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DEPARTMENT OF EDUCATION

# General Physics 1

## Quarter 2 - Module 11
## Thermodynamics Systems and Work done during Volume Changes


SELF-LEARNING MODULE

SLM

DEPARTMENT OF EDUCATION - SOCCSKSARGEN

**General Physics 1 – Grade 12**
**Self-Learning Module (SLM)**
**Quarter 2- Module 10:** **Thermodynamics Systems and Work done during Volume Changes**
**First Edition, 2020**



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# 12

# General Physics 1

## Quarter 2 - Module 11

## Thermodynamics Systems and Work done during Volume Changes

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# Introductory Message

For the facilitator:

Welcome to the General Physics 1 Grade 12 Self-Learning Module (SLM) on **Thermodynamics Systems and Work done during Volume Changes!**

This module was collaboratively designed, developed and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

In addition to the material in the main text, you will also see this box in the body of the module:

***Notes to the Teacher***

This contains helpful tips or strategies that will help you in guiding the learners.

As a facilitator you are expected to orient the learners on how to use this module. You also need to keep track of the learners' progress while allowing them to manage their own learning. Furthermore, you are expected to encourage and assist the learners as they do the tasks included in the module.

For the learner:

Welcome to the General Physics 1 Grade 12 Self-Learning Module (SLM) **Thermodynamics Systems and Work done during Volume Changes!**

An understanding of the gaseous state of matter is an essential part of the study of chemistry in the laboratory. Usually the amount of gaseous substance is determined by measuring its volume. However, because the volume of a gas varies with the pressure and temperature, these two conditions must be measured also.

Gases of all sorts act in remarkably similar ways when subjected to changes in pressure and temperature. We can describe the behavior of gases in terms of simple laws of nature called the *gas laws*.

The study of gases is also fundamental to our understanding of the ways in which the particles of the reactants come together to interact with each other.

The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

This module has the following parts and corresponding icons:

| | | |
|---|---|---|
|  | ***What I Need to Know*** | This will give you an idea of the skills or competencies you are expected to learn in the module. |
|  | ***What I Know*** | This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module. |
|  | ***What's In*** | This is a brief drill or review to help you link the current lesson with the previous one. |
|  | ***What's New*** | In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation. |
|  | ***What is It*** | This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills. |
|  | ***What's More*** | This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module. |

| | |
|---|---|
| ***What I Have Learned*** | This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson. |
| ***What I Can Do*** | This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns. |
| ***Assessment*** | This is a task which aims to evaluate your level of mastery in achieving the learning competency. |
| ***Additional Activities*** | In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts. |
| ***Answer Key*** | This contains answers to all activities in the module. |

At the end of this module you will also find:

| | |
|---|---|
| ***References*** | This is a list of all sources used in developing this module. |

The following are some reminders in using this module:

1. Use the module with care. Do not put unnecessary mark/s on any part of the module. Use a separate sheet of paper in answering the exercises.
2. Don't forget to answer *What I Know* before moving on to the other activities included in the module.
3. Read the instruction carefully before doing each task.
4. Observe honesty and integrity in doing the tasks and checking your answers.
5. Finish the task at hand before proceeding to the next.
6. Return this module to your teacher/facilitator once you are through with it.

If you encounter any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator. Always bear in mind that you are not alone.

We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

# *What I Need to Know*

Boiling or freezing water, driving a car, turning on an air conditioner, and using a refrigerator are examples of processes on involving heat. But what is heat? How does it differ from temperature? Why does heat always flow from hotter objects to cooler objects? Given a certain amount of heat, why is it impossible to convert all of it to mechanical energy? What laws govern heat transfer?

The answers to these and other similar questions require a clear understanding of the concept of heat and the laws of thermodynamics.

This module is divided into two lessons:

**Lesson 1: Thermodynamics System**

**Lesson 2: Work done during Volume Changes**

After going through this module, you are expected to:

1. Describe and discuss the three types of thermodynamic system;
2. Interpret PV diagrams of a thermodynamic system.
3. Compute the work done by a gas using dW=PdV; and
4. State the relationship between changes internal energy, work done, and thermal energy supplied through the First Law of Thermodynamics.

## *What I Know*

**Direction:** Read and understand the questions. Write the letter of the correct answer on a separate sheet.

1. Which of the following quantities occurs constantly where a type of process does not need outside energy to reverse?
   A. Pressure B. Speed C. Temperature D. Volume

2. Which of the following conditions in any process will maximize the amount of heat that can be converted to mechanical energy?
   A. Depends only on the exhaust temperatures
   B. Depends only on the intake temperatures
   C. Depends on the intake and exhaust temperatures
   D. Depends on whether kinetic energy or potential energy is involved

3. What is the work output of every engine?
   A. It equals the difference between its heat intake and heat exhaust.
   B. It equals the heat engine with the same intake and exhaust temperature.
   C. It depends only on its intake temperature
   D. It depends only on its exhaust temperature.

4. What is the area enclosed by the P-V graph of a complete heat engine cycle?
   A. Equals the heat intake per cycle
   B. Equals the heat output per cycle
   C. Equals the work done on the engine per cycle
   D. Equals the work done by the engine per cycle

5. At a constant temperature, an ideal gas is compressed from 6.0L to 4.0 L by a constant external pressure of 5.0 atm. How much work is done on the gas?
   A. W = + 10 L-atm
   B. W = -10 L-atm
   C. W = +30 L-atm
   D. W = -30 L-atm

6. A system suffers an increase in an internal energy of 80 J and at the same time has a 50 J of work done on it. What is the heat change of the system?
   A. +130 J B. +30 J C. -130 J D. -30 J

7. Calculate the amount of work done for the conversion of 1.00 mol of Ni to Ni(CO)4 in the reaction below at 348 K. Assume that the gases are ideal, the value of R is 8.31 J/mol.K

   **Ni + 4CO --> Ni(CO)4**

   A. 1800 J B. 8680 J C. -1800 J D. -8680 J

8. What substance does not have a standard of formation value of zero at 298 K and 1.0 atm?
   A. N2 B. Fe C. Ne D. H

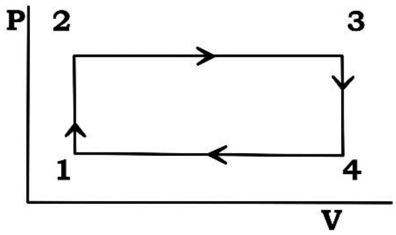
9. The temperature of an ideal gas increases from 20°C to 40°C while the pressure stays the same. What happens to the volume of the gas?
   A. It doubles
   B. It quadruples
   C. It slightly increases
   D. It slightly decreases

10. A container with rigid walls filled with a sample of ideal gas. The absolute temperature of the gas is doubled. What happens to the pressure of the gas?
    A. Decreased to one-half
    B. Doubles
    C. Quadruples
    D. Triples

11. Which of the following quantities will the average molecular kinetic energy of a gas depends on?
    A. Density
    B. Pressure
    C. Temperature
    D. Volume

12. The change of the state of an ideal gas is presented by the diagram. What is the ratio between work done on the gas during the process 2-->3 and work done on the gas during the process 4-->1?

    A. 2/1
    B. 1/2
    C. 4/1
    D. 3/1




13. An ideal gas engine operates between two temperatures 600K and 900K. What is the efficiency of the engine?
    A. 33%
    B. 50%
    C. 80%
    D. 100%

14. Which of the following is true for a steady flow system?
    A. Mass does not enter or leave the system
    B. Mass entering can be determined only if you measure it.
    C. Mass entering can be more or less than mass leaving.
    D. Mass entering equals mass leaving

15. Which of the following represents the energy in storage?
    A. External energy
    B. Heat
    C. Internal Energy
    D. Work

# Lesson 1 Thermodynamics Systems

**Learning Objectives:**

1. Describe and discuss the three types of thermodynamic system; and
2. Interpret PV diagrams of a thermodynamic system;

## *What's In*

### Activity 1: Who am I?

**Direction:**

Fill in the boxes with the correct term given the description below. Write your answer on the separate sheet. Find the hidden term by using the letters from 1 - 4.

**HINT:** I am the energy in transferring to or from a thermodynamic system, by mechanisms other than thermodynamic work or transfer of matter.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | G | | | | 1. | | | | | |
| | | | | | R | 2. | | S | | | |
| | | M | | | | 3. | T | | | E | |
| | | | N | | | 4. T | | | | | |

1. It is the pictorial representation of the relationship between variables.
2. It is defined as the force exerted perpendicular to a surface divided by the area over which the force is exerted.
3. It is a measure of the average kinetic energy of the particles in a system.
4. It is the mass per unit volume of any object. It is calculated by dividing the mass of an object by its volume.

The hidden term is ________________________________________.

# *What's New*

This time, we will perform activity related to heat, work and internal energy!

## Activity 2: Heat Me Up!

**Materials:**

| | | | |
|---|---|---|---|
| Activity Sheets | Writing Materials | casserole | water |
| timer | match | fire wood | |

**CAUTION!!!**

**Be careful in handling hot objects.**

**Direction:**

Perform the following activities and answer the questions that follow:

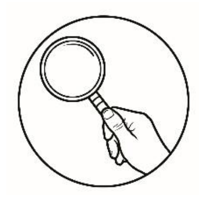
I. Start rubbing your hands together. What did you observe? What if your two hands are just placed together without rubbing, would the result be the same?

II. For this activity, **make sure you observe the safety measures in place. Be careful when handling hot objects.**

1. Get a casserole. Fill the casserole with water; let it remain undisturbed for 3 minutes. Dip your hand. What do you observe?
2. Put the casserole on the fire for five minutes. Gently touch the surface of the water with your finger. What did you feel?

**Guide Question:**

1. Were there changes in the temperature?
2. What possible factor/s made the changes in temperature?



# *What is It*

In this module, we will begin our study of the thermal properties of matter by looking at some macroscopic aspects of matter in general.

In activity 2, Heat Me Up, set up I allowed the learners to observe and produce heat by simply rubbing hands together. In set up II, a casserole with water is placed on a stove and energy is added to the water. These activities showed changes on the temperature of water, producing heat in the process. If energy is supplied to the casserole longer, the water will boil and its particles expand. It does work as it exerts an upward force on the lid of the casserole and moves it through a displacement. The state of the water changes in this process, since the volume, temperature, and pressure of the water changes as it boils. A process such as this in which there are changes in the state of thermodynamic system is called a thermodynamic process.

Thermodynamics is concerned with *systems.* A system is a space singled out for study. It has definite boundaries so that it is possible to define what is inside the system and what is outside the system. The system may contain a combination of substances on a various physical states, objects, engines, motors, and other kinds of devices. A system can interact with the environment outside the system either by absorbing heat from the environment or transferring heat to it. A system is also capable of doing work for its environment by having work done on it by its environment.

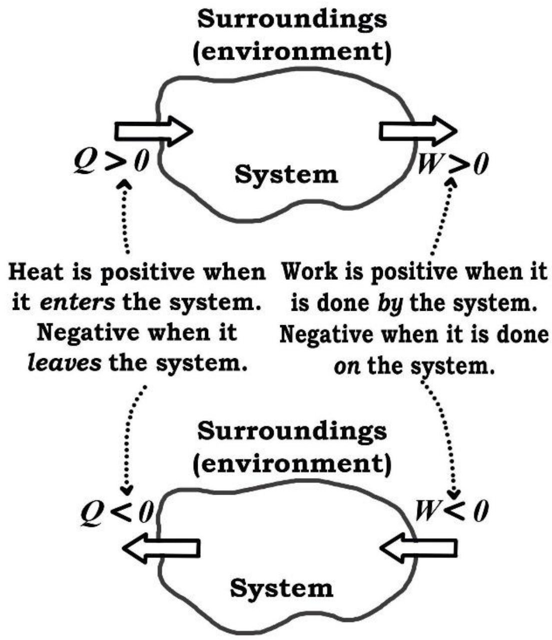



Figure 1. A thermodynamic system may exchange energy in its surroundings by means of heat, work or both.

To illustrate, consider the system shown in figure 2. It consists of an air filled cylinder closed at one end and with a freely moving piston at the other. If the heat from outside the system is applied to a cylinder, it will cause the air to expand or push the piston outward, thus, doing work against the opposing atmospheric pressure. In this case, the system takes in heat and uses work to do on its environment.

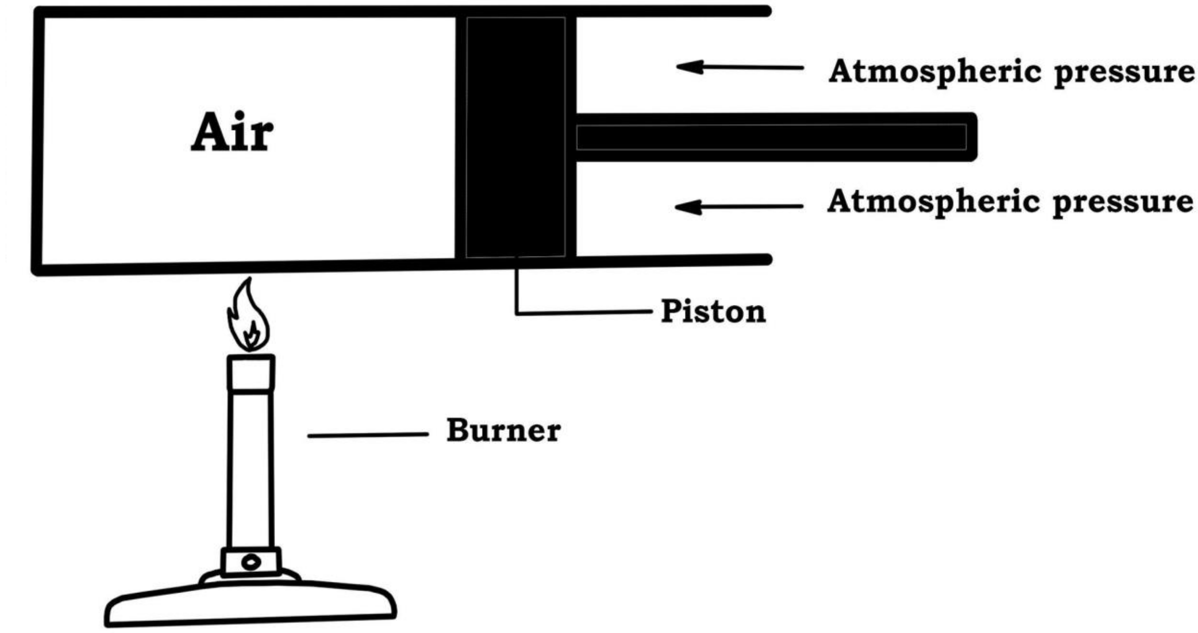



Figure 2. Heating the air in the cylinder

There are three main types of system. All of these have been described below:

A. **1. Open system:** The system in which the transfer of mass as well as energy can take place across its boundary is called an open system. Example of this is an engine, and this case we provide fuel to engine and it produces power which is given out, thus there is a change of mass as well as energy. The engine also emits heat which is a change in surroundings.

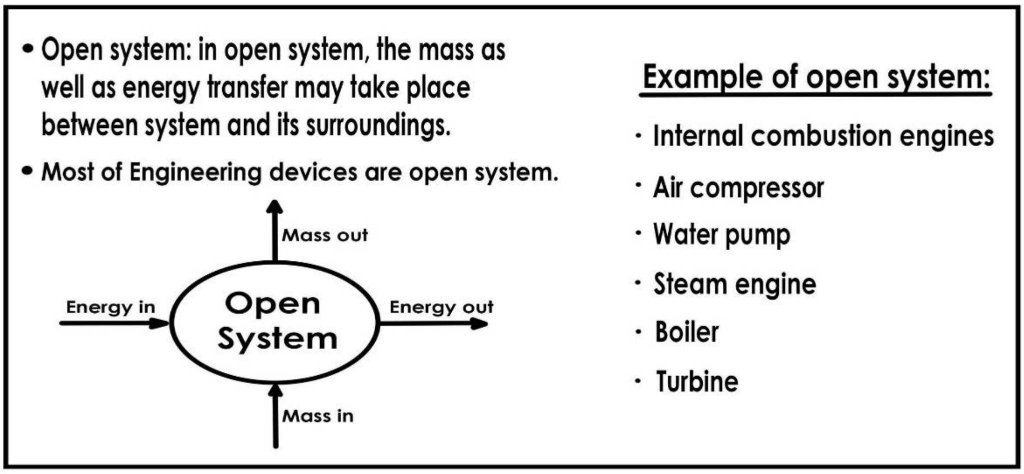



Figure 3: An Open System

**2. Closed System:** The system in which the transfer of energy takes place across its boundary with its surrounding, but no transfer of mass takes place is called as close system. The closed system is fixed mass system. The fluid like air or gas being compressed in the piston and cylinder is an example of a closed system. In this case, the mass of the gas remains constant but it gets heated or cold.

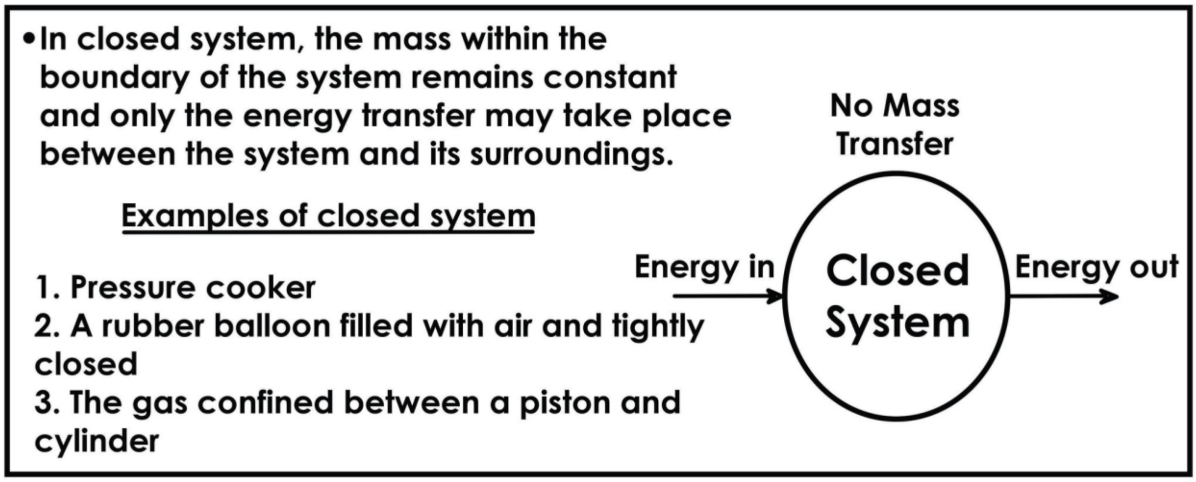



Figure 4: A Closed System

**3. Isolated System:** The system in which neither the transfer of mass nor that of that energy takes place across its boundary with the surrounding is called the isolated system. For example if the piston and cylinder arrangement in which the fluid like air or gas is being compressed or expanded is insulated it becomes isolated system. Here there will neither transfer of mass nor that of energy. Similarly hot water, coffee or tea kept in the thermos flash is closed system. However, if we pour this fluid in a cup, it becomes an open system.

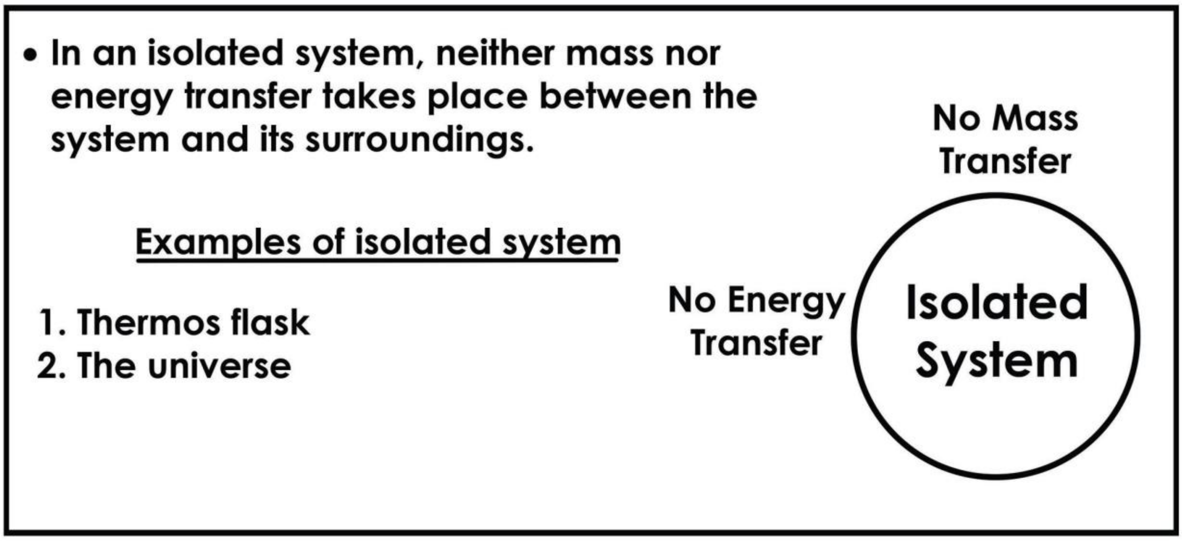



Figure 5: Isolated System

In an expansion from 1 to 2 in figure 2a below, the area under the curve and the work are positive. A compression from 1 to 2 in figure 2b gives a negative area; when a system is compressed its volume decreases and it does negative work on its surroundings. If the pressure, P remains constant while the volume changes $V_1$ to $V_2$ in figure 2c, the work done by the system is zero because there is no displacement.

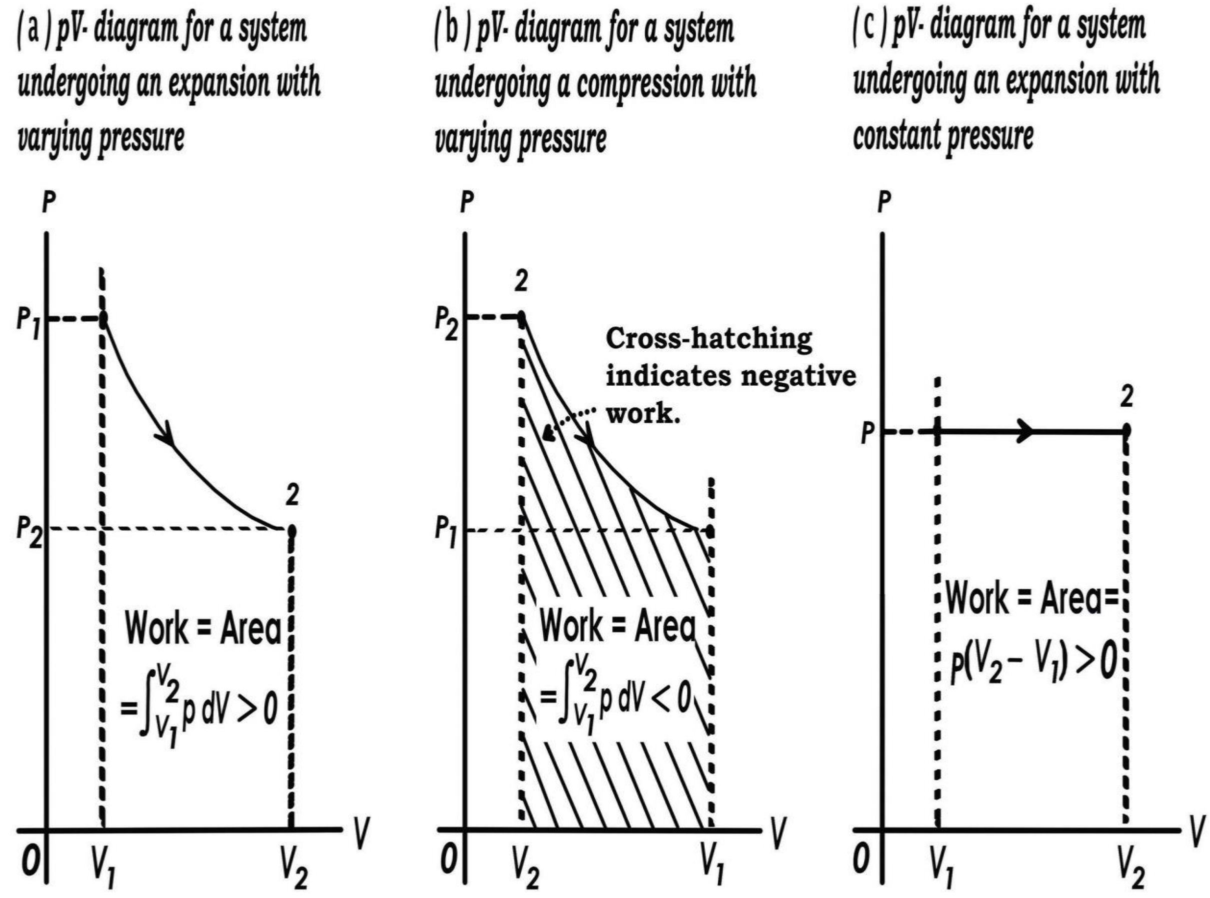



Figure 2. PV diagram

## What's More

By simplest description of work in a thermodynamic setting, work is the product of the pressure on or by the gas and the change in volume. This time you are going to perform an activity about pressure and volume. Are you ready?

### Activity 3: Under Pressure!

**Materials:**

activity sheets    writing materials

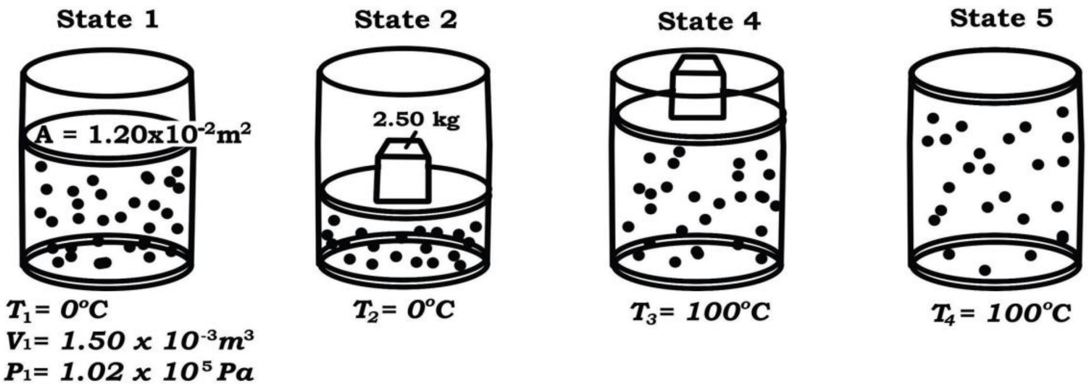



Figure 1. A cylinder fitted with a freely moveable piston

A cylinder is fitted with a freely moveable piston of area 1.20 X 10-2 $m^2$ and negligible mass. The cylinder below the piston is filled with a gas. At state 1, the gas has volume $1.50 \times 10^{-3}$ $m^3$, pressure $1.02 \times 10^5$ Pa, and the cylinder is in contact with a water bath at a temperature of O ℃. The gas is then taken through the following four-step process. (NOTE: You will have to convert to Kelvin)

- A 2.50 kg metal block is placed on top of the piston, compressing the gas to state 2, with the gas still at 0 ℃.
- The cylinder is then brought in contact with a boiling water bath, raising the gas temperature to 100℃ at state 3.
- The metal block is removed and the gas expands to state 4 still at 100 ℃.
- Finally, the cylinder is again placed in contact with the water bath at O ℃, returning the system to state 1.

1. Describe the pressure of the gas in state 2.

2. Describe the volume of the gas in state 2.

## *What I Have Learned*

### Activity 4: Guess Me!

**Materials:**

activity sheets writing materials

**Direction:**

Fill in the blanks with the correct term. Write your answer on a separate piece of paper.

Thermodynamics is concerned with *systems.* A (1) _____________ is a space singled out for study. It has definite (2) ___________ so that it is possible to define what is inside the system and what is outside the system. The system may contain a combination of substances on a various physical states, objects, engines, motors, and other kinds of devices. A system can interact with the environment outside the system either by (3) _____________ heat from the environment or transferring heat to it. A system is also capable of doing work for its environment by having work done on it by its environment.

The system in which the transfer of mass as well as energy can take place across its boundary is called an (4) __________ system.

The system in which the transfer of energy takes place across its boundary with its surrounding, but no transfer of mass takes place is called as close system.

The system in which neither the transfer of mass nor that of that energy takes place across its boundary with the surrounding is called the (5) ________ system.

# Lesson 2 Work done during Volume Changes

**Learning Objectives:**

1. Compute the work done by a gas using dW=PdV; and
2. State the relationship between changes internal energy, work done, and thermal energy supplied through the First Law of Thermodynamics.

## *What's In*

### Activity 1: Where Do I Belong?

**Materials**:

activity sheet    writing material

**Direction:**

Tell whether the given system is OPEN, CLOSED or ISOLATED. Write your answer on a piece of paper.

1. Pressure cooker
2. Water pump
3. Thermos flask
4. Air compressor
5. Rubber balloon filled with air

## What's New

### Activity 2: Size Matters!

**Materials:**

| | | |
|---|---|---|
| Activity Sheets | Writing materials | |
| Rice | Pot | Stove/any available source of heat |

**Procedure:**

1. Prepare the materials needed for the activity.
2. Place and clean the rice in the pot enough for the family to consume for a meal.
3. Place the pot with rice and water over the fire then observe.

**Guide Question:**

1. What happened to the water after few minutes?
2. What happened to the lid of the Pot? Support your answer.
3. What happened to the rice and the water?

## What is It

From the activities, you have learned that energy is needed to perform work. When work is done on a body, energy is transferred to that body.

We describe the energy relationships in any thermodynamic process in terms of the quantity of heat, Q added to the system and the work, W done by the system. Both Q and W maybe positive, negative, or zero.

A positive value of Q represents heat flow into the system, with a corresponding input of energy to it; negative Q represents the heat flow out of a system. A positive value of W represents work done by the system against its surroundings such as work done by an expanding gas, and hence corresponds of energy leaving on a system. Negative W, such work done during compression of a gas in which work is done on the gas by its surroundings, represents energy in entering the system.

If heat is added to the system of gas the gas inside will expand thus pushing the particles upward. Pushing action is equivalent to the amount of work done by gas.

$$P = \frac{F}{A};\ F = PA$$

$$W = Fd\ ;\ W = PA \bullet \Delta d$$

$$A\Delta h = \Delta V\ ;\ \Delta V = A \bullet \Delta d$$

$$W = P \bullet \Delta V$$

Where: P = Pressure

F = Force

A = Cross-sectional Area

Δd = Distance moved

ΔV = change in Volume

W = Work

**Sample Problem 1**

As $0.90 m^3$ of air at temperature at $37^oC$ rises on a hot summer day, the pressure of surrounding air decreases from 101 325 Pa to 70927 Pa, and the volume of the air increases to $1.15 m^3$. Calculate the work done on the air.

Given: $V_1 = 0.90\ m^3$
$V_2 = 1.15\ m^3$
$T = 37^oC$
$P_1 = 1.00$ atm
$P_2 = 0.70$ atm
Find: W = ?

Solution: $W = \Delta P \bullet \Delta V$
$W = (P_2 - P_1)(V_2 - V_1)$
$W = (\ 70927\ Pa - 101\ 325\ Pa)(1.15\ m^3 - 0.90 m^3)$
$W = (-30\ 398\ Pa)\ (0.25\ m^3)$
$W = -7\ 599.5\ Pa.m^3$
$W = -7\ 599.5\ J$

In thermodynamics, the internal energy of a system is the energy contained within the system. The internal energy of the system can be increased by the introduction of matter by heat, or reduced when thermodynamic work is done by the system.

Internal energy is a state function of the system, since its value depends only on a current state on the system and not on the path chosen to reach it. It is an extensive property. At any temperature, greater than absolute zero, microscopic potential energy and kinetic energy are constantly converted into one another, but the sum remains constant in an isolated system.

In a thermodynamic process, the internal energy, U of a system may (a) increase ($\Delta U>0$), (b) decrease ($\Delta U < 0$), or (c) remain the same ($\Delta U = 0$).

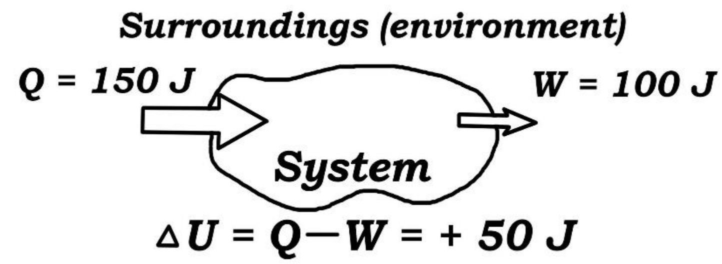



Figure 2(a).

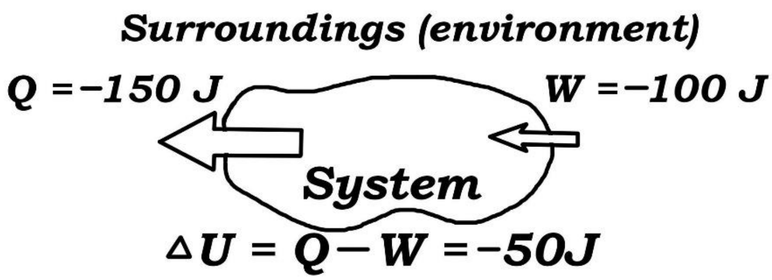



Figure 2(b).

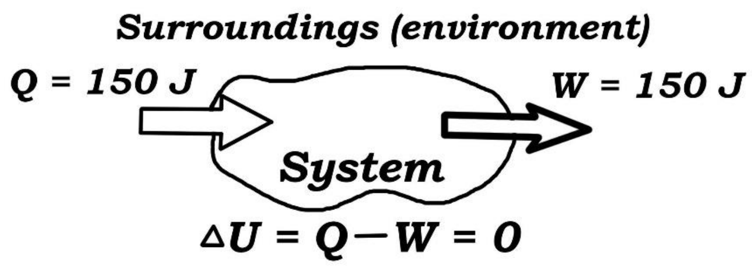
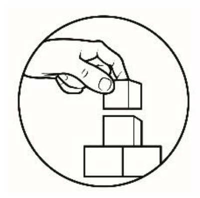



Figure 2 (c).

In figure 2 (a), more heat is added to system than system does work so Internal Energy of system increases.

In figure 2 (b), more heat flow out of system than work is done so, internal energy of system decreases.

In figure 2 (c), heat is added to system equals work done by system so, internal energy of system unchanged.



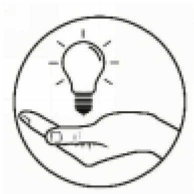
# *What's More*

## Activity 3: Push me up and down!

**Materials:** activity sheets writing materials (pencil, pens, marker)

**Problem**

A cylindrical container with a cross-sectional area of $0.020m^2$ and a movable piston contains a certain amount of a gas. If the gas exerts a constant pressure of 250 000 Pa, causing the piston to move 0.050m, how much work was done by the expanding gas?



# *What I Have Learned*

## Activity 4: Did you know that?

**Materials:**

activity sheets writing materials

**Direction:**

Fill in the blanks with the correct term. Write your answer on a separate piece of paper.

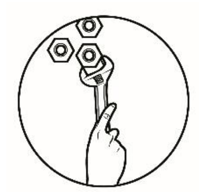
In a (1)___________, the internal energy, U of a system may (a) increase ($\Delta U>0$),

(b) decrease ($\Delta U < 0$), or (c) (2) ____________($\Delta U = 0$).

More heat is added to system than system does work so Internal Energy of system (3)_____________.

More heat flow out of system than work is done so, internal energy of system (4) _____________.

Heat is added to system equals work done by system so, internal energy of system (5)______________.



## What I Can Do

Congratulations! You have made it! However, you still have one more activity in which you are going to apply what you have learned in this module. It's your turn now!

### Activity 5: Heat me up one more time!

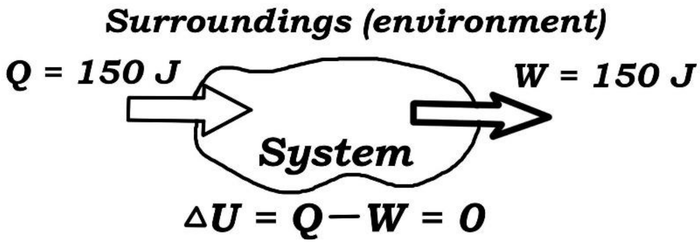
**Materials:**

activity sheet        writing materials

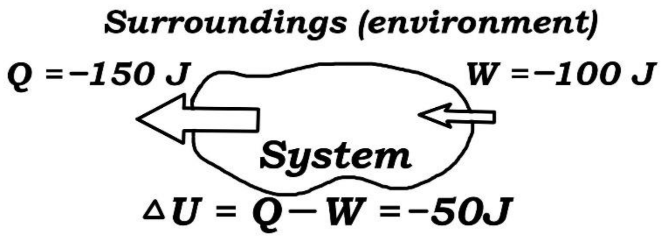
**Direction:**

State the relationship of the heat, work and the internal energy of the given illustration below.

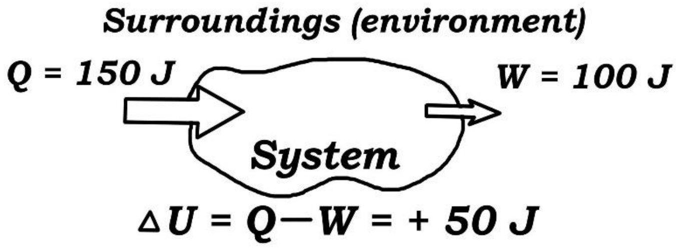
1.




2.




3.



## *Assessment*

Congratulations! You have made it! Before we end up, let us test your mastery of the concepts by answering the questions below.

**Direction:** Read and understand the questions. Write the letter of the correct answer on a separate sheet.

1. The temperature of an ideal gas increases from 20°C to 40°C while the pressure stays the same. What happens to the volume of the gas?
   A. It doubles
   B. It quadruples
   C. It slightly increases
   D. It slightly decreases

2. Which of the following quantities occurs constantly where a type of process does not need outside energy to reverse?
   A. Pressure
   B. Speed
   C. Temperature
   D. Volume

3. Which of the following conditions in any process will maximize the amount of heat that can be converted to mechanical energy?
   A. Depends only on the exhaust temperatures
   B. Depends only on the intake temperatures
   C. Depends on the intake and exhaust temperatures
   D. Depends on whether kinetic energy or potential energy is involved

4. What is the work output of every engine?
   A. It equals the difference between its heat intake and heat exhaust.
   B. It equals that of a heat engine with the same intake and exhaust temperature.
   C. It depends only on its intake temperature
   D. It depends only on its exhaust temperature.

5. What is the area enclosed by the P-V graph of a complete heat engine cycle?
   A. Equals the heat intake per cycle
   B. Equals the heat output per cycle
   C. Equals the work done on the engine per cycle
   D. Equals the work done by the engine per cycle

6. At a constant temperature, an ideal gas is compressed from 6.0L to 4.0 L by a constant external pressure of 5.0 atm. How much work is done on the gas?
   A. W = + 10 L-atm
   B. W = -10 L-atm
   C. W = +30 L-atm
   D. W = -30 L-atm

7. A system suffers an increase in an internal energy of 80 J and at the same time has a 50 J of work done on it. What is the heat change of the system?
   A. +130 J
   B. +30 J
   C. -130 J
   D. -30 J

8. Calculate the amount of work done for the conversion of 1.00 mol of Ni to $Ni(CO)_4$ in the reaction below at 348 K. Assume that the gases are ideal, the value of R is 8.31 J/mol.K

$$Ni + 4CO \rightarrow Ni(CO)_4$$

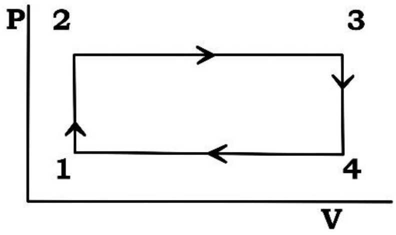
   A. 1800 J
   B. 8680 J
   C. -1800 J
   D. -8680 J

9. What substance does not have a standard of formation value of zero at 298 K and 1.0 atm?
   A. $N_2$
   B. Fe
   C. Ne
   D. H

10. A container with rigid walls filled with a sample of ideal gas. The absolute temperature of the gas is doubled. What happens to the pressure of the gas?
   A. Decreased to one-half
   B. Doubles
   C. Quadruples
   D. Triples

11. Which of the following quantities will the average molecular kinetic energy of a gas depends on?
   A. Density
   B. Pressure
   C. Temperature
   D. Volume

12. The change of the state of an ideal gas is presented by the diagram. What is the ratio between work done on the gas during the process 2-->3 and work done on the gas during the process 4-->1?




A. 2/1
B. 1/2
C. 4/1
D. 3/1

13. An ideal gas engine operates between two temperatures 600K and 900K. What is the efficiency of the engine?
A. 33%
B. 50%
C. 80%
D. 100%

14. Which of the following represents the energy in storage?
A. External energy
B. Heat
C. Internal Energy
D. Work

15. Which of the following is true for a steady flow system?
A. Mass does not enter or leave the system
B. Mass entering can be determined only if you measure it.
C. Mass entering can be more or less than mass leaving.
D. Mass entering equals mass leaving

## *Additional Activities*

Great job! You have shown a lot of patience and understanding for performing well. I know you can do more. Perform the last activity that would test your ability in comprehension. Good Luck!

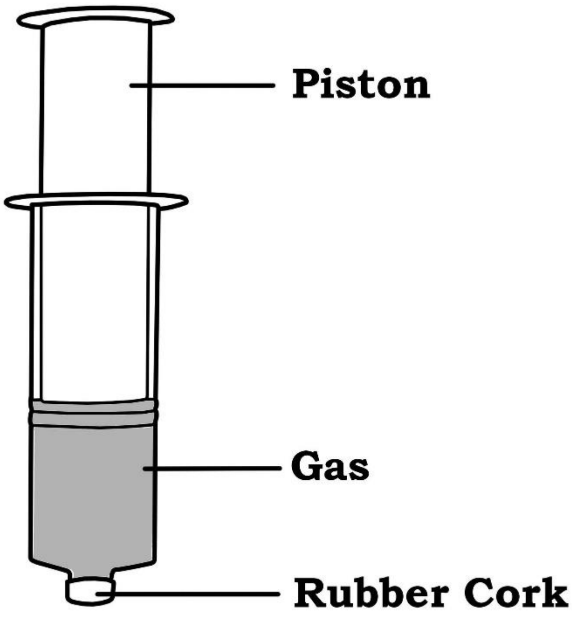
### Activity 6: Press Me Down!

**Materials:**

Writing Materials      Activity Sheet

Scenario:

The illustration below is a syringe filled with gas. A downward force is applied on the piston to compress the gas inside the syringe.




**Guide Question:**

1. What happened to the gas when you push the piston down?
2. What causes the compression of the air?

# Answer Key

**Pre test**

1. C
2. C
3. A
4. D
5. A
6. B
7. B
8. D
9. C
10. B
11. C
12. D
13. A
14. D
15. C

**Post test**

1. C
2. C
3. C
4. A
5. D
6. A
7. B
8. B
9. D
10. B
11. C
12. D
13. A
14. C
15. D

**Lesson 1: Activity 1**
Who am I?
Hint: HEAT

1. Graph
2. Pressure
3. Temperature
4. Density

**Lesson 1: Activity 2**
**Heat me Up!**

**1. Yes**
**2. Presence of heat**

**Lesson 1Activity 3**
**Under Pressure!**

**1. answer may vary**
**2. answer may vary**

**Lesson 1: Activity 4**
**Guess Me!**

**1. System**
**2. Boundaries**
**3. Absorbing**
**4. Open**
**5. Isolated**

**Lesson 2: Activity 1**
Where do I belong

1. Closed
2. Open
3. Isolated
4. Open
5. Closed

**Lesson 2: Activity 2**
Size Matters!
1. It boils

2. It moves, because of the steam inside the pot.

3. The rice increases in size and the water disappear

**Lesson 2: Activity 3. Push me up and down!**

Given: $A = 0.020\ m^2$
$P = 250\ 000\ Pa$
$\Delta d = 0.050\ m$
Find: $W = ?$
Solution: $W = P\Delta V = PA\Delta d$
$= (250\ 000\ Pa)(0.020 m^2)(0.050 m)$
$= 250\ J$

Lesson 2: Activity 4:
Did you know?

1. thermodynamic process
2. remain the same
3. increases
4. decreases
5. unchanged

**Lesson 2: Activity 5 Heat me Up one more time!**

1. Heat is added to system equals work done by system so, internal energy of system unchanged.
2. More heat flow out of system than work is done so, internal energy of system decreases.
3. More heat is added to system than system does work so Internal Energy of system increases.

Lesson 2: Activity 6 Press me Down!

1. The volume of the gas decreases

2. Downward force

# *References*


**BOOKS**

Aquino, Marites D, Jonna M Abistado, and Rex S Forteza. Worktext in Science and Technology : Science Links Physics. Philippines: Rex Book Store, Inc, 2012.pp. 175-193

Jose Perico H. Esguerra, Ph.D., R. A. (2016). Teaching Guide for Senior High School: General Physics 1. Edited by Eduardo C. Cuansing, Ph.D, Voltaire M. Mistades, Ph.D. 4th Floor Commission on Higher Education, Garcia Avenue, Diliman, Quezon City: Commission on Higher Education. Pp. 120-133

Heuvelen, Alan Van. Physics: A General Introduction. United States of America: HarperCollinsPublisher, 1986.pp.261-274

**WEBSITE**

*Thermodynamic Processes and PV Diagrams Worksheet.* n.d. https://www.jcschools.us/cms/lib03/MO01909951/Centricity/Domain/1935 /Thermodynamic%20Processes%20and%20PV%20Diagrams%20Worksheet.pdf (accessed August 12, 2020).

**EDITOR'S NOTE**

This Self-learning Module (SLM) was developed by DepEd SOCCSKSARGEN with the primary objective of preparing for and addressing the new normal. Contents of this module were based on DepEd's Most Essential Learning Competencies (MELC). This is a supplementary material to be used by all learners of SOCCSKSARGEN Region in all public schools beginning SY 2020-2021. The process of LR development was observed in the production of this module. This is version 1.0. We highly encourage feedback, comments, and recommendations

**For inquiries or feedback, please write or call:**

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