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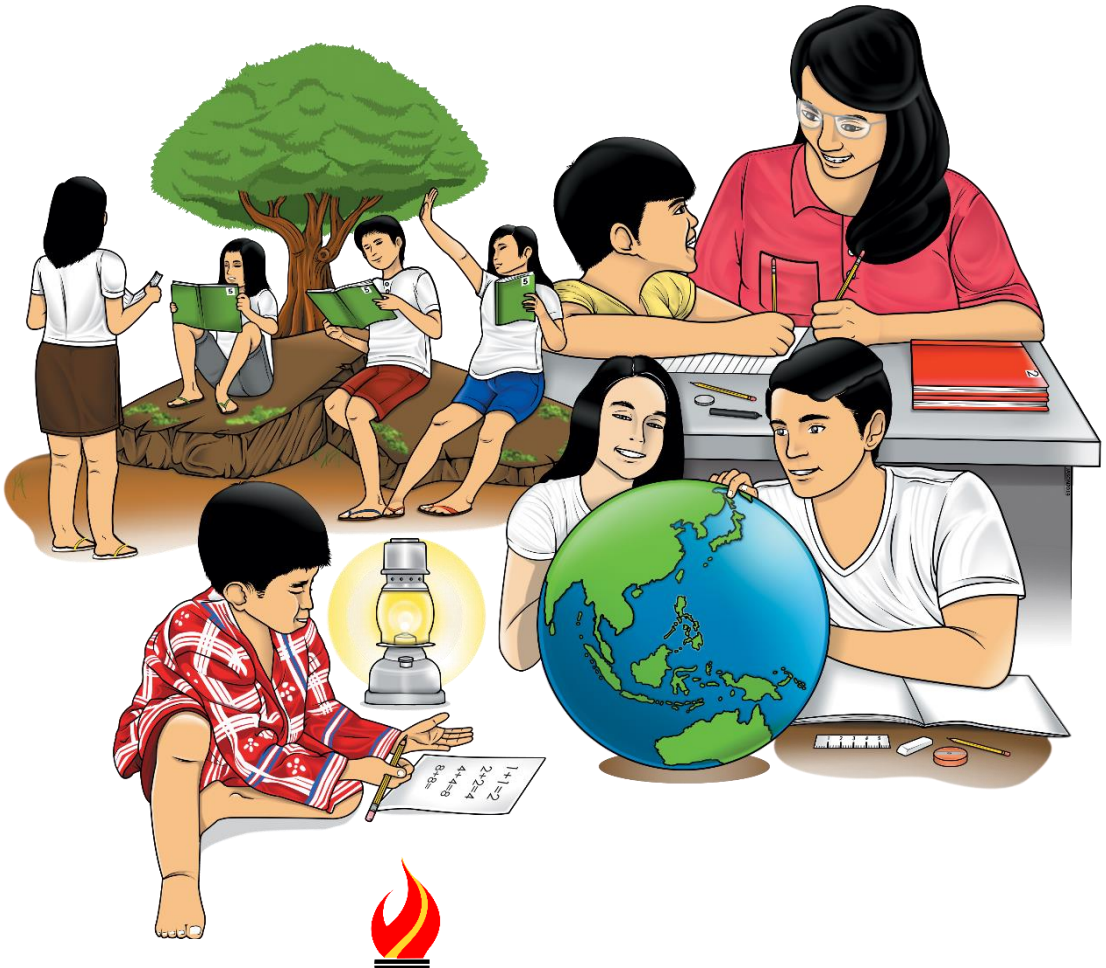
Science
Quarter 1 – Module 3: Potential Energy and Kinetic Energy



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Science
Quarter 1 – Module 3: Potential Energy and Kinetic Energy

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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the materials in the main text. Notes to the teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and texts. And used the instructions carefully before performing the task.

If you have any questions in using the SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

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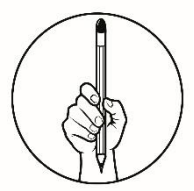
What I Need to Know

This module was designed and written with you in mind. It is here to help you master potential and kinetic energy. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

After going through this module, you are expected to:

1. Identify and explain the factors that affect potential and kinetic energy. (MELC Week 2-3)



What I Know

Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

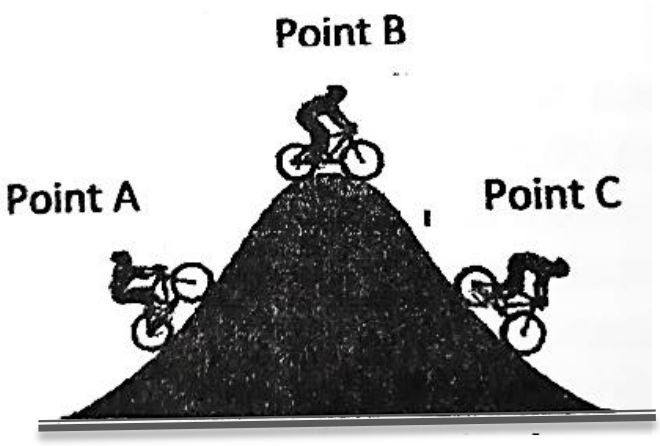
1. An object from a certain height falls freely. Which of the following happens to PE and KE when the object is half on its way down?
   A. loses PE and gains KE
   B. gains PE and loses KE
   C. loses both PE and KE
   D. gains both PE and KE

2. How do you compare the PE of the moving object at the highest point compared to its KE?
   A. PE is greater than KE
   B. PE is equal to KE
   C. PE is lesser than KE
   D. KE is greater than PE

3. Which of the following quantities has the greatest influence on the amount of kinetic energy of a car while traveling on a highway?
   A. mass
   B. size
   C. speed
   D. weight

4. Which of the following pair of quantities are the factors that affect kinetic energy?
   A. force and distance
   B. mass and height
   C. mass and speed
   D. time and height

For Questions 5-6. Refer to the illustration below.



5. Which point has increasing kinetic energy?
   A. Point C
   B. Point B
   C. Point A
   D. Point A & C

6. Which point has the greatest potential energy?
   A. Point A
   B. Point B
   C. Point C
   D. Point A & C

7. Which of the following statements is TRUE about potential energy?
   A. It is dependent on the speed of an object.
   B. It does not depend on the mass of the object.
   C. It does not depend on the strength of gravity.
   D. It is affected by the mass and location of an object with respect to the ground.

8. Which of the following does not affect the amount of potential energy of an object?
   A. mass
   B. speed
   C. height or location
   D. strength of gravity

9. The following applies the concept of potential energy EXCEPT:
   A. water in a dam
   B. a person playing the guitar
   C. a rock sitting at the edge of a cliff
   D. tree branches high up in a tree

10. What happens to the kinetic energy of an object if its speed is doubled?
   A. twice as much
   B. thrice as much
   C. increases four times
   D. decreases four times

Lesson 1 Potential Energy and Kinetic Energy

The word energy is used very often in our daily life. In science, there are many forms of energy; however, this module shall only focus on Potential Energy and Kinetic Energy.

What's In

Energy: The ability to do work

Let us consider the following situations: A fast-moving softball hit a stationary, open door which caused it to move. An object lifted to a certain height using a rope, elevated the object from the ground. A hammer struck on a nail that was placed on a piece of wood, pushed the nail into the wood. A toy car's key was twisted, placed on the floor, and started to move. In all these situations, forces acting on the objects are doing work.

An object requires energy to do work. Consider two objects A and B that are about to interact with each other. When object A is pushed, an applied force is doing work on it. Object A possesses kinetic energy while moving towards a stationary object B. In this situation, object A loses energy while object B gains energy. When this happens, energy is transferred from object A to object B. This indicates that any object that has energy can do work.

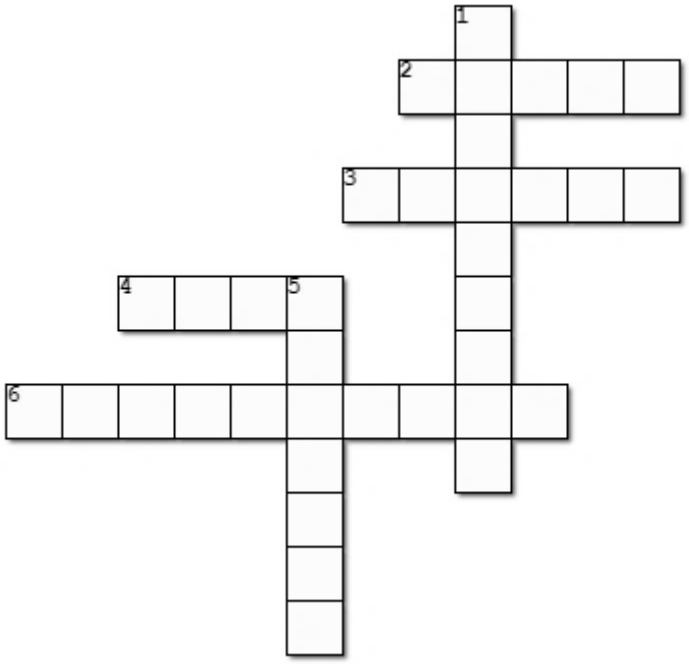
Energy is the ability or capacity to do work. Its unit is the same as the unit of work, expressed in joule (J) in the SI system. One (1) J is the energy needed to accomplish one (1) joule of work. A larger unit of energy called kilojoule (kJ) is sometimes used. One (1) kJ is equal to1000 J.

What's New

Activity 1. Energy Crossword Puzzle

Objective: Familiarize the words that are associated to the concept of energy.

Complete the crossword puzzle below.



Across:

2. _____ is the unit of energy in SI system.
3. The ability to do work is _____.
4. The product of force and displacement is _____.
6. The total _____ energy is the sum of kinetic and potential energy.

Down:

1. _____ energy is stored due to the object's position.
5. _____ energy is associated with motion.

Notes to the Teacher

Provide extra copies of this page for students' use.

What is It

Potential Energy

In the previous lesson, you were asked if the man lifting the box is doing work on it.

Figure 1. A man lifting a box

Source: Pia C. Campo, et. Al., A man lifting a box, Science 8 Learner's Material, Philippines, FEP Printing Corporation, 2016

Which or who is doing work in Figure 1? Is it the table, the box, or the man? Yes, you are correct! The man is doing work on the box. Specifically, the force he applied while lifting is doing work on the box. What is the direction of the force exerted by the man on the box? What is the direction of the motion of the box? Yes, both are directed upward. Work, as discussed earlier, is a way to transmit energy. Hence, when the man exerted force in lifting the box, he loses energy. Work is done on the box, and the box gains energy.

You have learned that force of gravity is the force exerted by the Earth on all things. It is always directed downward or towards the center of the Earth. Consequently, when an object is raised from the Earth, the force exerted in lifting the object is equal to its weight,

$$F = Weight = mg$$

The work done in lifting the object is:

$$W = Fd$$

where, the displacement (d) is the height (h) the object is raised. Thus, the work done in lifting the object against the gravitational force is given by

$$W = m\ g\ h$$

The work performed in lifting an object is equals to the potential energy the object gains. An object absorbs energy when lifted from the ground and when allowed to fall, it loses energy. The energy that the body gains or losses with respect to its position is called potential energy (PE) and is given by

$$PE=mgh$$

where: *PE* is the potential energy in joules (J);

m is the object's mass in kilograms (kg);

g is the acceleration due to gravity which is 9.8 m/s^2; and

h is the height of the object from the reference point (e.g., ground) in meters (m).

Kinetic Energy

What is common in the following situations? A running athlete on the track, a flowing water on the ground, a falling coconut from its tree, a rolling rock on the seashore, and a soaring airplane into the air. They are all moving and are acted upon by forces. Any object that moves possesses energy and can do work. An object that moves quicker can do more work than an identical object that moves slowly. How much energy does a moving object possess? We say that the kinetic energy of an object moving at a certain speed is equal to the work done to make it acquire that speed.

The energy of a moving object is called energy of motion or kinetic energy (KE). The word kinetic comes from the Greek word *kinetikos* which means moving. Kinetic energy measures the amount of work the object can do because of its motion.

This can be computed using the formula:

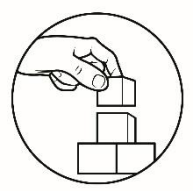
$$KE = \frac{1}{2} mv^2$$

where: *KE* is the kinetic energy in joule (J),

m is the object's mass in kilogram (kg), and

v is the object's speed in meter per second (m/s).

From the formula, the kinetic energy of an object depends on its mass and speed. What will happen to the KE of an object if its mass is doubled but the speed remains the same? The KE of an object is also doubled. How about if the speed is doubled but the mass remains the same? The KE of an object increases four times. This means that the greater the mass, the greater the kinetic energy; and the faster the speed the higher the kinetic energy as well.



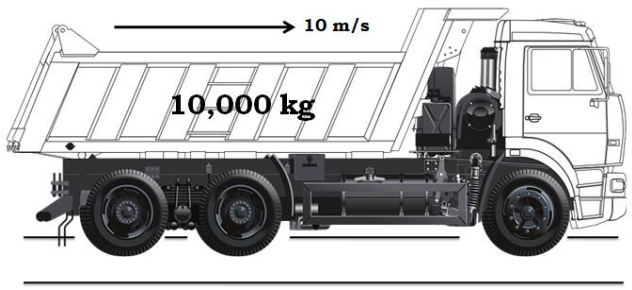
What's More

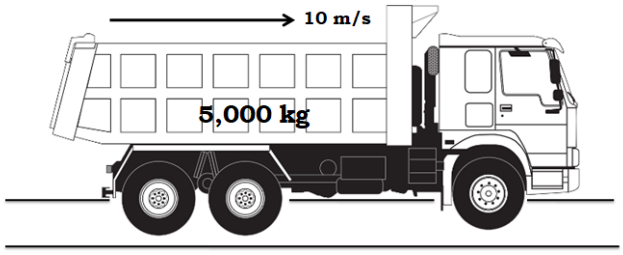
Activity 2. Kinetic Energy

Objective:

After performing this activity, you should be able to investigate that increasing or reducing the mass and/or speed affect/s the kinetic energy of the object. The situations and explanations below are introduced to guide and help you answer the questions that follow.

Situation A: Two vehicles of different mass moving at same speed.





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The kinetic energy of a 10,000-kg vehicle is twice as much as the kinetic energy of a 5,000-kg vehicle when both are travelling at the same speed.

Why is this so?

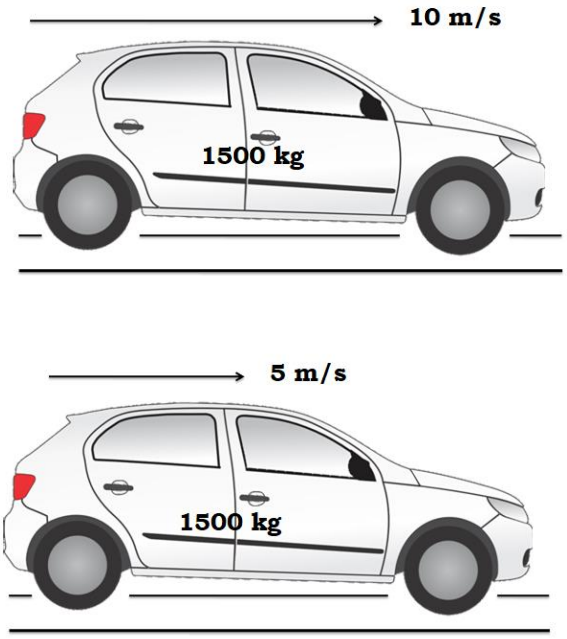
The 10,000-kg vehicle has twice as much the mass of the 5,000-kg car. Since they are travelling at the same speed, using the formula of kinetic energy,

$$KE = \tfrac{1}{2}mv^2$$

$$= \tfrac{1}{2}(2m)v^2$$

Therefore, $KE = 2(\tfrac{1}{2}mv^2)$. The kinetic energy is doubled.

Situation B: Two vehicles of the same mass moving at different speed.



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The kinetic energy of a car travelling at 10 m/s is four times the kinetic energy of a car travelling at 5 m/s.

Why is this so?

Car travelling at 10 m/s has twice as much the speed of the other car. Since the mass is the same for both vehicles, using the formula of kinetic energy.

$$KE = \frac{1}{2} mv^2$$

$$= \frac{1}{2} m(2v)^2$$

$$= \frac{1}{2} m (4v^2)$$

Therefore, $KE = 4(\frac{1}{2}mv^2)$. The kinetic energy is increased four times.

Procedures:

1. Complete the table below. Refer to the situations and explanations above to guide and help you determine what happens to kinetic energy of an object when either mass or speed is changed. Use directly the formula of kinetic energy, $KE=\frac{1}{2}mv^2$. Number 1 is done for you.

Table 1. Effects of mass and speed to kinetic energy

Kinetic Energy (KE)	Mass	Speed
1. doubled	doubled	constant
2.	constant	tripled
3.	doubled	doubled
4.	reduced to ½	reduced to ½
5.	tripled	tripled
6.	reduced to ½	doubled

Questions:

1. Which of the numbers above is KE largest? _____

2. Which of the numbers above is KE smallest? _____

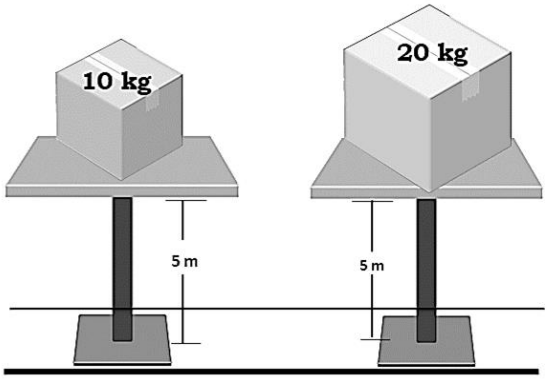
3. Rank the KE of the numbers above from smallest to largest. _____

Activity 3. Potential Energy

Objective:

After performing this activity, you should be able to investigate that increasing or reducing the mass and/or height affect/s the potential energy of the object. The situations and explanations below are introduced to guide and help you answer the questions that follow.

Situation A: Two objects of different mass are situated at the same height.



The potential energy of 20-kg box is twice as much as the potential energy of a 10-kg box when both boxes are of the same height from the ground.

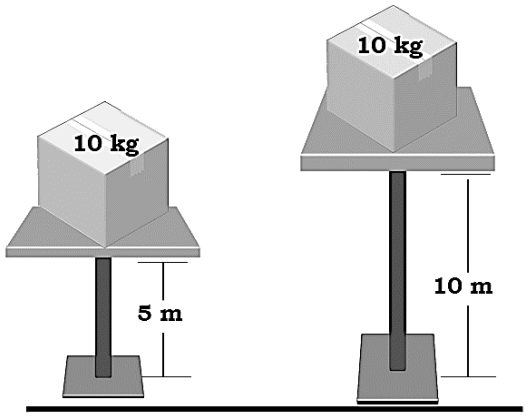
Why is this so?

The 20-kg box has twice as much the mass of the 10-kg box. Since they are of the same height from the ground, using the formula of potential energy, PE = mgh

= (2m)gh

Therefore, PE = 2mgh. The potential energy is doubled.

Situation B: Two objects of the same mass are situated at different height.



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The potential energy of the box that is 10 m from the ground is twice as much the potential energy of the box that is 5 m from the ground when both boxes are of the same mass.

Why is this so?

The box that is 10 m from the ground has twice as much height of the other box. Since mass is the same for both boxes, using the formula of potential energy,

PE = mgh

=mg(2h)

Therefore, PE = 2mgh. The potential energy is doubled.

Procedure:

1. Complete the table below. Refer to the situations and explanations above to guide and help you determine what happens to potential energy of an object when either mass or height is changed given a constant value of acceleration due to gravity, g = 9.8m/s^2. Use directly the formula of potential energy, PE = mgh. Number 1 is done for you.

Table 2. Effects of mass and height to potential energy

Potential Energy (PE)	Mass	Height
1. doubled	doubled	constant
2.	constant	tripled
3.	doubled	doubled
4.	reduced to ½	reduced to ½
5.	tripled	tripled
6.	reduced to ½	doubled

Questions:

1. Which of the numbers above is PE largest? _____

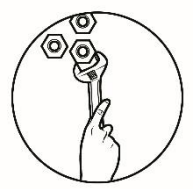
2. Which of the numbers above is PE smallest? _____

3. Rank the PE of the numbers above from largest to smallest. _____

What I Have Learned

Fill in the blanks with the correct answers to complete the statements. Write your answers on a separate sheet of paper.

1. The _____of the object increases when elevated from the ground to a certain height.
2. An object's potential energy can be computed using the formula_____.
3. Any moving object possesses energy called _____ and can be computed using the formula _____.
4. _____ is the ability or capacity to do work.
5. When an object's speed doubles, its kinetic energy _____.
6. When an object's mass doubles, its kinetic energy also _____.
7. The more mass an object has when lifted to a certain height, the _____ potential energy.



What I Can Do

Activity 4: Potential Energy and Kinetic Energy

Identify whether the objects in the given situations possess *Potential Energy* or *Kinetic Energy*. Write your answers on a separate sheet of paper.

1. Bird flying
2. Log in a fireplace
3. Watermelon on a desk
4. Car travelling on the highway
5. Car sitting in a driveway
6. Bunch of coconut stick on a table
7. Ball bouncing on the floor
8. Child jumping on his bed
9. Child sleeping on the crib
10. Marble rolling down the ramp

Assessment

Choose the letter of the correct answer. Write your answers on a separate sheet of paper.

1. The following situations demonstrate potential energy EXCEPT:
   A. a bullet fired from a gun
   B. a child at the top of a slide
   C. a car parked at the top of a hill
   D. river water at the top of a waterfall

2. The potential energy is the energy an object has due to its _____.
   A. mass
   B. motion
   C. position
   D. weight

3. The following conditions exhibits kinetic energy EXCEPT:
   A. water inside a glass
   B. rolling stone from the hill
   C. running athlete on the field
   D. dancing kids in the living room of the house

4. Which of the following quantities, when doubled, has the greatest effect on the amount of kinetic energy?
   A. mass
   B. size
   C. speed
   D. weight

5. If a green ball is higher from the ground than a yellow ball and both have the same mass, which ball has more potential energy?
   A. green ball
   B. yellow ball
   C. both has the same PE
   D. both has the same KE

6. Which of the following factors does not affect the amount of potential energy of an object?
   A. gravity
   B. height
   C. mass
   D. speed

7. Which happens to kinetic energy if mass is doubled?
   A. doubled
   B. the same
   C. tripled
   D. quadrupled

8. Potential energy is the energy of an object based on its _____.
   A. height and mass
   B. mass and speed
   C. speed and height
   D. weight and speed

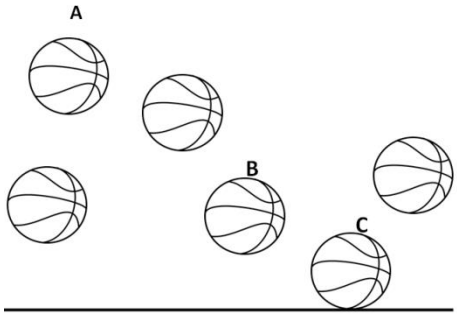
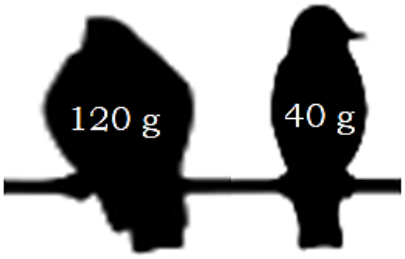
9. Where does a car on a hill have the greatest potential energy?
   A. top of the hill
   B. bottom of the hill
   C. halfway down the hill
   D. it has the same potential energy at all points

10. Kinetic energy is the energy an object possessed due to its _____.
   A. mass
   B. motion
   C. position
   D. weight

Additional Activities

Activity 5: More About PE and KE

Given the pictures below, answer the corresponding questions that follow. Write your answers on a separate sheet of paper.

	A ball bounces on the ground. At what position (A, B, C) does the ball have the greatest potential energy? Kinetic energy? Explain your answer.
	Which bird on the wire has the more potential energy? Prove your answer using the formula of potential energy.

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Rubric for Scoring

Points	Description
2	Discussion is complete with no misconception.
1	Discussion is incomplete with minor misconception.
0	No discussion

Answer Key

Additional activities

A. The greatest potential energy is at point A, because the ball is at its maximum height. On the other hand, the greatest kinetic energy is at point B, because the ball is at its maximum speed before it hits the ground.

B. The 120-g bird has three times more potential energy than the 40-g bird. Using the formula PE=mgh,
=(3m)gh
Therefore, PE=3mgh.The potential energy is tripled at the same height.

What's More

Activity 1. Kinetic energy

1. Doubled
2. 9 times the original KE
3. 8 times the original KE
4. 1/8 of the original KE
5. 27 times
6. Doubled

Questions:

1. Largest KE: Number 5, 27 times
2. Smallest KE: Number 4, 1/8 of the original KE.
3. Rank KE smallest to largest: 4,1,6,3,2,5

Activity 2. Potential Energy

1. Doubled
2. Tripled
3. 4 times the original PE
4. ¼ of the original PE
5. 9 times original PE
6. Same as initial PE

Questions

1. PE largest: Number 5, 9 times the original PE
2. PE smallest: Number 4, ¼ of the original PE
3. PE largest to smallest: 4,6,1,2,4,9

Assessment

1. A
2. D
3. A
4. C
5. A
6. D
7. A
8. A
9. A
10. B

What can I do

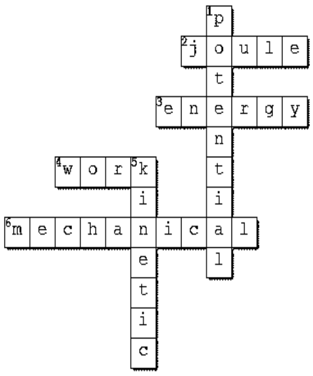
1. Kinetic energy
2. Potential energy
3. Potential energy
4. Kinetic energy
5. Potential energy
6. Potential energy
7. Kinetic energy
8. Kinetic energy
9. Potential energy
10. Kinetic energy

What I have learned

1. potential energy.
2. PE = m g h.
3. kinetic energy

$$,KE = \frac{1}{2}mv^2$$

4. energy
5. quadruples
6. doubles
7. more



What I have learned

1. A
2. B
3. C
4. B
5. A
6. B
7. D
8. D
9. B
10. C

References

Books

Campo, Pia C., et.al.*Science Learner's Module 8.* Pasig City: Department of Education, 2016.

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