PEAC
PRIVATE EDUCATION ASSISTANCE COMMITTEE
Trustee of the Fund for Assistance to Private Education

DepED
DEPARTMENT OF EDUCATION

2019

LEARNING MODULE

Science G9| Q4

Force, Motion, and Energy

PEAC
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Trustee of the Fund for Assistance to Private Education

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NOTICE TO THE SCHOOLS

This learning module (LM) was developed by the Private Education Assistance Committee under the GASTPE Program of the Department of Education. The learning modules were written by the PEAC Junior High School (JHS) Trainers and were used as exemplars either as a sample for presentation or for workshop purposes in the JHS In-Service Training (INSET) program for teachers in private schools.

The LM is designed for online learning and can also be used for blended learning and remote learning modalities. The year indicated on the cover of this LM refers to the year when the LM was used as an exemplar in the JHS INSET and the year it was written or revised. For instance, 2017 means the LM was written in SY 2016-2017 and was used in the 2017 Summer JHS INSET. The quarter indicated on the cover refers to the quarter of the current curriculum guide at the time the LM was written. The most recently revised LMs were in 2018 and 2019.

The LM is also designed such that it encourages independent and self-regulated learning among the students and develops their 21st century skills. It is written in such a way that the teacher is communicating directly to the learner. Participants in the JHS INSET are trained how to unpack the standards and competencies from the K-12 curriculum guides to identify desired results and design standards-based assessment and instruction. Hence, the teachers are trained how to write their own standards-based learning plan.

The parts or stages of this LM include Explore, Firm Up, Deepen and Transfer. It is possible that some links or online resources in some parts of this LM may no longer be available, thus, teachers are urged to provide alternative learning resources or reading materials they deem fit for their students which are aligned with the standards and competencies. Teachers are encouraged to write their own standards-based learning plan or learning module with respect to attainment of their school's vision and mission.

The learning modules developed by PEAC are aligned with the K to 12 Basic Education Curriculum of the Department of Education. Public school teachers may also download and use the learning modules.

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SCIENCE 9

Module 4: Force, Motion, And Energy

Lesson 1: Two Dimensional Motion

☑ INTRODUCTION AND FOCUS QUESTION(S):

Everyday we encounter around us activities that depict two dimensional motion like projectile motion for instance in the motion of a ball or stone through the air after being thrown or hit, a bullet after being fired from the barrel of a cannon or rifle and before it hits its target, an athlete during a jump in the high-, long-, or pole vault disciplines, or a parachutist after jumping from a plane. Have you ever wondered why an object when thrown in the air follows a curve/parabolic path? What makes a projectile's trajectory appear the way it does?

When we introduced the words "force", "position", "velocity", and "acceleration", we found out that their precise physical definitions were actually

quite close to their use in our everyday language. With the term "momentum" the situation is more analogous to "energy", another term where one can make a vague connection between conversational use and precise physical meaning.

In politics, one sometimes hears that the campaign of a particular candidate gains momentum. With the momentum of the candidate, it could become hard for the opposing candidate to stop it. And, of course, sports teams or individual players can gain or lose momentum. What one implies with these statements is that the objects said to gain momentum are now harder to stop. In terms of momentum and impulse, why do airbags in cars reduce the chances in injury in accident? Why are nylon ropes (which stretch considerably under tension) favored by mountain climbers? Why is a punch more forceful with a bare fist than with a boxing gloves?

Have you at a certain time asked yourself **can we predict the outcome of object's motion? How can we ensure safety if we can predict the outcome of an object's motion?**

These are the questions you will find answers to as you go through this module.

☑ LESSONS AND COVERAGE:

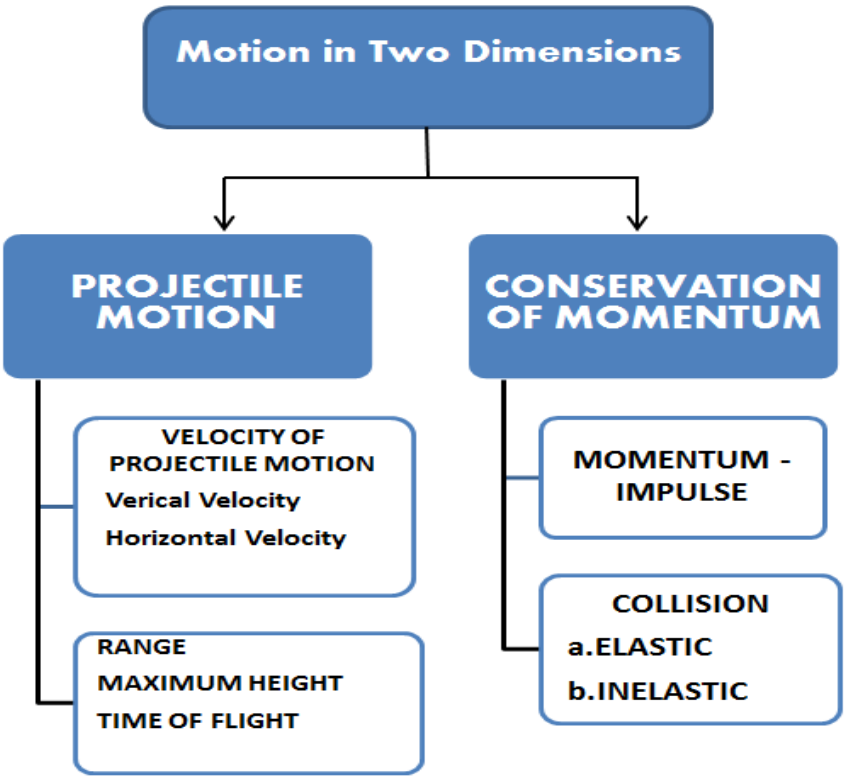
In this module, you will examine this question when you take the following lessons:
Lesson 1.1 – Projectile Motion
Lesson 1.2 – Conservation of Linear Momentum

In these lessons, you will learn the following:

Lesson 1.1	• Cite examples of projectile motion • Describe the horizontal and vertical motions of projectile • Recognize that vertical and horizontal components of projectile motion are independent from each other. • Compute the values of different components in projectile motion • Investigate the relationship between the angle of release and the height and range of the projectile
Lesson 1.2	• Relate impulse and momentum to collision of objects • Infer that the total momentum before and after collision is equal • Examine effects and predict causes of collision –related damages/injuries

☑ MODULE MAP:

Here is a simple map of the above lessons you will cover:



☑ EXPECTED SKILLS:

To do well in this module, you need to remember and do the following:

1. Read the all instructions carefully before starting anything.
2. Complete all the activities and worksheets. Follow instructions on how to submit them.
3. Look up the meaning of words that you do not know.
4. You will frequently come across process questions as you go through different lessons. Keep a notebook (or use the Notepad) where you can write (and revise) your answers to these questions. Use also the notebook to jot down short notes, draw diagrams, and summarize what you have just read.
5. For worksheets and reports that need to be submitted, use the provided checklist and rubric to evaluate your work before submission.
6. Allow time for relaxation and recreation when you are mentally tired. Make a time table to schedule your study and recreation.

PRE-ASSESSMENT

Let's find out how much you already know about this module. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

1. Airbags in automobiles have saved countless lives in accidents. Airbags would be safer because they ____.

http://www.electron.rmutphysics.com/physics/charud/scibook/Physics-for-Scientists-and-Engineers-Serway-Beichne%206edr-4/9%20%20Linear%20Momentum%20and%20Collisions.pdf

a. increase the impact force
b. increase the impact force
c. decrease an occupant's impulse
d. none of the above

2. In basketball, a 95-kg center, running at 8.2 m/s, collides with a 128-kg defensive center moving in the opposite direction. Both players end up with zero speed. What was the player's momentum before the collision?

a. 7.8 x 10^2 kg m/s
b. 8.7 x 10^2 kg m/s
c. 7.1 x 10^2 kg m/s
d. 8.0 x 10^2 kg m/s

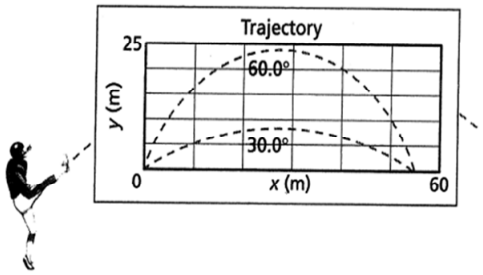
3. How long does it take for the stone to reach the bottom of the cliff?
   a. 4.0 s
   b. 3.0 s
   c. 3.4 s
   d. 3.1 s

4. How far from the base of the cliff does the stone hit the ground?
   a. 19 m
   d. 21 m
   c. 20 m
   d. 22 m

5. What are the horizontal and vertical components of the stone's velocity just before it hits the ground?
   a. 5.0 m/s , 39.2 m/s
   b. 6.0 m/s, 39.2 m/s
   c. 30.2 m/s, 4.0 m/s
   d. 4.5 m/s, 40.0 m/s

6. During a tennis serve, the racket of a tennis player continues forward after it hits the ball. Is momentum conserved in the collision?
   a. No, because the mass of the racket is much larger than that of the ball, it is being held by a massive moving arm which is in contact with Earth.
   b. Yes, because of the interaction of racket and tennis player.
   c. No, because the system involve is the player and the tennis ball.
   d. Yes, because the tennis player is able to hit the tennis ball.

7. Assume that air resistance is negligible, what is the ball's total hang time?
   a. 2.76 s
   b. 7.2 s
   c. 6.2 s
   d. 6.0 s



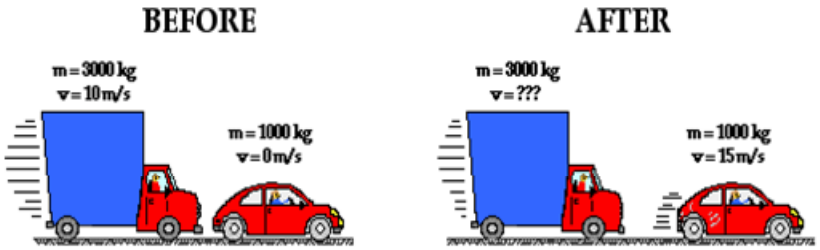
8. What is the ball's maximum height?
   a. 9.30s
   b. 9.0 s
   b. 4.90 s
   d. 4.0 s

9. How far from the player will the ball reach?
   a. 65.5 m
   b. 56.4 m
   c. 65.4 m
   d. 64.5 m

10. How will horizontal velocity change?
   a. will not change
   b. remain the same
   c. will decrease
   d. cannot be determined

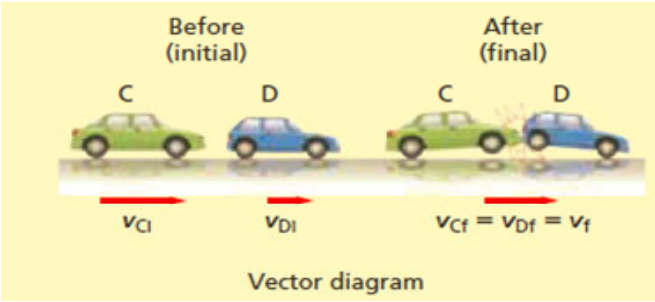
11. How will maximum height change?
   a. will be larger
   b. will be smaller
   c. will be the same
   d. cannot be determined

12. A 3000-kg truck moving with a velocity of 10 m/s hits a 1000-kg parked car. The impact causes the 1000-kg car to be set in motion at 15 m/s. Assuming that momentum is conserved during the collision, determine the velocity of the truck immediately after the collision.



a. 2.5 m/s
b. 3.0 m/s
c. 4.0 m/s
d. 5.0 m/s

13. A 187-kg car going 23 m/s rear-ends a 1025-kg compact car going 17 m/s on ice in the same direction. The two cars stick together. How fast doe the two cars move together immediately after the collision?
    a. 17 m/s
    b. 18 m/s
    c. 16 m/s
    d. 21 m/s



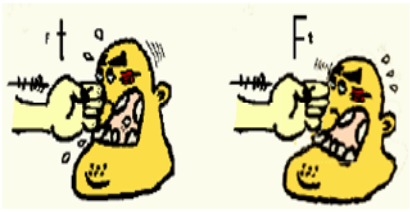
14. Which of the following best describes why projectiles move in a curved path?
    a. They have horizontal velocity and vertical acceleration.
    b. They have momentum.
    c. They have mass.
    d. They have weight.

15. The momentum of an object depends upon the object's _____.
    a. mass and acceleration
    b. position and velocity
    c. mass and velocity
    d. weight and position

16. Consider the mass and velocity values of Objects A and B below. Compared to Object B, Object A has ____ momentum.
    a. two times the
    b. four times the
    c. eight times the
    d. the same

17. A(n) _____ causes and is equal to a change in momentum.
    a. force
    b. impulse
    c. impact
    d. collision

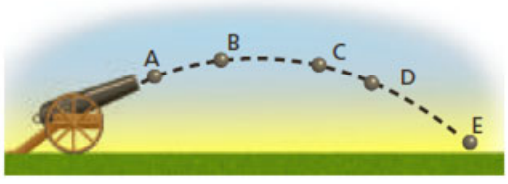
18. When a boxer recognizes that he/she will be hit by an opposing fist, he/she rides the punch. Does it change the impact of the punch?



    a. Yes, the impact of the punch is lesser because the time of impact is extended.
    b. No, since the force of the impact is directly proportional with time of impact.
    c. No, because still the impact of the punch is just the same whether direct hit or ride the punch.
    d. Yes, because the punch is not that strong

19. What is the momentum of a 0.148 kg baseball thrown with a velocity of 35 m/s toward home plate?
    a. 5.1 kg m/s toward home plate
    b. 5.1 kg m/s away from home plate
    c. 5.2 kg m/s toward home plate
    d. 5.2 kg m/s away from the home plate

20. Consider the trajectory of the cannon ball shown below. Where is the magnitude of the acceleration is zero?



    a. point A
    b. point B
    c. point C
    d. point E

Lesson 1.1: Projectile Motion

EXPLORE

Projectile motions are integral parts of our daily lives. From kicking a soccer ball to picking up shoes to wear to dropping a pair of slippers, force and motion are always at play. Objects moves in predictable ways, as described with accepted principles of force and motion. Everything is always in constant motion because forces are always at work. By learning about force and motion, you will understand how force and motion can be used to produce motions that allow you to be safe and sound.

ACTIVITY 1. Picture Analysis

Observe and analyze the pictures below

▲ Lava spews from a volcanic eruption. Notice the parabolic paths of embers projected into the air. We will find in this chapter that all projectiles follow a parabolic path in the absence of air resistance. (© Arndt/Premium Stock/PictureQuest)

Questions to answer

1. What do you notice in each of the pictures?
2. How do you describe motion of each object in the pictures?
3. Why do objects in the pictures follow a curve path?
4. What concepts do you think are depicted by the pictures?
5. Can we predict the motion of a moving object? Explain.

You just gave your thoughts about the preceding questions. Let us check your answers by doing the next activity.

ACTIVITY 2. ANTICIPATION/REACTION GUIDE ACTIVITY

Instruction: Respond to each statement twice (once before the lesson and again after covering it). Answer only the first column and after the topic has covered you will answer the third column.

- *Write A if you agree with the statement*
- *Write B if you disagree with the statement*

Response Before Lesson	PROJECTILE MOTION	Response After Lesson
	1. In projectile motion, the horizontal displacement of an object is called *range.*	
	2. At the top of the object's flight, the velocity of the object in projectile motion is zero.	
	3. The path of the object in projectile motion is a parabola.	
	4. Projectile motion consists of two independent vertical and horizontal motions.	
	5. An object in projectile motion is only affected by the force of gravity.	
	6. All projectiles experience acceleration due to the force of gravity.	
	7. The trajectory of projectile motion depends only on vertical motion.	
	8. A projectile lunched horizontally has no initial vertical velocity.	
	9. Horizontal velocity of projectile decreases as the projectile moves.	
	10. Horizontal forces are required to keep a projectile moving horizontally.	

How did you answer the above statements? What are your bases for your answers? Do you think learning the right response in every given statement is essential? Can we predict the motion of an object?

END OF EXPLORE

FIRM-UP

Your goal in this section is to learn and understand key concepts about projectile motion. The competencies you are to learn are listed in the checklist below. Monitor your accomplishment in these competencies.

CHECKLIST OF COMPETENCIES	
	Describe the horizontal and vertical motions of projectile
	Recognize that vertical and horizontal components of projectile motion are independent from each other.
	Compute the values of different components in projectile motion

Your goal in this section is to learn and understand some key concept by answering this question: *How can we ensure safety if we can predict the outcome of object's motion?*

ACTIVITY 3. Key Terms/Formula Organizer through Web-Page Reading

A projectile has a motion which is both horizontal and vertical at the same time. These two components of motion can be described by kinematic equations. The perpendicular components of motion are independent of each other, any motion in the horizontal direction is unaffected by a motion in a vertical direction (and vice versa). As such, two separate sets of equations are used to describe the horizontal and the vertical components of a projectile's motion. Read the website below and organize quantities in the table provided.
http://www.physicsclassroom.com/calcpad/vecproj

Quantity (Horizontal Motion)	Symbol	Formula Involve
Quantity (Vertical Motion)		

You have already familiarized the key terms of projectile motion. Remember that familiarization of key terms will help you start learning the concept of projectile motion. In the next activity you will use the terms in describing projectile motion.

Type I - Horizontally Launched Projectiles

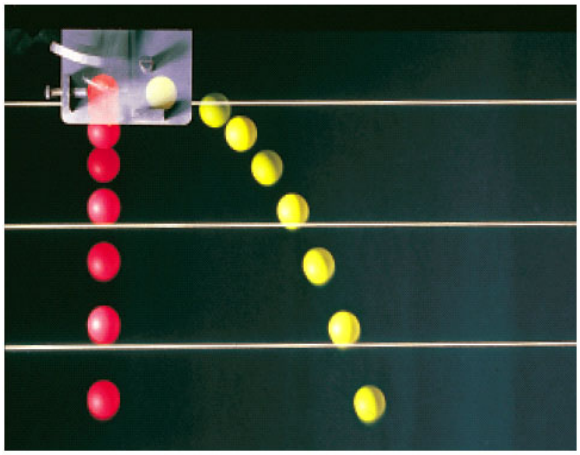
ACTIVITY 4. Video Analysis

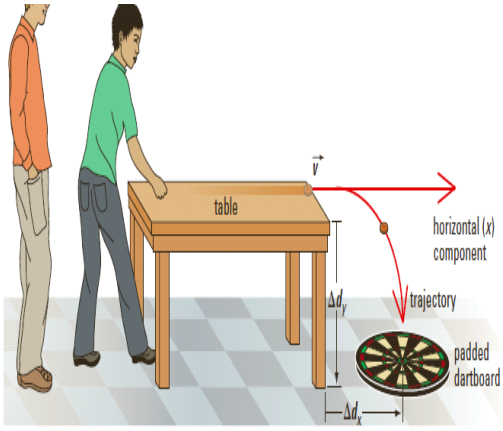
https://www.youtube.com/watch?v=vUW-0SqMy0g
The video presentation shows people jumping from the top of a cliff.
https://www.youtube.com/watch?v=z24_ihikEqQ&list=PLD519023E0E933E94&index=5

Process Questions:

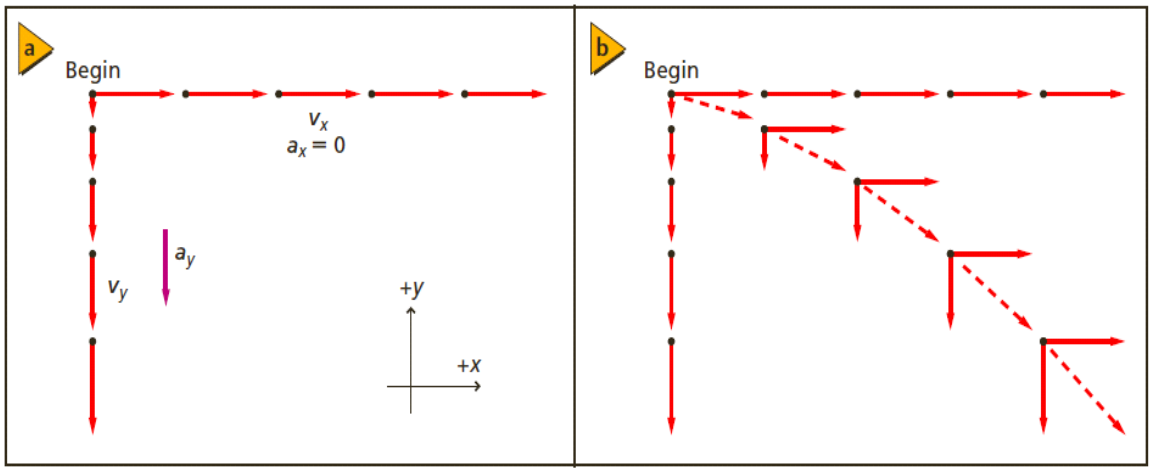
1. What do you observe in the video presentation?
2. How would you describe the horizontal and vertical velocities of a diver after taking off from the cliff?
3. How does gravity affect the motion of the diver after leaving the top of the cliff?
4. How do you describe the path of the diver from the top to the sea water?

Activity - **Let‘s examine vector modeling**





The projectile motion shown above can be broken down to two components. The breakdown of x – component and y-component are shown in the next picture.



ACTIVITY 5. "How does it Happen"

Click the site below and analyze the different components of projectile motion that is launch horizontally. What will be the path of the cannonball and how can the motion of the cannonball be described? Use the table below to describe the horizontal and vertical components.
http://www.physicsclassroom.com/mmedia/vectors/hlp.cfm
Fill in the table with the necessary information.

Quantity	Horizontal Motion	Vertical Motion
Forces (Present?-Yes or No) (If present, what direction)		
Acceleration		

(Present?- Yes or No (If present, what direction)		
Velocity Constant or Changing		

Now that you have described and dissected the different components of motion for an object that is launched horizontally, you are going to do the same for an object that is launched at an angle.

Type II- Projectile Launch At an Angle

ACTIVITY 6. Video Analysis

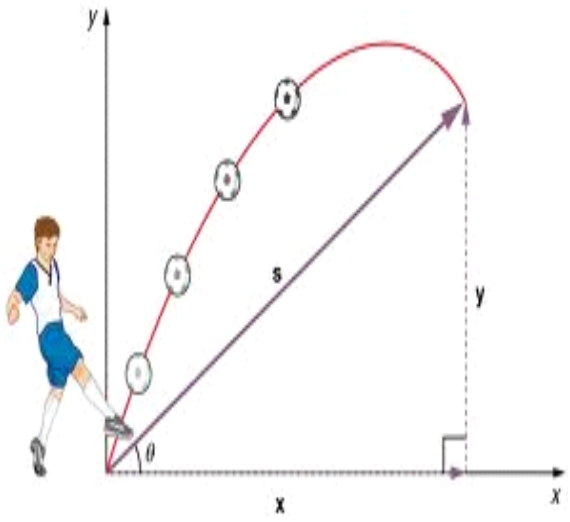
https://www.youtube.com/watch?v=9N7qMqx9rNs
The video shows long jumping competition
https://www.youtube.com/watch?v=hlW6hZkgmkA&index=1&list=PLD519023E0E933E94
Process Questions

1. What do you observe in the videos?
2. How would you describe the motion of the object when in air?
3. When in the air, what type of path do objects follow? Explain by illustrating.

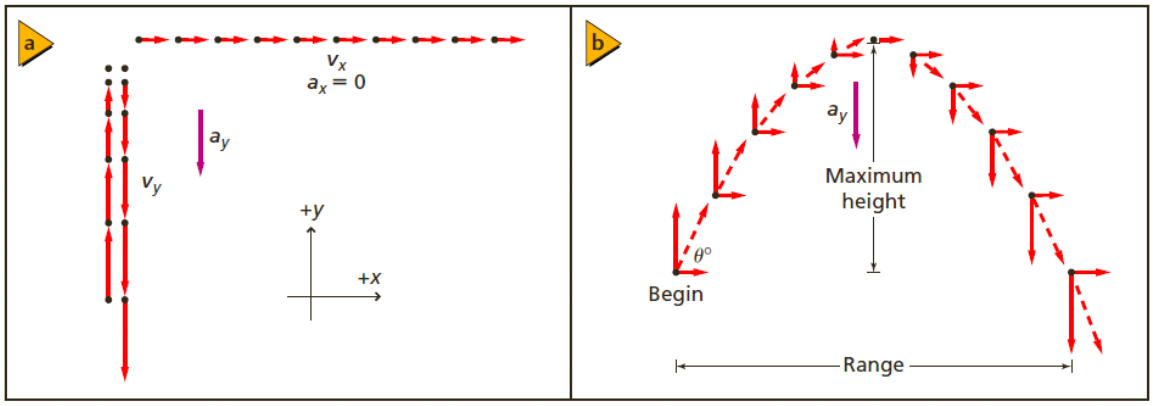
The videos above have illustrated projectile launch at an angle. In the next activity you will break down the vertical and horizontal motion of projectile.

ACTIVITY 7. Picture Analysis

Object launched at an angle can be broken down to x-component and y-component that is shown below.



http://philschatz.com/physics-book/contents/m42042.html
http://sportsnscience.utah.edu/tag/drive/



Part I
Questions to answer

1. What is projectile motion?
2. How do components of velocity affect the trajectory of projectile motion?
3. If an object is launch horizontally, how do you describe its motion if without the presence of gravity? Explain your answer
4. When an object is projected with an angle, how do you describe initial velocity, horizontal velocity and vertical velocity at the top of projection? Explain your answer

ACTIVITY 8. Projectile Simulator Interactive

Use the Projector Simulator to answer table below
http://www.physicsclassroom.com/shwave/projectile

Angle-Launched Projectiles
Directions and Questions: 1. **Horizontal and Vertical Velocity:** Click the **Start** button and observe the simulation. The red arrows are velocity vectors. They are indicators of how fast the object is moving horizontally and vertically. The length of the arrow indicates how fast the object is moving in that direction. Describe the horizontal and the vertical velocity: The horizontal velocity (vx) is _____ (constant, changing) and the vertical velocity (vy) is _____ (constant, changing).
2. Vertical Velocity at Peak

Carefully observe the vertical velocity vector as the projectile approaches the highest point (i.e., the *peak*). At its highest point, the vertical velocity is _____.

3. **Time to Rise and Time to Fall**
   As the simulation runs, the time is displayed at the top of the Interactive. If the **Pause** button is pressed, arrows appear next to the time to step the simulation forward or backward. Use these controls to measure the time it takes to rise to the peak, the total time in the air, and the time it takes to fall from the peak. Record to the first decimal place.
   t_{rising} = _____ s t_{total} = _____ s $t_{falling}$ = _____ s

   Analyze these measurements and make a generalized statement about t_{rising} and $t_{falling}$.

4. Anna Litical makes the following claim:
   The vertical velocity (vy) 1.0 second before reaching the peak is the same size as the vertical velocity (vy) 1.0 second after reaching the peak. The same is true of the **vy** values 2.0 seconds before and after the peak.

   Do you agree or disagree with Anna's claim? _____ Perform some trials and support your answer the evidence and reasoning.

You are going to see why projectile follows parabolic path. Play the interactive site by putting values on the boxes and then fire the projectile.

ACTIVITY 9. Let's Play Golf Activity

Click the site below, you will understand the different variables that involves in projectile launch horizontally. Manipulate the different variables by putting values on its designated boxes. Analyze how these variables influence its other. Then, answer the following questions given in the table below.
http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=26

Situation A

Set the initial velocity to 75 m/s and Θ 45^0

1. What launch angle do you think yields the longest drive?

   _____

2. With the velocity set to 75 m/s, explore with a variety of launch angles until you find out the longest distance.
   a. What launch angle produces the longest distance?

      _____
      _____
      _____

   b. How far did the ball travel?

      _____
      _____

   c. Why do you think the ball travelled farther in this situation?

      _____
      _____

3. Run the program with the optimum launch angle, what kind of path did the ball follow?

   _____
   _____

4. What launch angle yields the longest distance?

   _____

5. The moon has much less gravity than earth and has extremely thin atmosphere. How would this factor affect the trajectory of a ball on the moon?

   _____
   _____

Situation B

1. Velocity is an example of vector quantity since it describes the speed and direction of an object. The velocity of an object through the air can be described into two components: a horizontal component (v_x) and vertical component (v_y). Set the initial velocity to 50 m/s and the angle to 45^0. Run the program and focus on the arrows that represent the horizontal and vertical components of ball's velocity.

   a. As the ball flies through the air, what do you notice with the vertical arrow?

   _____
   _____

   b. As the ball flies through the air, what have you observed with the horizontal arrow?

   _____
   _____

   c. Try other velocities and angle. Do these results the same?

   _____
   _____

   d. How does velocity of an object change as it flies through space?

   _____
   _____

2. Use your calculator to solve the horizontal and vertical velocity of ball's velocity.
   a. To calculate the v_x, multiply initial velocity by the cosine of the the angle:
      v_x = initial velocity · cosine (Θ) _____
      v_y = initial velocity · sine (Θ) _____
   b. Turn on the velocity vector of the program, were correct? _____

3. An object flying through the air is said to in the state of free-fall. As you observed, the horizontal component of the velocity **(v_x)** does not change as the object moves, but the vertical component **(v_y)** decreases over the time.

   a. What force causes **v_y** to change as the ball travels?

   _____

   b. Why does the horizontal component **(v_x)** remain constant as the ball travels?

   _____

Situation C

1. Set the initial velocity to 75 m/s and angle to 50^0. Suppose that you know the horizontal component of ball's velocity **(v_x)** and the time it had travelled through the air **(t)**. How could you calculate how far the ball travelled?

   _____

   _____

   a. What is the horizontal velocity of the ball?_____
   b. What is the hang time of the ball?_____
   c. How far does the ball travel before it hits the ground?_____
   d. Complete the table below, calculate the answer manually then verify it using the program.

Initial Velocity	Θ	**v_x** (m/s)	**v_y (m/s)**	Hang Time t (s)	Distance (m)
60 m/s	30^0				
30 m/s	45^0				
80 m/s	60^0				
50 m/s	75^0				

ACTIVITY 10. Life without Gravity

Watch the video below and observe the motion of object without the influence of the force of gravity.
http://www.youtube.com/watch?v=tgRMAVoHRbk
The video is about life in outer space where there is no force of gravity.

Process Questions:

1. What do you observe in the video presentation?
2. Why do you think objects follow a horizontal direction in the video?
3. How does gravity affect the motion of object?
4. Why does object follow a parabolic path in projectile motion?
5. What are the factors that influence object's motion in projectile motion?
6. How would you describe motion of object if without gravity?
7. **How would you describe an object's motion if the object is in zero gravity condition?**
8. How would our life be without the force of gravity? Cite situations and explain.
10. **How can we ensure safety if we can predict the outcome of an object's motion?**

ACTIVITY 11. Bring Ideas Together

Use the interactive Website to summarize the concept of projectile motion.
http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=26

Fill in the table with the necessary information.

Quantity	Horizontal Motion	Vertical Motion
Forces (Present?-Yes or No) (If present, what direction)		
Acceleration (Present?- Yes or No (If present, what direction)		
Velocity Constant or Changing		

How did you fare with the different activities above? Did it help you understand the basic of projectile motion? Can one predict the motion of an object? In the next activity you will evaluate how far have you gone in learning projectile motion.

ACTIVITY 12. Let's do the computation

Click the websites below and analyse all the examples presented

1. http://www.ck12.org/physics/Projectile-Motion-Problem-Solving/
   Website illustrates to use the equations of motion in two dimensions in order to solve problems for projectiles
2. https://www.youtube.com/watch?v=hO_SBQY6fJg
   Video shows example on how analyse and solve projectile motion.
3. https://www.youtube.com/watch?v=qji2SDGNfwk
   Video shows example on how analyse and solve projectile motion.

Watch the video presentation then fill in the table below.

1. A car traveling with speed of 20m/s loses its brake and fall into 80-m cliff. Fill in the unknown quantities.	
a. Initial velocity	
b. Time for the car to hit the ground	
c. How far from the foot of the cliff will the car reach?	
2. A soccer ball is kicked and leaved the ground at an angle 38 degrees above the horizontal, moving at 20 m/s.	
a. Hang time of the ball	
b. Initial horizontal velocity	

c. Initial vertical velocity	
d. Maximum height	
e. The range travelled by the ball	

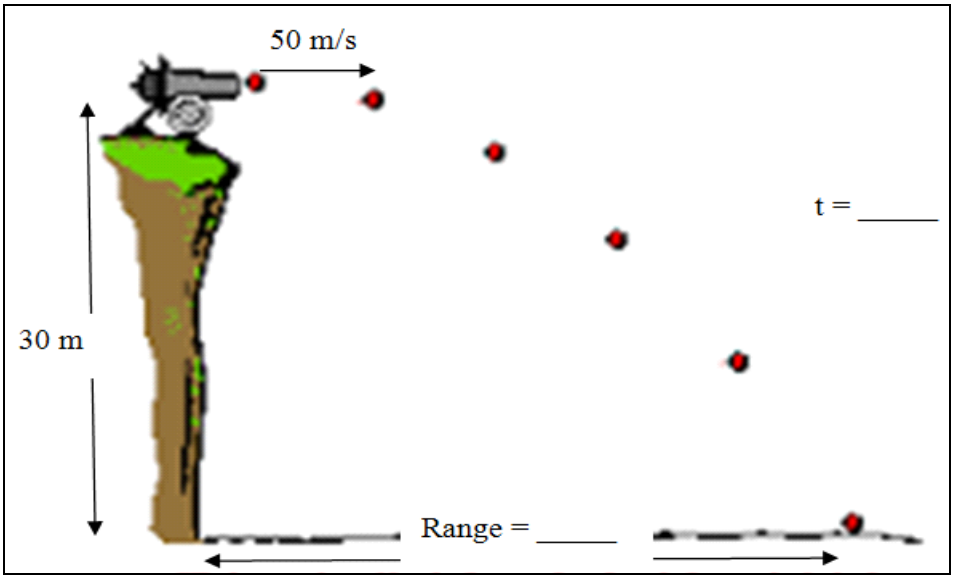
Based on your answers given in table, answer the following guide questions.
Guide Questions
1. What component of projectile motion is constant?
2. What are the steps in solving projectile motion?
3. How do steps in solving projectile motion help you?
4. Why does an object in projectile motion follow a parabolic path?
5. Can we launch a projectile and hit a target at a known distance? Explain.
6. **How can we ensure safety if we can predict the outcome of object's motion?**

ACTIVITY 13. Drills and Exercises Activity

Before doing the next activity, review how to calculate problem solving in projectile motion. Click the site below for your review.
https://www.youtube.com/watch?v=KbBj8vgSRI8
Drills and exercises video

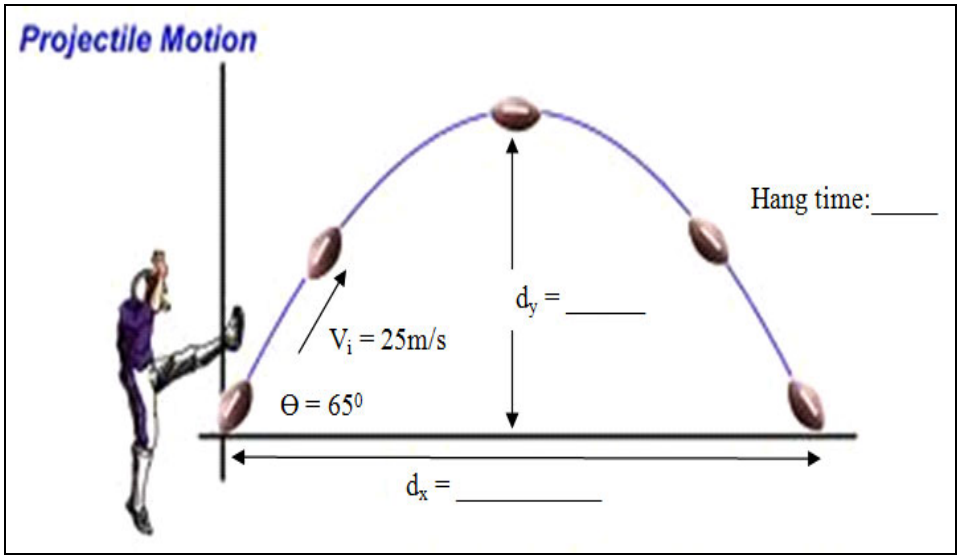
After viewing the video analyze the following illustrations and solve for the unknown quantities.

1.



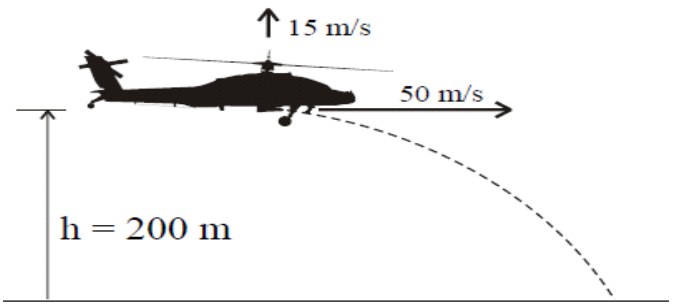
http://www.physicsclassroom.com/class/vectors/Lesson-2/Characteristics-of-a-Projectile-s-Trajectory

2.



http://sdsu-physics.org/physics180/physics180A/units/unit1/chapter3.html

3.

A helicopter is rising vertically at 15 m/s. When it is at a height of 200 m above the ground, it fires a projectile horizontally with a velocity of 50 m/s. Determine: **Identify the given:**	 http://www.chegg.com/homework-help/questions-and-answers/relief-airplane-delivering-food-package-group-people-stranded-small-island-island-small-pl-q7614341
a. The time it takes the projectile to hit.	b. The horizontal displacement.

How did you fare with the previous activities? Did the previous activities help you understand projectile motion? In the next activity you will compute the values of different components of projectile motion.

ACTIVITY 14. HIT THE TARGET ACTIVITY

Click the website below and use kinematic equations and projectile motion principles to predict a launch speed, horizontal displacement, or launch height in order to successfully fire a cannonball into the target position.
http://www.physicsclassroom.com/shwave/targetsh.cfm

Instruction: Read the direction carefully in the interactive site. The data sheet is given below for you to accomplish.

Hit the Target Activity Data Sheet
Problem Type: Launch Speed and Height Known; Find Horizontal Displacement

Given:

v_{ox} = _____ m/s

y = _____ m

Show your solution here:

Problem Type: Launch Speed and Horizontal Displacement Known; Find Launch Height

Given:

v_{ox} = _____ m/s

x = _____ m

y = ????

Show your solution here:

Problem Type: Launch Height and Horizontal Displacement Known; Find Launch Speed

Given:

y = _____ m

x = _____ m

v_{ox} = ???

Show your solution here:

ACTIVITY 15. 3 – 2 – 1 CHART Activity

3 THINGS YOU FOUND OUT	2 INTERESTING THINGS	1 QUESTION YOU STILL HAVE

END OF FIRM-UP

Since you have understood the basic concept of different type of projectile motion, you will go deeper into the how to compute the different components of projectile motion. Your goal in this section is to take a closer look at some aspects of projectile motion. You are going to use what you have learned in our previous activities.

In the next activity, you are going to use your knowledge of different components of projectile motion in analyzing and computing its values.

DEEPEN

ACTIVITY 16. Simulation Activity

Click the site below and examine the presentation.
http://www.physicsclassroom.com/mmedia/vectors/hlp.cfm
The website is a simulation of projectile that launch horizontally

Process Questions

1. What is the path of cannon ball?
2. How can the cannon ball's motion be described?
3. What velocity component of the motion is constant? Explain why this component is constant.

4. At the moment the cannon ball is released, what is the value of initial vertical velocity?
5. What do the arrows signify?
6. **How can we ensure safety if we can predict the outcome of an object's motion?**

ACTIVITY 17. Case Study Analysis

Click the website below and use the simulation in the site to conduct your simple case study on projectile motion.
http://phet.colorado.edu/sims/projectile-motion/projectile-motion_en.html

a. Form hypothesis:

1. What launch angle do you think will yield the longest drive? _____

b. Experiment:
With the velocity set to 40 m/s, experiment with a variety of launch angles until you find the one that yields the longest driving distance.

2. What launch angle produced the longest drive? _____

3. How far did the ball travel? _____

c. Observe:
Take one swing with the launch angle set to the optimum. The curved path the ball takes through
the air is its trajectory.

4. Look closely at the trajectory. Does it appear symmetrical? Explain.
_____

5. The curve is slightly steeper on the right than on the left as a result of air resistance.
How is air resistance affect the trajectory? Explain.
_____
__

d. Experiment:
Click **Reset**, then select **Atmosphere: None**. As before, use trial and error until you find the launch angle that produces the longest drive.

6. What launch angle produced the longest drive?
_____

7. How far did the ball travel? _____ 8. Why do you think the ball traveled farther in this situation? _____
e. Extend your thinking: The Moon has much less gravity than Earth and has an extremely thin atmosphere. How would these factors affect the trajectory of an object on the Moon? _____ ____

Be sure that everything is understood before you continue to the next activity. Use the table below for self-monitoring guide:

ACTIVITY 18. Competency-Check List

Skills	GREEN I understand the concepts and ready to go	YELLOW More than 50% of the concepts I fully understand	RED Not ready to go. Need more examples
Describe the horizontal and vertical motions of projectile			
Recognize that vertical and horizontal components of projectile motion are independent from each other.			
Compute the values of different components in projectile motion			

How far have you understood the lesson? In the next activity you are going to watch video presentation on “Goal Keeper Training”. This activity will equip you with the necessary idea on how to punt a soccer ball.

ACTIVITY 19. Video Analysis "Goal Keeper Training: How to Punt a Soccer Ball"

Click the site below and watch the video Science in Soccer.
https://www.youtube.com/watch?v=HANyK23Hquc

Situation: Your friend Ramon is a neophyte soccer player. He would like to understand on techniques to punt the football. After viewing and analyzing the presentation what advice you can share to Ramon for an optimum kick of soccer ball. In the table below are the techniques for proper punting.

a. What advice about angle and kicking speed would you give to a punter who wants to maximize the distance of a punt? Why?	b. What advice about angle and speed, would you give a punter that is ***not*** trying to maximize distance, but instead wants a long "hang time" to allow his teammates as much time as possible to "get downfield".

How was the previous activity? Was it helpful? In the next activity you will generalize the thoughts you learned from the preceding activities.

ACTIVITY 20. Making Generalization Activity

Use the table below for you to make a generalization about projectile motion. Answer the following problems and construct your conclusion.

Human Cannonball.	**Stunt Motorcylist**	**Tennis**
A circus performer is launched from a cannon and lands in a net. Your tabletop ball launcher represents a small-scale working model of this human cannonball system. Your goal is to figure out what angle to launch the ball and where to place the net so that the flight time of the ball is equal to 0.50 seconds and the ball lands in the net. 1. What angle must be the ball launcher be set to make sure the human will exactly at the net? 2. What distance from the ball launcher must the net be placed to ensure exact landing of human cannonball?	A stunt motorcyclist takes off at a speed of 35 m/s up a ramp of 30° to the horizontal to clear a river 50 m wide. 1. Does the cyclist succeed in doing this? 2. What determines the motion of a projectile? 3. What must be predicted to ensure the safety of stunt motorcyclist?	A tennis player plays a ball with speed 20 m/s horizontally straight down the court from the backline.  1. What is the least height at which she can play the ball to clear the net? 2. How far behind the net does the ball land when it is played at this height?
ANSWER	ANSWER	ANSWER
GENERALIZATION: **How can we ensure safety if we can predict the outcome of an object's motion?**		

Write your final answers to these questions in the **response after lesson** column of the ARG. Compare your new answers with your answers in the previous columns.

ACTIVITY 21. ANTICIPATION/REACTION GUIDE ACTIVITY (revisit)

Instruction: Respond to each statement twice (once before the lesson and again after covering it). Answer only the first column and after the topic has covered you will answer the third column.

- Write A if you agree with the statement
- Write B if you disagree with the statement

Response Before Lesson	PROJECTILE MOTION	Response After Lesson
	1. In projectile motion, the horizontal displacement of an object is called *range.*	
	2. At the top of the object's flight, the velocity of the object in projectile motion is zero.	
	3. The path of the object in projectile motion is parabola.	
	4. Projectile motion consists of two independent vertical and horizontal motions.	
	5. An object that is in projectile motion is only affected by the force of gravity.	
	6. All projectiles experience acceleration due to the force of gravity.	
	7. The trajectory of projectile motion depends only on vertical motion.	
	8. A projectile lunched horizontally has no initial vertical velocity.	
	9. Horizontal velocity of projectile decreases as the projectile moves.	
	10. Horizontal forces are required to keep a projectile moving horizontally.	

How did you compare your answer of the first column and the third column? Are there changes in your answer? Now in the next activity you are going to write your learning from previous activities.

In this section, you have acquired deep understanding on projectile motion. You have found out that motion of an object can be predicted through analysis of components.

END OF DEEPEN

Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

TRANSFER

ACTIVITY 22. Projectile Forensic

The Scenario:

It is the morning of January 1, 2014, during the new year celebration, you heard gun shots at a distant. Mang Ernesto your neighbor, woke up to find his five year old bulldog dead of a gunshot wound. You begin to think that the gun shots heard the night before may have something to do with the incident. The local barangay tanod is intrigued by your theory and introduce you to the crime scene investigators on the case. The barangay police are taking the incident very seriously because these random gunshots could have killed anyone. It is your job to help the crime scene investigators to pinpoint the location at which the shots originated.

Crime Scene Notes:
The bullet extracted from the dog has been matched to a .45 caliber pistol. This gun releases bullets with an exit velocity of 380 m/s. The bullet entered the dog at an angle of 70^0 from the horizontal.

There are three suspects in the neighborhood that are registered owners of .45 pistol:

Arthur Alpore
Arthur has a record of noise violations for loud parties he frequently holds at his residence.

Carlos Baloy
Has no criminal record

Ramon Reyes
Ramon has a record that includes possession of prohibited drugs. He served time in prison and released after the completion of sentence.

The dog was lying on Mang Ernesto's deck when it was shot. The deck is 1.75 m above the ground.

Investigate It
Click the site below for you to be guided on how to conduct investigation. After reading the article you can start conducting your own investigation based on the given scenario.

http://www.oceg.org/resources/illustration-how-should-we-conduct-investigations/#fullcontent

Initial Report:
Based on the information collected in the crime scene, describe how you plan to proceed. Include a discussion of the suspects and other information from the scene. What do you think is the most important piece of information or evidence?

Research:

Research information on bullet trajectories, forensic ballistics, projectile motion to augment your findings. Remember, your goal is to identify the perpetrators from the list of suspects. You are expected to show calculations that support your accusation.

Rubrics for the performance task

Criteria	Excellent 4	Satisfactory 3	Developing 2	Beginning 1
Computation	Includes comprehensive computation. Shows multiple computational approaches	Shows accurate computation and several computational approaches	Computation shows little evidence of understanding	Computation shows no evidence of understanding
Approach to the Problem	Clear and concise organized method.	Appropriate method is used to solve the problem	Begins in a reasonable way, but does not finish important part of the solution	Begins but fail to complete
Explanation	Demonstrates thinking with a clear ~~sequential~~ and elaborate explanation	Explanation is clear and ~~elaborated~~ correct~~ly~~	Explanation is basic and incomplete	Explanation is unclear and erroneous
Organization of Thought	Work is clearly sequential and includes step by step analysis	Well sequenced thought is evident	Work shows some sequence but is jumbled in some parts	Lack of sequential approach to the problem

END OF TRANSFER:
In this section, your task was to investigate on a problem or issue related to projectile motion.

How did you find the previous activity? How did the task help you see the real world use of the topic?

You have completed this lesson. You may now proceed to the next lesson.

Lesson 1.2 Conservation of Momentum

Have you heard a sports analyst saying “Going into game seven San Mig Coffee has the momentum”? or during time out of UAAP Women’s Volleyball one coach said “ You have the momentum of the game, use that momentum to defeat your opponents”. We could say that a team that has the momentum is really on the move and is going to be hard to stop. What is meant by momentum in sports? Is it related to momentum in Physics? How does momentum be conserved? In this lesson you will learn about momentum, impulse and how momentum is conserved. You will start the lesson by doing next activity.

ACTIVITY 23. Video Analysis

Click the video below
http://www.youtube.com/watch?v=MbYoxTyKD28

Process Questions

1. What do you observe in the video?
2. How does the trailer truck manage to dampen car?
3. What makes the trailer truck a devastating force in the street?
4. In the collision of trailer truck and car, why is trailer truck possess more momentum than the car? Explain.
5. **How is momentum conserved when two trailer trucks collide heads on?**
6. **How can we ensure safety if we can predict the outcome of an object’s motion?**

To begin, complete the first column by supplying your initial thoughts about how momentum is conserved? Can one predict the motion of an object? How can your knowledge of motion help us solve problems in daily life? (Initial Thoughts) in the table below. We shall return to this table as we go along understanding this lesson.

ACTIVITY 24. Eliciting Prior Knowledge Through Generalization Table

What were your initial answers to the questions posed in the previous activity? Summarize your answers to the questions, and your thoughts and ideas in the first column of the IRF Chart.

GENERALIZATION TABLE

MY INITIAL THOUGHTS	MY FINDINGS & CORRECTIONS	SUPPORTING EVIDENCE/CONDITION	MY GENERALIZATIONS

END OF EXPLORE:

You just tried to identify momentum, impulse and how momentum is conserved. Now, let's find out in the next lesson how speed and velocity be expressed in quantifiable values. In the next activity, you are going to encounter the basic concept of momentum-impulse relationship and how momentum is conserved in a system.

FIRM-UP

ACTIVITY 25. Web Page Reading

Click the website below
http://www.physicsclassroom.com/class/momentum/Lesson-1/Momentum
The site is about the basic concept of momentum, impulse and conservation of momentum

Term	Description	Equation
1. Momentum		
2. Impulse		
3. Elastic Collision		
4. Inelastic Collision		
5. Conservation of momentum		

How did you fare in the previous activity? Did website help you identify the basic concept of conservation of momentum? Now that you have identified the different terms involve in conservation of momentum, you will now use your knowledge in solving problems related to momentum.

ACTIVITY 26. Video Analysis

Click the site and watch the presentation.
http://www.youtube.com/watch?v=3g4v8x7xggU
Youtube presentation is about the relationship between momentum and impulse.

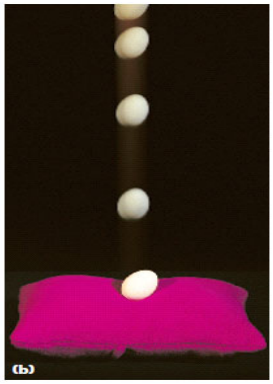
Process Questions:
1. What is momentum?

2. How does momentum differ from the word momentum used in sports?
3. What is impulse?
4. How does momentum relate to impulse?
5. Why does a 80,000 pound big rig traveling at 2 mph have the same momentum as a 4,000 pound sport utility vehicle (SUV) traveling at 40 mph? Explain
6. What determines if one car has more momentum than another in a two-car collision? Illustrate your answer.

In the next activity you will analyse pictures that would help you understand the relationship between impulse and momentum. You will encounter in this activity the importance of time of impact in impulse-momentum relationship

ACTIVITY 27. Picture Analysis

Two sets of picture below depict the impulse-momentum relationship.



http://www.finneytown.org/Downloads/te_ch06.pdf
https://www.google.com.ph/search?q=momentum
Pictures show an egg falling to a plate and a pillow.

The pictures depict the impact of a punch, one is able to ride away from punch and while the other

Process Questions:

1. What do you observe in the pictures?
2. Which of the pictures depicts a greater impact? Explain
3. Explain the momentum-impulse relationship shown in the pictures.
4. Does increasing an object's mass increase its momentum?

5. How can people survive a major collisions?
6. How does physics explain the effectiveness of seat belts and airbags?
7. List other vehicle safety devices that reduce the impact force by increasing the time of impact.

Did the previous activity help you understand the momentum-impulse relationship? The next activity will guide you comprehend the lesson through simulation activity

ACTIVITY 28. Simulation Activity

Click the sites below
1. https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html
2. http://www.mrwaynesclass.com/teacher/Impulse/SimFriction/home.html

The simulate impulse-momentum relationship

1. Instruction: Use the simulation to fill the table of data. Manipulate the different variables in the simulation and record your data.

Object	Mass 1	Mass 2	Velocity 1	Velocity 2	Momentum

2. What would happen to the total momentum if the masses of objects are doubled?

   _____
   _____

3. Complete the following verbal statements to illustrate your understanding of the effect of varying mass on the post collision velocity.
   a. If an object of mass m collide and velocity v collides inelastically with an object of mass 3m that is initially at rest, then the amount of total system mass in motion will increase by a factor of _____and the velocity of

the system will decrease by a factor of _____.The new velocity (v') will be_____

b. If an object of mass 3m collides and velocity v collides inelastically with an object of mass 4m that is initially at rest, then the amount of total system mass in motion will increase by a factor of _____and the velocity of the system will decrease by a factor of _____. The new velocity (v') will be _____v.

4. What conclusion can you formulate in your data table regarding the momentum of the object before and after the impact?

_____
_____
_____

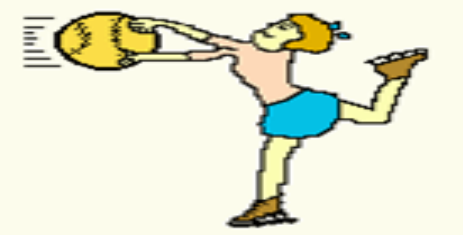
How do you find the previous activity? Does simulation helpful to you? Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

ACTIVITY 29. Collision Analysis

Instruction: Analyze the following problems and write your answer on the given table.

1. A 12-kg medicine ball is thrown at a velocity of 10 km/hr to a 50-kg skater who is at rest on ice. The skater catches the ball and subsequently slides with the ball across the ice. Consider the skater and the ball as two separate parts of an isolated system. (no external forces). Fill in the before- and after-collision table below.
http://www.physicsclassroom.com/class/momentum/Lesson-2/Using-Equations-as-a-Recipe-for-Algebraic-Problem

Before

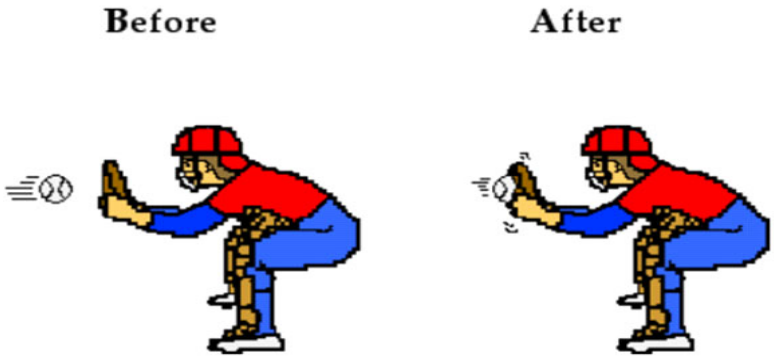


After

Person/Object	Momentum before Collision	Momentum after Collision	Momentum Change
Ball			
Skater			
Total			

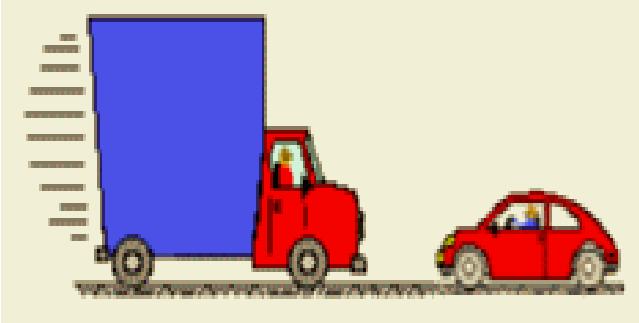
Compute the velocity of medicine ball and the skater after the collision.

2. A 0.120-kg baseball moving at a speed of 40.0 m/s crosses the plate and strikes the 0.250-kg catcher's mitt (originally at rest). The catcher's mitt immediately recoils backwards (at the same speed as the ball) before the catcher applies an external force tostop its momentum. If the catcher's hand is in a relaxed state at the time of the collision, it can be assumed that no net external force exists and the law of momentum conservation applies to the baseball-catcher's mitt collision. Fill in the before- and after collision table below.



Person/Object	Momentum before Collision	Momentum after Collision	Momentum Change
Ball			
Catcher's Mitt			
Total			
Determine the velocity of the baseball/catcher's mitt immediately after the collision.			

3. A 4000-kg truck traveling with a velocity of +5.0 m/s collides head-on with a 1200-kg car traveling with a velocity of -15 m/s. The truck and car entangle and move together after the collision. Fill in the before- and after collision table below.



Person/Object	Momentum before Collision	Momentum after Collision	Momentum Change
Car			
Truck			
Total			
Determine the velocity of the truck and car immediately after the collision.			
Explain why airbags are **not** alternatives to seat belts but are intended to be used with seat belts to increase safety.			
Can we predict the motion of an object? Explain			

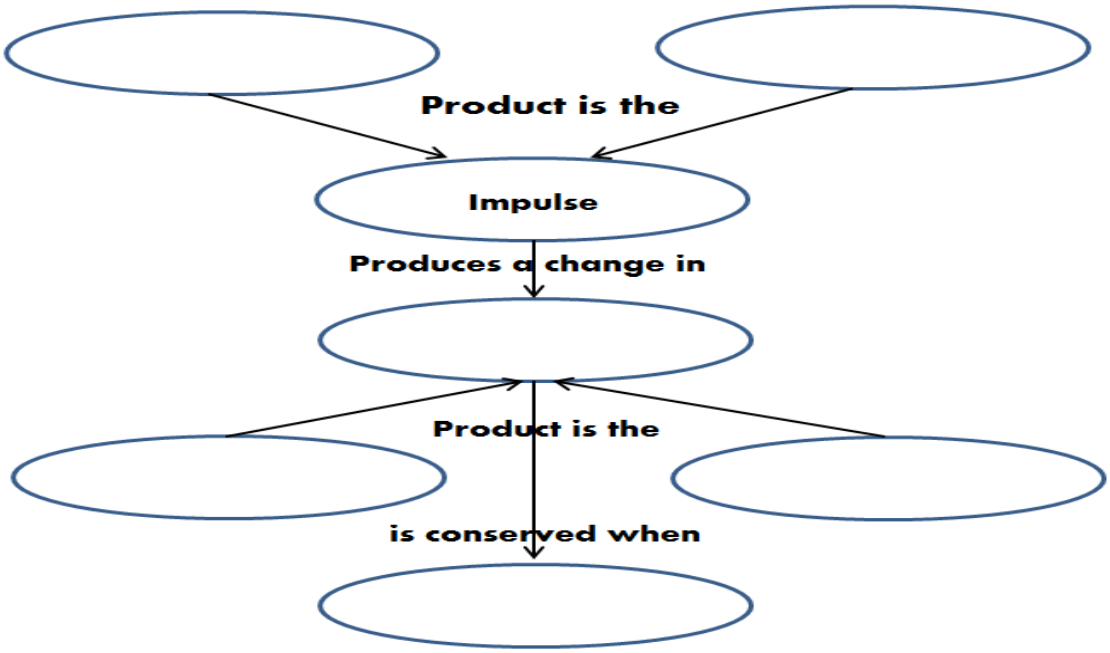
END OF FIRM UP

Since you have understood the basic concept of momentum, impulse and conservation of momentum, you will go deeper in understanding the application of the concept. Your goal in this section is to take a closer look at some aspects of momentum, impulse and conservation of momentum. You are going to use what you have learned in our previous activities.

DEEPEN

ACTIVITY 30. Graphic Organizer

Before moving on to the next lesson, let us summarize what you learned about speed and velocity. Fill up this graphic organizer by identifying what is missing in the map.



How is your performance so far with the previous activities? Did you gain the important points of impulse-momentum relationship? In the next activity you are going to see the basic idea of collision.

ACTIVITY 31. Understanding Car Crashes: It's Basics Physics

https://education.ufl.edu/gjones/files/2013/04/teachers_guidePhysics.pdf

Thousands of people are alive today because of their airbags. Seat belts and airbags stop occupants with less damage by applying a small force over a large time interval. The amount of damage in a collision is related to the time during which the force stopped the object.

Click the site below to view videos related to collision.
http://www.iihs.org/iihs/videos

Answer the following questions in the table below.

Explain why airbags are NOT alternatives to seat belts but rather are intended to be used WITH seat belts to increase safety.
List other vehicle safety devices that reduce the impact force by increasing the time of impact.
How does physics explain the effectiveness of seat belts and airbags?
Are bigger, more massive cars safer? Explain.
How is the momentum of two isolated objects conserved?
How can we ensure safety if we can predict the outcome of an object's motion??

Were you able to answer all the process questions from previous activities? Does it make sense? In the next activity you are going to analyse three different articles regarding the application of collision in real life.

ACTIVITY 32. Webpage Article Analysis

Read the websites below to answer the table below
http://newsinfo.inquirer.net/684841/davao-citys-speed-limit-reduces-accidents-but-businesses-also-affected
Davao City's speed limit reduces accidents, but businesses also affected

http://www.gmanetwork.com/news/story/267871/newstv/angpinaka/ang-pinaka-top-10-most-common-causes-of-road-accidents
Ang Pinaka' Top 10 Most Common Causes of Road Accidents

http://www.abs-cbnnews.com/nation/metro-manila/02/25/09/grade-4-ateneo-student-dies-car-accident-report
Ateneo pupil dies after being pinned by car

Article 1	Article 2	Article 3
Davao City's speed limit reduces accidents. 1. How does Davao City's speed limit reduce accidents on the road? 2. How important is speed in ensuring safety on the road? 3. Do you believe that lowering speed limit can reduce road accidents? Explain.	**Ang Pinaka' Top 10 Most Common Causes of Road Accidents** 1. What is the most common cause of road accidents? 2. Why is speed necessary in ensuring road safety? 3. In what way can we reduce road accidents?	**Ateneo pupil dies after being pinned by car** 1. How did the accident happen inside the campus? 2. How can we avoid a similar accident? Explain 3. What might happen if the car's driver immediately stepped on the brake pedal?
GENERALIZATION: **How can we ensure safety if we can predict the outcome of object's motion?**		

You are going to revisit the generalization given before this lesson. You will fill in the fourth column with your generalization you have for this lesson

ACTIVITY 33. Revisiting GENERALIZATION TABLE

Write your findings and corrections to your initial answers to the questions posed in the previous activity. Write your generalization on the third column of the table.

GENERALIZATION TABLE

MY INITIAL THOUGHTS	MY FINDINGS & CORRECTIONS	SUPPORTING EVIDENCE/CONDITION	MY GENERALIZATIONS

How far have gone in understanding the concept? Have you encounter difficulty in drawing your conclusion? What do you think are reasons of difficulty? Now since you have deep understanding on the concept of momentum, impulse and conservation of momentum, you will now see its real-life application.

END OF DEEPEN

TRANSFER

Your goal in this section is apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding. The article below pointed out the road mishap that involves public utility vehicles. Use the application http://www.glogster.com/ for your comprehensive material.

http://www.philstar.com/business/2014/02/13/1289646/impact-public-safety-taken-lightly#main-content

Impact of public safety taken lightly

(The Philippine Star)

The Philippines is becoming one of the most notorious countries in the world for having the most number of coffins on wheels, specifically public transportation buses that people use when travelling on the roads.

The most recent mishap was about a week ago when a bus plunged into a 500-meter-deep ravine on the outskirts of Bontoc, Mountain Province early morning, killing 14 passengers including two European tourists.

In the last quarter of 2013, three major passenger bus accidents also occurred. In October, 20 lives were lost and more than 50 others were injured in Atimonan, Quezon when three buses and four other trucks were involved in a vehicle pile-up.
The following month, in November, a bus headed for the south mowed into a bus stop at the outskirts of Makati City killing six commuters and injuring 33 others.

Then in December, in one of the more bizarre accidents to happen in the country, a bus jumped the concrete side barriers of the elevated Skyway to land on a truck plying the ground level road. More than 20 people died and several others suffered injuries.
In fact, data from the Metro Manila Accident Reporting and Analysis System (MMARAS) points to a steadily growing number of accidents involving public buses, so much so that there is now statistically an average of at least one accident per bus.

Public Utility Roadworthiness

President Benigno Aquino summoned all government agencies responsible for road safety. He is very concerned with public safety, most especially with buses. Rampant road mishap for the last 5 years involves bus accidents. Buses are now considered as coffins on wheels because of chronic road accidents. In response to the call of the President, the Land Transportation Regulatory and Franchising Board (LTFRB) has solicited the community to come up with a scientific safety measures in all public utility vehicles. Since you are one of officers of a local NGO who advocates road safety, you are tasked to create guidelines of for the roadworthiness of all public utility vehicles. Your material will be uploaded to the official website of LTFRB to be used for the community to understand the importance of public utility vehicles roadworthiness. Your material will be evaluated based on depth of content, comprehensive, scientific reasoning, practicality of recommendations and impact on readers.

PERFORMANCE TASK RUBRIC

CRITERiA	4 EXCELLENT	3 SATISFACTORY	2 DEVELOPING	1 BEGINNING
Depth of content	Depth of content is evident in an interesting way. Important and updated evidences are extensively presented	Depth of content is provided. Important evidences are adequately presented.	Depth of content is not clear. Some presented evidence are not related to the problem	No depth in content. No evidences are presented
Compre-hensive	The guide-lines is extensively supported with valid facts and ideas.	The guidelines is adequately supported with valid facts and ideas.	Some important facts and evidences are lacking or erroneous	Not compre-hensive. Needs facts and evidences to support claims and ideas.
Scientific Reaso-ning	Strategy and procedure are presented in great detail	Evidence of strategy or procedure are appropriately used	Inappropriate use of scientific reasoning	No evidence of scientific reasoning used
Practica-lity of recom-menda-tions	Recommen-dations are attainable by any individual and simple to execute.	Recommendations are attainable for any individual	Recommen-dations are not attainable by any individual	Recommen-dations are impossible to achieve.

Impact on readers	Impact on readers is highly observed	Impact on readers is observed	Impact on readers is fairly observed	Impact of readers is totally not observed

END OF TRANSFER:

How did you find the performance task? How did the task help you see the real world use of the topic? Write a **reflective journal** of your experiences and the things you learned about the task.

Write a reflection about your experiences while taking the entire module.
Your reflection will emphasize the following guide questions:

1. What did you find as the most important learning in this module?
2. What did you find as the most challenging yet engaging?
3. What difficulties did you have while taking the entire module?
4. What other performance task you can think of doing which is relevant to the lesson?

You have completed this lesson. Before you go to the next lesson, you have to answer the following post-assessment questions.

LEARNING LOG			
GOALS		**ASSESSMENT OF GOALS**	
Unit Goals ***(Goals prescribed by the curriculum)***	**My Personal Goals** *(How can I personalize the goals prescribed by the curriculum?)*	**My Personal Assessment**	**Teacher's Assessment**
In summary, what have I achieved from this module?			

POST-ASSESSMENT

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

1. How does the force of gravity affect a ball that is thrown horizontally?
   a. The ball accelerates at the same rate as a ball falling from rest
   b. The ball begins to fall vertically only when it begins to slow down
   c. The ball falls at a speed that is proportional to the horizontal velocity
   d. The ball is not affected by gravity because it has a horizontal velocity

2. Which of the following does not affect the total flight time of a projectile?
   a. acceleration due to gravity
   b. initial vertical velocity
   c. initial height
   d. initial horizontal velocity

3. Which of the following must be 0 for a projectile to be at its maximum height?
   a. The horizontal position
   b. The vertical position
   c. The horizontal velocity
   d. The vertical velocity

4. An object is launched with a velocity of 20.0 m/s at an angle of 30.0^{o} above the horizontal. What is the magnitude of the ball's velocity at the highest point in the path?
   a. 0.00 m/s
   b. 17.3 m/s
   c. 10.0 m/s
   d. 20.0 m/s

5. A 1.0 kg block is dropped from the roof of a tall building at the same time as a 3.0 kg ball is thrown horizontally from the same height. Which of the following statements best describes their motion?
   a. The 1.0 kg block hits the ground first because it has no horizontal velocity
   b. The 3.0 kg ball hits the ground first because it has more mass
   c. The 3.0 kg ball hits the ground first because the force of gravity on it is greater
   d. Both hit the ground at the same time because they experience the same vertical acceleration

6. A ball rolls off a ledge with a velocity of 1.44m/s. If the ball hits the floor in 0.455s, how high is the table?
   a. 2.23m
   b. 4.46m
   c. 1.02m
   d. 4.98m

7. What is the trajectory of a projectile in the absence of friction?
   a. a straight line
   b. a curve
   c. a circle
   d. a zigzag

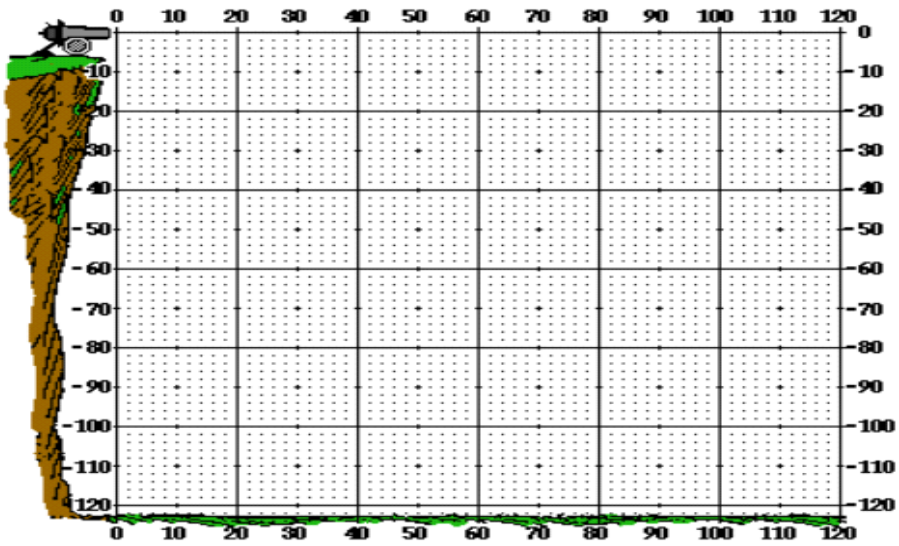
8. A football is kicked into the air at an angle of 45 degrees with the horizontal. At the very top of the ball's path, its acceleration is _____. (Neglect the effects of air resistance.)
   a. entirely vertical
   b. both vertical and horizontal
   c. entirely horizontal
   d. not enough information given to know

9. What can be said about the acceleration in the horizontal acceleration?
   a. It changes
   b. It is – 9.8 m/s/s
   c. It is negative
   d. It is zero

10. Which of the following descriptions of moving objects accurately portray a projectile?
    a. an object which is moving through the air and not touching any surface
    b. a falling skydiver with an open parachute
    c. a free-falling object
    d. a falling feather

11. At what point in its path is the horizontal component of the velocity (v_x) of a projectile the smallest?
    a. The instant it is thrown
    b. It is constant throughout the path
    c. Halfway to the top
    d. At the top

12. A cannonball is launched from the top of a 125-meter high cliff with an initial horizontal speed of 20 m/s. The (x, y) coordinate position of the launch location is designated as the (0, 0) position. What is the (x, y) coordinate positions of the cannonball at 1-second intervals during its path to the ground? Assume g = ~10 m/s/s, down.



a. 20 m , -5 m
b. 5m , -20m
c. 40m , -20m
d. -20m, 40m

13. Consider a karate expert. During a talent show, she executes a swift blow to a cement block and breaks it with her bare hand. During the collision between her hand and the block, the ___.
    a. time of impact on both the block and the expert's hand is the same
    b. force on both the block and the expert's hand have the same magnitude
    c. impulse on both the block and the expert's hand have the same magnitude
    d. all of the above.

14. In order to catch a ball, a baseball player naturally moves his or her hand backward in the direction of the ball's motion once the ball contacts the hand. This habit causes the force of impact on the players hand to be reduced in size principally because ___.
    a. the resulting impact velocity is lessened
    b. the momentum change is decreased
    c. the time of impact is increased
    d. the time of impact is decreased

15. Which has a greater momentum a semi-truck at rest or a bicycle in motion?
    a. truck
    b. neither has momentum
    c. bicycle
    d. same

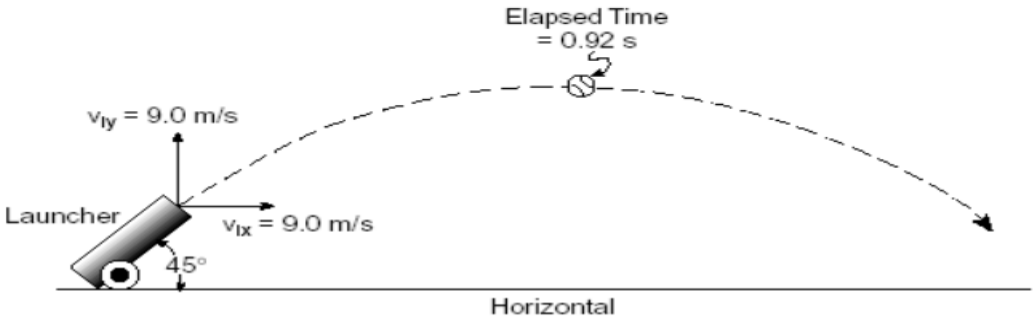
16. Cars are equipped with padded dashboards. In collisions, the padded dashboards would be safer than non-padded ones because they ____.
    a. increase the impact force
    b. increase the impact force
    c. decrease an occupant's impulse
    d. none of the above

17. Which of the following statements are true about elastic and inelastic collisions?
    a. Perfectly elastic and perfectly inelastic collisions are the two opposite extremes along a continuum; where a particular collision lies along the continuum is dependent upon the amount kinetic energy which is conserved by the two objects.
    b. Most collisions tend to be partially to completely elastic.
    c. Momentum is conserved in an elastic collision but not in an inelastic collision.
    d. The kinetic energy of an object remains constant during an elastic collision.

18. Consider a karate expert. During a talent show, she executes a swift blow to a cement block and breaks it with her bare hand. During the collision between her hand and the block, the ___.
    a. time of impact on both the block and the expert's hand is the same
    b. force on both the block and the expert's hand have the same magnitude
    c. impulse on both the block and the expert's hand have the same magnitude
    d. all of the above.

19. In order to catch a ball, a baseball player naturally moves his or her hand backward in the direction of the ball's motion once the ball contacts the hand. This habit causes the force of impact on the players hand to be reduced in size principally because ___.
    a. the resulting impact velocity is lessened
    b. the momentum change is decreased
    c. the time of impact is increased
    d. the time of impact is decreased

20. A machine launches a tennis ball at an angle of 45^0 with the horizontal, as shown below. The ball has an initial velocity of 9 m/s and initial horizontal velocity of 9 m/s. The ball reaches its maximum height 0.92 s after its launch. What is the total horizontal distance travelled by the tennis ball from the machine launcher? (Neglect air resistance).



a. 23 m
b. 17 m
c. 8.3 m
d. 4.1 m

GLOSSARY OF TERMS USED IN THIS LESSON:

Projectile motion is motion with a constant horizontal velocity combined with a constant vertical acceleration caused by gravity.

Horizontal displacement d_x is called the horizontal range of the projectile.

Momentum can be defined as "mass in motion."

Impulse is the quantity Force multiplied by time

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

1. http://www.physicsclassroom.com/class/vectors/u3l2a.cfm - Discussion on Two Dimensional motion

2. http://www.youtube.com/watch?v=tgRMAVoHRbk – Life on the international space station

3. http://www.physicsclassroom.com/mmedia/vectors/hlp.cfm - Multimedia presentation on projectile motion

4. http://phet.colorado.edu/sims/projectile-motion/projectile-motion_en.html - Simulation on projectile motion

5. http://www.ck12.org/physics/Projectile-Motion-Problem-Solving/ - Sample problem solving activity

6. http://eci.wrdsb.ca/sites/eci.wrdsb.ca/files/More%20Projectile%20Motion%20Problems%20%28with%20Detailed%20Solutions%29.pdf – Drills and exercises on projectile motion

7. http://www.nbclearn.com/portal/site/learn/nfl/cuecard/50689/ - Video on Science of Football

8. http://www.youtube.com/watch?v=MbYoxTyKD28 – Maritx videos that shows collision of trucks

9. http://www.physicsclassroom.com/class/momentum/Lesson-1/Momentum- Website for discussion of momentum, impulse and conservation of momentum

10. http://www.youtube.com/watch?v=3g4v8x7xggU – Videos for momentum, impulse discussion

11. https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html - Simulation activity on Collision

12. http://www.mrwaynesclass.com/teacher/Impulse/SimFriction/home.html - Interactive activity on conservation of momentum

13. http://www.glogster.com/ - Website used for presentation of output

14. http://newsinfo.inquirer.net/684841/davao-citys-speed-limit-reduces-accidents-but-businesses-also-affected
Davao City's speed limit reduces accidents, but businesses also affected

15. http://www.gmanetwork.com/news/story/267871/newstv/angpinaka/ ang-pinaka-top-10-most-common-causes-of-road-accidents
Ang Pinaka' Top 10 Most Common Causes of Road Accidents

16. http://www.abs-cbnnews.com/nation/metro-manila/02/25/09/grade-4-ateneo-student-dies-car-accident-report
Ateneo pupil dies after being pinned by car

Lesson 3.1 Heat, Work and Efficiency

☑ INTRODUCTION AND FOCUS QUESTION(S):

Every time you listen to news reports on TV, you will always hear something about the status of power generation in the country. It has been reported that the power generated different power generating companies is not enough to supply the needs of the consuming public. Why is this so? Why do we have power shortage when we have several working power plants in the country? Do we have alternative solutions for this?

In this module, you will learn more about the different power plants that supply electricity to your house. You will also look at how these power plants are operated.

This module will also cover an important concept that is related to power plant operation – thermodynamics. In particular, you will study the relationship between heat, work, and efficiency, which are vital to the operation of power plants. You will explore answers to the following important questions: How does heat and work determine the efficiency of machines? What do power plants need in order to effectively generate, transmit, and distribute electrical energy?

☑ LESSON COVERAGE:

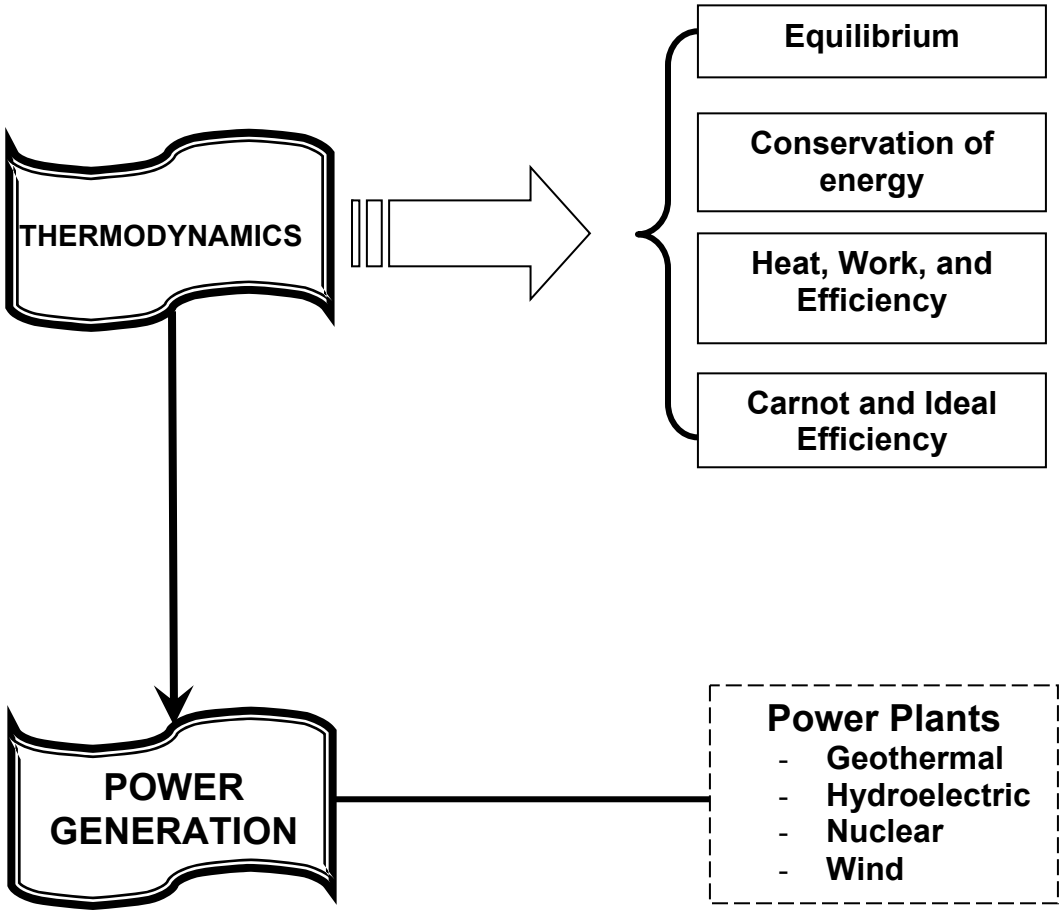
In this lesson, you will examine this question when you take the following lessons:
Lesson 3.1 – Heat, Work, and Efficiency
Lesson 3.2 – Power Generation

In these lessons, you will learn the following:

3.1	• Construct a model to demonstrate that heat can do work. • Infer that heat transfer can be used to do work, and that work involves the release of heat. • Explain why machines are never 100-percent efficient. • Explain using thermodynamic laws, and other physics concepts, the factors that affect the efficiency of household appliances. • Explain how heat transfer and energy transformation make heat engines like geothermal plants work.
3.2	• Explain how electrical energy is generated, transmitted, and distributed.

☑ MAP OF THE LESSONS:

Here is a simple map of the above lessons you will cover:



☑ EXPECTED SKILLS:

To do well in these lessons, you need to remember and do the following:

7. Read the instructions carefully before starting anything.
8. Complete all the activities and worksheets. Follow instructions on how to submit them.
9. Look up the meaning of words that you do not know.
10. You will frequently come across process questions as you go through different topics. Keep a notebook (or use the Notepad) where you can write (and revise) your answers to these questions. Use also the notebook to jot down short notes, draw diagrams, and summarize what you have just read.
11. For worksheets and reports that need to be submitted, use the provided checklist and rubric to evaluate your work before submission.
12. Allow time for relaxation and recreation when you are mentally tired. Make a time table to schedule your study and recreation.

PRE-ASSESSMENT:

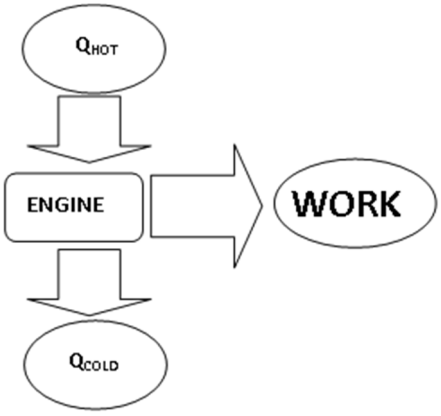
Let's find out how much you already know about these lessons. Click on the letter that you think best answers the question. Please answer all items. After taking this short test, you will see your score. Take note of the items that you were not able to correctly answer and look for the right answer as you go through this module.

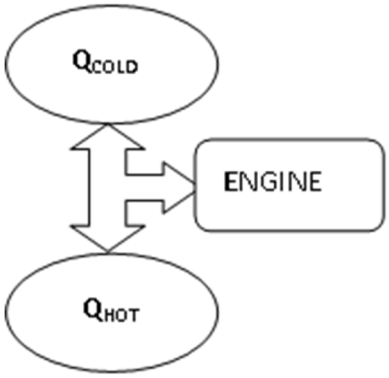
1. A heat engine absorbs 1000 kJ of heat and releases 350 kJ into the cold reservoir. What is the efficiency of the heat engine?
   a. 35%
   b. 50%
   c. 65%
   d. 285%

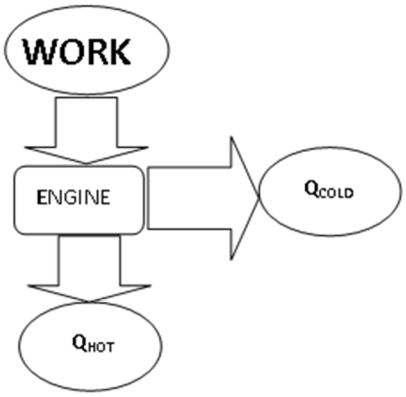
2. How does a geothermal power plant utilize the natural heat coming from underneath the earth?
   a. The heat coming from the earth is used by a turbine to create electricity.
   b. The heat coming from the earth is directly converted to electricity by means of an inverter.
   c. The heat coming from the earth is funneled into distribution pipes that is used to power electrical appliances.
   d. The heat coming from the earth boils water in a tank. When water turns to steam, the steam rotates the blades of a turbine. The turbine converts mechanical energy to electricity.

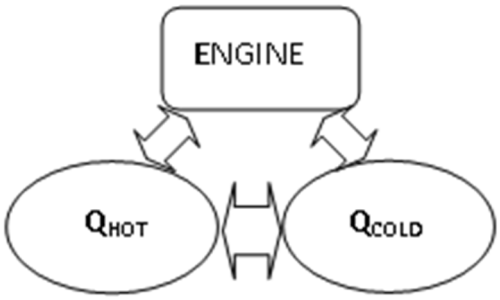
3. What function does the transformer near your house do?
   a. It increases the voltage carried by the electricity that is suited for our home.
   b. It increases the current carried by the electricity to suit the needs of our home.
   c. It is a step down transformer that decreases the current to suit the needs of our home.
   d. It is a step down transformer that decreases the voltage to suit our home.

4. Which of the following is a correct diagram of how a heat engine works?

a.


c.


b.


d.


5. How are gasoline engines and steam turbines similar?
   a. Both of these machines use work to transfer heat from a cold region to a hot region.
   b. Both of these machines are perfectly efficient and are able to do their function.
   c. Both of these machines use heat in order to do mechanical work.
   d. Neither of these two operate at high temperatures which make them highly efficient.

6. In an effort to cool his kitchen, your friend opened the door of his refrigerator. Would this action cool your friend's kitchen?
   a. Yes, because the refrigerator will absorb the heat from the kitchen.
   b. Yes, because the refrigerator is an efficient machine that can absorb as much heat from the kitchen.
   c. No because the refrigerator has to be big in order to cool the kitchen which is considerably bigger than the refrigerator.
   d. No, because the refrigerator will absorb the heat from air near it and at the same time expel heat from the condenser coils inside the kitchen.

7. Imagine a special air filter placed in a window of a house. The tiny holes in the filter allow only air molecules moving faster than a certain speed to exit the house, and allow only air molecules moving slower than that speed to enter the house from outside. Would this air filter cool the house?
   a. Yes since the filter allows molecules that are of considerably high speed to remain inside the room. High speeding molecules is a characteristic of warm air.
   b. Yes since the filter allows molecules that move considerably slower to remain inside the room. Slow moving molecules are a characteristic of cold air.
   c. No because the slow moving molecules should be the one that exit the filter. Otherwise, the room will remain warm.
   d. No because all molecules should exit the room through the filter so that the room will be cold.

8. Using the same situation in question no. 7, would it be possible to build such a filter?
   a. Yes it would be possible to build such a filter as one would only need to ensure that molecules in the air move at a certain speed.
   b. Yes it would be possible to build such a filter as we only need a carbon compound that will be placed in the filter so that it can distinguish which air molecule can exit through it.
   c. No because the filter does not have the internal energy to allow these molecules to pass through.
   d. No because the filter cannot do mechanical work. In order to reverse the flow of heat, work must be done.

9. A heat engine with an efficiency of 30.0% performs 2500 J of work. How much heat is discharged to the lower temperature reservoir?
   a. 5 749 J
   b. 5 833 J
   c. 11 499 J
   d. Cannot be determined

10. A heat pump that uses an underground water reservoir as heat source extracts 2.1×10^5 J each cycle while requiring 3.0×10^4 J. How much heat is delivered to the inside of the house?
   a. 2.4×10^3 J
   b. 2.4×10^4 J
   c. 2.4×10^5 J
   d. 2.4×10^6 J

11. A certain nuclear-power plant has a mechanical-power output (used to drive an electric generator) of 330 MW. Its rate of heat input from the nuclear reactor is 1300 MW. What is the thermal efficiency of the system?
   a. 25%
   b. 50%
   c. 74%
   d. 76%

12. Why would a power plant operate more efficiently at the North Pole than at the equator? Assume the power plant burns fossil fuel, and the fuel always is burned at the same temperature, regardless of location.
   a. Lubricants would not be easily diminished in that region owing to e colder temperature.
   b. There is less friction in the North Pole owing to the fact that there is more ice in that region of the earth.
   c. There is an abundant source of fossil fuels in the North Pole. These are stored right under the frozen land mass.
   d. The outside temperature is much lower than the input temperature thus T_C/T_H will be much lower making the efficiency higher.

13. Will a machine be perfectly efficient if the cold reservoir reaches absolute zero?
   a. Yes because there will be no more friction when the temperature reaches absolute zero.
   b. Yes because it's thermal efficiency will be 1 since the numerator in the expression T_C/T_H will become zero.
   c. No because there will be no more heat for the machine when the temperature reaches absolute zero.
   d. No because the machine can no longer perform its work when the temperature reaches absolute zero.

14. Real heat engines, like the gasoline engine in a car and in some fuel-fired power plants, always have some friction between their moving parts, although lubricants keep the friction to a minimum. Would a heat engine with completely frictionless parts be 100% efficient? Why or why not?
    a. Yes because no input heat will be lost in the process hence all the input heat goes into doing mechanical work.
    b. Yes because a frictionless engine would mean that its efficiency is 100% automatically.
    c. No because 100% efficiency can only be reached if the cold reservoir reaches absolute zero which is impossible to reach.
    d. No because an engine can never be 100% efficient and no inventor has yet to make one.

15. A power plant has been proposed that would make use of the temperature gradient in the ocean. The system is to operate between 20^{o}C (surface water temperature) and 5^{o}C (water temperature at a depth of about 1 km). This plant works with an efficiency of 5.1% while producing 75 MW of power. What compensating factor would make this proposal of interest despite its low efficiency?
    a. It produces a lot of energy.
    b. The temperature difference is small.
    c. The maintenance cost is not so high.
    d. There's a lot of sea water.
16. Why should the voltage of the electricity coming from substations that travel to the transmission lines be very high?
    a. It is high because the substation makes it high.
    b. The voltage is high because it comes directly from the power plant hence it has a lot of energy.
    c. The voltage is high because it contains a lot of energy that will be equally distributed to consumers who need electricity.
    d. The voltage should be high because it has to travel through long transmission lines which dissipate part of the energy that it carries. It can no longer be distributed equally if it has low energy.

17. Which of the following are the main reasons why the Bataan Nuclear Power Plant was never operated by the Philippine government?
    a. economic
    b. environmental
    c. natural disasters
    d. all of the above

18. A step-up transformer can be found in all wind turbines. Why should there be step-up transformers right below the wind turbines?
    a. The electricity produced is stored in these transformers for later use.

b. The voltage of the electricity generated by the turbines has to be increased so that it can travel to transmission lines and not be dissipated along the way.
c. The current of the electricity generated by the turbines has to be increased so that it can travel to transmission lines and not be dissipated along the way.
d. These transformers simply store the electricity and then transfer it to another station.

19. Why should transmission lines be made of low resistance wires and cables?
    a. High resistance wires will just absorb the energy of the electricity thus it will not reach the intended consumers.
    b. High resistance wires have huge diameters that will allow electricity to pass through it without diminishing the energy it carries.
    c. Low resistance wires allow electricity to pass through it without dissipating much of its energy thereby getting maximum efficiency.
    d. Low resistance wires will allow the passage of electricity but will dissipate the energy that it carries with it.

20. Wind turbines in Pagudpud, Ilocos Norte are placed at certain angles with respect to one another. Not all fans can be seen rotating all at the same time. Why is this so?
    a. The placement allows the accommodation of several wind turbines within the specific area.
    b. The placement maximizes the limited space allocated for the wind turbines.
    c. The wind does not blow in one direction only so the placement of the turbines allows any one of these to capture wind thus making it move.
    d. The government has limited budget for the acquisition of more turbines.

Lesson 1: Heat, Work, and Efficiency

EXPLORE

In the previous grade, you learned about the distinction between heat and temperature. You were also introduced to the conservation of energy and the many transformations that it can have. In your early topics in Physics, you also learned that work is the product of net force acting on a body and distance. Now the question is, can heat do work? Recall that heat is energy in motion and that it cannot be contained by an object. So how will it do work? How does the work done by heat determine efficiency?

Let's start the module by gathering your thoughts about a few household appliances which may be of interest to you. Before starting the first activity, remember to write down your observations.

ACTIVITY 1. Our Home Appliances

Look around your house and you will see that you have household appliances that have made your life as comfortable as it can be. Notice that these appliances operate by consuming electricity. Notice also that some of these heat up.

Fill-up the table below with the necessary information. Make sure that you write down your observations.

Appliance Name	***Purpose (What is it used for?)***	***Power Consumption***	***Does it heat up?***	***How long is it used in a day?***	***How should it be used in order to achieve maximum efficiency?***

Note: You may add more rows if you have more appliances.

Process Questions:

1. Which of the appliances you listed produce heat?
2. Why is there a need for these appliances to produce heat?
3. Which of your appliances do you think absorbs heat?
4. What happens to the immediate vicinity of these appliances?
5. *What should the relationship of heat and work be in order for a machine to be efficient?*

ACTIVITY 2. Eliciting Prior Knowledge Through I-R-F Chart

In the previous activity, you were asked to think about the relationship between heat and work. ***What should their relationship be for maximum efficiency?***

What are your initial answers to this question?
Summarize your answers to the question, and your thoughts and ideas in the first column (Initial) of the IRF Chart. When you are finished, click on "Submit."

What should the relationship of heat and work be for maximum efficiency?		
Initial	Revised	Final

END OF EXPLORE:

You gave your initial ideas on the relationship between heat, work, and efficiency by answering the IRF chart.

Let's find out how others would answer the above and compare their ideas to our own. As you compare, you will find out if your ideas are in line with the standard. You will also learn other concepts which will help you complete a required project found at the end. This project is for you to create a hypothetical machine that is highly efficient.

We will start by doing the next activity.

FIRM-UP

Your goal in this section is to learn and understand key concepts about thermodynamics: the science that deals with energy transformations and energy in motion. As you go along this section, remember to fill-up this table from time to time.

Key Concept	***Where am I?***
Equilibrium state	
Thermodynamic processes	
Heat, work and efficiency	
Carnot and the Ideal Efficiency	

ACTIVITY 3. Thermodynamics

In your previous topics in Physics, you were able to distinguish the difference between heat and temperature. Heat is a form of energy that is constantly in motion. This was explained to you using the Kinetic Molecular Theory of Matter which gave you an idea that matter is composed of molecules and that these molecules are in constant motion. Temperature, on the other hand, is a measure of the average kinetic energy of these molecules.

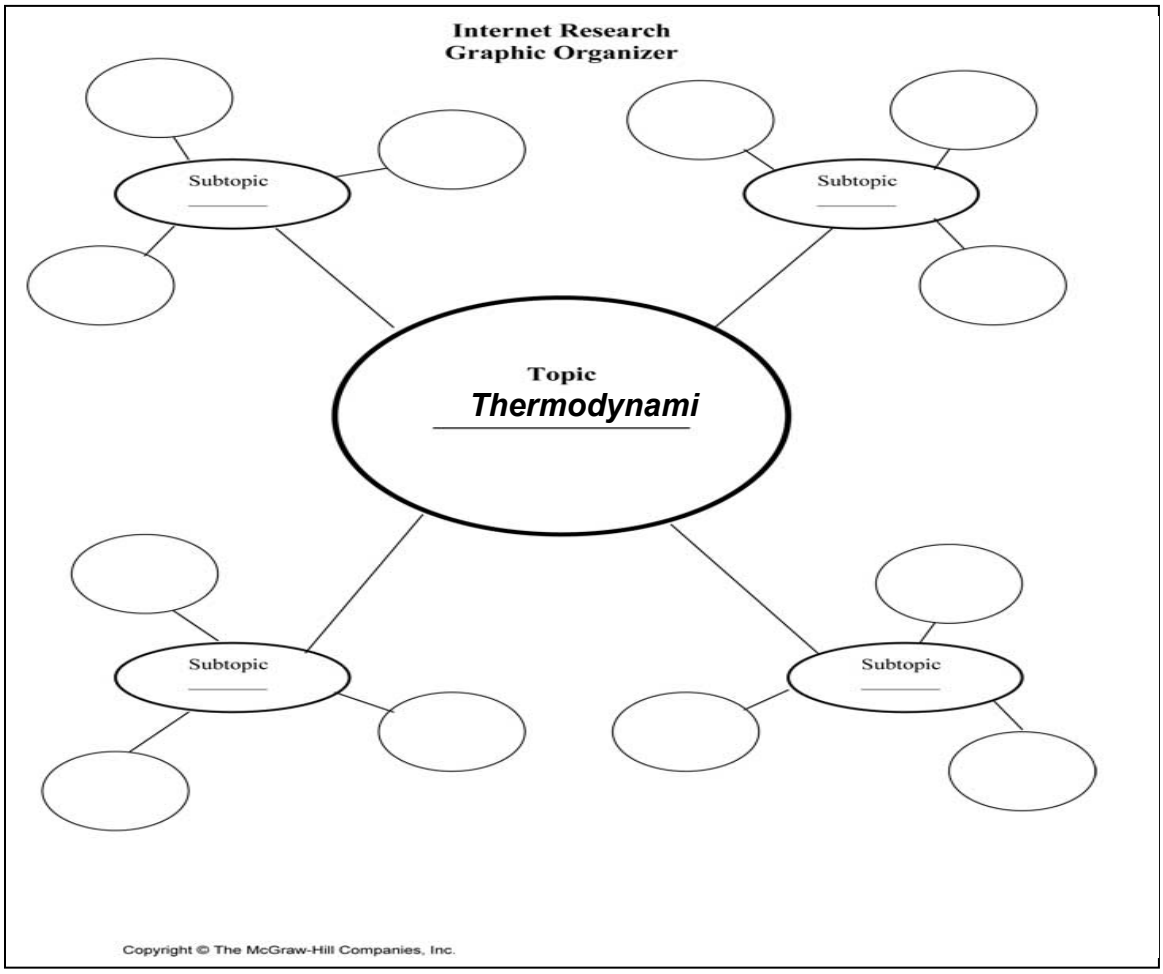
Let us now go into a branch of Physics that considers the interplay between heat and temperature – thermodynamics. Click on the website below and remember to take down notes of the different terms used in the video.

https://www.youtube.com/watch?v=kLqduWF6GXE – Thermodynamics and kinetics lecture from MIT

Process Questions:

1. What is thermodynamics?
2. In brief, what are the laws of thermodynamics?
3. Of what use do state variables have?
4. What are the different processes that are involved in thermodynamics?
5. Why is there a need to consider systems all the time?
6. What kind of interactions can happen within the system?

After watching the lecture video, complete the graphic organizer below with thermodynamics at its center.



ACTIVITY 4. Zeroth Law?

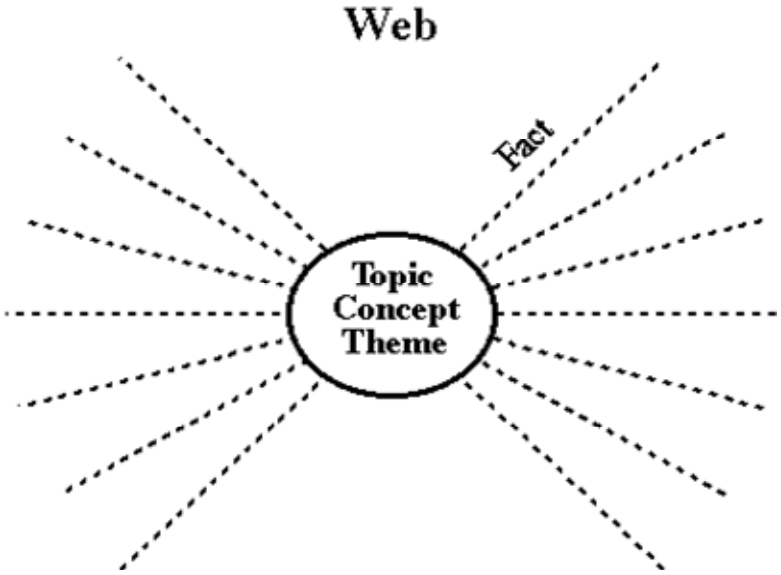
After the introduction to thermodynamics, consider the question: Why is there a zeroth law? Consider putting a metal spoon in a glass of hot water. What happens to the spoon? How about the water? Through time, will they eventually have the same temperature?

The concept of equilibrium happens naturally and everything else will always come to it unless external forces intervene. Like the metal spoon in a glass of hot water, they will eventually have the same temperature as time passes by. Watch the video below and learn more about the zeroth law of thermodynamics. https://www.youtube.com/watch?v=3NdCQpSmZN4 – video on the zeroth law of thermodynamics.

Process Questions:

1. What is the zeroth law of thermodynamics?
2. What happens to two objects in a system if these two have a temperature difference?
3. Suppose we add a third object in the system, what happens between the third and one of the two objects?
4. Why was there a need to add the zeroth law?

Click this website http://www.physicsplanet.com/articles/three-laws-of-thermodynamics and read more about the zeroth law and fill-up this organizer for you notes.



http://writedesignonline.com/organizers/brainstorm.html

ACTIVITY 5. The First Law and Thermodynamic Processes

Now that you understand the zeroth law and the concept of equilibrium, consider what happens to a system when it absorbs heat? What happens to the system at equilibrium? How about if the system's temperature is kept constant? Observe what happens when you pump air into your bicycle using an air pump. What happens to the sides of the pump?

In the previous module, you learned about the conservation of energy. In this activity you will explore what happens to heat as it is absorbed by the body. Where does this heat go? What happens to a system when it absorbs heat? Click on the websites below and watch the video.

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/firlaw.html - gives a brief discussion on the first law of thermodynamics

http://www.physicsplanet.com/articles/three-laws-of-thermodynamics - gives a brief discussion on the three laws of thermodynamics

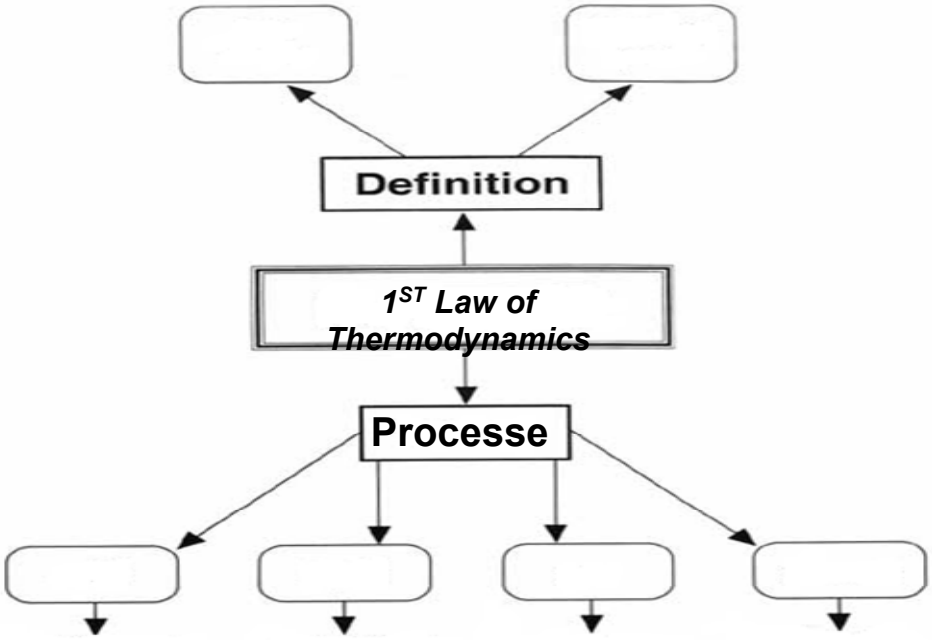
https://www.youtube.com/watch?v=kLqduWF6GXE – Thermodynamics and kinetics lecture from MIT

https://www.youtube.com/watch?v=Xb05CaG7TsQ – from Khan Academy on the first law of thermodynamics

Process Questions:

1. What does the first law of thermodynamics say about energy?
2. Why is the first law considered as restatement of the conservation of energy?
3. Describe each of the following processes:
   a. Adiabatic,
   b. Isobaric,
   c. Isochoric or isovolumetric, and
   d. Isothermal.
4. What transformation of energy happens in the processes?
5. How does this relate to efficiency of machines and of systems in general?

After knowing the first law and the different thermodynamic processes, complete the organizer below.



https://sites.google.com/site/msquilici/science-units/powerpoints-1/properties-of-matter-powerpoints

ACTIVITY 6. Concept Check

The first law has reminded you once again that energy is conserved in all systems even though it is transformed into several forms. Heat that flows through a system is used in doing work or in increasing the systems internal energy. Now you only have to remember that Work (W) is force (F) times distance (d). But force is pressure (P) times area (A), hence W = PAd. Now area times distance is just the volume. Hence, work is equal to the pressure exerted to the system times the change in its volume that it experiences due to the pressure.

What do the facts above tell us about the relationship between heat (Q), change in internal energy (ΔU), and work? Fill-up the table below and show what happens.

1ST Law Equation: Q = ΔU + W		
PROCESS	***WHAT IS KEPT CONSTANT?/DESCRIPTION***	***RELATIONSHIP BETWEEN Q, ΔU, W***
Adiabatic		
Isobaric		
Isochoric or Isovolumetric		
Isothermal		

Now try answering these questions:

Part I Conceptual Questions
Read, analyze, and answer each question carefully. Remember to look for the key terms in each question to guide you on how you should answer the question.

1. What happens to the internal energy of a system when work is done on it? What happens to its temperature?

2. What is the relationship between heat added to a system and the internal energy and external work done by the system?

3. If work is done adiabatically on a system, will the internal energy of the system increase or decrease? If work is done by a system, will the internal energy of the system increase or decrease?

4. What condition is necessary for a process to be adiabatic?

5. What generally happens to the temperature of rising air?

Part II Computational Questions
Read, analyze, and answer each question carefully.

1. A volume of air cools adiabatically reducing its internal energy by 400 J. How much work is done? Who does the work?

2. A volume of air is heated in a constant volume container and 2 000 J of heat is added to it. What is the change in internal energy? What happens to its temperature?

3. A liter of water is heated at a constant pressure of 1 atm. It exerts 700 J of work against the lid of the container. If the temperature of the water changed from 20 ^{0}C and 95 ^{0}C, how much is the change in internal energy?

4. In moving out a dormitory, a student does 1.6x104 J of work. In the process, he losses 4.2x104 J of internal energy. Determine the amount of heat lost from the student. If he released the heat in the form of perspiration, how much water evaporated out of his body?

5. The system's internal energy is increased by 800 J and the system does 1000 J of work. How much heat is absorbed by the system?

Good job! You have seen how systems in equilibrium states (zeroth law) can be affected when energy, in the form of heat, is supplied to it (1st law). Heat, as you encountered in the previous activities, can change a systems internal energy thus giving the system a source for doing work. Take the case of steam coming out of a pot. As it comes out of the pot, where it absorbed heat, it has a lot internal energy and the molecules are moving (kinetic energy?) faster. This causes it to rise up and at the same time bump off air molecules surrounding it (work). Eventually, as it rises up, it will come to an equilibrium with the surrounding air (zeroth law again). When it settles on top, its internal energy has already been expended thus it will feel colder.

In what direction does heat flow? Does this happen to the appliances you listed in a table? Remember this table below?

Appliance Name	*Purpose (What is it used for?)*	*Power Consumption*	*Does it heat up?*	*How long is it used in a day?*	*How should it be used in order to achieve maximum efficiency?*

Which of these uses heat to do work? Which of these use work to get heat off? The answers to all these questions lie in the next activity.

ACTIVITY 7. NET EXPLORATION: Engines and Refrigerators

So you've had the zeroth law and the first law of thermodynamics, but in which direction does heat flow? If some of your appliances use heat to do work, does all the heat absorbed become work? How much of the heat absorbed is actually used in doing useful work?

Read the following webpages and watch the video that follows.

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/seclaw.html - discussion of the Second law of thermodynamics

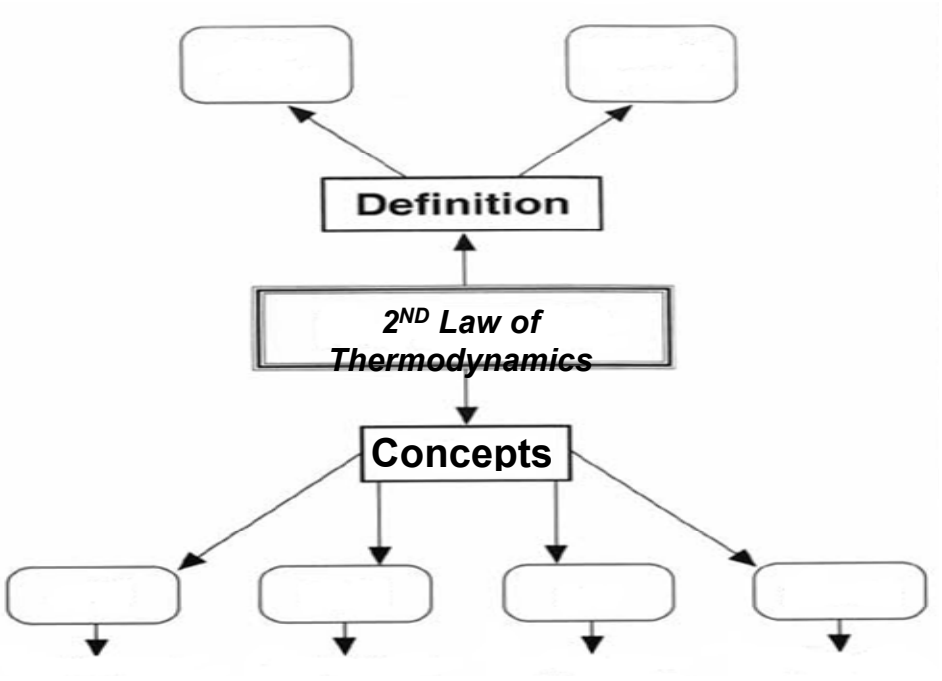
https://www.grc.nasa.gov/www/k-12/airplane/thermo2.html - discussion of the second law of thermodynamics and entropy

https://www.youtube.com/watch?v=DHUwFuHuCdw – animation on the second law of thermodynamics from tutorvista.com

Process Questions:

1. What does the second law of thermodynamics say about heat transfer?
2. What is entropy?
3. Why isn't all the energy absorbed by an engine go into doing useful work?
4. Is it possible to convert all of mechanical work into heat?
5. Why is entropy considered as time's "arrow"?
6. What is efficiency?
7. *What should you do in order to have an efficient engine*?

Now that you know the second law, complete the organizer below.



https://sites.google.com/site/msquilici/science-units/powerpoints-1/properties-of-matter-powerpoints

ACTIVITY 8. Practice Makes Perfect!

You've been introduced to the heat engine and the heat pump. What's the difference between the two? An engine is a machine that absorbs heat to do work. On the other hand, a pump is a machine that uses work in absorbing heat. Notice the difference? Now repeat the statements. What does a heat engine do again? How about a heat pump?

It was also mentioned in the websites that the second law gives an idea of how efficiency for the two machines can be calculated. Think of the purpose of each machine. One can only consider a machine efficient if it has served its purpose with less input right? For a heat engine, it is only efficient if it does more work for less heat input. Thus its efficiency ε = work done / heat input or absorbed = W / Q_H. A heat pump's efficiency is called its Coefficient of Performance or COP. Now, as stated earlier, a heat pump uses work to absorb heat from an already cold area and releases it to a warmer area. Thus it's COP = heat absorbed / work done.

This is just logical because you can never say that an air conditioner is efficient if it doesn't cool the room for which it was supposed to do so right?

Now you can start practicing with some problems on engines and refrigerators. Try this.

Read, analyze, and answer each problem carefully.

1. A window air-conditioner absorbs 80 000 J of heat and expels 130 000 J of heat in the environment. How much work is done and what is the COP of the pump?

2. A heat engine absorbs 30 000 J of heat and releases 15 000 J of heat per cycle. How much work is done by the engine per cycle? What is the thermal efficiency of the engine?

3. A heat pump can take out 50 000 J of heat from a room and require 20 000 J of work during the process. How much heat is expelled into the surrounding? What is the COP of the heat pump?

4. A refrigerator absorbs 200 000 J of heat from 1 kg of water with an initial temperature of 20 0C. In the process, the refrigerator released 400 000 J of heat into the environment. How much work is done by the refrigerator? What is the COP of the refrigerator? Did the water freeze completely? Why or why not?

ACTIVITY 9. What is Ideal?

Now you have done the necessary computations on engines' and refrigerators' efficiency, have you imagined what it would take for these machines to be perfectly efficient? What conditions should be observed in order for these to operate with maximum efficiency?

Click on the websites below and find out more about ideal efficiency.

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/carnot.html - discussion of the Carnot cycle

https://www.boundless.com/physics/thermodynamics--3/the-second-law-of-thermodynamics/carnot-cycles/ - discussion of the Carnot cycle

Process Questions:

1. How is the Carnot or ideal efficiency of an engine or refrigerator defined?
2. Using the equation for ideal efficiency, at what temperature will a machine be perfectly efficient?
3. What do power plants need in order to effectively generate, transmit, and distribute electrical energy?

Remember to take note of the important concepts of this activity.

ACTIVITY 10. How Sad It Is?

In the previous activity, you learned that the greater the temperature difference between the hot reservoir and the cold reservoir the greater will be the efficiency of a machine. Hence, most machineries would need to operate under high temperatures in order to be efficient. What if the cold reservoir reaches absolute zero? Can it reach 0 Kelvin?

Click on the website below and find out the answers to the questions above.

https://www.youtube.com/watch?v=kLqduWF6GXE – Thermodynamics and kinetics lecture from MIT

http://news.bbc.co.uk/dna/place-lancashire/plain/A780266 - discussion on the laws of thermodynamics

Process Questions:

1. At what temperature will any machine be perfectly efficient?
2. Why can't absolute zero be reached?
3. Will a machine still work in absolute zero?

ACTIVITY 11. Sum It Up

Go back to the focus question: ***What should the relationship of heat and work be for maximum efficiency?***

What are now your revised answers to this question?

Summarize your answers to the question, and your thoughts and ideas in the second column (Revised) of the IRF Chart. Compare your new ideas with your initial ideas. When you are finished, click on "Submit."

What should the relationship of heat and work be for maximum efficiency?		
Initial	**Revised**	Final

Do you also now have revised insights on the working conditions of your appliances?

Appliance Name	***Purpose (What is it used for?)***	***Power Consumption***	***Does it heat up?***	***How long is it used in a day?***	***How should it be used in order to achieve maximum efficiency?***

With all the information you have learned in the previous activities, how will ensure that your appliances are working efficiently?

Confirm your answers in the next section.

END OF FIRM UP:

In this section, the discussion was about the relationship between heat and work using the different laws of thermodynamics. You have also learned when a machine can be perfectly efficient using the Carnot or ideal efficiency.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision? What new learning goal should you now try to achieve? Go back to your key concepts checklist and find out where you are in terms of these concepts:

Key Concept	***Where am I?***
Equilibrium state	
Thermodynamic processes	
Heat, work and efficiency	
Carnot and the Ideal Efficiency	

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

You have learned about the different laws of thermodynamics and how they explain the concept behind a heat engine and a heat pump. You have also computed efficiencies of engines, refrigerators, heaters, and air conditioners.

Your goal in this section is to take a closer look at how these appliances put the laws of thermodynamics in action. While watching the videos or reading the websites, remember to look at your appliances if you have these at home. Try to do a tracing of your own and find out.

ACTIVITY 12. Principles of Mechanical Refrigeration

In the previous section of this module you learned that a refrigerator or an air conditioning unit functions in a similar way. These machines use mechanical work in absorbing heat from an already cold region. In the case of the refrigerator, the cold region is its inside and the hot region is the surroundings where the refrigerator can be found. Air conditioning units have the room as the cold region and the surrounding area outside the room as the hot region.

Find out how your refrigerator works by watching the video below.
https://www.youtube.com/watch?v=_b29-MrNL38 – American air force video on the principles of mechanical refrigeration

Process Questions:

1. What role does the refrigerant do in the operation of a refrigerator?
2. Why should a refrigerant have a lower specific capacity than that of water?
3. What does pressure difference have to do with the circulation of the refrigerant?
4. How important is the compressor?
5. What should you do in order to make sure that your refrigerator is working efficiently?

Now draw a picture of your very own refrigerator or if you are not good in drawing, download a picture of a refrigerator similar to yours then upload this picture in Blabberize.com. Your refrigerator should say messages of how it can be maintained to work with the maximum efficiency.

ACTIVITY 13. How a Gasoline and a Diesel Engine Work?

You have learned in the previous activity the basic principle behind each refrigerator. In this activity you will explore how a gasoline and a diesel engine works. What is the main difference between the two? Where do the thermodynamic processes occur in these engines? How come most of the jeepneys and buses in the Philippines are diesel powered? Aside from economy, because it works on a cheaper fuel, what advantage does a diesel engine have over a gasoline engine?
Click on the websites below and watch the videos. Remember to take note of important concepts.

https://www.youtube.com/watch?v=ASJmVNcJqk4 – video on the heat engines

https://www.youtube.com/watch?v=g39nM7GbSJA – how a heat pump works

http://www1.eere.energy.gov/vehiclesandfuels/pdfs/basics/jtb_diesel_engine.pdf - discussion on the diesel engine and its advantages against gasoline

http://www.rcfb.org/images/How_Diesel_Engines_Work.pdf - discussion on how diesel engines work

https://www.youtube.com/watch?v=s2WGFELXPNg – diesel engine animation

Process Questions:

1. What are the different processes that happen in a gasoline engine?
2. Why should the gas be sparked?
3. As the gas in the chamber expands and pushes the piston down, does the energy from the expansion of the gas go into pushing the pistons down? Or it also goes into counteracting the friction between the piston and the chamber?
4. Why is there a need for fuel and air to mix in the chamber?
5. What is the difference between a gasoline engine and a diesel engine?
6. Why are most jeepneys and buses in the Philippines diesel-powered?
7. Which of the two types of engines is more efficient?

ACTIVITY 14. Strengthening New Knowledge Through I-R-F CHART

The focus question for this lesson is: ***What should the relationship of heat and work be for maximum efficiency?***

What are your final answers to this question? Your answers should reflect your wider understanding the relationship between heat and work and how this relationship affects the efficiency of a machine.

Summarize your answers to the question, and your thoughts and ideas in the third column (Final) of the IRF Chart. Compare your new ideas with your previous ideas. When you are finished, click on “Submit.”

What should the relationship of heat and work be for maximum efficiency?		
Initial	Revised	**Final**

END OF DEEPEN:

In this section, the activities focused on mechanical refrigeration and engines that are used in our country. You learned the working conditions for these machines and how these can be kept working efficiently.

What new realizations do you have about the topic? What new connections have you made for yourself? What helped you make these connections?

Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is to apply your learning to real life situations. You will be given a practical task which will demonstrate your understanding.

ACTIVITY 15. My Highly Efficient Machine

You've learned everything about machine efficiency in with respect of heat and work. Now in this activity, you are going to go over the table you filled-up in the previous activities.

Remember this table -

Appliance Name	*Purpose (What is it used for?)*	*Power Consumption*	*Does it heat up?*	*How long is it used in a day?*	*How should it be used in order to achieve maximum efficiency?*

TASK

Your task in this activity is to investigate on the amount of power that you consume for a given month and then trace which of the appliances in your list contributed to most of the power consumed. Your investigation should include calculations of how much power the appliance consumes based from the wattage given in the user's manual of the machine.

Once you have done this, present your results using Prezi.

Process Questions:

1. Which of the appliances consumed less power?
2. Which of the appliance was used most often?
3. Are these appliances really necessary or you can do away with them?
4. How will you increase the efficiency of these appliances and bring down the cost of your electric bill?

End of TRANSFER:

In this section, your task was to investigate on a problem or issue related to heat, work, and efficiency.

How did you find the performance task? How did the task help you see the real world use of the topic?

You have completed this lesson. You may now proceed to the next lesson.

Lesson 3.2: Power Generation

EXPLORE

In the previous lesson you learned about heat, work, and efficiency. You also learned that the laws of thermodynamics govern the relationship of heat and work. Engines, from the second law of thermodynamics, use heat that they absorb in doing work. But not all of the absorbed heat goes into doing useful work. Some of it is released as waste products into a colder region. Refrigerators and air conditioners, collectively known as heat pumps, use mechanical work to extract heat from an already cold region and transfer it into a hotter region. The laws of thermodynamics also gave you an idea of how a machine's efficiency can be calculated. But what does this have to do with how electrical energy is generated?

You must have an idea of where the electricity you use at home comes from right? If so, how do they generate electricity? What role does the efficiency of an engine play in the effective generation, transmission, and distribution of electricity? Or in another sense, how does the relationship of heat and work affect the operation of power plants?

Let's find out more through the activities below.

ACTIVITY 1. The Chernobyl Disaster

What happens when heat increases at an enormous rate? Will a machine still work? Click on the website below and watch the story of the Chernobyl disaster.

https://www.youtube.com/watch?v=5WGUbfzr31s – a National Geographic Channel video on the Chernobyl explosion

Process Questions:

1. What did you feel while watching the video?
2. Could there have been precautionary measures done?
3. What happened when heat rose to an extremely dangerous level?
4. Why should temperature and pressure be controlled?
5. Should the Philippines consider nuclear energy?

ACTIVITY 2. Eliciting Prior Knowledge Through I-R-F CHART

As you go through this lesson, always consider these focus questions: ***What do power plants need in order to effectively generate transmit, and distribute electrical energy?***

What are your initial answers to these questions?
Summarize your answers to the question, and your thoughts and ideas in the first column (Initial) of the IRF Chart. When you are finished, click on “Submit.”

What do power plants need in order to effectively generate, transmit, and distribute electrical energy?		
Initial	Revised	Final

END OF EXPLORE:

You gave your initial ideas regarding what power plants need in order to effectively generate, transmit, and distribute electrical energy.

Find out how others would answer the above and compare their ideas to your own. As you compare, you will find out if your ideas are in line with the standard. You will also learn other concepts which will equip you as you complete the transfer task found at the end of this lesson. The task is to create a multimedia presentation that shows the advantages and disadvantages of certain source of electrical energy including how it should be transmitted and distributed to households in the Philippines.

We will start by doing the next activity.

FIRM-UP

Your goal in this section is to learn and understand how the different power plants from sources that are found in the Philippines.

Complete the first two columns (GOALS Columns) of this **learning log** to keep you guided as you accomplish your goals:

POWER GENERATION			
What I need to accomplish?	***How will I accomplish them?***	***What do I think of my performance?***	***What does my teacher think about what I've accomplished?***
Explain how heat transfer and energy transformation make heat engines like geothermal plants work			
Explain how electrical energy is generated, transmitted, and distributed.			

ACTIVITY 3. The Fukushima Daiichi Nuclear Plant

In the previous section, you learned about the Chernobyl disaster and how it has affected neighboring countries and states. What happened in that power plant was due to the build-up of an enormous amount of heat and energy that were uncontrollable. You must have seen in the video how that power plant works? It might have made you wonder why some countries still prefer using nuclear energy in the production of electrical energy. The consultant scientist in that video said that the design of the power plant was flawed. What other designs could there be?

In this activity, find out how two nuclear power plants are designed differently from the Chernobyl power plant and compare the three by filling-up the table below.

http://www.youtube.com/watch?v=JMaEjEWL6PU – shows what happened during the Fukushima nuclear plant meltdown

http://www.youtube.com/watch?v=PKNbwclaGng – shows how a nuclear power plant works in Canada

Nuclear Power Plant	Design Features	Amount of Electrical Energy Generated	Shortcomings
Russian Power Plant (Chernobyl)			
Japanese Power Plant (Fukushima Daiichi)			
Canadian Power Plant			

Process Questions:

1. What are the main parts of a nuclear power plant?
2. What role do radioactive elements play in the power plant?
3. How is heat used in the power plant?
4. Which power plant uses nuclear power efficiently?
5. What do power plants need in order to effectively generate, transmit, and distribute electrical energy?

In order to prepare you for the task at the end of this lesson, fill-up the table below.

NUCLEAR POWER PLANT	
Advantages	**Disadvantages**

ACTIVITY 4. Geothermal Power Plants

In the previous activity, you learned about how a nuclear power plant works. This source of electrical energy uses radioactive elements that undergo fission. The fission process generates enough heat to boil water to steam that turns turbines attached to generators. In this activity, you will explore how geothermal power plants work.

Try to find out how geothermal power plants are similar to nuclear power plants. In what way are they the same? How are they different?
Where can these power plants be built? Which power plant is safer?

Click on the websites below and find out more about geothermal power plants.

http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-12-35.pdf - text on the basic principles of thermodynamics to be treated in lectures “Steam cycles for geothermal power production”, “Design of the main components of a steam cycle power plant”, “Binary cycles for geothermal power production” and “Design of the main components of a binary cycle power plant”

http://geoheat.oit.edu/bulletin/bull20-2/art1.pdf - gives a brief history of geothermal power generation

http://www.doe.gov.ph/renewable-energy-res/geothermal - shows the different benefits which the Philippines has reaped from geothermal power plants

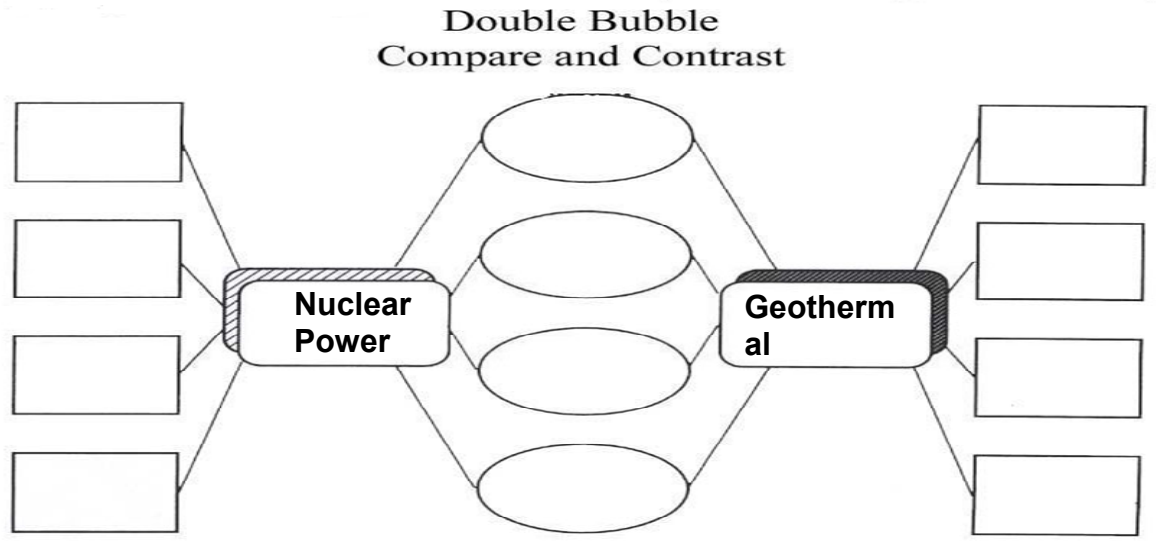
http://www.geo-energy.org/reports/Geothermal%20Technology%20-%20Part%20II%20(Surface).pdf – gives an explanation on how a geothermal power plant works

Process Questions:

1. Where do geothermal power plants get the heat that it uses in generating electricity?
2. Is the heat source of a geothermal power plant renewable or non-renewable? Explain.
3. Where should we build geothermal power plants? Why?
4. What do power plants need in order to effectively generate, transmit, and distribute electrical energy?

Now that you have an idea about geothermal power plants, fill-up the compare and contrast matrix below

(Used with Permission: Cambridge, Massachusetts Public Schools)



http://www.ecusd7.org/ehs/ehsstaff/jparkin/Academics/Medieval_World_History/Resources/Study_Aids/Graphic_Organizers/Compare_and_Contrast-Double_Bubble.jpg

ACTIVITY 5. The Power of Water

In the previous activities, you encountered power plants that had sources of heat that boils water into steam which turns turbines connected to generators. In this activity, you will explore how the power of water is used in generating electrical energy. How does a hydroelectric power plant work? What energy transformations happen in a hydroelectric power plant? Why is there a need to store water in dams?

Click on the websites below and watch how a hydroelectric power plant operates.

http://www.doe.gov.ph/renewable-energy-res/hydropower advantages and disadvantages of hydroelectric power plants in the Philippines

https://www.youtube.com/watch?v=rnPEtwQtmGQ – animation showing how electricity is generated using hydroelectric power


Process Questions:

1. How is water used in hydroelectric power plants?
2. Why does water have to be stored in dams in order for it to be useful in hydroelectric power plants?
3. Can the water used in the power plant still be used for other purposes?
4. What are the energy transformations that happen in a hydroelectric power plant?
5. What do power plants need in order to generate, transmit, and distribute electrical energy?

ACTIVITY 6. Wind Power

In the previous activity, you learned how a natural resource such as water is used in generating electrical energy. In this activity, you are going to explore how another natural resource can be used to generate electrical energy – wind.

Click on the website below and watch how a wind turbine generator is operated.

http://www.youtube.com/watch?v=LNXTm7aHvWc - An overview of the layout of utility-class wind turbine generators - where are the major components, what do they do, and what differences can be found between models and size ranges.

Process Questions:

1. How is wind used in generating electricity?
2. What is the role of step-up transformers in a wind turbine tower?
3. What are the different energy transformations that happen in wind turbines?
4. What do power plants need in order to effectively generate, transmit, and distribute electrical energy?

ACTIVITY 7. Revising Prior Knowledge Through I-R-F CHART

Now that you know more about the power plants that produce electrical energy, what new ideas do you have? What ideas need to be changed?

Fill-up the second column of the table below.

What do power plants need in order to effectively generate, transmit, and distribute electrical energy?		
Initial	**Revised**	Final

END OF FIRM UP:

In this section, the discussion was about power plants and how they generate electrical energy.

Go back to the previous section and compare your initial ideas with the discussion. How much of your initial ideas are found in the discussion? Which ideas are different and need revision? What new learning goal should you now try to achieve? Go back to your *learning log* and do self-monitoring of your accomplishment of the listed goals.

Now that you know the important ideas about this topic, let's go deeper by moving on to the next section.

DEEPEN

As shown in the previous section, some of these power plants were operated at a certain cost. Others were too costly that life was taken away. The construction of these power plants requires certain financial considerations as well as space considerations.

In this section, you will be skilled at identifying where these power plants can be built in the Philippines. With the looming energy crisis, it is but timely that you locate places in the Philippines where power plants can be constructed.

ACTIVITY 8. Putting Through the Right Pieces Together

Now that you know how different power plants work, complete the table below.

Characteristic	Nuclear	Geothermal	Hydroelectric	Wind
Source of Energy				
Electricity generated (in MW)				
Location				

Hazards				
Manpower Availability				
Operational Costs				

After filling-up the table, look at the map of the Philippines and identify at least 5 areas where at least one or two power plants can be built. Do not include areas where there is an existing power plant.

Process Questions:

1. Which provinces in the Philippines are suited for any of the four power plants mentioned in the previous activities?
2. Why are these places suited for a particular power plant?
3. How will the electrical energy generated from this power plant be transmitted and distributed?
4. Will a power plant work if it is privately owned or government controlled? Explain.
5. What mechanisms must be in place for the power plant to effectively generate, transmit, and distribute electrical energy?

ACTIVITY 9. Strengthening New Knowledge Through I-R-F CHART

Consider again these focus questions: ***What do power plants need in order to effectively generate, transmit, and distribute electrical energy?***

What are your final answers to these questions? Your answers should reflect your wider understanding of species extinction.
Summarize your answers to the questions, and your thoughts and ideas in the third column (Final) of the IRF Chart. When you are finished, click on “Submit.”

What do power plants need in order to effectively generate, transmit, and distribute electrical energy?		
Initial	Revised	**Final**

END OF DEEPEN:

In this section, you investigated further the practicality of building any of the four power plants discussed in the previous section in the Philippines.

What new realizations do you have about the topic? What new connections have you made for yourself? What helped you make these connections?

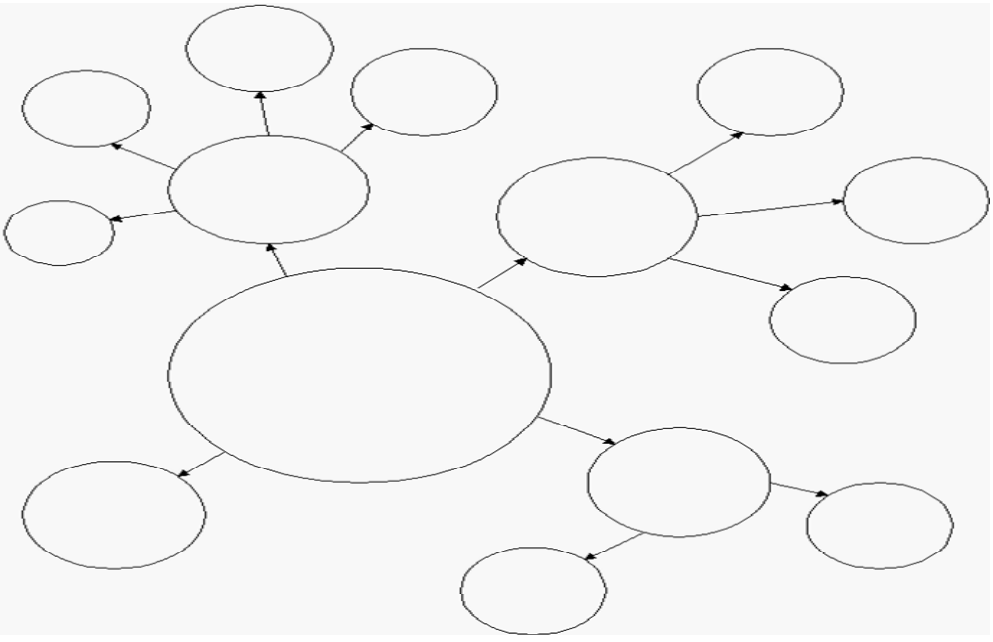
Now that you have a deeper understanding of the topic, you are ready to do the tasks in the next section.

TRANSFER

Your goal in this section is to apply your learning to real life situations. You will be asked to create multimedia presentations based from what you've learned in this module and from you've encounter in your own research.

ACTIVITY 10. Concept Map

You're almost done with the module. Try to summarize everything you learned through a **concept integration map.** Make the relationship between topic 1 (heat, work, and efficiency) and topic 2 (power generation) evident in your map.



http://www1.chapman.edu/cll/faculty/piper/2042/graphorg.htm

Process Questions:

1. In what way is the concept of heat, work, and efficiency related to the operations of power plants?
2. What do power plants need in order to effectively generate, transmit, and distribute electrical energy?

ACTIVITY 11. PERFORMANCE TASK

TASK

A certain power company has once again asked the Energy Regulatory Commission (ERC) to grant its petition for increase in its power charges. With the looming rate hike and the threat of rotational brownouts, a non-government organization (NGO) is inviting all concerned citizens to create multimedia presentations on the different energy sources in the hope of finally stabilizing power distribution in the country. This presentation will be presented to the commissioners of the ERC.

Hence, your group's task is to create a multimedia presentation focusing on one particular energy source. This presentation should present where this source of energy can be taken, how energy is transformed, and how it can be effectively distributed to its consumers. Part of this presentation should be your research on the viability of building a power plant for the energy source.

Your group's presentation will be graded according to the following criteria: accuracy of information, depth of analysis, and creativity.

Rubric:

CRITERIA	Outstanding 4	Satisfactory 3	Developing 2	Beginning 1	RATING
Accuracy of Information	The information presented is accurate and detailed. Contains a short history of power generation using this alternative and how much electricity this method of power generation contributes. It also traces how electricity is generated, transmitted, and distributed from this method.	The information presented is accurate and detailed. Contains a brief history of power generation using this alternative but contains an inaccurate computation of how much electricity is generated. Traces how electricity is generated and transmitted but lacks a way of distributing it to individual homes.	The information is inaccurate but detailed. Does not contain a history of power generation using this alternative and an inaccurate computation of how much electricity is generated. Traces how electricity is generated using this method but does not show how it is transmitted and distributed to individual homes.	The information presented is inaccurate and not detailed. Does not contain a history of power generation using this alternative and has an inaccurate computation of how much electricity is generated. Does not show how electricity is generated, transmitted and distributed.	

Depth of Analysis	The presentation contains all possible advantages and disadvantages of using a method of power generation. It also considers the feasibility of building a power plant and the sites where it can be constructed.	The presentation contains all possible advantages and disadvantages of using this method of power generation. It considers the feasibility of building a power plant but does present possible sites where it can be constructed.	The presentation contains all possible advantages and disadvantages of using this method of power generation. However, it does not consider the feasibility of building a power plant and the sites where it can be constructed.	The presentation sparsely contains the advantages and disadvantages of using this method of power generation. It does not consider the feasibility of building power plants and where these can be built.	
Creativity	The presentation is creatively done using at least 4 media of presentation. Color combination is well observed that enhances the presentation.	The presentation is creatively done using 3 media of presentation only. Color combination is well observed that enhances the presentation.	The presentation is creatively done using 2 media of presentation only. Color combination is a little bit distracting and does not blend well.	The presentation is creatively done with only 1 medium of presentation. Color combination is very distracting and does not blend well.	
				OVERALL RATING	

End of TRANSFER:

In this section, your task was to make a multimedia presentation about power generation.

How did you find the performance task? How did the task help you see the real world use of the topic?

Have a final assessment of your accomplishment of the goals for this lesson (What do I think of my performance? 3rd column). Then, give this form to your teacher so he/she can give his/her assessment of you.

POST-ASSESSMENT:

It's now time to evaluate your learning. Click on the letter of the answer that you think best answers the question. Your score will only appear after you answer all items. If you do well, you may move on to the next module. If your score is not at the expected level, you have to go back and take the module again.

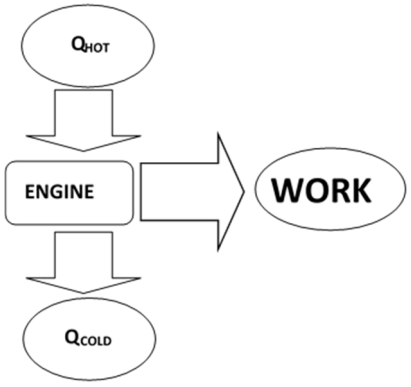
1. Modern automobile engines have efficiencies of about 25%. About what percentage of the heat of combustion is not used for work but released as heat?
   a. 25%
   b. 50%
   c. 75%
   d. 100%

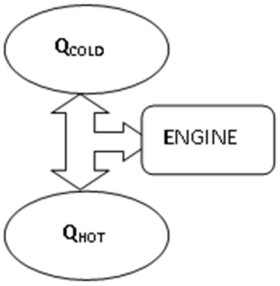
2. What role do radioactive elements play in a nuclear power plant?
   a. Radioactive elements are the source of direct electrical energy in a nuclear power plant.
   b. These elements undergo nuclear fission and give off enormous amounts of energy that is directly converted as electrical energy.
   c. The heat coming from these radioactive elements is converted directly into electrical energy.
   d. When these elements undergo nuclear fission, they release an enormous amount of heat that boils water into steam. This steam enters into a turbine that converts mechanical energy into electrical.

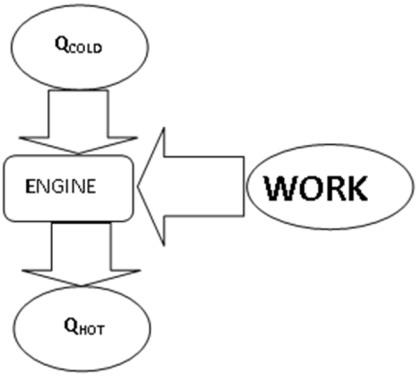
3. What function do substations play in the transmission of electricity?
   a. These substations are the ones that directly distribute the electricity to houses.

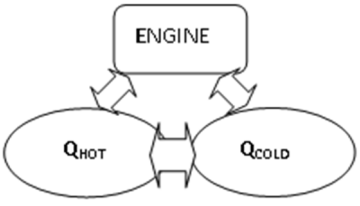
b. These substations have step-down transformers that reduce the voltage of the electricity before it distributes it to houses.
c. These substations have step-up transformers that increase the voltage of the electricity before it travels through the transmission lines again.
d. The substations collect all the electricity from different sources and then redistribute them to different houses.

4. Which of the following is a correct diagram of how a heat pump works?

a.


c.


b.


d.


5. How are refrigerators and aircon units similar?
   a. Both of these machines use work to transfer heat from a cold region to a hot region.
   b. Both of these machines are perfectly efficient and are able to do their function.
   c. Both of these machines use heat in order to do mechanical work.
   d. Neither of these two operates at high temperatures which make them highly efficient.

6. An air conditioner's coefficient of performance (COP) is mathematically identical to that of a refrigerator, that is, $COP_{AC}=COP_{ref}=Q_C / W$. However a heat pump's COP id defined differently, as $COP_{hp} = Q_H / W$. Why are their COP's defined differently?
   a. The function of a refrigerator and an aircon is to absorb heat from a hotter area. While that of a heat pump is to absorb heat from a colder area.
   b. Refrigerators and aircons both absorb heat from an already cold area and dump it into a hot area. While the main function of a heat pump or heater is to dump more heat into a hotter area.
   c. Refrigerators and aircons require more work in order to reverse the flow of heat. While heat pumps need less work in order to reverse the flow of heat.
   d. All three of them require work to do their function. The only difference is that they are located in different places in the house which would dictate what they absorb.
7. In buildings that are being electrically heated, is it at all wasteful to turn all the lights on?
   a. Yes because the lights consume a lot of electrical energy thus you will have to pay more for the energy consumed.
   b. Yes because these bulbs will become busted eventually and will have to be replaced from time to time.
   c. No because, as stated in the first part of the statement, the building is being heated thus these lights would contribute to heating the building.
   d. No because the lights consume only a minimal amount of electrical energy thus it would not all be wasteful.

8. A refrigerator moves heat from cold to warm. Does this violate the second law of thermodynamics?
   a. Yes it would because heat moves from an area of high temperature to an area of low temperature and not the other way around.
   b. Yes because the refrigerator is not doing any work to move heat from cold to warm. The items placed in the refrigerator just cool down naturally.
   c. No because the refrigerator is not doing the actual movement of heat. It is the heat from the items placed inside that goes out.
   d. No because an external agent, the refrigerator's compressor, does the work on the system.

9. A Carnot engine operates between a cold temperature reservoir of 27 ^{0}C and a high temperature reservoir of 127 ^{0}C. What is its efficiency?
   a. 21%
   b. 25%
   c. 75%
   d. 79%

10. A refrigerator absorbs 5.0 kJ of heat from a cold reservoir and releases 8.0 kJ to a hot reservoir. What is its coefficient of performance?
   a. 0.63
   b. 1.60
   c. 1.63
   d. 1.70

11. What is the ideal efficiency of an engine wherein fuel is heated to 2700 K and the surrounding air is 300 K?
   a. 50%
   b. 74%
   c. 80%
   d. 89%

12. Why do steam-power-plant designers try to increase the temperature of the steam as much as possible?
   a. An increase in the temperature would mean more heat for the engines to absorb thereby allowing it to do more work in producing electricity.
   b. Increasing the temperature of the steam increases the Carnot efficiency, and generally increases the efficiency of any heat engine.
   c. The increased temperature would mean less friction for the engines parts to work on thus it becomes more efficient.
   d. When the temperature is increased, more molecules can be directly converted to electrical energy as these carry with them lots and lots of energy.

13. How does the ideal efficiency of an automobile relate to the temperature of the engine and the temperature of the environment in which it operates?
   a. The ideal efficiency of this automobile would be higher if the difference in temperature smaller between the heat source (combustion chamber in the engine) and the sink (air surrounding the exhaust).
   b. The ideal efficiency of this automobile would be higher if there is a greater difference in temperature between the heat source (combustion chamber in the engine) and the sink (air surrounding the exhaust).

c. There is no effect at all in the ideal efficiency of the automobile because the heat source (combustion chamber in the engine) and the sink (air surrounding the exhaust) operate at the same temperature.
d. Ideal efficiency is not related at all to the temperatures of the heat source and the sink because it has something to do with how much the automobile moves for a given explosion in the combustion chamber of the engine.

14. Which is possible: converting (i) 100 J of work entirely into 100 J of heat, (ii) 100 J of heat entirely into 100 J of work?
    a. Only (i) is possible.
    b. Only (ii) is possible.
    c. Both (i) and (ii) are possible.
    d. Neither (i) nor (ii) is possible.

15. The second law of thermodynamics tells us that heat can be converted to work and this work is what can drive a generator to produce electricity. So why then are cooling rods necessary in the operation of a nuclear power plant?
    a. These cooling rods are used to cool off excess heat coming from the nuclear reactors.
    b. The rods reduce the exhaust temperature in order to increase the Carnot efficiency of the reactor.
    c. The rods allow the operators to switch from one reactor to the other in order to increase the efficiency of the power plant.
    d. The rods control the nuclear fission process thus reducing the amount of heat that boils off the water and thereby reducing pressure in the boilers.

16. Why are most nuclear power plants located near bodies of water?
    a. These bodies of water provide cooling effect to steam thus condensing it back to water for boiling in power plants that use boiling water.
    b. These bodies of water provide a place for the power plant to dump its waste without directly putting people in danger.
    c. These bodies of water provide the needed water supply that will be boiled in the nuclear reactor thus providing enough steam for the turbine to work.
    d. These bodies of water provide a natural ground for some of the spent fuel rods to be buried so that no one can ever find it.

17. The Philippines is located near the Pacific ring of fire which means that we have several volcanoes in our country. Which of the following sources of electrical energy do you think should be capitalize on?
    a. geothermal
    b. hydroelectric
    c. nuclear
    d. wind

18. In producing electrical energy, all power plants rely on which particular machine(s)?
    a. Boilers
    b. Generators
    c. Transformers
    d. Turbines

19. Before electricity is transmitted through long transmission lines, it always goes through a step-up transformer. Why is there a need for it to be always at a high voltage?
    a. It is always at a high voltage so that more people can benefit from it once it reaches the transformers located at the poles.
    b. It is always at a high voltage so that there is more energy that can be distributed throughout different substations.
    c. When electric current passes through the transmission cables, part of the energy is lost as heat. Hence, it is always transmitted at a high voltage to reduce lost due to heat.
    d. Substations always require high voltage electricity because they also use part of it and that several big industries require more electricity for operation.
20. Why should hydroelectric power plants be constructed near big waterfalls?
    a. Big waterfalls have enough water that can be used to fill-up dams and thus operate the hydroelectric power plant.
    b. The placement of these power plants near waterfalls would enhance the natural flow of water from the falls to its outlet.
    c. The water that falls from these natural resources could be used to turn the turbines of a hydroelectric power plant.
    d. Most of these waterfalls are uninhabited by humans thus it is ideal to construct a power plant near it.

GLOSSARY OF TERMS USED IN THIS LESSON:

air conditioner a heat pump that absorbs heat from an already cold region and dumps this heat into a hot region

adiabatic process a thermodynamic process in which no heat enters or leaves a system

coefficient of performance a measure of the efficiency of a heat pump calculated in terms of the amount of heat taken over the work done in extracting the heat

efficiency (thermal) for heat engines is the amount of work done over the heat absorbed

entropy a measure of the disorder of a system

generation the process of producing electricity

heat energy in motion and is produced by the movement or jostling of the molecules of a substance

heat engine a machine that absorbs heat and uses this heat to do mechanical work

heat pump a machine that uses mechanical work in extracting heat from an already cold area and expelling this into a hot area

ideal efficiency the efficiency of a machine in terms of the temperature differences, in Kelvin, between the hot and cold reservoirs

internal energy the sum total of all the energies in a substance

isobaric process a thermodynamic process where the pressure on a system is kept constant

isochoric or isovolumetric process a thermodynamic process where the volume of a system is kept constant

isothermal process a thermodynamic process where the temperature of a system is kept constant

nuclear fission the breaking down of an atom's nucleus due to the bombardment of particles

radioactive element an unstable element that constantly emits radiation

refrigerator a heat pump that absorbs heat from its internal compartment and dumps it into its surroundings

thermodynamics the branch of physics that deals with the interactions of heat

transmission the process of carrying electricity through wires and cables into substations

work the product of an applied force and the distance traveled by an object where the force is applied

REFERENCES AND WEBSITE LINKS USED IN THIS LESSON:

https://www.youtube.com/watch?v=kLqduWF6GXE – Thermodynamics and kinetics lecture from MIT

https://www.youtube.com/watch?v=3NdCQpSmZN4 – video on the Zeroth law of thermodynamics
http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/firlaw.html - gives a brief discussion on the first law of thermodynamics

http://www.physicsplanet.com/articles/three-laws-of-thermodynamics - gives a brief discussion on the three laws of thermodynamics

https://www.youtube.com/watch?v=kLqduWF6GXE – Thermodynamics and kinetics lecture from MIT

https://www.youtube.com/watch?v=Xb05CaG7TsQ – from Khan Academy on the first law of thermodynamics

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/seclaw.html - discussion of the Second law of thermodynamics

https://www.grc.nasa.gov/www/k-12/airplane/thermo2.html - discussion of the second law of thermodynamics and entropy

https://www.youtube.com/watch?v=DHUwFuHuCdw – animation on the second law of thermodynamics from tutorvista.com

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/carnot.html - discussion of the Carnot cycle

https://www.boundless.com/physics/thermodynamics--3/the-second-law-of-thermodynamics/carnot-cycles/ - discussion of the Carnot cycle

https://www.youtube.com/watch?v=kLqduWF6GXE – Thermodynamics and kinetics lecture from MIT

http://news.bbc.co.uk/dna/place-lancashire/plain/A780266 - discussion on the laws of thermodynamics

https://www.youtube.com/watch?v=_b29-MrNL38 – American air force video on the principles of mechanical refrigeration

https://www.youtube.com/watch?v=ASJmVNcJqk4 – video on the heat engines

https://www.youtube.com/watch?v=g39nM7GbSJA – how a heat pump works

http://www1.eere.energy.gov/vehiclesandfuels/pdfs/basics/jtb_diesel_engine.pdf - discussion on the diesel engine and its advantages against gasoline

http://www.rcfb.org/images/How_Diesel_Engines_Work.pdf - discussion on how diesel engines work

https://www.youtube.com/watch?v=s2WGFELXPNg – diesel engine animation

https://www.youtube.com/watch?v=5WGUbfzr31s – a National Geographic Channel video on the Chernobyl explosion

http://www.youtube.com/watch?v=JMaEjEWL6PU – shows what happened during the Fukushima nuclear plant meltdown

http://www.youtube.com/watch?v=PKNbwclaGng – shows how a nuclear power plant works in Canada

http://www.os.is/gogn/unu-gtp-sc/UNU-GTP-SC-12-35.pdf - text on the basic principles of thermodynamics to be treated in lectures “Steam cycles for geothermal power production”, “Design of the main components of a steam cycle power plant”, “Binary cycles for geothermal power production” and “Design of the main components of a binary cycle power plant”

http://geoheat.oit.edu/bulletin/bull20-2/art1.pdf - gives a brief history of geothermal power generation

http://www.doe.gov.ph/renewable-energy-res/geothermal - shows the different benefits which the Philippines has reaped from geothermal power plants

http://www.geo-energy.org/reports/Geothermal%20Technology%20-%20Part%20II%20(Surface).pdf – gives an explanation on how a geothermal power plant works

http://www.doe.gov.ph/renewable-energy-res/hydropower advantages and disadvantages of hydroelectric power plants in the Philippines

https://www.youtube.com/watch?v=rnPEtwQtmGQ – animation showing how electricity is generated using hydroelectric power

http://www.youtube.com/watch?v=LNXTm7aHvWc - An overview of the layout of utility-class wind turbine generators - where are the major components, what do they do, and what differences can be found between models and size ranges