W1	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Forces and Motion
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Describe the horizontal and vertical motions of a projectile.
III. CONTENT/CORE CONTENT	Projectile Motion

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

Uniformly Accelerated Motion

A body is said to have uniform acceleration if it maintains a constant change in its velocity in each time interval along a straight line. This can be along the horizontal (rectilinear) or along the vertical (free fall). For rectilinear motion, let us take a track and field runner competing in the 100-m run as an example. If the runner's positions are taken at equal time intervals and the change in position for each time interval is increasing, then, the runner is moving faster and faster. This means that the runner is accelerating.

The pull of gravity acts on all objects. So, when you drop something or even when you throw something up, it will go down. Things thrown upward always fall at a constant acceleration which has a magnitude of 9.8 m/s^2. This means that the velocity of an object changes by 9.8 m/s every second of fall. Consider a ball thrown upward. As the ball goes up, it decelerates until it stops momentarily and changes direction. That means, it reaches its maximum height before it starts to fall back to the point where it was thrown, and its speed will be equal to the speed at which it was thrown. Note that the magnitudes of the two velocities are equal, but they have opposite directions – velocity is upward when it was thrown, but downward when it returns. Free-fall is an example of uniformly accelerated motion, with its acceleration being -9.8 m/s^2, negative because it is downward.

The equations for Uniformly Accelerated Motion (UAM) are:

$$v_f = v_i + at$$

$$d = v_i t + \frac{1}{2}at^2$$

$$v_f^2 = v_i^2 + 2ad$$

$$d = \left(\frac{v_i + v_f}{2}\right)t \text{ or } d = \bar{v}t$$

where: v_f = final velocity/speed

v_i = initial velocity/speed

a = constant acceleration

t = time

d = distance/displacement

$\bar{v}$ = average speed/velocity

D. Development (Time Frame: Day 2)

Motion in Two Dimensions

Many of the games you play and sporting events you join/officiate in during PE classes involve flying objects or balls. Have you noticed the *curved paths* they make in mid-air? This curve is what naturally happens when an object, called a *projectile*, moves in *two dimensions* –having both horizontal and vertical motion components, acted by gravity only. In physics this is called projectile motion. Not only balls fly when in projectile motion. Have you noticed that in many sports and games, players come "flying" too? Understanding motion in two-dimensions will help you apply the physics of sports and enhance game events experiences.

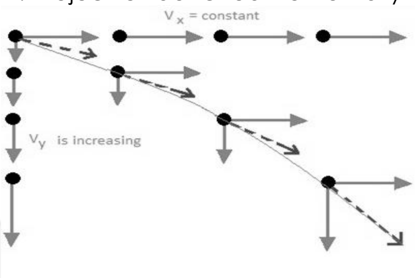
Projectile motion is a combination of uniform motion along the horizontal and the motion of a freely falling body along the vertical. It is an instance of uniformly accelerated motion in two-dimensions. The moving body is called a *projectile*, the curved path it travels is known as the *trajectory* and the horizontal distance it covers is called *range*. The horizontal and vertical motions of a projectile are completely independent of each other.

Therefore, horizontal and vertical motion can be treated separately.

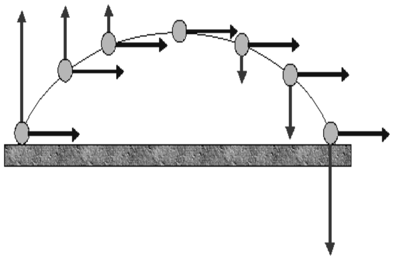
IV. LEARNING PHASES AND LEARNING ACTIVITIES

Types of Projectile Motion

I. Projectile Launched Horizontally



II. Projectile Launched at an Angle



Learning Task 1: JUMBLED LETTERS: Rearrange the letters to form the word described in each statement.

1. It is a combination of uniform horizontal motion and free fall.	**C E E I J L O P R T I M N O O T**
2. It is the curved path traveled by a projectile.	**A C E J O R R T T Y**
3. It is a body traveling in projectile motion.	**C E E I J L O P R T**
4. It is the horizontal distance traveled by a projectile.	**A E G N R**
5. It is the vertical distance traveled by a projectile.	**E G H H I T**

E. Engagement (Time Frame: Day 3)

Kinematic Equations for Projectile Motion

Horizontal Motion	*Vertical Motion*
$d_x = v_{ix}t$ $d_x = \frac{v_i^2 \sin(2\theta)}{g}$ $v_{ix} = v_{fx}$ $v_{ix} = v_i \cos\theta$ $t_T = \frac{2v_i \sin\theta}{g}$	$d_y = v_{iy}t + \frac{1}{2}gt^2$ $d_y = \left(\frac{v_{fy} - v_{iy}}{2}\right)t$ $d_y = \frac{v_i^2 sin^2\theta}{2g}$ $v_{fy} = v_{iy} + gt$ $v_{fy}^2 = v_{iy}^2 + 2gd_y$ $v_{iy} = v_i \sin\theta$

where:

d_x = range
v_i = initial velocity/speed
v_{ix} = initial horizontal velocity
v_{fx} = final horizontal velocity
t_T = total time of flight
θ = angle of projection

d_y = height
v_{iy} = initial vertical velocity
v_{fy} = final vertical velocity
g = acceleration due to gravity (9.8 m/s^2)
t = time of flight

Note: You will use the equations with *sin* or *cos* when the angle is given.

Sample Problem: If a bullet is fired with a speed of 600 m/s horizontally from a height of 48 m, how long will it take to hit the ground? What is the range of the projectile? Assume that there is no air resistance.

Given: v_{ix}= 600 m/s
v_{iy}= 0 (bullet was fired horizontally)
d_y = - 48 m (negative sign indicates height of fall)

IV. LEARNING PHASES AND LEARNING ACTIVITIES

Analyzing the situation given, we can see the available information in the horizontal and vertical axes, respectively.

Horizontal information	Vertical information
d_x = ? *(range)*	d_y = -48 m
v_{ix} = 600 m/s	v_{iy} = 0
a_x = 0	a_y = -9.8 m/s^2

Find: t and d_x

Solution: The original equation that we need to use is:

$$d_y = v_{iy}t + \frac{1}{2}gt^2$$

It is simplified to:

$$t = \sqrt{-\frac{2d_y}{g}}$$

then substitute the values

$$t = \sqrt{-\frac{2\,(-48\,m)}{9.8\,m/s^2}}$$

$$\boxed{t = \mathbf{3.1\,s}}$$

$$d_x = v_{ix}t$$

$$d_x = \left(600\frac{m}{s}\right)(3.1\,s)$$

$$\boxed{d_x = \mathbf{1\,860\,m}}$$

Learning Task 2: PROBLEM-SOLVING: A marble is thrown horizontally from a tabletop with a velocity of 1.50 m/s. The marble falls 0.70 m away from the table's edge. How high is the lab table? What is the marble's velocity just before it hits the floor?

A. Assimilation (Time Frame: Day 4)

The Newbie Archer

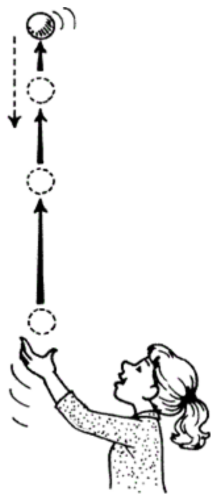
A school introduced the sports of archery so they can send players to Division and Regional Sports competition in the future. A student tries out. He was taught how to handle the equipment. Then, he sets a bow and arrow and directs it to the target, so the arrow is almost in direct line with the bull's eye target 30 m away. Will the boy hit a bullseye? Why?

Image sources:
https://classroomclipart.com/images/gallery/Clipart/Black_and_White_Clipart/Sports/TN_black-white-boy-aiming-with-bow-and-arrow-archery-clipart.jpg
https://cdn.britannica.com/26/91526-050-C4C7B73A/Archer-recurve-bow-target.jpg

V. ASSESSMENT (Time Frame: Day 5)

(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Directions. Choose the letter of the best answer.
*For questions 1-5, consider the given situation.
Maria throws a ball straight up with an initial velocity of 10 m/s.



SOURCE: GRADE 9 SCIENCE LM

1. What is its velocity at the highest point?
2. What is its velocity when it returned to the elevation from where it was thrown?
3. What is its acceleration at the highest point?
4. What is its acceleration just before it hits the ground?
5. After 1 second what is the acceleration of the ball?
   A. 0 m/s
   B. 0 m/s^2
   C. 9.8 m/s^2
   D. - 9.8 m/s^2
   E. 10 m/s^2
   F. -10 m/s
   G. cannot be determined

IV. LEARNING PHASES AND LEARNING ACTIVITIES

6. If a freely falling ball is somehow equipped with a speedometer, by how much would its speed-reading increase for every second?
   A. 0 m/s
   B. 9.8 m/s
   C. 10 m/s
   D. 20 m/s
7. A *sepak takraw* ball is hit vertically upward by a player. What is its acceleration after 1 second?
   A. 0
   B. 1 m/s^2
   C. 9.8 m/s^2
   D. -9.8 m/s^2
8. A volleyball is tossed vertically upward, with an initial velocity of 5 m/s and caught back at the same level as when it was thrown. What is the velocity of the ball at that point?
   A. 0 m/s
   B. -5 m/s
   C. -9.8 m/s
   D. 9.8 m/s^2
9. The motion of an object with constant acceleration is also known as
   A. Motion
   B. Uniform Motion
   C. Constant Motion
   D. Uniformly Accelerated Motion
10. A ball is thrown vertically upward. What is its instantaneous speed at its maximum height?
   A. 0
   B. 5 m/s
   C. 9.8 m/s
   D. 9.8 m/s^2

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.
✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.
? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1. Science – Grade 9 Learner's Material, First Edition 2015. Pasig City: REX Book Store and DepEd-IMCS, 2015.
2. Science – Grade 9 Teacher's Guide, First Edition 2015. Pasig City: REX Book Store and DepEd-IMCS, 2015.
3. https://www.basic-mathematics.com/projectile-launched-horizontally.html
4. http://www.studyphysics.ca/newnotes/20/unit02_circulargravitation/chp07_2d/lesson27.htm
5. https://sites.google.com/site/fradleyphysics/mechanics/projectile-motion?tmpl=%2Fsystem%2Fapp%2Ftemplates%2Fprint%2F&showPrintDialog=1
6. https://classroomclipart.com/images/gallery/Clipart/Black_and_White_Clipart/Sports/TN_black-white-boy-aiming-with-bow-and-arrow-archery-clipart.jpg
7. https://cdn.britannica.com/26/91526-050-C4C7B73A/Archer-recurve-bow-target.jpg

Prepared by:	Anthony F. Batuto	Checked by:	Edna B. Gabriel Rizalito A. Licos Mary Ann L. Castro Rosziel S. Rosales

W2	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Forces and Motion
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Investigate the relationship between the angle of release and the height and range of a projectile.
III. CONTENT/CORE CONTENT	Projectile Motion

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

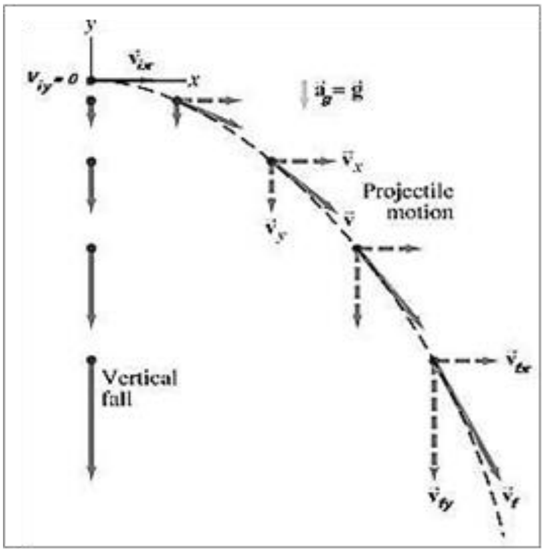
Types of Projectile Motion

I. Projectile Released Horizontally (θ = 0°)

A projectile launched horizontally has no initial vertical velocity. Thus, its vertical motion is identical to that of a dropped object. The downward velocity increases uniformly due to gravity as shown by the vector arrows of increasing lengths. The horizontal velocity is uniform as shown by the identical horizontal vector arrows.

The dashed black line represents the path of the object. The velocity vector v at each point is in the direction of motion and thus is tangent to the path. The velocity vectors are solid arrows, and velocity components are dashed. (A vertically falling object starting at the same point is shown at the left for comparison; v_y is the same for the falling object and the projectile.)

For a projectile beginning and ending at the same height, the time it takes a projectile to rise to its highest point equals the time it takes to fall from the highest point back to its original position.



Source: Grade 9 Science LM

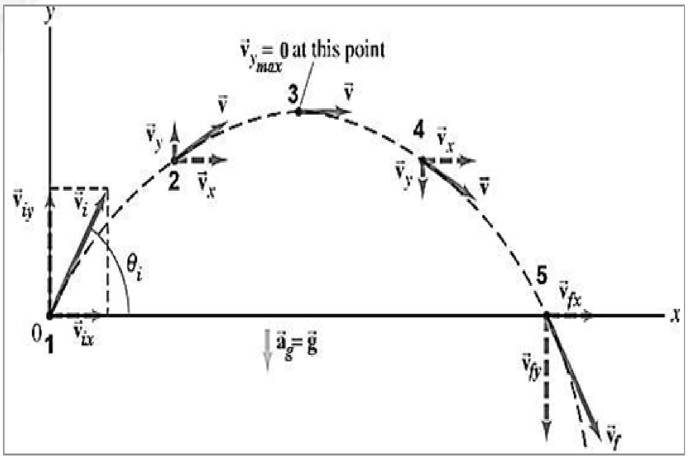
Figure 1. Velocity component vector diagram for projectiles fired horizontally.

II. Projectiles Launched at an Angle (θ > 0°)

When a projectile is launched upward at an angle, its velocity has two components:

1. a constant horizontal velocity that moves in the same direction as the launch, the acceleration of which is zero; and
2. an upward positive vertical velocity component that is decreasing in magnitude until it becomes zero at the top of the trajectory (therefore it no longer goes up any further). But because gravity makes it accelerates downward at a rate of 9.8 m/s per second or 9.8 m/s^2, (therefore it stays at rest only for an instant) it will start to descend with an increasing negative vertical velocity until it is stopped by something.

So as the projectile moves forward horizontally with uniform velocity, its vertical velocity is also accelerated creating a trajectory that is a parabola. The trajectory is shown in black dash, the velocity vectors are in solid arrows, and velocity components are dashed.



Source: Grade 9 Science LM

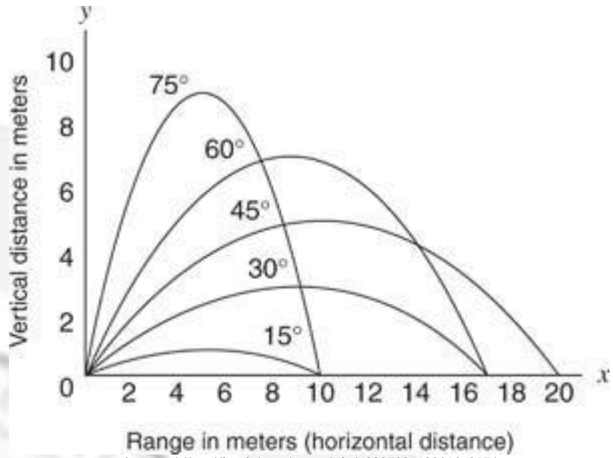
Figure 2. Path of a projectile launched at an angle

IV. LEARNING PHASES AND LEARNING ACTIVITIES

D. Development (Time Frame: Day 2)

Learning Task 1: Figure Analysis

The motion of a projectile may be described in terms of range and the maximum height it reaches. But what affects these kinematic quantities? Below is a figure of the height reached and range covered by a projectile launched at the same initial velocity but at different angles. Study it carefully and answer the questions that follow.



Source: https://in.pinterest.com/pin/489273946990104217/

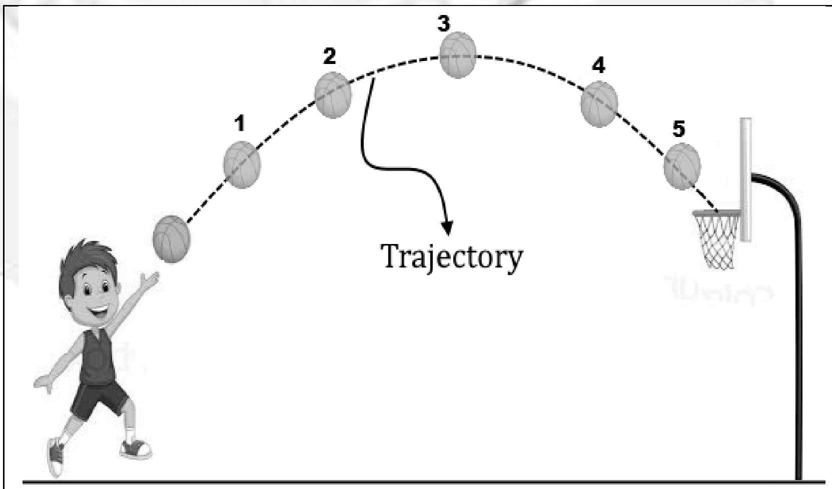
Figure 3. Height and range of a projectile launched at different angles

Questions:

1. How do you describe the height reached by the projectile at different projection angles?
2. At what angle does it reach the highest? the lowest?
3. Does the projection angle affect the maximum height reached? Why do you say so?
4. How do you describe the range covered by the projectile at different projection angles?
5. At what angle/s does it reach the farthest? the nearest?
6. What angles cover the same range? What do you call these angles?
7. Does the projection angle affect the range covered? Explain briefly.

E. Engagement (Time Frame: Day 3)

Learning Task 2: Choose the letter that correctly describes the motion of the basketball at different positions as indicated in the diagram below.



Source: https://www.quora.com/What-is-trajectory-of-a-projectile

1. _____ 2. _____ 3. _____ 4. _____ 5. _____

A. vertical velocity is zero; horizontal velocity is constant
B. final velocity is maximum
C. initial velocity is maximum
D. vertical velocity decreases; horizontal velocity is constant
E. vertical velocity increases; horizontal velocity is constant
F. vertical velocity increases; horizontal velocity decreases
G. vertical velocity decreases; horizontal velocity increases

IV. LEARNING PHASES AND LEARNING ACTIVITIES

A. Assimilation (Time Frame: Day 4)

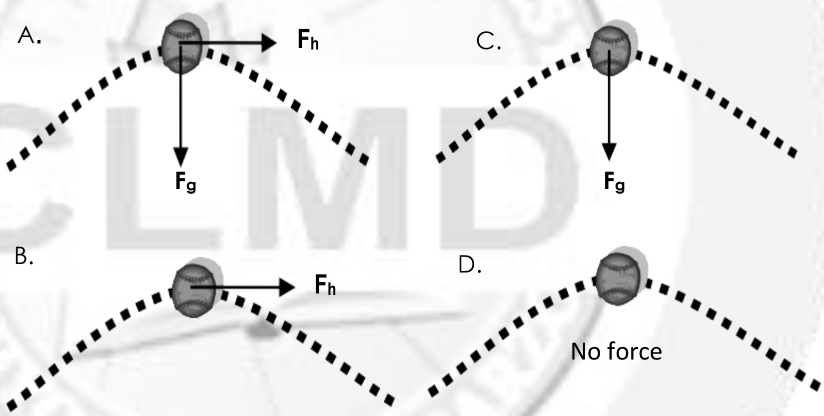
Supposed you are a javelin throw athlete; how will you apply your knowledge of projectile motion in order to win the event?

Source: https://www.teachpe.com/biomechanics/fluid-mechanics/projectiles

V. ASSESSMENT (Time Frame: Day 5)
(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Choose the letter of the correct answer.

1. An object moving with constant acceleration has
   A. motion
   B. uniform motion
   C. constant motion
   D. uniformly accelerated motion
2. The diagram that correctly shows the force(s) acting on a baseball thrown in the air (F_g represents the force of gravity and F_h refers to the throwing force) is



3. A ball is hit at an angle of 30°. Along its path, this projectile will have the least speed
   A. just after it was launched
   B. at the highest point in its flight
   C. just before it hits the ground
   D. halfway between the ground and the highest point
4. If a water hose is aimed in order for the water to land with the greatest horizontal range, the angle of projection should be
   A. 0°
   B. 30°
   C. 45°
   D. 60°
5. A ball reaches a distance of 50 m after is hit at an angle of 30°. Given the same initial velocity, the ball will also reach the same distance if it was hit at
   A. 15°
   B. 45°
   C. 60°
   D. 75°

IV. LEARNING PHASES AND LEARNING ACTIVITIES

6. When do we get maximum range in a simple projectile motion?
   A. When θ = 45°
   B. When θ = 60°
   C. When θ = 90°
   D. When θ = 0°
7. When do we get maximum height in a simple projectile motion?
   A. When θ = 45°
   B. When θ = 60°
   C. When θ = 90°
   D. When θ = 0°
8. At what angle of projectile (θ) is the horizontal range minimum?
   A. θ = 45°
   B. θ = 60°
   C. θ = 90°
   D. θ = 75°
9. A stand holds two white balls. At the same instant one ball is dropped straight down; the other ball is shot straight out. Which ball will hit the ground first? (Neglect Air resistance)
   A. the dropped ball
   B. the shot ball
   C. both
   D. none of the above
10. Which two angles will produce the same range?
   A. 35° and 65°
   B. 30° and 60°
   C. 45° and 15°
   D. 40° and 60°

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

✰ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.
✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.
? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1. Science – Grade 9 Learner's Material, First Edition 2015. Pasig City: REX Book Store, 2015.
2. Science – Grade 9 Teacher's Guide, First Edition 2015. Pasig City: REX Book Store, 2015.
3. https://in.pinterest.com/pin/489273946990104217/
4. https://www.quora.com/What-is-trajectory-of-a-projectile
5. https://www.teachpe.com/biomechanics/fluid-mechanics/projectiles

Prepared by:	Anthony F. Batuto	Checked by:	Edna B. Gabriel Rizalito A. Licos Mary Ann L. Castro Rosziel S. Rosales

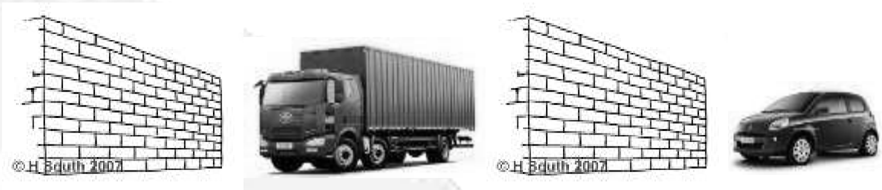
W3	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Forces and Motion
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Relate impulse and momentum to collision of objects (e.g., vehicular collision).
III. CONTENT/CORE CONTENT	Momentum and Impulse

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

Study the given figures.



Source: Grade 9 Science LM

Figure 1. A truck and a car hitting a wall

If the two vehicles in Figure 1 suddenly lose their breaks and crash against the brick wall, which do you think would be more damaging? What factor would affect the impact of collision if their velocities were the same?

Source: Grade 9 Science LM

Figure 2. Identical cars of different velocities

In Figure 2, car A (#7) is travelling at 80 km/h while car B (#4) is travelling at 30 km/h. Which of the two cars would be more difficult to stop? Which of the two cars has more momentum?

Source: Grade 9 Science LM

Figure 3. Hitting a baseball

The baseball player in Figure 3 exerts a great amount of force in hitting the baseball. What is/are the effect/s of this force on the baseball? Why does the man have to do a "follow through" after hitting the baseball?

IV. LEARNING PHASES AND LEARNING ACTIVITIES

A body's *momentum* is its tendency to resist any change in its state of motion or rest. It is also known as inertia in motion. Momentum depends on two factors, mass, and velocity. For bodies moving at the same velocity, the more massive body has greater inertia in motion therefore has greater momentum. Thus, in Figure 1, if both the truck and the car are moving at the same velocities and lose their brakes, the truck would cause more damage on the wall by virtue of its mass. Two bodies of the same mass but different velocities will also have different momenta. In Figure 2, cars A and B have the same mass. But since car A has greater velocity, it has greater momentum making it more difficult to stop than car B. In physics, an external force acting on an object over a specific time leads to a change in momentum of the object. A special name is given to the product of the force applied and the time interval during which it acts: *impulse*. As shown in Figure 3, the baseball player exerts force to change the baseball's momentum by hitting it with a bat. He does a "follow through" to increase his time of contact with the baseball and change its momentum further.

D. Development (Time Frame: Day 2)

The momentum (p) of a body is the product of its mass (m) and its velocity (v), as in the equation: $p = mv$. Force is needed to change the momentum of a body. This *force* (F) multiplied by the time of contact (t) is known as *impulse* (I): $I = Ft = \Delta p$. Bodies change their momentum through collisions, which may be *elastic* or *inelastic*. The SI unit for momentum (p) and impulse (I) is newton-second (Ns) or kilogram-meter per second (kg·m/s).

Sample Problems:

1. What is the momentum of a 22-kg grocery cart which travels at 1.2 m/s?

Given: m = 22 kg; v = 1.2 m/s

Find: p

Solution:

$$p = mv$$
$$= (22\text{ kg})\ (1.2\text{ m/s})$$
$$= \mathbf{26.4\ kg \cdot m/s}$$

2. An offensive player passes a football of mass 0.42 kg with a velocity of 25.0 m/s due south. If the player is in contact with the ball for 0.050 s, what is the magnitude of the average force he exerts?

Given: m = 0.42 kg; v = 25.0 m/s, south; t = 0.050 s

Find: F

Solution:

$$Ft = mv$$
$$F = \frac{mv}{t}$$
$$= \frac{(0.42\text{ kg})\ (25.0\text{ m/s})}{0.050\text{ s}}$$
$$= \mathbf{210\ kg \cdot m/s^2}$$

Learning Task 1: Given the following data, complete the table below.

Object	*Mass (kg)*	*Velocity (m/s)*	*Momentum (kg·m/s)*
Bird	0.03	18	
Basketball player	100	5	
Bullet	0.004	600	
Baseball	0.14	30	
Frog	0.9	12	

E. Engagement (Time Frame: Day 3)

Learning Task 2:

Changes in momentum happen every time. A fast-moving car when suddenly stopped might have damaging effects not only to the vehicle itself but also to the person riding it. Various devices have been installed in vehicles to ensure the safety of the passengers. Can you think of some safety devices installed on vehicles (public/private)? Name at least five (5) of them.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

A. Assimilation (Time Frame: Day 4)

Explain this: "Sometimes thinking too much can destroy your momentum." — Tom Watson.

V. ASSESSMENT (Time Frame: Day 5)

(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Choose the letter of the correct answer.

1. Which has more momentum, a heavy truck moving at 30 km/h or a light truck moving at 30 km/h?
   A. heavy truck
   B. light truck
   C. both has the same momentum
   D. cannot be determined.
2. A moderate force will break an egg. However, an egg dropped on the road usually breaks, while one dropped on the grass usually does not break. This is because for the egg dropped on the grass
   A. the change in momentum is greater.
   B. the change in momentum is less.
   C. the time interval for stopping is greater.
   D. the time interval for stopping is less.
3. The impulse experienced by a body is equal to the change in its
   A. velocity
   B. kinetic energy
   C. momentum
   D. potential energy
4. In certain martial arts, people practice breaking a piece of wood with the side of their bare hand. Use your understanding of impulse to explain how this can be done without injury to the hand.
   A. Given the same change in momentum, when the time interval is smaller the impact force is bigger.
   B. Given the same change in momentum, when the time interval is bigger the impact force is bigger.
   C. Given the same change in momentum, when the time interval is smaller the impact force is smaller.
   D. Given the same change in momentum, when the time interval is bigger the impact force is smaller.
5. A lady tennis player hits an approaching ball with a force of 750 N. If she hits the ball in 0.002 s, how much impulse is imparted to the tennis ball?
   A. 0 N•s
   B. 1.5 N•s
   C. 3.0 N•s
   D. 6.0 N•s

*For questions 6 and 7, refer to the data below:

Vehicle	*Mass, m (kg)*	*Velocity, v (m/s)*
jeepney	2000	10
motorcycle	300	20

6. In the table above, what is the momentum of the jeepney?
   A. 6,000 kg•m/s
   B. 40,000 kg•m/s
   C. 20,000 kg•m/s
   D. 3,000 kg•m/s
7. Which has greater momentum, the jeepney or the motorcycle?
   A. jeepney
   B. motorcycle
   C. both have the same momentum
   D. cannot be determined

IV. LEARNING PHASES AND LEARNING ACTIVITIES

8. Two identical cars are travelling along EDSA. Which of the two cars would have a greater momentum?
   A. the slower car
   B. the faster car
   C. both have the same momentum
   D. cannot be easily determined
9. A bus and a car are travelling along EDSA having the same velocity. Which of the two vehicles would have a greater momentum?
   A. the bus
   B. the car
   C. both have the same momentum
   D. cannot be easily determined
10. A 25-kg girl is riding a 5-kg with a velocity of 5 m/s the East. What is the total momentum of a girl and a bike together?
   A. 100 kg•m/s
   B. 125 kg•m/s
   C. 150 kg•m/s
   D. 200 kg•m/s

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.

✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.

? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1. *Science – Grade 9 Learner's Material*, First Edition. Pasig City: REX Book Store, 2015.
2. *Science – Grade 9 Teacher's Guide*, First Edition. Pasig City: REX Book Store, 2015.
3. Macalalad, Ernest, Rhonalyn Vergara, Susan Sta. Ana, and Wilfredo Romano Jr. *Exploring the Realms of Science: PHYSICS*. Valenzuela City: JO-ES Publishing House, Inc., 2011.
4. Ferrer, Rhodora Angela and Olivia Ungson. *Science, Environment, Technology, and Society: Physics.* Quezon City: Sibs Publishing House, Inc., 2010.

Prepared by:	Anthony F. Batuto	**Checked by:**	EDNA B. GABRIEL RIZALITO A. LICOS MARY ANN L. CASTRO ROSZIEL S. ROSALES

W4	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Forces and Motion
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Infer that the total momentum before and after collision are equal.
III. CONTENT/CORE CONTENT	Conservation of Momentum

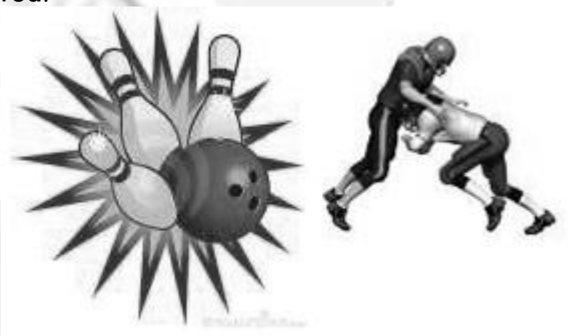
IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

Momentum Conservation

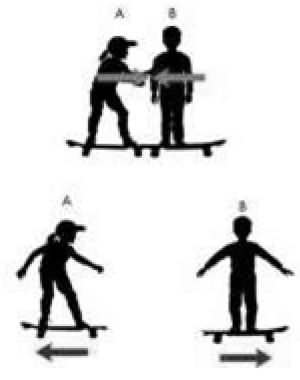
You have learned before that an external force is required to make an object accelerate. Similarly, if we want to change the momentum of an object, an external force is required. There will be no change in momentum if there is no external force.

Let us take this situation as an example. Two children on skateboards are initially at rest. They push each other so that eventually the boy moves to the right while the girl moves in the opposite direction away from each other. Newton's Third Law tells us that the force that the girl exerts on the boy and the force that makes the girl move in the other direction are of equal magnitude but opposite direction. The boy and the girl make up a system – a collection of objects that affect one another (Figure 1). No net/unbalanced external force acts on the boy-girl system, thus, the total momentum of the system does not change (Figure 2). Remember that momentum, like velocity and force, is a vector quantity. The momentum gained by the girl is of equal magnitude but opposite direction to the momentum gained by the boy. In this system, no momentum is gained or lost. We say that momentum is **conserved**.



Source: Grade 9 Science LM

Figure 1. A system is a group of objects that interact and affect each other. Examples are (a) Bowling ball and pin and (b) two football players.



Source: Grade 9 Science LM

Figure 2. In this example, the total momentum of the boy- girl system before pushing is zero. After pushing, the total momentum of the boy-girl system is still zero because the momentum of the girl is of equal magnitude but opposite direction to the momentum of the boy. Note that the momentum of the boy alone is not the same before and after pushing; and the momentum of the girl alone is not the same before and after pushing.

D. Development (Time Frame: Day 2)
Learning Task 1: Balloon Rocket

Objective: Describe how a balloon rocket works and how conservation of momentum explains rocket motion.
Materials: balloon (long shape, if available) drinking straw, string (nylon, if available), and adhesive tape

Procedure:
1. Stretch the string over two posts. You can use chairs or iron stands as posts. Make sure that the string is taut.
2. Inflate the balloon. Twist the open end and temporarily secure it with a paper clip.
3. Tape the straw to the balloon such that it is aligned with the balloon's opening (see Figure 3).

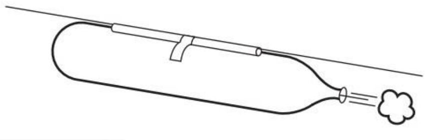


Figure 3. Balloon rocket set up.

4. Draw a diagram showing the momentum vectors of your balloon rocket and the air.

Questions:
1. How do these momenta compare?
2. How does the velocity of the air that is pushed out of the rocket compared to the velocity of the balloon rocket?

In this activity, the system at the start, which consists of the balloon and the air inside it are stationary, so the total momentum of the system is zero. When we let the air inside the balloon out, we notice that the balloon moves. The force that causes the balloon to move comes from the air that is pushed out of it. There is no external force involved. Thus, the total momentum of the system is conserved and must remain zero. If the balloon has momentum in one direction, the air must have an equal and opposite momentum for the total momentum to remain zero.

Change in momentum = 0
Total Initial Momentum = Total Final Momentum

$$0 = p_{balloon} + p_{air}$$
$$-p_{balloon} = p_{air}$$
$$-(mv)_{balloon} = -(mv)_{air}$$

Since the mass of the balloon is greater than the mass of air, the velocity of the air must be greater in magnitude than the velocity of the balloon and must be opposite in direction.

Sample Problem: Two ice skaters stand together. They "push off" and travel directly away from each other, the boy with a velocity of 1.50 m/s. If the boy weighs 735 N and the girl, 490 N, what is the girl's velocity after they push off? (Consider the ice to be frictionless.)

Given: v_{boy} = 1.50 m/s; w_{boy} = 735 N; w_{girl} = 490 N
Find: v_{girl}
Solution:

Remember that w = mg, thus, m = w/g.

$$m_{boy} = w_{boy}/g = 735\ N/9.8\ m/s^2 = 75\ kg$$
$$m_{girl} = w_{girl}/g = 490\ N/9.8\ m/s^2 = 50\ kg$$

The ice where they stand on is frictionless, thus, no external force is present. The momentum of the boy-girl system is conserved. There is no change in the momentum of the system before and after the push off.

Total Initial Momentum = Total Final Momentum

$$0 = p_{boy} + p_{girl}$$
$$-p_{boy} = p_{girl}$$
$$-(mv)_{boy} = (mv)_{girl}$$
$$-(75\ kg \times 1.50\ m/s)_{boy} = (50\ kg \times v)_{girl}$$
$$-37.5\ kg\ m/s = 50\ kg\ (v_{girl})$$
$$\frac{-37.5\ kg\ m/s}{50\ kg} = \frac{50\ kg\ (v_{girl})}{50\ kg}$$
$$\mathbf{-0.75\ m/s} = v_{girl}$$

The girl moves with a velocity of 0.75 m/s opposite to the direction of the boy.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

Learning Task 2: Answer the problem below.
A 0.30 kg cart moves on an air track at 1.2 m/s. It collides with and sticks to another cart of mass 500 g, which was stationary before collision. What is the velocity of the combined carts after collision?

E. Engagement (Time Frame: Day 3)

Elastic and Inelastic Collisions

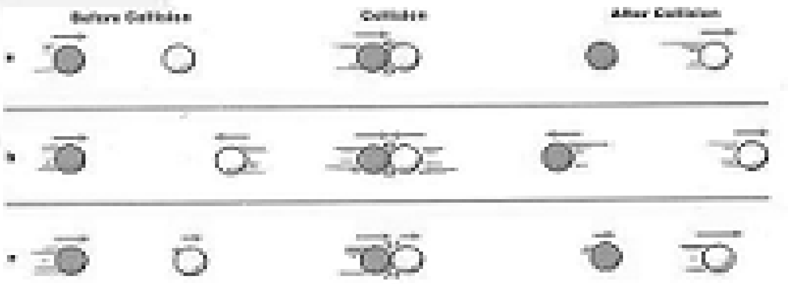
A *collision* is an encounter between two objects resulting in exchange of impulse and momentum. Because the time of impact is usually small, the impulse provided by external forces like friction during this time is negligible. If we take the colliding bodies as one system, the momentum of the system is therefore approximately conserved. The total momentum of the system before the collision is equal to the total momentum of the system after the collision.

total momentum before collision = total momentum after collision

Collisions are categorized according to whether the total kinetic energy of the system changes. Kinetic energy may be lost during collisions when (1) it is converted to heat or other forms like binding energy, sound, light (if there is spark), etc. and (2) it is spent in producing deformation or damage, such as when two cars collide. The two types of collision are:

1. *Elastic collision* – one in which the total kinetic energy of the system does not change, and colliding objects bounce off after collision.

Figure 4. Elastic Collisions. (top) moving object collides with a stationary object (middle) two moving objects collide head-on (bottom) two objects moving in the same direction collide



Source: Grade 9 Science LM

2. *Inelastic collision* – one in which the total kinetic energy of the system changes (i.e., converted to some other form of energy). Objects that stick together after collision is said to be *perfectly inelastic*.

Figure 5. Inelastic Collision. Two objects collide, stick together, and move as one.

Source: Grade 9 Science LM

Learning Task 3: Look around you. List down at least five (5) collisions that you have observed and identify if it is an elastic or inelastic collision. You may also draw them if you like.

A. Assimilation (Time Frame: Day 4)

Explain how Momentum Conservation is applied in any of the following (choose only one):

A. Ball games (e.g., billiards, bowling, baseball)
B. Contact sports (e.g., boxing, wrestling, mixed martial arts)
C. Theme Park rides/games (e.g., bumper car/boat, air hockey, pin ball)
D. Vehicular accidents

IV. LEARNING PHASES AND LEARNING ACTIVITIES

V. ASSESSMENT (Time Frame: Day 5)
(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Choose the letter of the correct answer.

1. Which is a necessary condition for the total momentum of a system to be conserved?
   A. Kinetic energy must not change.
   B. No external force is present.
   C. An object must be at rest.
   D. Only the force of gravity acts on the system.

*For numbers 2 and 3: Two 0.5 kg balls approach each other with the same speed of 1.0 m/s.

2. What is the total momentum of the system before collision?
   A. 0
   B. 0.50 kg m/s
   C. 1.0 kg m/s
   D. -1.0 kg m/s
3. If there is no external force acting on the system, what is the total momentum of the system after collision?
   A. 0
   B. 0.50 kg m/s
   C. 1.0 kg m/s
   D. -1.0 kg m/s
4. Two billiard balls approach each other at equal speed. If they collide in a perfectly elastic collision, what would be their velocities after collision?
   A. zero
   B. same in magnitude and direction
   C. same in magnitude but opposite in direction
   D. different in magnitude and opposite in direction
5. A 50-kg astronaut ejects 100 g of gas from his propulsion pistol at a velocity of 50 m/s. What is his resulting velocity?
   A. -0.10 m/s
   B. -0.50 m/s
   C. 0 m/s
   D. -100 m/s

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.
✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.
? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1. *Science – Grade 9 Learner's Material*, First Edition. Pasig City: REX Book Store, 2015.
2. *Science – Grade 9 Teacher's Guide*, First Edition. Pasig City: REX Book Store, 2015.

Prepared by:	Anthony F. Batuto	Checked by:	EDNA B. GABRIEL RIZALITO A. LICOS MARY ANN L. CASTRO ROSZIEL S. ROSALES

W5	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Work, Power and Energy
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Perform activities to demonstrate conservation of mechanical energy
III. CONTENT/CORE CONTENT	Conservation of mechanical energy

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

You have learned that moving objects possess momentum. In addition to that, moving objects also have energy. To be more general though, all objects regardless of their state of motion (at rest or moving) possess a certain amount of energy. You cannot do anything without energy. You exert energy while you are sitting, while you are walking or even while you are sleeping. Apart from that, energy can be transformed from one form to another. In such transformations, energy is said to be conserved. We will learn more about these transformations in this lesson.

One form of energy is **mechanical energy**. Mechanical energy is energy acquired by objects upon which work is done. This form of energy closely relates to the elementary definition of energy which is *the capacity to do work*. There are two kinds of mechanical energy.

1. **Potential Energy** is energy possessed by objects at rest. It has two kinds.

   a. **Gravitational Potential Energy** is the energy possessed by an object because of its location or position. For example, a book on top of the table, car parked on a ramp.
   b. **Elastic Potential Energy** is the energy stored in a stretched or compressed elastic material such as spring. For example, the spring on the handle of a pinball machine has more energy when compressed than when in a relaxed position.

2. **Kinetic Energy** is the energy possessed by an object by virtue of its motion. Examples of which are a bullet in motion, stream of flowing water, rock falling off a cliff, roller coaster.

D. Development (Time Frame: Day 2)

The **Law of Conservation of Mechanical Energy** states that energy can neither be created nor destroyed. It can only be transformed from one form to another.

In Figure 1 below, a pendulum is held at point A. At this point, the potential energy of the pendulum is maximum because of its height while the kinetic energy is zero since it is held at rest. When it is released, the potential from point A to point B decreases because of a decrease in height while the kinetic energy increases due to the movement of the pendulum. At point B, the kinetic energy is now maximum, while the potential energy is minimum. Then it swings to point C, with decreasing kinetic energy and increasing potential energy due to it being at a higher position. Then at point C, the potential energy is again maximum, while the kinetic energy is zero, just like it is at point A.

As the pendulum moves continuously back and forth, the height reached decreases because other factors (friction, air resistance) cause some mechanical energy to be transformed, until it eventually stops.
When a body is raised to a certain height, the gravitational energy increases and when it is released, the kinetic energy increases during its course of movement.

Based on the conservation of energy, all the potential energy is converted to kinetic energy upon reaching the ground.

The total mechanical energy of an object is equal to the sum of the potential energy and kinetic energy if friction is negligible.

Total Energy = Potential Energy + Kinetic Energy
T.E. = P.E. + K.E. The unit of energy is Joule, J.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

Learning Task 1:

You can do this simple activity on pendulum. Identify the positions where kinetic energy and potential energy is maximum or minimum.

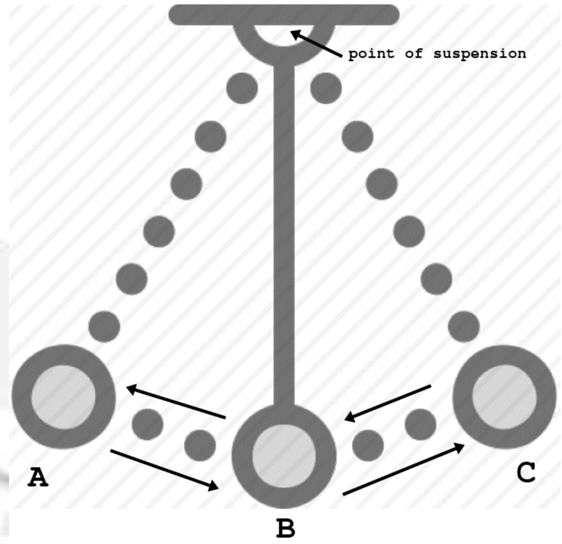


Figure 1: Pendulum
Source: https://tinyurl.com/psbetthv

Procedure:

Fill in the table below with the value of potential energy, kinetic energy and total energy. Refer to the figure of the pendulum above.

Location of the Pendulum	Potential Energy	Kinetic Energy	Total Energy (PE + KE)
At point A	50 J	0	50 J
At point B	0	50 J	
At point C	50 J	0	

Example: Total Energy = P.E. + K. E.

= 50 J + 0 = **<u>50 J</u>**

Guide Questions:

1. At what point in the pendulum is the potential energy maximum?
2. At what point in the pendulum is the kinetic energy zero?
3. At what point in the pendulum is the potential energy zero?
4. At what point in the pendulum is the kinetic energy maximum?
5. What is the total mechanical energy of the pendulum?
6. Describe the Law of Conservation of Mechanical Energy.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

E. Engagement (Time Frame: Day 3)

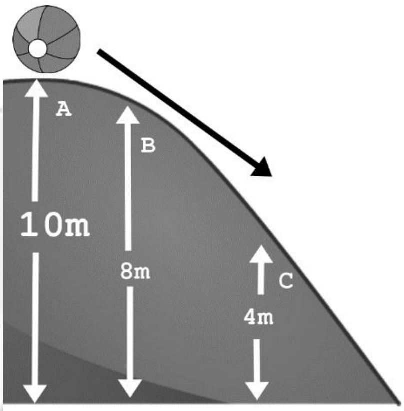
The gravitational potential energy of an object is determined by this equation:

$$GPE = \frac{1}{2}mgh$$

where m is the mass of the object, g is acceleration due to gravity ($9.8\frac{m}{s^2}$) and h is the height or elevation of the object. The kinetic energy of an object in motion is determined by the formula

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

where m is the mass of the object and v is its velocity.



Sources: https://tinyurl.com/vdmasfwc and https://tinyurl.com/2dcbxabf

Consider the figure on the left. If the ball has a mass of 0.1 kg, the gravitational potential energy it contains is

$$GPE = \frac{1}{2}mgh = \frac{1}{2}(0.1\,kg)\left(9.8\frac{m}{s^2}\right)(10\,m) = 4.9\,J$$

Since the ball is at rest, it has no kinetic energy and thus the total mechanical energy of the ball is also 4.9 J. If the ball moves downhill, some gravitational potential energy gets transformed to kinetic energy. At point B, the gravitational potential energy decreases.

$$GPE = \frac{1}{2}mgh = \frac{1}{2}(0.1\,kg)\left(9.8\frac{m}{s^2}\right)(8\,m) = 3.92\,J$$

But since the total mechanical energy is a constant, the kinetic energy of the ball is

$$TKE = PE + KE$$
$$4.9\,J = 3.92\,J + KE$$
$$KE = 0.98\,J$$

Learning Task 2:

Using the same diagram and situation, determine the gravitational potential and kinetic energy of the ball at point C and on the ground (h=0). Write your answers on the table below.

Point	Gravitational Potential Energy	Kinetic Energy
C		
Ground		

A. Assimilation (Time Frame: Day 4)

Fill in the blanks with the appropriate words. Select from the given choices in the box.

water	energy	hydropower	electricity	kinetic

Hydropower is using (1) _____________to make electricity. Water constantly moves through a vast global cycle, evaporating from lakes and oceans, forming clouds, precipitating as rain or snow, then flowing back down to the ocean.

When flowing water is captured and turned into (2) ____________, it is called hydroelectric power or (3) ____________. There are several types of hydroelectric facilities; they are all powered by the (4) ______________ energy of flowing water as it moves downstream. Turbines and generators convert the (5) ___________ into electricity, which is then fed into the electrical grid to be used in homes, businesses, and by industry.

Hydroelectric power plant makes use of the kinetic energy of the falling water in producing electricity. This type of power plant is the major source of electrical energy in the country. The power plants in Ambuklao and Binga in the Mt. Province, Angat in Bulacan, Caliraya in Laguna and Maria Cristina Falls in Iligan uses hydroelectric power.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

V. ASSESSMENT (Time Frame: Day 5)

(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Encircle the letter of the best answer.

1. Which of the following is true of the conservation of energy in a closed system?
   A. Kinetic energy is always conserved.
   B. Potential energy is always conserved.
   C. Mechanical energy is always conserved.
   D. Total energy is always not conserved.

2. The mechanical energy of a system of objects is
   A. the sum of kinetic energy and gravitational potential energy.
   B. the sum of kinetic energy and elastic potential energy.
   C. the sum of kinetic energy and all relevant forms of potential energy.
   D. the sum of all forms of energy.

3. Mechanical energy is not conserved when
   A. gravitational potential energy is converted to kinetic energy.
   B. kinetic energy is converted to gravitational potential energy.
   C. kinetic energy is converted to elastic potential energy.
   D. friction is not negligible.

4.Which event illustrates the direct transformation of potential to kinetic energy?
   A. A basketball player catches a flying ball.
   B. A *kalesa* moves from rest.
   C. Kathy's arrow is released from its bow.
   D. The spring mechanism of a toy is rotated until it locked.

5. If mechanical energy is conserved in a system, the energy at any point in time can be in the form of
   A. kinetic energy.
   B. gravitational potential energy
   C. elastic potential energy
   D. all of the above

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.

✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.

? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1.Grade 9 Learners Material in Science, pp. 326-348

2. Aquino, Marites D., Abistado, Jonna M. and Forteza, Rex S. Worktext in Science and Technology - Science Links-Physics, Rex Bookstore Inc., 2012, pp.71-73.

3. Padua, Alicia and Crisostome, Ricardo, Practical and Explorational Physics Modular Approach, Lilia M. Rabago, Ph. D, Vibal Publishing House, 2003, pp. 138-140.

4. Sabalburo, Lucita, et.al., Science and Life Series Physics, Ernesto Guillermo Jr., Sunshine Interlinks Publishing House,Inc. 2009, pp. 240-243.

Prepared by:	Mary Jean B. Barrera	**Checked by:**	EDNA B. GABRIEL RIZALITO A. LICOS MARY ANN L. CASTRO ROSZIEL S. ROSALES

W6	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Heat, Work and Energy
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Construct a model that heat can do work
III. CONTENT/CORE CONTENT	Relationship among heat, energy and efficiency.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

The production of heat is one of the driving forces of human activity. We use it in daily chores, like cooking and drying and ironing clothes. It is also needed to greater extent in commercial and industrial applications especially in the field of manufacturing where many substances are made with the use of enormous amounts of heat. So, understanding how heat works and how it interacts with various objects is studied since it will help in making many different processes efficient.

Heat and temperature are often confused with one another. Temperature in the simplest sense is a measure of hotness or coldness of an object; an object that is hot has a high temperature, and a cold object has a lower temperature. Heat on the other hand is energy transferred from one object to another due to a difference of temperature between the two objects.

D. Development (Day 2)

Heat and Work

Energy is needed to perform work. When work is done on an object, energy is transferred to that object. The transfer of energy to the object increases its internal energy. The internal energy will later decrease as the object dissipates it as to heat.

James Prescott Joule investigated in mechanical equivalent of heat. He set up an apparatus in its simplified form. The weight were made to fall through a certain distance. As they dropped, the wires to which they were attached made one shaft and paddles turn. The friction resulting from the paddling warmed the water and raised its temperature. Almost all the work done on the machine was transformed into heat.

Using this device, he found out that 4.194 J is equivalent to 1 calorie. A calorie is a unit of energy that is equivalent to amount of energy needed to raise the temperature of 1g of water by 1°C, ideally measured from 14.5°C to 15.5°C.

You have learned that energy is needed to perform work. When work is done on an object, energy is transferred to that object. The transfer of energy to the object increases its internal energy. The internal energy will later decrease as the object dissipates it as to heat.

First Law of Thermodynamics

How is energy conserved when you eat breakfast? The chemical energy in food will be converted into mechanical energy that enables you to do work. But not all the chemical energy is converted to mechanical energy, some will be converted in the form of heat.

The concept of the conservation of energy states that energy cannot be created nor destroyed. The First Law of Thermodynamics is based on this concept.

First Law of Thermodynamics states that**: The change in internal energy of a system equals the difference between the heat taken in by a system and the work done by the system.**

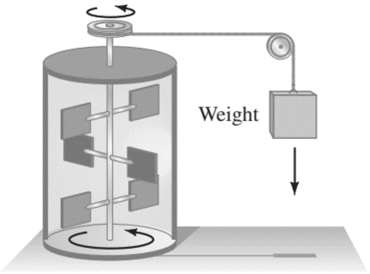


Figure 1. Joule's device. (Giancoli, 2014)

Internal energy of a substance is the sum of the molecular kinetic energy (due to the random motion of the molecules), the molecular potential energy (due to the forces that act between the atoms of a molecule and between the molecules), and other kinds of molecular energy.

When heat flows in instances where the work done is negligible, the internal energy of the hot substance decreases and the internal energy of the cold substance increases. While heat may originate in the internal energy supply of a substance. It is not correct to say that a substance contains heat. The substance has internal energy not heat. The word "heat" is used only when referring to the energy in transit from hot to cold.

The law is expressed as:

$$\Delta U = Q - W$$

where Q = the amount of heat flowing into the system
W =the net work done by the system
ΔU = the change in the system's internal energy

This is derived from the conservation of energy given as how heat is related to work.

$$Q = W + \Delta U$$

We will use Joule (J) as our SI unit for energy. The first law tells us that a system's internal energy can be changed by transferring energy by either work, heat or a combination of the two.

Heat Pump

Normally, heat flows from a hotter object to a cooler object when the two objects are placed in contact. It is for this reason that a pot of coffee feels hot to touch, while the scoop of an ice cream feels cold. The temperature of ice cream is lower than 37°C.

When you touch a cup of hot coffee, heat flows from a hotter cup to a cooler hand. When you touch a cone of ice cream, heat again flows from hot to cold, in this case, from the warmer hand to the colder cone.

The response of the nerves in the hand to the arrival or departure of heat prompts the brain to identify the cup of coffee as being hot and the cone of ice cream as being cold.

The reverse can be done, i.e., heat flows from a colder object to a hotter object, with the use of a heat pump. It is a device that allows heat to transfer from a colder reservoir to a warmer reservoir which is not a natural process. Work is required for the heat to flow from a lower to higher temperature. This work is provided by the motor of heat pump.

What is the difference between spontaneous and non-spontaneous process?

In **spontaneous process heat** flows from higher temperature to a lower temperature. It does not require any external energy to occur.

In **non –spontaneous process** heat flows from lower temperature to higher temperature, it needs mechanical energy to occur.

Learning Task 1:

Distinguish the process as spontaneous or non-spontaneous process. Write **S** if spontaneous and **NS** if non-spontaneous on the blank.

________1. Melting of Ice
________2. Rusting of Iron
________3. Marble going down the spiral.
________4. Going up hill
________5. Keeping the food fresh from spoilage

Guide Questions :

1. Which of the example is spontaneous process ?
2. Which of the given example is a non-spontaneous process?
3. What is the difference between spontaneous and non spontaneous process ?
4. What is needed to reverse the process?

IV. LEARNING PHASES AND LEARNING ACTIVITIES

E. Engagement (Time Frame: Day 3)

Learning Task 2:

Objective: Make a simple model that shows heat can do work.
Materials: candle, match, cardboard, scissors, pointed stick, bond paper, glue

Precautionary measures: Be careful when using fire and scissors. Ask for adult supervision if necessary.

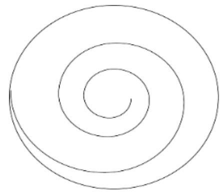


Fig. 2. Spiral pattern.

Procedure:

1. Cut a piece of carboard to a circular shape.
2. Cut a circular piece of the bond paper and cut a spiral out of it as shown on Figure 2.
3. Glue the stick to the cardboard so that it stands upright on the cardboard.
4. With the stick pointing upwards, make a crease on the top of the spiral cutout and let the crease rest on the pointed end of the stick. Let the spiral fall. Refer to Figure 3.
5. Put a candle below the spiral, resting in the cardboard. Light the candle using the match. Make sure that the candlelight does not reach the bond paper.

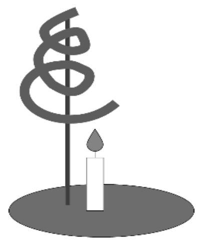


Fig. 3. Setup for the experiment.

Guide Questions:

1. What happens to the spiral when you light the candle?
2. What causes the spiral to behave that way?

A. Assimilation (Time Frame: Day 4)

What do you think is the most efficient way to heat and cool your home?

V. ASSESSMENT (Time Frame: Day 5)

(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. First Law of Thermodynamics deals with
   A. Conservation of Mass
   B. Conservation of Energy
   C. Conservation of Momentum
   D. Conservation of Pressure

2. All the following are examples of spontaneous reaction EXCEPT
   A. Going up hill
   B. Melting of ice
   C. Keeping the food fresh from spoilage
   D. Rusting of iron

3. How does the water from the deep well move upward?
   A. It occurs naturally.
   B. It uses water heat pump.
   C. It is a spontaneous process.
   D. It flows from higher temperature to cooler temperature.

4. All the following are example of non – spontaneous process EXCEPT
   A. Keeping the food fresh from spoilage
   B. Going up hill
   C. Melting of ice
   D. Breakage of egg

5. What is the used of heat pump? It is used to
   A. transfer heat from a colder reservoir to a warmer reservoir.
   B. transfer heat from a warmer reservoir to a colder reservoir
   C. transfer heat to a colder reservoir
   D. change heat.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.

✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.

? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1.Grade 9 Learners Material in Science, pp. 350-360.

2. Aquino, Marites D. Abistado, Jonna M. and Forteza, Rex S. Worktext in Science and Technology - Science Links-Physics, Rex Bookstore Inc., 2012, pp.177-187.

3. Giancoli, D. C. (2014). Physics: Principles with applications (Seventh edition). Pearson.

4. Padua, Alicia and Crisostomo, Ricardo, Practical and Explorational Physics Modular Approach, Lilia M. Rabago, Ph. D, Vibal Publishing House, 2003, pp. 232-233

5. Sabalburo, Lucita, et.al., Science and Life Series Physics, Ernesto Guillermo Jr., Sunshine Interlinks Publishing House, Inc. 2009, pp. 280-282.

Prepared by:	Mary Jean B. Barrera	**Checked by:**	EDNA B. GABRIEL RIZALITO A. LICOS MARY ANN L. CASTRO ROSZIEL S ROSALES

W7	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Heat Engines and Thermal Efficiency
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Explain how heat transfer and energy transformation make heat engines like geothermal plants work.
III. CONTENT/CORE CONTENT	Heat, Work and Efficiency

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

Work requires an amount energy. This energy can be of different forms. It includes mechanical, chemical, electrical, or thermal. Sometime energy needs to be converted from one form to another in order to make work. One such object that allows us to produce mechanical work from a type of energy is called an engine. If the energy that was used to perform work was thermal energy or heat, then the engine is called a heat engine.

To perform work, heat is taken in by the engine from a heat source, also called the high temperature reservoir. The energy absorbed by the heat engine is used to perform useful work. However, not all of the heat absorbed by the engine can be converted into useful work. There will always be a portion of heat that will be lost as a result of other interactions like friction. This lost heat is called as waste heat. This waste heat goes to the low temperature reservoir or the heat sink of the heat engine.

The energy converted as useful mechanical work is equal to the difference in the heat input from high temperature reservoir and the heat output that was received by the low temperature reservoir.

Work = Heat Input – Heat Output

A heat engine allows us to use heat to perform work. Which of the following objects below can be considered a heat engine? Write the letter of all possible answers.

Image Source-tinyurl.com/nruvmajv

H

Image Source-tinyurl.com/fdfz775

W

Image Source: tinyurl.com/rw8w8um6

E

Image Source: tinyurl.com/4mhny8cu

O

Image Source: tinyurl.com/2vtb57r6

A

Image source: tinyurl.com/62zhj37k

R

Image source: tinyurl.com/9yjfjh8d

T

Image Source: tinyurl.com/44wnms4y

K

D. Development (Time Frame: Day 2)

What is a heat engine?

A **heat engine** is a device which converts thermal energy to mechanical energy. A very important component of heat engines then is that high temperatures are involved. In one round of a cycle, the system is heated, at another is cooled.

Three things happen in a full cycle of a heat engine:

1. Heat is added. It is an input heat which is relatively high temperature.
2. Some of that energy from that input heat is used to do work.
3. The rest of the heat is removed at a relatively cold temperature.

A common type of heat engine is called the combustion engine. In a combustion engine, heat is produced using a combustion process, which in turn makes use of a fuel and an oxidizer for that fuel like air. There are two classes of combustion engines

External combustion engine – burning of fuel takes place outside the engine. Examples are steam, piston engine and the atmosphere.

Internal combustion engine – burning of fuel takes place inside the cylinder or turbine engine. Examples are gasoline, diesel engine and our human body.

Most automobiles make use of either a diesel engine or a gasoline engine. In the case gasoline engines, most have four cylinders, each containing a piston. Each piston undergoes a series of four movements or strokes.

Four Stroke Cycle in a Gasoline Engine

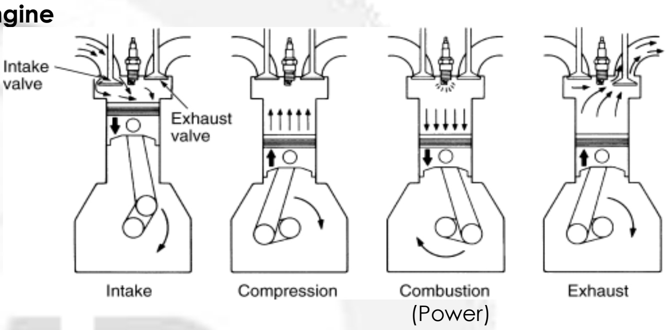


Image source: https://tinyurl.com/5cvc2cwp

Fig. 1. The four-stroke cycle in a gasoline engine.

1. **INTAKE STROKE**
   The intake valve opens, allowing the cylinder to receive the fuel-air mixture as the piston moves downward.
2. **COMPRESSION STROKE**
   The piston moves up compressing the fuel-air mixture.
3. **POWER STROKE**
   The spark plug at the top of the cylinder causes the mixture to ignite and combust making its temperature high. With this increase in temperature, the pressure inside the cylinder increases causing the piston to go down and perform mechanical work
4. **EXHAUST STROKE**
   The combusted gases are pushed out of the opened exhaust valve through an upward motion on the piston. The intake valve opens and the cycle repeats.

Learning Task 1: Start the Engine

Fill in the table below.

Four Stroke Cycle	Movement of the piston	What happened to the mixture of gases?
Intake		
Compression		
Power		
Exhaust		

Guide Questions:

1. How does the piston behave during intake stroke? What happens to the gas mixture?
2. What happens to the piston and gases during compression stroke?
3. What is the function of the spark plug? What is its effect to the gas mixture's temperature?
4. Describe the piston and gases during power stroke.
5. In the exhaust stroke, what happens to the piston and mixture of gases?
6. What do you think is the effect of this exhaust gases into the environment?
7. Can you consider the heat engine to be 100% efficient?

Thermal Efficiency

The thermal energy produced from the combustion of fuel-air mixture is transformed into mechanical energy which moves the car. However, not all thermal energy is converted into useful work. Parts of the engine itself, the cooling water in the radiator and the surrounding air will absorb the heat and will not be available to perform work.

This thermal energy which is not converted to useful work is called **waste heat.** These heat losses are unavoidable and greatly limit the efficiency of heat engines.

For example, the engines of a cars are only 30% efficient. This means that for every 100 joules of thermal energy produced by the combustion of gasoline, only 30 joules are used to actually move the car. Therefore, it is impossible to construct a heat engine that is 100% efficient which can fully convert all the heat into useful work.

An engine that converts energy into more work and less waste is said to be more **efficient**. However, **Sadi Carnot** have found out that while it is true that we can express efficiency in terms of work, the efficiency of ideal heat engines depends only on the temperatures of the hot and cold reservoir. According to him, an engine operating between two reservoirs of higher temperature difference is more efficient than an engine operating between reservoirs of nearly the same temperatures.

The efficiency is calculated as:

$$\text{Efficiency} = \frac{\text{Work done}}{\text{Input heat}} \times 100\%$$

But since work is just the input heat minus the exhaust heat, the equation becomes

$$\text{Efficiency} = \frac{Q_H - Q_C}{Q_H} \times 100\% = \left(1 - \frac{Q_C}{Q_H}\right) \times 100\%$$

Where Q_C = energy removed by heat/ energy in cold reservoir
Q_H = energy added by heat / energy in hot reservoir

The equation for efficiency can also be modified to use temperature measurements instead of the energy values.

$$\text{Efficiency} = \left(1 - \frac{T_C}{T_H}\right) \times 100\%$$

Where T_C = absolute temperature in cold reservoir
T_H = absolute temperature in hot reservoir

Note: The temperatures are the absolute temperatures on the Kelvin scale.

Studying our equation, we can only have a 100 % efficiency if there is no energy transferred away from the engine by heat. In reality, there is no 100% efficient engine as there will always be waste heat.

Sample Problems:

1. What is the efficiency of a gasoline engine that receives 193 J of energy from combustion and lose 125 J by heat to exhaust during one cycle?
   Given: Q_C = 125 J
   Q_H = 193 J
   Find: Efficiency
   Solution:
   $$\text{Efficiency} = \left(1 - \frac{Q_C}{Q_H}\right) \times 100\%$$
   $$= \left(1 - \frac{125J}{193J}\right) \times 100\%$$
   $$= 35.23\%$$
2. Suppose a steam engine receives steam at 600 K. The engine uses a part of this thermal energy for work. It exhausts the rest to a condenser at a temperature of 350 K. What is the maximum efficiency of this steam engine ?
   Given: T_C = 350 K
   T_H = 600 K
   Find: Efficiency
   Solution:
   $$\text{Efficiency} = \left(1 - \frac{T_C}{T_H}\right) \times 100\%$$
   $$= \left(1 - \frac{350K}{600K}\right) \times 100\%$$
   $$= 41.67\%$$

IV. LEARNING PHASES AND LEARNING ACTIVITIES

E. Engagement (Time Frame: Day 3)

Learning Task 2: Solve the following problems on efficiency.

1. A hot gas is injected into an engine at 573 K and exhausts at 343 K. What is the highest efficiency of this engine?
2. What is the efficiency of a gasoline engine that receives 185 J of energy from combustion and lose 130 J by heat to exhaust during one cycle?

A. Assimilation (Time Frame: Day 4)

In 3 to 4 sentences, answer the following questions. Write your answer on a paper.

As a student, how can you help minimize the effects of thermal pollution?

V. ASSESSMENT (Time Frame: Day 5)

(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Multiple Choice: Write only the letter of the correct answer.

1. Which is the correct sequence of the four-stroke cycle?
   A. Intake, Compression, Power and Exhaust Stroke
   B. Power, Intake, Exhaust, and Compression Stroke
   C. Compression, Power, Intake, and Exhaust Stroke
   D. Power, Compression, Intake and Exhaust Stroke

2. What is the function of heat engine?
   A. It converts chemical energy to mechanical energy.
   B. It converts thermal energy to mechanical energy.
   C. It converts mechanical energy to chemical energy.
   D. It converts thermal energy to chemical energy.

3. Why is heat engine not 100% efficient?
   A. Because all mixture of gases is converted into work.
   B. Because engine needs to be cooled down.
   C. All the gases are used up by the engine.
   D. Some of the gases is taken up in the piston.

4. What causes thermal energy?
   A. exhaust of different vehicles.
   B. exhaust from different industrial engines.
   C. degradation of water.
   D. All of them

5. What is the function of the spark plug?
   A. The spark plug ignites the mixture making it temperature high.
   B. The spark plug pushes the piston down
   C. The spark plug pushes the piston up.
   D. The spark plug pushes the gases out of the cylinder.

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.

✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.

? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1. Grade 9 Learners Material in Science, pp. 361-371
2. Aquino, Marites D., Abistado, Jonna M. and Forteza, Rex S. Worktext in Science and Technology - Science Links-Physics Bookstore Inc., 2012, pp.177-187.
3. Padua, Alicia and Crisostome, Ricardo, Practical and Explorational Physics Modular Approach, Lilia M. Rabago, Ph. D, Vibal Publishing House, 2003, pp. 235-237.
4. Sabalburo, Lucita, et.al., Science and Life Series Physics, Ernesto Guillermo Jr., Sunshine Interlinks Publishing House, Inc. 2009, pp. 283-284.

Prepared by:	Mary Jean B. Barrera	Checked by:	EDNA B. GABRIEL RIZALITO A. LICOS MARY ANN L. CASTRO ROSZIEL S. ROSALES

W8	Learning Area	Science	Grade Level	9
	Quarter	4th	Date	

I. LESSON TITLE	Electricity and Magnetism
II. MOST ESSENTIAL LEARNING COMPETENCIES (MELCs)	Explain how electrical energy is generated, transmitted, and distributed.
III. CONTENT/CORE CONTENT	Electricity Generation, Transmission, and Distribution

IV. LEARNING PHASES AND LEARNING ACTIVITIES

I. Introduction (Time Frame: Day 1)

E – Generation

Electricity is vital to mankind in this modern age. Industries use it to make different products that are beneficial to man. We also enjoy its benefits in our homes through our electrical appliances, gadgets, lights, alarm systems, and others. Electricity has been an integral part of our lives since the time it was discovered. Most of the comforts we enjoy nowadays employ the use of electricity. As you read this text under the light of a lamp, switch on the TV to your favorite program, or plug-in your charger to charge your device, do you ever imagine how electricity reaches you from where it came from?

How is electricity produced? Electricity must be generated from a source – the power plant. There are different types of power plants depending on the source of energy that is used to generate electricity. For example, a geothermal power plant uses heat from within the earth to produce electricity. Geothermal power plants require high-temperature (300 °F to 700 °F) hydrothermal resources that come from either dry steam wells or from hot water wells. These resources are used by drilling wells into the earth and then piping steam or hot water to the surface. The hot water or steam drives generator turbines that produce electricity. When the steam cools, it condenses to water and is injected back into the ground to be used again. This can be summarized through the illustration below.

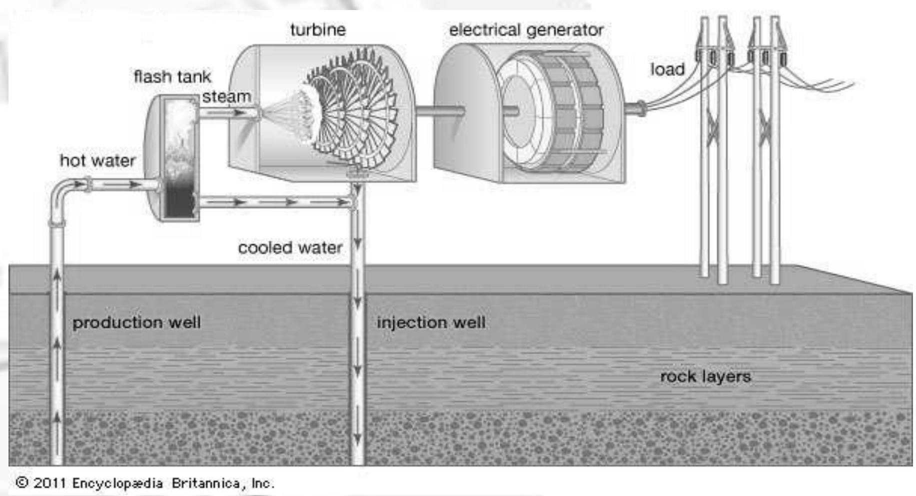


Figure 1. Geothermal power plant

Electricity may also be generated from other sources such as running water, wind, light and heat from the sun, nuclear reactions, and burning fossil fuels. The Philippines, in its quest to sustain its rising economy has tapped several viable yet non-conventional energy resources.

Match the type of power plant with its energy source. Write the letter of the correct answer.

Type	*Energy Sources*
___1. Hydroelectric	A. heat from the sun
___2. Geothermal	B. moving air
___3. Solar	C. nuclear reaction
___4. Wind	D. flowing water
___5. Biomass	E. organic waste
	F. heat from earth

IV. LEARNING PHASES AND LEARNING ACTIVITIES

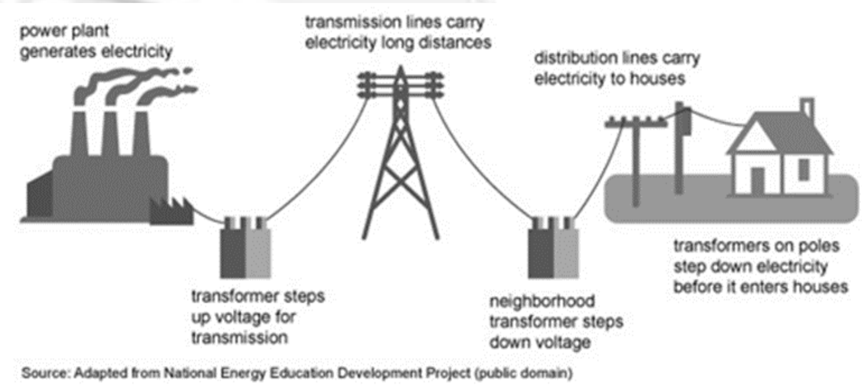
D. Development (Time Frame: Day 2)

E – Generation and Magnetism

Previously, it was discussed that electricity can be generated through a variety of sources. These sources supply the energy necessary to turn large turbines which are then connected to a device called a generator. This device converts mechanical energy to electrical energy. How is this possible? It is made possible by the interaction between a changing magnetic field and a conductor inside the generator assembly. A magnet at rest or a conductor at rest cannot produce electric current. So current is induced by either moving the magnet or the conductor. This phenomenon was discovered by Michael Faraday and is known as *electromagnetic induction.*

E – Transmission and Distribution

How does electricity reach you? After generating electricity in the power plant, it then flows through large wires connected to a step-up transformer. A step-up transformer raises the voltage as high as 756 kV so it can travel long distances. The electric current then travels through transmission power lines going to the substations where it is lowered by a step-down transformer to between 13 kV – 2 kV. From the substations, electricity is sent to a pole transformer or a transformer box where it is lowered again to between 240 volts – 120 volts. It is from here where electricity comes into your home through a service box, where your electric meter is located to measure how much you consume. Wires around your house take electricity to power your lights and appliances. Can you trace back the path taken by electricity?



Source: Science – Grade 9 LM

Learning Task 1: Trace the path of electricity by arranging the steps chronologically from 1 - 6. Write the number on the space provided before each step.

_____ Electricity is then taken through the lines to a pole transformer – or a transformer box if underground – and voltage is lowered again to between 120 and 240 volts.

_____ Electricity flows from the power plant through wires to the step-up transformer. The transformer raises the voltage so it can travel long distances – its raised as high as 756,000 volts.

_____ From here electricity comes into your home through a service box, where your meter is located to measure how much you use. Wires take electricity around your home powering your lights and all your other appliances.

_____ The steam powers a turbine which spins a huge magnet inside a copper wire. Heat energy converts to mechanical energy which then converts to electrical energy in the generator.

_____ The electric current then runs through the power lines to the substation transformer where voltage is lowered to between 2000 and 13000 volts.

_____ Steam is generated at the electricity plant by the burning of fossil fuels – or at a nuclear or hydroelectric plant.

IV. LEARNING PHASES AND LEARNING ACTIVITIES

E. Engagement (Time Frame: Day 3)

E – CONSUMPTION: How is it computed?

How much did you or your family paid for electricity this month? Do you have any idea how electric companies charge your use of electricity? It depends on how much electrical energy you used. Let us find out how. One thing to be considered is how much electrical power was consumed. Aside from electrical power consumed, the time of usage of electricity is also considered. To get the total energy used, multiply the power consumption by the amount of time or duration of use as in the formula below:

$E = Pt$

where: E = Energy used (kWh)
P = Power (W)
t = Time (s)

The unit of measurement for energy used is kilowatt-hour (kWh), which is one kilowatt of power for a period of one hour. The electrical energy used in the household is measured by an electric meter which is usually located outside the house for easy access to reading.

Sample Problem: How much electrical energy is used by a 250-W refrigerator for 8 hours? If the cost of electricity is Php 8.32 per kWh, how much will the use of the refrigerator cost?

Given: $P = 250$ W
$t = 8$ h

Find: E, Cost

Solution:
$E = Pt$
$= (0.25 \text{ kW})(8 \text{ h})$
$= \mathbf{2\ kWh}$

Cost = Cost per kWh x E
= (Php 8.32/kWh) (2 kWh)
= **Php 16.64**

Learning Task 2: Compute for your household's electrical consumption in one (1) day. List down all electrical appliances/devices you have at home, organize them in a table (see sample below) and complete the necessary data.

*Sample only.

APPLIANCE	POWER, P (W)	TIME, t (h)	ENERGY, E (kWh)	COST (Php)
TV	150	10	1.5	12.48
Flat iron	1000	1	1	8.32
Rice cooker	200	1	0.2	1.66
		Total	2.7	22.46

Basic cost of electricity is Php 8.32 per kWh.

A. Assimilation (Time Frame: Day 4)

Explain briefly (in your own words) how electricity reaches your house from its main source. You may also draw a diagram to support your idea.

V. ASSESSMENT (Time Frame: Day 5)

(Learning Activity Sheets for Enrichment, Remediation, or Assessment to be given on Weeks 3 and 6)

Choose the letter of the correct answer.

1. All the following power plants use steam to drive the turbines to produce electricity except
   A. hydropower C. coal-fired
   B. geothermal D. nuclear
2. Electrical power generated in power plants is measured in
   A. watts C. kilowatts
   B. joules D. megawatts
3. The unit of electricity used to measure electrical consumption in homes is
   A. watt-hour C. watt-second
   B. kilowatt-hour D. kilowatt-second

IV. LEARNING PHASES AND LEARNING ACTIVITIES

4. A step-up transformer
   A. lowers the voltage to make it safe for household consumption
   B. raises the voltage for long distance travel
   C. lowers the voltage for lesser bill payment
   D. raises the voltage for faster travel
5. Whenever you switch/turn on an appliance, electricity travels from
   A. power plants → transmission substations →distribution substations → residences
   B. transmission substations → power plants → residences →distribution substations
   C. power plants →distribution substations → transmission substations → residences
   D. distribution substations → power plants → transmission substations → residences
6. Power stations generate alternating current (AC) because
   A. the transformers they use work with AC
   B. it is more efficient and economical
   C. it is easier to generate, safer and more economical to transmit
   D. it is used in mobile devices and gadgets
7. The relationship between electricity and magnetism was discovered by
   A. Benjamin Franklin
   B. Michael Faraday
   C. James Watt
   D. Hans Christian Oersted
8. A generator transforms
   A. mechanical energy to electrical energy
   B. electrical to mechanical energy
   C. mechanical to heat energy
   D. electrical to light energy
9. In a coil of wire, electric current may be induced
   A. by holding a magnetic compass beside it
   B. by rapidly inserting a magnet into and out of the coil of wire
   C. by connecting it to a galvanometer
   D. by holding a magnet stationary inside the coil of wire
10. To reduce your electric bill, you should
    A. connect appliances in series
    B. make use of limited appliances
    C. put off appliances when not in use
    D. put off the main switch during the day

VI. REFLECTION (Time Frame: Day 5)

- Communicate your personal assessment as indicated in the Learner's Assessment Card.

Personal Assessment on Learner's Level of Performance

Using the symbols below, choose one which best describes your experience in working on each given task. Draw it in the column for Level of Performance (LP). Be guided by the descriptions below:

☆ - I was able to do/perform the task without any difficulty. The task helped me in understanding the target content/ lesson.

✓ - I was able to do/perform the task. It was quite challenging, but it still helped me in understanding the target content/lesson.

? – I was not able to do/perform the task. It was extremely difficult. I need additional enrichment activities to be able to do/perform this task.

Learning Task	LP	Learning Task	LP	Learning Task	LP	Learning Task	LP
Number 1		Number 3		Number 5		Number 7	
Number 2		Number 4		Number 6		Number 8	

VII. REFERENCES

1. *Science – Grade 9 Learner's Material*, First Edition. Pasig City: REX Book Store, 2015.
2. *Science – Grade 9 Teacher's Guide*, First Edition. Pasig City: REX Book Store, 2015.
3. https://www.eia.gov/energyexplained/index.php?page=electricity_delivery
4. https://www.eia.gov/energyexplained/index.php?page=geothermal_power_plants
5. https://www.britannica.com/science/binary-cycle-geothermal-power

Prepared by:	Anthony F. Batuto	**Checked by:**	EDNA B. GABRIEL RIZALITO A. LICOS MARY ANN L. CASTRO ROSZIEL S, ROSALES