A Wild Ride! Week 2

Day 3: Don't Look Down!

Teacher/Parent Background:

Not all forces can be directly observed! The force of gravity cannot be seen, however, its effects on objects all around us can be observed daily; as the force of gravity pulls objects towards Earth's center. In addition to forces causing motion, there are forces (frictional force) that oppose the motion of objects, slowing them down and eventually bringing them to a rest. Engineers make good use of these forces to construct safe, fun roller coaster rides!

Overview:

In this activity, students will engage in a hands-on investigation to explore how the force of gravity and friction affect the motion of objects. Students will return to their week-long challenge: *How can we design a roller coaster using force and motion concepts*?, in order to reflect upon what they have learned that will help them address the challenge and what they still need to know to move forward.

Related Standards:

- Construct an explanation using evidence to demonstrate that objects can affect other objects even when they are not touching.
- Obtain, analyze, and communicate evidence of the effects that balanced and unbalanced forces have on the motion of objects.
- Define problems and design solutions pertaining to force and motion.

Key Terms:

- Gravity: a force of attraction that pulls objects on Earth towards its center
- Friction: a force that opposes or slows down motion

Materials List:

- Internet access
- Journal
- Pen/pencil
- Colored pencils/crayons
- Computer/phone with audio
- Floor space
- Ball (medium size/weight)
- Ramp

    - Stack of books
    - Piece of cardboard/wood
    - Duct tape (as needed to secure the ramp)
- *Student Resources - Page 6*
    - *Ramp & Ball Data Table*

Activity Description:

- Ask students to review the "Learned" table from *Day 2: I Push, You Pull!*. Briefly discuss with students:
    - What did you learn about force and motion during our investigation?
        - A force is a push or a pull.
        - Forces can cause the motion of objects.
        - Motion is a change of an object's position, or its location.
        - The way I push or pull on an object affects its speed.
- It seems like we have already learned a lot about force and motion concepts to help us during our challenge! However, let's look back at the "Ask" step of our challenge; what else do we need to know to move forward?
    - Ask students to revisit the "Ask" step and discuss other "need to knows". Possible student responses may include:
        - How does a roller coaster work?
            - I already learned what force and motion is, but how does force and motion make a roller coaster work?
- In order to learn more about this, we are going to need to investigate how force and motion concepts make a roller coaster work!
- To begin, let's take a virtual field trip to visit a real roller coaster...*The Big Thunder Mountain Railroad* at Disneyland!
        - Play the video: *360° Ride on Big Thunder Mountain Railroad Disneyland*
- I don't know about you, but I could really feel those pushes and pulls as if I was actually riding the roller coaster in person! Let's discuss, what examples did you observe of how forces affected the roller coaster ride and it's passengers?
    - Ask students to discuss. Possible student responses may include:
        - The cart of passengers is pulled up the track, reaching hills.
        - Then, the cart of passengers zooms down the track, after reaching hills.
- It seems that the cart is pulled as it first starts to travel up the track and then, CLICK, CLICK, CLICK...it speeds down the track and the passengers go wild!

- But, there is not a giant hand pushing or pulling the cart down the track. What brings the cart down the track?
- In order to help us answer that question, let's investigate!
    - First, ask students to build a ramp on the ground, using the stack of books and a piece of cardboard/wood.
        - As needed, assist students in using duct tape to secure the piece of cardboard/wood to the top of the stack of books.
    - Ask students to place the ball at the top of the ramp and release it, being careful not to add an outside force by pushing on the ball.
        - Ask students to record their observations of the ball's motion from start to finish in the *Ramp & Ball Data Table*.
    - Once completed, discuss the results of the investigation:
        - What did you observe during the ramp/ball investigation?
            - At first, the ball was not moving. Then, I released it and it traveled down the ramp.
            - It came to a rest on the ground after it left the bottom of the ramp.
        - Did you push the ball down the ramp?
            - No
        - If not, then how was the ball able to travel down the ramp? Was a force involved?
            - Yes, something pushed or pulled it down the ramp.
        - In fact, there was a force acting on the ball, making it travel down the ramp. You can't see this force, but you can see its effects on objects on Earth every day! In the science community, we describe this interaction as *gravity*, a force of attraction that pulls objects on Earth towards its center.
        - When you released the ball, the force of gravity was able to act fully upon the ball, pulling it down the ramp, as your hand was no longer in the way/holding it back.
- We now know that the force of gravity pulls objects towards Earth's center, just like the ball was pulled down the ramp! But, what does this have to do with a roller coaster? What brings a roller coaster cart down the track?
    - Play the video: *How Do Roller Coaster Work?* from timestamp 0:00 - 4:40.
    - Engage students in a discussion of main ideas:
        - What part of the train or cart helps it move as fast as possible along the track?
            - It's wheels help the train/cart travel quickly on the track!
            - Without wheels, the train/cart would have to slide along the track and would be slowed down by a force called *friction*. Friction is a force that opposes or slows down motion. Without wheels, the force of friction

would slow the train down. That wouldn't make for a fun ride!

- At the start, what helps the train/cart travel up the track?
  - A chain powered by a motor pulls the train/cart up the track.
- Once the train/cart reaches its highest point/hill, what drives it down the track?
  - The force of gravity pulls the train/cart down the track.
- Since we want to make our roller coasters as thrilling as we can, how do you think we need to design our first hill in order to make our train/cart travel through other hills/the rest of the track?
  - Our first hill should be the tallest. This will allow the train/cart to increase its speed and travel along the rest of the track.

Closure:

- Today, we have learned a lot about how roller coasters use the force of gravity to pull the train/cart down a track! To help us make sense of all that we learned, let's take some time to reflect.
  - Ask students to discuss and record what they have learned by adding to their "Learned" table.
    - Significant learnings should include:
      - Gravity is a force that pulls objects towards Earth's center.
      - Once a train/cart is pulled up to a high hill using a chain, the force of gravity pulls it down the track.
      - It's wheels work against the force of friction, helping it travel quickly along a track.
      - When designing our roller coaster, the first hill should be the tallest. That way, the train/cart can gain a lot of speed to travel through the rest of the track.
- Looking back at the "Ask" step of our challenge, what else do we need to know to move forward?
  - Ask students to revisit the "Ask" step and update/add new ideas to their tables. Possible student responses may include:
    - I need to know...
      - How many hills can my roller coaster have?
      - Can my roller coaster have loop-de-loops?
      - What materials do we have to build the roller coaster?
      - How much time will we have to build the roller coaster?

Extensions:

Watch & Play: BrainPOP jr. - *Gravity*

Watch: Crash Course Kids - *Danger! Falling Objects*

Continue the Investigation - Some students may be questioning what specific forces keep the train/cart in motion after it travels down the first hill and how the train/cart can travel through a loop-de-loop.

- Play the duration of the video and engage students in a discussion of these main ideas:
    - What keeps the train/cart in motion after it travels down the first, big hill?
        - The force of gravity makes the train/cart speed-up, giving it momentum or power. The higher the first drop, the more speed and momentum the train/cart can build up and the farther it can go, before it eventually slows down and comes to a stop.
    - What has to happen for the train/cart to make it up a second hill in the track?
        - The train/cart will have enough momentum to go back uphill against the pull of gravity as long as the second hill is shorter than the first hill.
    - How does the train/cart travel through a loop-de-loop?
        - When the train/cart starts from a high enough hill and is traveling fast enough, the train/cart's momentum can be enough to carry it upside down through a loop-de-loop.
        - The train/cart wants to go straight up but the track guides it, making it follow the track of a loop.

ARIZONA SCIENCE CENTER
Never stop wondering.
Never stop imagining.™

Student Resources

Ramp & Ball Data Table

Ball On Top of Ramp	Ball Traveling Down Ramp	Ball's Ending Position