine the meaning of words and phrases as they are used in a text, including figurative and connotative meanings; analyze the impact of specific word choices on meaning and tone, including analogies or allusions to other texts.
- RL.8.3. Analyze how particular lines of dialogue or incidents in a story or drama propel the action, reveal aspects of a character, or provoke a decision.
- RL.8.2. Determine a theme or central idea of a text and analyze its development over the course of the text, including its relationship to the characters, setting, and plot; provide an objective summary of the text.
- SCRE.ETS3:10-Create a journal and/or lab notebook for recording qualitative and quantitative data.

Rushing Ice Riders

Ice cubes are small enough to hold and pass, yet slippery enough to slide easily. That makes them naturally fun when used as sleds on a simple roller coaster. Get several boards or stiff sheets of cardboard, ex. from a box and create separate sections on it so that you can put multiple different racers on the same board. Have students create their ice cube sleds and slide them down the board at different times. Record the time of how long it took each team's ice cube to slide down the board and whether they lost their passenger.

Materials:

- Ice Cubes
- Paper plates
- Salt
- Other available construction materials (ex. craft foam, cloth, etc.)
- Cardboard covered in wax paper, outside slide, tray, or other materials to form a ramp.
- Stopwatch
- Small plastic figurines, ex. the size that would be on cupcakes
- Optional: Sand for the end of the ramp
- Optional: Bubble wrap, felt, or other materials to test during friction variation

Present the problems to the students: **What size of sled and what materials will make an ice cube slide down the ramp or slide the fastest possible without losing its passengers?**

Divide students into groups, pairs, or have them work individually. Give each group some of the materials to work with. **What solutions can they come up with? Do they discover the connection between salt and ice?**

For younger students: If students want to build bigger sleds, demonstrate that shaking a little salt on the ice to act as glue as the salt melts the ice a little to help the cold cubes stick to one another.

To test: If using a flat surface, tilt it at an angle on a table. Line the ice cube sleds up, keeping them in place with a yardstick and then let them loose all at once for a fun

and crazy race. The ice sleds melt, turn, spin and slide at the whimsy of the weather and heat. Your room probably won't be as cold as Russia! Some zoom by and knock others out of the way.

Retest: Whose method was most effective? What did students learn from their first efforts? What ideas do they have for improvements? Does salt help things stick together? Have students rebuild and retest.

Observe: Do partially melted ice cubes travel down the slide more slowly than the ice cubes that have not yet melted much?

Use caution to not slip on puddles of melted water or dropped ice cubes!

Variation: Feeling the Friction

Friction and gravity are in a constant battle much of the time. Challenge students to determine if and/or how we can overcome the friction force (which makes us lose kinetic energy (energy of motion) by turning it into heat energy) by reducing the amount of friction and allowing gravity to do its work.

Divide the tray or angled surface into three lengthways and choose two different surfaces/materials to test. The third surface will be the smooth inside of the tray or the ramp/slide.

Time how long it takes the ice cube to reach the bottom on each surface.

For more reliable results, repeat each slide three times and find the average time for each.

Standards:

K

- K.LS1.3 Explain how humans use their five senses in making scientific findings.
- K.PS1.3 Construct an evidence-based account of how an object made of pieces can be disassembled and made into a new object.
- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- 7.11.1 Explore different ways that objects move.
- W.K.7. Participate in shared research and writing projects.
- K.ETS1.1 Ask and answer questions about the scientific world and gather information using the senses.
- K.ETS1.2 Describe objects accurately by drawing and/or labeling pictures.
- K.ETS2.1 Use appropriate tools to make observations and answer testable scientific questions.
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts.

1

- W.1.7. Participate in shared research and writing projects.
- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- ETS1:1 Solve scientific problems by asking testable questions, making short-term and long-term observations, and gathering information.
- ETS1: 2 1) Use appropriate tools to make observations and answer testable scientific questions.

2

- W.2.7. Participate in shared research and writing projects.
- RI.2.3. Describe the connection between a series of historical events, scientific ideas or concepts
- 2.ETS1.2 Develop a simple sketch, drawing, or physical model that communicates solutions to others.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 2.ETS1.3 Recognize that to solve a problem, one may need to break the problem into parts, address each part, and then bring the parts back together
- 2.ETS1.4 Compare and contrast solutions to a design problem by using evidence to point out strengths and weaknesses of the design.
- 2.ETS2.1 Use appropriate tools to make observations, record data, and refine design ideas.

3

- 3.ETS2.1 Identify and demonstrate how technology can be used for different purposes.
- W.3.7. Conduct short research projects that build knowledge about a topic.
- RI.3.3. Describe the connection between a series of historical events, scientific ideas or concepts.
- 7.Inq.3 Maintain a science notebook that includes observations, data, diagrams, and explanations.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 7.11.1 Plan an investigation to illustrate how changing the mass affects a balanced system.
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 7.11.2 Demonstrate how changing the mass affects a balanced system.

4

- 4.ETS1.1 Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.
- 4.ETS2.1 Use appropriate tools and measurements to build a model.
-
- 7.11.1 Recognize that the position of an object can be described relative to other objects or a background.
- 7.11.2 Design a simple investigation to demonstrate how friction affects the movement of an object.
- 7.11.3 Investigate the relationship between the speed of an object and the distance traveled during a certain time period.
- 7.11.1 Identify the position of objects relative to fixed reference points.
- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion.
- 7.11.3 Complete a coordinate graph, table, or diagram to describe the relative positions of objects.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.
- 7.11.5 Design and implement an investigation to determine that the speed of an object is equal to the distance traveled over time.
- 7.11.1 Describe the position of an object relative to fixed reference points.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- 4.ETS2.2 Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.

- 4.ETS2.3 Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones).
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.

5

- 5.ETS2.3 Identify how scientific discoveries lead to new and improved technologies.
- 5.ETS1.1 Research, test, re-test, and communicate a design to solve a problem.
- 7.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled.
- 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
- 7.11.2 Explain the relationship that exist among mass, force, and distance traveled.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
- 5.ETS1.2 Plan and carry out tests on one or more elements of a prototype in which variables are controlled and failure points are considered to identify which elements need to be improved. Apply the results of tests to redesign the prototype.
- 5.ETS1.3 Describe how failure provides valuable information toward finding a solution.
- 5.ETS2.2 Use appropriate measuring tools, simple hand tools, and fasteners to construct a prototype of a new or improved technology.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

6

- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

7

- W.7.7. Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- 7.11.3 Distinguish between speed and velocity.
- 7.11.4 Investigate how Newton’s laws of motion explain an object’s movement.
- 7.11.3 Summarize the difference between the speed and velocity based on the distance and amount of time traveled.

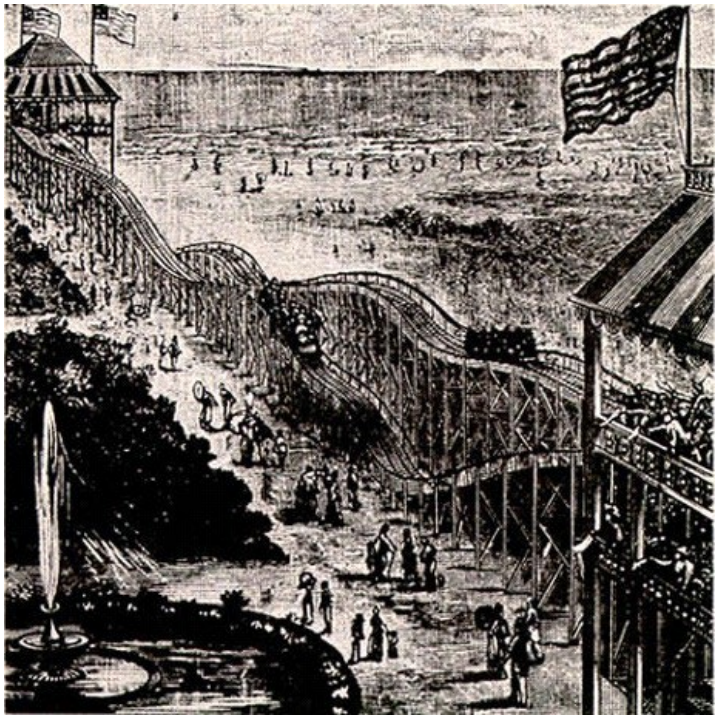
- 7.11.4 Recognize how a net force impacts an object's motion.
- 7.11.3 Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

8

- 7.12.5 Recognize that gravity is the force that controls the motion of objects.
- 7.12.5 Explain the difference between mass and weight.
- 7.12.7 Explain how the motion of objects is affected by gravity.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
- SCRE.ETS3:10-Use a scientific journal and/or lab notebook for recording qualitative and quantitative data.

Man-made Mountains

The name *Russian Mountains* to designate a roller coaster is preserved in most Latin languages. Ironically, the Russian term for roller coasters is американские горки("amerikanskie gorki") "American Mountains".



In 1827, a mining company in Summit Hill, Pennsylvania constructed the Mauch Chunk gravity railroad, an 8.7 mile long (14 km) downhill track used to deliver coal to Mauch Chunk (now known as Jim Thorpe), Pennsylvania. By the 1850s, the "Gravity Road" (as it became known) was providing rides to thrill-seekers for 50 cents a ride. [Today it's $104 per person for a one-day pass into Disneyland. The most expensive US amusement park is Busch Gardens at $126 per person for one day. The average ticket price of other parks hovers around $60-$80 per person. And modern rides only last about 1-4 minutes.]

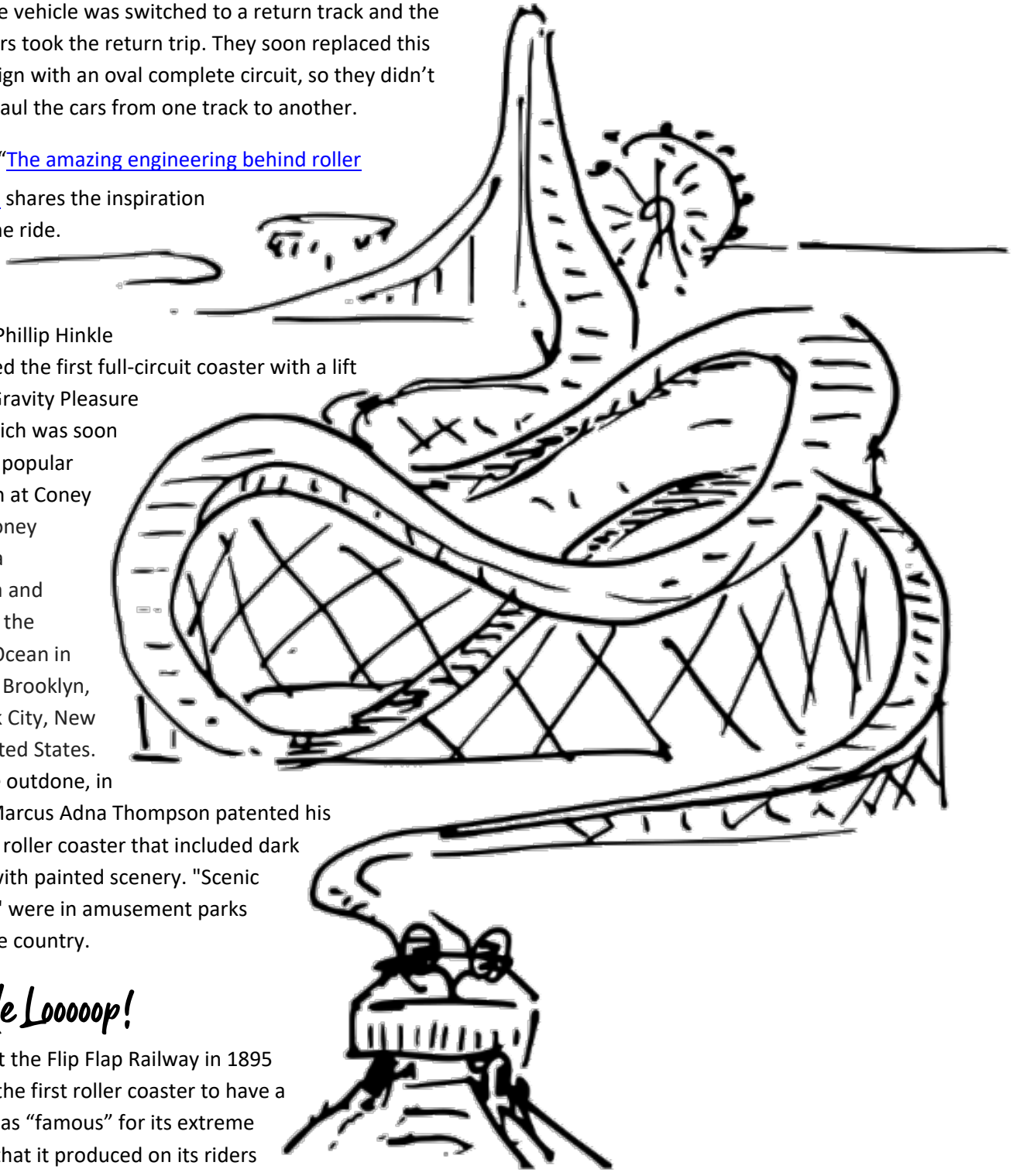
Railway companies used similar tracks to provide amusement on days when ridership on the train was low. Railway companies, in search of ways to keep passenger usage up on the weekends, set up parks here at the end of the rail lines and introduced weekend and summer activities. The first rides at these parks were carousels, but in 1884, they introduced the first gravity switchback train. This was the first true roller coaster in America.

Using this idea as a basis, LaMarcus Adna Thompson began work on a gravity Switchback Railway that opened at Coney Island in Brooklyn, New York, in 1884.

Charging only 5 cents per ride, he made hundreds of dollars every day. Passengers climbed to the top of a platform and rode a bench-like car down the 600 ft (180 m) track up to the top of another tower,

where the vehicle was switched to a return track and the passengers took the return trip. They soon replaced this track design with an oval complete circuit, so they didn't have to haul the cars from one track to another.

Watch This! "The amazing engineering behind roller coasters" shares the inspiration behind the ride.



In 1885, Phillip Hinkle introduced the first full-circuit coaster with a lift hill, the Gravity Pleasure Road, which was soon the most popular attraction at Coney Island. Coney Island is a peninsula and beach on the Atlantic Ocean in southern Brooklyn, New York City, New York, United States. Not to be outdone, in 1886 LaMarcus Adna Thompson patented his design of roller coaster that included dark tunnels with painted scenery. "Scenic Railways" were in amusement parks across the country.

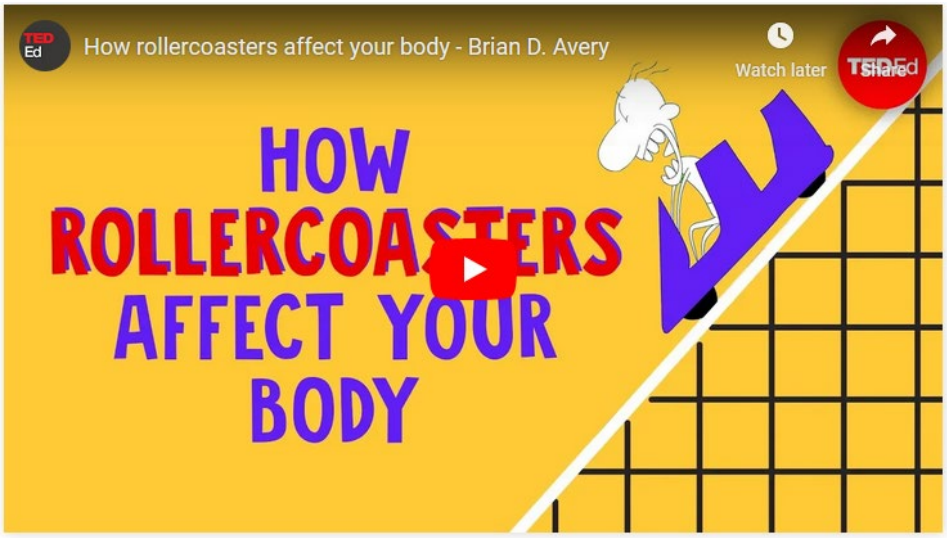
Loop de Looooop!

They built the Flip Flap Railway in 1895 and was the first roller coaster to have a loop. It was "famous" for its extreme g-forces that it produced on its riders of approximately 12gs. The circular nature of the coaster's loop along with its small diameter of 25 feet caused riders to experience neck injuries from whiplash.

There are some interesting accounts where riders are hanging on for dear life in a death grip on the sides of the railcar and surviving a 12g ride which is absolutely crazy and incredibly dangerous! Modern looping roller coasters all use teardrop-shaped loops to reduce the g-forces. The Flip Flap Railway was the last coaster to use a truly circular loop.[2]

Watch This! Watch an early film clip of it in operation here.

Watch This!



Have students learn more about the Flip Flap coaster and modern coasters by watching the excellent TedEd lesson, "How Rollercoasters Affect Your Body." *As always, please pre-watch all videos to ensure appropriateness for your students' ages and sensitivities.*

In 1895, crowds flooded Coney Island to see America's first-ever looping coaster: the Flip Flap Railway. But it's thrilling flip caused cases of severe whiplash, neck injury and even ejections. Today, coasters can pull off far more exciting tricks and do it safely. Brian D. Avery investigates what rollercoasters are doing to your body and how they've gotten scarier and safer at the same time.

[2] https://www.arborsci.com/cool/pocketlab-voyager-2/

And/or this! Why roller coaster loops aren't circular

"The G forces were out of this world."

If you've ever been on a modern looping roller coaster, you've probably experienced a thrilling, safe, and mostly comfortable ride. But this wasn't always the case. Just over 100 years ago, loop-the-loops were painful, not sturdy, and much more dangerous than they are today. Between the 1840s and early 1900s, loops on roller coasters were perfectly circular — meaning riders would go from traveling in a straight line to immediately moving into a curve.

This rapid onset of curvature caused extreme G force spikes that rattled passengers to their core. Once the danger of extreme G force was revealed, these circular loop coasters were shut down. Looping coasters wouldn't find success again until the 1970s with a new loop shape, new materials, many more cars — and, thankfully, fewer G's. In this video, we break down all the advancements that helped make looping coasters the popular ride they are today.

Let's Get Physics-al![3]

How much energy does a roller coaster need to go through a loop without getting stuck? Students build their own marble loop coaster in this project and find out!

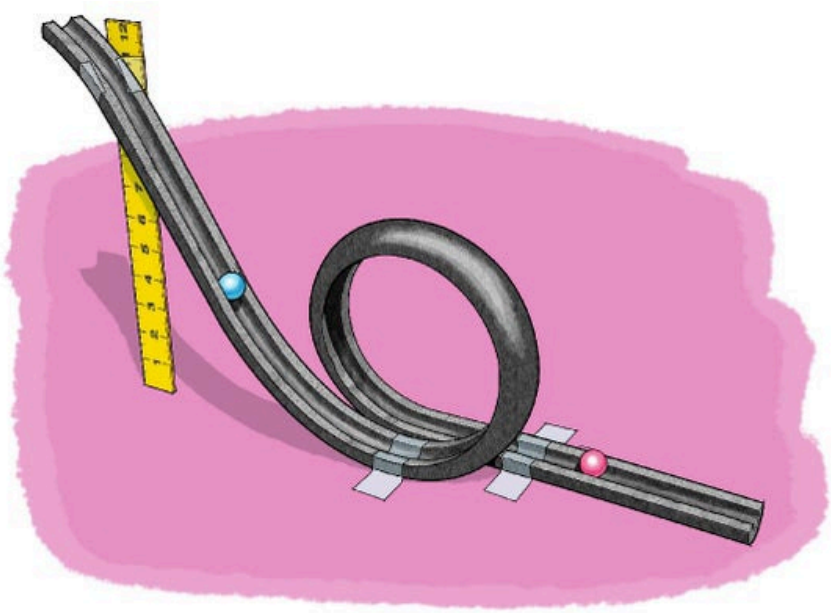


Image Credit: Scientific American and Science Buddies

Background Information:

Roller coasters rely on two types of energy to operate: gravitational potential energy and kinetic energy. Gravitational potential energy is the energy an object has stored because of its mass and its height off the ground. Kinetic energy is the energy an object has because of its mass and its velocity.

When a roller-coaster car reaches the very top of its first big hill it has a lot of potential energy because it is very high off the ground. It moves over the top of the hill very slowly, so it has almost no kinetic energy. Then it drops down the other side of the hill and starts going very fast as its height rapidly decreases. The potential energy is converted to kinetic energy. This process repeats as the car goes through hills, loops, twists and turns. Whenever it goes up it gains more potential energy with height but loses kinetic energy as it slows down. Energy is never created or destroyed—it just converts from one form to another. This principle is known as conservation of energy.

We know, however, that a roller coaster doesn't keep going forever. Eventually it slows down because of friction (a combination of air resistance and contact with the track). If energy isn't created or destroyed, where does that energy go? It is converted into heat. This is why you can rub your hands together to warm them up—friction converts energy from your moving hands into heat!

Ask students: Does conservation of energy restrict a roller coaster's movement? For example, can a roller coaster ever go through a loop that is taller than its initial hill? Try this project to find out![4]

[3] A physics project from Science Buddies By Science Buddies, Ben Finio on November 14, 2019
[4] Information gathered from https://www.scientificamerican.com/article/make-a-marble-roller-coaster/

Materials for each group:

- Foam pipe insulation (1.5 inches in diameter, at least 6 feet in length—or more if you would like to eventually add more features to your roller coaster). Variations to try: baby proofing edge guard or even pool noodles can also work.
- At least one glass marble (or other small heavy ball that will roll easily through the foam insulation, such as a metal ball bearing)
- Masking tape
- Utility knife: Teacher uses the utility knife to cut the pipe insulation in half lengthwise, forming two U-shaped channels.
- Table or chair
- Measuring devices as appropriate for grade level: rulers, tape measure, yardstick, stopwatches, timers, etc.
- Pencils & paper to record data

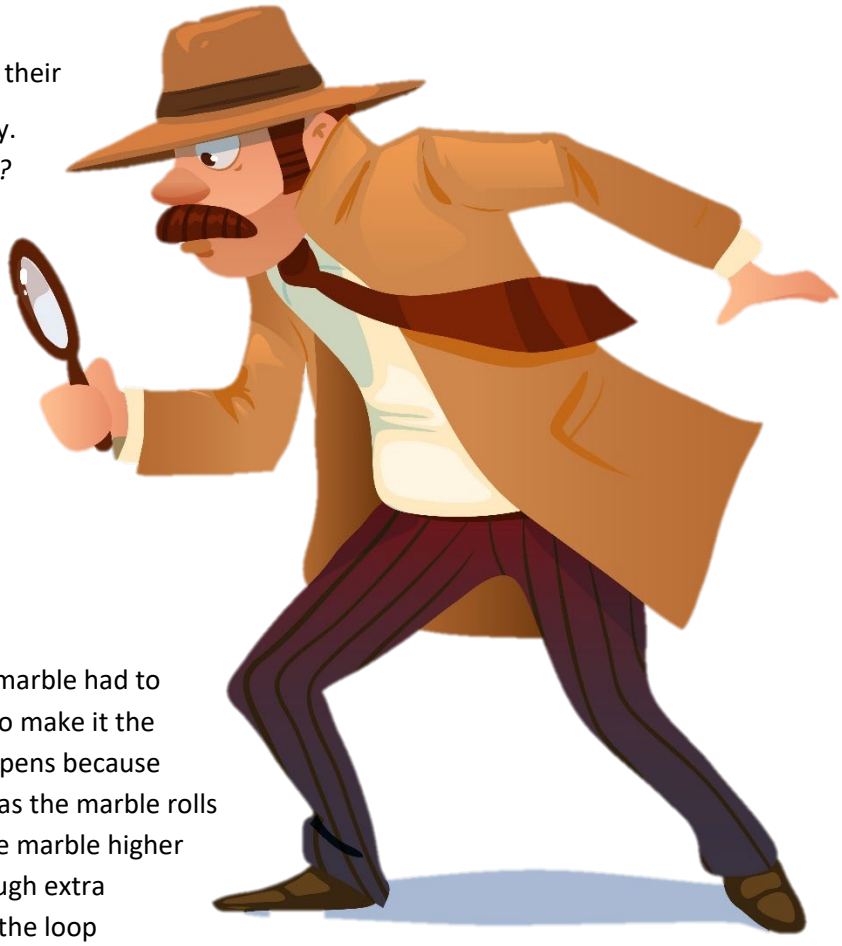
Student Instructions:

1. Curl one end of a piece of pipe insulation into a loop, roughly 1 foot in diameter.
2. Use masking tape to hold the loop in place and tape it to the floor on both sides of the loop. Make sure tape is not blocking the inside of the channel (it's okay to have tape on the inside, just make sure it is pressed flat against the foam and will not block the marble).
3. Tape the free end of the pipe insulation to a table or chair, forming a large hill leading down to the loop.
4. Place your marble a few inches from the bottom of the hill and release it. *Does the marble make it through the loop?*
5. Move your marble a few inches up the track and release it again. Keep repeating this process until the marble goes the whole way through the loop. *How high does the starting position need to be before the marble goes through the loop? Is it lower, the same height or higher than the top of the loop?* Keep track of the heights and measurements.
6. If you need to make your hill higher, tape the two pieces of pipe insulation together end-to-end, and keep trying from greater heights. Keep track of the heights and measurements.
7. *Can you describe how energy is changing throughout your marble's journey down the "coaster"?*

Extra Challenge: Have students add other features to their roller coaster, such as twists, turns and spirals. *How high does the hill need to be for the marble to make it through all the features without stopping?*

Extra Challenge: Have students watch their marble closely and observe its velocity. *Where is the marble going the fastest? Where is it going the slowest?*

Extra Challenge: Add a straight piece of track to the end of your roller coaster at the bottom of the loop. *How far does the marble roll before friction brings it to a stop? Measure and record the distance.*



Observations and Results

Students should have found that the marble had to start higher than the top of the loop to make it the entire way through the loop. This happens because some energy is always lost to friction as the marble rolls down the track. They need to start the marble higher than the top of the loop so it has enough extra energy to get the entire way through the loop without stopping.

If you watch the marble closely, you might be able to see that it is going the fastest right at the bottom of the hill before it enters the loop.

As the marble rolls down the hill its potential energy is converted to kinetic energy (its height decreases, but its velocity increases). When the marble goes back up the loop its height increases again and its velocity decreases, changing kinetic energy into potential energy. If you added a straight piece of track at the bottom of your loop, you could observe how the marble gradually rolled to a stop because of friction.

The more features you add to your track, the more initial potential energy the marble will need to make it through all of them without stopping. You might notice that the pipe insulation flexes and bends as the marble zips around—this can also cause the marble to lose some energy (it takes energy to bend the

insulation). Making your track more rigid by taping it to supports (such as boxes or pieces of furniture) will help avoid this type of energy loss, allowing your marble to go farther.[5] Try it!

Additional information found at Science Buddies: Marble Roller Coaster: How Much Height to Loop the Loop?

[5] https://www.scientificamerican.com/article/make-a-marble-roller-coaster/

Standards:

K

- K.LS1.3 Explain how humans use their five senses in making scientific findings.
- K.PS1.3 Construct an evidence-based account of how an object made of pieces can be disassembled and made into a new object.
- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- 7.11.1 Explore different ways that objects move.
- W.K.7. Participate in shared research and writing projects.
- K.ETS1.1 Ask and answer questions about the scientific world and gather information using the senses.
- K.ETS1.2 Describe objects accurately by drawing and/or labeling pictures.
- K.ETS2.1 Use appropriate tools to make observations and answer testable scientific questions.
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts.
- RI.K.2. With prompting and support, identify the principal topic and retell key details of a text.
- RL.K.10. Actively engage in group reading and listening activities with purpose and understanding.
- SL.K.2. Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- RL.K.3. With prompting and support, identify characters, settings, and major events in a story.
- RI.K.3. With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.

1

- RL.1.9. Compare and contrast the adventures and experiences of characters in stories.
- SL.1.2. Ask and answer questions about key details in an oral, digital, or visual text.
- RL.1.7. Use illustrations and details in a story to describe its characters, setting, key ideas, or events.
- RI.1.9. Identify basic similarities in and differences between two texts on the same topic.
- W.1.7. Participate in shared research and writing projects.
- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- ETS1:1 Solve scientific problems by asking testable questions, making short-term and long-term observations, and gathering information.
- ETS1: 2 1) Use appropriate tools to make observations and answer testable scientific questions.

2

- W.2.7. Participate in shared research and writing projects.
- RI.2.3. Describe the connection between a series of historical events, scientific ideas, or concepts.
- RI.2.1. Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- RL.2.3. Describe how characters in a story respond to major events and challenges.
- 2.ETS1.2 Develop a simple sketch, drawing, or physical model that communicates solutions to others.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 2.ETS1.3 Recognize that to solve a problem, one may need to break the problem into parts, address each part, and then bring the parts back together
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- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 7.11.2 Demonstrate how changing the mass affects a balanced system.

4

- 4.ETS1.1 Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.
- 4.ETS2.1 Use appropriate tools and measurements to build a model.
- RI.4.3. Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.
- 7.11.1 Recognize that the position of an object can be described relative to other objects or a background.

- 7.11.2 Design a simple investigation to demonstrate how friction affects the movement of an object.
- 7.11.3 Investigate the relationship between the speed of an object and the distance traveled during a certain time period.
- 7.11.1 Identify the position of objects relative to fixed reference points.
- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion.
- 7.11.3 Complete a coordinate graph, table, or diagram to describe the relative positions of objects.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.
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- 4.ETS2.2 Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.
- 4.ETS2.3 Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones).
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- 5.ETS1.1 Research, test, re-test, and communicate a design to solve a problem.
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- 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
- 7.11.2 Explain the relationship that exist among mass, force, and distance traveled.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
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- 5.ETS1.3 Describe how failure provides valuable information toward finding a solution.
- 5.ETS2.2 Use appropriate measuring tools, simple hand tools, and fasteners to construct a prototype of a new or improved technology.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

6

- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

7

- W.7.7. Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- RI.7.9. Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
- RI.7.8. Trace and evaluate the argument and specific claims in a print or digital text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims.
- 7.11.3 Distinguish between speed and velocity.
- 7.11.4 Investigate how Newton's laws of motion explain an object's movement.
- 7.11.3 Summarize the difference between the speed and velocity based on the distance and amount of time traveled.
- 7.11.4 Recognize how a net force impacts an object's motion.
- 7.11.3 Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

8

- 7.12.5 Recognize that gravity is the force that controls the motion of objects.
- 7.12.5 Explain the difference between mass and weight.
- 7.12.7 Explain how the motion of objects is affected by gravity.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

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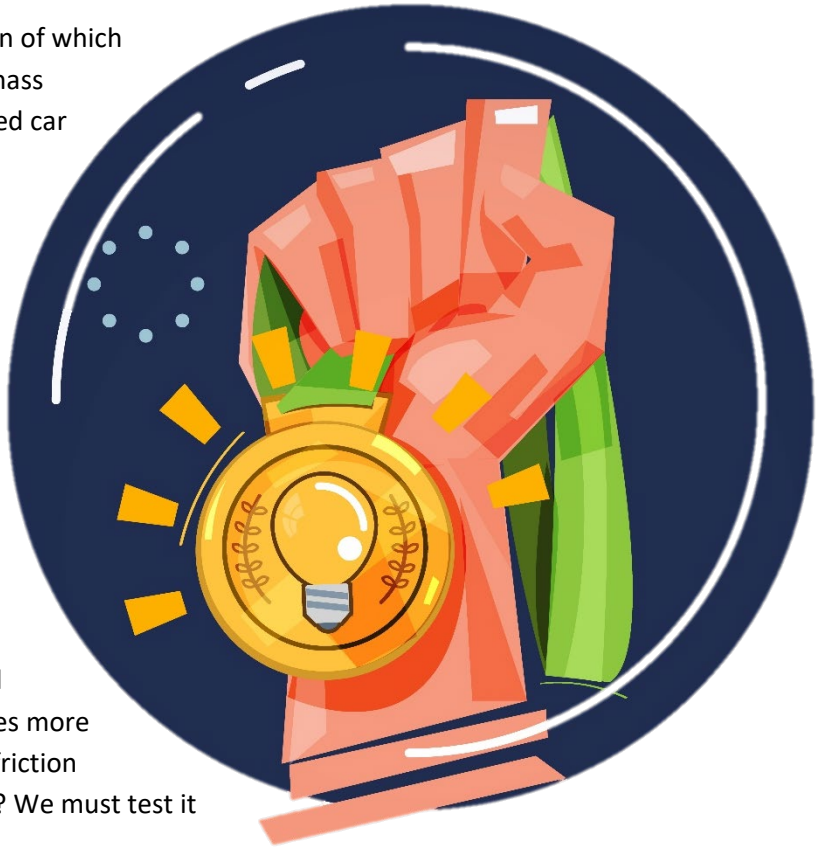
- SCRE.ETS3:10-Use a scientific journal and/or lab notebook for recording qualitative and quantitative data.

Flip! Flap! Loop the Lab!

In honor of the Flip Flap Loop de Loop let's do some Hot Wheels™ STEM projects and get a little loopy ourselves! These science experiments may feel like play, but students will explore the physics concepts of velocity, mass, momentum, friction, air resistance, centrifugal force, and more.

Matchbox Matchup: Battle of the Heavyweight Champions



This experiment helps students answer the question of which will travel farther – a car on its own, or a car with mass added to it? Students may guess that the unmodified car will travel farther because it's lighter.

It's true that a lighter object requires less force to get going because it has less inertia to overcome. However, a heavier car will gain more momentum. Momentum is "mass in motion."

The amount of momentum an object has depends on both its mass and its speed.

Ask students: Which would be easier to stop – a pigeon on roller skates or an elephant on roller skates? Definitely the pigeon!

So, we can hypothesize that the heavier car will roll farther because it has more momentum, and it takes more force to stop it. Here, the force stopping the car is friction between the wheels and the floor.] Are we correct? We must test it and see!

Materials for each group:

- Track materials, ex. Hot Wheels track, straight plastic rain gutters, boards
- Blocks or books to prop up the track
- Measuring devices, ex. rulers, yardsticks, measuring tapes
- Cars
- Three quarters
- Masking or painter's tape
- Pencils
- Paper to record data

Procedure:

Have students create a simple ramp, ex. a track made of Hot Wheels track, rain gutters, or boards propped up on blocks, for this experiment.

Have students measure and mark (using masking or painter's blue tape) how far the car traveled past the end of the ramp so that their procedure will be consistent each time.

Matchbox cars can be a little temperamental and veer to either side depending on how bent the wheels are. Have students conduct three trials of each car to be sure they are getting accurate results. Record the data!

After three trials with just the car, students will send the car down the ramp with three quarters taped to it for added weight.

For older students, have them find an average of trials 1, 2, and 3.[6]

Compare and discuss results as an entire class. What conclusions can students draw from the data? Do they think type of car, vehicle style, toy brand, or track materials affected the results?

Resource Tip: Find sample printable Data Sheets for this experiment at Frugal Fun for Boys & Girls: Hot Wheels STEM Recording Sheets. You can always have students create their own, as well.

[6] https://frugalfun4boys.com/hot-wheels-science-experiments/

It's Wheely Windy Out Here!

If a wind blows on a rollercoaster can anyone feel it? In this experiment students test the effect of air resistance on (rollercoaster) cars.

Materials for each group:

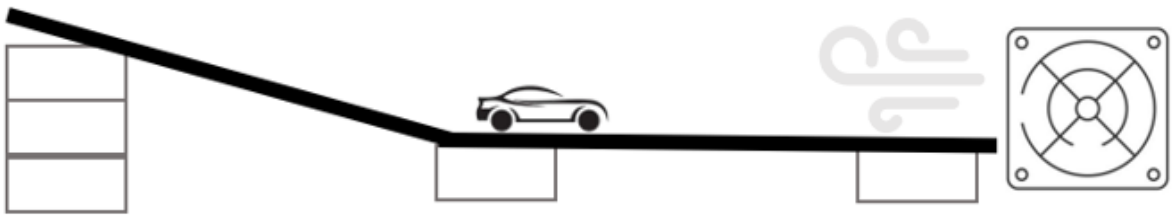
- Track materials, ex. Hot Wheels track, straight plastic rain gutters, boards, foam board, cardboard, or cardboard tubes
- Blocks, books or other items to prop up the track
- Measuring devices, ex. rulers, yardsticks, measuring tapes
- Cars
- Small box fan
- Masking or painter's tape and/or dry erase markers
- Pencils
- Paper to record data
- Optional: Quarters and tape

Procedure:

Set up a simplified wind tunnel. You'll need to align your ramp so that it's in line with the air coming from the fan. There are a variety of ways to do this with the materials suggested above and others. You can get as complex as you'd like. See an example here. Experimentation is essential to any engineering process. The method suggested below is the simplest version we've found.

Use two pieces of plastic rain gutter to create a track as illustrated below. Use two wooden blocks to prop up each end of the first section (closest to the fan). This section of the track should be level.

Then add another section of rain gutter to create the ramp part behind/leading into the flat section. The ramp should be long enough that the car stops itself before arriving at the end (with the fan OFF).

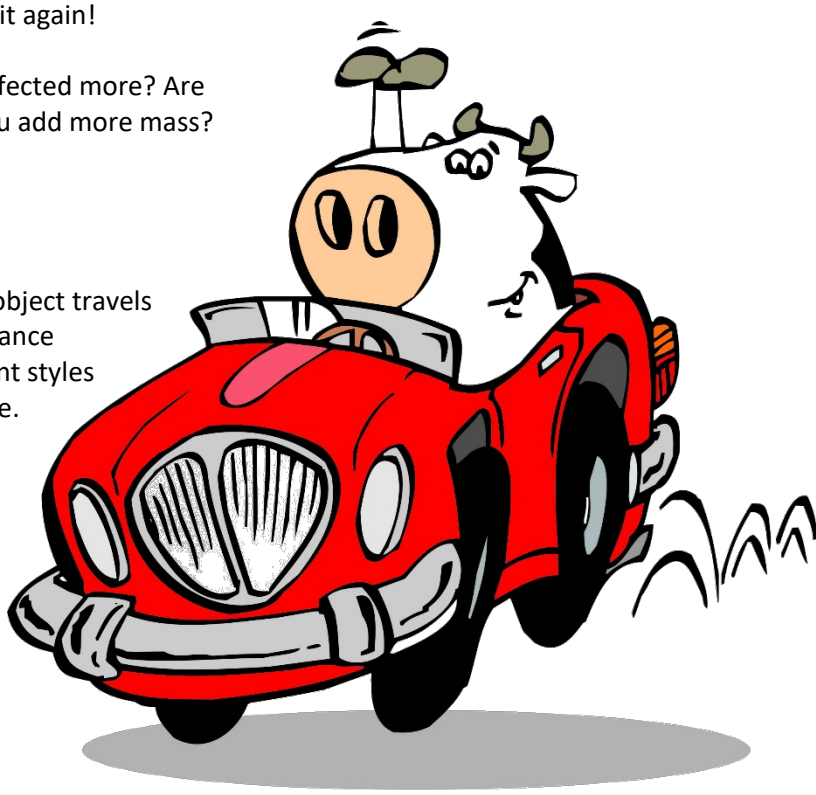


Have students use dry erase markers or tape to mark on the track where the car stops with the fan OFF. Measure the distance from the start.

Then, turn the fan on and test the same car. Have students mark where it stopped with the fan ON. Measure the distance and calculate the difference.

After each trial, you can wipe off the marker and do it again!

Test different vehicles. Are taller blockier vehicles affected more? Are heavier or lighter vehicles affected more. What if you add more mass?



Air Resistance Explanation

Air resistance is basically friction with the air. As an object travels in one direction, it experiences the force of air resistance pushing in the opposite direction. In real life, different styles of cars experience different amounts of air resistance. Think about the effects of air resistance on a boxy van versus a low profile sports car, for example!

We found that it's harder to compare the amount of air resistance caused by the shape of the car using Hot Wheels because the wheels are easily bent and can contribute more to a car's poor function than its air resistance. Also, there are big differences in the mass of these cars.[7]

Notes: If you don't have plastic rain gutters, students can create a wind tunnel by building walls on either side of some plastic track. There are a few possibilities for the walls – cardboard, LEGO bricks (the big DUPLO ones would be fastest), books, or building blocks. Have students come up with additional ideas.

We recommend rain gutters for their simplicity, and also because you can mark right on them! Students can use a dry erase marker to mark how far the car traveled.

[7] https://frugalfun4boys.com/hot-wheels-science-experiments/

Getting Loopy!

Students use Hot Wheels® loop tracks to create and test their own loop de loop rides. Can they keep the car on the track? How does friction affect the cars and their movement?

Materials for each group of 2–3 students:

- Hot Wheels™ set with loop-the-loop and ramp
- small car
- meter stick, tape measure, or other measuring device
- timing device
- masking or painter's tape
- paper and pencils to record data
- Optional: Computer interface photogates, if possible.

Tip: For most predictable results secure the track, loop-the-loop and ramp with clamps or tape. It is important to secure the track to the floor so some of the car's energy is not transformed into motion of the track.[8]

Note: The principle of conservation of energy (Energy always goes somewhere. It's never lost.) is one of the most powerful and widely used concepts in solving science related problems. Students deal with friction in these experiments in a practical way and apply it to make predictions of motion of the Hot Wheels™ car.

Challenge One: It Rubs Me the Wrong Way! (Aka Loss of energy due to friction)

Elevate both ends of the track to a height of about 1m above the floor or lab table so the track makes a widely sloped U shape with the bottom of the U secured to the floor. *It is important to secure the track to the floor so some of the car's energy is not transformed into motion of the track.* Measure the length of the track. This will be the "standard length" that test results are compared to.

[8] https://www.as.wvu.edu/phys/rotter/phys201/5_Energy/How_Hot_Are_Your_Hot_Wheels.htm

Have one team member release the car from the starting point A. Record this height (*h*1) and the height to which the car rises (*h*2) on the other end of the track. Have the students make several (at least three) trials and record their results.

Compare and Discuss:

1. What did students notice? Ex. *Friction drained off some of the energy the car started with. We could see it happen because the car didn't reach the same height on the other.*
2. For older students: What is the average height ratio, or efficiency?
3. In what unit is efficiency measured? *Efficiency is a ratio, so it has no units. The units always divide out.*

For older students: What was happening?

Friction reduces the effect of useful work and basically drains off some of the energy into a heating effect. To compare the initial height, *h*1, of the car with the final height, *h*2, is to compare the initial potential energy of the car with its potential energy on the other side of the track (because m and g are constant). An efficiency of 80% means that 80% of the initial potential energy at *h*1 transfers to potential energy at *h*2 or that 20% of the initial potential energy was lost to frictional forces. This efficiency applies only to the "standard length" of track. For a longer track, the difference in elevations would be greater.

The ratio of the final height to the initial height is equal to the ratio of potential energy transferred back into the car going up the left ramp to the potential energy the car had at the top of the right ramp at point A. Call this ratio of *h*2 to *h*1 the "efficiency" of the system for the car going from point A to point B on the track. The distance along the track from A to B is called the "standard length" so the ratio of *h*2 to *h*1 (efficiency) represents the fraction of the initial energy the car will have when it reaches point B on the track. This ratio is used in later experiments to determine how high the car must start, so it will have a predictable total amount of energy when it reaches certain points on the track.

Challenge Two: Loop the Loop

Place a loop-the-loop section in the track at about the standard length from the starting end of the track. The challenge is to predict the minimum height from which the car must start, so it will successfully travel all the way around the loop without falling away from the track.

Note: For this to take place, there must be centripetal force acting on the car as it goes around the loop. This force *Fc* must be equal to the weight of the car.

Have students make predictions on how high the car will need be lifted in order for the car to successfully travel all the way around the loop. Have them write down their hypothesis and then test it (with three trials) and track the results.

If their hypothesis wasn't accurate then have them adjust their hypothesis and retest until they're successful. What did they conclude was the optimal height?

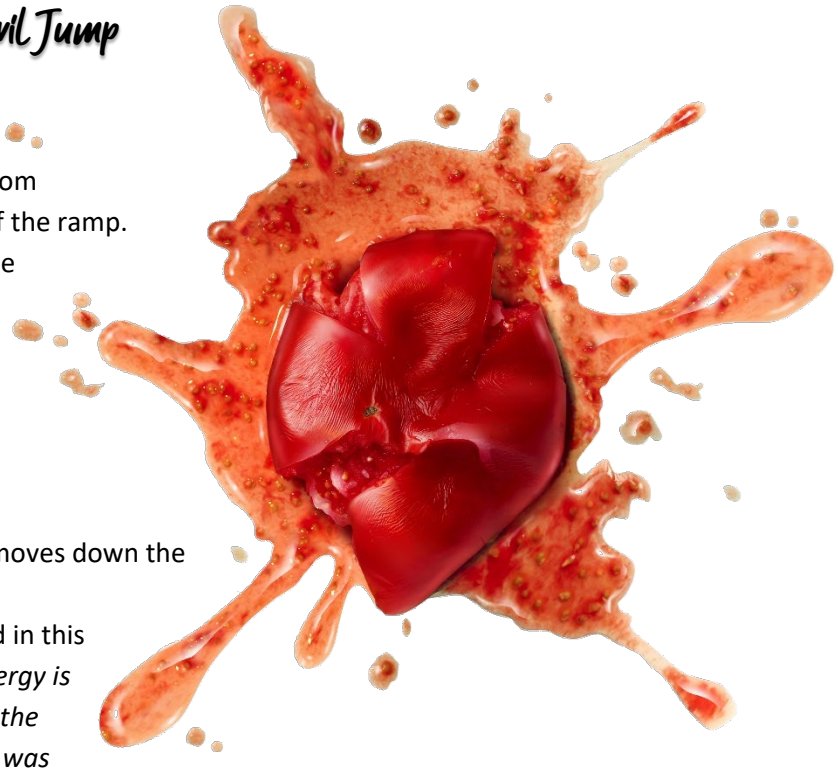
What was happening?

When the car is lifted, work is done on it, increasing its potential energy. The work done to lift it to point A equals its potential energy at point A. As the car is released, it rolls down the ramp, losing some of its potential energy, but gaining in kinetic energy. The loss in potential should equal the gain in kinetic.

At the bottom, the potential is zero, but the kinetic should be equal to what the potential was at point A. As the car enters the loop-the-loop, it loses kinetic energy but gains potential. The opposite happens on the way down. At any point, the total energy should equal the work done in lifting the car to point A.

If there were no friction, the car should start from a height, *h,* to make it around the loop. Since the system has friction, the car must start from a point just higher to make up for the frictional loss.

Challenge Three: Splat! Aka Daredevil Jump



The challenge here is to measure the range of the car's jump when you release it from a chosen height (*h*) above the launch point of the ramp. The starting point of the jump should be at the "standard length" from the release point of the car.

Discuss:

1. What did students observe?
2. Describe the energy changes as a car moves down the track and completes the jump.
3. Explain whether energy was conserved in this activity. *Within experimental error, energy is conserved. Work was done in lifting in the car. From that point on, no more work was done on the car (except friction) to change the total energy.*

Resource: Advanced Physics Instructions and diagrams for these projects are available at: How Hot are Your Hot Wheels Project by Professor Carl A. Rotter[9]

Behind the wheels:

According to *Road and Track*, "Hot Wheels is all about igniting the challenger spirit. But have you ever wondered how your favorite die-casts can complete loop after loop on your orange track? Ted Wu, Global Head of Vehicle Design at Hot Wheels, explains three factors designers need to consider when building their cars."

Mass of the car

[10]"Going through a loop is all about gravity, which is an invisible force that pulls objects toward each other, and inertia, the resistance of an object to any change in speed or motion. The more mass a car has and the higher on a ramp you start, the more gravity will push the car down the track. That speed gets it off the ground and all the way around the loop."

Wheel Type

"Did you know Hot Wheels cars come with all different wheel sizes, ranging from the mini wheels on some of our cool collectibles to the giant wheels you may have seen on our massive Monster Truck? Well, small wheels aren't as prime for completing loops, so you should look for a car with medium wheels if you want the best performance to guarantee you beat all your friends on the track. A wider wheel may also help you get more friction, or force between two surfaces that are sliding or slipping across each other, on the track."

[9] https://www.as.wvu.edu/phys/rotter/phys201/5_Energy/How_Hot_Are_Your_Hot_Wheels.htm
[10] https://www.darcymillerdesigns.com/discount.php?cid=95&shop=all+types+of+hot+wheels&g=1

"Shape of the car

"If a car has too low of a front or rear bumper or too low of a spoiler in the back, it won't be able to successfully complete a loop. We're constantly innovating to allow new cars to be able to go through loops. Take the super cool pink Beach Bomb—it could never make it through a loop, because the surfboard in the back made the van too narrow. We needed to widen the car, so we moved the surfboard to the side of the car...and voila! Some cars aren't meant for loop challenges, and that's okay! To determine how 'track compatible' a die-cast is, we put it through a series of approximately 10 tests and then give it a rating."

Try crafting your own experiments

Example: Try using different-shaped cars to see what stunts each can dominate.[12]

Write that Down! Writing Prompt Ideas

Have students write a story that goes up and down like a roller coaster! A good thing. A bad thing. Then a good thing. A bad thing. Etc... Add in a twist!

Ex. I got a bag full of money at my door. It exploded! The explosion unstuck my drawer that held my favorite photo album. My photo album went sailing out the window. […]

[11] https://hotwheels.fandom.com/wiki/Volkswagen_Beach_Bomb_Too
[12] https://www.roadandtrack.com/car-culture/entertainment/a33851290/the-science-of-hot-wheels-building-the-perfect-loop/

Standards:

K

- K.LS1.3 Explain how humans use their five senses in making scientific findings.
- K.PS1.3 Construct an evidence-based account of how an object made of pieces can be disassembled and made into a new object.
- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- 7.11.1 Explore different ways that objects move.
- W.K.7. Participate in shared research and writing projects.
- K.ETS1.1 Ask and answer questions about the scientific world and gather information using the senses.
- K.ETS1.2 Describe objects accurately by drawing and/or labeling pictures.
- K.ETS2.1 Use appropriate tools to make observations and answer testable scientific questions.
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts.

1

- W.1.7. Participate in shared research and writing projects.
- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- ETS1:1 Solve scientific problems by asking testable questions, making short-term and long-term observations, and gathering information.
- ETS1: 2 1) Use appropriate tools to make observations and answer testable scientific questions.

2

- W.2.7. Participate in shared research and writing projects.
- 2.ETS1.2 Develop a simple sketch, drawing, or physical model that communicates solutions to others.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 2.ETS1.3 Recognize that to solve a problem, one may need to break the problem into parts, address each part, and then bring the parts back together
- 2.ETS1.4 Compare and contrast solutions to a design problem by using evidence to point out strengths and weaknesses of the design.
- 2.ETS2.1 Use appropriate tools to make observations, record data, and refine design ideas.

3

- 3.ETS2.1 Identify and demonstrate how technology can be used for different purposes.
- W.3.7. Conduct short research projects that build knowledge about a topic.
- 7.Inq.3 Maintain a science notebook that includes observations, data, diagrams, and explanations.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 7.11.1 Plan an investigation to illustrate how changing the mass affects a balanced system.
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 7.11.2 Demonstrate how changing the mass affects a balanced system.

4

- 4.ETS1.1 Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.
- 4.ETS2.1 Use appropriate tools and measurements to build a model.
- 7.11.1 Recognize that the position of an object can be described relative to other objects or a background.
- 7.11.2 Design a simple investigation to demonstrate how friction affects the movement of an object.
- 7.11.3 Investigate the relationship between the speed of an object and the distance traveled during a certain time period.
- 7.11.1 Identify the position of objects relative to fixed reference points.
- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion.
- 7.11.3 Complete a coordinate graph, table, or diagram to describe the relative positions of objects.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.
- 7.11.5 Design and implement an investigation to determine that the speed of an object is equal to the distance traveled over time.
- 7.11.1 Describe the position of an object relative to fixed reference points.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- 4.ETS2.2 Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.
- 4.ETS2.3 Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones).
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.

5

- 5.ETS2.3 Identify how scientific discoveries lead to new and improved technologies.
- 5.ETS1.1 Research, test, re-test, and communicate a design to solve a problem.
- 7.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled.
- 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
- 7.11.2 Explain the relationship that exist among mass, force, and distance traveled.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
- 5.ETS1.2 Plan and carry out tests on one or more elements of a prototype in which variables are controlled and failure points are considered to identify which elements need to be improved. Apply the results of tests to redesign the prototype.
- 5.ETS1.3 Describe how failure provides valuable information toward finding a solution.
- 5.ETS2.2 Use appropriate measuring tools, simple hand tools, and fasteners to construct a prototype of a new or improved technology.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

6

- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

7

- W.7.7. Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- 7.11.3 Distinguish between speed and velocity.
- 7.11.4 Investigate how Newton’s laws of motion explain an object’s movement.
- 7.11.3 Summarize the difference between the speed and velocity based on the distance and amount of time traveled.
- 7.11.4 Recognize how a net force impacts an object’s motion.
- 7.11.3 Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.11.4 Identify and explain how Newton’s laws of motion relate to the movement of objects.

- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

8

- 7.12.5 Recognize that gravity is the force that controls the motion of objects.
- 7.12.5 Explain the difference between mass and weight.
- 7.12.7 Explain how the motion of objects is affected by gravity.
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- SCRE.ETS3:10-Use a scientific journal and/or lab notebook for recording qualitative and quantitative data.

An Amusing Menu

Many people have memories of eating cotton candy after a ride on the carousel or stealing a bite of a sibling's ice cream cone at the Boardwalk. It's true that over the years, amusement parks have provided snacks and sweets. One of the most famous is the Coney Island hot dog.

Feltman & the Invention of the Hot Dog

Information and Feltman's image from [westland.net](). Copyrighted © 1997 by Jeffrey Stanton. All Rights Reserved.

According to the article Coney Island: Food & Dining by Jeffrey Stanton: In 1867, Charles Feltman owned a pie-wagon that delivered his freshly baked pies to the inns and saloons that lined Coney Island's beaches. His clients also wanted hot sandwiches to serve to their customers, but his wagon was small and Feltman knew it would be hard to make a variety of sandwiches in such a tiny space. He thought that perhaps something simple, like a hot sausage served on a roll, might solve his problems. He presented his problem to Donovan, the wheelwright who had built Feltman's original pie-wagon. The engineer thought he saw an answer; ***(What do students think he could do? What were some workable solutions they might have used?)*** he could build a metal-lined box to keep the rolls fresh and put in a small charcoal stove inside on which Feltman boil sausages in a pot.

When the wheelwright finished his creation, they fired up the stove for a test run. Donovan thought that the sausage sandwich was a bit of a strange idea, but he was willing to try it as Feltman boiled the delicious pork sausage and placed between a roll. The wheelwright tasted the new sandwich and liked it. Thus, the hot-dog was born.

In 1871, Feltman leased a tiny plot of land on one of the big shore lots. He served hot dogs to 3,684 people that first summer. After a few summer seasons, he was successful enough to buy his own shore lot and so in 1874 he paid $7500 for the restaurant property at a time when per capita income in the

United States was $173 for an entire year.

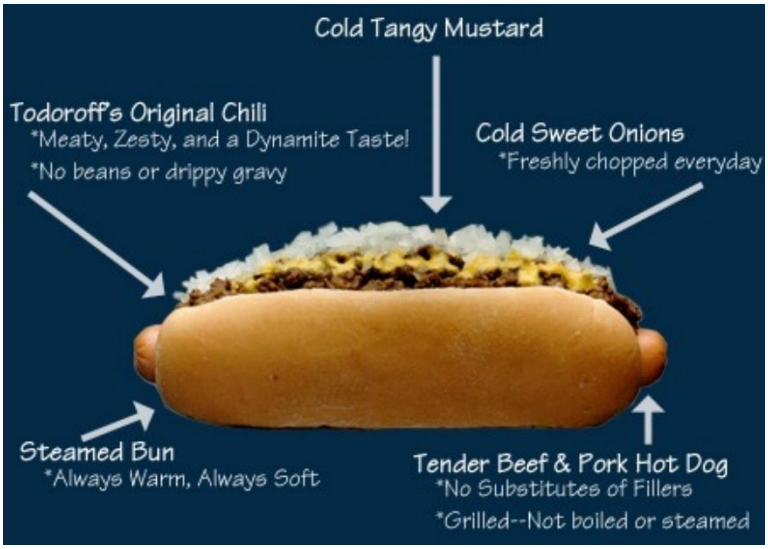
The hot dog, however, didn't go unchallenged. Rumors spread that Feltman made the sausages of dog meat and the politicians alleged they found a plant making sausages for Coney Island out of dead horses.

The Chief protested that, "Nobody knows what is inside these sausages." He slapped an excise tax of $200 on every sausage stand. That would be around $7610.18 dollars in today's money. *Remember, the average income was only $173 for a whole year!*

"We cannot dictate to a man what he must sell," said the Chief, "but we can make it hard for him to carry on his business." ***What do the students think of local authorities trying to run people out of their business? Were they right for doing what they did?***

Fortunately for Feltman, the rumors soon died down, and the food became popular again. Feltman's served 200,000 patrons a year during the 1880s, 370,000 a year during the 1890s, 900,000 during the first decade of the 20th century and over 2,000,000 a decade later. The endless dining rooms could serve 8,000 customers at a time. Feltman's all-time record was serving 100,000 people and 40,000 hot dogs in a single day. That would be 3,333 per hour if the restaurant was open for 12 hours!

A note on "The Coney Island Dog."



Despite the name, the "Coney Island" hot dog preparation style has little direct association with Coney Island, New York itself, beyond a recognition of the birthplace of the original hot dog.

Except for beginning in Michigan, who originated the Coney Island Chili Dog is in dispute with American and Lafayette Coney Islands, Detroit, Michigan and Todoroff's Original Coney Island, Jackson, Michigan which all claiming to have been the first to load up a hot dog with chili on one side, a stripe of yellow mustard on the other and fresh chopped white onions on top.

A Taste of Travel

Students might not visit Coney Island any time soon, or Feltman's restaurant, but they can get a taste of it. In honor of Feltman's and the coney dog, have your students construct their own hot dogs with warm buns, chili, onion, and mustard, or whatever they like best.

Materials:

- Warm hot dog buns
- Cooked hot dogs
- Mustard
- Onions (chopped)
- chili
- Other Condiments as necessary

Write that Down! Writing Prompt Ideas

What food would you want to eat after riding a roller coaster? Why would you want that food?

What food would you never want to eat after riding a roller coaster? Write an argument to your friend about why every person should eat that food after riding a rollercoaster.

Imagine you're a hot dog in Feltman's cart. What would your day be like? Do you want to be eaten or hope to avoid your fate?

Standards:

K

- K.2.03 a. Explain why people have jobs.
- K.2.03 b. Distinguish between needs and wants.
- K.2.03 c. Recognize that all jobs are significant and realize that some jobs are interdependent.

1

- 1.2.02 Give examples of how individuals, businesses and governments operate in a market economy.
- 1.2.02 a. Recognize that goods and services are exchanged.
- 1.2.03 Understand fundamental economic concepts.
- 1.2.03 a. Distinguish the difference between goods and services.
- 1.2.03 b. Differentiate between consumers and producers.

2

- 2.2.03 Understand fundamental economic concepts.
- 2.2.03 a. Categorize resources needed to operate businesses.
- 2.2.02 Give examples of the interaction of individuals, businesses and governments in a market economy.
- 2.2.02 b. Recognize that communities and individuals around the state and world are economically interdependent.
- RI.2.1. Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- 2.2.01 b. Describe how society depends upon workers with specialized jobs and the ways in which they contribute to the production and exchange of goods and services.

3

- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.
- 3.2.02 Give examples of fundamental economic concepts.

4

- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.

- 4.2.02 Give examples of the interaction of groups, businesses, and governments in a
- market economy.
- 4.2.03a Understand fundamental economic concepts.
- 4.2.03 b. Describe the relationship of price to supply and demand.
- 4.2.03 c. Use economic concepts such as supply, demand, and price to help explain events.

5

- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.
- 5.2.02 Give examples of the interaction of individuals, businesses, and governments in a market economy.
- 5.2.03 Understand fundamental economic concepts.
- 5.2.03 a. Explain how supply and demand affects production and consumption in the
- United States.
- 5.2.04 Understand the patterns and results of trade.

6

- 7.T/E.1 Explore how technology responds to social, political, and economic needs.
- 7.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- 6.2.03 Understand the potential costs and benefits of individual economic choices.
- 6.2.03 a. Differentiate between needs and wants.
- 6.2.03 b. Analyze how supply and demand, and change in technologies impact the cost for
- goods and services.

7

- 7.T/E.1 Explore how technology responds to social, political, and economic needs.
- 7.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- 7.2.01 Understand fundamental economic concepts and their application to a variety of economic systems.
- 7.2.02 Understand global economic connections, conflicts, and interdependence.
- 7.2.02 a. Recognize that resources, goods, and services are exchanged worldwide.

8

- 7.T/E.1 Explore how technology responds to social, political, and economic needs.
- 7.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.

- 8.2.04 Understand the interactions of individuals, businesses, and the government in a market economy.
- 8.2.03 b. Analyze how supply and demand, and change in technologies impact the cost for
- goods and services.
- 8.2.02 Understand economic connections, conflicts, and interdependence.
- 8.2.01 Understand fundamental economic concepts and their application to a variety of economic systems.
- 8.2.01 a. Describe the role that supply and demand, prices, incentives, and profits play in determining what is produced and distributed in a competitive market system.

Moving Forward

Soon, roller coasters spread to amusement parks all around the world. In the 1920s there were between 1,500 and 2,000 roller coasters. Perhaps the best-known historical roller coaster, The Cyclone, opened at Coney Island in 1927. Leap the Dips is one of the few roller coasters that exist from this time and is the oldest coaster still running in the world. E. Joy Morris built it in 1902and it is at Lakemont Park, Pennsylvania.

The Great Depression marked the end of the first golden age of roller coasters, and amusement parks went into decline. Because of the depression, the number of coasters went from between 1,800 and 2,000 in 1930 to 245 in 1939. In the 1940s to 1960s many rides had to close due to "white only" rules. They ran out of money when they only let a section of the public in and excluded the rest.

Write that Down!

Writing Prompt Ideas

There's a mysterious roller coaster where people who ride it disappear. What happens to them? Do they go back in time? Is it so fast it takes them to the future? What other ideas do you have?

The Enchanted Forest in Toledo, Ohio. Seph Lawless

Extra! Extra! Abandoned Fun?

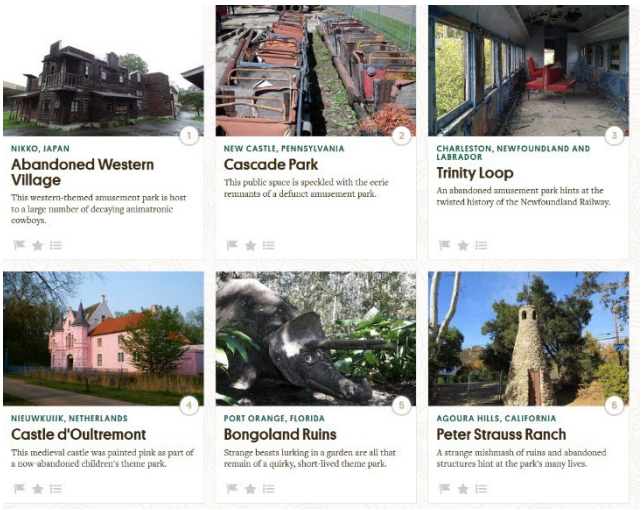
"The fun and rides stopped, but the memories linger."

Explore images of abandoned theme parks around the world with students. As a group, or in pairs, or individually write a news article about what happened. And/or imagine an alternative

explanation of what happened to them. Why were they abandoned? Do they come awake at night? Will they ever reopen?

[A World Tour of Abandoned Amusement Parks]

[30 photos of abandoned amusement parks around the US that will give you the chills]: "Seph Lawless has made a career of documenting urban decay and abandoned theme parks in the US, and the photos are haunting."

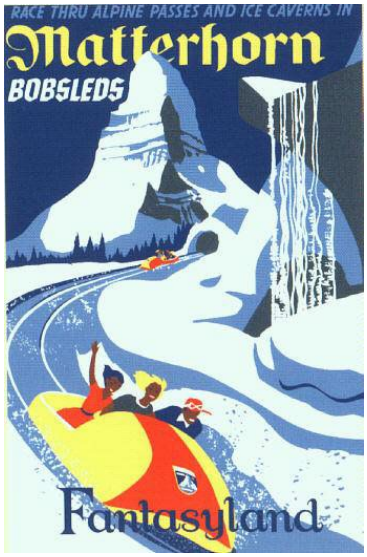


[27 Eerie Photos Of Abandoned Amusement Parks] "Abandoned amusement parks (the New Orleans Six Flags in particular) have been used as sets for movies such as *Jurassic World*."

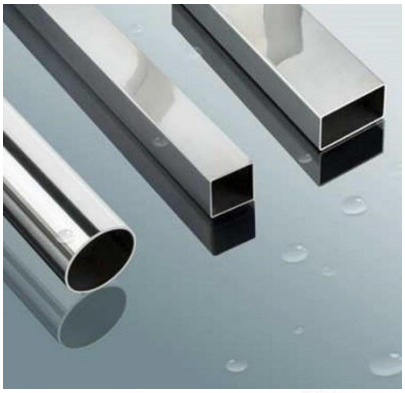
Optional Resource:

Students may find more to explore with the book, *Abandoned: Hauntingly Beautiful Deserted Theme Parks*, by Seph Lawless. Huffington Post called him "a master of the abandoned"—and for good reason. Take a strange and wonderful photographic journey into a world time has forgotten—amusement parks that have been shut down and overgrown.

The Birth of Disneyland



"Disneyland will never be completed; it will continue to grow as long as there is imagination left in the world." -Walt Disney [13]



In the 1950s roller coasters for children grew in popularity. In 1955, the nation's first theme park opened: Disneyland.

Not only did Disneyland usher in a new era for amusement parks, it also helped bring about some radical changes in roller coaster design. Until this time, coasters were built out of wood, which limited the way loops could be handled.

In 1959 Disney introduced the Matterhorn, the first tubular steel coaster. This was the first roller coaster to use a tubular steel track. Unlike wooden coaster rails, which are generally formed using steel strips mounted on laminated wood, tubular steel can be easily bent in any direction, which allows designers to incorporate loops, corkscrews, and many other maneuvers into their designs. Most modern roller coasters are made of steel, although wooden coasters are still being built.

The exciting features we expect from today's coasters—loops, a corkscrew track, and stability—can be traced back to that first steel coaster. In the 60s, many of the small family-owned amusement parks were bought and replaced by large theme parks like Six Flags. In 1972, when The Racer was built at Kings Island in Mason, Ohio (near Cincinnati and designed by John Allen), the instant success of The Racer began a second golden age, which has continued to this day.

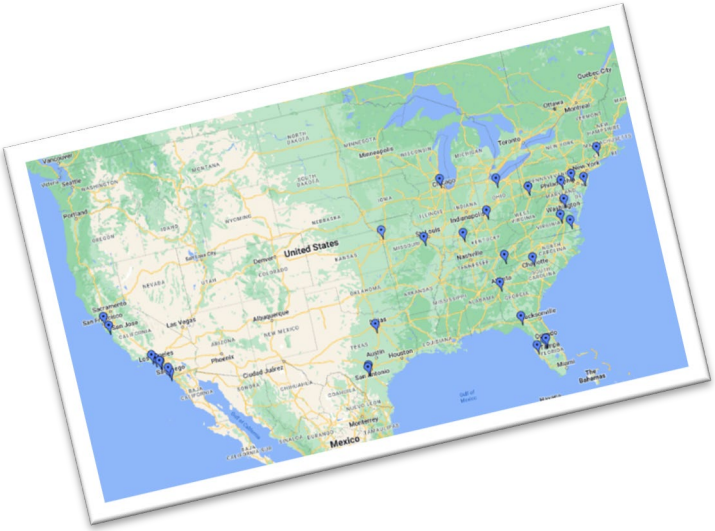
[13] https://www.washingtonpost.com/outlook/2021/09/24/it-wont-be-easy-disneyland-transcend-rigid-hierarchies-its-founding/

The first successful inverted (upside down) coaster was introduced in 1992, and now you can find passengers riding in coasters with their feet dangling freely below them (and occasionally above them) as they travel the track. In 1997, a coaster opened at Six Flags Magic Mountain whose design would have been impossible even a few years before. This scream machine is 415 feet tall and can reach a speed of 100 miles per hour. Technology, working with the laws of physics, continues to push what is possible in ride design.

Until the late 1970s, roller coasters were fairly standard. Whether they made the tracks of wood or steel, a slow lift chain, powered by a motor, click-clack-clicked, and pulled coaster trains slowly up a lift hill. At the top of the hill, the chain unhooked, and gravity took over. Most new coasters still use the tried-and-true approach, but attraction designers have been experimenting with a number of launch systems to ratchet up the acceleration, speeds, heights, and (of course) the thrills, as well as create a different kind of ride experience. Some use a catapult style launch and others use a hydraulic push. Either way, or regardless of the method, screaming out of the loading station the new breed of coasters eliminates the anticipation of the lift hill and deliver non-stop action from beginning to end.

Put a pin in it!

Have students practice their geography skills and explore this map of 'Theme Parks in the United States'! Have they been to any of the listed parks? Any that aren't on the map? What do they notice about the locations of where most theme parks are concentrated? Do they think those old railroad destinations still affect modern theme park locations?



Watch this: Expedition Everest A modern Disney Marvel

"With incredible themeing and thrills galore, could this be Disney's best roller coaster? Taking six years to design and construct at an estimated total cost of $100 million, this Vekoma custom coaster is listed in the Guinness World Records as the most expensive roller coaster in the world." Ride along by clicking here or on the photo. **How did students feel when they saw the broken track? The Yeti? Do students notice the steps and stairs beside the track? Why are they there?**

Magic Mountain: "Thrill Capital of the World!"

"While it's now known as the "Thrill Capital of the World" — and, in the early 1980s, was the largest amusement park in Southern California (yes, even bigger than Disneyland) — it had more humble beginnings, with only 70 acres in its original $20 million complex."

It opened on May 29, 1971, as a development of the Newhall Land and Farming Company (local real estate developers) and Sea World Inc.

In the decades that followed, Magic Mountain changed hands multiple times (In 1979, Six Flags purchased the park and added "Six Flags" to the park's name) and even declared bankruptcy. But through it all, Magic Mountain has survived — and boy, has it grown. With 20 roller coasters, Six Flags Magic Mountain holds the world record for most roller coasters in an amusement park.

Believe it or not, there are still *original* rides from Magic Mountain's opening 50 years ago. You might even think that Colossus (er, rather, *Twisted* Colossus) is the only historical ride left at Six Flags Magic Mountain.

But keep your eyes peeled, and you just might spot some original — or, at least, very old — signs of that ol' "mountain magic."

Check out this list of nine areas of "old school" Magic Mountain that you can visit today for a true throwback Southern California theme park adventure and learn more[14]

[14] Source: https://www.kcet.org/shows/socal-wanderer/beyond-colossus-tracing-50-years-of-thrilling-history-at-six-flags

Want to Learn more? Watch this!

As time allows have students watch clips from a well-crafted five-part documentary, The History of Six Flags Magic Mountain (1971-2021) - The Complete Documentary, created by Airtime Thrills and available on YouTube. *As always, please pre-watch all videos to ensure appropriateness for your students' ages and sensitivities.*

"This is a top-level documentary production." -Reed Engineering

Take Note! Have students:

- List six facts described in the film that impressed you.
- Describe any aspect of the film that showed you something you hadn't seen before, caused you to think in a new way, or helped you understand something more thoroughly than before. In addition, describe how it changed your thinking.
- Did the narration always work well with what was occurring visually in the film? Describe any scenes in which you thought it didn't and your reasons for this conclusion.
- If someone asked you whether you would recommend this film, how would you respond? Fully explain your reasons.

Write that Down! Writing Prompt Ideas

What weird theme do you think would be great for an amusement park? How would you sell this idea to your boss if you worked for a large company like Disney or Six Flags?

Write a story that contains the line. "I pulled my lap bar down just in time."

Standards:

K

- SL.K.2. Confirm understanding of a text by asking and answering questions about key details and requesting clarification if something is not understood.
- SL.K.1. Participate in collaborative conversations with diverse partners about visual or digital texts with peers and adults in small and larger groups.
- 3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- K.3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- Explain what a globe and map represent.
- Use personal directions such as up, down, left, right, near and far to describe relative direction.
- 3.03 Demonstrate how to identify and locate features on globes and maps.

1

- SL.1.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- SL.1.2. Ask and answer questions about key details in a visual or digital text, e.g., one read aloud.
- RI.K.3. With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
- 1.3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- Recognize that maps and globes are representations or models of specific places.
- 1.3.02 Recognize how to identify and locate major physical and political features on
- maps and globes.
    - a. Define what cardinal directions are.
    - b. Locate places using cardinal directions on maps and globes.
    - c. Locate cities, states, countries, and continents on maps and globes and major bodies of water on maps and globes.
    - d. Describe the concept of human features as in cities, buildings, farms, roads, and railroads.

2

- SL.2.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- RI.2.3. Describe the connection between a series of historical events, scientific ideas or concepts.

- RI.2.1. Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- SL.2.1. c) Ask for clarification and further explanation as needed about the visual or digital texts under discussion.
- 2.3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.

3

- SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RI.3.3. Describe the connection between a series of historical events, scientific ideas or concepts
- SL.3.1. c) Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
- SL.3.1. d) Explain their own ideas and understanding in light of the discussion
- 3.3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.

4

- SL.4.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.4.1. c) Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
- SL.4.1. d) Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.
- 3.3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- 3.03 Understand how to identify and locate major physical and political features on globes and maps.
- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.

5

- SL.5.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.5.1. c) Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
- SL.5.1. d) Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
- 3.3.01 Understand how to use maps, globes, and other geographic representations, tools, and technologies to acquire, process and report information from a spatial perspective.
- 3.03 Understand how to identify and locate major physical and political features on globes and maps.
- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.

6

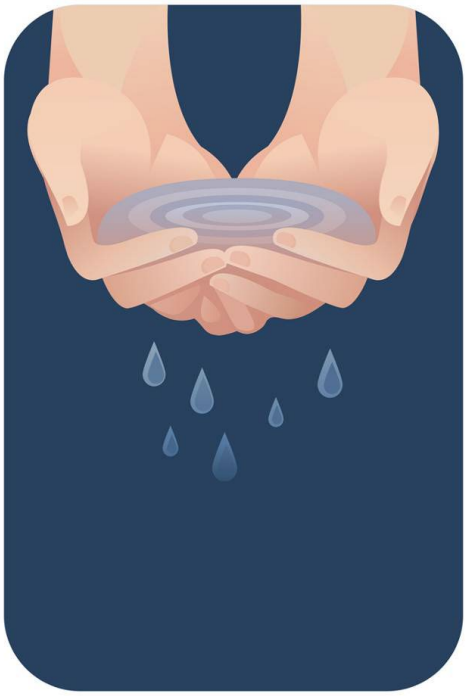
- SL.6.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.6.1. c) Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
- SL.6.1. d) Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing
- 3.01 Understand the characteristics and uses of maps.
- 3.02 Know the location of places and geographic features, both physical and human.
- 7.T/E.1 Explore how technology responds to social, political, and economic needs.

7

- SL.7.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.7.1. c) Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
- SL.7.1. d) Acknowledge new information expressed by others and, when warranted, modify their own views.
- 7.3.01 Understand the characteristics and uses of maps, globes, and other geographic tools and technologies.
- 7.3.02 Know the location of places and geographic features, both physical and human, locally, regionally and globally.
- 7.T/E.1 Explore how technology responds to social, political, and economic needs.

8

- SL.8.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.8.1. c) Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
- SL.8.1. d) Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
- 8.3.01 Understand the characteristics and uses of maps, globes, and other geographic tools and technologies.
- 8.3.02 Know the location of places and geographic features, both physical and human, locally, regionally and globally.
- 7.T/E.1 Explore how technology responds to social, political, and economic needs.



Two Pieces of the Puzzle

In order to understand how roller coasters work we need to understand a bit about two basic elements used in our modern day roller coasters. The launch and the stop. In some coasters, that's done through Hydraulics and Magnetic Brakes**.**

In order to give students a better understanding of these two elements, watch the video and conduct the following experiments. Discuss with students what part hydraulics and magnets might play in roller coaster construction.

Watch This! The Physics of Rollercoasters

Roller coasters give people the opportunity to experience physics in dramatic ways. In this episode of SciShow (Voted 'Best of the Web' by TedEd), (Find it here: Physics of Rollercoasters) they break down how physics work on roller coasters to give you the ride of your life! *As always, please pre-watch all videos to ensure appropriateness for your students' ages and sensitivities.*

Record-breaking Ride

When it debuted in 2005, Kingda Ka at New Jersey's Six Flags Great Adventure laid claim to the twin titles of the world's tallest and fastest roller coaster. Its 50.6-second adrenaline rush of a ride sends coaster freaks up a 456-foot top hat tower and reaches a maximum speed of 128 mph in 3.5 seconds. Yikes!

What gives Kingda Ka its incredible record-breaking oomph? Hydraulics.

If that pithy explanation has you scratching your head, let's dive into some details. Until the late 1970s, nearly all modern roller coasters were fairly standard. Whether they made the tracks of wood or steel, a poky lift chain powered by a motor click-clack-clicked a coaster train slowly up a lift hill. At the top of the hill, the chain disengaged, and gravity took over.

Most coasters built from the late 1970s on still use the tried-and-true approach, but some ride designers have been replacing conventional

lift hills with a number of launch systems. They can ratchet up the acceleration, speeds, heights, and (of course) the thrills, as well as create different ride experiences. Screaming out of the loading station, launched coasters like Kingda Ka eliminate the anticipation of the lift hill and deliver non-stop action from beginning to end.

To send coaster trains and their fearless passengers screaming from the get-go, ride designers have developed a variety of launch methods including magnetic propulsion, compressed air, and jazzed-up electric motors. But hydraulics offers a relatively simple and efficient way to get coaster cars moving quickly—VERY quickly.[15]

Watch this! Kingda Ka POV 'Behold the King of Coasters'

"Kingda Ka, the world's tallest roller coaster launches you up 456 feet in the air at a breath-taking 128 miles per hour in 3.5 seconds! Crest the top hat long enough to see the striking views before plummeting through a 270-degree spiral straight back down to Earth. Can't catch your breath? There's a 129-foot camel hump waiting for you at the end of the ride! Phew! You made it back to the station!"

Official Kingda Ka POV 2021 - 4k 60fps - Six Flags Great Adventure

[Watch the official Six Flags video on YouTube.]

Did students hear the hiss of the hydraulics at the beginning? Why might they have the second 'camel hump' towards the end of the track? What purpose could it serve from a physics standpoint?

[15] https://www.tripsavvy.com/how-kingda-ka-works-3226405

Water? Power!

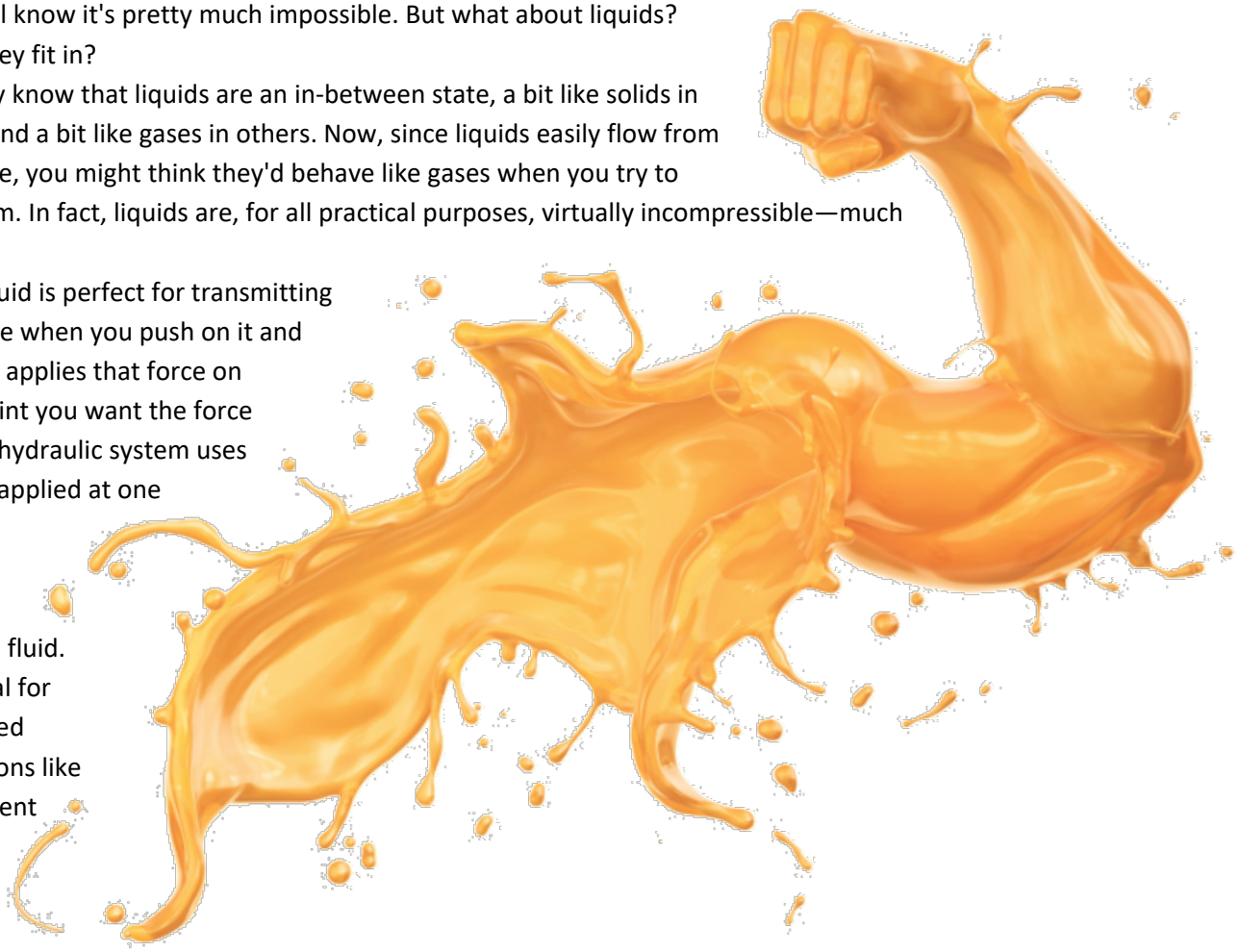
A Simple Demonstration of Fluid Mechanics, a.k.a. Hydraulics.

Often force must be transferred from one part of a machine to another to control a moving part. Fluids (liquids) squeezed in high pressure tubing are often used to transmit a large force, like in roller coasters, where hydraulic systems provide enormous amounts of power to launch those carts along the track. A roller coaster engineer likens the hydraulic launch process to blowing up balloons. *Blow up a balloon to demonstrate.* "They store huge amounts of energy, then at the precise moment, poof, they release it."

Discovery and use of hydraulics spans back hundreds of years. The basic idea behind any hydraulic system is very simple: Force that is applied at one point is transmitted to another point using an incompressible ("unsquishable") fluid. The fundamental principle on which hydraulics work is that water cannot be compressed (squeezed and made smaller).

Gases are easy to squash: everyone knows how easy it is to squeeze a balloon. Solids are just the opposite. If you've ever tried squeezing a block of metal or a lump of wood, with nothing but your fingers, you'll know it's pretty much impossible. But what about liquids? Where do they fit in?

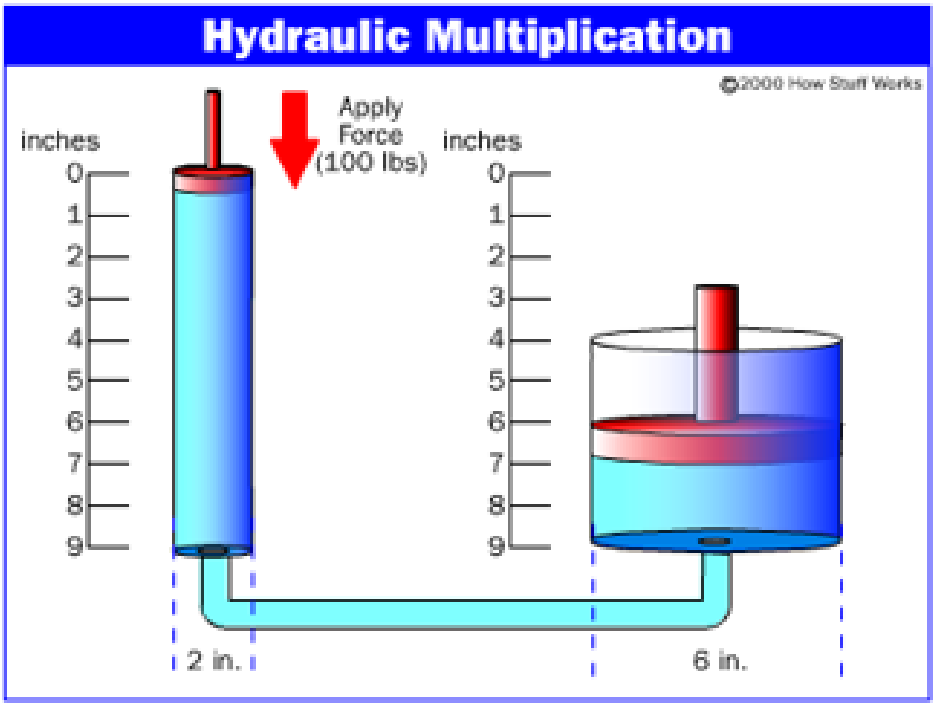
You probably know that liquids are an in-between state, a bit like solids in some ways and a bit like gases in others. Now, since liquids easily flow from place to place, you might think they'd behave like gases when you try to squeeze them. In fact, liquids are, for all practical purposes, virtually incompressible—much like solids.



Therefore, fluid is perfect for transmitting force because when you push on it and squeeze it, it applies that force on whatever point you want the force delivered. A hydraulic system uses force that is applied at one point and is transmitted to another point using a fluid. Water is ideal for uncomplicated demonstrations like the one student will do; however, in industrial

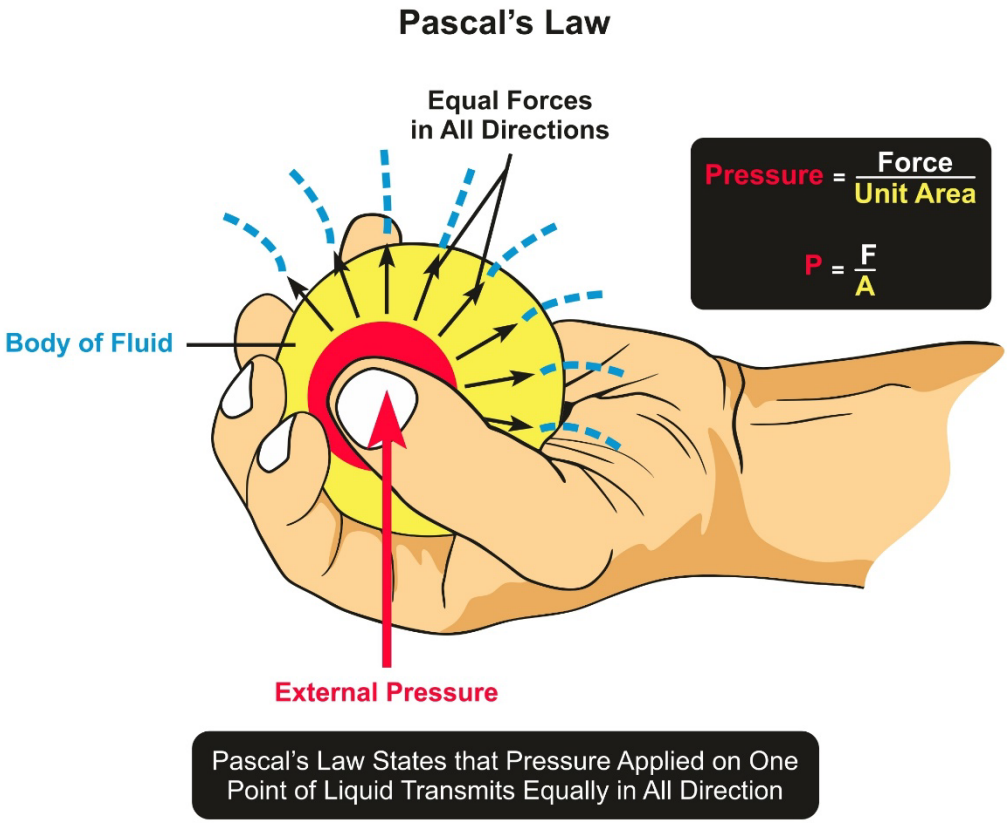
applications; specialized hydraulic fluid is more often used.

The basic rule of using hydraulic power is called Pascal's Principle or Pascal's Law.



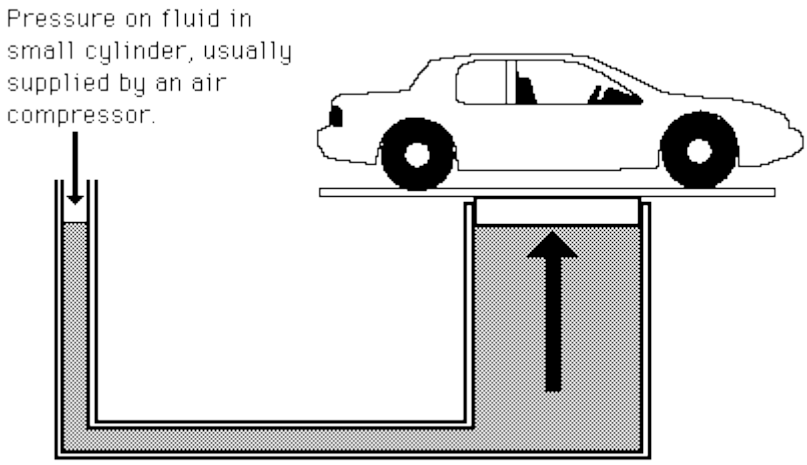
Pascal's Principle: Pressure exerted on a fluid is distributed equally throughout the fluid.

Of course, as Prof. Newman says, "there is no free lunch," In order to move the larger area, the smaller area must move a lot in order to move the larger area a little.
In our picture, the larger area is nine times greater than the smaller area. In order to move the larger piston one inch, the smaller piston has to move nine inches.



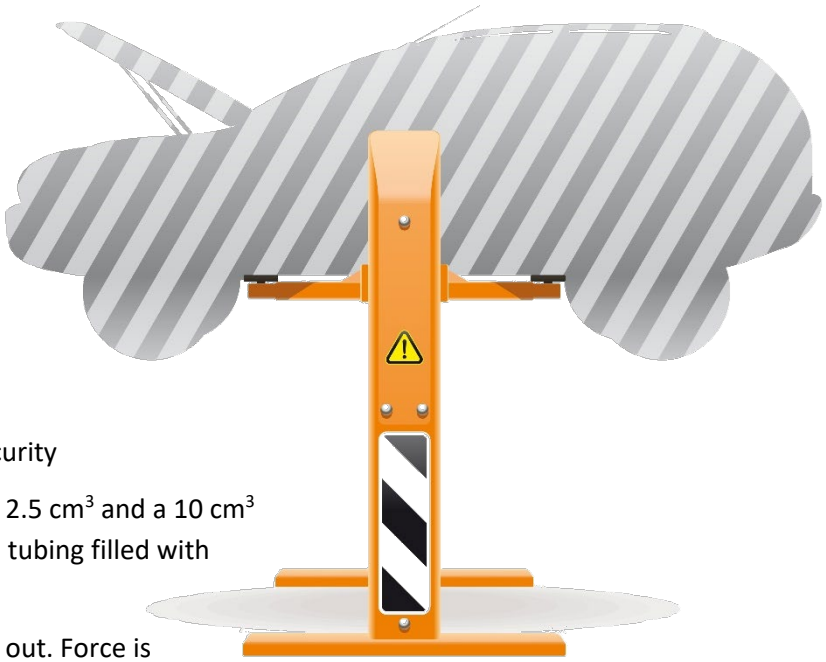
The great thing about hydraulic systems is that the pipe connecting the two cylinders can be any length and shape, allowing it to snake through all sorts of things separating the two pistons. The pipe can also fork, so that one master cylinder can drive more than one slave cylinder if desired.

Now, students get to become hydromechanics and try it for themselves.



www.allstar.fiu.edu/aero/Hydr01.htm

Can you give me a lift?



Materials:

- Water
- Aquarium Tubing
- 2.5 cm^3 syringes
- 10 cm^3 syringes
- Books, bricks, or other heavy objects
- Option: sealant or waterproof tape for security

We can conduct a simple hydraulic activity using a 2.5 cm^3 and a 10 cm^3 syringe connected by a 1m long piece of aquarium tubing filled with water, as shown in the image on the next page.

As we push one plunger down the other is pushed out. Force is transmitted through the water from one syringe to the other. ***Have students follow precisely a multistep procedure to put together their hydraulic system and when carrying out their own experiments, taking measurements, or performing technical tasks.***

Once the setup is put together, how far does the plunger of the big syringe move out when students push in the small syringe 4cm?

Ask your students to place their thumb over one of the plungers and try to stop it from moving outwards while their partner presses down on the other. Which syringe, the 2.5 cm3 or 10 cm3, will they use to push their partner's thumb upwards?

Now, have students set up their own experiment, ex. they may try to lift a heavy object like a book, or a brick, or try to use more than two syringes. ***When lifting objects is it best to put the small syringe under the heavy object, as shown in the picture, or is it best to put the bigger syringe under the heavy object?***

Extension: ***Can students come up with any other experiments or ideas to test or areas to possibly apply this system? What about a hydraulic braking system for a rollercoaster?***

Ex: Some students have constructed models that transfer the force of one syringe to a small brake. The brake pad can simply be an eraser glued to the end of the other syringe plunger. Students will also need to set up a positioning apparatus; however this should not prove difficult. For example, one set up may have a student press one plunger into the syringe, and the other syringe plunger applying brake pressure to a spinning model wheel. Have students watch this example for ideas.

Note: Air in the System?

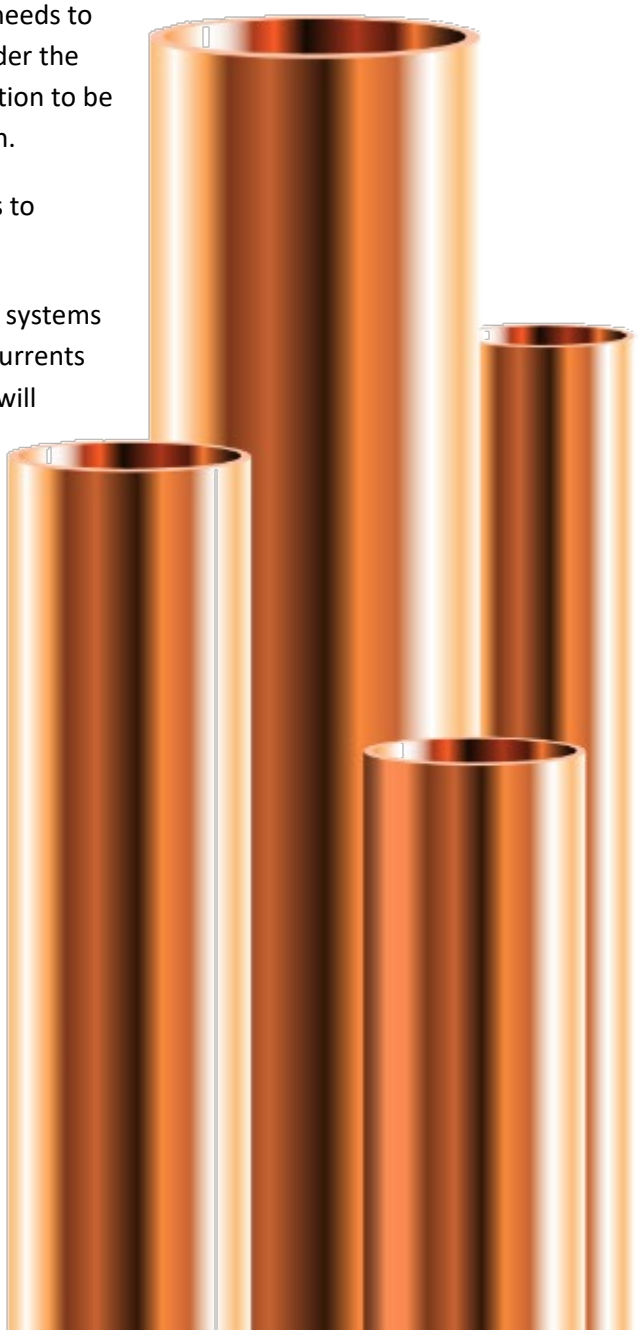
It is important that a hydraulic system contains no air bubbles. You may have heard about the need to "bleed the air out of the brake lines" of your car. If there is an air bubble in the system, then the force applied to the first piston gets used compressing the air in the bubble rather than moving the second piston, which has a big effect on the efficiency of the system, as your students may notice.

The Stop: Magnetic Braking Systems

Like any train, a roller coaster needs a brake system so it can stop precisely at the end of the ride or in an emergency. In roller coasters, the brakes aren't built into the train itself; they're built into the track. Many times, the system is very simple; they position a series of clamps at the end of the track and at a few other braking points. A central computer operates a hydraulic system that closes these clamps when the train needs to stop. The clamps close in on vertical metal fins running under the train, and this friction [rubbing which causes energy of motion to be converted into heat energy] gradually slows the train down.

New braking systems are regularly being developed thanks to technological advancements in design.

Another system has grown in popularity, magnetic braking systems using Lenz's law. Lenz's law gives the direction of electric currents created by changing magnetic fields. The electric currents will be in a direction in which magnetic fields caused by the current will oppose the cause of the change. One result of this law is the magnetic braking effect, which makes a memorable physics demonstration experiment for students.



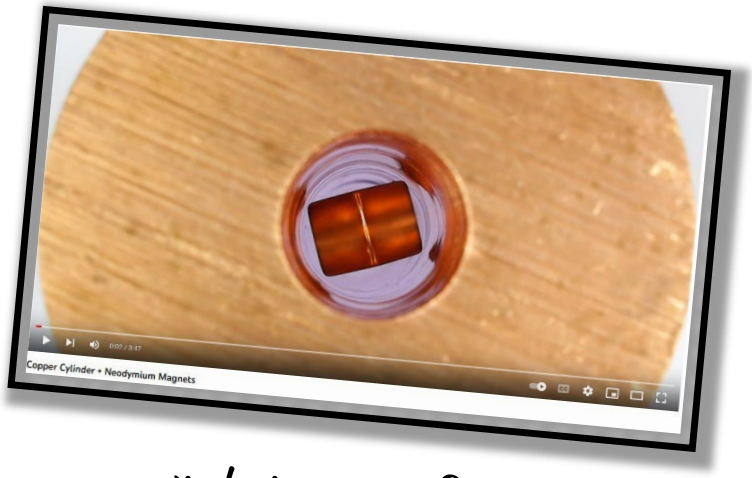
Materials:

- A copper or aluminum pipe.
- A fairly powerful neodymium magnet (or several small ones stacked together) or cow magnet that is small enough to fit inside the pipe.
- Option: PVC pipe to match the size of your copper pipe, for comparison.
- Option: A large roll of aluminum foil.
- Option: Non-magnetic pizza cutter.
- Option: Powerful horseshoe magnet.

Note: The size and shape of the magnet does not matter if it can fit easily into the pipe. The exact length of the pipe is also unimportant, but the **type** of pipe matters. It **must** be a metal that conducts electricity but is

nonmagnetic. Copper or aluminum will work. Iron, steel, or any type of PVC will not work. Does a large roll of aluminum foil work?

Demonstrate with the PVC pipe, if you have one. ***After, have students predict how fast they think the magnet will fall through the pipe, record their predictions. Have them make predictions about whether and how the pipe may be affected by a magnet.*** Now simply drop the magnet down the pipe and have students watch what happens. It will take much longer than one would expect. **Option:** For a similar experiment working on the same principle, find a pizza cutter, or similar spinning disk, made of a nonmagnetic metal. Taking care not to cut your hands, get the disk spinning as fast as possible. Then place the spinning disk inside a powerful horseshoe shaped magnet. Watch it quickly stop spinning.



Watch this! Check out the YouTube video Copper Cylinder + Neodymium Magnets with students to see what's happening in many variations.

What's happening?

Ask students: Have students identify how magnets attract or repel one another. ***Have them give their ideas on why the magnet falls so slowly. Why does the pizza cutter disk stop spinning? Discuss their theories.*** Faraday's law and Lenz's law provide the keys to understanding these demonstration experiments and the magnetic braking effect used by roller coasters.

Draw a diagram for students as you discuss how the experiment works. Have students work to fill in the parts they can with their ideas. While the magnet is entering the pipe, it creates a magnetic current and multiple magnetic fields (eddy currents) in the pipe. The pipe tries to resist the change by repelling (pushing against) the falling magnet. The opposing force on the magnet slows the magnet down (N to N). Then, when the magnet is leaving the coil, the pipe creates a magnetic current to, again, slow the magnet, this time, from leaving it (S to N). We can think of the pipe itself as a magnet which repels the entering magnet and attracts the departing magnet. The moving magnet is repelled in front and attracted in rear.

Similarly, the spinning pizza cutter disk has caused eddy currents. The currents induce magnetic fields that oppose their cause, which is the spinning disk. The disk slows to a stop, rather like a roller coaster wheel.

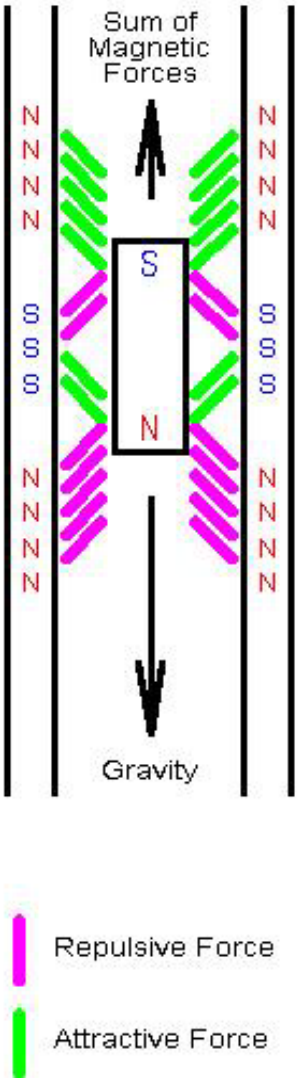
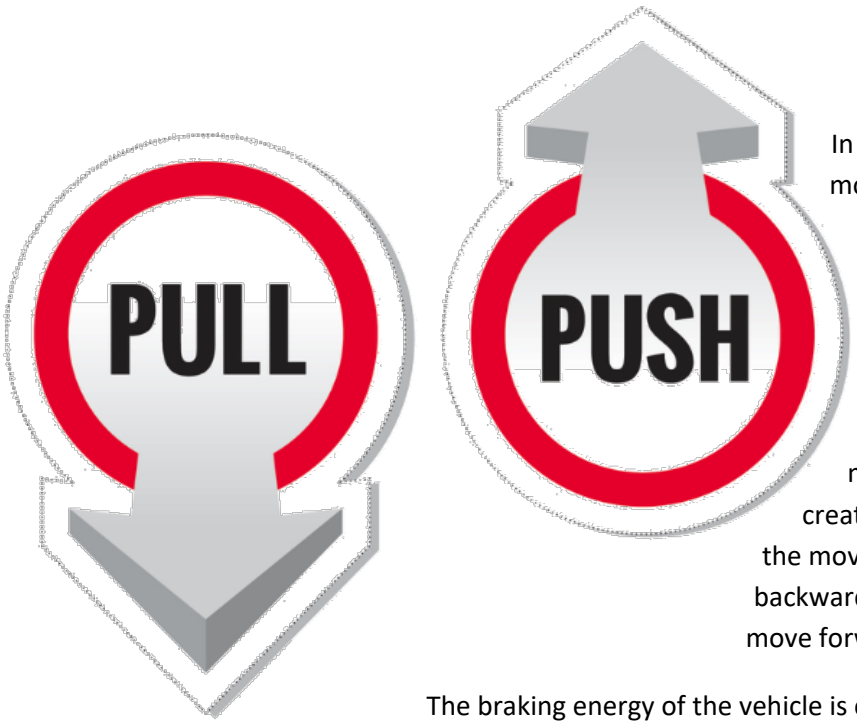


Image Credit: http://www.coolmagnetman.com/magpipes.htm. All Rights Reserved



In transportation systems, when the magnet is moved along the rail, it creates a moving magnetic field in the rail's head, which then generates electrical tension (Faraday's induction law) and causes eddy currents. These change the magnetic field in such a way that the magnetic force is changed to the opposite of the direction of the movement, (pulling backwards), thus creating a horizontal force, which works against the movement of the magnet. It's pulling it backwards while the magnet continues to try to move forward because of momentum.

The braking energy of the vehicle is converted in eddy current losses into heat which lead to a warming of the rail. Regular magnetic brakes, in wide use in railways, exerts its braking force by friction with the rail, which also creates heat.

Eddy current brakes don't physically touch the rail, and thus they don't wear down (not like tires on your car that eventually grind down because of friction) even if it's used for a long time and creates no noise (no big shrieks!) or odor (like the smell of burning breaks if you try to stop your car too fast).

Eddy current brakes are unusable at low speeds but can be used at high speeds both for emergency braking and for regular braking. ***Why do students think it would be unusable at low speeds?***

Modern roller coasters use this type of braking, but to avoid the risk of potential power outages they use permanent magnets instead of electromagnets, thus not requiring any power supply. However, they lose the ability to adjust the braking strength as easily as they could if they used electromagnets. ***What could be potential dangers of depending on electricity to stop a roller coaster car? What if the power went out, what might happen to the riders?***

Write that Down! Writing Prompt Ideas

Do you think understanding the science behind a fear, like roller coasters, helps you to overcome them? Why or why not?

Standards:

K

- K.LS1.3 Explain how humans use their five senses in making scientific findings.
- K.PS1.3 Construct an evidence-based account of how an object made of pieces can be disassembled and made into a new object.
- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- 7.11.1 Explore different ways that objects move.
- W.K.7. Participate in shared research and writing projects.
- K.ETS1.1 Ask and answer questions about the scientific world and gather information using the senses.
- K.ETS1.2 Describe objects accurately by drawing and/or labeling pictures.
- K.ETS2.1 Use appropriate tools to make observations and answer testable scientific questions.
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts.

1

- W.1.7. Participate in shared research and writing projects.
- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- 7.12.1 Experiment with magnets to determine that objects can move without being touched.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- 7.12.2 Realize that things fall toward the ground unless something holds them up.
- 7.12.1 Investigate materials that are attracted to magnets.
- 7.12.1 Identify and classify objects in the classroom as magnetic or non-magnetic.
- 7.12.1 Explain how two magnets interact.
- 7.12.2 Make predictions about how various objects will be affected by a magnet.
- 7.12.2 Describe what happens when an object is dropped and record the observations in a science notebook.
- ETS1:1 Solve scientific problems by asking testable questions, making short-term and long-term observations, and gathering information.
- ETS1: 2 1) Use appropriate tools to make observations and answer testable scientific questions.

2

- W.2.7. Participate in shared research and writing projects.
- 2.ETS1.2 Develop a simple sketch, drawing, or physical model that communicates solutions to others.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.

- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 7.12.1 Explore how magnets attract objects made of certain metals.
- 7.12.1 Experiment with magnets to determine how distance affects magnetic attraction.
- 7.12.1 Recognize that magnets can move objects without touching them.
- 7.12.2 Determine that only certain types of objects are attracted to magnets.
- 7.12.2 Identify objects that are attracted to magnets.
- 2.ETS1.3 Recognize that to solve a problem, one may need to break the problem into parts, address each part, and then bring the parts back together
- 2.ETS1.4 Compare and contrast solutions to a design problem by using evidence to point out strengths and weaknesses of the design.
- 2.ETS2.1 Use appropriate tools to make observations, record data, and refine design ideas.

3

- 3.ETS2.1 Identify and demonstrate how technology can be used for different purposes.
- W.3.7. Conduct short research projects that build knowledge about a topic.
- 7.Inq.3 Maintain a science notebook that includes observations, data, diagrams, and explanations.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 7.12.1 Explore the interactions between magnets.
- 7.12.1 Explore how magnets attract objects made of certain metals.
- 7.12.1 Experiment with magnets to determine how distance affects magnetic attraction.
- 7.12.2 Determine that only certain types of objects are attracted to magnets.
- 7.12.1 Recognize that magnets can move objects without touching them.
- 7.12.2 Identify objects that are attracted to magnets.
- 7.11.1 Plan an investigation to illustrate how changing the mass affects a balanced system.
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 7.11.2 Demonstrate how changing the mass affects a balanced system.

4

- 4.ETS1.1 Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.
- 4.ETS2.1 Use appropriate tools and measurements to build a model.
- 7.11.1 Recognize that the position of an object can be described relative to other objects or a background.
- 7.11.2 Design a simple investigation to demonstrate how friction affects the movement of an object.
- 7.12.2 Determine how an electrically charged material interacts with other objects.
- 7.12.1 Identify how magnets attract or repel one another.

- 7.12.1 Explore the interactions between an electrically charged object and other materials.
- 7.12.1 Explore the interactions between magnets.
- 7.11.3 Investigate the relationship between the speed of an object and the distance traveled during a certain time period.
- 7.11.1 Identify the position of objects relative to fixed reference points.
- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion.
- 7.11.3 Complete a coordinate graph, table, or diagram to describe the relative positions of objects.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.
- 7.11.5 Design and implement an investigation to determine that the speed of an object is equal to the distance traveled over time.
- 7.11.1 Describe the position of an object relative to fixed reference points.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- 4.ETS2.2 Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.
- 4.ETS2.3 Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones).
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.

5

- 5.ETS2.3 Identify how scientific discoveries lead to new and improved technologies.
- 5.ETS1.1 Research, test, re-test, and communicate a design to solve a problem.
- 7.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled.
- 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
- 7.11.2 Explain the relationship that exist among mass, force, and distance traveled.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
- 5.ETS1.2 Plan and carry out tests on one or more elements of a prototype in which variables are controlled and failure points are considered to identify which elements need to be improved. Apply the results of tests to redesign the prototype.
- 5.ETS1.3 Describe how failure provides valuable information toward finding a solution.
- 5.ETS2.2 Use appropriate measuring tools, simple hand tools, and fasteners to construct a prototype of a new or improved technology.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

6

- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

7

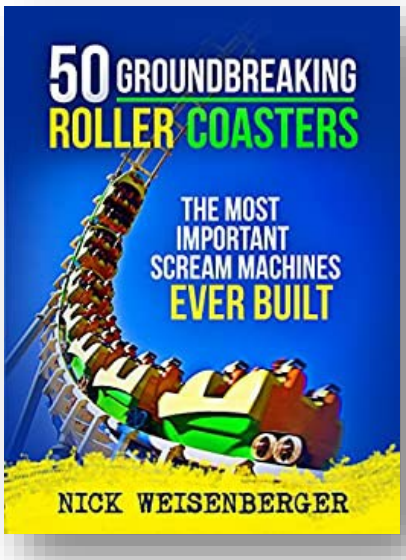
- W.7.7. Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- 7.11.3 Distinguish between speed and velocity.
- 7.11.4 Investigate how Newton's laws of motion explain an object's movement.
- 7.11.3 Summarize the difference between the speed and velocity based on the distance and amount of time traveled.
- 7.11.4 Recognize how a net force impacts an object's motion.
- 7.11.3 Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.11.4 Identify and explain how Newton's laws of motion relate to the movement of objects.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

8

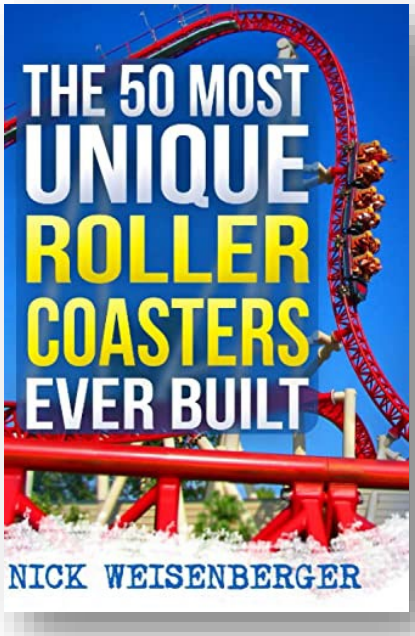
- 7.12.5 Recognize that gravity is the force that controls the motion of objects.
- 7.12.5 Explain the difference between mass and weight.
- 7.12.7 Explain how the motion of objects is affected by gravity.
- 7.12.1 Investigate the relationship between magnetism and electricity.
- 7.12.3 Explore how electromagnets have varying strength.
- 7.12.2 Describe the basic principles of an electromagnet.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

- SCRE.ETS3:10-Use a scientific journal and/or lab notebook for recording qualitative and quantitative data.
- 1.1.5 Evaluate and describe the phenomena related to Pascal's Principle.

Researching the Record Breakers:



"Tired of the same old, rickety wooden roller coasters? Crave more thrills than the typical vertical loops and camelback hills found at every local amusement park? Fortunately, roller coasters come in a mind-blowing profusion of styles, shapes, and sizes. From innovative track designs to unusual seating configurations, from ridiculous locations to bizarre theming, the experience never gets old." -Nick Weisenberger

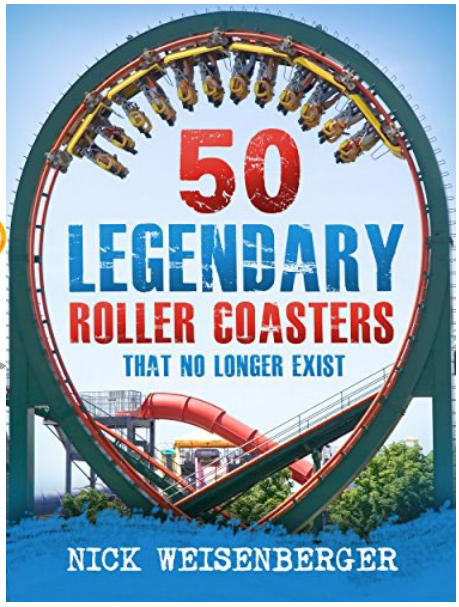


The best thing, for riders, about record-breaking roller coasters is that those records never last for long. We know it won't be long before another ride comes along and blows the previous record out of the water.

Explore with students some of the following resources (including the Amazing Roller Coaster Series).

After they've researched have write down or share their opinions (based on facts) about which coasters are the best of the best in each category. Which coaster will come out on top with the most votes and the staunchest supporters?

In *The 50 Most Unique Roller Coasters Ever Built* students will explore a roller coaster...
...powered by people
....inspired a popular computer game
....uses a Ferris wheel as a lift
....requires an on-board brakeman
....where the louder you scream the faster you go
....built on top of a skyscraper
....known as the "dog fart" coaster (yes, you read that right!).

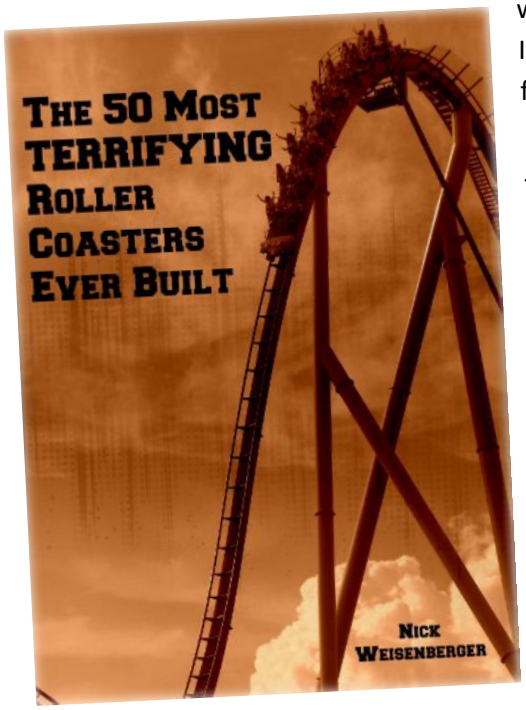


The 50 Most Unique Roller Coasters Ever Built is a list comprising unusual, and hard to find scream machines. Plus, get a peek into the future of roller coaster including new for 2023 coasters."

Write that Down! Writing Prompt Ideas

If you could resurrect any deceased roller coaster which one would it be?

There are currently over 4,000 operating roller coasters on the planet today. But did you know there have also been well over 3,000 coasters built throughout history that no longer exist? Countless historic scream machines are nameless, long since forgotten, having left no proof of ever terrorizing its riders, not even a photograph. While others, even after a hundred years, are still praised with regard and reverence.



If a roller coaster is "legendary" why is it torn down and removed in the first place? If it was such a special ride, why does it no longer exist?

50 LEGENDARY ROLLER COASTERS THAT NO LONGER EXIST explains what goes into the tough decision to remove a multi-million-dollar attraction and which roller coasters in history were the most notorious.

Write that Down! Writing Prompt Ideas

What factors make a roller coaster the most terrifying?

Mega roller coasters of today reach heights of over 400 feet and speeds over 100 miles per hour. Roller coasters towering taller than a certain height are terrifying for many individuals, but it would be boring to make a list of the world's tallest coasters. As a result, most of the bone-chilling machines in this list do not use sheer height to terrify, but prey on our fears and emotions in other, more creative ways. One element alone may not make a ride terrifying but the sum of all of its parts does. What factors make a roller coaster terrifying? Height, speed, inversions, backwards segments, unique track elements, darkness, and unexpected surprises all contribute to making your head spin and your knees tremble.

Where are the most terrifying roller coasters found? Who designs them? Which park builds the craziest rides? Find out by reading *The 50 Most Terrifying Roller Coasters Ever Built*!

Standards:

K

- SL.K.2. Confirm understanding of a text by asking and answering questions about key details and requesting clarification if something is not understood.
- SL.K.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- RI.K.2. With prompting and support, identify the main topic and retell key details of a text.
- W.K.7. Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
- W.K.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

1

- SL.1.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- SL.1.2. Ask and answer questions about key details in a text, e.g., one read aloud.
- RI.1.9. Identify basic similarities in and differences between two texts on the same topic (e.g., in illustrations, descriptions, or procedures).
- W.1.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.1.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.1.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

2

- SL.2.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- SL.2.1. c) Ask for clarification and further explanation as needed about the texts under discussion.
- RI.2.1. Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- W.2.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.2.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

- W.2.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

3

- SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.3.1. c) Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
- SL.3.1. d) Explain their own ideas and understanding in light of the discussion.
- W.3.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.3.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.3.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

4

- SL.4.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.4.1. c) Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
- SL.4.1. d) Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.
- W.4.8. Recall information from experiences or or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.
- W.4.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (e.g., "Explain how an author uses reasons and evidence to support particular points in a text").

5

- SL.5.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.5.1. c) Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.

- SL.5.1. d) Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
- W.5.8. Recall information from experiences or or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- W.5.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (e.g., “Explain how an author uses reasons and evidence to support particular points in a text”).

6

- SL.6.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others’ ideas and expressing their own clearly.
- SL.6.1. c) Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
- SL.6.1. d) Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing
- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- W.6.8. a) Gather relevant information from multiple print and digital sources;
- b) assess the credibility of each source;
- c) quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources."
- W.6.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

7

- SL.7.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others’ ideas and expressing their own clearly.
- SL.7.1. c) Pose questions that elicit elaboration and respond to others’ questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
- SL.7.1. d) Acknowledge new information expressed by others and, when warranted, modify their own views.
- W.7.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.7.8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

- W.7.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

8

- SL.8.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.8.1. c) Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
- SL.8.1. d) Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- W.8.8. Gather relevant information from multiple print and digital sources,
    - using search terms effectively;
    - assess the credibility and accuracy of each source;
    - quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- W.8.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced").

Estimation Launching Station: Comparing Coasters

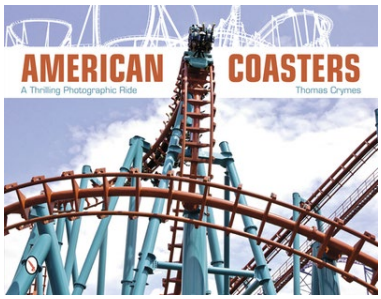
Information and activities gathered and modified from those at http://illuminations.nctm.org/LessonDetail.aspx?id=L241 © 2000 - 2012 National Council of Teachers of Mathematics. Used with permission for non-commercial educational use. All Rights Reserved.

No two coasters are the same. There are attributes that vary from coaster to coaster, attributes that make each scream machine uniquely thrilling and which lead roller coaster enthusiasts to travel across the country to seek them out, even if the ride only lasts 59 seconds. To have students get an idea of just how different each roller coaster can be from another, and to practice their estimation skills, have students to go to the Roller Coaster Database to view **ONLY photos** (only click the photo icon next to the name) of roller coasters from around the world or from a specific theme park such as Six Flags Magic Mountain. *With twenty operating roller coasters, Six Flags Magic Mountain holds the world record for most roller coasters in an amusement park.*

Tip: Click the 'gallery/grid' icon in the upper right-hand corner of the screen (next to the X) when you're looking at the photo to explore more photos of the coaster.

For example, at Magic Mountain:

- X2
- Tatsu
- The Riddler's Revenge
- Twisted Colossus



Additional resources: If you can't access the internet have students look at books such as, *American Coasters: A Thrilling Photographic Ride* by Thomas Crymes and *American Coasters 2*.

Remember! We're not looking at stats yet, just photos.

Students will choose two coasters, listing their names, and solely based on the pictures, predict which coaster they think is faster, which rises higher, which goes farther, and which takes longer to ride. ***With students younger than 3rd grade, they may still use this activity as a class discussion/project with using whole group comparisons and discussions. They may not be able to make estimation score calculations, but they will still be able to note differences and make comparisons and predictions.***
As students study their chosen two photos, ask questions to asked questions to clarify and extend their understanding of the content such as:

- **Which of the two coasters do you think is faster? Why? (Sample response: The Twisted Colossus because it looks higher and it looks like a pretty smooth ride.)**
- **About how fast do you think each coaster can go? Faster than a school bus? Faster than a car on a highway? Record your estimates in the first two rows of the chart on your Recording Sheet. (Estimates will vary.)**
- **Which of the two coasters is higher? Why do you think so? (Sample response: The X2 looks higher with the circular piece of track.)**
- **About how high do you think each coaster is? Record your estimates. (Estimates will vary.)**
- **Which coaster appears to have the longer track? Why do you think so? (Sample response: The Twisted Colossus looks longer because it has lots of dips and twists.)**
- **About how long do you think each coaster is? Record your estimates. (Estimates will vary.)**
- **Which ride do you think lasts longer? Explain why you think so. (Sample response: Tatsu, because it has to slow down as it tries to climb steep tracks.)**
- **About how long do you think each ride lasts? Record your estimates. (Estimates will vary.)**

Once students have made their comparisons and shared their estimates (justifying and defending their reasoning in a clear and logical manner), have them go to the Roller Coaster Database (www.rcdb.com) or one such as Theme Park Center: The Official Theme Park Blog to get verified data and POV videos on each roller coaster they chose.
Have students record this information on their Actual Data Table. Give students time to compare their estimates with the actual data for the two roller coasters.

Sample:

Estimate					Actual Data			
Coaster	Speed	Height	Length	Duration	Speed	Height	Length	Duration
X2	75 mph	150 ft.	500	1 min.	76 mph	175 ft.	3,610.0 ft	2:00
Tatsu	90 mph	200 ft.	1000 ft.	45 sec.	62 mph	170 ft	3,602.0 ft	2:30

Explain to the class that there is a way to calculate how good an estimate is. Show students the formula given below and have them use calculators to find the Estimation Score for each estimate they made. Make sure students understand that the lower the Estimation Score, the better the estimate.

$$\text{Estimation Score} = \frac{\text{Difference between estimated and actual amounts}}{\text{Actual amount}} \times 100$$

For example, suppose the actual speed is 50 mph and the estimate is 90 mph:

$$\text{Estimation Score} = \frac{90 - 50}{50} \times 100 = \frac{40}{50} \times 100 = 80$$

If students get stuck while using this formula with estimates of duration, you may want to suggest that they try changing each time into seconds only. For example, suppose the ride actually lasts 1:40 and the estimate is 45 seconds:

1:40 = 1 min. + 40 sec. = 60 sec. + 40 sec. = 100 sec.
45 sec. = 45 sec

$$\text{Estimation Score} = \frac{100 - 45}{100} \times 100 = \frac{55}{100} \times 100 = 55$$

Tell students to round each score to the nearest whole number. (If they haven't done decimal rounding yet, simply tell them to use just the whole numbers in their answers.)

If the students are familiar with percent, you can tell them that the Estimation Score is commonly called percent error.

Extension: Math Practice, Make it a Game!

Organize the class into pairs. Tell students that partners in each pair will take turns:

- Choosing a picture of a coaster
- Estimating the speed, height, length and duration of the ride, and
- Recording those estimates.

- Then partners work together to find and record the actual data. Students earn a point for each category (speed, height, etc.) in which their coaster is better than their partner's.

From the theme park website, Player A chooses a picture of a coaster that he or she thinks is fast, high, etc.

Player A estimates the chosen coaster's speed, height, length, and duration, and writes the estimates on the Roller Coaster Data activity sheet. (Students will evaluate these estimates at the conclusion of the activity using the formula to see if their estimating skills improved during the game.)

Player B repeats steps 1 and 2, trying to pick a coaster that appears to be faster, higher, etc. than Player A's estimates. These estimates are also written on the same activity sheet as Player A.

Together, the players get actual data for their coaster's speed, height, etc. from the Roller Coaster Database and record this information on the Roller Coaster Data activity sheet.

Have students compare the actual data for their coasters, noting which coaster is faster, higher, etc. by circling the greater measurement in each category. They award a point to the player whose coaster is faster, a point to the player whose coaster is higher, and so on. Players total their scores for the round.

Sample:

Estimate					Actual				
Coaster	Speed	Height	Length	Duration	Speed	Height	Length	Duration	Points
King Cobra	75 mph	150 ft.	500	1 min.	50 mph	95 ft.	2219 ft.	2:00	0
Vortex	90 mph	200 ft.	1000 ft.	45 sec.	55 mph	148 ft	3800 ft.	2:30	4

On the next round, Player B chooses a picture first, Player A chooses second. Players must always choose a picture that either player in the current round or in previous rounds has not used.

The player with the most points from all rounds is the winner. After the time is up, pose questions such as the following to students:

- **What features in a roller coaster will you look for that might contribute to a faster speed? (Sample responses: Height, a smoother track, not having too many dips and twists.)**
- **How many coaster pictures do you want to review before choosing one you think will score a lot of points?**
- **To the player who goes second: What will you look for in your roller coaster picture now that you have seen what your partner has chosen? Why do you think the roller coaster you're choosing goes faster (is higher, is longer, lasts longer) than your partner's?**

Use the following guiding questions about students' estimates:

- **How can you use the information from previous rounds to estimate the speed (height, length, duration) of this coaster from its picture?**
- **Why is your estimate for this roller coasters speed (height, length, duration) greater (less) than your previous roller coaster?**

- **To the player who goes second: About how much faster do you think this roller coaster goes than your partner's? Why do you think so?**

Are Your Estimates Getting Better?

After students have played a game of two or more rounds, ask them if they think their ability to estimate from pictures is improving. Have them see if their estimates have been getting better using the Estimation Score formula you practiced earlier.

Write that Down! Writing Prompt Ideas

A roller coaster tells its owners that it refuses to run anymore until we meet its demands. What kinds of demands might a roller coaster have? Think of funny, silly, or serious things that a roller coaster might want and how it would negotiate. Perhaps the cars running along its tracks tickle? Perhaps it's jealous that it's not the fastest roller coaster in the park anymore?

Roller Coaster Data

NAME ______________________________

Record the names of the roller coasters and the required data in the charts below.

	Estimate				Actual				
Coaster	Speed	Height	Length	Duration	Speed	Height	Length	Duration	Points

	Estimate				Actual				
Coaster	Speed	Height	Length	Duration	Speed	Height	Length	Duration	Points

	Estimate				Actual				
Coaster	Speed	Height	Length	Duration	Speed	Height	Length	Duration	Points

	Estimate				Actual				
Coaster	Speed	Height	Length	Duration	Speed	Height	Length	Duration	Points

Estimation Score Charts

Use the charts below to record your scores from the *Coaster Contest*.

Estimation Score Chart for _____

(First Player's name)

Round	Coaster	Speed	Height	Length	Duration
1					
2					
3					
4					
5					
6					
7					
8					

Estimation Score Chart for _____

(Second Player's name)

Round	Coaster	Speed	Height	Length	Duration
1					
2					
3					
4					
5					
6					
7					
8					

Standards:

K

- K.MD.1. Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
- K.MD.2. Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and describe the difference.
- SL.K.2. Confirm understanding of a text by asking and answering questions about key details and requesting clarification if something is not understood.
- SL.K.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- RI.K.2. With prompting and support, identify the main topic and retell key details of a text.
- W.K.7. Participate in shared research and writing projects (e.g., explore a number of books by a favorite author and express opinions about them).
- W.K.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.

1

- 1.MD.1. Order three objects by length; ex. compare the lengths of two objects indirectly by using a third object.
- 1.MD. 1 Measure lengths indirectly and by iterating length units.
- 1.MD.2. a) Express the length of an object as a whole number of length units
- SL.1.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- SL.1.2. Ask and answer questions about key details in a text, e.g., one read aloud.
- RI.1.9. Identify basic similarities in and differences between two texts on the same topic (e.g., in illustrations, descriptions, or procedures).
- W.1.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.1.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.1.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

2

- 2.MD.3. Estimate lengths using units of inches, feet, centimeters, and meters.
- 2.MD.1 Measure and estimate lengths in standard units.

- 2.MD.4. Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.
- 2.MD.5. Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units.
- SL.2.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- SL.2.1. c) Ask for clarification and further explanation as needed about the texts under discussion.
- RI.2.1. Ask and answer such questions as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- W.2.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.2.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.2.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

3

- 3.MD.1 Solve problems involving measurement and estimation, ex. intervals of time.
- 3.MD.1. a) Tell and write time to the nearest minute and measure time intervals in minutes.
- 3.MD.4. a) Generate measurement data by measuring lengths.
- SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.3.1. c) Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
- SL.3.1. d) Explain their own ideas and understanding in light of the discussion.
- W.3.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.3.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.3.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.

4

- 4.MD. 1 Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
- 4.MD.1. a) Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec.

    - b) Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit.
    - c) Record measurement equivalents in a two-column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in.
- 4.MD.2. Use the four operations to solve word problems involving:
    - a) distances,
    - b) intervals of time,
    - d) masses of objects,
    - e) money,
    - f) simple fractions
    - g) decimals,
    - h) problems that require expressing measurements given in a larger unit in terms of a smaller unit.
- 4.MD.4 Represent and interpret data.
- RI.4.7. Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams) and explain how the information contributes to an understanding
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- SL.4.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.4.1. c) Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
- SL.4.1. d) Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.
- W.4.8. Recall information from experiences or or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.
- W.4.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (e.g., "Explain how an author uses reasons and evidence to support particular points in a text").

5

- 5.MD.1. a) Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m),
    - b) Use these conversions in solving multi-step, real world problems.
- 5.MD.2. Represent and interpret data.
- SL.5.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.

- SL.5.1. c) Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
- SL.5.1. d) Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
- W.5.8. Recall information from experiences or or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- W.5.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (e.g., “Explain how an author uses reasons and evidence to support particular points in a text”).

6

- SL.6.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others’ ideas and expressing their own clearly.
- SL.6.1. c) Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
- SL.6.1. d) Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing
- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- W.6.8. a) Gather relevant information from multiple print and digital sources;
    - b) assess the credibility of each source;
    - c) quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources."
- W.6.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.6.2. Organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables).

7

- 7.11.3 Distinguish between speed and velocity.
- SL.7.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others’ ideas and expressing their own clearly.
- SL.7.1. c) Pose questions that elicit elaboration and respond to others’ questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.

- SL.7.1. d) Acknowledge new information expressed by others and, when warranted, modify their own views.
- W.7.7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- W.7.8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.
- W.7.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.7.2. Organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables).

8

- 6.Math.7 Use length to estimate and explain real-world problems.
- SL.8.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- SL.8.1. c) Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
- SL.8.1. d) Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- W.8.8. Gather relevant information from multiple print and digital sources,
    - using search terms effectively;
    - assess the credibility and accuracy of each source;
    - quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation."
- W.8.9. Draw evidence from literary or informational texts to support analysis, reflection, and research. e.g., "Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced").
- W.8.2. Organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables).

And We're Off!

What riders may not realize as they're cruising down the track at 95 miles an hour is that the coaster has no engine. The car is pulled to the top of the first hill at the beginning of the ride, but after that the coaster must complete the ride on its own. It isn't being propelled around the track by a motor or pulled by a hitch. The conversion of potential energy to kinetic energy drives the roller coaster, and all the kinetic energy you need for the ride is present once the coaster descends the first hill. Those high hills give your coaster the maximum potential energy for the rest of the ride. ***Have students heard of potential and kinetic energy? Can energy really be transformed from one type to another? If something "loses energy" where does it go?***

The purpose of the coaster's initial ascent is to build up a sort of reservoir of potential energy. The concept of potential energy, often referred to as energy of position, is very simple: As the coaster gets higher in the air, gravity can pull it down a greater distance. ***Discuss with students: You experience this phenomenon all the time, when? Can they think of examples? —*** think about driving your car, riding your bike or pulling your sled to the top of a big hill. The potential energy you build going up the hill can be released as kinetic energy — the energy of motion that takes you down the hill.

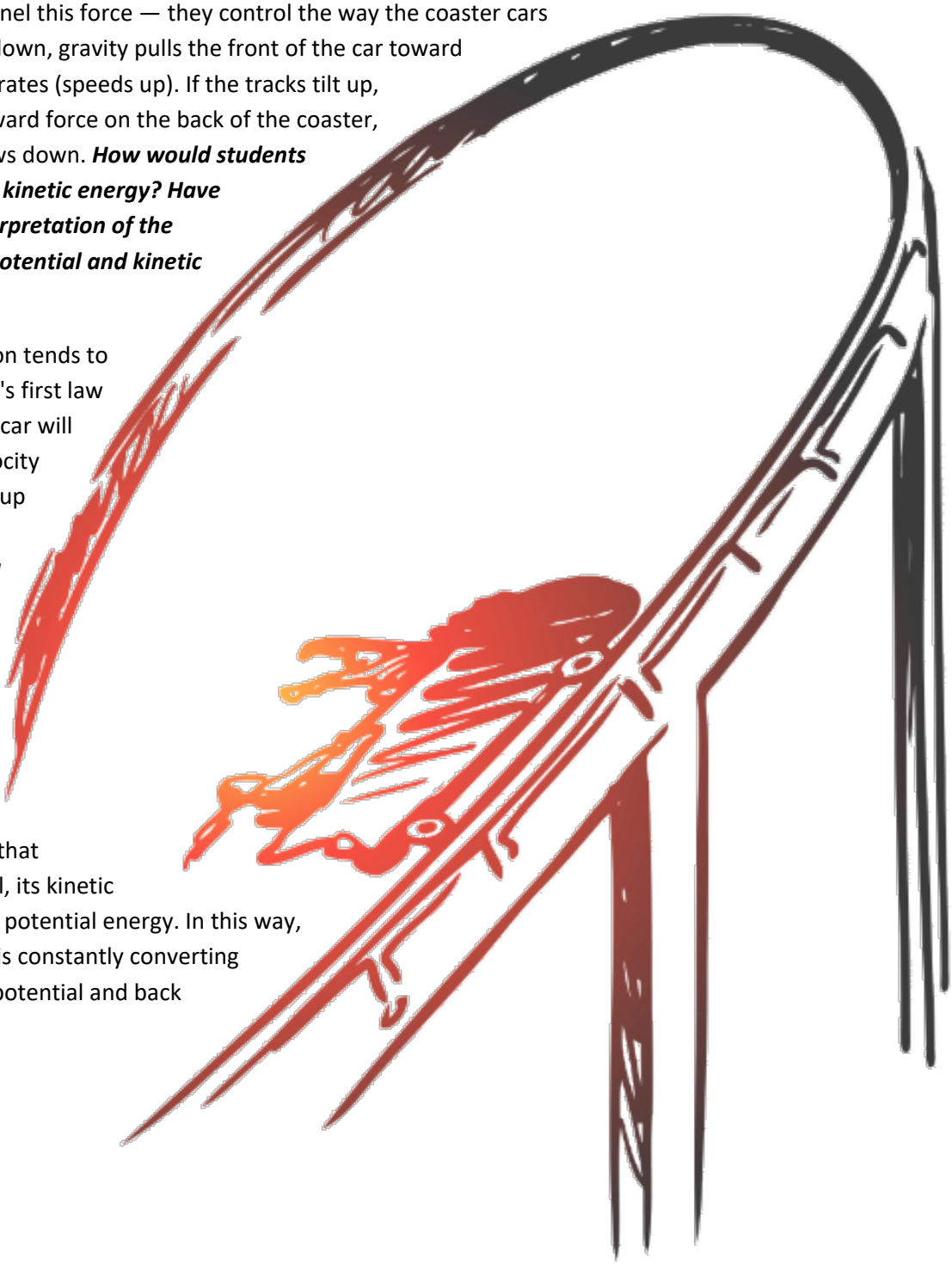
Once you start cruising down that first hill, gravity takes over and all the built-up potential energy changes to kinetic energy. Gravity applies a constant downward force on the cars.

A roller coaster's energy is constantly changing between potential and kinetic energy.

Draw a diagram of a large lift hill (a), followed by a dip (b), a second hill (c), and a loop-the-loop (d & e) before the end of the ride. Then discuss with students, at the top of the first lift hill (a), there is maximum potential energy because the train is as high as it gets. As the train starts down the hill, this potential energy is converted into kinetic energy — the train speeds up. At the bottom of the hill (b), there is maximum kinetic energy and little potential

energy. The kinetic energy propels the train up the second hill (c), building up the potential-energy level. As the train enters the loop-the-loop (d), it has a lot of kinetic energy and not much potential energy. The potential-energy level builds as the train speeds to the top of the loop (e), but it is soon converted back to kinetic energy as the train leaves the loop.

The coaster tracks channel this force — they control the way the coaster cars fall. If the tracks slope down, gravity pulls the front of the car toward the ground, so it accelerates (speeds up). If the tracks tilt up, gravity applies a downward force on the back of the coaster, so it decelerates or slows down. ***How would students compare potential and kinetic energy? Have students give their interpretation of the relationship between potential and kinetic energy.***



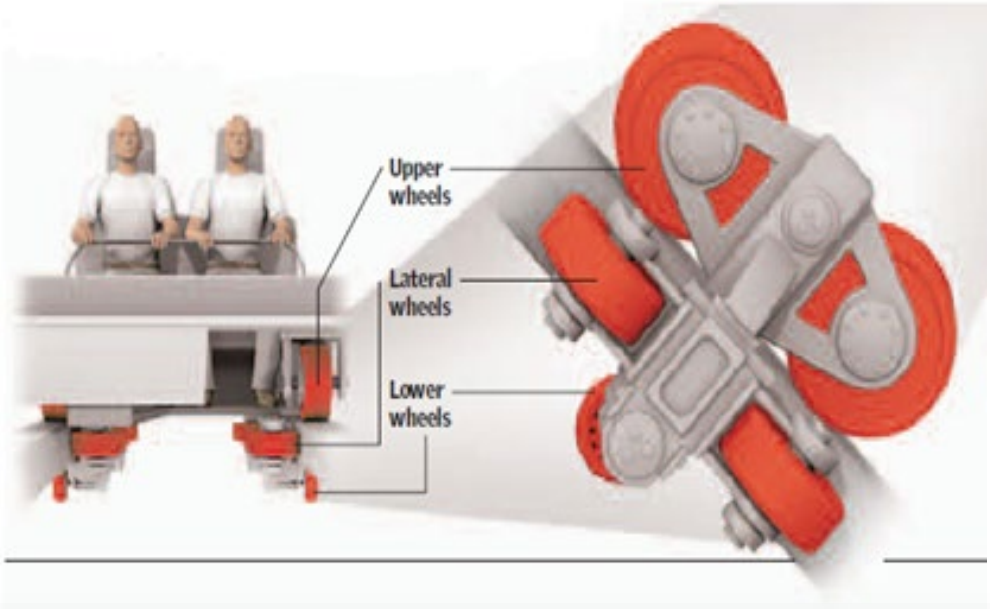
Since an object in motion tends to stay in motion (Newton's first law of motion), the coaster car will maintain a forward velocity even when it is moving up the track, opposite the force of gravity. ***Draw a diagram on the board as you discuss the hills and energy, ex. draw a large hill and a series of smaller hills after it.*** When the coaster ascends one of the smaller hills that follows the initial lift hill, its kinetic energy changes back to potential energy. In this way, the course of the track is constantly converting energy from kinetic to potential and back again.

This fluctuation in acceleration is what makes roller coasters so much fun. In most roller coasters, the hills decrease in height as you move along the track. This is necessary because the total energy reservoir built up in the lift hill is gradually lost to friction between the train and the track, as well as between the train and the air. When the train coasts to the end of the track, the energy reservoir is almost completely empty. At this point, the train either comes to a complete stop or is sent up the lift hill for another ride.

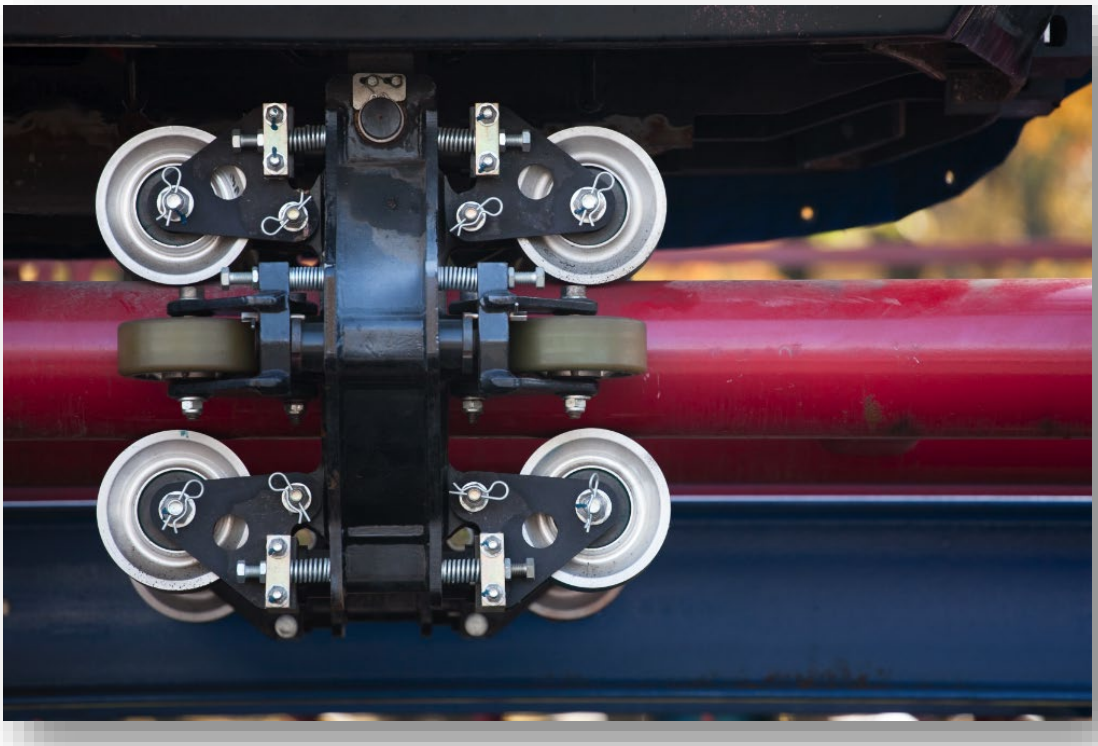
At its most basic level, this is all a roller coaster is — a machine that uses gravity, momentum, and inertia to send a train along a winding track.

Once you're underway, different types of wheels help keep the ride smooth. Running wheels guide the coaster on the track. Friction wheels control lateral motion (movement to either side of the track). A final set of wheels keeps the coaster on the track even if it's upside down. And brakes stop the car as the ride ends.

Wheels of Motion

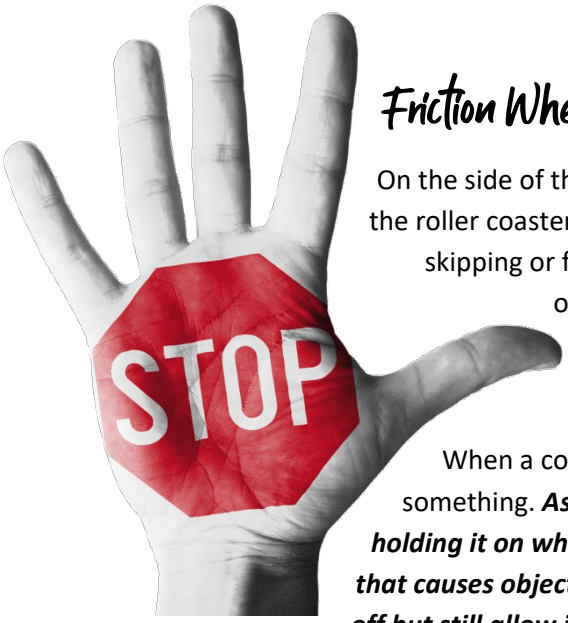


As coasters have evolved, they have become safer, more advanced, and more thrilling. On the original wooden coasters, the wheels would sometimes fall off or the car might fail to stop at the end of the track. Today's coasters are built with many safety features to keep riders safe while still allowing a thrilling ride.



Running Wheels

These wheels are the primary wheels of the coaster. They're used to guide the coaster down the track. Positioned on top of the tracks, like the wheels of a train, they are made of metal and grooved on one side with a lip on the other to limit side-to-side movement.



Friction Wheels

On the side of the track, friction wheels control the lateral, or sideways, motion of the roller coaster. This allows the coaster to handle extremely sharp turns without skipping or flying off the track. When you feel the coaster whiplash as it comes out of a turn, the friction wheels are holding the coaster in place.

Upstop Wheels

When a coaster flips upside down, it needs to be attached to the track by something. ***Ask students what would happen if there wasn't something holding it on when the car went around the loop. Have students identify the force that causes objects to fall to the earth. How might they keep the cart from falling off but still allow it to move around the track?*** Positioned underneath the track, the upstop wheels hug the bottom of the rail and prevent the cars from becoming airborne and hold the coaster down, even when inverted (upside down). Without these wheels, the coaster could not handle the extreme loops common in today's amusement parks.

Watch this!

[Impossible Engineering: Why Don't Roller Coasters Fly Off the Tracks?](#) See how "Upstop wheels apply friction under the tracks to prevent roller coasters from derailing during zero-G drops and turns."

Watch This! Engineer Explains Every Roller Coaster for Every Thrill | A World of Difference | WIRED

In this edition of "A World of Difference," Korey Kiepert, owner, and engineer with The Gravity Group, goes through the 8 main types of roller coasters and breaks down how they work as well as the decisions behind why they get built in the first place. Korey explains the difference between a giga coaster and a strata coaster, as well as what separates a "wild mouse" from a "mine train." Watch on [YouTube](#) or at [Wired](#).

Wooden or steel coaster: Does it really make a difference?

Roller coasters can be wooden or steel, and can be looping or non-looping. Riders notice a big difference in the ride depending on the type of material used. In general, wooden coasters are non-looping. Many times, they're also not as tall and not as fast, and they don't feature quiet as extremely steep hills (though they can seem quite steep when you're flying up and down them) or as long a track as steel ones do.

Wooden coasters offer one advantage over steel coasters, assuming you're looking for palm-sweating thrills: they sway a lot more. Tubular steel coasters allow more looping, higher and steeper hills, greater drops and rolls, and faster speeds.

Ask students what might be some advantages of wooden roller coasters over steel? Wooden roller coasters are amusement park staples. They offer a rickety ride that preceded the steel variety in theme parks across the country. Wooden coaster enthusiasts enjoy the rough ride and the feeling of being jostled around on the tracks.

To many, these coasters represent a part of theme park history that can still be enjoyed by today's coaster enthusiasts. Many wooden coasters in today's theme parks have been around since the 1950s. In fact, the "Leap-the-Dips" coaster at Lakemont Park in Pennsylvania has been operating since 1902.

One advantage of wooden roller coasters over steel coasters is the cost to build them. Wood is cheaper than steel, making it a cheaper way to create a thrill ride. However, wooden coasters typically require more maintenance. According to ThemedAttraction.com, all roller coasters are subject to daily inspections. But on wooden roller coasters, technicians can walk the entire track, checking for loose nuts and bolts and any other irregularities, attending to the ride with a more hands-on approach. This differs from steel coasters, as technicians cannot walk the entire track and must use binoculars to check for potential hazards.

One of the primary struggles in managing huge, physically complicated assets like these is that it is usually not practical to inspect every square inch of the structures and rides. A new company, 'Flyability,' is using drone (flown by a certified pilot) called 'Elios' for inspections, "cutting inspection times from 10-20 hours to just 1-2 hours, and potentially reducing the cost of inspection by more than 80%."[16]

Did You Know?

There is more than meets the eye when it comes to being an amusement ride inspector. According to Zippia they make an average of $22.11 an hour. That's $45,983 a year! The top 10 percent makes over $81,000 per year. Between 2018 and 2028, the career is expected to grow 7% and produce 7,700 job opportunities across the U.S.

While steel roller coasters are generally taller, longer, faster, smoother and considered more thrilling than wooden roller coasters, they can also engineer wooden roller coasters with similar intensity.

For instance, Cedar Point's "Mean Streak" in Ohio features a 161-foot drop and 5,400 feet of track. The "El Toro" coaster at Six Flags Great Adventure in New Jersey is a 181-foot-tall wooden coaster that reaches speeds

[16] https://www.flyability.com/casestudies/amusement-park-inspections-faster-safer-and-more-economical-with-the-elios

of 70 mph. It's the only wood coaster in the world to feature a 76-degree angle drop. Wooden coasters are one of the oldest means of theme park entertainment and continue to be enjoyed today's riders.[17]

Watch this!

Roller Coasters: Wood VS Steel "There's a well-known rivalry surrounding roller coasters. It's not one of height, speed, or length; but one of material - wood vs steel. As most of you already know, the first roller coasters were made out of wood, but today the majority of coasters are steel! So what are the differences between these two materials, why has steel gone onto dominate the industry and most importantly, which is better?"

El Toro! "When taking the bull by the horns was first said, we don't think they anticipated ANYTHING like this! Climb 181 feet in the air and plummet down 176 feet at 70 mph as El Toro traverses its 4,400-foot-long course! From Airtime to swift s-bending turns, this bull loves to keep you on your toes!" **Do students think the track looks bumpier as they move along? Do they notice the 'jostle'? Would they rather ride a wood or steel coaster?**

Now take a ride on the Mean Streak! Built by Curtis D. Summers, Inc., Mean Streak opened in 1991 at Cedar Point as the world's tallest (161 feet) and fastest (65 mph) wooden roller coaster. More than 26 million guests have boarded its three trains of green, gold and red with signature storm cloud and lightning bolt graphics, and experienced its 155-foot drop, tall hills and rattling turns

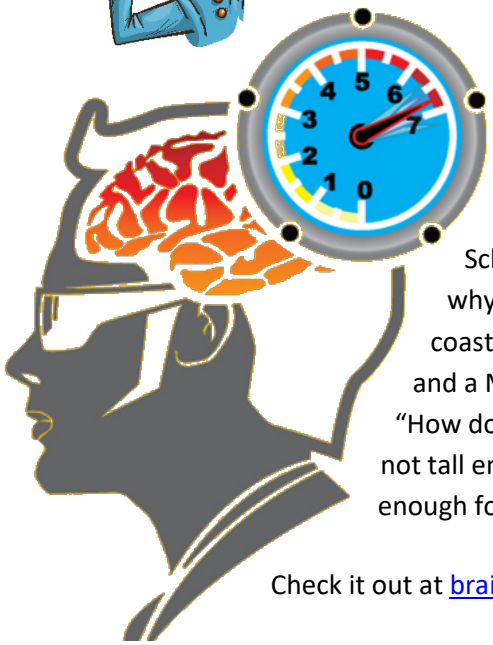
[17] *Information gathered from http://www.learner.org/interactives/parkphysics/coaster.html © Annenberg Foundation 2012. All rights reserved. And, from Tom Harris at, "How Roller Coasters Work" HowStuffWorks.com. http://science.howstuffworks.com/engineering/structural/roller-coaster3.htm. All rights reserved.*

over more than 1.7 million board feet of treated Southern yellow pine. It closed for good in September 2016. **Would students bring it back if they could or is it better lost to history?**

"In all my years," thought Mine Adventure, an old wooden roller coaster relic, "I've had lovers and haters, criminals, and kids take a spin in the mine cart. But I've never had passengers like this..."

Your best friend is terrified of roller coasters but doesn't want to miss the class trip to the theme park next week. You decide to go there with her ahead of time to help her get past her fear.

Listen up! Roller coasters: from dream to extreme.



"Up the hill and down the drop, work on those auditory skills and hop aboard this episode of Brains On!

How do roller coaster designers go from dream to reality? Before they start building have students listen as world-renowned roller coaster designer Alan Schilke tells us how he does it in this Brains On podcast episode. Also includes — why do some people feel sick or dizzy after riding them? And how do coasters make you feel like you're floating? Plus: a tricky mystery sound and a Moment of Um that answers the question, "How do boomerangs come back?" Even if you're not tall enough for every ride, you're definitely tall enough for this episode."[18]

brains on!

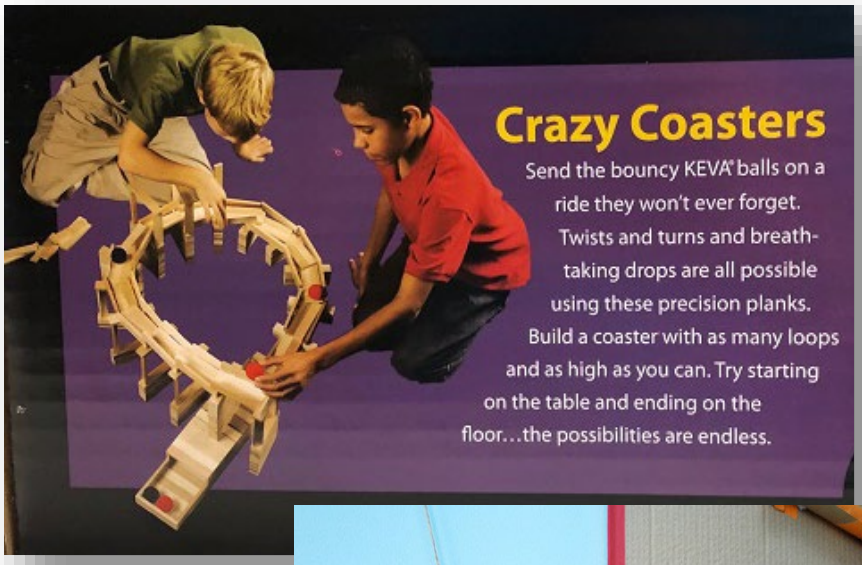
Check it out at brainson.org

Write that Down! Writing Prompt Ideas:

You are designing a roller coaster in space. How would you get it to work without Earth's gravity?

[18] *Information gathered from https://www.brainson.org/episode/2014/12/17/roller-coasters-from-dream-to-extreme. All rights reserved*

Extension: Grab the Bull by the Horns!



In honor of all the wild wooden and super steel coasters challenge students to put their energy to use and build their own crazy coaster from available materials.
Can they keep their ball on the tracks or will it fly free?

Ideas for Materials:

- KEVA planks, ex. Contraptions box
- Cardboard tubes (ex. from paper towels, toilet paper, plastic wrap, or other tubes)
- Colorful tape
- Marbles or ping pong balls
- Craft sticks
- Hot glue guns
- Glue dots
- Scissors
- Blocks
- Paper plates: Look for plates with a design on them and a smooth rim around the edge.

Watch this! Backyard coasters?

Want your own coaster at home? Then check out the work of Paul Gregg, a retired aerospace engineer who holds 29 US and foreign patents, two special invention awards, and was Boeing Aerospace Engineer of the Year in 1988. Paul uses his engineering skills to design and test his backyard roller coasters until he can prove they are reasonably safe to ride and operate (which his grand children love!)
Read this interview and then check out his YouTube channel!

Standards:

K

- K.LS1.3 Explain how humans use their five senses in making scientific findings.
- K.PS1.3 Construct an evidence-based account of how an object made of pieces can be disassembled and made into a new object.
- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- 7.11.1 Explore different ways that objects move.
- W.K.7. Participate in shared research and writing projects.
- K.ETS1.1 Ask and answer questions about the scientific world and gather information using the senses.
- K.ETS1.2 Describe objects accurately by drawing and/or labeling pictures.
- K.ETS2.1 Use appropriate tools to make observations and answer testable scientific questions.
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts.

1

- W.1.7. Participate in shared research and writing projects.
- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- ETS1:1 Solve scientific problems by asking testable questions, making short-term and long-term observations, and gathering information.
- ETS1: 2 1) Use appropriate tools to make observations and answer testable scientific questions.

2

- W.2.7. Participate in shared research and writing projects.
- 2.ETS1.2 Develop a simple sketch, drawing, or physical model that communicates solutions to others.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 2.ETS1.3 Recognize that to solve a problem, one may need to break the problem into parts, address each part, and then bring the parts back together
- 2.ETS1.4 Compare and contrast solutions to a design problem by using evidence to point out strengths and weaknesses of the design.
- 2.ETS2.1 Use appropriate tools to make observations, record data, and refine design ideas.

3

- 3.ETS2.1 Identify and demonstrate how technology can be used for different purposes.
- W.3.7. Conduct short research projects that build knowledge about a topic.
- 7.Inq.3 Maintain a science notebook that includes observations, data, diagrams, and explanations.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- 7.11.1 Plan an investigation to illustrate how changing the mass affects a balanced system.
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 7.11.2 Demonstrate how changing the mass affects a balanced system.

4

- 4.ETS1.1 Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.
- 4.ETS2.1 Use appropriate tools and measurements to build a model.
- 7.11.1 Recognize that the position of an object can be described relative to other objects or a background.
- 7.11.2 Design a simple investigation to demonstrate how friction affects the movement of an object.
- 7.11.3 Investigate the relationship between the speed of an object and the distance traveled during a certain time period.
- 7.11.1 Identify the position of objects relative to fixed reference points.
- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion.
- 7.11.3 Complete a coordinate graph, table, or diagram to describe the relative positions of objects.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.
- 7.11.5 Design and implement an investigation to determine that the speed of an object is equal to the distance traveled over time.
- 7.11.1 Describe the position of an object relative to fixed reference points.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- 4.ETS2.2 Determine the effectiveness of multiple solutions to a design problem given the criteria and the constraints.
- 4.ETS2.3 Explain how engineers have improved existing technologies to increase their benefits, to decrease known risks, and to meet societal demands (artificial limbs, seatbelts, cell phones).
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.

5

- 5.ETS2.3 Identify how scientific discoveries lead to new and improved technologies.
- 5.ETS1.1 Research, test, re-test, and communicate a design to solve a problem.
- 7.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled.
- 7.11.1 Predict how the amount of mass affects the distance traveled given the same amount of applied force.
- 7.11.2 Explain the relationship that exist among mass, force, and distance traveled.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
- 5.ETS1.2 Plan and carry out tests on one or more elements of a prototype in which variables are controlled and failure points are considered to identify which elements need to be improved. Apply the results of tests to redesign the prototype.
- 5.ETS1.3 Describe how failure provides valuable information toward finding a solution.
- 5.ETS2.2 Use appropriate measuring tools, simple hand tools, and fasteners to construct a prototype of a new or improved technology.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.

6

- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

7

- W.7.7. Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- 7.11.3 Distinguish between speed and velocity.
- 7.11.4 Investigate how Newton’s laws of motion explain an object’s movement.
- 7.11.3 Summarize the difference between the speed and velocity based on the distance and amount of time traveled.
- 7.11.4 Recognize how a net force impacts an object’s motion.
- 7.11.3 Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.11.4 Identify and explain how Newton’s laws of motion relate to the movement of objects.

- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

8

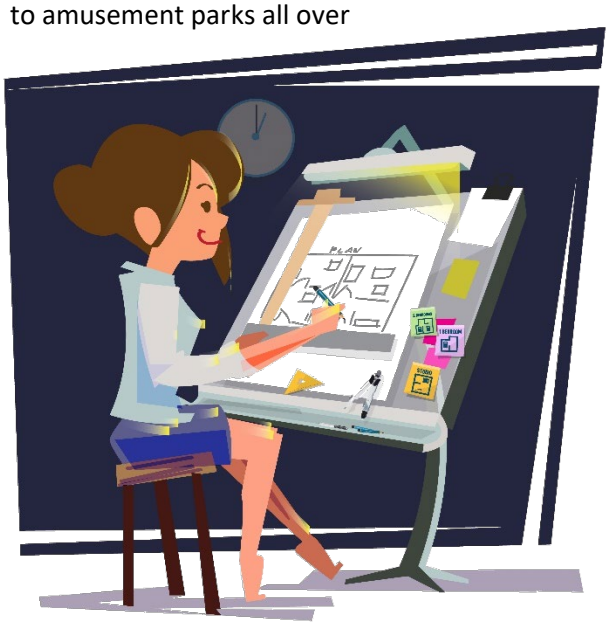
- 7.12.5 Recognize that gravity is the force that controls the motion of objects.
- 7.12.5 Explain the difference between mass and weight.
- 7.12.7 Explain how the motion of objects is affected by gravity.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- RST.6-8.9. Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.
- WHST.6-8.2. Write informative/explanatory texts, including the narration of scientific procedures/ experiments, or technical processes. Include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
- SCRE.ETS3:10-Use a scientific journal and/or lab notebook for recording qualitative and quantitative data.

Coaster Challenge!

Using forces of nature (and quite a bit of cardstock) students will make a marble 'rider' loop-de-loop on a track that they design.

The Project

The students are designers of roller coasters for a company that sells coasters and rides to amusement parks all over the world. They have just developed a new roller coaster and need to prepare a portfolio of materials for the potential buyers. This portfolio must include the roller coaster design (including their scale drawings and calculations of scale), the speed of the coaster, and the cost of the coaster.



Using the principles of potential and kinetic energy, the students should be able to design their investigation to demonstrate the difference between potential and kinetic energy through constructing a roller coaster. As the marble moves down, potential energy changes to kinetic energy. As the marble moves up, kinetic energy changes to potential energy.

Friction is also a factor because it uses up some of the potential energy so there is not as much kinetic energy available.

The potential energy at the top of the roller coaster must be enough to move the marble through all the loops and hills without stopping.

Note: You will want to set a length of time the ride must last as part of the challenge. Ex. 30 seconds.

Materials:

- Cardstock, white and colored (six different colors)
- Marbles (for riders)
- Ball-point pens, for scoring templates
- Pencils (for drawings, notes, and keeping track of costs, measurements, etc.)
- Notebook paper (for notes, keeping track of costs, measurements, putting together the portfolio, calculating speed, etc.)
- 12" rulers (1-2 per group)
- Magazine or catalog - used as a cushion, it helps to score the templates when tracing.
- Rolls of transparent tape (1-2 per group) Ex. One class may need six rolls of 3/4" x 600" transparent tape.
- Roller Coaster Element Standard & Advanced Templates from paperrollercoasters.com (an average class will need six times as many pre-printed sheets of card stock and marbles as found in an Individual Set):
    - Copy the structural pieces (i.e., columns, beams, diagonal supports, and shelves) on white paper. Then **copy each of the other pieces on different colored paper**. That makes it much easier for the students to find the desired piece and copy the template and use it to inspire a redesign or adjustment. It also helps you to see which pieces are getting low.
    - Cut the sheets into strips using a paper cutter or scissors. Tips: *Cut along every thin gray line.* ***Practice making each piece, so you'll be able to explain it to your students****.*
    - *Create a sample reference board with each stage of each piece (including a completed one) for students to go to when confused. This saves the teacher being asked many many times "How does this one go?" You'll want to decide on a price for each piece to help students calculate how much their roller coasters would cost to 'build' for their portfolios.*
- The Booklet Step-by-Step Instructions for Building Incredible Roller Coasters by Andrew Gait, www.paperrollercoasters.com

- A Master Template reference board with each template at each stage from initial cuts to final construction and a price for that piece
- Scissors (1 per student)
- Graph paper (for scale drawings, multi-view drawings of each group's unique track element template, etc.)
- Stop watches (1-2 total that students can borrow)
- Optional: Foam board or cardboard for bases
- Optional: cup and/or other materials to add in
- Optional: mailing labels to identify areas and shifts of potential and kinetic energy on the roller coasters

Students will learn about common vision, teamwork, and division of labor. For example, Disney hires a team that includes a cross section of wildly different disciplines to handle the construction of a new ride. These people are called "Imagineers," a word that combines "engineers" and "imagination," like the concept map an Imagineer drew on a napkin.

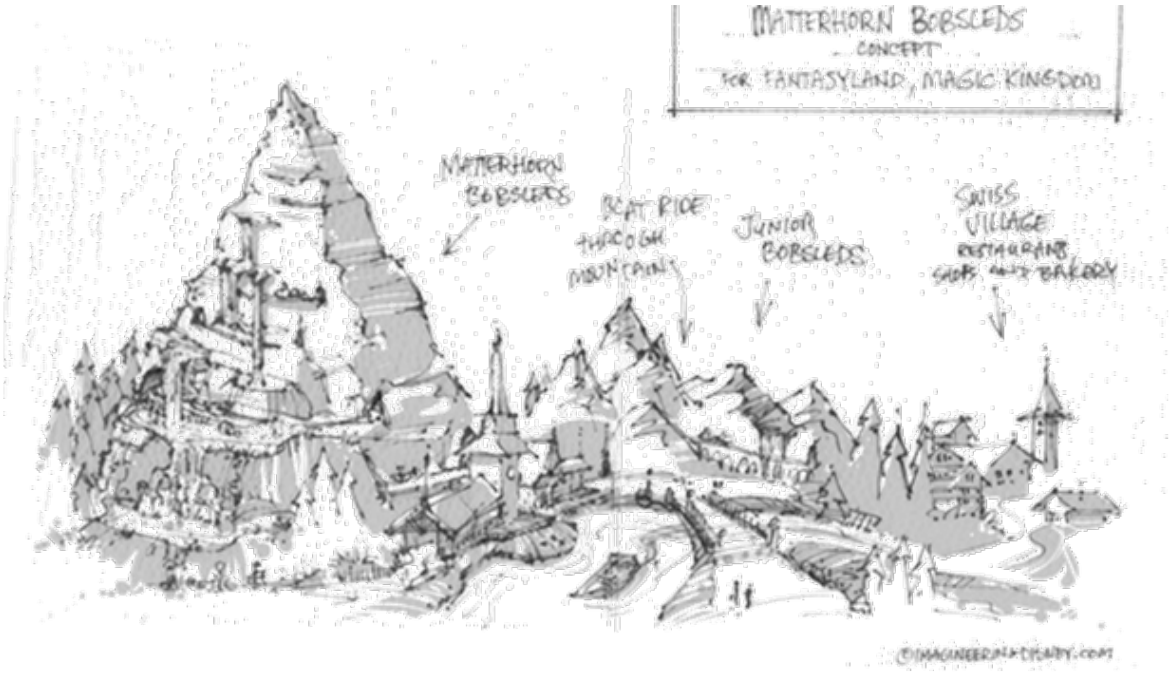


Image Credit: Imagineering Disney. http://www.imagineeringdisney.com/blog/2010/7/25/matterhorn-for-magic-kingdom-fantasyland.html

Getting it ALL on Paper

To give your students some imaginative ideas for their roller coasters, show your students all the roller coasters in the gallery on the website: www.PaperRollerCoasters.com and other sites. Have students [individually, in pairs, or in small teams] then build a roller coaster using a marble, cardstock, foam board or cardboard base, scissors, and tape. Build the support structure!

As stated In this challenge, prior to the final competition, teams design, build, and test a Roller Coaster track to guide a ball/sphere that uses gravitational potential energy as its sole means of propulsion to travel as close as possible to a Target Time and meet the specification guidelines.

Staying on Track with the Budget!

Roller coasters form the heart of nearly every theme park – providing visual and ride entertainment. But, if you're planning to build one, you can often expect costs to be extremely high.

In the real world, engineers do not have unlimited resources to build a rollercoaster.

Some of the world's most popular rollercoasters cost upwards of $100 million to build. While most won't cost that much, you can still expect prices to be high. The average cost to build a roller coaster is about $8 million dollars, and it typically involves the input of the entire engineering team.

"So, how much does it cost to build a rollercoaster? On average, about $5 million. That works out to an average of $1,000-$2,000 per foot. In addition, pre-built roller coasters often cost between $700,000 and $1,500,000 each depending on size."[19]

Cost also depends a lot on the technology used and what size your roller coaster is going to be.

"Often, the size of your roller coaster will be one of the most important factors in pricing the project.

Roller Coaster Type	Minimum Cost	Maximum Cost	Average Cost
Accelerator Coaster	$12,500,000	$25,000,000	$16,000,000
Flying Roller Coaster	$12,000,000	$50,000,000	$18,000,000
Bobsled Roller Coaster	$2,000,000	$12,000,000	$5,000,000
Stand-Up Coaster	$3,000,000	$14,000,000	$5,000,000
Floorless Roller Coaster	$8,000,000	$20,000,000	$15,000,000
Dive Coaster	$9,000,000	$25,000,000	$12,000,000
Inverted Roller Coaster	$6,000,000	$28,000,000	$14,000,000
Pipeline Roller Coaster	$3,000,000	$20,000,000	$14,000,000
Wing Coaster	$12,000,000	$30,000,000	$20,000,000

For example, the Kiddie Coaster at Rye Playland is just 300 feet long and 16 feet high. It cost just $2,537.50 to build in 1927. Adjusted for inflation, that works out to $43,284.50, today.

On the other hand, Son of a Beast, a record-breaking wooden rollercoaster opened in 1999; in today's dollars, it would have cost $35,631,212.48. But at 7,032 feet long and 218 feet tall, it's also significantly bigger."

Contemplating Costs & Cost Factors

Explore the ins and outs of coaster construction costs with students in this article [How Much Does It Cost to Build A Roller Coaster?] (2022) by the Cost Guys.

Learn more about cost factors such as:

Design: The design or theme of your roller coaster will be an extremely expensive part of the total cost.

For example, most "simple" coasters, consisting of rails and a cart cost somewhere between $4,000,000 and $12,000,000. Bigger coasters with themed displays can cost well over $30,000,000.

The Expedition Everest at Disney's Animal Kingdom in Florida, for instance, is one of the most expensive roller coasters ever built.

[19] https://thecostguys.com/business/build-roller-coaster

At $100,000,000, it's out of budget for almost any theme park but Disney. But at 199.5 feet, with almost 4,000 feet of track, it's also massive. And the artificial mountain contains over 38 miles of rebar and 10,000 tons of concrete.

Not all designs have to be that expensive. Many coasters feature no embellishments at all. Others feature simple blinking lights.

But, any design you opt for will have to be drawn up and brought to life.

Engineering/Architecture: Most organizations building roller coasters purchase a roller coaster design or technology. They then modify the track and design to meet their speed, height, and theme needs. even prefabricated roller coasters can be extremely expensive. For example, Intamin's famous prefabricated wooden roller coasters start from about $10 million.

In other cases, you can buy a prefabricated steel coaster for as little as $30,000 for a small one. You're much more likely to pay somewhere between $750,000-$1,250,000.

If you want to pay to have one designed especially for you, you'll pay significantly more.

Here, mechanical engineers, electrical engineers, and civil engineers must work together to create a design that is structurally sound, functionally sound, and "fun".

Each of these people will require a salary ranging between $50 and $150 per hour.

In addition, with no guarantee on how long it takes to design something creative, the amount of design time can vary significantly.

Materials: Nearly all coasters are made of wood, steel, or a combination of the two. All coasters will also use concrete for the foundations. However, every aspect of building a roller coaster must be considered. Those material costs can be immense.

Material	Cost Per Square Foot
Steel	$6-$120
PVC	$4-$8.50
Wood Lumber	$2-$18
Plywood (Cars)	$4.50-$18
Concrete (reinforced)	$4-$12
Fiberglass	$0.88-$1.54
Rebar	$1.40-$2.55
Piles	$12-$819

For example, the Pepsi Max Big One Coaster contains 2,215 tons of steel and over 1,270 wooden piles. The Expedition Everest contains over 5,000 tons of steel and 10,000 tons of concrete.

Considering you may need several hundred thousand square feet of any one of these materials, material costs are normally the largest cost factor in your build.

Land Preparation: Before you install your coaster, you'll have to clear and prep the land. Often, this means correctly measuring and marketing support areas for the coaster. This can range from $1.45-$3 per square foot to clear the land. You can also expect to pay $18-$60 per foot for drilling or driving piles if you're in soft soil.

Electrical Work: Electrical work, including wiring, lighting, circuit boards, etc., can be considerable. In most cases, wiring is done during construction. Electrical engineers typically work for $44-$125 per hour in the United States. In addition, electricians can earn anywhere from $18-$125 per hour in most parts of the US

Foundation: Whichever route your park takes, you'll need significant foundation work.

Plumbing: Most coasters need drainage, wire protection, and other plumbing installed. That becomes more impactful if your coaster has water features such as spray or waterfalls.

Maintenance Cost: Depending on the size and material used for the coaster, you might need anywhere from $10,000-$100,000+ per year for maintenance.

Construction and Labor (XTime): You can expect labor costs to total between $11,200 and $125,000 **per day**, with an average of about $30,000-$40,000.

Did you know? Most roller coasters around the world are made and built by one of 19 different companies, like The Gravity Group, where Korey Kiepert, owner and engineer, works. Some parks choose to have their own engineers and designers. However, almost all existing roller coasters are designed by one of those 19 companies or a company that has since gone out of business or sold to another.[20]

Something to think about: Would students want to do any of the jobs mentioned as a career? Why or why not?

Your Turn!

It is helpful and realistic to have students practice calculating costs for materials and staying within a budget.

Part of the challenge is to construct the most cost-effective rollercoaster possible. During construction students must also calculate the cost of the materials they use to construct their rollercoaster, including any they wasted or broke.

Cost: Calculate the cost of their rollercoaster by using the following Cost Specifications:

[20] https://thecostguys.com/business/build-roller-coaster

Tailor the budgeting challenge to the age and capabilities of your students as well as what the standards expect them to understand.

$ _____ for 1 Roll of Tape (ex. $1,000)

$ _____ per beam

$ _____ per support

$_____ per funnel

$ _____ per loop

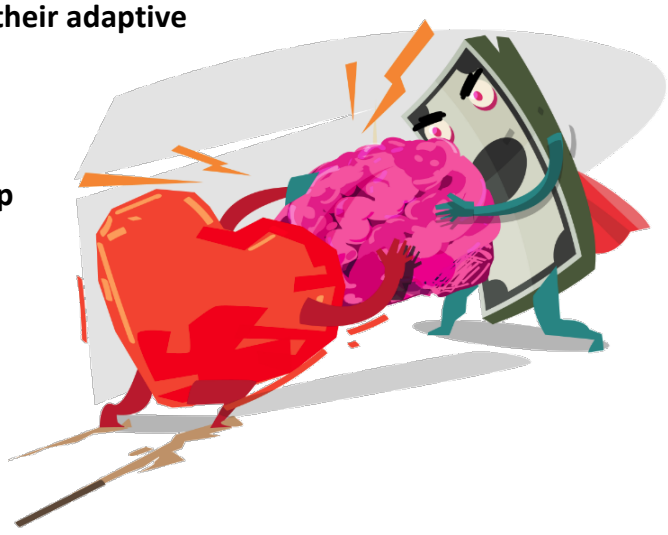
$ _____ etc.

Put the cost of each part on your parts reference board.

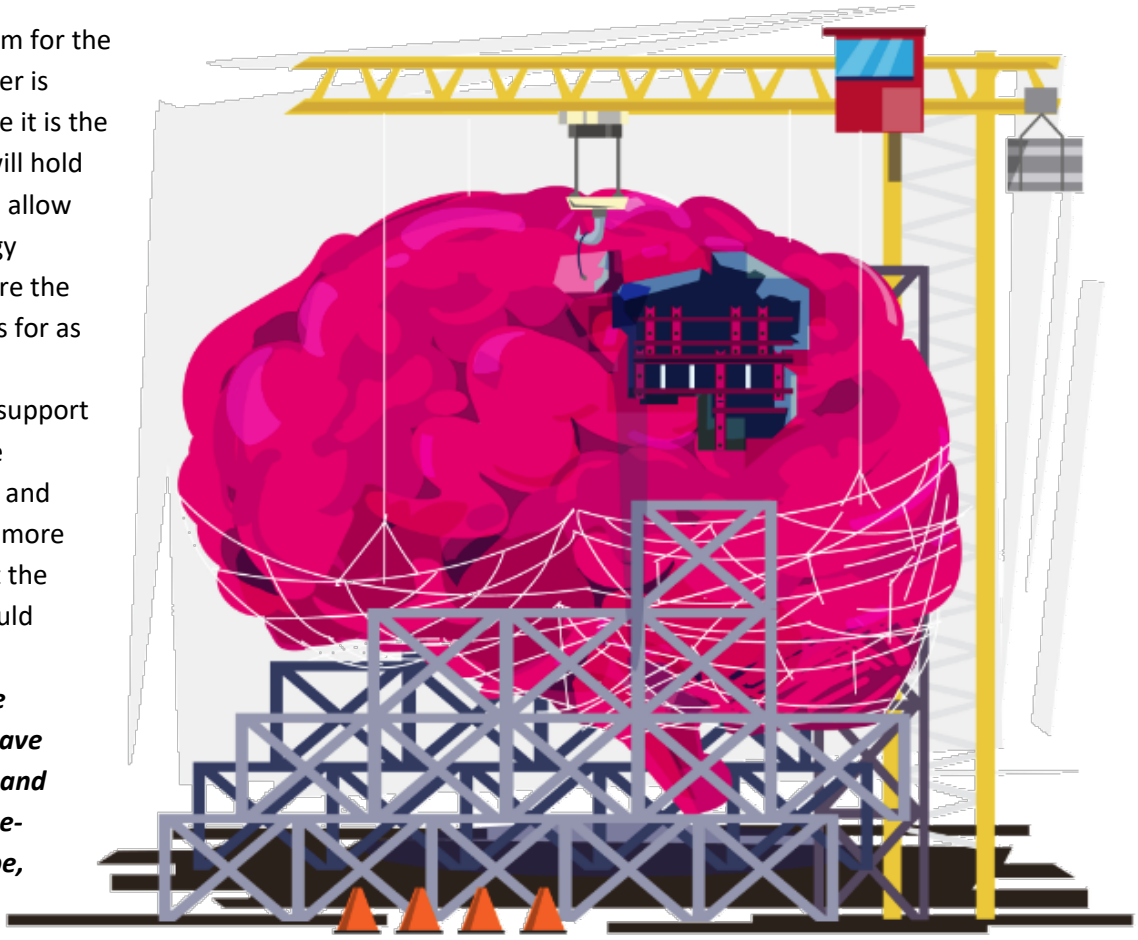
Options & Ideas: You can also charge students for an 'engineering consultation' if they ask you to help them with a template or design element after the initial instruction is complete. Pre-built templates could cost more. Have students have to calculate in a cost for time spent on construction. The possibilities are endless.

After reviewing and testing sample templates of track pieces, structural pieces, and other roller coaster elements (i.e., columns, beams, diagonal supports, and shelves), have students use their imaginations and engineering skills to construct their own templates for additional or unique track elements, using paper and pencil, to form and format the shapes on cardstock and test out their designs. Have students design a series of multi-view drawings that others could use to reconstruct their adaptive design and test its effectiveness.

Option: If other students want to use their unique element they could 'sell' them for a price and recoup some of their budget costs.



The Support System:



The support system for the paper roller coaster is important because it is the framework that will hold the track in place, allow for efficient energy transfer and ensure the roller coaster lasts for as long as possible.
The intent of the support structure is to use geometric shapes and angles to provide more strength than just the material alone could provide. **[*While constructing have discussions and have students analyze and compare the three-dimensional shape, they are creating to their two- dimensional shape counterparts, and describe their similarities, differences, parts (e.g., number of sides and vertices/ "corners") and other attributes (e.g., having sides of equal length), triangles are the strongest shape to build with, etc.*]**

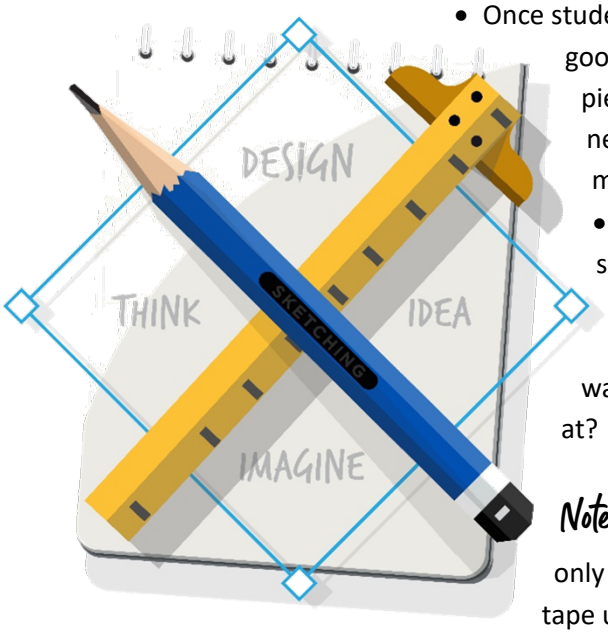
Design Parameters

- They will need more emphasis to be given to the overall design and quality of construction than just the simple "it needs to remain upright" goal.
- The columns and all supports must fit within the foundation (ex. foam board) provided if you are having them use a foundation.
  The structure must be rigid and not be moved or shifted while the marble is moving down the track. All columns must rise at a 90-degree angle from the foundation, older students may be required to measure the angles using a compass. Columns should not twist or be miss-shaped. All columns should be rectangular. Note: They can cut them to different lengths!

- Diagonal supports will be affixed at 45-degree angles (measured using a compass) to the column and will be secured on both ends. Horizontal beams must travel at 90-degree angles from the column and must be rectangular. No twisting or warping.

Measurement: Building it Up Inch by Inch

- With younger students have them measure and record the length of each element or piece by selecting and using appropriate tools such as rulers, yardsticks, meter sticks and measuring tapes.
- Have students use length units of different lengths for the two measurements, ex. inches and centimeters.
- Have younger students order three components by length; and compare the lengths of two objects indirectly by using a third object ("See, this one is longer than those two, we should use it next.")
- Have older students measure using appropriate tools to determine how much longer one support is than another, expressing the length difference in terms of a standard-length unit and record it.



- Once students have a good understanding of the average piece sizes, they can then estimate what size element will be needed next, using units of inches, feet, centimeters, and/or meters.
- These measurements can also be used to determine a scale when their roller coaster is complete. They can include this scale as part of their portfolio. If their roller coaster is 24 inches tall, how tall would it be in real life if their scale was 1 inch for every ____ feet? What scale should they draw it at?

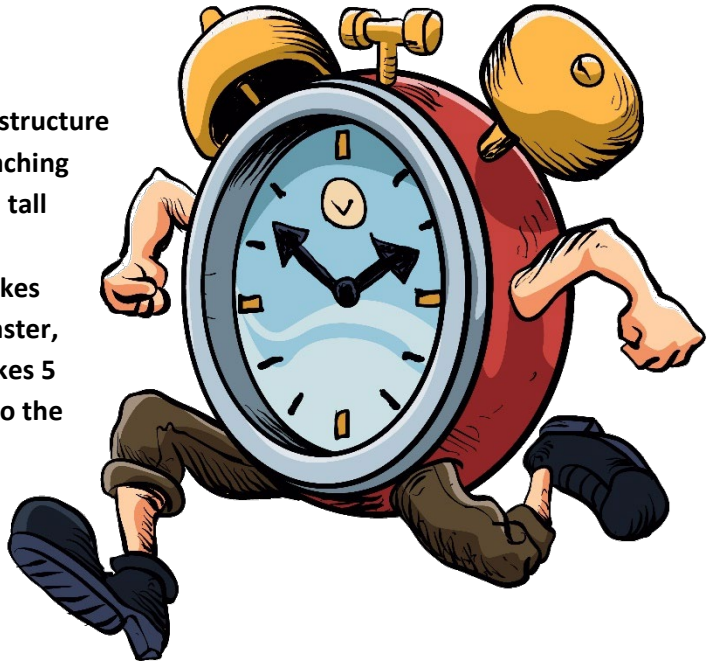
Note: Tape IS NOT to be used as a load bearing component. It is only to be used to secure or connect support systems. The less tape used the better, as long as all objects are secure.

Any column not serving a purpose should be trimmed or removed as necessary. Try to keep the visual clutter to a minimum. The roller coaster should be able to be moved, transported, and used without any "normal" breakdown from use. Design the supports to last!

Option: If doing group competitions, the support system could be worth points, ex. 50 points.

The Track

Build the track! The roller coaster is to be built with the same quality in mind as the structure. Once again, the shapes students create, and the card stock itself should do the work and NOT the tape.



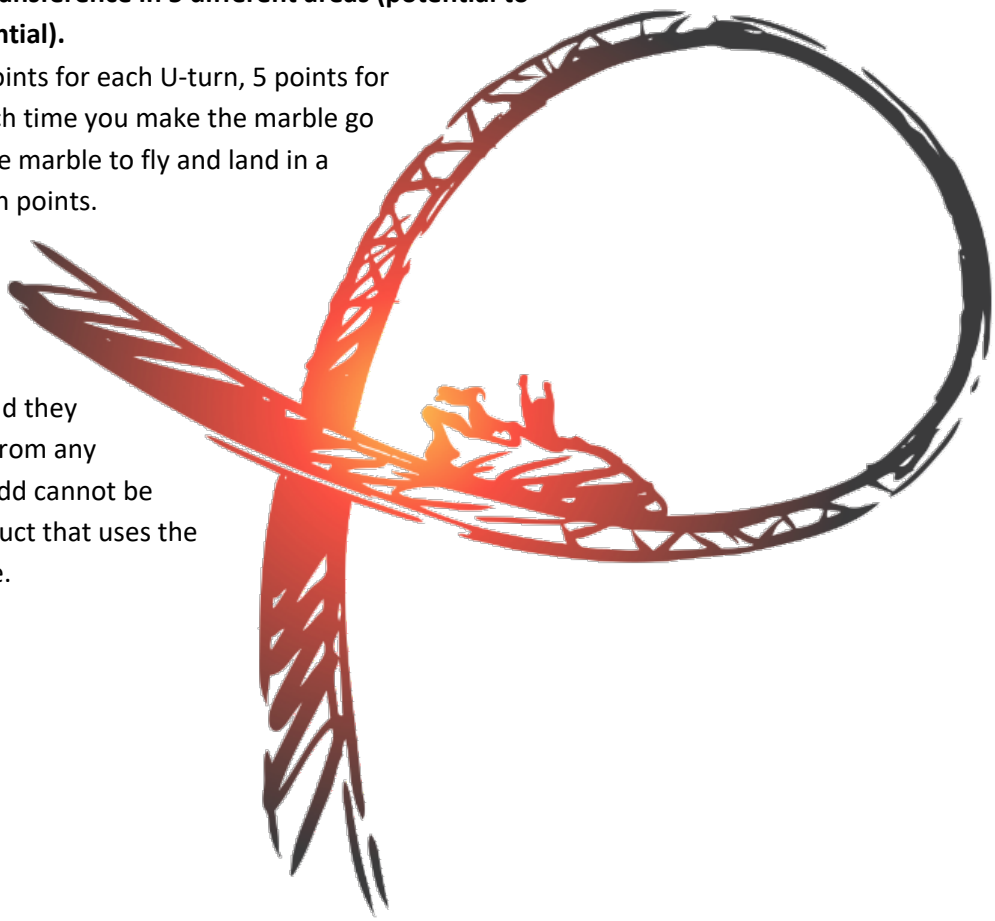
Share Tips for Success with Students:

- **Start small - You can always continue to build a structure taller later. Build a small structure and start attaching tracks. You might find out that you don't need a tall structure to make an interesting roller coaster.**
- **A slow marble can be impressive - If a marble takes 30 seconds to reach the bottom of the roller coaster, it will be more impressive than one that only takes 5 seconds. Keep the incline of your tracks gentle so the marble doesn't reach the end too fast.**
- **Only use steep tracks when necessary. If the marble flies off the track, make the slope gentler to keep the marble's speed under control.**

Track Specifications: *Adjust according to your students' abilities and grade-level standards as necessary.*

- Roller coaster must run for **at least _____** [ex. 30 seconds]
- Roller coaster marble "rider" must complete the track, from start to finish without any help and the marble must not fall out of the track under any circumstances
- All tracks must be supported, and they should not move while the marble is in motion.
- The roller coaster must have… [ex: six drops, six turns, 1 large funnel drop minimum, 2 maximum, a loop, and a minimum of 1 advanced element [the tipping switch, rotating arm, mini-funnel, switchbacks, zigzags, and/or the half-pipe.] Points are deducted for fewer drops, turns, or no loop.]
- Excessive tape is NOT allowed!

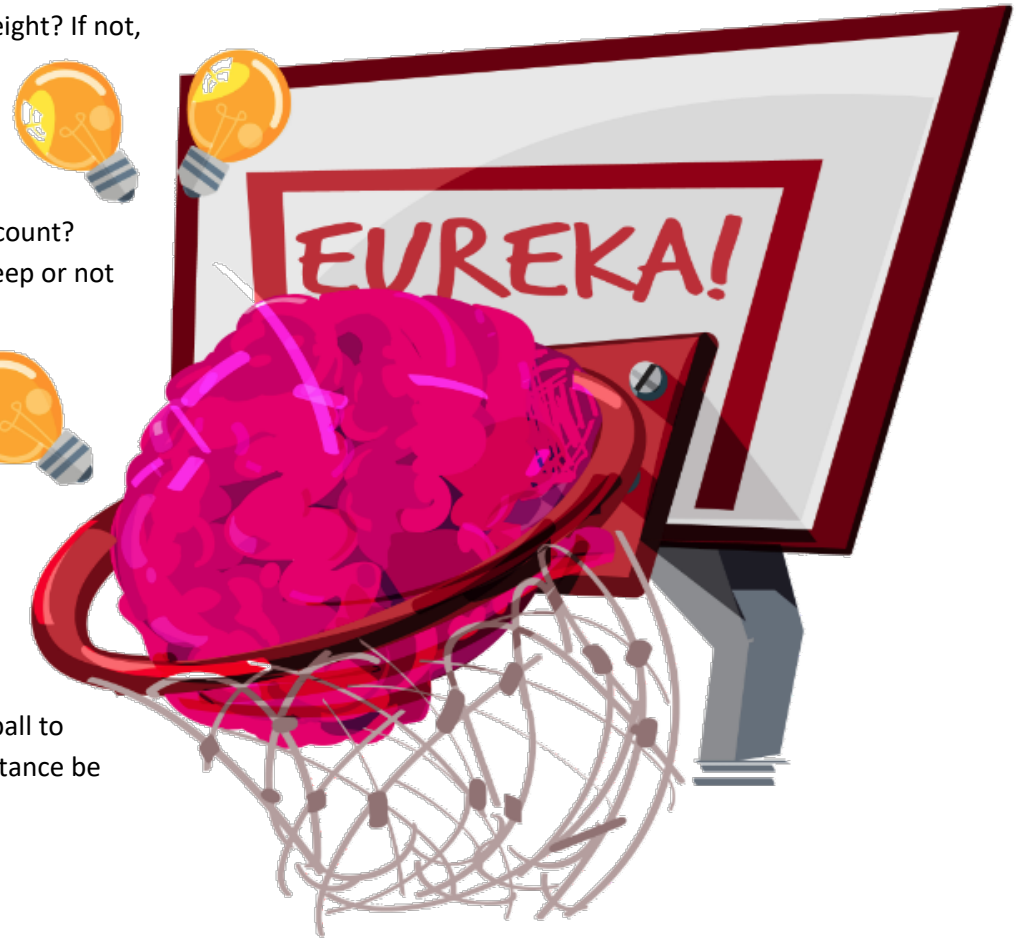
- If you use a "Y" intersection, the marble must be able to move in either direction randomly.
- **They must label energy transference in 5 different areas (potential to kinetic, or kinetic to potential).**
- Options: Students get 3 points for each U-turn, 5 points for each loop, and 1 point each time you make the marble go up a hill. If they can get the marble to fly and land in a cup, they earn an extra ten points.
- At least one track design piece that is not one of the supplied templates. But they can make it from them or pieces of them and they can add your own pieces from any material. The piece they add cannot be part of a commercial product that uses the transportation of a marble.



Using Logic & Pondering the Problems

As they build [and adjust] their design have the students consider the following questions. What forces are moving the ball around the track (Gravitational Potential Energy and Kinetic Energy)

1. Can all the hills be the same height? If not, why? Can they get bigger, or must they get smaller? How will you determine how big or how small the hills can be?
2. Does the steepness of the hill count? Is it better to make the hills steep or not so steep? Why?
3. How curvy should the tops of the hills and the valleys be? Should you design sharp turns or smooth turns? Why?
4. What factors affect the speed and distance traveled by an object in motion?
5. What provides resistance on the roller coaster causing the ball to slow down? How can this resistance be reduced?



Time to Compare

Once their tracks are built (with any due adjustments to drawings and projected data as construction warrants them) have students test and compare their projected data to the real-world data they record using their models.

Note: ***Leave students with enough time to make revisions to their original design—an important factor in the process of design and engineering.***

- When their roller coasters are completed, have students solve unit rate problems including those involving unit pricing and constant speed, acceleration, and momentum, the average speed, speed at different points, and time for these tracks using a stopwatch and a timer. Have students record the data on a chart.
- Students can find the average speed of their coaster and compare it with the rest of the class.
- How does the projected data from their scale drawings compare to the data from the model? Are they comparable? What factors are different between the two?

- Students may alter the design of their coaster to come up with the optimum speed and time of ride and to allow the marble to move through the entire track without help. **(*Have students differentiate between potential and kinetic energy and determine where each is most effective. Is the potential energy at the top of the roller coaster enough to move the marble through all the loops and hills?)*** How do those adjustments affect the rest of their data? Have the students compare data with other groups.

Additional questions and ideas to have students consider while creating their portfolio/coaster.

1. How does changing the height or the length of a hill of a roller coaster affect the speed?
2. Is friction slowing their marble down? If not, do they want it to in certain parts? How could they increase or reduce friction?
3. How does the rate of interest affect the payments that must be made on money that is borrowed? How does the length of time of the loan affect the total amount of interest paid when borrowing money?
4. How might students estimate the amount of money that can be generated by a roller coaster?

Bonus Additions for Competitions:

- Best scenery (+2 additional points) Lots of quality scenery covering the entire coaster and platform. Spending money on fancy scenery will not automatically make students a winner. Simple, but clever or well done, unique, designs show more creativity -especially when they support the name and theme of your coaster.
- Best Theme [+2 additional points] What's the name of their roller coaster? Does their scenery support this theme? Does the design support their theme? Is there a coolness or cleverness factor to their name? Pupils can investigate how different themes are used when designing a rollercoaster (e.g., Accelerator, a roller coaster in the UK, is themed on a Caterham racing car).
- Most creative design element [+2 additional points] You're looking for something different. Students may use items not made from paper for this. They cannot use anything that was originally designed as a part of any kind of roller coaster toy.
- Most complex design. (+2 additional points) Wow. We're looking at the loops, twists, dips, turns, etc.

Calculations and Formulas:

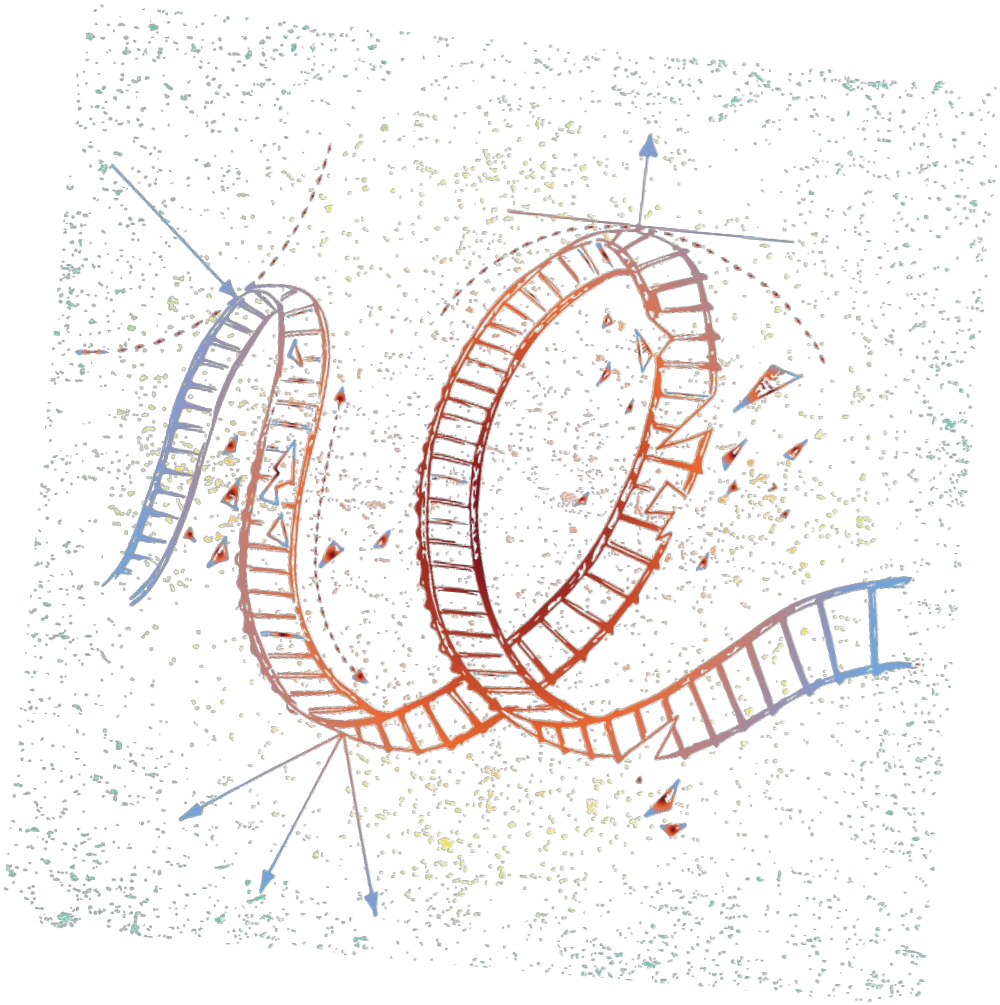
Have students investigate and apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity; track the data they measure; use equations and formulas; analyze the data using graphs and tables and relate these to the equation. For example: To calculate the speed of an object we must know how far it's gone and how long it took to get there. In determining motion at constant speed, have older students list and graph ordered pairs of distances and times, and plug

the information into the speed formula to represent the relationship between distance and time and/or use the included worksheets.
During your discussion and class practice, work through discussion, demonstration, and practice to help students understand the concept that if they have any two pieces of the equation (ex. speed and distance), they can find the third (ex. time) by *transposing formulae*. Remind them we must take care with the units, ex. If the speed is given in cm/second, then time must be in seconds and distance will be given in centimeters.

- **Average Speed:** Calculates average speed to ride a fixed distance in a given time. Formula: Speed = Distance ÷ Time
- **Time:** Calculates time required to ride a fixed distance in a given average speed. Formula: Time = Distance ÷ Speed
- **Distance:** Calculates distance covered from average speed and time elapsed. Formula: *Distance = Speed × Time*
- **Velocity:** Velocity equals displacement* (change in position) divided by time. v=d/t

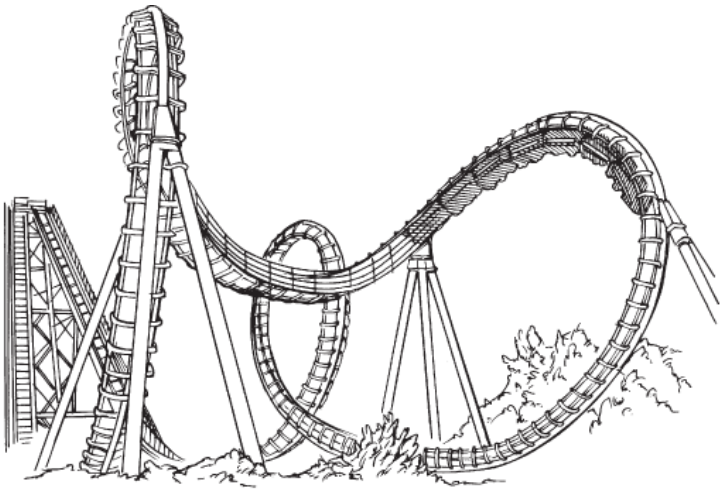
  Average velocity is mathematically defined as *average velocity = total displacement/time elapsed.*

  *Note that displacement (distance from starting position) is not the same as distance traveled. If a car travels one mile east and then returns one mile west, to the exact same position, the total displacement is zero and so is the average velocity over this time period. Displacement is measured in units of length, such as centimeters, meters, or kilometers, and velocity is measured in units of length per time, such as meters/second (meters per second).



Option: Older students may calculate:

Speed at Specific Points: Have students prepare calculations to show the speed of their new roller coaster at several points along the track, for example, they will want to show the speed at the top of each of the hills. Ex: Suppose their coaster reaches its maximum speed of 72 miles per hour at the bottom of their second hill, which is 200 feet tall. The formula for determining the speed of a coaster at the top of any hill is



$v_1 = \sqrt{(v_2)^2 + 2gh_2 - 2gh_1}$, where

v_1 = speed at the top of the hill in ft/sec,
v_2 = speed at the bottom of the hill in ft/sec,
h_1 = height at top of hill in feet,
h_2 = height at bottom of hill in feet, and
g = 32 ft/sec^2, the constant for gravity.
Assume that the bottom of the hill has height 0 ft.

1. What will be the value of $2gh_2$? Why?
2. The value of v_2 in the formula should be expressed in ft/sec since the value of g is in ft/sec^2. What is the maximum speed of the coaster at the bottom of the hill in ft/sec?
3. List the values for each variable to use in the expression on the right side of the formula.
4. What is the speed of the coaster at the top of the second hill?

Standards:

K

- K.G.1.a. Describe objects in the environment using names of shapes.
- K.G.1. b. Describe the relative positions of these objects using terms such as above, below, besides, in front of, behind, and next to.
- K.G.2. Correctly name shapes regardless of their orientations or overall size.
- K.G.3. Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
- K.G.5. Model shapes in the world by building shapes from components and drawing shapes.
- 7.11.1 Use a variety of objects to show different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- K.MD.2. Directly compare two objects with a measurable attribute in common, to see which object has “more of”/ “less of” the attribute and describe the difference. For example, directly compare the lengths of two pieces and describe one piece as longer/shorter.

1

- SL.1.5. Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.
- 1.MD.1. Order three objects by length; compare the lengths of two objects indirectly by using a third object.
- 1.MD.2. a Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end.
- 1.MD.2. b Understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- 1.G.2. Compose two-dimensional shapes and/or three-dimensional shapes to create a composite shape.
- 1.MD.4. Organize, represent, and interpret data with up to three categories.
- 1.NBT.4. Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10.
- 1.OA.5. Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).

2

- W.2.7. Participate in shared research and writing projects.

- 2.MD.1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
- 2.MD.3. Estimate lengths using units of inches, feet, centimeters, and meters.
- 7.12.2 Describe what happens when an object is dropped and record the observations
- 2.MD.9. a. Generate measurement data by measuring lengths of several objects to the nearest whole unit.
- 2.MD.9. b. Generate measurement data by making repeated measurements of the same object.
- 2.MD.10. a Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories.
- 2.G.1. Recognize and draw shapes having specified attributes, ex. such as a given number of angles.

3

- W.3.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.
- 3.MD.1. Tell and write time to the nearest minute and measure time intervals in minutes.
- 3.MD.1.b. Solve problems involving addition and subtraction of time intervals in minutes
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 3.MD.4. a Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
- 3.MD.3. a Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.
- 3.MD.3b Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs.
- 3.MD.8. Solve real-world and mathematical problems involving perimeters of polygons

4

- SL.4.4. Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes.
- 4.MD.1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit.
- 4.MD.2. Use the four operations to solve word problems involving:
    - a) distances,

- b) intervals of time,
- e) money,
- f) simple fractions
- g) decimals,
- h) problems that require expressing measurements given in a larger unit in terms of a smaller unit.

- 4.MD.6. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.
- 4.MD.5. a Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint.
- 4.MD.5. b) understand concepts of angle measurement:
- 4.MD.6. a) Measure angles in whole-number degrees using a protractor.
- 4.MD.6 b) Sketch angles of specified measure.
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.

5

- 5.MD.1.a. Convert among different-sized standard measurement units within a measurement system (e.g., convert 5 cm to 0.05 m),
- 5.MD.1.b. Use these conversions in solving multi-step, real-world problems.
- 7.12.2 Identify the force that causes objects to fall to the earth.
- 7.10.1 Differentiate between potential and kinetic energy.
- 7.10.1 Design and conduct an investigation to show the difference between potential and kinetic energy.
- 5.NF.5. Interpret multiplication as scaling (resizing), by comparing the size of a product to the size of one factor based on the size of the other factor, without performing the indicated multiplication.
- Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension. Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.

6

- SL.6.4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to stress main ideas or themes; use eye contact, adequate volume, and clear pronunciation.
- 6.SP.5. Summarize numerical data sets in relation to their context, such as by:
    - a) Reporting the number of observations.
    - b) Describing the attribute under investigation, including how it was measured and its units of measurement.
- 6.RP.1. Understand the concept of a ratio and scale and use ratio language to describe a ratio relationship between two quantities.
- SPI 7.10.2 Interpret the relationship between potential and kinetic energy.
- SPI 7.10.3 Recognize that energy can be transformed from one type to another.
- 7.10.1 Compare potential and kinetic energy.
- 6.NS.3. Fluently add, subtract, multiply, and divide using the standard algorithm for each operation.

7

- SL.7.4. Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
- 7.NS.3. Solve real-world and mathematical problems involving the four operations with rational numbers.
- 7.G.2. a) Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions.
- 7.11.3.a. Summarize the difference between the speed and velocity based on the distance and amount of time traveled.
- 7.11.3.b. Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.RP.3. Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.
- 7.11.4 Identify and explain how Newton’s laws of motion relate to the movement of objects.

8

- SL.8.4. Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

- 8.G.7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
- 7.T/E.2 Apply the engineering design process to construct a prototype that meets certain specifications.
- G-MG.1. Use geometric shapes, their measures, and their properties to describe objects.
- G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost.
- 7.T/E.5 Develop an adaptive design and test its effectiveness.
- N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.
- N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- 1.1.1 Explore displacement, velocity, and/or acceleration
- N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.
- 1.T/E.7 Design a series of multi-view drawings that can be used by others to construct an adaptive design and test its effectiveness.

A Need for Speed!

Calculating average speed student worksheet

In a most roller coasters, even paper ones, the speed of a cart or marble will increase and decrease many times as it rolls through. In this activity, you will find the speed of the marble in different portions of your paper roller coaster. You will also find the average speed of the marble during the entire trip down the paper roller coaster.

Materials:

Make sure you have each of these and check them off as you get them.

- ☐ completed Paper Roller Coaster
- ☐ yard stick
- ☐ pencil
- ☐ calculator
- ☐ string

Divide your paper roller coaster into three different sections by placing the following four marks on the tracks.

1. Start at the top and label the beginning of the roller coaster with an "A."

2. About 1/3 of the way down the roller coaster, label the track with a "B."

3. About 2/3 of the way down the roller coaster, label the track with a "C."

4. And finally, label the very end of the roller coaster with a "D."

Measuring Distances between points

1. We need to measure the distance that the marble must travel to get from Point A to Point B. To do this, lay one end of your string on the track at Point A.
2. Now, stretch the string exactly along the path that the marble will travel. When it reaches it, mark the string where it meets Point B on the track.
3. Remove the string from the track and measure the length of the string that reached from Point A to Point B when it was lying on the track. Record the distance in meters on the data table.
4. Do the same thing, again, to measure the distance from Point B to Point C and the distance from Point C to Point D. Record these distances in the data table.
5. Now we need to know how long it takes (the amount of time) for the marble to roll from Point A to Point B. To do this, put the marble at Point A, let go of it, and use a stopwatch to find how long it takes for the marble to reach Point B. Record this time in the data table.
6. Do this three times and record your results in the data table every time. Find the average for the three trials and enter that time in the data table. To do that take the three amounts of time (for this example 30 seconds, 32 seconds, and 28 seconds) and add them up. For example: 30 + 32 + 28 = 90. Then divide your answer by the number of trials. In this time, you did three, so in our example: 90/3 = 30. The average time is 30 seconds.

7. Now, measure the time it takes for the marble to roll from Point B to Point C. Do not release the marble at Point B. Instead, release the marble at Point A again and start the stopwatch when it passes Point B. Stop the timer when the marble passes Point C. Repeat for three trials and calculate the average like you did before
8. Measure the time it takes for the marble to roll from Point C to Point D. Do not start the marble at Point C. Instead, release the marble at Point A again and start the stopwatch when it passes Point C. Stop the timer when the marble reaches Point D. Repeat for three trials and calculate the average.
9. Calculate the average speed of the marble between Point A and Point B. In order to do it you need to divide the distance between Point A and Point B by the average time that it took to get from Point A to Point B. For example, if your distance is 10 inches and it took, on average between the three trials, 5 seconds then you would divide 10 by 5.

$$\frac{10 \text{ inches}}{5 \text{ seconds}} = 2 \text{ inches per second}$$

10. Enter the speed of your marble in the data table. Use the correct units in the table.
11. Calculate the average speed of the marble between Point B and Point C. Record your result in the box on the table. Repeat the same steps to calculate the average speed of the marble between Point C and Point D.

	Test Trials			Results & Averages
	One	Two	Three	
Distance A to B				
Time from A to B				Average:
Speed b/w A and B				
Distance B to C				
Time from B to C				Average:
Speed b/w B and C				
Distance C to D				
Time from C to D				Average:
Speed b/w C and D				

1. Between which two points did the marble have the highest average speed? _____
2. Why do you think that the marble was moving the fastest on this part of your roller coaster?

   _____

   _____
3. Between which two points did the marble have the slowest average speed?

   _____

4. Why do you think that the marble was moving the slowest on this part of your roller coaster?

_____

_____ _____

6. If you wanted to make a roller coaster on which the marble would have the slowest average speed from the top to the bottom, how would you design it?

_____

_____

_____

6. Calculate the average speed of the marble during the entire trip down the paper roller coaster.

	Test Trials			Averages & Results
	One	Two	Three	
Distance from A to D				
Time from A to D				Average:
Speed from A to D				

Challenge: Calculate the velocity of your roller coaster from start to finish and from start to midpoint. Velocity equals displacement* (change in position) divided by time. v=d/t *Note that displacement (distance from the starting position) is not the same as distance traveled. If a car travels one mile east and then returns one mile west, to the exact same position, the total displacement is zero and so is the average velocity over this time period.

Distance marble traveled (in units of length)	Time it took (in units of time)	Velocity

Summarize the difference between the speed and velocity based on the distance and amount of time traveled. _____

_____.

Write that Down! Informative Writing Prompt Ideas

Explain why it is important for engineers to understand how roller coasters work.
Explain in physics terms how your model roller coasters (will) work.
With designing roller coasters, describe some constraints that engineers would have to consider.
Ex. They might have some practical limitations, such as available or preferred building materials, a construction budget and timeframe, safety measures for users, ongoing maintenance requirements and/or expected weather.
The amusement park client may also give requirements for the type of movement they want for the ride, such as upside-down loops, corkscrews, specific degree turns, length of drops or maximum speed, or safety assurances for users (safe for people taller than four feet high).
Another basic constraint that always applies is consideration of the natural physical laws that exist in our world, such as the limits of gravity and effects of slope, speed and friction. This is an example of how an engineer's understanding of the fundamental laws of physics is very important to the success of a project. Coming up with a design solution that takes all these factors into consideration and works reliably, safely, and as intended is what engineers do.

Standards:

K

- K.G.1.a. Describe objects in the environment using names of shapes.
- K.G.1. b. Describe the relative positions of these objects using terms such as above, below, besides, in front of, behind, and next to.
- K.G.3. Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
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- K.MD.2. Directly compare two objects with a measurable attribute in common, to see which object has “more of”/ “less of” the attribute and describe the difference. For example, directly compare the lengths of two pieces and describe one piece as longer/shorter.

1

- 1.MD.1. Order three objects by length; compare the lengths of two objects indirectly by using a third object.
- 1.MD.2. a Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end.
- 1.MD.2. b Understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps.
- 7.11.2 Investigate and explain how different surfaces affect the movement of an object.
- 1.MD.4. Organize, represent, and interpret data with up to three categories.
- 1.NBT.4. Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10.
- 1.OA.5. Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).

2

- W.2.7. Participate in shared research and writing projects.
- 2.MD.1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
- 2.MD.3. Estimate lengths using units of inches, feet, centimeters, and meters.
- 7.12.2 Describe what happens when an object is dropped and record the observations
- 2.MD.9. a. Generate measurement data by measuring lengths of several objects to the nearest whole unit.

- 2.MD.9. b. Generate measurement data by making repeated measurements of the same object.
- 2.MD.10. a Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories.

3

- W.3.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.
- 3.MD.1. Tell and write time to the nearest minute and measure time intervals
- 3.MD.1.b. Solve problems involving addition and subtraction of time intervals
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 3.MD.4. a Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
- 3.MD.3. a Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories.

4

- SL.4.4. Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes.
- 4.MD.1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit.
- 4.MD.2. Use the four operations to solve word problems involving:
    - a) distances,
    - b) intervals of time,
- 7.11.3 Determine the relationship between speed and distance traveled over time.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.4 Plan and execute an investigation that demonstrates how friction affects the movement of an object.

5

- 5.MD.1.a. Convert among different-sized standard measurement units within a measurement system (e.g., convert 5 cm to 0.05 m),
- 5.MD.1.b. Use these conversions in solving multi-step, real-world problems.
- 7.12.2 Identify the force that causes objects to fall to the earth.

- 7.10.1 Differentiate between potential and kinetic energy.
- 7.10.1 Design and conduct an investigation to show the difference between potential and kinetic energy.

6

- SL.6.4. Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to stress main ideas or themes; use eye contact, adequate volume, and clear pronunciation.
- 6.SP.5. Summarize numerical data sets in relation to their context, such as by:
    - a) Reporting the number of observations.
    - b) Describing the attribute under investigation, including how it was measured and its units of measurement.
- 6.RP.1. Understand the concept of a ratio and scale and use ratio language to describe a ratio relationship between two quantities.
- SPI 7.10.2 Interpret the relationship between potential and kinetic energy.
- SPI 7.10.3 Recognize that energy can be transformed from one type to another.
- 7.10.1 Compare potential and kinetic energy.
- 6.NS.3. Fluently add, subtract, multiply, and divide using the standard algorithm for each operation.

7

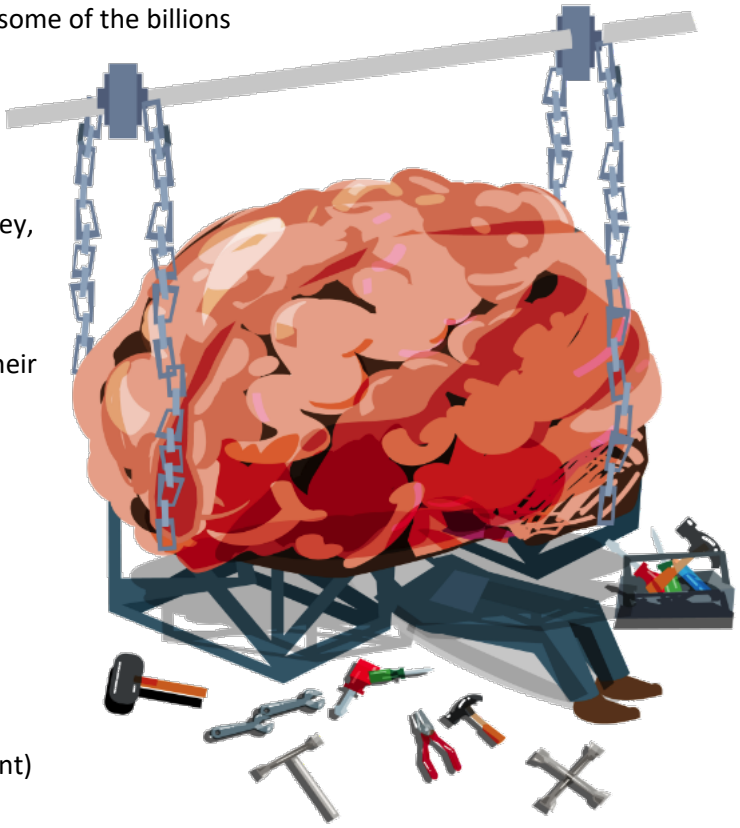
- SL.7.4. Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.
- 7.NS.3. Solve real-world and mathematical problems involving the four operations with rational numbers.
- 7.G.2. a) Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions.
- 7.11.3.a. Summarize the difference between the speed and velocity based on the distance and amount of time traveled.
- 7.11.3.b. Apply proper equations to solve basic problems pertaining to distance, time, speed, and velocity.
- 7.11.4 Identify and explain how Newton’s laws of motion relate to the movement of objects.

8

- SL.8.4. Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
- G-MG.1. Use geometric shapes, their measures, and their properties to describe objects.
- N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.
- N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- 1.1.1 Explore displacement, velocity, and/or acceleration
- N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.

Imagineers: Design in Mind?

Each year, amusement park owners compete to earn some of the billions of dollars people spend on entertainment. In order to have customers come back year after year the parks need to have customers have fun the first time and newer, faster, more exciting rides the next time, especially roller coasters. But it takes time, money, work, and someone, or quite a few someones, on a team, to build them.

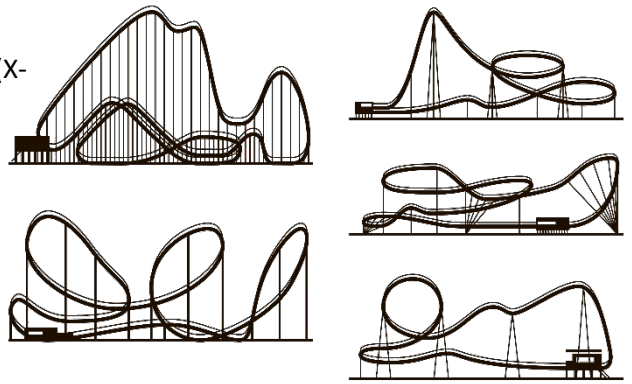


And before they can build them, someone must get their new idea down on paper.

Materials:

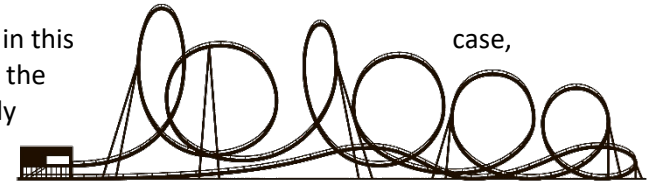
Per group:

- ☐ completed Paper Roller Coaster
- ☐ 2 sheets of graph paper per student
- ☐ yard stick
- ☐ 12-inch rulers with centimeters (one per student)
- ☐ Protractors (one per student)
- ☐ Pencils (one per student)
- ☐ White board or large sheet of paper
- ☐ White board markers or regular markers



Have a student come to the front of the class and draw a 2-D (X-Y plane) roller coaster on the board. Discuss with the students what you would have to know to build this roller coaster. What they made it of, etc. Bring in the concepts of scale factor. Know how high the tallest point is, how big the loops are… before you can do anything you have to have some idea of scale.

Scaled drawings are a means of communication between the contractor and the designer of a product, such as a house, or in this case, a roller coaster. Scaled drawings are used because they allow the designer to put a large amount on information into a relatively small, portable, easily changed, and easily read package. ***Discuss with the students any difficulties that might occur with a designer trying to put a life size drawing of their roller coaster on to paper.***



One key part of every scale drawing is the scaling factor. This number represents the degree to which your scale drawing or scale model has been reduced in size when compared to the original. For example, a scaled drawing could show 1 inch for every 10 feet of the actual object. That's a scale of 1/10, or 1 cm for every 32 ft, that's a scale of 1/32.

Practice

Have students practice by doing the following activity on graph paper:

Students will draw a 2-D model (a flat drawing on paper) of a roller coaster with the following dimensions. Their drawing should be a 1/32 scale (1 cm for every 32 ft) drawing on graph paper. Have students turn their graph paper sideways to allow enough room for their rollercoaster to fit. Use of a ruler and other measuring/drawing devices such as a compass is expected.

Start with a 20 cm level area

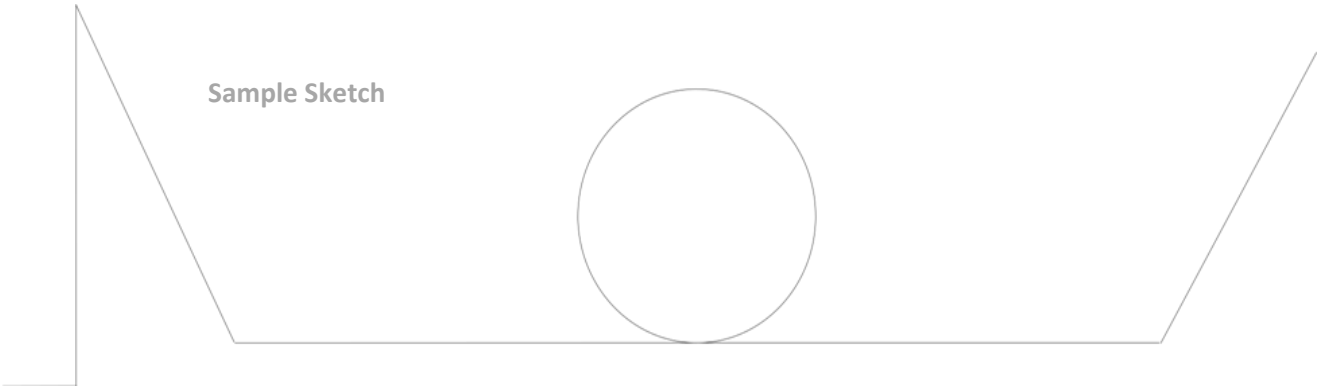
Then 96 cm vertical rise

After that an 80 cm 45-degree downward slope

Next a 360 cm level area with a 64 cm loop in the middle of the 360 cm length.

Finish with a 30-degree upward slope that is 75 cm long.

Younger students may copy the angles desired as demonstrated by the teacher and identify shapes as



two-dimensional (lying in a plane, "flat") or three-dimensional ("solid"). For example, with younger students sizes may be compared directly or visually, not compared by measuring. With third graders, measure length by counting unit squares (square cm or improvised units, ex. graph paper squares). With middle students the teacher may show them how to use a compass and have them copy the angles.

Have students express measurements in a larger unit in terms of a smaller unit and determine the full scale (real world) dimensions of this roller coaster if the model is a 1/100 scale of a full scale roller coaster, meaning 1 cm for every 100 feet.

Next, have students alter their drawing and draw it again at 1/16, 1 cm for every 16 feet. How does that change the appearance of their coaster? Why? What do they note about the slope of the angled lines when they scale up and scale down? Have students consider both accuracy of drawing and capacity to draw the model in a reasonable overall size of graph paper.

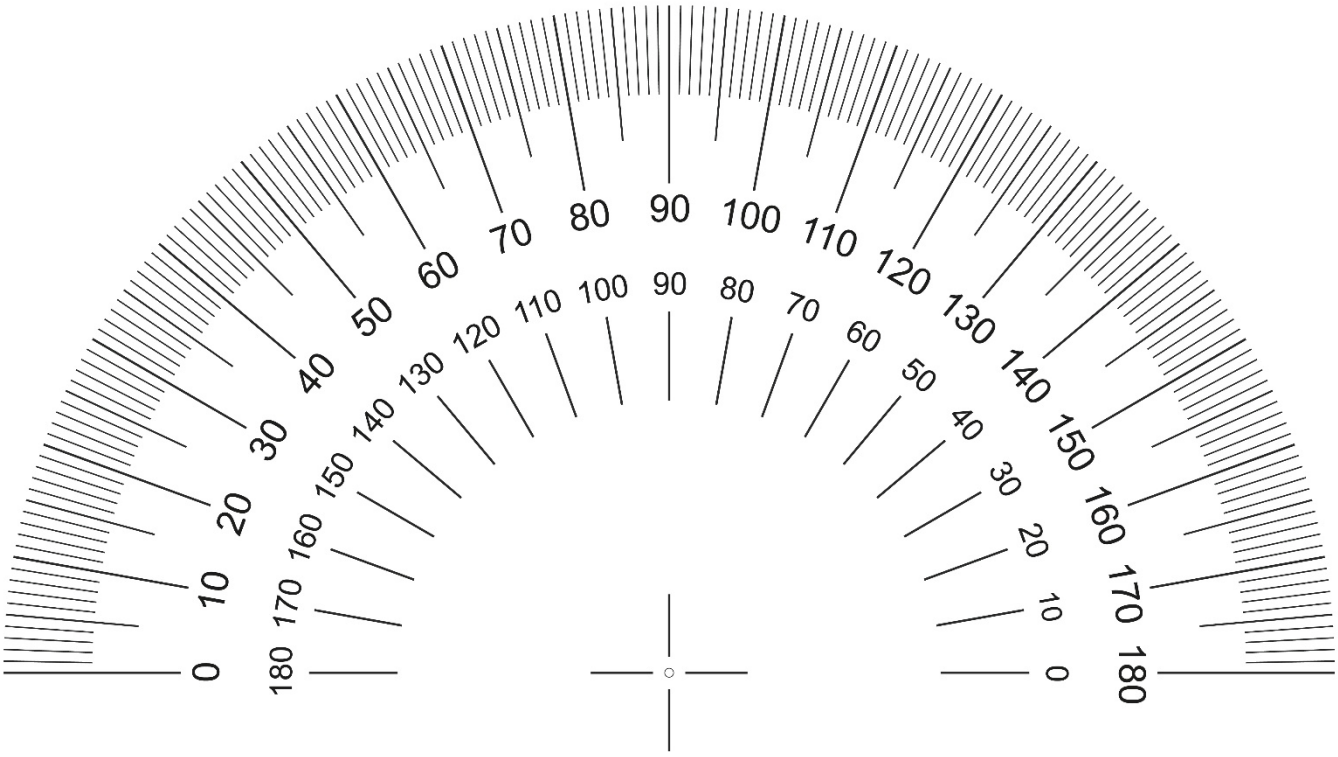
Now, have students create scaled drawings of their completed roller coasters for their portfolios.

Watch this!

Jurassic Park was about a theme park that never opened. Then…it became a ride. Take students behind-the-scenes of Jurassic World – The Ride to [see what it takes to bring dinosaurs to life!]

Design-a-Ride Prompt

If you were going to create a roller coaster based off of your favorite movie what would it be? How you make it fun? What kinds of surprises or parts of the story would you include?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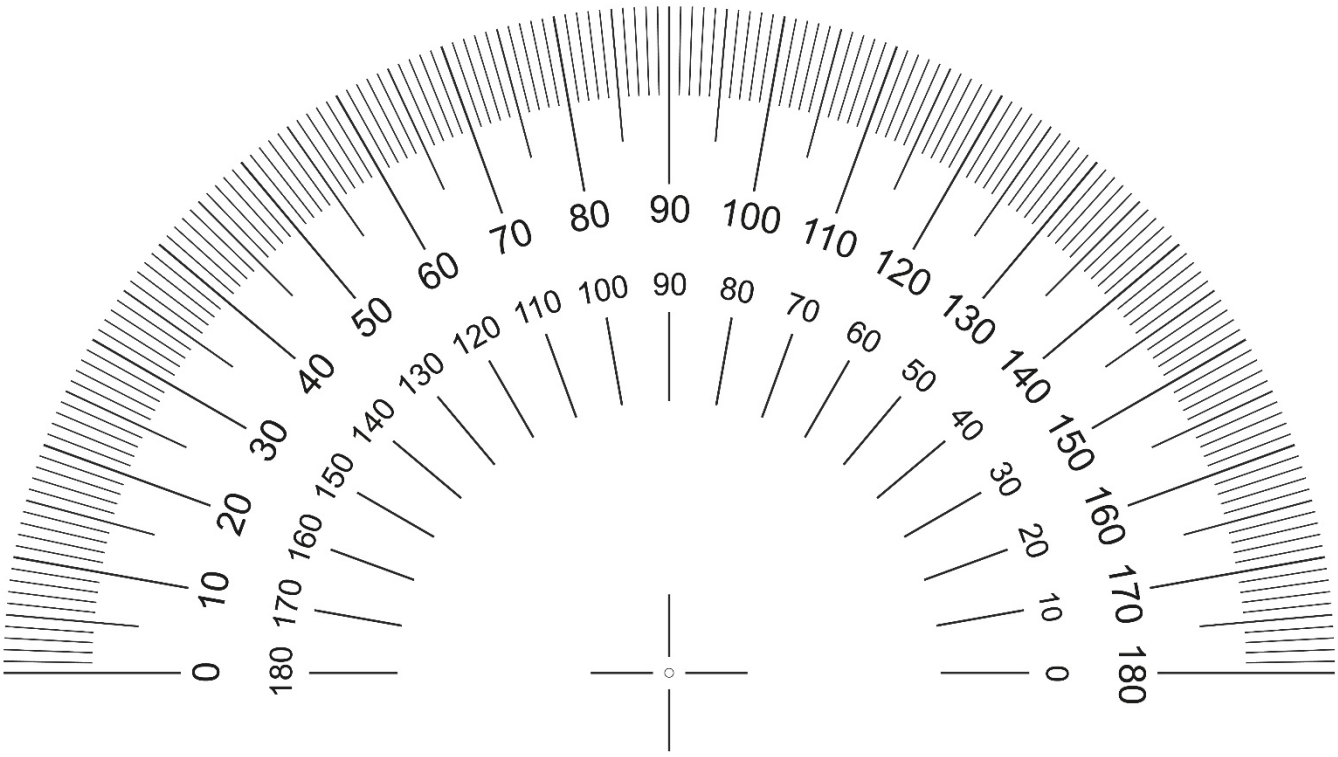
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0


0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0

Standards:

K

- K.G.1.a. Describe objects in the environment using names of shapes.
- K.G.1. b. Describe the relative positions of these objects using terms such as above, below, besides, in front of, behind, and next to.
- K.G.2. Correctly name shapes regardless of their orientations or overall size.
- K.G.3. Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
- K.G.5. Model shapes in the world by drawing shapes.
- K.MD.2. Directly compare two objects with a measurable attribute in common, to see which object has “more of”/ “less of” the attribute and describe the difference. For example, directly compare the lengths of two pieces and describe one piece as longer/shorter.

1

- SL.1.5. Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.
- 1.MD.1. Order three objects by length; compare the lengths of two objects indirectly by using a third object.
- 1.MD.2. a Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end.
- 1.MD.2. b Understand that the length measurement of an object is the number of same-size length units that span it with no gaps or overlaps.
- 1.G.2. Compose two-dimensional shapes and/or three-dimensional shapes to create a composite shape.
- 1.OA.5. Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).

2

- 2.MD.1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.
- 2.MD.3. Estimate lengths using units of inches, feet, centimeters, and meters.
- 2.MD.9. a. Generate measurement data by measuring lengths of several objects to the nearest whole unit.
- 2.MD.9. b. Generate measurement data by making repeated measurements of the same object.

- 2.G.1. Recognize and draw shapes having specified attributes, ex. such as a given number of angles.

3

- 3.MD.4. a Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
- 3.MD.3. a Draw a scaled picture.

4

- SL.4.4. Report on a topic or text, tell a story, or recount an experience in an organized manner, using appropriate facts and relevant, descriptive details to support main ideas or themes.
- 4.MD.1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit.
- 4.MD.2. Use the four operations to solve word problems involving:
    - a) distances,
    - h) problems that require expressing measurements given in a larger unit in terms of a smaller unit.
- 4.MD.6. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.
- 4.MD.5. a Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint.
- 4.MD.5. b) understand concepts of angle measurement:
- 4.MD.6. a) Measure angles in whole-number degrees using a protractor.
- 4.MD.6 b) Sketch angles of specified measure.
- 7.11.3 Determine the relationship between speed and distance traveled over time.

5

- 5.MD.1.a. Convert among different-sized standard measurement units within a measurement system (e.g., convert 5 cm to 0.05 m),
- 5.MD.1.b. Use these conversions in solving multi-step, real-world problems.
- 5.NF.5. Interpret multiplication as scaling (resizing), by comparing the size of a product to the size of one factor based on the size of the other factor, without performing the indicated multiplication.

6

-

- 6.RP.1. Understand the concept of a ratio and scale and use ratio language to describe a ratio relationship between two quantities.
- 6.NS.3. Fluently add, subtract, multiply, and divide using the standard algorithm for each operation.

7

- 7.NS.3. Solve real-world and mathematical problems involving the four operations with rational numbers.
- 7.G.2. a) Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions.

8

- G-MG.1. Use geometric shapes, their measures, and their properties to describe objects.
- N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
- 1.1.1 Explore displacement, velocity, and/or acceleration
- N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.
- 1.T/E.7 Design a series of multi-view drawings that can be used by others to construct an adaptive design and test its effectiveness.

Marketing: Buyer's Market, Seller's Pitch

Have students make a sales portfolio for their new ride, advertising the name, thrills, and statistics of their roller coaster to get riders on board and financial backers to pull out their pocketbooks.

Options: Have students design and launch a marketing campaign for their rollercoaster, creating leaflets, posters and a 'launch event'. They could even create a TV advert using video cameras.
Their rollercoaster could be part of a school theme park. Students should consider what else a park would need to be successful e.g., restaurants, gift shops, other attractions.

Tips and Tools:

Have students use online tools like Canva, PiktoChart, Venngage, Picassa, Posterini, or Smore to amp up their portfolio and practice 21st century skills!
Infographics are a wonderful way to tell a story or present your information in a clearly laid out and visually appealing setting. Infogr.am is the perfect tool for students to create their own infographics in a snap.
Canva is a haven for all your students' marketing material needs. This design platform is a comprehensive tool for your online & offline graphic needs. From business cards design to flyers & advertising, to your social media pages, this intuitive program really is a lifesaver for easy and effective marketing goods.

Materials:

- ☐ Completed Paper Roller Coaster
- ☐ Completed speed calculations (as appropriate for grade level)
- ☐ Completed cost of building calculations (as appropriate for grade level)
- ☐ Completed scale drawings on graph paper (as appropriate for grade level)
- ☐ Description of building process and engineering decisions
- ☐ Paper

- Pencils
- Optional: Poster boards/trifold for presentation of materials
- Optional: Manila folders for presentation of materials
- Art materials (for promotional materials, ex. A themed poster, roller coaster name, etc.)

Students may also prepare a story board that documents their research and the construction of the roller coaster. In their storyboards students may answer questions such as:

- Does math apply in the "real world?"
- How did they build their coaster, and did it work perfectly the first time?
- What is the name of their roller coaster?
- Do they have any safety features?
- What are its measurements, rate of speed, etc.?
- What formulas did they use to arrive at their conclusions?
- How do those formulas work?
- How many loops, turns, and hills did their roller coaster have?
- What did they have to do to make the ball go faster or slower?
- How did they make the ball turn?
- If a life-sized version of your roller coaster was built, would they want to ride it?
- How would you handle any problems that arose?

Have students write a one-page summary of their project, including what they have learned from researching this topic and answering the following question. If a life-sized version of their roller coaster was built, would they want to ride it?

Financial Figures and Rates of Pay: While students are preparing a portfolio for their roller coaster design the company wants to know the total cost, how much money they will have to pay per months, and how many months it will take them to pay for their new ride. Ex: If you calculate that the cost of your new roller coaster to build was $1,000,000. Assume that an amusement park wants to make a down payment of 10%,that would be $100,000. Then they will finance the remaining $900,000 for 30 years. The current rate of interest offered by the nearest bank is 7.25%. The amusement park wants to know the monthly payment, so use the formula $P = \frac{Cr(1+r)^N}{(1+r)^N - 1}$, where P = monthly payment, C = amount of loan, r = interest rate ÷ 1200, and N = total number of monthly payments.

1. Why do you think that the interest rate, 7.25%, is divided by 1200 in the formula? (The interest rate is divided by 1200 because there are twelve months in a year. You want to reflect the interest rate

charged as a decimal, so you can get the true monthly payment because most loans are not calculated with simple interest, but daily compounding interest. In this sample, the 1,200 represents 12 months.)

2. List the values for each variable to use in the expression on the right side of the formula. Be sure you find the total number of monthly payments, not just the number of years of payments.
3. Find the monthly payment for the roller coaster.
4. What if they want to pay over 15 years, 30 years, 60 years? Have students find the different payment rates for at least two options.

Getting that Gold!

Now that you are done building your roller coaster, it is time to get people to ride it!

Ask students:

- Where do you encounter advertising? (They will probably mention social media, internet searches, television, billboards, radio, Websites, school hallways, and so on.)
- Which specific advertisements "stick in your head?"
- What makes these advertisements memorable? (They might mention celebrities or influencers, music, catchy slogans, the appeal of the product itself, and so forth.)
- Do you think advertisements affect your personal interests?

You'll likely find that students have little trouble naming ads with which they are familiar, but most will claim that they have little effect on their habits, interests, or behaviors.

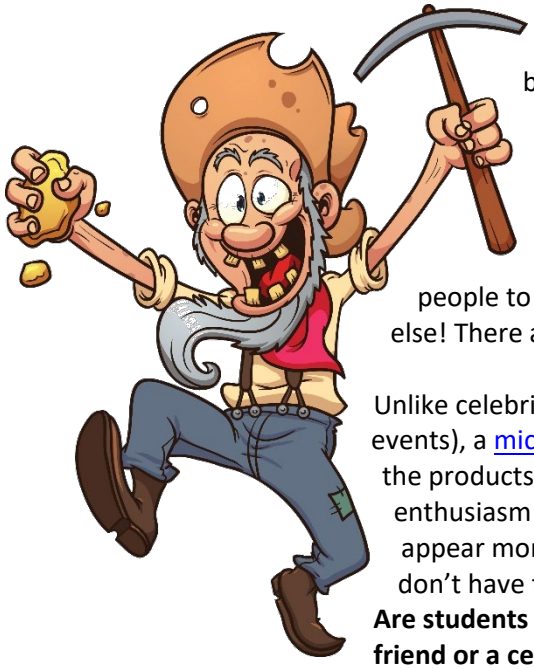
Explain to students that advertisers carefully construct their ads to make them memorable and appealing to consumers, and that the ways in which they try to convince them to buy products are similar to the ways they have been taught to write persuasively, using certain techniques and aiming toward a particular audience.

Knowing how to market a theme park is not as effortless as Disney may make it seem. The top 25 global parks generated approximately half of all theme park revenue last year.

This is fantastic news for the likes of Disney and Universal Studios, but with over 1000 parks currently open to the public around the globe, it creates a dilemma for many.

Here are 4 lessons we can learn from the marketing geniuses who have enabled Disney to remain the "happiest place on Earth" throughout the ages:

I. Every Visitor is a Micro-Influencer



From Instagram to Facebook and every social media platform in between, there is no shortage of people sharing photos of their trips to Disney World or Disneyland.

This allows every visitor to become a micro-influencer and is an effortless way for businesses to create earned income. This means FREE advertising for Disney. Remember: Disney isn't paying those people to promote Disney. They had to pay to get in the park the same as anyone else! There aren't any discounts for posting pics.

Unlike celebrity influencers (who companies have to pay to share their products or events), a micro-influencer has a genuine personal excitement for and connection to the products or experiences that they promote. Because they aren't faking that enthusiasm they have a drastically higher rate of engagement with their followers, appear more authentic and provide valuable backlinks. (And, ahem, companies don't have to pay them. Win-win for the company!) They increase demand. **Discuss: Are students more likely to buy tickets, go to an event, or buy a product based on a friend or a celebrity endorsement?**

Example: 5 words. $1 billion in sales

In 2020, Patrick Mahomes said "I'm going to Disney World!" to the 102 million tv viewers watching after he won the Super Bowl and MVP title. Experts say the quarterback's shoutout is worth at least $5 million in publicity for Disney, and could generate over $1 billion in extra sales. "Paid 30-second ads were $5.6 million this year, and it's a very safe bet to say that Disney got at least that from Patrick Mahomes' on-camera moment," Mae Karkowski, the founder and CEO of influencer agency Obviously, told Business Insider in an email.

"A naturally branded moment like this is priceless," she continued. "It's like the difference between an organic endorsement from a huge celebrity versus a paid advertisement."
For example, the shoutout is likely to spur thousands of people to book Disney hotels and cruises, buy tickets to its theme parks, subscribe to Disney+, see "Mulan" at the cinema, and purchase Disney toys, clothing, and video games.

"There's also intangible value in having the MVP of the Super Bowl say they're going to Disneyland," Douglas added. "It reinforces the Disney brand — it's safe, it's fun, and it's where champions go."[21]

Although Mickey Mouse played a large role in garnering the Disney company a whopping net worth of over 98 billion dollars in the U.S. and an additional 59.43 billion dollars in the global market in 2018, a large volume of micro-influencers can and do elicit the same sense of connection between the company and the masses. And a lot more cheaply for the company.

[21] https://markets.businessinsider.com/news/stocks/super-bowl-patrick-mahomes-made-billion-disney-5-words-value-2020-2-1028878034

Did they realize? Every time someone buys a t shirt that has a logo on it, mascot, or a brand they're paying to advertise for that company? And often they're paying MORE for that tshirt, bag, or product than they would if it didn't have that label or logo on it.

Your Coaster Needs a FACE!

Whether a cat, a dog or something else entirely, mascots go a long way in the marketing industry. They present opportunities for meet and greets and photo shoots which will find their way to social media. A mascot goes a long way in personifying a brand and garnering micro-influencers for any amusement park and shockingly, produces twice as much buzz on social media as using a celebrity endorser.

Mickey Mouse is recognized around the world, by people of all backgrounds and ages. These micro-influencers each come with their own followings, no matter how small, which all add to the immense popularity of the Disney corporation. **While it is hard to mimic the success of the legendary Mickey Mouse, marketers can elicit similar results by introducing and promoting a mascot of their own.**

Have students ponder their coaster's mascot and jotting down ideas.

Tips: The difference between an outstanding mascot and a cheesy one comes down to three things:

- *Visual storytelling: A mascot should describe a brand story visually, be it through colors, shape, gesture, or any other feature.*
- *Brand persona: Technically, a brand mascot creates a long-term relationship with the customer, so it should be something they're drawn to. Something they'd like to have as a sticker on their water bottle or car.*
- *Character Psychology: Deep down, a mascot is like a brand ambassador, so it should possess all the qualities that brands and the target audience aim for. Ex. Courage, bravery, cuddliness?*

The concept of your mascot is the feeling, goal, value, and idea you want to convey through your personified character. [22]

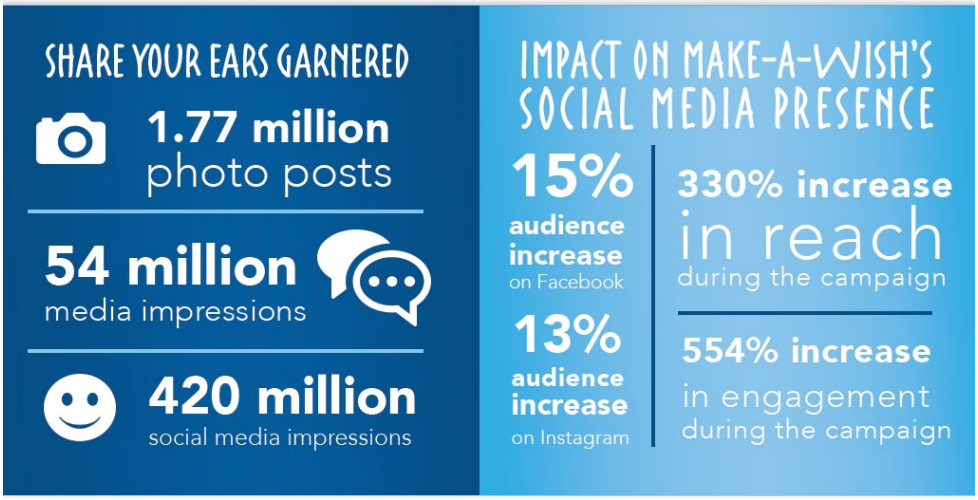
2. Use Branding and Visuals to Tell a Story

Videos are an immensely effective way to pair branding and visual elements together to tell a story. In fact, recent studies show that videos are a staggering 600% more effective for marketing than both print and direct mail combined.

Disney marketing gurus know the power of video and branding, so it comes as no surprise that this is a large part of their strategy. From YouTube to television commercials, Disney videos are everywhere.

[22] https://dreamfarmstudios.com/blog/how-to-create-brand-mascot/

One video in 2015 announced a campaign known as "Share Your Ears". Disney announced that for each photo shared of a person wearing their iconic Mickey Mouse ears, the corporation would donate $5 (up to one million) to the Make-A-Wish Foundation.[23]



Disney received an overwhelming response, garnering 1.7 million photos, 54 million media impressions and 420 million social media impressions during the campaign. A case study outlines a level of engagement that skyrocketed by 554% with an increase of 330% in reach. Likewise, the company earned an additional $150,000 in revenue just from additional sales of their licensed "ears" during the campaign.

The level of participation was so high that Disney doubled their original maximum donation and raised two-million dollars for critically ill children. To date, the "Share Your Ears" campaign has been launched on several other occasions and has received a staggering response on social media each time. Check out the video about the campaign.

This is a common theme in the world of Disney. **Their content is always chock full of emotion, nostalgia, storytelling, and branding.**

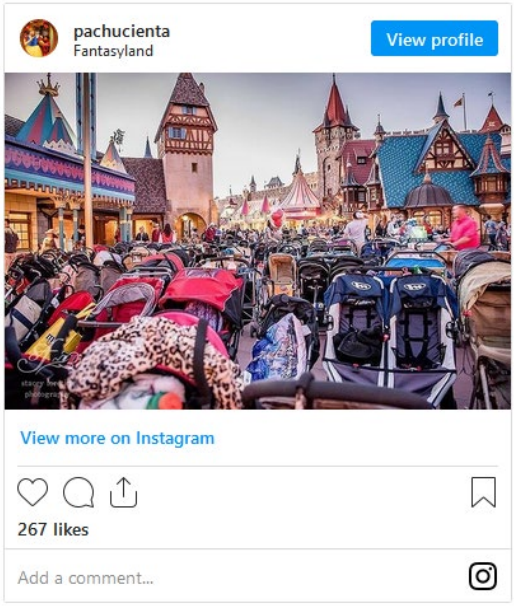
The key to achieving this feat like Disney is to consider the values of your audience and then develop a story or campaign that meets these values. Whether it is a fundraiser, as showcased by Disney or a fun event advertised through video, even small businesses can use relatable concepts and incorporate branding.

If tv commercials are out of the budget, keep in mind that 4.6 billion video ads are watched online each year. The ROI on video marketing is one of the highest of all digital marketing channels.

[23] https://dccr.disney.com/share-your-ears.html

Promote What the Experience is Actually Like on social media

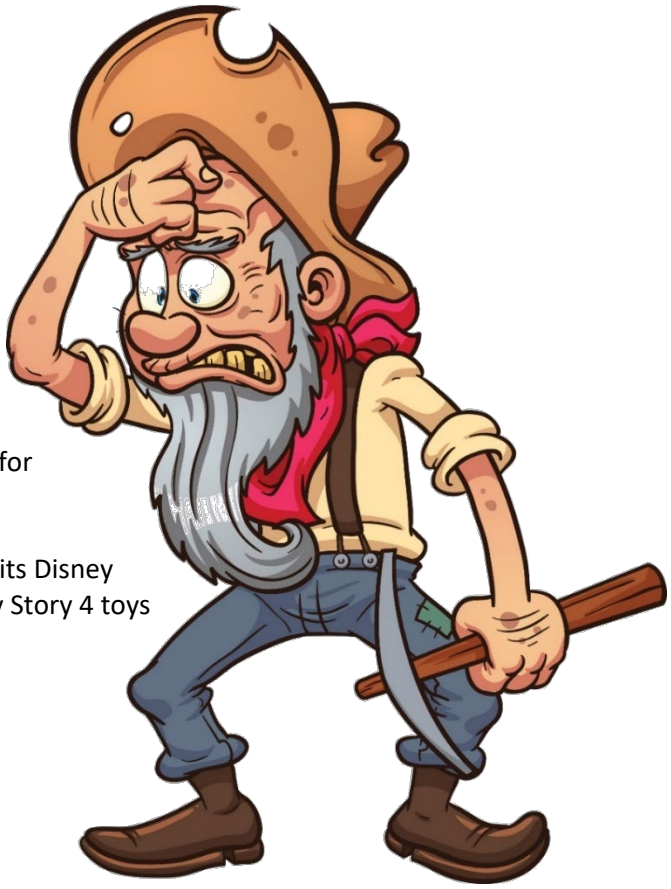
Another way to promote a theme park on social media is to share unique aspects of the establishment. Disney does its fair share of magical storytelling but some of its most popular posts are ones that give users a realistic view of what to expect during their visit.



For instance, Disney has an employee who gathers up rogue baby strollers at one of their parks.

He arranges them neatly in an area where they are easily found by their owners after they exit roller coasters or other rides. While most parks would advise visitors to heed the instructions of their stroller parking signs in the event of abandoned strollers, Disney shares this one-of-a-kind stroller guy on social media.

Know Your Target Market



Disney has an expansive audience around the world. From children to the elderly, they know that each market will respond differently to different content.

So, they personalize content to target different markets. Facebook posts and topiaries in classic characters target older nostalgic demographic.

For younger kids who aren't likely to have social media accounts? TOYS! Disney relies on television commercials aired during children's programming and toys/licensed merchandise for marketing.

For instance, advertising the new Toy Story Land attractions to its Disney World Park during children's television shows and releasing Toy Story 4 toys and merchandise shortly after it opened.

Discuss: How would you incorporate the following in 'selling' your ride?

1. **Every visitor is an influencer**—What's going to get them to share? What's the emotion associated with your ride?
2. **Use branding and visuals to tell a story**—What's the biggest image associated with your ride? Who is your mascot? What's their story?

3. **Promote what the experience is like on social media** — What's unique about your ride?
4. **Know your target market**—Who are they?

Note: Social media markets are significant areas to focus on when promoting your amusement park/roller coaster but there are other options to consider: Wise marketers also partner with local hotels, other businesses, and create promotional packages. (Remember Make-a-Wish + Disney?) They also advertise at places where people travel through such as buses, trains, and airports. [24]

Great resources: Persuasive Writing For Kids: What is It? And http://bit.ly/PersuasiveWrtngTchnqs

[24] https://crowdriff.com/resources/blog/how-to-market-a-theme-park

Standards:

K

- K.2.03 a. Explain why people have jobs.
- K.2.01 Describe potential costs and benefits of personal economic choices in a market economy.
- K.2.03 b. Distinguish between needs and wants.
- K.2.03 c. Recognize that all jobs are significant and realize that some jobs are interdependent.

1

- 1.2.01 Describe the potential costs and benefits of personal economic choices in a market
- economy.
- 1.2.01 a. Recognize that workers who provide services earn money to meet needs and
- wants.
- 1.2.01 b. Recognize that people advertise goods and services through different forms of
- communication.
- 1.2.01 Identify how people exchange goods and services.
- 1.2.01 d. Describe the requirements of various jobs and the characteristics of a job well
- performed.
- 1.2.01 e. Describe how specialized jobs contribute to the production of goods and services.
- 1.2.02 Give examples of how individuals, businesses and governments operate in a
- market economy.
- 1.2.02 a. Recognize that goods and services are exchanged worldwide.
- 1.2.02 b. Give examples of industries and the resources needed to operate industries.
- 1.2.02 Identify examples of goods and services in the home, school, and community.
- 1.2.03 Understand fundamental economic concepts.
- 1.2.03 a. Distinguish the difference between goods and services.
- 1.2.03 b. Differentiate between consumers and producers.

2

- 2.2.03 Understand fundamental economic concepts.
- 2.2.03 a. Categorize resources needed to operate industries.
- 2.2.03 b. Understand the necessity of importing resources needed for industry.
- 2.2.02 Give examples of the interaction of individuals, businesses and governments in a market economy.
- 2.2.02 b. Recognize that communities around the state and world are economically
- interdependent.
- 2.2.01 a. Explain how work provides income to purchase goods and services.

- 2.2.01 b. Describe how society depends upon workers with specialized jobs and the ways in which they contribute to the production and exchange of goods and services.

3

- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.
- 3.2.03 b. Explain the characteristics of a technologically expanding global economy.
- 3.2.03 f. Trace the development of a product from start to a finished product.
- 3.2.03 e. Be aware of how goods and services are interchanged between communities at the
- local, national, and international levels.

4

- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.
- 4.2.02 Give examples of the interaction of groups, businesses, and governments in a market economy.
- 4.2.03a Understand fundamental economic concepts.
- 4.2.03 b. Describe the relationship of price to supply and demand.
- 4.2.03 c. Use economic concepts such as supply, demand, and price to help explain events.

5

- 7.T/E.2 Recognize that new tools, technology, and inventions are always being developed.
- 7.T/E.4 Recognize the connection between scientific advances, new knowledge, and the availability of new tools and technologies.
- 5.2.02 Give examples of the interaction of individuals, businesses, and governments in a market economy.
- 5.2.03 Understand fundamental economic concepts.
- 5.2.03 a. Explain how supply and demand affects production and consumption in the United States.
- 5.2.04 Understand the patterns and results of international trade.

6

- 7.T/E.1 Explore how technology responds to social, political, and economic needs.
- 7.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- 6.2.03 Understand the potential costs and benefits of individual economic choices.
- 6.2.03 a. Differentiate between needs and wants.
- 6.2.03 b. Analyze how supply and demand, and change in technologies impact the cost for

- goods and services.

7

- 7.T/E.1 Explore how technology responds to social, political, and economic needs.
- 7.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- 7.2.01 Understand fundamental economic concepts and their application to a variety of economic systems.
- 7.2.02 Understand global economic connections, conflicts, and interdependence.
- 7.2.02 a. Recognize that resources, goods, and services are exchanged worldwide.

8

- 7.T/E.1 Explore how technology responds to social, political, and economic needs.
- 7.Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- 8.2.04 Understand the interactions of individuals, businesses, and the government in a market economy.
- 8.2.03 b. Analyze how supply and demand, and change in technologies, impact the cost for
- goods and services.
- 8.2.02 Understand global economic connections, conflicts, and interdependence.
- 8.2.01 Understand fundamental economic concepts and their application to a variety of economic systems.
- 8.2.01 a. Describe the role that supply and demand, prices, incentives, and profits play in determining what is produced and distributed in a competitive market system.

Catchy, creative, and… sticky?

As a future-but-not-yet hugely successful roller coaster creator, you want a coaster name that grabs the attention of all who hear it and holds on with a death grip. This may seem a silly and frivolous task, but it may be the most important decision you make.

The name of your coaster (or business if you want to compete against those 19 coaster companies) has a tremendous impact on how customers and investors view you and your product!

How can you come up with the perfect catchy name for your new coaster? First by brainstorming and making sure your name is:

- Original
- Future-proof
- User-friendly
- Available (in some form)
- Lovable

You ready? Let's delve into these qualities and look at tips to get through the coaster name creation process.

Being original can be scary (and hard) to do, but it's essential when naming your roller coaster — don't be afraid to stand out from the crowd! In the trade, this memorability is called "stickiness." You want to 'stick' in people's minds!

As a new creator, your name needs to compel people to sit up and take notice rather forget you ever existed. To generate a boatload of options to work with, don't edit yourself too much during the brainstorming process — it's all about a free flow of ideas and imagination. Even if they seem silly at first. Write it all down!

Not sure where to start?

- **Explore keywords.** Twinword has an outstanding free keyword tool that can help you find inspiration for your name. If you type a keyword related to your business into its search field, it'll give you a graph of all the other words related to it. Fire away!
- **Consult books.** Use a hard copy of a dictionary, a thesaurus, or other book for inspiration. You could even use one of your favorite novels. Flip through the pages and write words that resonate with you, even if they're not directly related to your business.
- **Play it up.** Another way to achieve originality is with some deliciously fun wordplay. Have a look at these examples of coasters and companies with clever titles and think about what you could come up with for your brand. It's a good idea starter! Examples: **Melon Cauli** (fruit and

vegetable store), **Sole Man** (shoe repairs), **Spoon Me** (frozen yogurt brand), and **Sensibill** (receipt management software).

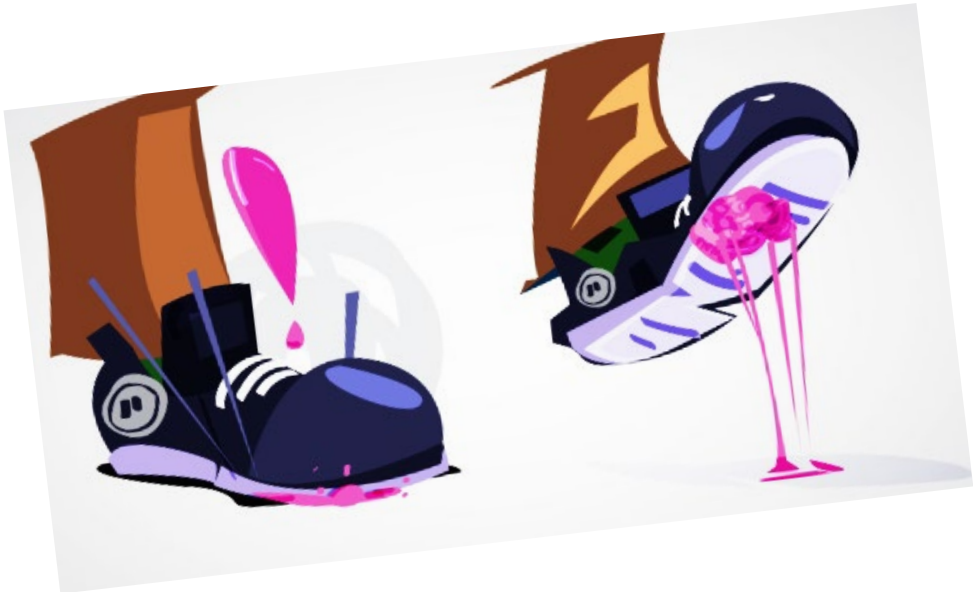
Don't Box Yourself In

One thing you don't want to do is create a name that sabotages your future expansion plans or limits your reach. Let's say, for instance, that you wanted to start a company that makes pain-free women's shoes, but you think you'll eventually try to crack the male market or develop an itch-free sweater line. Having a name like Fabulous Hurt-Free High High-Heels by Fiona wouldn't be helpful.

Or, if you're in a geographic location, but you'd like to expand and build your coasters all over the country restricting your name to the name of your town might be a little limiting later.

If you want little kids to ride your ride and buy toys related to your coaster's mascot naming it Night Terrors might narrow your audience a bit! If you want adventurous teens to ride it you might not want to name it Cuddly Wudkins Bunny Bopper. Of course, some might find that just terrifying enough to hop on board.

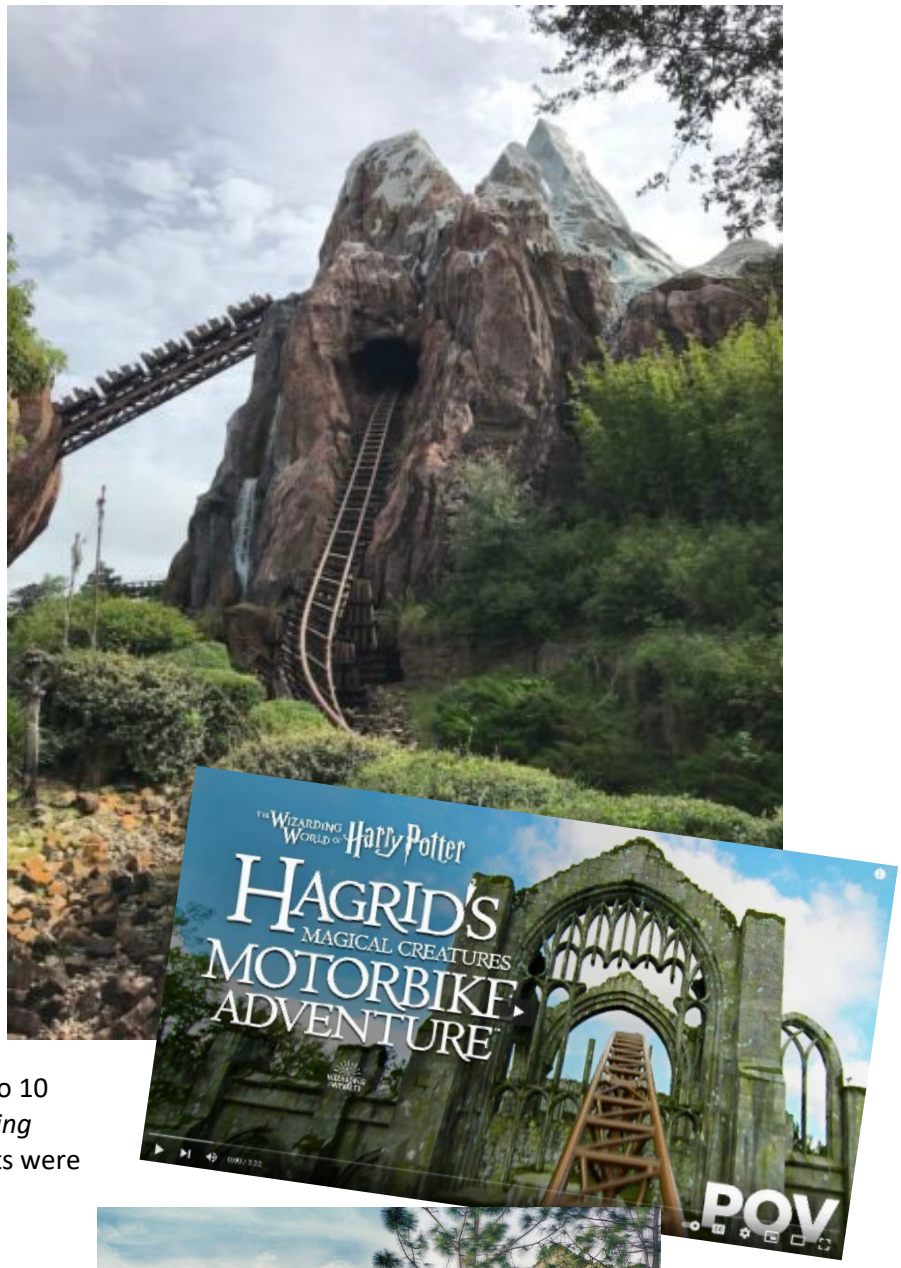
One way to future-proof your name is to think about your coaster's story, theme, mascot, and unique elements as you brainstorm.



A Rollercoaster Story?

Remember how the Disney ride 'Expedition Everest' tells a complete story? "Even the full title of the attraction, Expedition Everest – Legend of the Forbidden Mountain, lets you know that you're not simply going for a roller coaster ride; you're taking part in a legend. Expedition Everest is the perfect mix of strong story with beautiful, detailed scenery and effects." - Jeff DePaoli

Other rides tell stories too. Ex. Rock 'n' Roller Coaster Starring Aerosmith at Disney's Hollywood Studios. Although the track is just a steel coaster with painted neon flats, the attraction has a beginning, middle and end to its story. It sets it up nicely in the pre-show, where the guests are being invited by Aerosmith to their concert on the other side of town. After we board the "super stretch" limo, we ride through iconic Hollywood landmarks until we reach our destination at the concert.[25]



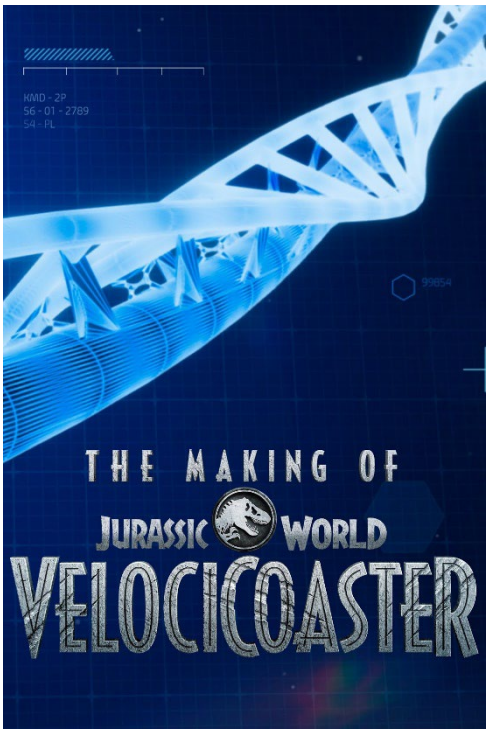
Universal Orlando recently opened Hagrid's Magical Creatures Motorbike Adventure which patrons have waited up to 10 HOURS to ride. *Thank you, brilliant marketing strategy!* The park opens at 9am, but guests were arriving as early as 6am to get in line.

Watch this!

Take a ride-along here. **Are they team motorcycle (like Hagrid) or team sidecar (like Harry)?** *Go to this blog to learn more fun facts about the wild ride.*

Credit: Discover Universal

[25] https://attractionsmagazine.com/depaoli-on-deparks%E2%80%A8-my-favorite-disney-storytelling-roller-coasters/



Watch this! VelociCoaster!

"Get your first peek as Universal Orlando Resort's team designs, builds, tests, and launches their newest attraction. This incredible video will let you watch as the team creates an amazing new thrill ride that sends you racing through a Velociraptor paddock, reaching speeds of 70 mph. From the initial brainstorming process to the development of the ride's story, from the breathtaking track layout to the imaginative incorporation of Velociraptors, from construction challenges to the first riders' cheers, "The Making of Jurassic World VelociCoaster" will take students along every step of the way." "The fact that they came up with a custom-designed smell for the raptors as you pass by them in the queue just makes you appreciate the level of (and attention to) detail even more."

Are you ready to brave the hunt? Race through the jungle alongside Velociraptors in this official front row POV of the thrilling Jurassic World VelociCoaster at Islands of Adventure. Experience the VelociCoaster yourself here.

Discuss:

What do students think? Are 'story coasters' and the unique themed experience they provide paving the way for a new generation of roller coasters? Or do riders want a pure coaster experience without a story element?[26] [27]

What story does your coaster tell?

- **Get reflective.** How would you describe your coaster to others? What are you trying to accomplish? What feelings do you want to evoke in your customers? What adjectives come to mind when you

[26] https://blooloop.com/theme-park/opinion/story-coaster-experience/
[27] https://blog.discoveruniversal.com/attractions/7-thrilling-details-about-hagrids/

think about your coaster? What do you do differently? Grab a piece of paper and a pen and start writing it all down.

- **Give a clue.** Try to adopt a coaster name that provides some information about what the ride will be like. Calling your terrifying landscaping and mowers run amuck themed ride "Lawn and Order" is appropriate, but the same name would not do well for a western themed or deep ocean roller coaster.
- **Keep it simple.** A coaster name shouldn't be a mashup of words trying to accomplish too many things — it needs to feel good and evoke positive emotions and associations in you and your future customers.

Make it user-friendly

You have a first-round list of original name ideas — now what? It's important to choose a name that's easy to say, spell, remember, and type into Google — even if it's a made-up word. Avoid unusual spellings!

Many people aren't great spellers! Choosing a name that helps people find you quickly can put you ahead of the game. And remember: if customers can't find you, they'll end up finding someone else!

- **Impose creative constraints.** As you get deeper into brainstorming, limit yourself to coming up with names with only one word or two syllables. The shorter the better — it'll help you focus on coming up with punchier name ideas. Other constraints to try? Coming up with only alliterative names (hello, Squarespace and PayPal), or only ones that begin with verbs (e.g., Dropbox, Shopify).
- **Test in different mediums.** To see how your name ideas look and sound, put them into a logo design sketch, say them out loud in a conversation (or to yourself in the mirror), and draft them in an email signature. Making your ideas feel real will help you determine if they connect!
- **Get feedback.** Ask your classmates, your friends, your teacher, or family members to weigh in on your name ideas. If you say a name and they immediately look confused or barrage you with questions, you may want to rethink its user-friendliness.

Do a Little Digging

Once you have a coaster name idea (or a few) that you're happy with, it's time to do some digging. For SEO and legitimacy purposes, you want the name in your website URL, so check if it's available in .com form.

If not, you can choose from about a hundred options from. net to.co.uk to. tv — but again, a .com URL can give your coaster/theme park an air of legitimacy and bring in more traffic.

The good news? Being creative will pay dividends because the more original your name, the more likely it is to be available as a web address.

Check it. GoDaddy is a go-to tool for checking domain availability and letting you see your .com alternatives. Type your ideas in, hold your breath, and see if the names are taken (we hope not!). If they are, see what businesses or pages are at those addresses and take note. You can also do a trademark search — here are the resources for the US, Canada, and the U.K.

Don't give up. If the domain is unavailable, you still have options. You can add a word at the start or end of your name — popular ones include "app," "get," and "hello."

Look at social handles. After checking the domain name, look at Namechk to see if the name you want is taken in social handles, particularly on the channels you plan to use to build your business.

If the exact handle name is unavailable (which is very likely), there are some easy fixes to try like adding a word or underscore. Again, check the content of handles that come up in your searches to see who else is using the name.

Make sure you LOVE it

It goes without saying that you have to love your new business name and feel confident about putting it out into the world. So that's why it's always a great idea to brainstorm plenty of ideas and take the time to mull them over before settling on a winner!

Talking the Talk! Don't get Jarred by Jargon!

Did you know most jobs or interests have a whole language all to themselves? It may sound like they're speaking the same language you are, but the words make absolutely no sense. That's jargon!

When you're having a discussion with a roller coaster enthusiast, it's easy to get lost in the conversation if you don't know the buzzwords like "Immelmann Roll."

Roller Coaster Terminology 101 and Coaster101 have zany lists of commonly used jargon by roller coaster enthusiasts to help you understand what the heck they're talking about and put you on the path to becoming a roller coaster expert yourself.

Got the Gab? Make it a Game! Read a word from the list and see who can guess correctly what it means! Or, have them make up their own definitions and see who gets the most votes. Ex. Airtime, Camelback, Dark Ride, Giga Coaster, Out and Back, cyclone coaster, Woodie, ERT, 4th Dimension, Mobius

Standards:

K

- L.K.5. With guidance and support from adults, explore word relationships and nuances in word meanings.
- L.K.5 d) Distinguish shades of meaning among words, e.g., verbs describing the same general action (e.g., walk, march, strut, prance), by acting out the meanings.
- R.L.K.5. Analyze the structure of print or digital texts, including how specific elements (e.g., dialogue, phrases, music clips, etc.) and larger portions of the text (e.g., a section or scene) relate to each other and the whole.
- R.L.K.6. Assess how point of view or purpose shapes the content and style of a print or digital text.

1

- L.1.5. With guidance and support from adults, demonstrate an understanding of figurative language, word relationships, and nuances in word meanings.
- L.1.5. d) Distinguish shades of meaning among verbs, e.g. those differing in manner (e.g., look, peek, glance, stare, glare, scowl) and among adjective, e.g. those differing in intensity (e.g., large, gigantic) by defining or choosing them or by acting out the meanings.
- RL.1.4. Identify words and phrases and other elements in print or digital text that suggest feelings or appeal to the senses.
- RL.1.6. Assess how point of view or purpose shapes the content and style of a print or digital text.

2

- L.2.5. Demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.2.5. b) Distinguish shades of meaning among closely related verbs (e.g., toss, throw, hurl) and closely related adjectives (e.g., thin, slender, skinny, scrawny).
- RI.2.6. Identify the main purpose of a print or digital text, including what the author wants to answer, explain, or describe.

3

- L.3.5. Demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.3.5. c) Distinguish shades of meaning among related words (e.g., knew, believed, suspected, heard, wondered).

- RL.3.6. Assess how point of view or purpose shapes the content and style of a print or digital text.
- RI.3.6. Distinguish their own point of view from that of the author of a print or digital text.

4

- L.4.4. c) Consult reference materials (e.g., dictionaries, thesauruses) to find, determine the pronunciation and determine or clarify the precise meaning of key words and phrases.
- L.4.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.4.5. c) Demonstrate understanding of words by relating them to their opposites (antonyms) and/or to words with similar but not identical meanings (synonyms).
- RI.4.5. Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, elements, or information in a print or digital text or part of a text

5

- L.5.4. c) Consult reference materials (e.g., dictionaries, thesauruses) to find, determine the pronunciation of and determine or clarify the precise meaning of key words and phrases.
- L.5.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.5.5. c) Use the relationship between particular words (e.g., synonyms) to better understand each of the words.
- RL.5.6. Describe how the author's purpose influences a print or digital text.

6

- L.6.4. Consult reference materials (e.g., dictionaries, thesauruses) to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
- L.6.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.6.5. c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., stingy, scrimping, economical, unwasteful, thrifty) to better understand each of the words.
- RI.6.6. Determine an author's point of view or purpose in a print or digital text and explain how it is conveyed in the text.

7

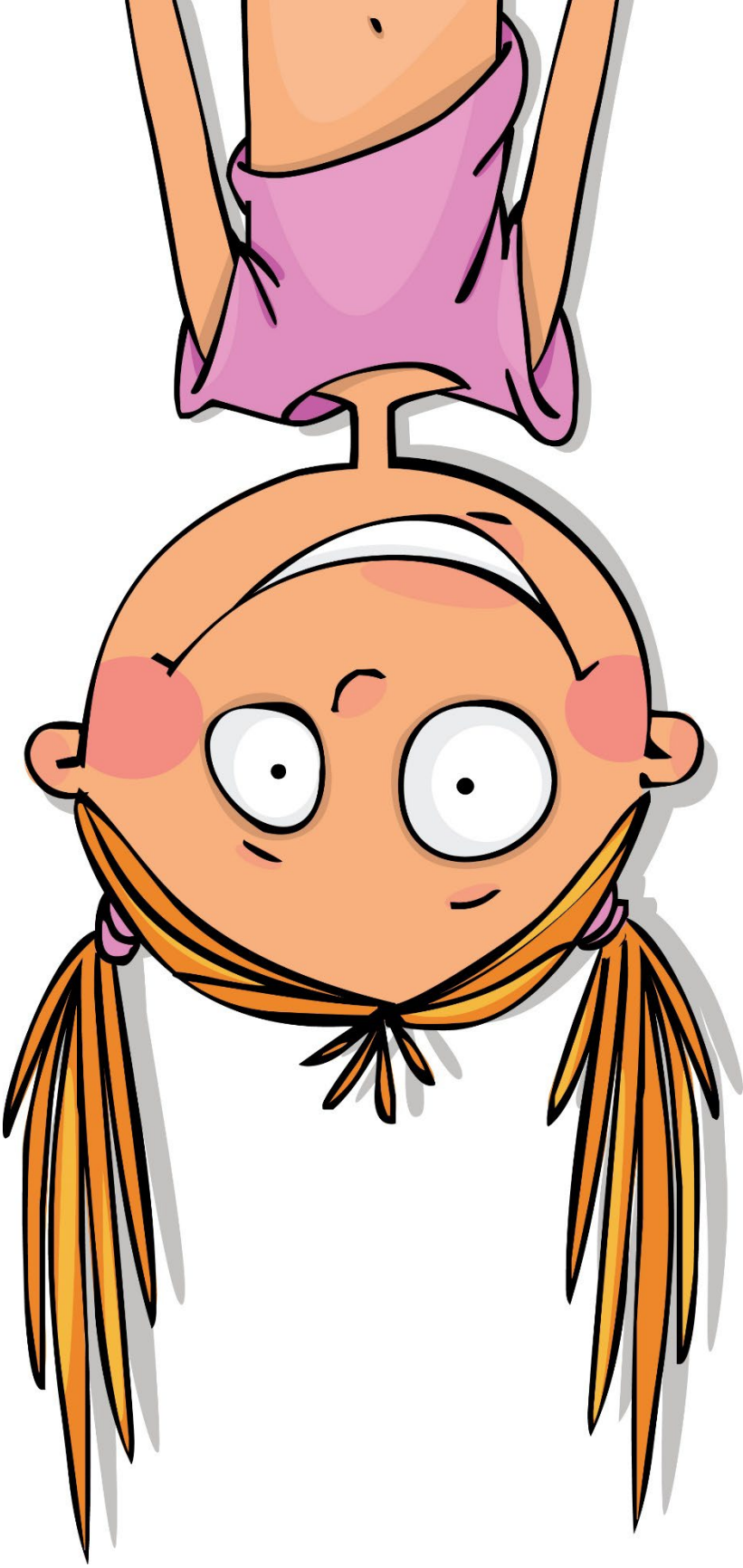
- L.7.4 c) Consult general and specialized reference materials (e.g., dictionaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.

- L.7.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.7.5 c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., refined, respectful, polite, diplomatic, condescending) to better understand each of the words.
- RI.7.6.a) Determine an author's point of view or purpose in a print or digital text.
- RI.7.5. Analyze the structure an author uses to organize a print or digital text, including how the various elements contribute to the whole and to the development of the ideas.

8

- L.8.4 c) Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
- L.8.5 b) Use the relationship between particular words to better understand each of the words.
- L.8.5 c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., bullheaded, willful, firm, persistent, resolute) to better understand each of the words.
- RI.8.5. Analyze in detail the structure of a specific print or digital text including the role of particular elements in developing and refining a key concept.
- RL.8.5. Compare and contrast the structure of two or more print or digital texts and analyze how the differing structure of each text contributes to its meaning and style.

Tag! You're It!



Do any of the following phrases sound familiar? Can students recognize the companies just from these few brief words?

- Just Do It! [Nike]
- Open Happiness! [Coca-Cola]
- Impossible is Nothing [Adidas]
- Enjoy Better [Time Warner Cable]
- Because You're Worth It! [L'Oreal]
- I'm Lovin' It! [McDonalds]
- Have it Your Way! [Burger King]
- Can you hear me now? [Verizon]
- The Breakfast of Champions [Wheaties]
- Go Further [Ford]
- I Will What I Want [Under Armour]
- Think Different [Apple]
- Everyday Moments [American Express]
- 15 minutes could save you 15% or more on car insurance [Geico]
- You're in good hands [Allstate]
- Everyday Low Price [Walmart]
- What's in Your Wallet? [Capital One]
- Mmmm! Good! [Campbells Soup]
- "Melts in Your Mouth, Not in Your Hands" [M&M's]
- Tastes so Good Cats Ask for It by Name [Meow Mix]

Were there any that they didn't recognize? What made some 'stickier' than others in their brains?

Brand slogans: Can't live with 'em. Can't live without 'em.

Every brand operating in the consumer marketplace today has a brand slogan, with varying degrees of emotional connection. The best brand slogans capture the spirit behind the brand – Their Big Why boiled down to a few words.

Think of it as a headline for your business. A quick shot at getting someone more interested. The tagline's job is to get attention and make people want to learn more!

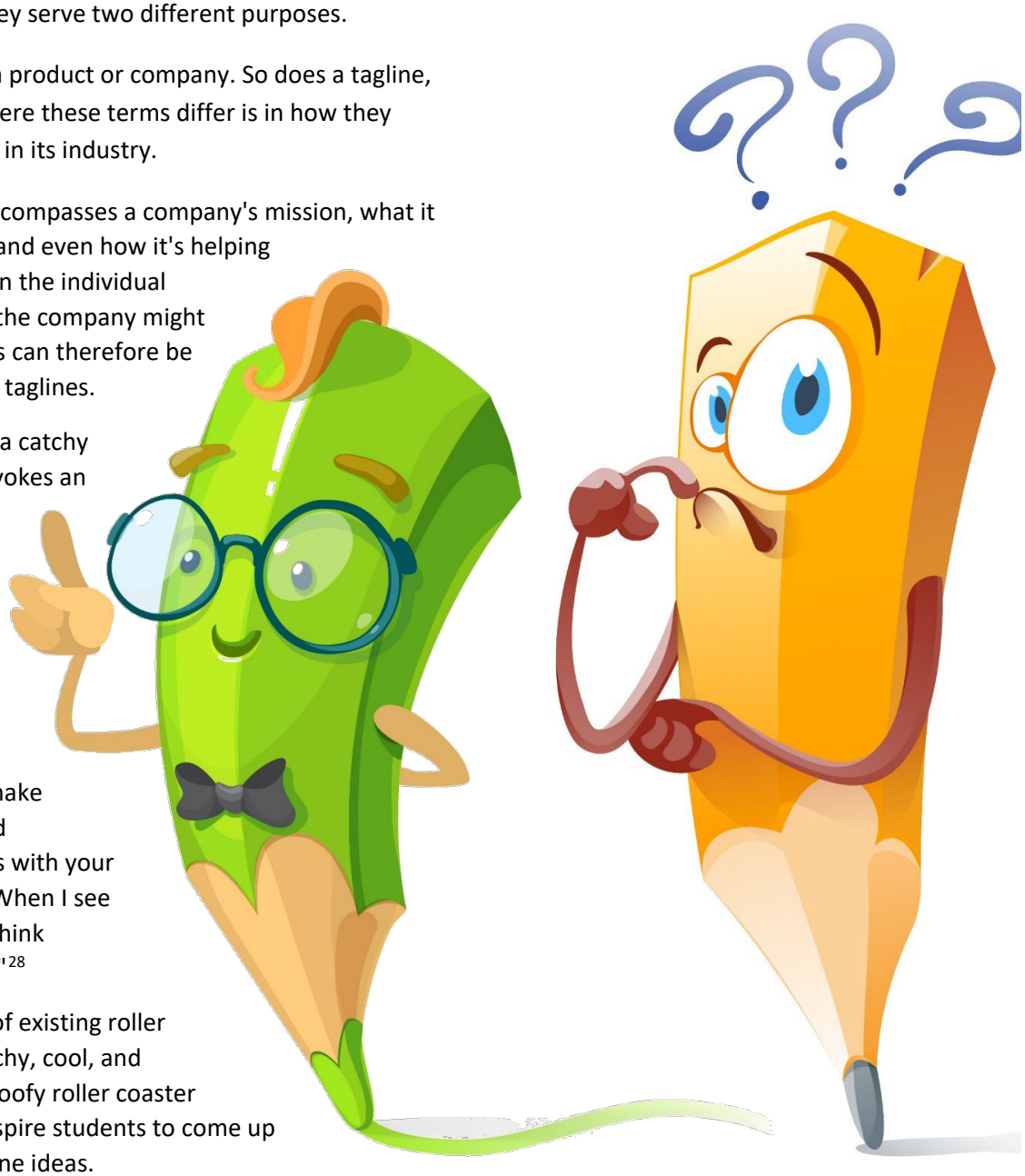
These brand tag lines are both concise and creative, conveying some quality that gets to the heart of the brand. The best tag lines activate an emotional stimulus within the brain, where neuroscientists estimate that 95% of human decisions are made, resulting in an emotional bond between brand and consumer.

Slogan vs. Tagline

Although both "slogan" and "tagline" tend to be used interchangeably, they serve two different purposes.

A slogan identifies a product or company. So does a tagline, for that matter. Where these terms differ is in how they position a company in its industry.

- A **slogan** encompasses a company's mission, what it stands for, and even how it's helping customers in the individual campaigns the company might run. Slogans can therefore be longer than taglines.
- A **tagline** is a catchy quip that evokes an image of your brand in the minds of your customers. Taglines enable people to make lighthearted associations with your business: "When I see [tagline], I think [company]."[28]



Check out taglines of existing roller coasters. These catchy, cool, and sometimes rather goofy roller coaster taglines will help inspire students to come up with their own tagline ideas.

[28] https://blog.hubspot.com/marketing/brand-slogans-and-taglines

- Tatsu- "Fly at the speed of fear!"
- Goliath “Bad to the Chrome.”
- Goldrusher "A Rip-Roaring Roller Coaster" o
- Pysclone's "The Ultimate Mindbender."
- Millenium Force "The Future Is Riding on It"
- Georgia Scorcher "Put Your Feet to The Fire"
- Mantis "Can You Stand it?"
- Raptor "Excuse Me While I Kick the Sky"
- Mr. Freeze "The Coolest Coaster on The Planet"
- Boomerang(s) "Coast to Coaster"
- Top Thrill Dragster "Race for The Sky"
- Twister II "Built Wilder the Second Time Around"
- Big Bad Wolf "Travel at the Speed of Fright"
- Drachen Fire "Speeding on the Flames of the Drachen Fire"
- MindBender (SFA) “See your face with your Mind Erased”
- Patriot- "Life, Liberty, And the Pursuit Of Weightlessness"
- Patriot “The American SCREAM” [It has two taglines.]
- Storm Runner "Vertical Horsepower"
- Wicked Twister "Break the Scream Barrier"
- Ninja "The Black Belt of Coasters"
- Roar “You'll never hear the end of it
- Kong “There's no escape”
- Zonga “Seriously Twisted”
- Medusa “She'll turn you into stone”
- Cyclone “It will blow you away”
- Silver Bullet “Ready, Aim, Scream”

Here's the 3-step process for creating a tagline or brand slogan:

Step 1.) Dump out your entire coaster idea in a few sentences.

Step 2.) Trim it down.

Step 3.) Trim it down to one short sentence.

Let's look at an example
Tagline Example:

Step 1.) Dump out your entire business/roller coaster concept in a few sentences:
“We create tools that go onto any webpage that help promote and share your website to

get more traffic through several tools: Share buttons, Welcome Mats, Pop Up email collects, and more. We make these tools really easy to use."

Step 2.) Trim it down:
"Tools that go onto your webpage to help promote and share your website to get more traffic."

Step 3.) Trim it down to one short sentence:
"Tools to Grow Your Website's Traffic."

Another Tagline Example:

Step 1.) Dump out your entire business in a few sentences:
"It's cheap to host a WordPress site, but when something goes wrong, your host will be nowhere to be found. Also, WordPress gets hacked if you don't upgrade it or choose poorly designed plugins."

Step 2.) Trim it down:
"WPengine makes hosting a website on WordPress super easy. We're like the perfect website host."

Step 3.) Trim it down to one short sentence:
"WordPress hosting, perfected." [29]

Thinking out Loud

Perhaps we decided we wanted our roller coaster, Phoenix, to have a tagline. And our whole concept is based on the idea that we're totally going to change how riding a roller coaster is done, from scratch. We're remaking coasters, getting rid of all old ideas, and beginning again with outstanding new ideas. Our tagline could be something like. *Rollercoasters. Reborn*. Or, if we think that riding our coaster is totally life changing and you'll come off the 90 second ride a totally different person? We might say: *Be Reborn.* Or *Feel the Burn.*

Your turn! Don't stress too much. Just have fun with it!

Your tagline will unlikely be your biggest driver of business. You've probably never gone to McDonald's or chose your insurance company or vehicle you buy solely based on "they had a better tagline." The only job of your tagline is to get attention and make your customer want to read/research more! Have fun with it.

[29] https://kopywritingkourse.com/how-to-create-a-great-tagline/

Standards:

K

- L.K.5. With guidance and support from adults, explore word relationships and nuances in word meanings.
- L.K.5 d) Distinguish shades of meaning among words, e.g., verbs describing the same general action (e.g., walk, march, strut, prance), by acting out the meanings.
- SL.K.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- R.L.K.5. Analyze the structure of print or digital texts, including how specific elements (e.g., dialogue, phrases, music clips, etc.) and larger portions of the text (e.g., a section or scene) relate to each other and the whole.
- R.L.K.6. Assess how point of view or purpose shapes the content and style of a print or digital text.

1

- L.1.5. With guidance and support from adults, demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.1.5. d) Distinguish shades of meaning among verbs, e.g. those differing in manner (e.g., look, peek, glance, stare, glare, scowl) and among adjective, e.g. those differing in intensity (e.g., large, gigantic) by defining or choosing them or by acting out the meanings.
- SL.1.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- RL.1.4. Identify words and phrases and other elements in print or digital text that suggest feelings or appeal to the senses.
- RL.1.6. Assess how point of view or purpose shapes the content and style of a print or digital text.

2

- L.2.5. Demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.2.5. b) Distinguish shades of meaning among closely related verbs (e.g., toss, throw, hurl) and closely related adjectives (e.g., thin, slender, skinny, scrawny).
- SL.2.1. Participate in collaborative conversations with diverse partners about texts with peers and adults in small and larger groups.
- RI.2.6. Identify the main purpose of a print or digital text, including what the author wants to answer, explain, or describe.

3

- L.3.5. Demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.3.5. c) Distinguish shades of meaning among related words (e.g., knew, believed, suspected, heard, wondered).
- SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RL.3.6. Assess how point of view or purpose shapes the content and style of a print or digital text.
- RI.3.6. Distinguish their own point of view from that of the author of a print or digital text.

4

- L.4.4. c) Consult reference materials (e.g., dictionaries, thesauruses) to find, determine the pronunciation and determine or clarify the precise meaning of key words and phrases.
- L.4.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.4.5. c) Demonstrate understanding of words by relating them to their opposites (antonyms) and/or to words with similar but not identical meanings (synonyms).
- SL.4.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RI.4.5. Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, elements, or information in a print or digital text or part of a text

5

- L.5.4. c) Consult reference materials (e.g., dictionaries, thesauruses) to find, determine the pronunciation of and determine or clarify the precise meaning of key words and phrases.
- L.5.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.5.5. c) Use the relationship between particular words (e.g., synonyms) to better understand each of the words.
- SL.5.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RL.5.6. Describe how the author's purpose influences a print or digital text.

6

- L.6.4. Consult reference materials (e.g., dictionaries, thesauruses) to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.

- L.6.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.6.5. c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., stingy, scrimping, economical, unwasteful, thrifty) to better understand each of the words.
- SL.6.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RI.6.6. Determine an author's point of view or purpose in a print or digital text and explain how it is conveyed in the text.

7

- L.7.4 c) Consult general and specialized reference materials (e.g., dictionaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
- L.7.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.7.5 c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., refined, respectful, polite, diplomatic, condescending) to better understand each of the words.
- SL.7.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RI.7.6.a) Determine an author's point of view or purpose in a print or digital text.
- RI.7.5. Analyze the structure an author uses to organize a print or digital text, including how the various elements contribute to the whole and to the development of the ideas.

8

- L.8.4 c) Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
- L.8.5 b) Use the relationship between particular words to better understand each of the words.
- L.8.5 c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., bullheaded, willful, firm, persistent, resolute) to better understand each of the words.
- SL.8.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on texts, building on others' ideas and expressing their own clearly.
- RI.8.5. Analyze the structure of a specific print or digital text including the role of particular elements in developing and refining a key concept.

- RL.8.5. Compare and contrast the structure of two or more print or digital texts and analyze how the differing structure of each text contributes to its meaning and style.
- SL.8.2. Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.

LOGO! Let's Go!

Once you have a roller coaster name (and the glimmer of an idea of what your coaster is all about) you can start building your brand!

Logo design is one of the most common skills you need in the graphic design industry. A logo is the first impression of any brand, and it needs to look professional to build brand awareness.

Before you design a logo, you must understand what a logo is, what it represents and what it is supposed to do. A logo is not just a mark. A logo shows who you are. A company/rollercoaster has a logo not only so that you can easily identify their product but also so that you'll know something about their company/ride at a glance. Even if there are no words, a good logo should communicate to its audience by shape, fonts, color, and / or images. A picture's worth a thousand words, right?

Marketers plant the seeds of brand recognition in very young children (ahem, toy sales, anyone?), hoping the seeds will grow into lifetime relationships. Brand loyalties and logo recognition can be established as early as age two, and by the time children head off to school most can recognize hundreds of logos.

A logo is for inspiring trust, recognition and admiration for a company or product, and it is our job as designers to create a logo that will do its job.

Seek inspiration (not imitation)

Explore roller coaster logos with students at Coasterpedia.net

Look for examples of students' favorite roller coasters. Discuss the types of colors that are used to represent different coasters in their logos and ads. What kinds of mascots do they use?

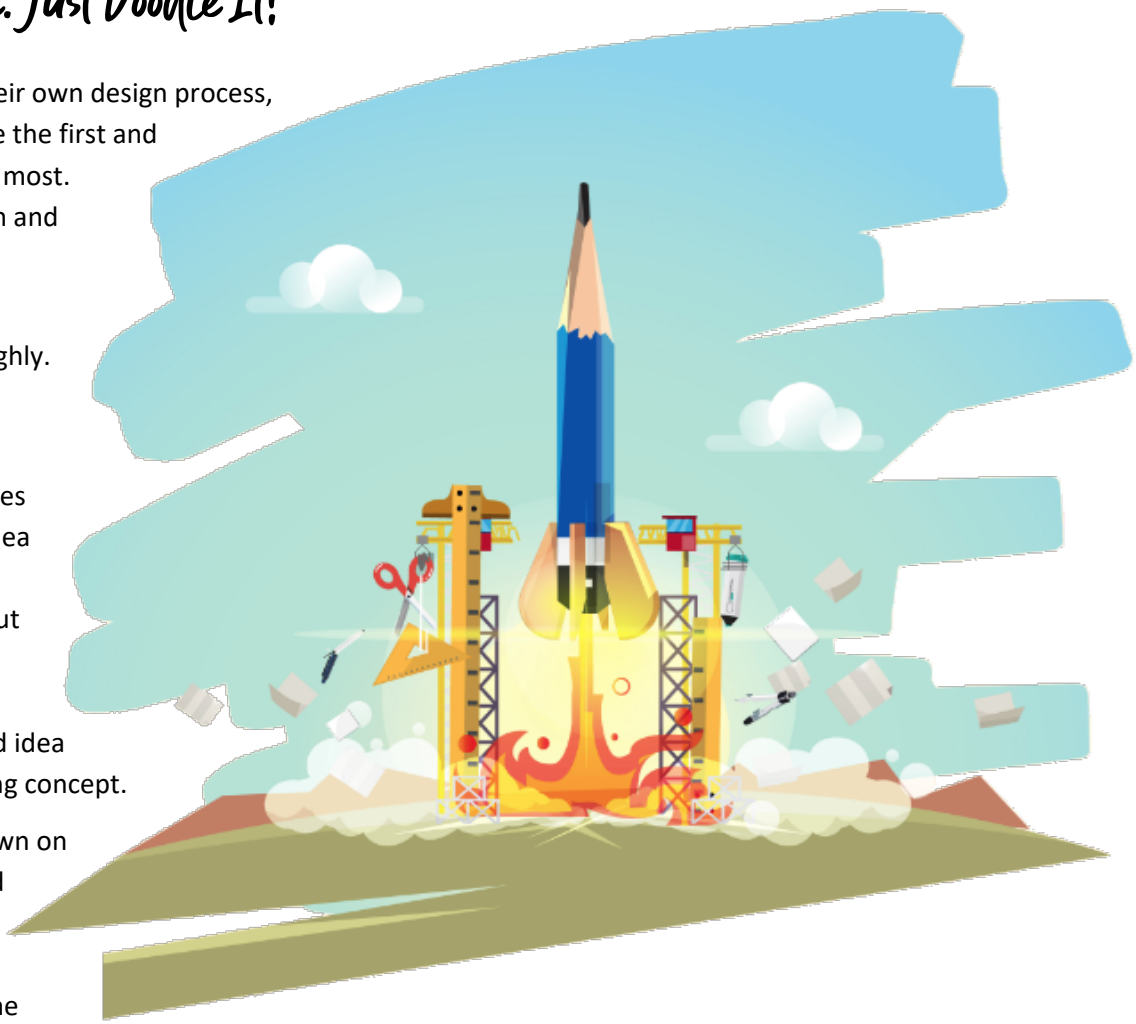
Rather than saying, 'I like the color red, so, it should be in my logo,' demonstrate to students how to really think about *why* the color red is important to *your* coaster. Your logo should be a representation of *your coaster*. What does red mean/say to consumers?

Do you expect the perfect logo design to pop up, fully formed, in your mind? If you do, you could be in for an endless wait.

Instead, it's up to you to seek logo design inspiration. If you let a wide variety of ideas collide inside your brain, gradually they should coalesce into the logo you're looking for. The trick is knowing where to look for inspiration.

Whenever you see something (anything!) that stands out or appeals to you, for whatever reason, file that thought. Let it inform your design process and contribute as your new logo evolves.

Discovery Phase: Just Doodle It!



Every designer has their own design process, but paper and pen are the first and best place to start for most. You can quickly sketch and explore ideas with no limitations.

Work quickly and roughly. Just doodle it!

These sketches are (normally) for your eyes only, and purely for idea generation. Any idea that comes to mind put on paper! Even if it seems bad as sometimes even a bad idea can form an interesting concept.

Putting every idea down on paper frees your mind to think of further ideas, so often the faster the sketches, the quicker the next idea forms.

You may well end up with a page of pointless scribbles, but somewhere in the disjointed mess of lines you might spot something that fires up that essential spark of inspiration.

Pro Tip! Keep it Simple!

Keep it simple. This can't be said too many times.

The best logos are ones that speak for themselves. (Think of ones like the Recycle, Reuse, Reduce logo. Three little simple arrows! But it says a lot.) Often, people think that something simple means it's not creative… when in fact, it's the complete opposite! It's easy to keep adding things on to your logo… it's difficult to have something simple that represents you perfectly!

Ask a friend

Once you have some ideas worked up, take them to a friend who has absolutely no connection to the project, and see what they think. Ask them what the logo says to them. Often someone's untainted opinion can be just what you need to fire up your imagination.

Testing, Testing…

Test it out like Carolyn Davidson did. Draw your logo on tissue paper and hold it up against a shoe, like your duct tape shoe. Does it look good?

You've really got it together!

When students have settled on a final design, have them present it. Have them explain their logo.

Talk about the mascot. Describe how the different parts of your logo (colors, shapes, symbols, images, font, text, etc.) represent different aspects of the concept they are trying to communicate.

Standards:

K

- K.G.3. Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
- K.G.1.a. Describe objects in the environment using names of shapes.
- K.G.1.b. Describe the relative positions of objects using terms such as above, below, beside, in front of, behind, and next to.
- K.G.4. Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/“corners”) and other attributes.
- K.G.5. Model shapes in the world by building shapes from components and drawing shapes.
- K.G.6. Compose simple shapes to form larger shapes.
- R.L.K.5. Analyze the structure of print or digital texts, including how specific elements (e.g., colors, images, font) and the text relate to each other and the whole.
- R.L.K.6. Assess how point of view or purpose shapes the content and style of a print or digital text.
- SL.K.5. Add drawings or other visual displays to descriptions and writing to provide additional detail.

1

- 1.G.1. Distinguish between defining attributes versus non-defining attributes (e.g., color, orientation, overall size) ; build and draw shapes to possess defining attributes.
- 1.G.2. Compose two-dimensional shapes or three-dimensional shapes to create a composite shape, and compose new shapes from the composite shape.
- RL.1.4. Identify words and phrases and other elements (e.g., colors and images) in print or digital text that suggest feelings or appeal to the senses.
- RL.1.6. Assess how point of view or purpose shapes the content and style of a print or digital text.
- SL.1.5. Add drawings or other visual displays to descriptions and writings when appropriate to clarify ideas, thoughts, and feelings.

2

- 2.G.1. Recognize and draw shapes having specified attributes.
- RI.2.6. Identify the main purpose of a print or digital text, including what the author (including themselves) wants to answer, explain, or describe.
- SL.2.5.b. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in text, to clarify ideas, thoughts, and feelings

3

- RL.3.6. Assess how point of view or purpose shapes the content and style of a print or digital text.
- RI.3.6. Distinguish their own point of view as an author of a print or digital text.
- SL.3.5. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in texts, to emphasize or enhance certain facts or details.

4

- 4.G.3. a) Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts.
- 4.G.3. b) Identify line-symmetric figures
- 4.G.3. c) Draw lines of symmetry.
- RI.4.5. Describe the overall structure ideas, concepts, elements, or information in a print or digital text or part of a text
- SL.4.5. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to enhance the development of main ideas or themes.

5

- 5.G.4. Classify two-dimensional figures in a hierarchy based on properties.
- RL.5.6. Describe how the author's purpose influences a print or digital text.
- SL.5.5. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to enhance the development of main ideas or themes.

6

- RI.6.6. Determine an author's point of view or purpose in a print or digital text and explain how it influences it.
- SL.6.5.. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to clarify information.

7

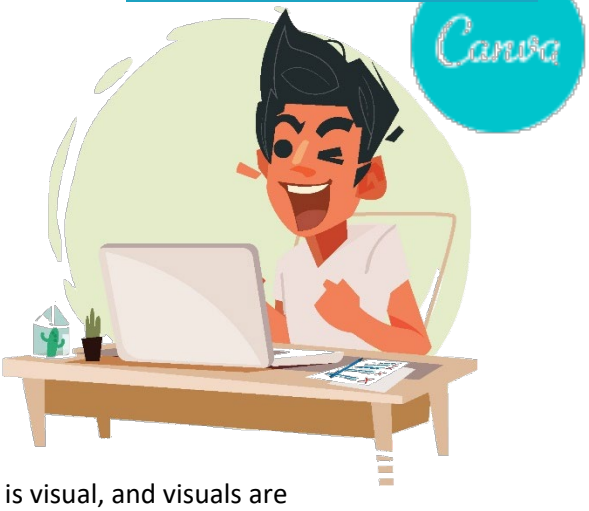
- 7.G.2. a) Draw (freehand, with ruler and protractor, and with technology) shapes with given conditions.
- RI.7.6.a) Determine an author's point of view or purpose in a print or digital text.
- RI.7.5. Analyze the structure an author uses to organize a print or digital text, including how the various elements contribute to the whole and to the development of the ideas.

- SL.7.5. Include multimedia components and visual displays, e.g., in presentations and story outlines, to clarify and emphasize salient points.

8

- G-MG.1. Use geometric shapes, their measures, and their properties to describe objects.
- G-MG.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost.
- G-GMD.4 Visualize relationships between two-dimensional and three-dimensional objects.
- S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).
- RI.8.5. Analyze in detail the structure of a specific print or digital text including the role of particular elements in developing and refining a key concept.
- RL.8.5. Compare and contrast the structure of two or more print or digital texts and analyze how the differing structure of each text contributes to its meaning and style.
- SL.8.5. Integrate multimedia and visual displays, e.g., in presentations and story outlines, to clarify information.

Show me Somethin' Good!



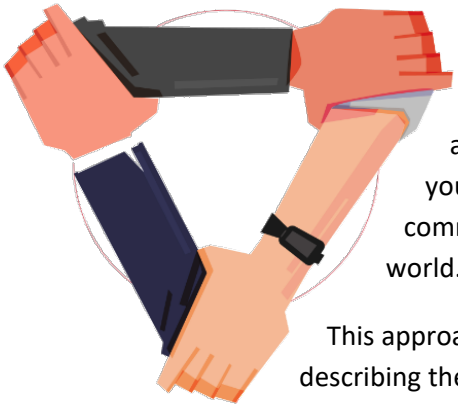
Tips and Tools:

Have students use online tools like Canva, PiktoChart, Venngage, BeFunky, or Smore to amp up their portfolio, create amazing posters, and practice 21st century skills!

There's plenty of evidence supporting the notion that visual-based learning is tied to better retention and recollection of new information and measurable success for students in the classroom. A study by 3M Corporation yielded astounding results showing that 90% of information transmitted to the brain is visual, and visuals are processed 60,000 times faster in the brain than text. Visual and project-oriented teaching strategies are becoming the norm and it's through these methodologies that a more holistic learning environment has been created and widely embraced.[30]

Goal: Students will concept, design, and create marketing pieces to advertise their or other students' roller coasters.

Variations: Students may either be assigned to create a poster for their own roller coaster to take advantage of their enthusiasm, or, to make the situation similar to real life, have each group trade and "hire" an advertising company (another group) to create the ad/poster. Receiving a project that you have no familiarity with is a common experience in the real-life design world.



This approach teaches them to problem solve and find the answers they need. When describing the project, if having them trade, tell students: They have selected your advertising agency to handle the advertising and marketing of a new roller coaster. Even if you've never heard of the coaster or been to an amusement park, you'll have to research this coaster (talk to the original group), think about what the public needs to know in order to attend and how you'll

[30] https://www.wabisabilearning.com/blog/7-creative-student-design-projects-try-canva

visually convey all that information to get attention! They can then work on submitting designs for approval to the original group, making a final official poster of an approved design, etc.

Have students interview each other as though they were a logo designer who is talking to a company about a design they want. Use questions such as the following.

Tell me about your coaster

- What is the name of your roller coaster? (This is the name that will be used in your logo design)
- Do you have a tagline or slogan that could be used as part of the logo?
- Do you have a mascot for your ride?
- Who are your competitors?
- What makes your ride different you from your competitors?
- Is there a unique story or theme behind your roller coaster?
- Are there any inspiring visuals associated with your coaster?
- Who is your target audience/rider/age group?
- What does your audience care about?
- What does your audience want?
- How does your audience learn about your roller coaster?
- Why should your audience choose your coaster/theme park over the competition?
- What words do you want your audience to associate with your roller coaster?
- What logos or brands do you think will appeal to your audience and why?
- What roller coaster logos do you like? What do you like about them?

- Your design preference likes/dislikes or expectations: Ex. Do you like bold designs.
- What colors do you think best represent your company? Why those colors?

Next Item on the List!

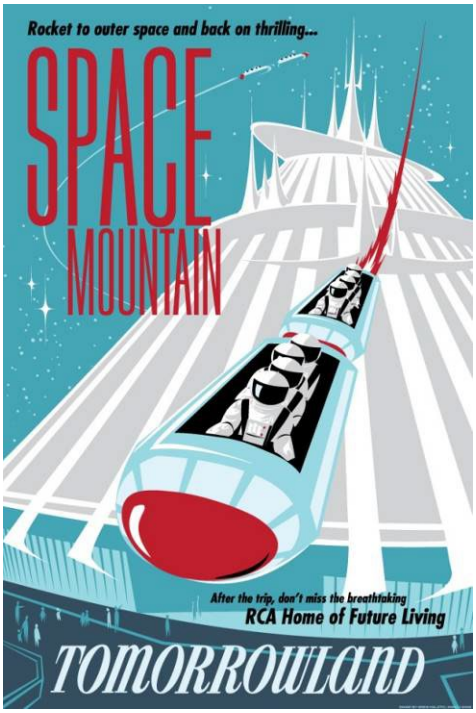
Now that they've designed it, pitched it, sold it, and built it, will people come to ride it? Like any business venture, roller coasters require strategic marketing in order to become successful. The goal of most media messages is to persuade the audience to believe or do something.

Image and marketing are a key element of roller coaster success, after all, they built roller coasters to make money, and advertisers have to capture the imagination of thrill seekers in order for them to spend money to ride it. For this they hire graphic designers.

Careers in graphics design are abundant and present career opportunities now and for the future. Along with writers, clients, and other creative people who decide on what the content or message should be, graphic designers make the content look appealing to the client's audience. Graphic designers are the people who design the magazines, product labels, shopping bags, websites, cereal boxes, newspapers, logos, stationery, books, movie posters, billboards, and millions of other things that we see many times every day.

Image Credit: Entertainment Designer http://entertainmentdesigner.com/news/theme-park-design-news/mirabilandia-italy-set-to-open-worlds-tallest-water-ride-in-june/#more-5803. All Rights Reserved.

Is their client's roller coaster the "biggest, baddest, longest, fastest wooden roller coaster in the world!" like King Island's Beast? Will they go for terror and "dare" people to ride, or for fun and adventure, or humor?



Have students work in groups and compile adjectives (discuss the differences between the difference between common, proper, and demonstrative), and intensifiers such as comparatives, hyperbole, and superlatives to describe their roller coaster. Demonstrate the conventions of standard English capitalization, punctuation, and spelling when writing as a group.

The language of ads is full of intensifiers, including superlatives (greatest, best, most, fastest, lowest prices), comparatives (more, better than, improved, increased, fewer calories), hyperbole (amazing, incredible, forever), exaggeration, and many other ways to hype the product.

Pretty or elegant? Good or scrumptious? Nice or delightful? ***As a group discuss and explore word relationships used in advertisements and nuances in word meanings and distinguish shades of meaning among closely related verbs (e.g., toss, throw, hurl) and closely related adjectives (e.g., thin, slender, skinny, scrawny, by acting out the meanings and through discussion.*** There is power in the adjectives (and other words) you choose. ***How can there be power in words? Have students give their explanation of the function of nouns, pronouns, verbs, adjectives, and adverbs in general and their functions in particular sentences*****.** Just like Clark Kent and Superman or Bruce Wayne and Batman, some adjectives are plain, ordinary, everyday words. Others are alter-ego Super Adjectives that leap into your customers' minds in a single bound. Adjectives are boring, but Super Adjectives impress, inspire, and convince your customers more effectively.

Examples:

Before: Great Drink for Hot Summer Days

When it's hot outside, this lemonade will help keep you cool. Made with fresh water, sugar, and lemon juice, you'll love how it tastes. Available in four flavors.

After: Icy Refreshment Perfect for Sticky Sweaty Summer Days
When the temperatures are steamy outside our ice-cold lemonade will help keep you perfectly cool. Made with ice cold distilled spring water, all-natural sweet cane sugar, and tangy fresh-squeezed organic lemons, you'll adore the refreshingly zingy taste and the way it banishes the heat. Now in four tasty fresh fruit flavors: tart raspberry, smooth mango, sweet peach, and tangy original lemonade.

What's the difference? Why are the "afters" so much more powerful than the "befores"? Because interesting adjectives were used. ***Have students analyze the adjectives role in the text.*** Adjectives let the reader know more about the product and develop a connection with it. But boring ordinary adjectives aren't the answer. You need Super Adjectives to entice your customers.

Putting it in Action

On the included "Ordinary, No Extraordinary!" sheet, and/or as a group, have students write a list in each column of nouns, adjectives, adverbs, and verbs they might ordinarily use to describe their coaster. Then, in to fill in the other columns, have students consult reference materials (e.g., dictionaries, thesauruses), both print and digital to look for **vivid** synonyms to those words that could be used instead, to spice up their ads. Attention grabbing superlative advertising brings in crowds, who bring in money.

Write that Down! Writing Prompt Ideas

Nouns & Verbs Action Poem

This is an exercise in doing the opposite of what we often do when we write poems—we often over-write and then go back and condense. This challenge is to under-write and then add only the most perfect and necessary details.

Write a poem using only nouns and verbs. That right, no other parts of speech are allowed at this point in the writing. Be aware as you write your poems must have meaning, so don't just write any old things that pops into mind. Or if you do, refine it! Be sequential, make sense, create the "skeleton" of the poem to come.

After you've written your noun-verb poem read it carefully and add only enough details to give your poem a "body." Be judicious in your use of modifiers, qualifiers, and don't add any word that isn't necessary.

Example:

Standing
Waiting

Anticipating
Sun pounds
Feet ache
At the gate!
Sit down
Hearts pound
Seats jerk
Hearts lurch
Stomach flips
Dive down
Spin ‘round
Where’s the ground?
Brakes squeal
Feet touch down
Another round?

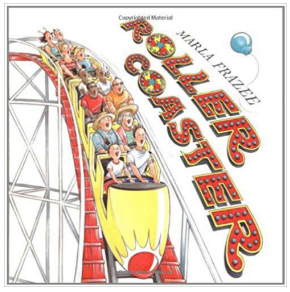
Onomatopoeia Poems/Stories

Onomatopoeia is a poetic device which uses phonetics to recreate actual sounds people hear. These words typically mimic the sound of an action or other sounds such as one's animals make. Some onomatopoetic words capture sounds from natural body functions like sneezing, wheezing, and sighing. When used well, this device helps a writer develop meaningful images which bring the reader closer to real-life experiences. Translating auditory experiences into words is a fundamental step in understanding the many layers of language.

Sample of an Onomatopoeia Poem

The Rollercoaster *By Kelly Roper*

Clickity-clackety, clickity-clackety,
The rollercoaster went up the track.
With a whoosh and a squeal
Down the smooth rails of steel,
The rollercoaster raced its way back.



Book Sample: Roller Coaster by Marla Frazee

Work as a class to create a list of onomatopoeia words related to amusement parks and roller coasters. Choose three or more words from the list and use them to write your own poem. It’s okay to use a different version of the word in the list. For example, if you choose “boom,” you might use one of these instead: booms, boomed, booming.

Examples of onomatopoetic words include:

- zap
- gurgle
- achoo
- boom
- jingle
- clanging
- fizz
- pop
- click

- clack
- hiss
- rattle
- vroom
- smash
- Bang
- Belch
- Buzz
- Click
- Crack
- Drip
- Flutter
- Gasp
- Growl
- Knock
- Murmur
- Plop
- Pop
- Purr
- Rustle
- Sizzle
- Splash
- Snap
- Thump
- Tweet
- Whip
- Zip

Get the Message! Art in Advertising

Posters and infographics are an awesomely fun design projects because students can bend the rules so many different ways. Posters are creative, bold, groovy and can provoke so many emotions too. Some posters get you excited and pumped up such as, hey, a roller coaster poster! Or music or event posters. And then others are chock full of information. Some may contain much more information than others. The key is finding the right balance with headline, copy, images, and logos. When you've achieved that, you've got one sweet poster.

Once students have determined what words they want to use, they then are ready to design a layout.

Materials:

- Computers & Printers (Optional)
- Poster boards
- Graph paper
- Paper
- Pencils
- Paints/Markers/Crayons/and other art supplies
- Construction paper
- Completed roller coasters
- List of adjectives/descriptions
- Selected themes

Tips:

To see examples of each of the following, explore this article with your students.

Keep it Clear & Concise! Posters should grab attention and be a quick read. Rank information in order of importance. If you're working with little copy, go for a bold, simple graphic or photo like this Columbus Creative poster by Mike Jones. If you have lots of information, have the type be your focus. Think about a big headline and group information into chunks.[31]

Experiment with Typography! So much can be conveyed in an event poster from just from the fonts. Show seriousness with a bold sans serif, enhance elegance with an italic serif or express playfulness or fun with a loose handwritten font. When selecting fonts, choose at least two — One for the headline. One for body copy.

Play with Color! Color is one aspect of the design that's wide open. Colors will create energy, elicit a mood and attract the eye. Depending on the poster subject, the colors will be bold, subtle or romantic. You can really go all out with color.

Use negative or white space to form a clever composition. Creating an image from another image is something like magic. When it finally pops out at you, it's amazing. Another way to use negative space is to draw the eye into a small object of focus with lots of negative space around it to let the viewer's eye breathe. Drop your copy into the open space to draw the eye but don't fill it. *Don't be afraid of empty spaces in your design.*

Remove unnecessary elements. Say more with less. Sometimes, less is more. It intrigues the viewer. A single word or dramatic image can communicate so much more than lots of words or intricate photos or illustrations. Don't add extra graphics or words just for the sake of adding more.

Create a point of focus. Use photography that's in or out of focus to give more weight to the text. Or crop a photo tight to show the most important feature. This will create drama or lead the eye around the page.

[31] https://www.canva.com/learn/25-ways-to-design-an-awesome-poster-and-create-a-buzz-for-your-next-event/

Use shapes to create visual interest. Shapes create other shapes. They create guidelines that lead the reader's eye around the poster. *You can create interesting areas in your design by using shapes. Break it up by using rectangles that can act as frames, etc.*

Be clever with your composition. Once you have your information, photos, or illustration, think about how to break it up and put it back together so it reads easily to the viewer. Put pieces of information together like a puzzle. YOU decide how the viewer will read the poster and get the message. Pay attention to how graphics interact with words or letters.

Play with layering to create depth and dimension. Layering images, colors and words create depth and dimension. It sucks you into the little world created on the board.

Emphasize elements to create energy and drama. When you use exciting, exhilarating photos, illustration and even fonts, you'll create a serious impact and most definitely get a reaction from the viewer. The emotion and energy 'll draw them in. We can usually accomplish drama using fewer words too.

Use humor. Be silly. Have fun. Create a play on words. Use unexpected imagery, unless, of course, you have a serious subject. *Humor attracts attention.*

For more tips explore 25 ways to design an awesome poster and create a buzz for your next event, with your students.

When complete: Have students present their designs to class. This is an opportunity to practice public speaking and group critiques.

Options:

- Posters may be worth points.
- Include requirements, based on grade levels and abilities, ex. Poster must be symmetrical, poster must use negative space, etc.

Ordinary? No, Extraordinary!

Noun	Vivid Synonym(s)	Verb	Vivid Synonym(s)	Adjective or adverb	Vivid Synonym(s)

Standards:

K

- L.K.5. With guidance and support from adults, explore word relationships and nuances in word meanings.
- L.K.5 d) Distinguish shades of meaning among words, e.g., verbs describing the same general action (e.g., walk, march, strut, prance), by acting out the meanings.
- R.L.K.5. Analyze the structure of print or digital texts, including how specific elements (e.g., dialogue, phrases, music clips, visual images, etc.) and larger portions of the text (e.g., a section or scene, the visual structure, or image) relate to each other and the whole.
- R.L.K.6. Assess how point of view or purpose shapes the content and style of a print or digital text.

1

- L.1.5. With guidance and support from adults, demonstrate an understanding of figurative language, word relationships, and nuances in word meanings.
- L.1.5. d) Distinguish shades of meaning among verbs, e.g. those differing in manner (e.g., look, peek, glance, stare, glare, scowl) and among adjective, e.g. those differing in intensity (e.g., large, gigantic) by defining or choosing them or by acting out the meanings.
- RL.1.4. Identify words and phrases and other elements in print or digital text that could suggest feelings or appeal to the senses.
- RL.1.6. Assess how point of view or purpose shapes the content and style of a print or digital text.

2

- L.2.5. Demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.2.5. b) Distinguish shades of meaning among closely related verbs (e.g., toss, throw, hurl) and closely related adjectives (e.g., thin, slender, skinny, scrawny).
- RI.2.6. Identify the main purpose of a print or digital text, including what the author wants to answer, explain, or describe.

3

- L.3.5. Demonstrate understanding of figurative language, word relationships and nuances in word meanings.
- L.3.5. c) Distinguish shades of meaning among related words (e.g., knew, believed, suspected, heard, wondered).

- RL.3.6. Assess how point of view or purpose shapes the content and style of a print or digital text.
- RI.3.6. Distinguish their own point of view from that of the author of a print or digital text.

4

- L.4.4. c) Consult reference materials (e.g., dictionaries, thesauruses) to find, determine the pronunciation and determine or clarify the precise meaning of key words and phrases.
- L.4.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.4.5. c) Demonstrate understanding of words by relating them to their opposites (antonyms) and/or to words with similar but not identical meanings (synonyms).
- RI.4.5. Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, elements, or information in a print or digital text or part of a text

5

- L.5.4. c) Consult reference materials (e.g., dictionaries, thesauruses) to find, determine the pronunciation of and determine or clarify the precise meaning of key words and phrases.
- L.5.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.5.5. c) Use the relationship between particular words (e.g., synonyms) to better understand each of the words.
- RL.5.6. Describe how the author's purpose influences a print or digital text.

6

- L.6.4. Consult reference materials (e.g., dictionaries, thesauruses) to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
- L.6.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.6.5. c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., stingy, scrimping, economical, unwasteful, thrifty) to better understand each of the words.
- RI.6.6. Determine an author's point of view or purpose in a print or digital text and explain how it is conveyed in the text.

7

- L.7.4 c) Consult general and specialized reference materials (e.g., dictionaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.

- L.7.5. Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.
- L.7.5 c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., refined, respectful, polite, diplomatic, condescending) to better understand each of the words.
- RI.7.6.a) Determine an author's point of view or purpose in a print or digital text.
- RI.7.5. Analyze the structure an author uses to organize a print or digital text, including how the various elements contribute to the whole and to the development of the ideas.

8

- L.8.4 c) Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning or its part of speech.
- L.8.5 b) Use the relationship between particular words to better understand each of the words.
- L.8.5 c) Distinguish among the connotations (associations) of words with similar denotations (definitions) (e.g., bullheaded, willful, firm, persistent, resolute) to better understand each of the words.
- RI.8.5. Analyze in detail the structure of a specific print or digital text including the role of particular elements in developing and refining a key concept.
- RL.8.5. Compare and contrast the structure of two or more print or digital texts and analyze how the differing structure of each text contributes to its meaning and style.

Optional Extension: Sell me Somethin' Good!

In our digital classrooms web pages remain popular projects for creative expression and content sharing. However, students and their peers are often faced with the same sense of immediacy for project development and product launch as any of the real-life businesses and coasters we've studied.

What if your theme park existed today and they not only needed to spread buzz about their opening but also needed a new website by 9am? After all, an online business website lets you stay open and reach customers 24 hours a day!

They'd be fine because you're going to design! You've got the skills they need! After all you've already designed a logo, roller coaster, a mascot, the ride itself! A real-life website? You can handle it!

A need for speed?

Proper HTML coding is unquestionably a valuable skill for any student, business owner, or graphic or web designer to learn, but it takes time and practice. So, what can they (and real businesses) do when they need something quick and professional-looking in no time flat?

Do like the professionals do! Using a free drag & drop website designer (like Wix.com or one of the others mentioned below) create a gorgeous professional website for your coaster!

You must include:

- Your rollercoaster name
- Your rollercoaster logo
- Mascot and coaster design sketches
- Photos of your completed roller coaster
- Price of each ride
- Stats about the ride: length, unique elements, etc.
- Budget for building it
- Your passion and inspiration! (Are you giving back or sharing profits? Tell us about it.)

- Include the story of you/your roller coaster!
- Any fun elements you'd like to add.

Total Design Freedom

Free website creator tools that have ready-to-use design templates are getting better all the time. It makes building a website today easier than ever. A business website can literally be up and running in minutes. It's as easy as adding text and images and clicking "publish."

These online website creator tools are in no particular order and are some of the best on the Web today. They are advertised mostly with business owners in mind but they also work superbly as immersive classroom applications. With any of these terrific tools your students can dive right in and begin designing and creating their own shoe business websites for free.

Website Creator Tools for Fast Results

These sites offer quality starter templates, easy drag-and-drop interfaces, and plenty of creative control for students. Besides this, the HTML/CSS on any many of them is fully editable. That's great news for students working to refine their coding skills.

Enjoy exploring these website creator tools you and your students can use to build amazing sites for their shoe business in minutes.

WIX @ Wix.com

Wix is probably one of the best free website creator tools out there, if not the most popular. Start with a blank slate or choose from over 500 designer-made templates, some of which are just stunning. Each template has a drag-and-drop interface that is very easy to navigate. Templates are fully customizable and there is plenty of creative control to be had here. With the world's most innovative drag-and-drop website builder, you can customize anything you want. Create beautiful websites with video backgrounds, parallax, animation, and more—all without worrying about code.

Duda @ www.dudamobile.com

Duda is all about personalization. It has built-in tool that can allow you to create personal one-on-one experiences for users. It also lets you build sites that are specifically for mobile. It's another decked out drag-and-drop website tool that's easy to use and gives great results.

Weebly @ www.weebly.com

Weebly has over 100 different website themes to choose from here. Get fancy with widgets, social media and blogging tools, and much more. Weebly also lets you edit the HTML and CSS of any theme you choose. Learn all about Weebly's features at their Help Center.

Yola @ yola.com

Yola websites are clean, beautiful, and ad-free. As with some of the other tools, you can create and customize an online store, and make use of drag-and-drop widgets for full interactivity. You can also keep a close eye on your site stats with their featured website reports.

Now, GO LIVE!

Standards:

K

- W.K.6. With guidance and support from adults, explore a variety of digital tools to produce and publish print and digital writing and images, including in collaboration with peers.
- SL.K.5. Add drawings or other visual displays to descriptions and stories to provide additional detail.

1

- W.1.6. With guidance and support from adults, use a variety of digital tools to produce and publish print and digital writing and images, including in collaboration with peers.
- SL.1.5. Add drawings or other visual displays to descriptions and stories when appropriate to clarify ideas, thoughts, and feelings.
- RI.1.7. Use the illustrations and details in a text to describe its key ideas.

2

- W.2.6. With guidance and support from adults, use a variety of digital tools to produce and publish print and digital writing and images, including in collaboration with peers.
- SL.2.5.b. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to clarify ideas, thoughts, and feelings

3

- W.3.6. With guidance and support from adults, use technology to produce and publish print and digital writing and images as well as to interact and collaborate with others.
- SL.3.5. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to emphasize or enhance certain facts or details.

4

- W.4.6. With some guidance and support from adults, use technology to produce and publish print and digital writing and images, including interacting and collaborating with others.
- SL.4.5. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to enhance the development of main ideas or themes.

5

- W.5.6. With some guidance and support from adults, use technology to produce and publish print and digital writing and images, including interacting and collaborating with others.
- SL.5.5. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to enhance the development of main ideas or themes.

6

- W.6.6. Use technology to produce and publish print and digital writing and images, including interacting and collaborating with others.
- SL.6.5.. Include multimedia components (e.g., graphics & images, notations about elements of music, dialogue, & sounds, etc.) and visual displays, e.g., in presentations and story outlines, to clarify information.

7

- W.7.6. Use technology to produce and publish print and digital writing and images, including interacting and collaborating with others.
- SL.7.5. Include multimedia components and visual displays, e.g., in presentations and story outlines, to clarify and emphasize salient points.

8

- W.8.6. Use technology to produce and publish print and digital writing and stories, including interacting and collaborating with others.
- W.9-10.6. Use technology to produce, publish, and update individual or shared writing products.
- W.9-10.6. c) Use technology to display information flexibly and dynamically.
- SL.8.5. Integrate multimedia and visual displays, e.g., in presentations and story outlines, to clarify information.

Extension Activity: Roller Coaster Review!

It's one wild ride! You can't predict what turns this game will take and the next question just might throw your team for a loop! Roller Coaster Review is a game that works for reviewing any subject.

Materials:

- Review questions related to math facts and calculations *
- Other review questions chosen from lesson materials (ex. science concepts like potential and kinetic energy, what is gravity, history of roller coasters, etc.)
- Sets of track piece point cards for each team printed out and points written in.
- Tape or magnets for the board/wall

1. Divide the class in two teams & assign crazy point values to each question. For example, make 2 matching sets of track piece point cards, such as 5 pts, 9 pts, 1000 pts, 2 pts, 500 pts, etc., for each team.
2. Then scramble each set of cards before starting the game, team #1's first correct answer might be worth 79 pts, team #2's question might be worth 1000.
3. Discuss with students the game set up and have them follow agreed-upon rules for discussions and carry out assigned team roles. Ask a team a review question if they get it right** they get to pick a track piece and they get however many points the track piece has on it. Have students put the track piece up for every question they got correct.
4. Students have a lot of fun adding up the total points at the end of the game and seeing who has the longest roller coaster. One team might have more points, but another team could have the longest craziest looping ride!

*Math facts can be as simple as addition, subtraction, division or multiplication tables students need further practice with or as complex as speed or velocity formulas.

** If needed: If teams or students are confused during the game, or have forgotten a concept, quickly review the key ideas expressed from the project and have students explain their own ideas and understanding in light of the discussion. Allow students to pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others, explicitly drawn on their experiences during the project and other information known about the topic to explore ideas under discussion.

Standards:

K

- SL.K.1. Participate in collaborative conversations with diverse partners about topics and texts with peers and adults in small and larger groups.
- Follow agreed-upon rules for discussions (e.g., listening to others and taking turns speaking about the topics and texts under discussion).
- Continue a conversation through multiple exchanges.
- SL.K.2. Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.
- SL.K.3. Ask and answer questions in order to seek help, get information, or clarify something that is not understood.
- RL.K.1. With prompting and support, ask and answer questions about key details in a text.

1

- SL.1.2. Ask and answer questions about key details in a text read aloud or information presented orally or through other media or experiences.
- SL.1.1. Participate in collaborative conversations with diverse partners about topics and texts with peers and adults in small and larger groups.
- Follow agreed-upon rules for discussions (e.g., listening to others with care, speaking one at a time about the topics and texts under discussion).
- Build on others' talk in conversations by responding to the comments of others through multiple exchanges.
- Ask questions to clear up any confusion about the topics and texts under discussion.
- SL.1.3. Ask and answer questions about what a speaker says in order to gather additional information or clarify something that is not understood.

2

- SL.2.1. Participate in collaborative conversations with diverse partners about topics and texts with peers and adults in small and larger groups.
- Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
- Build on others' talk in conversations by linking their comments to the remarks of others.
- Ask for clarification and further explanation as needed about the topics and texts under discussion.
- SL.2.2. Recount or describe key ideas or details from a text read aloud or information presented orally or through other media or experiences.

- SL.2.3. Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information, or deepen understanding of a topic or issue.

3

- SL.3.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 3 topics and texts, building on others' ideas and expressing their own clearly.
- Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- Follow agreed-upon rules for discussions (e.g., gaining the floor in respectful ways, listening to others with care, speaking one at a time about the topics and texts under discussion).
- Ask questions to check understanding of information presented, stay on topic, and link their comments to the remarks of others.
- Explain their own ideas and understanding in light of the discussion.
- SL.3.2. Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- SL.3.4. Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

4

- SL.4.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 4 topics and texts, building on others' ideas and expressing their own clearly.
- Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- Follow agreed-upon rules for discussions and carry out assigned roles.
- Pose and respond to specific questions to clarify or follow up on information, and make comments that contribute to the discussion and link to the remarks of others.
- Review the key ideas expressed and explain their own ideas and understanding in light of the discussion.
- SL.4.2. Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- SL.4.3. Identify the reasons and evidence a speaker provides to support particular points.
- SL.4.4. Report on a topic or text, tell a story, or recount an experience in an organized manner, use appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

5

- SL.5.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics and texts, building on others' ideas and expressing their own clearly.
- Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.
- Follow agreed-upon rules for discussions and carry out assigned roles.
- Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.
- Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.
- SL.5.2. Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- SL.5.3. Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.
- SL.5.4. Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.

6

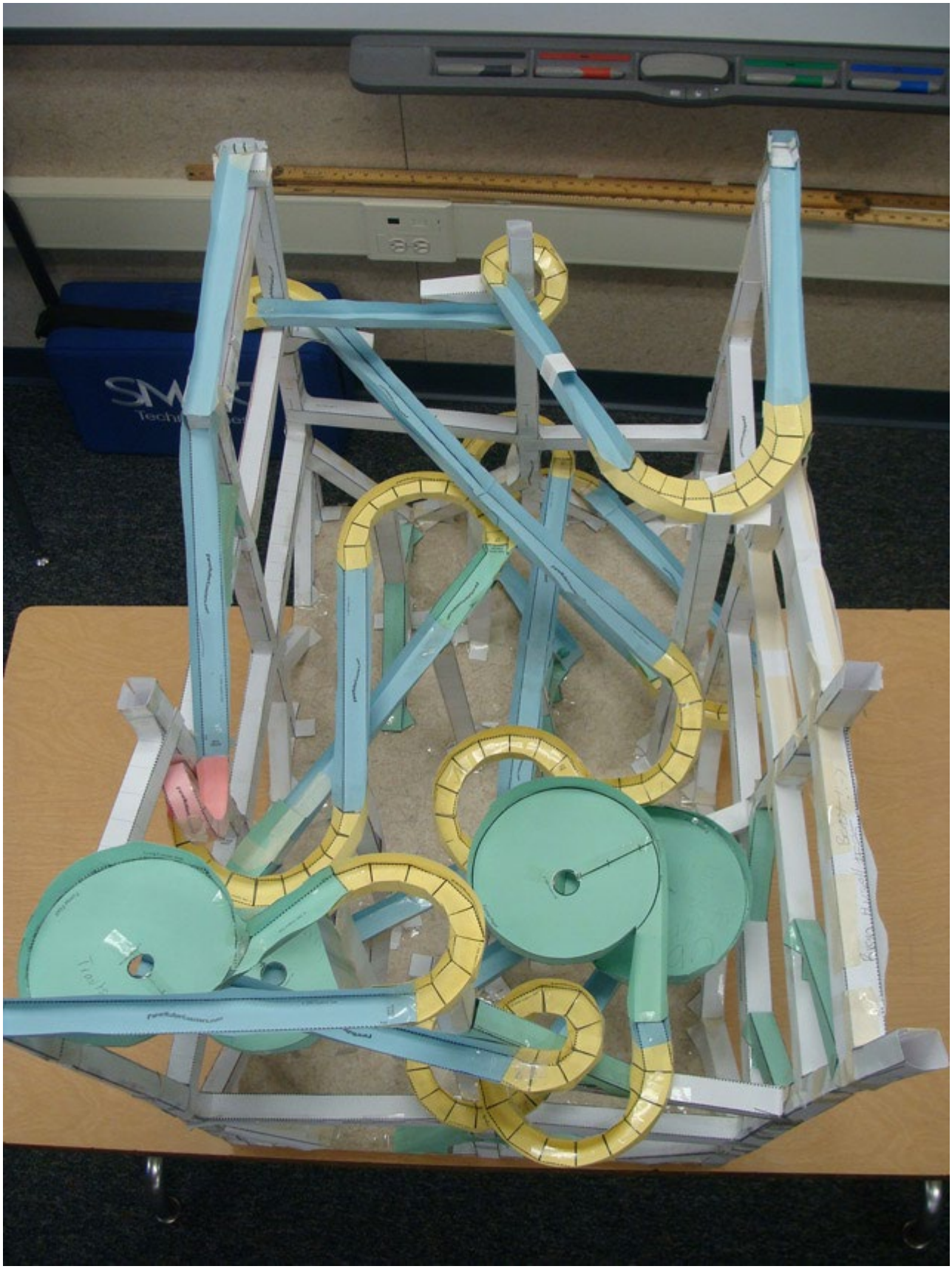
- SL.6.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly.
- Come to discussions prepared, having read or studied required material; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
- Follow rules for collegial discussions, set specific goals and deadlines, and define individual roles as needed.
- Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion.
- Review the key ideas expressed and demonstrate understanding of multiple perspectives through reflection and paraphrasing.
- SL.6.2. Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.
- SL.6.3. Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.
- SL.6.4. Present claims and findings, sequencing ideas logically, use pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

7

- SL.7.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly.
- Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
- Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.
- Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.
- Acknowledge new information expressed by others and, when warranted, modify their own views.
- SL.7.2. Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.
- SL.7.3. Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.
- SL.7.4.Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

8

- SL.8.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on topics, texts, and issues, building on others' ideas and expressing their own clearly.
- Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
- Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed.
- Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
- Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.
- SL.8.3. Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
- SL.8.4. Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.



Writing Prompt Sample Standards

Note:

A variety of writing prompts are contained throughout the unit. These prompts can be modified to suit your classroom' and student needs. The following are samples of standards (among others) that can be taught and reinforced through creative writing, non-fiction responses, narrative writing, oral responses, illustrated answers, and other formats as suggested throughout the curriculum. It is helpful to use these standards to guide your approach to and discussion around the prompts, especially if you're working with multiple grade levels.

K

- W.K.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.K.7. Participate in shared research and writing projects.
- W.K.5. With guidance and support from adults, respond to questions and suggestions and add details to strengthen writing as needed.
- W.K.6. With guidance and support from adults, explore a variety approaches, ex. digital tools, to produce and publish writing, including in collaboration with peers.
- W.K.1. Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book (e.g., My favorite book is...).
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.
- W.K.3. Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.
- SL.K.5. Add drawings or other visual displays to descriptions as desired to provide additional detail.
- W.K.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

1

- W.1.5. With guidance and support from adults,
    - focus on a topic,
    - respond to questions and suggestions from peers,
    - add details to strengthen writing as needed.
- W.1.6. With guidance and support from adults, use a variety of tools and approaches to produce and publish writing, including in collaboration with peers.

- W.1.7. Participate in shared research and writing projects.
- W.1.8. With guidance and support from adults, recall information from experiences or gather information from provided sources to answer a question.
- W.1.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.
- SL.1.4. Describe people, places, things, and events with relevant details, expressing ideas and feelings clearly.
- SL.1.5. Add drawings or other visual displays to descriptions when appropriate to clarify ideas, thoughts, and feelings.
- SL.1.6. Produce complete sentences when appropriate to task and situation.
- W.1. 1. Write opinion pieces in which they introduce the topic or name the book they are writing about, state an opinion, supply a reason for the opinion, and provide some sense of closure.
- W.1.2. Write informative/explanatory texts in which they name a topic, supply some facts about the topic, and provide some sense of closure.
- W.1.3. Write narratives in which they recount two or more appropriately sequenced events,
    - include some details regarding what happened,
    - use temporal words to signal event order,
    - provide some sense of closure.

2

- W.K.1. Use a combination of drawing, dictating, and writing to compose opinion pieces in which they tell a reader the topic or the name of the book they are writing about and state an opinion or preference about the topic or book (e.g., My favorite book is...).
- W.K.2. Use a combination of drawing, dictating, and writing to compose informative/explanatory texts in which they name what they are writing about and supply some information about the topic.
- W.K.3. Use a combination of drawing, dictating, and writing to narrate a single event or several loosely linked events, tell about the events in the order in which they occurred, and provide a reaction to what happened.
- SL.2.2. Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.
- W.2.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- W.2.5. With guidance and support from adults and peers, focus on a topic and strengthen writing as needed by
        - revising,
        - editing,
- W.2.6. With guidance and support from adults, use a variety of tools to produce and publish writing, including in collaboration with peers.

- SL.2.6. Produce complete sentences when appropriate to task and situation to provide requested detail or clarification.
- SL.2.4. Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences.
- SL.2.5. a) Create stories or poems, including audio recordings.
- SL.2.5. b) add drawings or other visual displays to stories or recounts of experiences when appropriate to clarify ideas, thoughts, and feelings.
- W.2.7. Participate in shared research and writing projects.
- W.2.8. Recall information from experiences or gather information from provided sources to answer a question.
- W.2.9 Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.2.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

3

- W.3.1. Write opinion pieces on topics or texts, supporting a point of view with reasons.
    - Introduce the topic or text they are writing about, state an opinion, and create an organizational structure that lists reasons.
    - Provide reasons that support the opinion.
    - Use linking words and phrases (e.g., because, therefore, since, for example) to connect opinion and reasons.
    - Provide a concluding statement or section.
- W.3.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
    - Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.
    - Develop the topic with facts, definitions, and details.
    - Use linking words and phrases (e.g., also, another, and, more, but) to connect ideas within categories of information.
    - Provide a concluding statement or section.
- W.3.3. Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.
    - Establish a situation and introduce a narrator and/or characters; organize an event sequence that unfolds naturally.
    - Use dialogue and descriptions of actions, thoughts, and feelings to develop experiences and events or show the response of characters to situations.
    - Use temporal words and phrases to signal event order.
    - Provide a sense of closure.

- W.3.4. With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.
- W.3.5. With guidance and support from peers and adults, develop and strengthen writing as needed by a) planning,
- b) revising,
- c) editing,
    - rewriting,
    - and/or trying a new approach.
- W.3.6. With guidance and support from adults, use technology to produce and publish writing (using keyboarding skills) as well as to interact and collaborate with others.
- W.3.8. Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.
- W.3.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.3.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- SL.3.3. Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
- SL.3.2. Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- SL.3.4. Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
- SL.3.5. Create engaging stories or poems, including audio recordings that demonstrate fluid reading at an understandable pace; add visual displays when appropriate to emphasize or enhance certain facts or details.

4

- SL.4.3. Identify the reasons and evidence a speaker provides to support particular points.
- SL.4.2. Paraphrase portions of a text read aloud, or information presented in diverse media and formats, including visually, quantitatively, and orally.
- W.4.1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
    - Introduce a topic or text clearly, state an opinion, and create an organizational structure in which related ideas are grouped to support the writer's purpose.
    - Provide reasons that are supported by facts and details.
    - Link opinion and reasons using words and phrases (e.g., for instance, in order to, in addition).
    - Provide a concluding statement or section related to the opinion presented.
- W.4.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

    - Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.
    - Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.
    - Link ideas within categories of information using words and phrases (e.g., another, for example, also, because).
    - Use precise language and domain-specific vocabulary to inform about or explain the topic.
    - Provide a concluding statement or section related to the information or explanation presented.
- W.4.3. Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.
    - Orient the reader by establishing a situation and introducing a narrator and/or characters; organize an event sequence that unfolds naturally.
    - Use dialogue and description to develop experiences and events or show the responses of characters to situations.
    - Use a variety of transitional words and phrases to manage the sequence of events.
    - Use concrete words and phrases and sensory details to convey experiences and events precisely.
    - Provide a conclusion that follows from the narrated experiences or events.
- W.4.4. Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.
- SL.4.4. a) Report on a topic or text,
- SL.4.4. b) tell a story,
- SL.4.4. c) or recount an experience in an organized manner,
- SL.4.4. d) use appropriate facts and relevant, descriptive details to support main ideas or themes.
- SL.4.5. Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes.
- W.4.5. With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing.
- W.4.6. With some guidance and support from adults, use technology, including the Internet, to
    - a) produce and publish writing.
    - b) interact and collaborate with others.
    - c) demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting.
- W.4.7. Conduct short research projects that build knowledge through investigation of different aspects of a topic.
- W.4.8. Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information and provide a list of sources.

- W.4.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
    - Apply grade 4 Reading standards to literature (e.g., “Describe in depth a character, setting, or event in a story or drama, drawing on specific details in the text [e.g., a character’s thoughts, words, or actions].”).
    - Apply grade 4 Reading standards to informational texts (e.g., “Explain how an author uses reasons and evidence to support particular points in a text”).
- W.4.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

5

- W.5.1. Write opinion pieces on topics or texts, supporting a point of view with reasons and information.
    - Introduce a topic or text clearly, state an opinion, and create an organizational structure in which ideas are logically grouped to support the writer’s purpose.
    - Provide logically ordered reasons that are supported by facts and details.
    - Link opinion and reasons using words, phrases, and clauses (e.g., consequently, specifically).
    - Provide a concluding statement or section related to the opinion presented.
- W.5.2. Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
    - Introduce a topic clearly, provide a general observation and focus, and group related information logically; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.
    - Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.
    - Link ideas within and across categories of information using words, phrases, and clauses (e.g., in contrast, especially).
    - Use precise language and domain-specific vocabulary to inform about or explain the topic.
    - Provide a concluding statement or section related to the information or explanation presented."
- W.5.3. Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.
    - Orient the reader by establishing a situation and introducing a narrator and/or characters; organize an event sequence that unfolds naturally.
    - Use narrative techniques, such as dialogue, description, and pacing, to develop experiences and events or show the responses of characters to situations.
    - Use a variety of transitional words, phrases, and clauses to manage the sequence of events.

    - Use concrete words and phrases and sensory details to convey experiences and events precisely.
    - Provide a conclusion that follows from the narrated experiences or events.
- SL.5.2. Summarize a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.
- SL.5.3. Summarize the points a speaker makes and explain how each claim is supported by reasons and evidence.
- W.5.4. Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.
- W.5.5. With guidance and support from peers and adults, develop and strengthen writing as needed by
    - a) planning,
    - b) revising,
    - c) editing,
    - rewriting,
    - and/or trying a new approach.
- W.5.6. With some guidance and support from adults, use technology, including the Internet,
    - a) to produce and publish writing
    - b) interact and collaborate with others.
    - c) demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.
- SL.5.4. Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace.
- SL.5.5. Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes.
- W.5.7. Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.
- W.5.8. a) Recall relevant information from experiences
- W.5.8. b) gather relevant information from print and digital sources;
- W.5.8. c) summarize or paraphrase information in notes and finished work,
- W.5.8. d) provide a list of sources."
- W.5.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
    - Apply grade 5 Reading standards to literature (e.g., “Compare and contrast two or more characters, settings, or events in a story or a drama, drawing on specific details in the text [e.g., how characters interact]”).
    - Apply grade 5 Reading standards to informational texts (e.g., “Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point[s]”)."

- W.5.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

6

- W.6.1. Write arguments to support claims with clear reasons and relevant evidence.
    - a) Introduce claim(s) and organize the reasons and evidence clearly.
    - b) Support claim(s) with clear reasons and relevant evidence, using credible sources and demonstrating an understanding of the topic or text.
    - c) Use words, phrases, and clauses to clarify the relationships among claim(s) and reasons.
    - d) Establish and maintain a formal style.
    - e) Provide a concluding statement or section that follows from the argument presented."
- W.6.2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
    - a) Introduce a topic; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
    - b) Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples.
    - c) Use appropriate transitions to clarify the relationships among ideas and concepts.
    - d) Use precise language and domain-specific vocabulary to inform about or explain the topic.
    - e) Establish and maintain a formal style.
    - f) Provide a concluding statement or section that follows from the information or explanation presented."
- W.6.3. Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
    - a) Engage and orient the reader by establishing a context and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically.
    - b) Use narrative techniques, such as dialogue, pacing, and description, to develop experiences, events, and/or characters.
    - c) Use a variety of transition words, phrases, and clauses to convey sequence and signal shifts from one time frame or setting to another.
    - d) Use precise words and phrases, relevant descriptive details, and sensory language to convey experiences and events.
    - e) Provide a conclusion that follows from the narrated experiences or events.
- W.6.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

- W.6.5. With guidance and support from peers and adults, develop and strengthen writing as needed by
    - a) planning,
    - b) revising,
    - c) editing,
    - d) rewriting,
    - e) and/or trying a new approach.
- W.6.6. Use technology, including the Internet, to
    - a) produce and publish writing
    - b) interact and collaborate with others;
    - c) demonstrate sufficient command of keyboarding skills to type a minimum of three pages in a single sitting.
- SL.6.2. Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.
- SL.6.3. Delineate a speaker's argument and specific claims, distinguishing claims that are supported by reasons and evidence from claims that are not.
- SL.6.4. Present claims and findings,
    - a) sequencing ideas logically
    - b) use pertinent descriptions, facts, and details to accentuate main ideas or themes;
- SL.6.5. Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.
- W.6.7. Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.
- W.6.8. a) Gather relevant information from multiple print and digital sources;
    - b) assess the credibility of each source;
    - c) quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources."
- W.6.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
    - a) Apply grade 6 Reading standards to literature (e.g., "Compare and contrast texts in different forms or genres [e.g., stories and poems; historical novels and fantasy stories] in terms of their approaches to similar themes and topics").
    - b) Apply grade 6 Reading standards to literary nonfiction (e.g., "Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not").
- W.6.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

7

- RI.7.9. Analyze how two or more authors (including students in class) writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
- W.7.1. Write arguments to support claims with clear reasons and relevant evidence.
    - Introduce claim(s), acknowledge alternate or opposing claims, and organize the reasons and evidence logically.
    - Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
    - Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), reasons, and evidence.
    - Establish and maintain a formal style.
    - Provide a concluding statement or section that follows from and supports the argument presented.
- W.7.2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
    - Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
    - Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples.
    - Use appropriate transitions to create cohesion and clarify the relationships among ideas and concepts.
    - Use precise language and domain-specific vocabulary to inform about or explain the topic.
    - Establish and maintain a formal style.
    - Provide a concluding statement or section that follows from and supports the information or explanation presented.
- W.7.3. Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
    - Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically.
    - Use narrative techniques, such as dialogue, pacing, and description, to develop experiences, events, and/or characters.
    - Use a variety of transition words, phrases, and clauses to convey sequence and signal shifts from one time frame or setting to another.
    - Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events.
    - Provide a conclusion that follows from and reflects on the narrated experiences or events.

- SL.7.2. Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.
- SL.7.3. Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and the relevance and sufficiency of the evidence.
- SL.7.4.a) Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples;
- b) use appropriate eye contact, adequate volume, and clear pronunciation."
- SL.7.5. Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.
- W.7.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- W.7.5. With some guidance and support from peers and adults, develop and strengthen writing as needed by
    - planning,
    - revising,
    - editing,
    - rewriting,
    - or trying a new approach, to focus on how well purpose and audience have been addressed."
- W.7.6. Use technology, including paper, pencils, or the Internet, to
    - produce and publish writing
    - link to and cite sources
    - to interact and collaborate with others,
    - include linking to and citing sources.
- W.7.7. Conduct short research projects to answer a question, drawing on several sources and generating additional related, focused questions for further research and investigation.
- W.7.8. Gather relevant information from multiple print and digital sources, a) using search terms effectively;
    - b) assess the credibility and accuracy of each source;
    - c) quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- W.7.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
    - Apply grade 7 Reading standards to literature (e.g., "Compare and contrast a fictional portrayal of a time, place, or character and a historical account of the same period as a means of understanding how authors of fiction use or alter history").
    - Apply grade 7 Reading standards to literary nonfiction (e.g. "Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims").

- W.7.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.
- RI.7.9. Analyze how two or more authors writing about the same topic shape their presentations of key information by emphasizing different evidence or advancing different interpretations of facts.
- RI.7.8. Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound, and the evidence is relevant and sufficient to support the claims.
- RI.7.7. Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium's portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).
- RI.7.4. Determine the meaning of words and phrases as they are used in a text, a) including figurative, connotative, and technical meanings;
    - analyze the impact of a specific word choice on meaning and tone.
- RI.7.1. Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.

8

- RI.8.7. Evaluate the advantages and disadvantages of using different mediums (e.g., print or digital text, video, multimedia) to present a particular topic or idea.
- RI.8.8. Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound, and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.
- RI.8.9. Analyze a case in which two or more texts provide conflicting information on the same topic and identify where the texts disagree on matters of fact or interpretation.
- W.8.1. Write arguments to support claims with clear reasons and relevant evidence.
- Introduce claim(s), acknowledge, and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically.
    - Support claim(s) with logical reasoning and relevant evidence, using accurate, credible sources and demonstrating an understanding of the topic or text.
    - Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence.
    - Establish and maintain a formal style.
    - Provide a concluding statement or section that follows from and supports the argument presented.
- W.8.2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
    - Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

    - Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples.
    - Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts.
    - Use precise language and domain-specific vocabulary to inform about or explain the topic.
    - Establish and maintain a formal style.
    - Provide a concluding statement or section that follows from and supports the information or explanation presented."
- W.8.3. Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.
    - Engage and orient the reader by establishing a context and point of view and introducing a narrator and/or characters; organize an event sequence that unfolds naturally and logically.
    - Use narrative techniques, such as dialogue, pacing, description, and reflection, to develop experiences, events, and/or characters.
    - Use a variety of transition words, phrases, and clauses to convey sequence, signal shifts from one time frame or setting to another and show the relationships among experiences and events.
    - Use precise words and phrases, relevant descriptive details, and sensory language to capture the action and convey experiences and events.
    - Provide a conclusion that follows from and reflects on the narrated experiences or events."
- W.8.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- W.8.5. With some guidance and support from peers and adults, develop and strengthen writing as needed by
    - planning,
    - revising,
    - editing,
    - rewriting,
    - or trying a new approach,
    - focusing on how well purpose and audience have been addressed.
- W.8.6. Use technology, including the Internet,
    - to produce and publish writing
    - present the relationships between information and ideas efficiently
    - interact and collaborate with others.
- Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.
- Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

- Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
- W.8.8. Gather relevant information from multiple print and digital sources,
    - using search terms effectively;
    - assess the credibility and accuracy of each source;
    - quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation."
- W.8.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
        - Apply grade 8 Reading standards to literature (e.g., “Analyze how a modern work of fiction draws on themes, patterns of events, or character types from myths, traditional stories, or religious works such as the Bible, including describing how the material is rendered new”).
        - Apply grade 8 Reading standards to literary nonfiction (e.g., “Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced”)."
- W.8.10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two.
- SL.8.2. Analyze the purpose of information presented in diverse media and formats (e.g., visually, quantitatively, orally) and evaluate the motives (e.g., social, commercial, political) behind its presentation.
- SL.8.4. Present claims and findings,
    - emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details;
    - use appropriate eye contact, adequate volume, and clear pronunciation.
- SL.8.5. Integrate multimedia and visual displays into presentations to
  a) clarify information,
    - strengthen claims and evidence
    - and/or add interest.

Scream Machines Activities Supply List

Notes:

- ☐ Writing prompts are contained throughout the curriculum. You'll just need some paper and pencils for all of them!
- ☐ *Always pre-watch all videos to ensure appropriateness for your students' ages and sensitivities.*

Introduction/Let's Ride-Along! pages 1–3

- ☐ Access to first person point of view (POV) roller coaster riding videos as part of introduction
- ☐ Images of roller coasters
- ☐ *The Pigeon Will Ride the Roller Coaster* by Mo Willems & video link version
- ☐ *Roller Coaster* by Marla Frazee & video version
- ☐ Paper
- ☐ Pencils

A Royal Ride pages 4–7

- ☐ Access to read-alouds , article links, podcasts, and videos
- ☐ *A Royal Ride: Catherine the Great's Invention* by Kristen Fulton and Lucy Fleming

Rushing Ice Riders pages 15–16

- ☐ Ice Cubes (1-2 per student)
- ☐ Paper plates (1 per student)
- ☐ Salt (1 canister)
- ☐ Other available construction materials (ex. craft foam, cloth, etc)
- ☐ Cardboard (1 large box should give enough) covered in wax paper (1 roll), outside slide, or other ramp materials to form a ramp.
- ☐ Stopwatch
- ☐ Small plastic figurines, ex. the size that would be on cupcakes
- ☐ Optional: Sand for the end of the ramp
- ☐ Optional: Bubble wrap, felt, or other materials to test during friction variation

Man-Made Mountains pages 21–24

- ☐ Access to videos
- ☐ Paper
- ☐ Pencils

Let's Get Physics-al pages 25–28

Materials for each group:

- ☐ Foam pipe insulation (1.5 inches in diameter, at least 6 feet in length—or more if you would like to eventually add more features to your roller coaster). Variations to try: baby proofing edge guard or even pool noodles can also work.
- ☐ At least one glass marble (or other small heavy ball that will roll easily through the foam insulation, such as a metal ball bearing)
- ☐ Masking tape
- ☐ Utility knife: Teacher uses the utility knife to cut the pipe insulation in half lengthwise, forming two U-shaped channels.
- ☐ Table or chair
- ☐ Measuring devices as appropriate for grade level: rulers, tape measure, yardstick, stopwatches, timers, etc.
- ☐ Pencils & paper to record data

Matchbox Matchup: Battle of the Heavyweight Champions pages 34–35

- ☐ Track materials, ex. Hot Wheels track, straight plastic rain gutters, boards
- ☐ Blocks or books to prop up the track
- ☐ Measuring devices, ex. rulers, yardsticks, measuring tapes
- ☐ Cars
- ☐ Three quarters per team
- ☐ Masking or painter's tape
- ☐ Pencils
- ☐ Paper to record data

It's Wheely Windy Out Here! Pages 36–37

- ☐ Track materials, ex. Hot Wheels track, straight
- ☐ plastic rain gutters, boards, foam board,
- ☐ cardboard, or cardboard tubes
- ☐ Blocks, books or other items to prop up the track
- ☐ Measuring devices, ex. rulers, yardsticks, measuring
- ☐ tapes
- ☐ Cars
- ☐ Small box fan
- ☐ Masking or painter's tape and/or dry erase markers
- ☐ Pencils
- ☐ Paper to record data
- ☐ Optional: Quarters and tape

Getting Loopy! Pages 38–42

- ☐ Hot Wheels™ set with loop-the-loop and ramp
- ☐ small car
- ☐ meter stick, tape measure, or other measuring device
- ☐ timing device
- ☐ masking or painter's tape
- ☐ paper and pencils to record data
- ☐ Optional: Computer interface photogates, if possible.

An Amusing Menu pages 47–49

- ☐ Warm hot dog buns
- ☐ Cooked hot dogs
- ☐ Mustard
- ☐ Onions (chopped)
- ☐ chili
- ☐ Other Condiments as necessary

Moving Forward pages 53–54

- ☐ Access to read-alouds, article links, and videos
- ☐ Paper
- ☐ Pencils

The Birth of Disneyland pages 55–56

- ☐ Access to read-alouds, article links, and videos
- ☐ Paper
- ☐ Pencils

Magic Mountain: "Thrill Capital of the World!" pages 57–58

- ☐ Access to read-alouds, article links, and videos
- ☐ Paper
- ☐ Pencils

Two Pieces of the Puzzle pages 63–64

- ☐ Access to articles and videos
- ☐ Paper
- ☐ Pencils

Water? Power! Pages 65–67

- ☐ Balloon
- ☐ Paper

- ☐ Pencils

Can you give me a Lift? Pages 67–68

- ☐ Water
- ☐ Aquarium Tubing
- ☐ 2.5 cm3 syringes (one per group)
- ☐ 10 cm3 syringes (one per group)
- ☐ Books, bricks, or other heavy objects
- ☐ Option: sealant or waterproof tape for security (one roll)
- ☐ Option: Pink erasers
- ☐ Option: Glue or tape
- ☐ Access to videos

The Stop: Magnetic Braking Systems Pages 69–71

*Note: If doing it as a demo, only one of each of the following is needed. Otherwise, one is needed per group of students.

- ☐ Access to articles and videos
- ☐ A copper or aluminum pipe
- ☐ A fairly powerful neodymium magnet (or several small ones stacked together) that are small enough to fit inside the pipe.
- ☐ Option: PVC pipe to match the size of your copper pipe, for comparison
- ☐ Option: Non-magnetic pizza cutter
- ☐ Option: Powerful horseshoe magnet

Researching the Record Breakers Pages 77–79

- ☐ Paper
- ☐ Pencils
- ☐ *The 50 Most Unique Roller Coasters Ever Built*
- ☐ *The 50 Most Terrifying Roller Coasters Ever Built*
- ☐ *50 Groundbreaking Roller Coasters: The Most Important Scream Machines Ever Built*
- ☐ *50 Legendary Roller Coasters That No Longer Exist*

Estimation Launching Station: Comparing Coasters Pages 84–88

- ☐ Printouts
- ☐ Access to websites and videos
- ☐ Pencils

And We're Off Wheels of Motion pages 96–104

- ☐ Access to websites, podcasts, and videos

- Pencils
- Paper

Extension Activity: Grab the Bull by the Horns! P 105

- Access to websites and videos
- KEVA planks, ex. Contraptions box
- Cardboard tubes (ex. from paper towels, toilet paper, plastic wrap, or other tubes)
- Colorful tape
- Masking tape
- Marbles or ping pong balls
- Craft sticks
- Hot glue guns
- Glue dots
- Scissors
- Paper plates: Look for plates with a design on them and a smooth rim around the edge.
- Blocks

Coaster Challenge! Pages 110–125

- Access to videos and articles
- Cardstock, white and colored (six different colors)
- Marbles (for riders)
- Ball point pens, for scoring templates
- Pencils (for drawings, notes, and keeping track of costs, measurements, etc.)
- Notebook paper (for notes, keeping track of costs, measurements, putting together the portfolio, calculating speed, etc.)
- 12" rulers (1-2 per group)
- Magazine or catalog - used as a cushion, it helps to score the templates when tracing.
- Rolls of transparent tape (1-2 per group) Ex. One class may need six rolls of 3/4" x 600" transparent tape.
- Roller Coaster Element Standard & Advanced Templates from paperrollercoasters.com (an average class will need six times as many pre-printed sheets of card stock and marbles as found in an Individual Set):
    - Copy the structural pieces (i.e. columns, beams, diagonal supports, and shelves) on white paper. Then **copy each of the other pieces on different colored paper**. That makes it much easier for the students to find the desired piece and copy the template and use it to inspire a redesign or adjustment. It also helps you to see which pieces are getting low.
    - Cut the sheets into strips using a paper cutter or scissors. Tips: *Cut along every thin gray line.* ***Practice making each piece so you'll be able to explain it to your students****.*

- *Create a sample reference board with each stage of each piece (including a finalized one) for students to go to when confused. This saves the teacher being asked many many times "How does this one go?" You'll want to decide on a price for each piece to help students calculate how much their roller coasters would cost to 'build' for their portfolios.*

- ☐ Paper for budget calculations
- ☐ The Booklet Step by Step Instructions for Building Incredible Roller Coasters by Andrew Gait, www.paperrollercoasters.com
- ☐ A Master Template reference board with each template at each stage from initial cuts to final construction as well as a price for that piece
- ☐ Scissors (1 per student)
- ☐ Graph paper (for scale drawings, multi-view drawings of each group's unique track element template, etc.)
- ☐ Stop watches (1-2 total that students can borrow)
- ☐ Optional: Foam board or cardboard for bases
- ☐ Optional: cup and/or other materials to add in
- ☐ Optional: mailing labels to identify areas and shifts of potential and kinetic energy on the roller coasters

A Need for Speed! Pages 131–134

Per group:

- ☐ completed Paper Roller Coaster
- ☐ yard stick
- ☐ pencil
- ☐ calculator
- ☐ string
- ☐ Optional: Mailing labels for identifying marks
- ☐ Printed test trials sheets and instructions

Imagineers: Design in Mind? Pages 139–142

Per group:

- ☐ completed Paper Roller Coaster
- ☐ 2 sheets of graph paper per student
- ☐ yard stick
- ☐ 12-inch rulers with centimeters (one per student)
- ☐ Protractors (one per student) – a printable is included as an option
- ☐ Pencils (one per student)
- ☐ White board or large sheet of paper

- ☐ White board markers or regular markers
- ☐ Access to videos

Marketing: Buyer's Market. Seller's Pitch! Pages 146–148

Per group:

- ☐ Completed Paper Roller Coaster
- ☐ Completed speed calculations (as appropriate for grade level)
- ☐ Completed cost of building calculations (as appropriate for grade level)
- ☐ Completed scale drawings (as appropriate for grade level)
- ☐ Description of building process and engineering decisions
- ☐ Paper
- ☐ Pencils
- ☐ Optional: Poster boards/trifolds for presentation of materials
- ☐ Optional: Manila folders for presentation of materials
- ☐ Art materials (for promotional materials, ex. A themed poster, roller coaster name, etc.)
- ☐ Access to websites and videos

Getting that Gold Pages 149–154

- ☐ Access to websites and videos
- ☐ Pencils
- ☐ Paper

Catchy, Creative, and . . . Sticky? Pages 158–164

- ☐ Access to websites and videos
- ☐ Pencils
- ☐ Paper

Tag! You're It! Pages 168–171

- ☐ Access to websites and videos, as needed.
- ☐ Pencils
- ☐ Paper

Logo! Let's Go! Pages 176–178

- ☐ Access to websites and videos, as needed.
- ☐ Pencils
- ☐ Paper

Show Me Something Good!, I Get the Message! Art in Advertising Pages 182–191

- ☐ Ordinary, No Extraordinary Sheets
- ☐ *Roller Coaster* by Marla Frazee
- ☐ Thesaurus
- ☐ Website Access, optional
- ☐ Paper
- ☐ Pencils
- ☐ Poster boards
- ☐ Graph paper
- ☐ Paints/Markers/Crayons/and other art supplies
- ☐ Construction paper
- ☐ Completed roller coasters
- ☐ List of adjectives/descriptions
- ☐ Selected themes

Sell Me Somethin' Good! Website Building Project Pages 195–197

- ☐ Completed roller coasters
- ☐ Compiled data about roller coaster ride/portfolio
- ☐ Design sketches
- ☐ Internet access
- ☐ Completed logo and tagline
- ☐ Mascot
- ☐ Paper
- ☐ Pencils

Roller Coaster Review! Pages 200–202

- Review questions related to math facts and calculations Math facts can be as simple as addition, subtraction, division or multiplication tables students need further practice with or as complex as speed or velocity formulas.
- Other review questions chosen from lesson materials (ex. science concepts like potential and kinetic energy, what is gravity, history of roller coasters, etc)
- Sets of track piece point cards for each team printed out and points written in.
- Tape or magnets for the board/wall

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