GENERATIONGENIUS
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LESSON PLAN

COLLISIONS
GRADES 3-5

SUMMARY

Students explore the science behind the energy of moving objects. For this activity students need to be able to understand that the further up a ramp a marble is released, the faster it will move.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object.

4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Science & Engineering Practices	Connections to Classroom Activity
Constructing explanations and designing solutions (4-PS3-1) **Asking questions and defining problems** (4-PS3-3)	• Observe how energy is transferred between two objects colliding at different speeds. • Construct an explanation as to how speed effects energy.

Disciplinary Core Ideas	Connections to Classroom Activity
PS3.A Definitions of Energy The faster a given object is moving, the more energy it possesses. (4-PS3-1) Energy can be moved from place to place by moving objects or through sound, light or electric currents. (4-PS3-3)	• Observe that the faster an object is moving when it collides with another object, the more energy is transferred. • Students predict the motion—based on energy transfer—of different objects after a collision. • Make predictions based on their understanding of cause and effect relationships.

PS3.B: Conservation of Energy and Energy Transfer Energy is present whenever there are moving objects, sound, light or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound reproduced. (4-PS3-3) **PS3.C: Relationship between energy and forces** When objects collide, the contact forces transfer energy so as to change the object's motion. (4-PS3-3)	• Observe energy transfer between moving objects and as sound and heat. • Recognize that moving objects have energy and that energy can be transferred as motion, sound, or heat. • Observe multiple examples of energy transfer as change in motion as a result of collisions. • Observe multiple examples of energy transfer as sound and heat as the result of collisions.
Crosscutting Concepts	**Connections to Classroom Activity**
Energy and Matter (4-PS3-1, 4-PS3-3)	• Observe energy transfer through motion, heat, and sound.

DURATION

Two+ 45-minute classroom periods (Engage/ Explore: 1 class period, Explain/Elaborate: 1 class period, Elaborate/Evaluate: up to 1 class period)

PRE-ASSESSMENT QUESTIONS

Please see discussion questions located under the video. These can be discussed as a group or answered individually in student science notebooks.

ENGAGE

Have students put their hands together and rub back and forth fast. This shows the students how energy is being transferred between the hands (moving objects), creating sound and heat energy. Then show students a video of a slow-motion collision in the context of sports (a foot kicking a soccer ball, a tennis ball and racket, and so forth). Plenty of examples can be found online.

MATERIALS

- Foam pipe insulation tubing or pool noodles, cut in half lengthwise (one or more)
- Marbles, small and large (at least one large, two small, in different colors)
- Small sticky note flags
- Wet erase markers
- Science notebooks
- Pencils

DIY Activity

- Several books
- Two surfaces at different heights
- Ruler
- Marker
- Binder clip
- 2 pencils
- Books
- Highlighter
- Tape
- Cup
- Candy (or other non-liquid material)
- Bowl
- Battery or other small heavy object
- An additional variety of classroom objects

EXPLORE

Explain to students that they will be exploring what happens to objects when they collide. They will be observing the motion of the objects before and after collision, and thinking about energy. Using half (lengthwise) of the diameter of a hollow tube of foam insulation or pool noodle, create a ramp with a long flat runout. Set up the half tube in a location where all students can see it (it may be useful to tape it to the wall and floor). Place one marble in the middle of the flat section. Make a mark partway up the ramp using a dry erase marker. Ask students to predict and create a chart (through discussion or in their science notebooks) on what will happen to both marbles when another marble (different color) is released at the middle of the ramp. Run the experiment three times to collect data and see whether the results are consistent. Use the wet erase marker to mark where each marble ends up after the collision. Discuss results vs. student predictions.

Now ask students to predict what they think will happen if a small marble is released at the top of the ramp (more speed) and collides with another small marble. Run the experiment three times. Discuss what happens. The stationary marble should move further than before because the faster moving marble that collided with it had more energy to transfer. Ask the following questions.

- What has changed compared to the initial trials? (The speed of the moving marble when it hits the stationary marble is much faster.)
- Have any other variables changed? (no)
- Is it fair to say that any change seen is the result of the motion of both marbles? (Yes, because only one variable has changed.)

Finally, ask students to predict what they think will happen if a large marble is released at the middle of the ramp and collides with a small marble.

Run the experiment. Discuss what happens. Ask students, what has changed in this scenario? (The size of the first marble. It is larger, heavier.) Have any other variables changed? (no) Is it fair to say that any change seen is the result of the motion of both marbles? (Yes, because only one variable has changed.) Similar scenarios could be set up using toy cars and track.

EXPLAIN

WATCH THE GENERATION GENIUS COLLISIONS VIDEO AS A GROUP

Then facilitate a conversation using the Discussion Questions.

ELABORATE

Use the DIY Activity to create your own Rube Goldberg machine just like Zoe's from the video. Then, individually or as a group, design your own Rube Goldberg machine using collisions.

EVALUATE

Ask students to sketch a model of their Rube Goldberg machine in their science notebooks, labeling their drawing to show how each collision plays a part in the transfer of energy. Alternatively, students could verbally describe their inventions.

EXTENSIONS

Explore the science behind collisions by connecting it to what they are currently playing in gym class.