Unit 1: Force and Motion

Content Area: **Science**
Course(s):
Time Period: **Generic Time Period**
Length: **3 weeks**
Status: **Published**

Essential Questions

Specific NGSS: 4-PS3-1 and 4-PS3-3

Essential Unit Question:

- What is the relationship between the speed of an object and the energy of that object?

Guiding Questions:

- What is the relationship between the speed of an object and its energy?

Objectives:

- SWBAT use evidence to construct an explanation relation the speed of an object to the energy of that object.
- SWBAT ask questions and predict outcomes about the changes in energy that occur when objects collide.

Concepts that will be taught...

1. Energy can be transferred in various ways and between objects.
2. The faster a given object is moving, the more energy it possesses.
3. Energy can be transferred in various ways and between objects.
4. Energy can be moved from place to place by moving objects or through sound, light, or electric currents.
5. Energy is present whenever there are moving objects, sound, light, or heat.
6. 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 is produced.
7. When objects collide, the contact forces transfer energy so as to change the objects' motions.

Standards

LA.4.W.4.7	Conduct short research projects that build knowledge through investigation of different aspects of a topic.
LA.4.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.
LA.4.W.4.9	Draw evidence from literary or informational texts to support analysis, reflection, and research.
SCI.4-PS3-1	Use evidence to construct an explanation relating the speed of an object to the energy of that object.
SCI.4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
LA.4.RI.4.1	Refer to details and examples in a text and make relevant connections when explaining what the text says explicitly and when drawing inferences from the text.
MA.4.4.OA.C	Generate and analyze patterns.
MA.4.4.MD.A.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
LA.4.W.4.2	Write informative/explanatory texts to examine a topic and convey ideas and information clearly.
LA.4.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.
LA.4.RI.4.9	Integrate and reflect on (e.g. practical knowledge, historical/cultural context, and background knowledge) information from two texts on the same topic in order to write or speak about the subject knowledgeably.
SCI.4-PS3-3	Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Disciplinary Core Ideas

Relationship Between Energy and Forces

- When objects collide, the contact forces transfer energy so as to change the objects' motions.

Energy in Chemical Processes and Everyday Life

- The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.

Learning Activities

- In order to understand and explain the relationship between an object's speed and its energy, students need multiple opportunities to observe objects in motion. Students can roll balls down ramps, build and race rubber band cars, or build roller coasters. As they observe the motion of objects, they should collect data about the relative speed of objects in relation to the strength of the force applied to them. For example, when a ball is placed at the top of a ramp, it has stored energy, due to the force of gravity acting on it. When the ball is released, that stored energy is changed (transferred) into motion energy. Increasing the height of a ramp also increases the amount of stored energy in the ball at the top of the ramp. If the ball is released from a higher starting point, it rolls faster and farther. Likewise, winding the rubber band in a rubber band car stores energy in the rubber band, which is then changed, or transferred, into motion energy (kinetic) as the car moves forward. The more times you wind the rubber band, the greater the amount of stored energy in the rubber band, and the farther and faster the car goes. As students investigate these types of force and motion systems, they should conduct multiple trials, increasing and decreasing the amount of energy, then collect qualitative data as they observe the impact differing amounts of energy have on the relative speed of the object in motion. Students should then use their data as evidence to support their explanation of the relationship between the relative speed of an object and its energy.

- Once students understand that the faster an object moves, the more energy it possesses, they can begin to explore ways in which energy can be transferred. As they investigated the relationship between speed and energy, students learned that stored energy was changed, or transferred, into motion energy. To broaden their understanding of energy transfer, students should be provided with opportunities to observe objects colliding and should be encouraged to ask questions that lead to further investigation. For example, if students roll a ball towards a wall, or roll two balls so that they collide, they may observe any or all of the following:

    - Change(s) in the direction of motion
    - Change(s) in speed
    - Change(s) in the type of energy (e.g., motion energy to sound energy, sound energy to heat energy)
    - Change(s) in the type of motion (rolling to bouncing).

- As students continue to investigate interactions between moving objects, they should notice that when a moving object collides with a stationary object, some of the motion energy of one is transferred to the other. In addition, some of the motion energy is changed, or transferred to the surrounding air, and as a result, the air gets heated and sound is produced. Likewise, when two moving objects collide, they transfer motion energy to one another and to the surrounding environment as sound and heat. It is important that as students observe these types of interactions, they collect observational data, document the types of changes they observe, look for patterns of change in both the motion of objects and in the types of energy transfers that occur, and make predictions about the future motion of objects. Their investigations will help them understand that:

    - Energy can be transferred in various ways and between objects.
    - Energy is present whenever there are moving objects.
    - Energy can be moved, or transferred, from place to place by moving objects.
    - When objects collide, some energy may be changed or transferred into other types of energy.

Mystery Science

Unit: Energizing Everything - Energy & Motion

***These 3 Mysteries provide 3 weeks of content. This introductory energy unit will encourage students to think about the energy that things need to move. Students will explore how energy makes things go, from powering vehicles to moving one's body. Students will experiment with rubber band racers to discover the relationship between how much energy is stored in a material and how much is released. They will investigate the role that hills play in making roller coasters move and the energy transfer that happens when two objects collide. Students will realize that thinking about the world in terms of energy helps them make sense of how and why things speed up and slow down. Hands-on activities focus on engineering, testing hypotheses and using results to develop their ideas.*

Mystery 1: Speed & Energy

***In this Mystery, students will explore how energy can make things go by learning about different ways of making things go. In the activity, students will make rubber-band racers and experiment to figure out how many times to twist the rubber band in order to win the "Sweet Spot" race.*

Essential Question - How can a car run without gas?

Materials: Each student will need - a 1/8 " wide rubber band, a paper cup (8 oz), two disposable plastic cup lids with straw slots in the middle (fast food kind), a pen or pencil that can write on the cup lid, a toothpick, a plastic straw, 2 pony beads (9mm size), a large paper clip, a 1" X 1" cardboard square (from a cereal box), a hole punch, a "Race to the Sweet Spot" worksheet. To set up the racetrack, you will need - a yardstick or tape measure, some masking tape, a clear floor space measuring at least 4 feet wide and about 14 feet long.

Procedure: Prior to teaching the lesson, watch activity instructions, troubleshooting video and tips video. Obtain and print out all necessary student materials & teacher answer keys. Cut cardboard squares for students & setup racetrack. Access Mystery Science website on SmartBoard. Utilize classroom iPads for small group/individual use as desired. View

Exploration video (20 min). Follow prompts for stopping points for questioning and discussion. Guide students in prepping and carrying out Activity: Rubber Band Racers (40 min). Optional Extras are available to supplement lesson (2 hrs).

Assessment: Informal observation during exploration & activity, Mystery 1 assessment

Mystery 2: Energy Conversion & Engineering

***In this Mystery, students will explore how energy can be stored as height. In the activity, they will investigate how hills give roller coasters energy by experimenting with a model "bumper coaster."*

Essential Question - What makes roller coasters go so fast?

Materials: **It's recommended to make 1 bumper coaster for every 3 students. Each group of 3 will need a floor space measuring about 6' X3'. Additionally, each group of 3 students will need a 3-foot-length of foam pipe insulation, 4 small marbles, a stack of books or a box to make a hill that's 12" tall, a 24" strip of masking tape, a ruler, scissors, a paper or Styrofoam cup, the "Bumper Coaster Experiments" worksheet, a pencil or pen. **Also note that students will reuse the foam tubing and marbles in Mystery 3.

Procedure: Prior to teaching the lesson, watch activity instructions and decide how many bumper coasters the class will make and use. Obtain and print out all necessary student materials and teacher answer keys. Access Mystery Science website on SmartBoard. Utilize classroom iPads for small group/individual use as desired. View Exploration video (15 min). Follow prompts for stopping points for questioning and discussion. Guide students in prepping and carrying out Activity: Bumper Coasters (45 min). Optional Extras are available to supplement lesson (2 hrs).

Assessment: Informal observation during exploration & activity, Mystery 2 assessment

Mystery 3: Energy & Collisions

***In this Mystery, students will explore how high the hills of a roller coaster can be. In the activity, students add hills to the Bumper Coaster they built in Mystery 2 and experiment to build a deeper understanding of hills and energy.*

Essential Question - Why is the first hill of a roller coaster always the highest?

Materials: Foam tracks that your class used in Mystery 2, a yardstick, tape measure, or ruler, masking tape, a pen that will write on masking tape, enough space on a table or floor to set up tracks side by side. Each group of 3 students will need - a labeled foam track, a stack of books or a box to make a hill that's 12" tall, two 20" strips pf masking tape, a ruler, a paper or Styrofoam cup, 2 small marbles, Each student will need the "Bumper Coaster with Hills" worksheet, and a pencil or pen.

Procedure: Prior to teaching lesson, watch activity instructions video and print out all necessary student materials & teacher answer keys. Decide if you will allocate more time to complete the Exploration and Activity, or if you will set up a demonstration bumper coaster. Follow Teacher Prep instructions to label the foam tracks (this will take about 20 min). Access Mystery Science website on SmartBoard. Utilize iPads for small group/individual use as desired. View Exploration video (20 min). Follow prompts for stopping points for questioning and discussion. Guide students in prepping and carrying out Activity: Bumper Coasters II (60 min). Optional Extras are available to supplement lesson (2 hrs).

Assessment: Informal observation during exploration & activity, Mystery 3 assessment

Accommodations & Modifications

- Large print textbooks
- Additional time for assignments
- Review of directions
- Have student restate information
- Provision of notes or outlines
- Concrete examples
- Adaptive writing utensils
- Support auditory presentations with visuals
- Weekly home-school communication tools (notebook, daily log, phone calls or email messages)
- Space for movement or breaks
- Extra visual and verbal cues and prompts
- Books on tape
- Graphic organizers
- Quiet corner or room to calm down and relax when anxious
- Preferential seating
- Alteration of the classroom arrangement
- Reduction of distractions
- Answers to be dictated
- Hands-on activities
- Use of Manipulatives
- Follow a routine/schedule
- Alternate quiet and active time
- Teach time management skills
- Rest breaks
- Verbal and visual cues regarding directions and staying on task
- Daily check-in special education teacher
- Visual daily schedule

- Varied reinforcement procedures
- Immediate feedback
- Personalized examples

Materials & Resources

www.mysteryscience.com

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Assessment

Science Textbook

- Chapter Review
- Chapter Test

Mystery Science

- Individual Mystery Assessments
- Summative Assessment
- Informal Observation during explorations & activities

Teacher-Made Assessments

- Quizzes
- Tests
- Classwork
- Homework
- Projects