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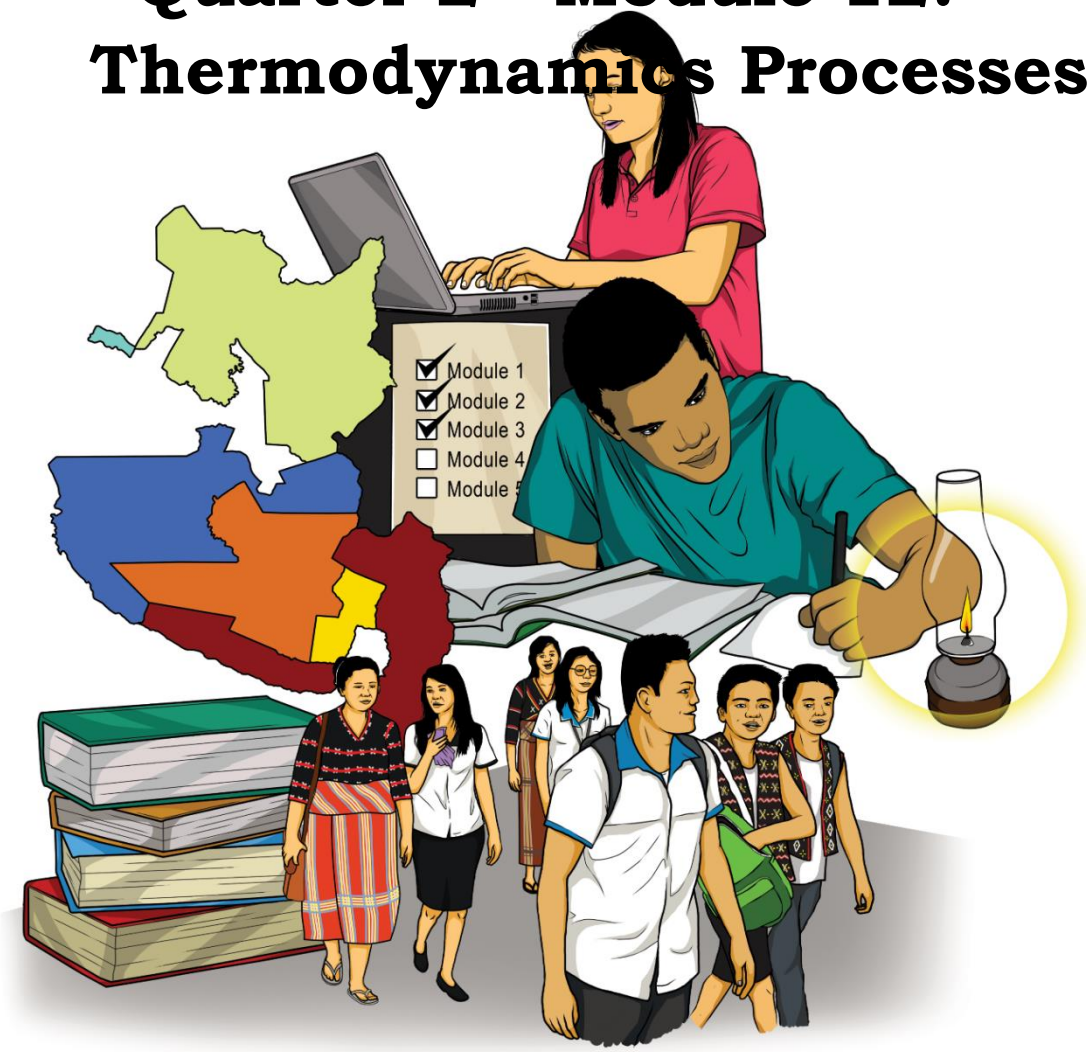
DEPARTMENT OF EDUCATION

General Physics 1

Quarter 2 - Module 12: Thermodynamics Processes



SELF-LEARNING MODULE

DEPARTMENT OF EDUCATION - SOCCSKSARGEN

General Physics 1 – Grade 12
Self-Learning Module (SLM)
Quarter 2 Module 12: Thermodynamics Processes
First Edition, 2020

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12

General Physics 1

Quarter 2 - Module 12:
Thermodynamics Processes

Introductory Message

For the facilitator:

Welcome to the **General Physics 1 Grade 12** Self-Learning Module (SLM) on **Thermodynamics Processes**

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 Processes**

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.

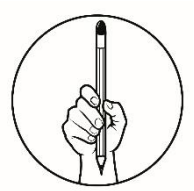
We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

What I Need to Know

Every time you drive a car, turn on an air conditioner, or cooked a meal, you reaped the practical benefits of *thermodynamics*, the study of relationships involving heat, mechanical work, and other aspects of energy and energy transfer.
For example, in a far engine heat is generated by chemical reaction of oxygen and vaporized gasoline in a cylinder. The heated gas pushes on the piston with in the cylinder, doing mechanical work that is used to propel the car. This is an example of a *thermodynamic process*.

After going through this module, you are expected to:

1. Describe isochoric, isobaric, isothermal, adiabatic and cyclic thermodynamic processes; and
2. Construct a PV diagram showing the different thermodynamic processes.



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 indicates an isochoric process?
   A. Free expansion takes place
   B. No mechanical work is done by the system
   C. Very little mechanical work is done by the system
   D. All parameters remain constant

2. Which of the following processes involves no change in the pressure of a system?
   A. adiabatic
   B. Isobaric
   C. isochoric
   D. isothermal

3. Which of the following processes involves no change in the volume of a system?
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

4. Which of the following conditions results if there is an addition of heat at constant pressure to a gas?
   A. Raising its pressure and doing external work
   B. Raising its temperature and pressure
   C. Raising its temperature and doing external work
   D. Raising its volume only

5. Which of the following is not a path function?
   A. heat
   B. kinetic energy
   C. thermal conductivity
   D. work

6. Which of the following is an isobaric process?
   A. No heat enters or leaves the system
   B. The pressure of the system is constant.
   C. The temperature of the system is constant.
   D. The volume of the system is constant.

7. What process is involved if a balloon is being expanded very rapidly?
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

8. Which of the following processes is involved if a balloon is being expanded very slowly by the addition of heat?
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

9. What process is involved if a balloon is being heated inside a solid metal case?
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

10. What will happen to a volume of a gas under constant temperature if the pressure increases?
   A. decreases
   B. expands
   C. increases
   D. remains the same

11. What will happen to the internal energy of gas molecules in an isothermal process?
   A. decreases
   B. increases
   C. may increase or decrease depending on the properties of gas
   D. remains constant

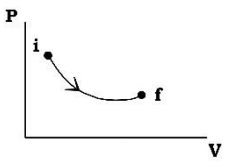
For items number 12-14, refer to the situations below.
Which best describes the following situations as one of the four types of thermodynamics system?

12. You let the bread rise on the counter.
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

13. A sealed cooler of dry ice evaporates
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

14. You boil the water in a pressure cooker.
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal

15. What type of gas process is shown in the graph?
   A. adiabatic
   B. isobaric
   C. isochoric
   D. isothermal



Lesson 1 Thermodynamics Processes

Learning Objectives:

At the end of the lesson, the learners are able to:

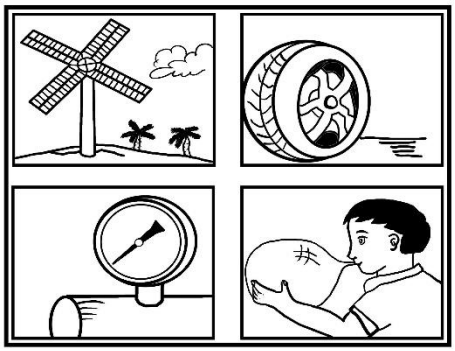
1. Describe isochoric, isobaric, isothermal, adiabatic, and cyclic thermodynamic processes; and
2. Construct a PV diagram showing the different thermodynamic processes.

What's In

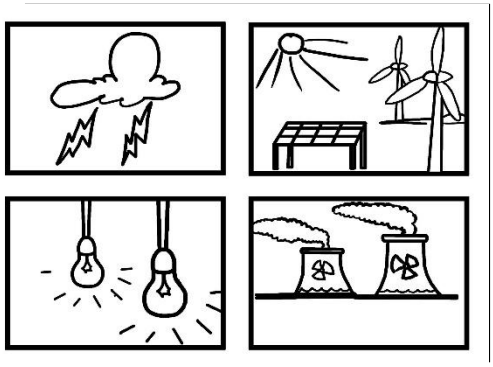
Activity 1: Guess Me!

Direction:

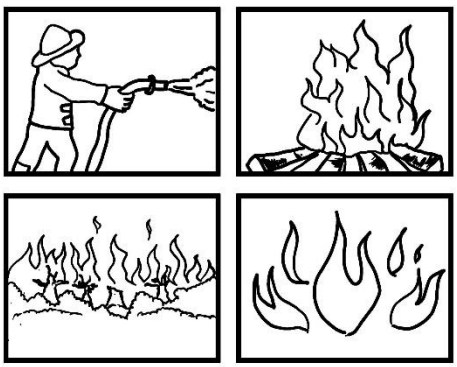
Fill in the lines with letters to show the correct term given the pictures below. Write your answer on the separate sheet



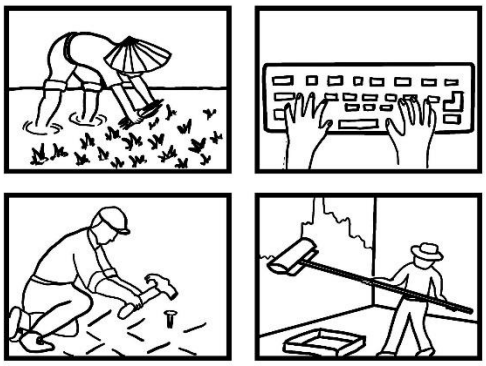
1. P _ _ _ S _ _ E



2. _ N _ _ G _



3. _ E A _



4. W _ _ K

What's New

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

Activity 2: Blow Me!

Materials:

activity sheets	writing materials	water
basin	match	heating materials
Balloon	rubber band	glass bottle of soft drinks

CAUTION!!!

Be careful in handling hot objects.

Direction:

1. Fit the opening of the balloon on the mouth of the bottle. Then, secure the balloon using a rubber band.
2. Get the basin and place the bottle with the balloon in standing position.
3. Boil 3 liters of water and pour it on the basin as shown in the set up below.

Figure 1. Pouring of boiling water in the basin

Guide Question:

1. What happens to the balloon as the boiling water is poured in the basin?
2. What had caused the change in the appearance of the balloon?

What is It

In Activity 2, it shows that when you put the bottle with the balloon into the basin, the hot water heats up the air in the bottle and makes it expand. (Gases always expand when they are warm-the heat gives the gas energy to spread out more). The expanding gas blows up the balloon. It explained one of the thermodynamic processes.

A **Thermodynamic Process** is a passage of thermodynamic system from an initial to a final state of thermodynamic equilibrium. The initial and final states are the defining elements of the process.

We describe four specific kinds of thermodynamic processes that occur often in practical situation. These can be summarized briefly as "no heat transfer" or **adiabatic**, "constant volume" or **isochori**c, "constant pressure" or **isobaric**, and "constant temperature" or **isothermal**.

An **adiabatic process** is defined as one with no heat transfer into or out of the system; Q = 0. We can prevent heat flow either by surrounding the system with thermally insulating material or by carrying out the process so quickly that there is not enough time for appreciable heat flow. For every adiabatic process,

U2 –U1 = ΔU = -W (adiabatic process)

Where U = internal energy
W = work
Q = heat

When a system expands adiabatically, W is positive (the system does work on its surrounding), so U is negative and the internal energy decreases. When a system is compressed adiabatically, W is negative (work is done on the system by its surrounding) and U increases. In many (but not all) systems an increase of internal energy is accompanied by a rise in temperature, and decrease in internal energy with a drop in temperature.

When the cork is pop on a bottle of champagne, the pressurized gases inside the bottle expand into the outside air so rapidly that there is time for them to exchange heat with their surroundings. Hence the expansion is adiabatic. As the expanding gases do work on their surroundings, their internal energy and temperature both drop; the lowered temperature makes water vapour condensed and form a miniature cloud.

An **isochoric process** is a constant-volume process. When the volume of a thermodynamic system is constant, it does no work on its surroundings. Then W = 0 and

U2 –U1 = c = Q (isochoric process)

In an isochoric process, all the energy added as heat remains in the system as an increase in an internal energy heating a gas in a closed constant-volume container is an example of an isochoric process.

An isobaric process is a constant-pressure process. In general none of the three quantities ΔU, Q, and W is zero in an isobaric process, but calculating W is easy nonetheless.

W = P (V2 – V1) **(isobaric process)**

Most cooking involves isobaric processes. That's because the air pressure above the sauce pan or frying pan, or inside a microwave oven, remains essentially constant while the food is being heated.

An isothermal process is a constant-temperature process. For a process to be isothermal, any heat flow into or out of the system must occur slowly enough that thermal equilibrium is maintained. In general, none of the quantities ΔU, Q, and W is zero in an isothermal process.

W = PΔV = P (Vf –Vi) **if applied to the first law,**
ΔQ = ΔU + PΔV

An example of isothermal process would be if we took a gas held behind a movable piston and compressed the piston, the volume has decreased and the pressure behind the piston has increased, since the molecules have less space in which to move. When you compressed the piston, you're using energy-you're doing work on the gas-normally the molecules would gain energy faster and the temperature would increase. So the only way for an isothermal process to happen if all that energy you put into compressing the gas comes out again.

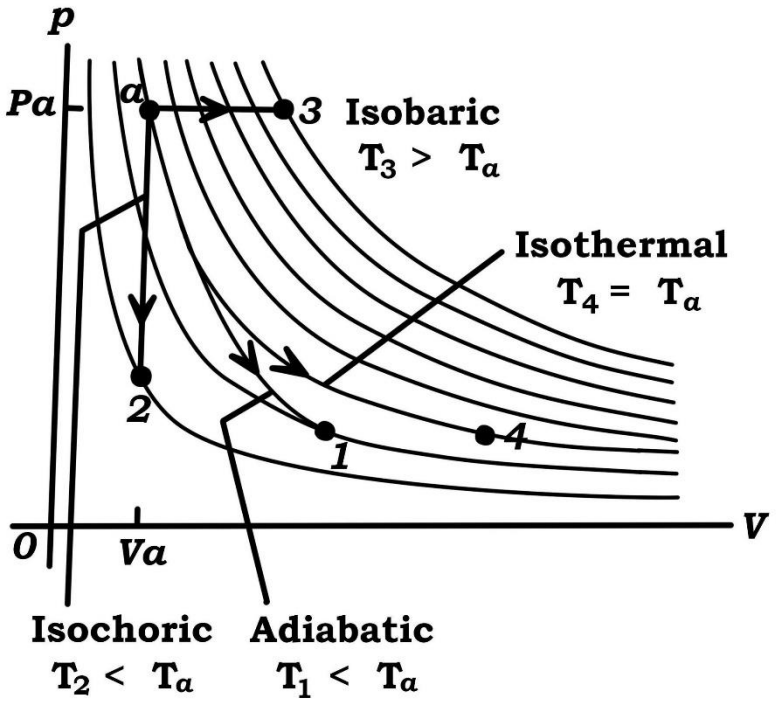


Figure 3. Thermodynamic processes.

Four different processes for the constant amount of ideal gas, all starting at state a. for adiabatic processes, Q=0; for the isochoric process, W=0; and for the isothermal process, ΔU=0. The temperature increases only during the isobaric expansion.

A cyclic process the system starts and returns to the same thermodynamic state. The network involved is the enclosed area on the P-V diagram. If the cycle goes counter clockwise work is done on the system.

An example of such a system is a refrigerator or air conditioner.
When a system undergoes a cyclic process, its initial and final energies are equal.

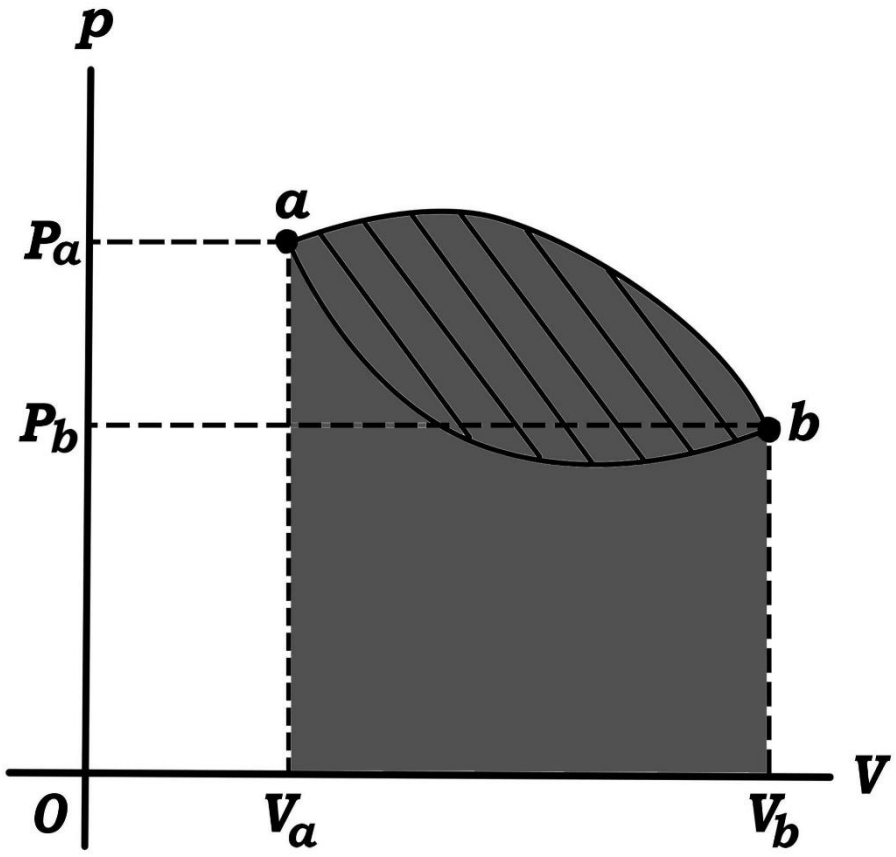
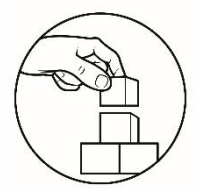


Figure 4. Work Done on a system

Set-Up: The thermodynamic processes here has two steps: a→b via the lower curve and b→a via the upper curve.



What's More

This time you are going to perform an activity about thermodynamic process. Are you ready?

Activity 3: Cool Me Down!

Materials:

activity sheets	writing materials	empty tin can (carbonated drink)
food tong	basin with cold water	pot holder

CAUTION!!!

Be careful in handling hot objects.

Direction:

1. Prepare the basin half-filled with cold water.
2. Produce a burning flame. Get the empty tin can using the food tong and place it over the burning flame as shown in the set up below. (to prevent the flow of heat into the hands, use the pot holder or any insulator in the food tong)

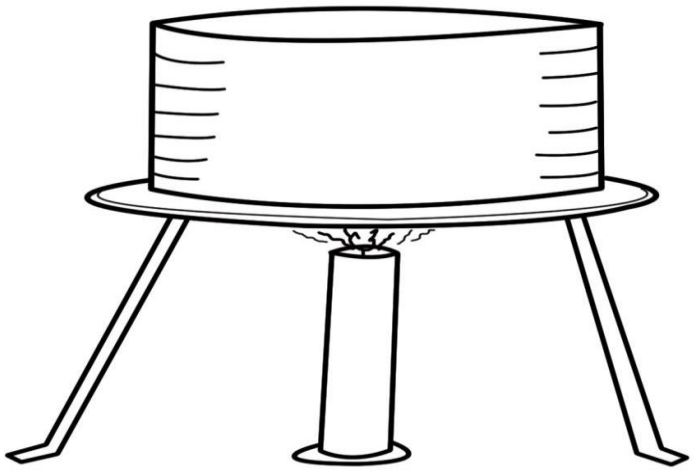


Figure 2. The heating of the tin can

3. Heat the tin can for about 3 minutes and quickly put it in the prepared basin with cold water.

Guide Questions:

1. What have you observed in the tin can when you quickly put it in the basin with cold water?
2. What had caused the change in the appearance of the tin can?

Activity 4: Fit Me In!

Direction: The following situations described as one of the 4 types of thermodynamic processes. Choose the correct answer from the box.

Isobaric	Isochoric	Adiabatic	Isothermal

_____1. You let the bread rise on the counter.
_____ 2. You sealed cooler of dry ice evaporates.
_____ 3. You boil the water in a pressure cooker.
_____4. Oxygen is carried from your lungs to cells in your blood vessels.
_____ 5. Freezing of water
_____ 6. A gas held behind a movable piston and compressed the piston.
_____ 7. Vertical flow of air in the atmosphere.

What I Have Learned

Activity 5: Did you remember me?

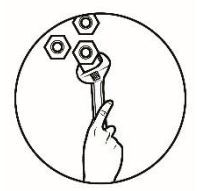
Materials:
activity sheets writing materials

Direction:

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

A (1) _____ process is a passage of thermodynamic system from an initial to a final state of thermodynamic (2)_____. The initial and final states are the defining elements of the process.

We describe four specific kinds of thermodynamic processes that occur often in practical situation. These can be summarized briefly as “no heat transfer” or (3) _____, “constant (4) _____” or isochoric, “constant pressure” or isobaric, and “constant temperature” or (5) _____.



What I Can Do

Activity 6: Fill Me In!

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

Direction:

Complete the table to show how the First Law will behave under the different types of thermodynamic processes. The first one is done for you as your guide. Write your answer on a separate sheet.

Number	Process	Definition	Interpretation
1	Adiabatic	No heat is added or removed from the system	Work done on the system increases the internal energy of the system
2	Isothermal		
3	Isochoric		
4	Isobaric		

Assessment

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

1. Which of the following is an isobaric process?
   A. No heat enters or leaves the system
   B. The pressure of the system is constant.
   C. The temperature of the system is constant.
   D. The volume of the system is constant.

2. What process is involved if a balloon is being expanded very rapidly?
   A. adiabatic B. isobaric C. isochoric D. Isothermal

3. Which of the following processes is involved if a balloon is being expanded very slowly by the addition of heat?
   A. adiabatic B. isobaric C. isochoric D. isothermal

4. What process is involved if a balloon is being heated inside a solid metal case?
   A. adiabatic B. isobaric C. isochoric D. isothermal

5. What will happen to a volume of a gas under constant temperature if the pressure increases?
   A. decreases B. expands C. increases D. remains the same

6. What will happen to the internal energy of gas molecules in an isothermal process?
   A. decreases
   B. increases
   C. may increase or decrease depending on the properties of gas
   D. remains constant

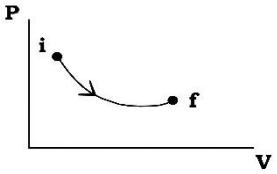
For items number 7-9, refer to the situations below.
Which best describes the following situations as one of the four types of thermodynamics system?

7. You let the bread rise on the counter.
   A. adiabatic B. isobaric C. isochoric D. isothermal

8. A sealed cooler of dry ice evaporates
   A. adiabatic B. isobaric C. isochoric D. isothermal

9. You boil the water in a pressure cooker.
   A. adiabatic B. isobaric C. isochoric D. isothermal

10. What type of gas process is shown in the graph?
    A. adiabatic
    B. isobaric
    C. isochoric
    D. isothermal



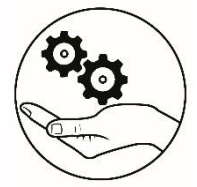
11. Which of the following indicates an isochoric process?
    A. Free expansion takes place
    B. No mechanical work is done by the system
    C. Very little mechanical work is done by the system
    D. All parameters remain constant

12. Which of the following processes involves no change in the pressure of a system?
    A. adiabatic B. Isobaric C. isochoric D. isothermal

13. Which of the following processes involves no change in the volume of a system?
    A. adiabatic B. isobaric C. isochoric D. isothermal

14. Which of the following conditions results if there is an addition of heat at constant pressure to a gas?
    A. Raising its pressure and doing external work
    B. Raising its temperature and pressure
    C. Raising its temperature and doing external work
    D. Raising its volume only

15. Which of the following is not a path function?
    A. heat
    B. kinetic energy
    C. thermal conductivity
    D. work



Additional Activities

How can we be more energy efficient? Most of our household energy consumption goes into heating and cooling and much is lost through walls and ceiling. Research on the insulating properties of various materials and their arrangement to help us resolve our household energy problem.

Activity 7: Give Me Tips!

Materials: activity sheet writing materials

Task: All energy transformation produces heat. This heat becomes waste and becomes a pollutant know on as thermal pollutant. Thermal pollutants add to the warming of the earth. One way of helping protect our environment is by conserving energy. In a separate sheet of paper write at least 5 tips on how to conserve energy at home, in school, and in the community.

Answer Key

Pre test

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

Activity 1
Guess Me

1. Pressure
2. Energy
3. Heat
4. Work

Activity 2
Blow Me!

1. **The balloon expand.**
2. **The balloon changed in appearance is due to the pressure of heat in the boiling water**

Activity 3
Cool me down!

1. **The can shrink**
2. **Change in temperature**

Activity 4: Fill me in!

1. Asobaric
2. Adiabatic
3. Isochoric
4. Isothermal
5. Isobaric
6. Isothermal
7. Adiabatic

Activity 5: Did you remember me?

1. thermodynamic
2. equilibrium
3. adiabatic
4. volume
5. isothermal

Activity 6. Fill me in!

Number	Process	Definition	Interpretation
1	Adiabatic	No heat is added or removed from the system	Work done on the system increases the internal energy of the system
2	Isothermal	The temperature of the system remains the same. Internal energy remains constant	Energy added to the system as the heat is used to do work
3	Isochoric	The volume of the system does not change. There is no work produced.	Heat added to the system is used to increase the internal energy.
4	Isobaric	The pressure in the system does not change	Heat added to the system is used to increase the internal energy and do work

Activity 7: Give Me Tips!

1. Answer may vary

Assessment

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

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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

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