Energy - Kinetic Energy and Potenial Energy

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Focus Questions

1. What is Potential Energy?
2. What is Kinetic Energy?
3. How does the speed of an object affect its kinetic energy?
4. How does the mass of an object affect its kinetic energy?
5. Where do you see the effects of kinetic energy in your daily life?

Introductory Exploration Activity (Assessing Prior Knowledge):

ENERGY Word Merge - Students define ENERGY, using their own words.
Write ENERGY on the board and let students take turns writing what they think it means.
Discuss everyone's thoughts about energy.

Talking About Energy

All energy can be described as being in two states – as **potential energy** or **kinetic energy**.
Potential energy is motion waiting to happen – stored energy that can be changed into kinetic energy. Examples of potential energy are: a soccer ball about to be kicked, a bird about to take off, a kangaroo about to jump, an arrow about to be shot, a car about to drive away.
Kinetic energy is the energy of motion (or action) – the kicked ball in motion, the bird flying, the kangaroo leaping, the arrow in flight, the car driving.

Simple Potential vs. Kinetic Energy Demonstration in the Classroom

Materials:

marble, billiard ball (or dense rubber ball), bucket of water

Procedures:

1. As the marble and the ball sit at the edge of the table explain their potential energy.
2. Roll each into the bucket of water and explain their kinetic energy.
3. Have students notes the larger splash of the bigger ball. Explain the effect of mass on kinetic energy.
4. Throw the ball into the bucket and have students note the larger splash.
5. Explain the effect of speed on kinetic energy.

Enduring Understandings:

1. Kinetic energy is the energy of objects that are in motion.
2. As the speed of an object increases, the kinetic energy of the object increases.
3. As the mass of an object increases, the kinetic energy of the object increases.
4. When two variables increase together, they have a direct/proportional relationship.

Types of Energy

There are six kinds of energy:

1. **Electrical Energy** is the action of electrons moving down a conductor pathway. An example of this is a wire carrying electricity.

2. **Chemical Energy** is released when compounds are broken down. An example of this is the digestion of food.

3. **Nuclear Energy** is released when the bonds of atoms are changed. An example of this is when uranium atoms are split.

4. **Thermal Energy** is the action of moving molecules. An example of this is when you turn up the heat on your electric stove and the molecules move faster and release more heat.

5. **Radiant Energy** is energy that is absorbed from an outside source and released as electromagnetic radiation. The most obvious example is the energy we absorb from the sun. Another is when you absorb energy as your socks move across the carpet and then release it when you touch the light switch - zing!

6. **Mechanical Energy** is released by the motion of any object. Examples of this include cars, waterfalls, people and animals moving, hail falling, etc.

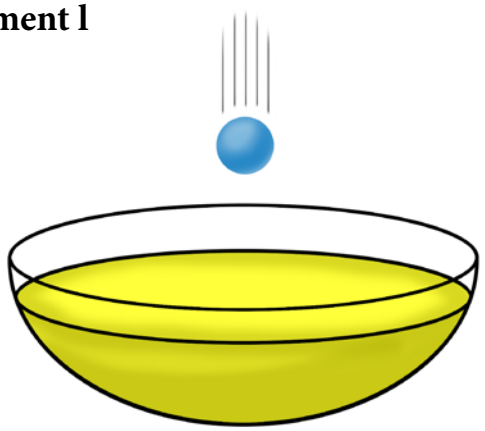
How much kinetic energy an object has depends on its **mass(m)** and **speed(v)**. Here is the equations used to find the kinetic energy of an object: **Kinetic Energy (KE) = .5 x mass x speed^2 or KE =.5 x m x v^2**

$$KE = .5mv^2$$

This equation shows us a pattern. The kinetic energy of any object changes in proportion to its speed. So, if a car doubles its speed, its kinetic energy is increased by four times (2 x 2 = 3), whereas if it triples its speed, it would increase its kinetic energy nine times (3 x 3 = 9). The greater the mass and velocity of the moving object, the greater its kinetic energy.

Kinetic Energy Introductory Experiment l

Part 1 - Demonstration

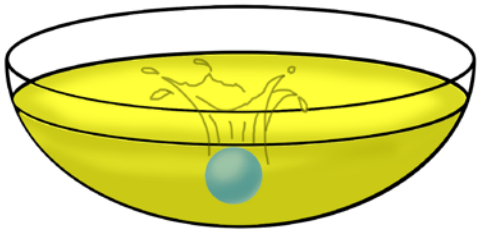


Objectives:

Look at how the speed and mass of an object affects its kinetic energy. Consider the examples of kinetic energy in every day life.

Materials:

1. marbles (all the same size)
2. several bowls of light colored jello
3. POE Handouts



Procedure:

1. Hold two small marbles in your hands. Explain to your students that you are going to drop one marble into the jello and throw one marble into the jello. Ask your students to write down their predictions of how each marble will affect the jello on their **Predict-Observe-Explain (POE) Data Sheet**.

2. Drop a marble into one bowl of jello. Have students look at its position in the jello.

3. Next, throw a marble into another bowl of jello. Have students look at its position in the jello.

4. Ask students to write down their observations of what happened on the POE Data Sheet.

5. Once students have finished their observations, encourage them to try to explain why they think these results happened on their POE Data Sheet.

6. Have students share their Data Sheet responses and new ideas in pairs and as a whole group.

7. Ask guiding questions to help them articulate that more speed makes the object have more of an effect on the jello => more speed means more kinetic energy.

8. Encourage students to think about the kinetic energy they see in their every day lives, i.e. coming down the stairs for breakfast, pouring milk on their cereal, slamming the door, the school bus driving them to school, the soccer ball flying through the air, dropping school books, raising their hand in class, etc. Ask them to suggest examples of their own.

Kinetic Energy Introductory Experiment ll

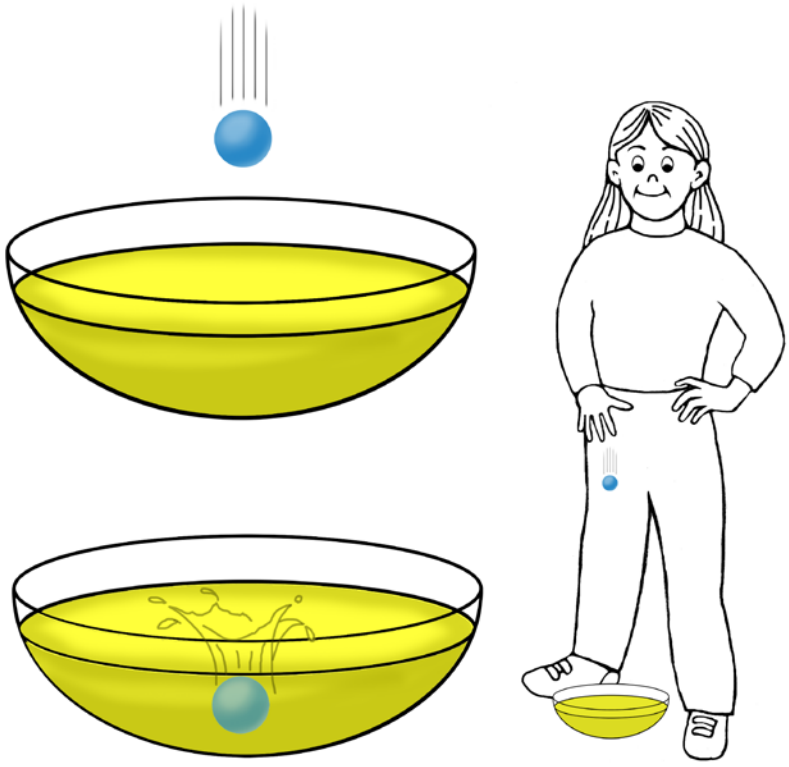
Part 1 - Exploration

Objectives:

Explore how the size of an object affects its kinetic energy.

Materials:

1. marbles (large and small)
2. clear plastic cups of light colored jello
3. POE Handouts



Procedure:

1. Explain to students that they will now be doing their own exploring in pairs/small groups to compare the energy of a large marble and a small marble.

2. Before handing out materials, have students share, as a group, what procedures should be followed. Encourage them to think about controls (e.g. the marble should be dropped from the same height).

3. Once a class procedure has been developed, have students write down their predictions on the POE Data Sheet.

4. Hand out one small marble, one large marble, and two clear plastic cups of jello to each pair/group of students. Ask students to perform the exploration.

5. Students should then record their observations and their explanations on the POE Data Sheet.

6. If students finish early, encourage them to try their own experiments with different variables and record their findings.

7. When all students are finished, discuss their results as a whole group. Ask guiding questions to help students articulate that **more mass creates more energy**.

8. Encourage students to think about how they have observed this in their daily lives. i.e. the impact of dropping a pencil off their desk vs. dropping a book, swinging a pillow at a friend in jest - but not a baseball bat, etc.

Name: _____ Date: _____

Predict-Observe-Explain (POE) Data Sheet

Experiment l - Observation - Fast Marble vs. Slow Marble

Predict: _____

_____

_____

Observe: _____

_____

_____

Explain: _____

_____

_____

_____

Experiment ll - Exploration - Small Marble vs. Large Marble

Predict: _____

_____

_____

Observe: _____

_____

_____

Explain: _____

_____

_____

_____

NGSS and Common Core Integration
MS-PS2 Motion and Stability: Forces and Interactions

Disciplinary Core Ideas:

PS2.A: Forces and Motion

• The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)

• All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)

PS2.B: Types of Interactions

• Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)

Crosscutting Concepts:

Cause and Effect

• Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3),(MS-PS2-5)

Systems and System Models

• Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1),(MS-PS2-4)

Stability and Change

• Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

Performance Expectations:

MS-PS2-2. Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. *[Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]*

MS-PS2-4. Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. *[Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]*

Science and Engineering Practices:

Asking Questions and Defining Problems

• Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

• Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums