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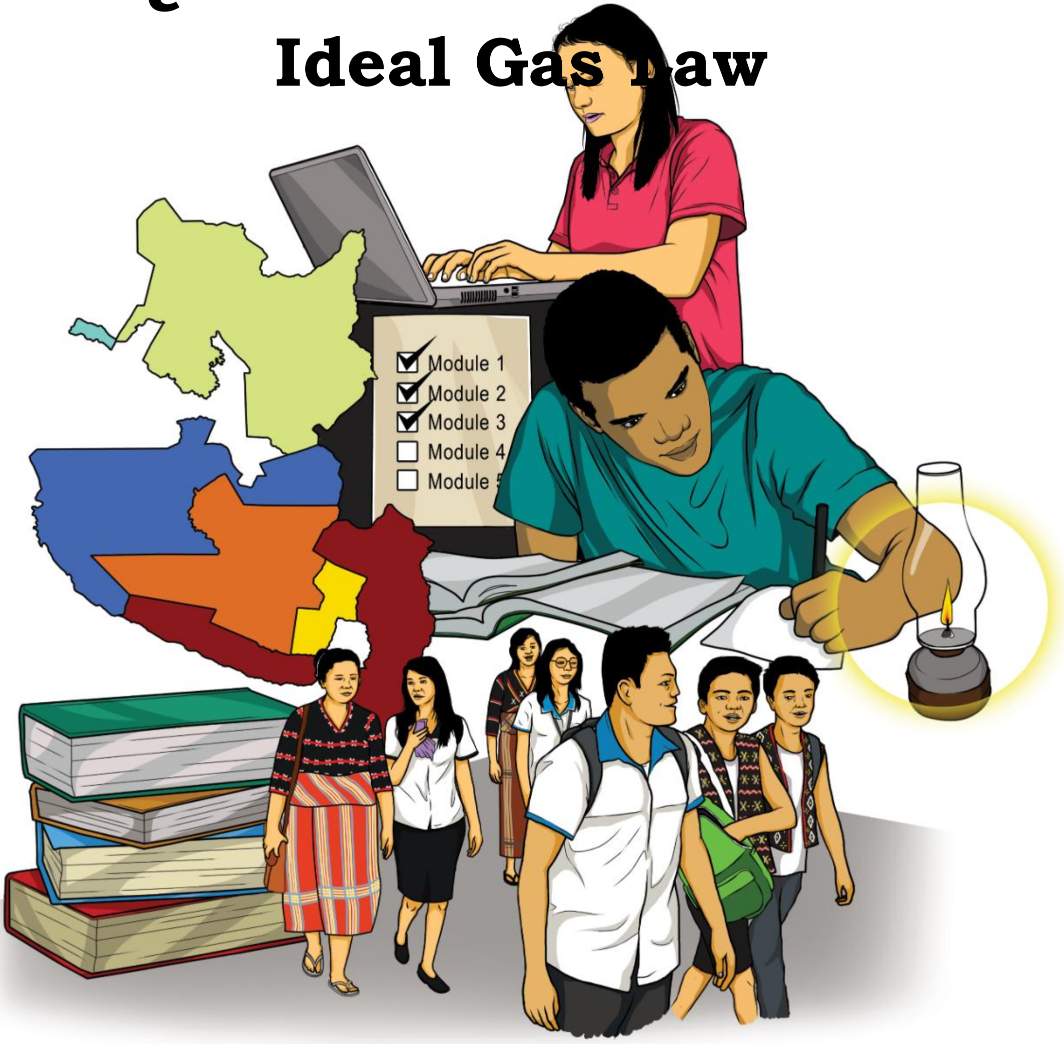
DEPARTMENT OF EDUCATION

General Physics 1

Quarter 2 - Module 10

Ideal Gas Law



SELF-LEARNING MODULE

DEPARTMENT OF EDUCATION - SOCCSKSARGEN

General Physics 1 – Grade 12
Self-Learning Module (SLM)
Quarter 2 Module 10: Ideal Gas Law
First Edition, 2020

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Introductory Message

For the facilitator:

Welcome to the General Physics 1 Grade 12 Self-Learning Module (SLM) on **Ideal Gas Law!**

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) **Ideal Gas Law!**

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 also be measured.

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.

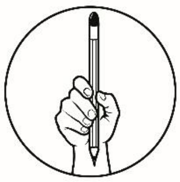
We hope that through this material, you will experience meaningful learning and gain deep understanding of the relevant competencies. You can do it!

What I Need to Know

Hello! How are you? Are you ready to explore and learn another concept about physics? Well, let us start moving!

After going through this module, you are expected to:

1. enumerate the properties of an ideal gas; and
2. solve problems involving ideal gas equations in the contexts such as, but not limited to, the design of metal containers for compressed gases.



What I Know

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

1. Which one of the following statements best explains why gases are not commercially sold by volume?
   A. Gas volume depends on temperature and pressure.
   B. Gas volume is difficult to measure.
   C. Gas volume is negligible
   D. Gases have comparatively low densities.

2. Which of the following factors is directly responsible for the pressure exerted by a confined gas?
   A. The atomic mass of the gas
   B. The collision of gas molecules with the sides of the containing vessel
   C. The density of the sample of molecules
   D. The temperature of the sample of molecules

3. Which of the following statements concerning the mole is false?
   A. It is defined in terms of the carbon-12 isotope
   B. It is related to Avogadro's number
   C. One mole of a substance contains the same number of particles as one mole of any other substance.
   D. One mole of a substance has the same mass as one mole of any other substance.

4. In the ideal gas law equation, which variable represents the gas constant?
   A. n
   B. R
   C. T
   D. V

5. A sample of a mono-atomic ideal gas is originally at 20 ^{o}C. What is the final temperature of the gas if both the pressure and volume are doubled?
   A. 5 ^{o}C
   B. 80 ^{o}C
   C. 900 ^{o}C
   D. 1200 ^{o}C

6. Which of the following laws accounts for temperature, volume, pressure, and moles of a gas within an individual system?
   A. Boyle's Law
   B. Charles' Law
   C. Ideal Gas Law
   D. Gay-Lussac's Law

7. Which statement is **false**?
   A. Gases can be expanded without limit
   B. Gases diffuse into each other and mix almost immediately when put into the same container.
   C. The density of a gas is constant as long as its temperature remains constant.
   D. The molecular weight of gaseous compound is non-variable quantity.

8. Under conditions of fixed temperature and amount of gas, what is required by Boyle's law?

I. $P_1V_1=P_2V_2$
II. PV=constant
III. $P_1/P_2=V_2/V_1$

   A. I only
   B. II only
   C. III only
   D. I, II, and III

9. In what condition does a real gas most closely approaches the behaviour of an ideal gas?
   A. High P and low T
   B. High P and T
   C. Low P and High T
   D. Low P and T

10. At constant temperature, what happens to the density of an ideal gas if the pressure is doubled?
   A. Double
   B. Reduce by Half
   C. Same
   D. Thrice

11. For a gas, which pair of variables is inversely proportional to each other if all other conditions remain constant?
   A. n, v
   B. P, T
   C. P, V
   D. V, T

12. Which statement is INCORRECT about an ideal gas?
   A. Conditions for a gas to behave as predicated by the ideal gas law
   B. Molecules do not occupy any space
   C. No attractive force exist between the molecules
   D. The gas molecules move in random, straight line motion

13. What is the volume of 20 grams of Oxygen in liter as standard conditions?
   A. 10
   B. 12
   C. 14
   D. 16

14. What is the density of carbon dioxide at 300 K at 0.987 atm?
    A. 1.76
    B. 2.76
    C. 3.76
    D. 4.76

15. 88 grams of CO_2 at 27°C is applying 5 atm, what is the volume occupied by it?
    A. 5.4 L
    B. 7.9 L
    C. 9.8 L
    D. 12.6 L

Lesson 1 Ideal Gas Law

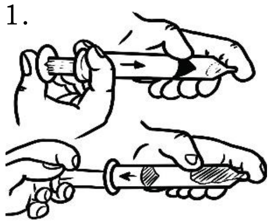
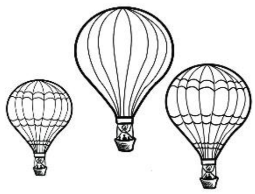
Learning Objectives:

1. enumerate the properties of an ideal gas; and
2. solve problems involving ideal gas equations in contexts such as, but not limited to, the design of metal containers for compressed gases.

What's In

Activity 1: Pair Me!

Direction: Fill in column B with the law that governs the picture in column A and write the relationship of volume, temperature and pressure of gas in column C. The first number is done for you.

Column A	Column B	Column C
1. 	**Boyle's Law**	**Pressure -Volume**
2. 		
3. 		

What's New

This time, we will perform an activity related to Ideal Gas Law!

Activity 2: Push Me Out!

Materials:

activity sheets
foldable straw
empty plastic bottle
balloon
Food coloring (any color)
writing materials
big nail (#4)
basin
water in a container

Procedure:

1. Make a hole at the middle portion of the empty plastic bottle using the big nail enough to fit the straw. Refer to the figure below.

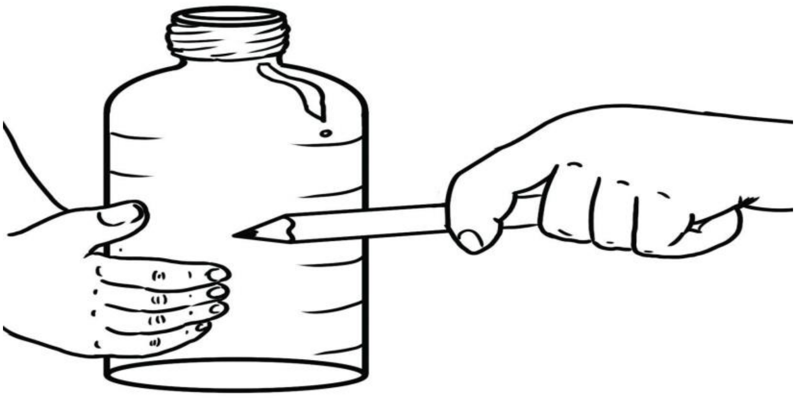


Figure 2. Making a hole at the middle portion of the bottle

2. Insert the foldable straw in the hole made at the side of the bottle.
3. Position the bottle beside the basin making sure the other end of the straw is lying at the opening of the basin.
4. Mix the water and the food color.
5. Add the colored water to the plastic bottle. Make sure it will not reach the hole made at the side of the bottle.

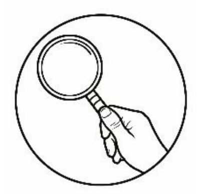
6. Inflate the balloon and secure the opening to prevent the air from escaping. Fasten the opening of the balloon to the mouth of the plastic bottle as shown in the figure below.

Figure 3. Fastening of the inflated balloon to the mouth of the plastic bottle

7. Observe what will happen.

Guide Questions

1. What did you observe to the balloon after inserting it in the bottle?
2. What happens to the water?
3. What did you notice on the volume of the water?
4. What had caused the decrease in the volume of the water?



What is It

Suppose you are going to take a ride in a hot air balloon, the captain turns on a propane burner to heat the air inside the balloon. How does this allow the balloon to rise? Can you think of a reason why a balloonist would prefer to fly in the morning?

The Push Me Out activity on page 5 is a manifestation of the behaviour of a gas. The learners had observed the change in the shape of the balloon and how the pressure affects the volume of the water in the bottle.

Below is a table showing the summary of the properties of a gas and the unit/s of measurement used.

Properties that describe a Gas

Property	**Description**	**Unit(s) of Measurement**
Pressure (P)	The force exerted by gas against the walls of the container	Atmosphere (atm); mmHg; kPa, torr
Volume (V)	The space occupied by the gas	Liter (L); milliliter (mL)
Temperature (T)	Determine the kinetic energy and the rate of motion of the gas particles	Celsius (^{0}C); Kelvin (K) **Note: Required in calculations**
Amount (n)	The quantity of a gas present in the container	Grams (g); mole (n) **Note: Required in calculations**

The four properties of gas mentioned above can be combined to give a single expression called the Ideal Gas Law, which is written as **PV = nRT.**

Where, n/V = ρ∞1/T, that means we can prove based on the ideal gas law that the density and temperature of gases are inversely proportional hence, hot air will rise in cool air because its density is less.

We can also use the ideal gas equation to determine gas density from pressure and temperature.

Using the definitions of density, ρ (density) =mass/volume, mass = n x M, and gas volume from the ideal gas equation, V=$\frac{nRT}{P}$, we get the following equation for density of an ideal gas

$$\rho = \frac{m}{V} = \frac{nxM}{\frac{nRT}{P}} = \frac{PM}{RT}$$

Where: ρ=density
n=amount of substance
V=volume
P= Pressure
M= Molar mass
R= ideal gas constant
T= temperature

Sample Problem 1

Calculate the density of N_2 with a molar mass of 28.0g/mol at 293K and 0.800 atm.

Given:
T = 293 K
P = 0.800 atm
M_{N2} = 28.0g/mol

Find: ρ

Solution: $\rho = \frac{PM}{RT}$

$$= \frac{0.800\ atm\ x\ 28.0\ g/mol}{0.08205\ L\frac{atm}{molK}x\ 293\ K}$$

= 0.932 g/L

IDEAL GAS is defined as one of which both the volume of molecules and the forces between the molecules are so small that they have no effect on the behaviour of the gas or it can be a gas that conforms, in physical behaviour, to a particular, idealized relation between pressure, volume and temperature.

According to the Kinetic Theory of Gases, an Ideal Gas has the following characteristics:

1. *Gases are made up of very tiny molecules.* The distances between molecules are very large. Therefore gases are mostly empty space. For an ideal gas, the molecule occupies zero volume.

2. *Gas molecules demonstrate rapid motion, move in a straight line, and travel in random directions.*

3. *Gas molecules show no attraction for one another.* After colliding with each other, molecules simply bounces off in different directions.

4. *Gas molecules have* **elastic collisions.** That is, gas molecules do not lose kinetic energy after colliding. If a high-energy molecule strikes a less energetic molecule, part of the energy can be transferred. The total energy of both molecules before and after collision does not change.

5. *The average kinetic energy of the gas molecules is proportional to the Kelvin temperature of gas.* At the same temperature, all gases have the same average molecular kinetic energy. At higher temperatures, molecules have faster and collide more frequently. At lower temperatures, molecules move slower and collide less frequently. Recall that the kinetic energy of a molecule is proportional to its mass and square of velocity. As consequences, smaller molecules move faster and larger molecules move slower at the same temperature.

The Ideal Gas Law equation is given as PV = nRT,

Where P = pressure (P)
V = volume
n = number of mole
T = temperature (K)
R = ideal gas constant
(0.0821 L-atm/molK, 62.4 L-mmHg/molK, 8.3145 L/kPaK

The value of the gas constant R, is derived as follows:

At Standard Temperature Pressure (STP), the pressure of the gas is 1 atm, the temperature is 273 K or 0^0C, and the volume of 1 mole of the gas is 22.4 L. Using this value in the equation for the ideal gas would result in PV = nRT.

Solving for R you have:

$$R = \frac{PV}{nT}$$

Substituting the values of $P_1V_1\,T_1$, n at STP

$$R = \frac{(1\text{ atm})(22.4\text{ L})}{(1\text{ mol})(273\text{ K})}$$

R = 0.0821 L-atm/molK

Sample Problem 2

A 6.50 mole of CO_2 occupies a volume of 13.5 L at 28.0^0C. Determine the pressure of CO_2 at this condition.

Given: n = 6.50 moles
V = 13.5 L
T = 28.0^0C
= 28.0^0C + 273.0 K
= 301.0 K

Required:
Pressure of the gas, P

Solution:
PV = nRT

Solving for P you have,

$$P = \frac{nRT}{V}$$

Substitute

$$P = \frac{(6.50\ \text{moles})(0.0821\ \text{L-atm/molK})(\ 301.0\ \text{K})}{13.5\ L}$$

$$= \frac{0.534\ \text{L-atm}}{13.5\ \text{L}}$$

$$P = 0.040\ \text{atm}$$

The temperature, pressure and volume of an ideal gas are related to each other by ideal gas equation. Since R is a constant, it does not change its numerical value at any condition of P, V, T, n.

This time we will explore another problem involving volume of gas.

Sample Problem 3

What volume will 1.27 mol of Helium Gas occupy at STP?

Given: n =1.27 mol
T = 273 K
P = 1.00 atm
R = 0.0821 L-atm/molK

Find: V=?

Solution:

PV = nRT

$$V = \frac{nRT}{P}$$

$$= \frac{(1.27\ mol)(0.0821\ \frac{L\text{-}atm}{molK})(273\ K)}{1\ atm}$$

$$= \frac{0.104\ L\text{-}atm/K(273\ K)}{1\ atm}$$

$$= \frac{28.46\ L\text{-}atm}{1\ atm}$$

= 28.46 L

Sample Problem 4

How many moles of gas are contained in a 50.0 L cylinder at a pressure of 100.0atm and a temperature of 35.0 ^{0}C?

Given: V = 50.0 L
P = 100.0 atm
T = 35.0 ^{0}C + 273.0 K = 308 K
R = 0.0821 L-atm/molK

Find: n=?

Solution: PV = nRT

$$n = \frac{PV}{RT}$$

$$= \frac{(100.0\ atm)(50.0L)}{(0.0821\ \text{L−atm/molK})(308\ \text{K})}$$

$$= \frac{5000.0\ L{-}atm}{(0.0821\ \text{L−atm/molK})(308\ \text{K})}$$

$$= \frac{5000.0\ L{-}atm}{(25.29\text{L−atm/mol}}$$

= 197.71 mol

Sample Problem 5

A 25.0 g sample of Nitrogen, N_2 has a volume of 50.0 L and a pressure of 0.829 atm. What is the temperature of the gas?

Given: m = 25.0 g
V = 50.0 L
P = 0.829 atm
R = 0.0821 L-atm/molK

Required:
a) Molar mass of the N_2
b) Temperature of the gas

Solution:
a) Start with the ideal gas law equation.
PV = nRT

$$n = \frac{PV}{RT}$$

$$= \frac{(0.829\ atm)(50.0\ L)}{(0.0821\ \text{L−atm/molK})(298\text{K})}$$

$$= \frac{41.45\ L{-}atm}{(24.47\ \text{L}\frac{\text{atm}}{\text{molK.K}})}$$

= 1.69 mol

Recall that,

$$n = \frac{mass\ (g)}{molar\ mass}$$

Solving for the molar mass of N_2

Molar mass of N_2 = $2\,\frac{(25.0\ g)}{(1.69\ mol)}$

Molar mass of N_2 = 2 (14.79 g/mol) = 29.58 g/mol

Substituting this to the ideal gas law to find T

b) $PV = \frac{mass\ (g)}{molar\ mass\ of\ N2}\ RT$

Rearranging to solve for T of the gas

$$RT\frac{mass}{molar\ mass\ of\ N2} = PV$$

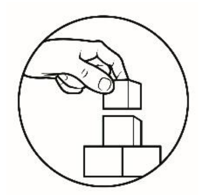
$$T = \frac{molar\ mass\ of\ N2}{mass}\ (\frac{PV}{R})$$

$$T = \frac{29.58\frac{g}{mol}}{25.0\ g}\ (\frac{0.829\ atm(50.0L)}{0.0821\ atm{-}L/molK})$$

$$T = 1.1832\ \text{mol}\ (\frac{(41.45\ atm{-}L)}{0.0821\ atm{-}L/molK})$$

T = 1.1832 mol (504.872 mol/k)

T = 597 K



What's More

Here's a simple challenge for you. Play with the problems below. Solve what is being asked using the different formula mentioned in What is It.

Activity 3: Cloud Computing!

Materials:

activity sheet
writing materials
calculator (if available)

Direction:

Read and analyze the problem. Show your complete solution in a separate sheet of paper.

Problems:

1. What pressure will be exerted by 0.400 mol of a gas in a 5.00 L container at 17.0^{0}C?

2. A 0.226 g sample of carbon dioxide, CO_2 with molar mass 44.01 g/mol has a volume of 5.25 L and a pressure of 0.599 atm. What is the temperature of the gas?

Activity 4: Check Your Knowledge!

Materials:

activity sheet
writing materials

Direction:

Create a graphic organizer enumerating the concepts of the Ideal Gas Law learned in this session. The content is given on the box. Do this in a long folder. Please be guided with the given rubrics below.

Determine the kinetic energy and the rate of motion of the gas particles	Pressure (P)	Atmosphere (atm); mmHg; kPa, torr
Volume (V)	The space occupied by the gas	Liter (L); milliliter (mL)
Temperature (T)	Amount (n)	The quantity of a gas present in the container
The force exerted by gas against the walls of the container	Celsius (^{0}C); Kelvin (K) **Note: Required in calculations**	Grams (g); mole (n) **Note: Required in calculations**

Rubric

Category	4 Very Good	3 Good	2 Fair	1 Poor
Pictures/ Graphics	Pictures/ concepts are clear and relevant	Some of the pictures/ concepts are clear and relevant	Few of the pictures/ concepts are clear and relevant	The student's Pictures/concepts are not clear and relevant
Required elements	All of the required elements are clearly visible, organized and well placed	Most of the required elements are clearly visible, organized and well placed	Few of the required elements are clearly visible, organized and well placed	Missing most or all of the required elements
Visual clarity and appeal	The project has an excellent design and lay out. It is neat and the content is easy to understand	The project has a good design and lay out. It is neat and easy to understand.	The project needs improvement in design, layout and neatness	The project's design and layout is not clear and neatness is not observed

What I Have Learned

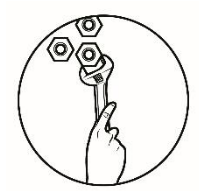
Activity 5: Pick me and Write me down!

Well, let's have more fun! This time you're going to assess your learning by filling in the blanks with the correct word/s to complete the statement. Choose your answer from the set of words found inside the box. Write your answer on a separate sheet of paper.

PV = nRT	Volume
Pressure	Universal gas constant
Temperature	

Ideal gas is defined as one for which both the volume of molecules and the forces between the molecules are so small that they have no effect on the behaviour of the gas or it can be a gas that conforms, in physical behaviour, to a particular, idealized relation between (1)_________, (2)_________ and (3)_________.

The Ideal Gas Law equation is given as (4)_________ where n is the number of moles of gas, and R= 8.31J/ (mol K) is known as the (5)________________.



What I Can Do

Job well done! You're almost there! This time, you will apply what you have learned in this module. Shall we start!

Activity 6: What Caused It?

Materials:

activity sheet writing material

Direction:

Name and describe at least three situations that happen in your daily routine involving ideal gas law that relates to what you had observed at home, at work, in school, or in the park.

Example:

SITUATION: flying hot air balloon

DESCRIPTION:

Increasing the temperature of the gas will also increase the volume while the density of the air decrease as the air inside the balloon is heated

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. Which one of the following statements best explains why gases are not commercially sold by volume?
   A. Gas volume depends on temperature and pressure.
   B. Gas volume is difficult to measure.
   C. Gas volume is negligible
   D. Gases have comparatively low densities.

2. Which of the following factors is directly responsible for the pressure exerted by a confined gas?
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   B. The collision of gas molecules with the sides of the containing vessel
   C. The density of the sample of molecules
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3. Which one of the following statements concerning the mole is false?
   A. It is defined in terms of the carbon-12 isotope
   B. It is related to Avogadro's number
   C. One mole of a substance contains the same number of particles as one mole of any other substance.
   D. One mole of a substance has the same mass as one mole of any other substance.

4. In the ideal gas law, which variable represents the gas constant?
   A. n
   B. R
   C. T
   D. V

5. A sample of a mono-atomic ideal gas is originally at 20 ^{o}C. What is the final temperature of the gas if both the pressure and volume are doubled?
   A. 5 ^{o}C
   B. 80 ^{o}C
   C. 900 ^{o}C
   D. 1200 ^{o}C

6. Which of the following laws accounts for temperature, volume, pressure, and moles of a gas within an individual system?
   A. Boyle's Law
   B. Charles' Law
   C. Ideal Gas Law
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   A. Gases can be expanded without limit
   B. Gases diffuse into each other and mix almost immediately when put into the same container.
   C. The density of a gas is constant as long as its temperature remains constant.
   D. The molecular weight of gaseous compound is non-variable quantity.

8. Under conditions of fixed temperature and amount of gas, what is required by Boyle's law?

   I. $P_1V_1=P_2V_2$
   II. $PV=constant$
   III. $P_1/P_2=V_2/V_1$

   A. I only
   B. II only
   C. II only
   D. I, II, and III

9. In what condition does a real gas most closely approaches the behaviour of an ideal gas?
   A. High P and low T
   B. High P and T
   C. Low P and High T
   D. Low P and T

10. At constant temperature, what happens to the density of an ideal gas when the pressure is doubled?
    A. Double
    B. Reduce by half
    C. Same
    D. Thrice

11. For a gas, which pair of variables is inversely proportional to each other (if all other conditions remain constant)?
    A. n, v
    B. P, T
    C. P, V
    D. V, T

12. Which statement is INCORRECT about an ideal gas?
    A.Conditions for a gas to behave as predicated by the ideal gas law
    B. Molecules do not occupy any space
    C. No attractive force exist between the molecules
    D. The gas molecules move in random, straight line motion

13. What is the volume of 20 grams of Oxygen in liter as standard conditions?
A. 10
B. 12
C. 14
D. 16

14. What is the density of carbon dioxide in km/m^3 at 27^{o}C at 100 kPa?
A. 1.76
B. 2.76
C. 3.76
D. 4.76

15. 88 grams of CO_2 at 27^{o}C is applying 5 atm, what is the volume occupied by it?
A. 5.4 L
B. 7.9 L
C. 9.8 L
D. 12.6 L

Additional Activities

Congratulations! You made it! However you've got one more activity that will measure your skills and expertise in dealing matters concerning Ideal Gas Law.

Activity 7: Give Me What I Want

Materials:

activity sheet writing materials

Direction:

In a short bond paper, you are going to create a Word Cloud enumerating the properties of the ideal gases. Please be guided with the given rubric below.

Rubric

Category	**4 Very Good**	**3 Good**	**2 Fair**	**1 Poor**
Pictures/ Graphics	Pictures/ concepts are clear and relevant	Some of the pictures/ concepts are clear and relevant	Few of the pictures/ concepts are clear and relevant	The student's Pictures/concepts are not clear and relevant
Required elements	All of the required elements are clearly visible, organized and well placed	Most of the required elements are clearly visible, organized and well placed	Few of the required elements are clearly visible, organized and well placed	Missing most or all of the required elements
Visual clarity and appeal	The project has an excellent design and lay out. It is neat and the content is easy to understand	The project has a good design and lay out. It is neat and easy to understand.	The project needs improvement in design, layout and neatness	The project's design and layout is not clear and neatness is not observed

Answer Key

Pre test

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

Post test

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

Activity 1
Pair Me!

1. Boyle's Law - Pressure-volume
2. Charles' Law - Temperature-volume
3. Gay-Lussac's Law – Temperature-pressure

Activity 2
Push Me Out!

1. **The balloon released the air into the bottle.**
2. **The water was displaced through the straw.**
3. **The amount of the water decreases.**
4. **The pressure from the air released by the balloon.**

Activity 5
Pick me and Write me down!

1. **Pressure**
2. **Volume**
3. **Temperature**
4. **PV= nRT**
5. **Universal Gas Constant**

Activity 4 Check Your Knowledge
Answer may vary

Activity 6 What Caused It
Answer may vary

Activity 7 Give Me What I Want
Answer may vary

Activity 4

Cloud Computing!

Problem 1

Given:

n = 0.400 mol
V = 5.00 L
T = 17.0⁰C + 273.0 K =290.0 K
Find: P
Solution:

$$P = \frac{nRT}{V}$$

$$= \frac{\mathbf{0.400\ mol(0.0821L-\frac{atm}{molK})(290K)}}{\mathbf{5.00L}}$$

$$= \frac{\mathbf{0.033L-atm(290K)}}{\mathbf{5.00L}}$$

$$= \frac{\mathbf{9.57L-atm)}}{\mathbf{5.00L}}$$

= 1.91 atm

Problem 2

Given: m = 0.226 g
V = 5.25 L
P = 0.599 atm
Molar mass CO_2 = 44.01 g/mol
Find: a) n b) T

Solution:

a) $n = \frac{mass\ of\ the\ gas}{molar\ mass\ of\ CO}$

$n = \frac{0.226\ g}{44.01\ g/mol}$

n = 0.0051 mol

b) PV = nRT

$$T = \frac{PV}{nR}$$

$$T = \frac{(0.599\ atm)(5.25L)}{(0.0051\ mol)(0.0821\ atm-L/molK)}$$

$$T = \frac{3.145\ atm;L}{0.00042\ mol.atm-L/molK}$$

$$T = \frac{(3.145\ atm-L}{(0.00042\ mol)} \cdot \frac{molK}{atm-L}$$

T = 7488 K

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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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