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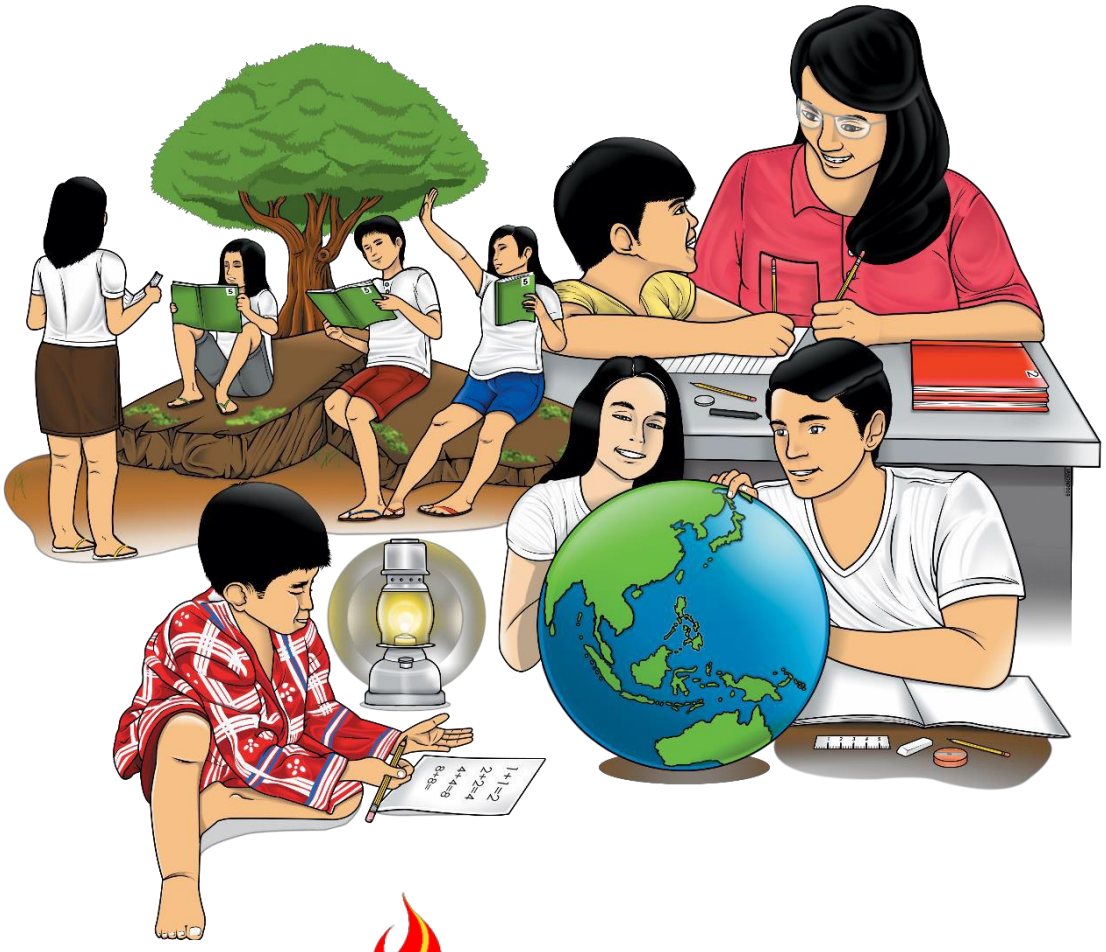
Science

Quarter 4 – Module 1.1:
Boyle's Law



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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

How can you relate pressure and volume in real life situation? Generally, you fill a car tire with compressed air pressure ranging from 30 to 35 psi. The psi (pounds per square inch) is a unit of measurement for pressure. As you put more and more air into the tire, you are forcing all the gas molecules to get packed together, reducing their volume and increasing the pressure pushing on the walls of the tire. As long as the air temperature remains the same, you are experiencing a real-life example of volume and pressure relationship.

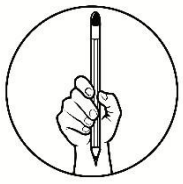
This module will provide you with information and simple activities to help you understand volume and pressure relationships at constant temperature.

After going through this module, you are expected to:

1. investigate the relationship between volume and pressure at constant temperature of a gas **(S10MT-IVa-b-21)**;
2. solve problems involving changes in the condition of the gas using the equation for Boyle's Law; and
3. give application of Boyle's Law in real life situations.

Going through this module can be a meaningful learning experience. All you need to do is make use of your time and resources efficiently. To do this, here are some tips for you:

1. Take the pretest before reading the rest of the module.
2. Take time in reading and understanding the lesson. Follow instructions carefully. Do all activities diligently. This module is designed for independent or self-paced study. It is better to be slow but sure than to hurry and miss the concepts you are supposed to learn.
3. Use a clean sheet of paper for your answers in each activity or assessment. Do not forget to write your name. Label it properly.
4. In problem solving, write first the given data as well as the required variable. Then identify the equation to be used.
5. Numerical answers should be in proper significant figures. In gas laws, use the smallest number of significant figures given in the problem.
6. Be honest. When doing the activities, record only what you have really observed. Take the self-assessments after each activity, but do not turn to the Answer Key page unless you are done with the entire module.
7. Don't hesitate to ask. If you need to clarify something, approach or contact your teacher or any knowledgeable person available to help you. You may also look into other references for further information. There is a list of references at the back part of this module.
8. Take the posttest prepared at the end of the module for you to assess how much you have learned from this module.
9. You can check your answers in the activities, self-assessments, and posttest after you have finished the entire module to know how much you have gained from the lesson and the activities.



What I Know

Directions: Answer the following questions to the best of your ability. The objective of this part is to gauge your prior knowledge on the relationship of volume and pressure at constant temperature. Use a separate sheet of paper for your answers.

1. Who was the English scientist who made accurate observations on the relationship of pressure and volume?
   a. Amedeo Avogadro
   b. Gay-Lussac
   c. Jacques Charles
   d. Robert Boyle
2. Which of the following is constant when using the Boyle's Law?
   a. energy
   b. pressure
   c. temperature
   d. volume
3. Which of the following is the SI standard unit of pressure?
   a. atm b. mmHg c. Pa d. torr
4. Which of the following is equal to the standard pressure?
   a. 1 atm b. 1 torr c. 273 kPa d. 760 atm
5. When pressure on a gas goes down, what happens to its volume?
   a. goes down then rises
   b. rises
   c. rises then falls
   d. stays the same
6. In the equation for Boyle's Law, P_1 stands for:
   a. difference in pressure
   b. initial pressure
   c. new pressure
   d. standard pressure, 1 atm
7. In the equation for Boyle's Law, V_2 stands for:
   a. difference in volume
   b. final volume
   c. initial volume
   d. standard volume
8. Which of the following graph correctly represents the relationship between pressure and the volume of an ideal gas that is held at constant temperature?

   a. P (Pa) V (m^3)

   b. P (Pa) V (m^3)

   c. P (Pa) V (m^3)

   d. P (Pa) V (m^3)

9. What is the equivalent value of 1 atmosphere (1 atm) in Pascal (Pa)?
   a. 1 Pa
   b. 76 Pa
   c. 760 Pa
   d. 101,325 Pa

For item 10, refer to the table on the next page.

Pressure-Volume Data Obtained at Constant Temperature

P (mmHg)	V (mL)
350	1000
700	500
1400	250
2800	125
3500	100

10. Based on the table, what relationship can be derived between pressure (P) and volume (V) at constant temperature?
    a. The volume is directly proportional to its pressure.
    b. The volume is insignificantly related to its pressure.
    c. The volume is inversely proportional to its pressure.
    d. The volume is inversely proportional to the square of its pressure.

11. Which of the following illustrates the mathematical statement of Boyle's Law?
    a. $P_1V_1 = P_2V_2$
    c. $P_1T_1 = P_2T_2$
    b. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
    d. $\frac{V_1P_1}{T_1} = \frac{V_2P_2}{T_2}$

12. A 2.75 L sample of dry air in a cylinder exerts a pressure of 3.00 atm at 30 °C. Without changing the temperature, a piston is moved until the pressure in the cylinder is reduced to 1.00 atm. What is the final volume of the gas?
    a. 0.121 L
    c. 1.10 L
    b. 0.917 L
    d. 8.25 L

13. If the pressure of a confined gas is doubled while the temperature remains constant, what change would be observed in the volume?
    a. It would be half as large.
    c. It would be four times as large.
    b. It would be doubled.
    d. It would remain the same.

14. A gas at a pressure of 658 mm Hg is held in a container with a volume of 595 mL. The volume of the container is then increased to 1,065 mL without a change in temperature. What is the new pressure of the gas?
    a. 2.72×10^{-3} mm Hg
    c. 963 mm Hg
    b. 368 mm Hg
    d. 1,178 mm Hg

15. Two hundred twenty-five cubic centimeter (225 cm^3) of a gas is contained in a vessel under a pressure of 800 mm Hg. What would be the new volume of the gas if the pressure is changed to 1000 mm Hg? Assume that the temperature remains constant.
    a. 2.81 cm^3
    b. 180 cm^3
    c. 800 cm^3
    d. 3,556 cm^3

Answer Key on page 18

How did you find the pre-test? What was your score? If you got 15 items correctly, you may skip the module. But if your score is 14 and below, you must proceed with the module.

Lesson 1

Boyle's Law

Like solids and liquids, gases are made up of molecules that behave differently. Most of the properties of gases can be attributed to the random and scattered arrangement of their molecules located as far away as possible from each other because they have a very weak intermolecular force of attraction. These topics were discussed in your Grade 8 Science.

What's In

A. Recall the symbol and common units of the following properties by completing the table.

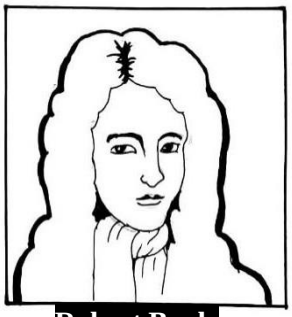
Property	Symbol	Three Common Units
Pressure		
Temperature		
Volume		

B. Identify the word being described below by providing the missing letters in the box.

1. It is the measure of the hotness or coldness of an object.		E			E		A				E
2. It is an average effect of the forces of the colliding molecules.			E					E			
3. It refers to the amount of space occupied by the gases.				U		E					
4. It is a unit of pressure.				O				E		E	
5. It is a unit of volume.	L			E							

C. Mark "√" in the first column if the sentence describes gases and "X" if it does not portray gases.

	1. Gases are hard to compress.
	2. Gases expand to fully fill their containers.
	3. Gases take the shape of the container wherein particles are able to move naturally to all parts of the container.
	4. Particles of gases move at random directions very fast travelling in straight-line paths
	5. The molecules of the gas are very large compared to the very short distances between them.



Robert Boyle

Illustrator: Anjo C. Layoso
SDO-San Carlos City, Pangasinan

Robert Boyle in 1662 studied the relationship between the volume of a gas and its pressure. Boyle varied the pressure and noticed its effect on the volume of the gas, without changing its temperature. He noticed that the volume of the gas decreased as the pressure exerted on it increased. This experience is now known as Boyle's Law.

Syringes of all types utilize Boyle's law on a very basic level. Experience this phenomenon by performing the following activity.

What's New

Marvelous Marshmallow!

What you need:

syringe rubber stopper marshmallow

What you have to do:

1. Remove the plunger from the syringe. Place the marshmallow inside and then reinsert the plunger.
2. Seal the syringe with the rubber stopper.
3. Increase the pressure by giving the plunger inward push.
4. What happened to the size (volume) of the marshmallow when pressure was increased?

   _____
5. Decrease the pressure by slowly pulling the plunger outwards.
6. What happened to the size (volume) of the marshmallow upon reducing the pressure?

   _____

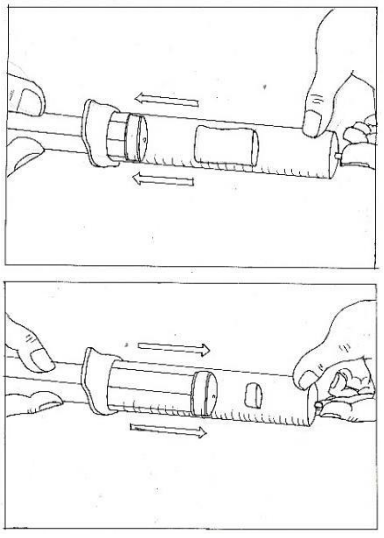
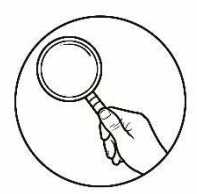


Figure 1. Marshmallow inside the syringe

Illustrator: Anjo C. Layoso
SDO-San Carlos City, Pangasinan



What is It

What have you observed on the previous activity? What can you conclude about the relationship of pressure and volume?

Kinetic Molecular Theory can be employed to explain Boyle's conclusion. The molecules of a gas exert pressure on the walls of its container. The molecules move nearer to one another when pressure is applied on the gas resulting in the decrease in volume. This increases the chances of collision among the molecules and the walls of the container; thus, pressure is increased.

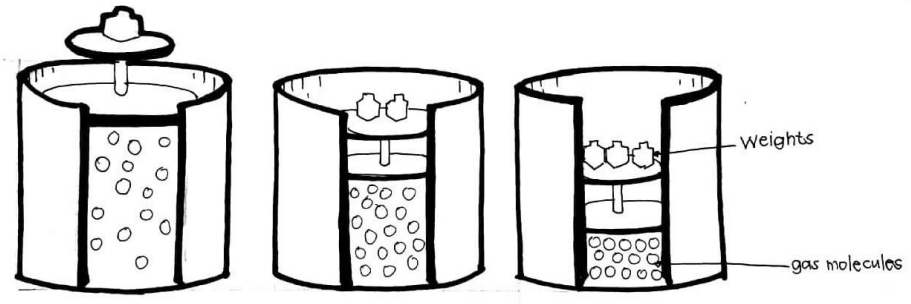


Figure 2. Boyle's Law

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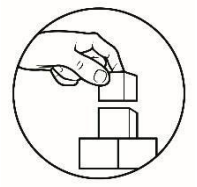


What's More

Activity 1. Measurable Properties of Gases

In dealing with Gas Laws, it is important to know the commonly used units in volume, pressure and temperature. Please do the activity below to be familiar with the common units used in dealing with Gas Laws.

Gases are generally described based on their measurable properties. The following measurable properties are usually used in dealing with gas laws:

1. Pressure - the force exerted by the gas on the walls of its container divided by the surface area of the container.

   The common units of pressure are the following:

   - Pascal (Pa) - standard unit of pressure under Systemé International (SI) which is equivalent to a force of one newton ($1N = 1\ kg\ m/s^2$) acting on an area of one square meter.
   - Atmosphere (atm)
   - Torr
   - Millimeter mercury (mm Hg)

Pressure can be converted from unit to another using the following conversion:

1 atm = 760 torr = 760 mm Hg

1 torr = 1 mm Hg

1 atm = 101,325 Pa

2. Volume –defined as the space occupied. The volume of the gas is equal to the volume of the vessel or container.

   Common Units of Volume: cubic meter (m^3), cubic centimeter (cm^3), liter (L) milliliter (mL)

3. Temperature –defined as the degree of hotness or coldness**.**

   Units: degree Celsius (^oC), degree Fahrenheit (^oF), Kelvin (K)

The temperature of a gas together with its atmospheric pressure differ from place to place and from time to time. As the volume of a gas is dependent on its temperature and pressure, it is significant to have a set of standard conditions for these quantities. This set of standard condition is named as standard temperature and pressure or simply STP**.**

The standard temperature is 0 ºC or 273.15 K and the standard pressure is 1 atm pressure. This is the freezing point of pure water at sea level atmospheric pressure. At STP, one mole of gas occupies 22.4 L of volume.

A. **Directions:** Read the definition on Column **A** and match it to the correct word in Column **B**. Write the letter of your answer on a clean sheet of paper.

Column A	**Column B**
1. Force per unit area	a. Volume
2. Amount of the gas measured	b. Pascal
3. International unit of pressure	c. Pressure
4. Degree of hotness or coldness	d. Mole
5. Space occupied	e. Temperature
	f. Density

B. The SI unit of pressure is the Pascal, Pa, but in the V-P relationship of gases, it is necessary to be familiarized with the different units of pressures and the corresponding values for unit conversion.

1 atm = 760 torr

1 atm = 760 mm Hg

1 atm = 101,325 Pa

1 atm = 76 cm Hg

Convert the following to the required unit of pressure. The first one is done for you.

1. 1.10 atm = _____torr

$$1.10\ \cancel{atm}\left(\frac{760\ torr}{1\ \cancel{atm}}\right) = 836\ \text{torr}$$ ***Answer***

2. 675 mm Hg = _____torr
3. 121 590 Pa = _____atm
4. 1,140 torr = _____atm
5. 2.5 atm = _____cm Hg

Give the standard value of the following gas properties.

Property	Standard Value
Pressure	1. _____ atm
	2. _____ mm Hg
	3. _____ torr
Temperature	4. _____ K
Volume of one mole of a gas	6. _____ L

Assessment 1

Directions: Given the unit, identify the measurable property. Use a separate sheet for your answers.

Unit	Measurable Property (pressure, volume, temperature)
1. Atmosphere	
2. Kelvin	
3. Liter	
4. m^3	
5. Pascal	

Activity 2. Gaze, Compare, and Conclude

Suppose we have a theoretical gas confined in a jar with a piston at the top as seen in the illustration below. The left side indicates the initial state while that on the right shows the final state after slowly adding weights to the top of the piston. The unit of volume is in cubic meters (m^3), while that of pressure is kilopascal (kPa). The temperature is in kelvin (K)

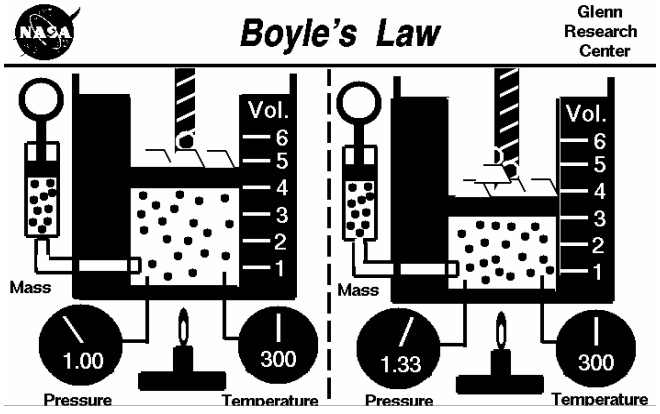


Figure 3.
Pressure – Volume Relationship
Source: www.grc.nasa.gov

Using **Figure 3** in page 6, answer the following questions:

2. Which variable (pressure, temperature or volume) is kept constant? _____
3. What is the volume reading when the pressure is at 1 atmosphere? _____
4. What is the volume reading when the pressure is 1.33 atmosphere? _____
5. Based on the figure, as the pressure increases, what happened to the volume of the gas? _____

Let us see if you have grasped the essence of our enrichment activity. Answer the assessment below:

Assessment 2

Directions: Read carefully each item. Write only the letter of the correct answer for each question. Use a separate sheet for your answers.

1. Which of the following needs to remain constant when using the Boyle's Law?
   a. energy b. pressure c. temperature d. volume
2. Which variables are being compared in Figure 3 at page 8?
   a. mass and pressure
   b. mass and temperature
   c. volume and pressure
   d. volume and temperature
3. When pressure on a gas goes up, what happens to its volume?
   a. decreases
   b. increases
   c. decreases then increases
   d. stays the same
4. When volume on a gas goes down, what happens to its pressure?
   a. decreases
   b. increases
   c. decreases then increases
   d. stays the same
5. Based on Figure 3, what relationship can be derived between pressure (P) and volume (V) at constant temperature?
   a. The volume is directly proportional to its pressure.
   b. The volume is insignificantly related to its pressure.
   c. The volume is inversely proportional to its pressure.
   d. The volume is inversely proportional to the square of its pressure.

Activity 3. Mathematical Feature of Boyle's Law

Boyle's Law can be expressed mathematically as

$$P \alpha \frac{1}{V} \quad \text{at constant temperature}$$

The constant k is introduced to remove the proportionality sign

$$P \quad k \frac{1}{V}$$

Therefore,

$$PV = k$$

The k is a constant for a given sample of gas and depends only on the mass of the gas and the temperature. The table below shows pressure and volume data for

a set amount of gas at a constant temperature. The third column represents the value of the constant (*k*) for this data and is always equal to the pressure multiplied by the volume. As one of the variables changes, the other changes in such a way that the product of P×V always remains the same. In this particular case, that constant is 500 atm·mL.

Pressure (atm)	Volume (mL)	P x V = *k* (atm.mL)
0.5	1000	500
0.625	800	500
1.0	500	500
2.0	250	500
4.0	125	500
5.0	100	500
6.0	83.0	500
8.0	62.5	500
10.0	50.0	500

A graph of the data in the table further illustrates the inverse relationship nature of Boyle's Law (Figure 4). Volume is plotted on the x -axis, with the corresponding pressure on the y -axis.

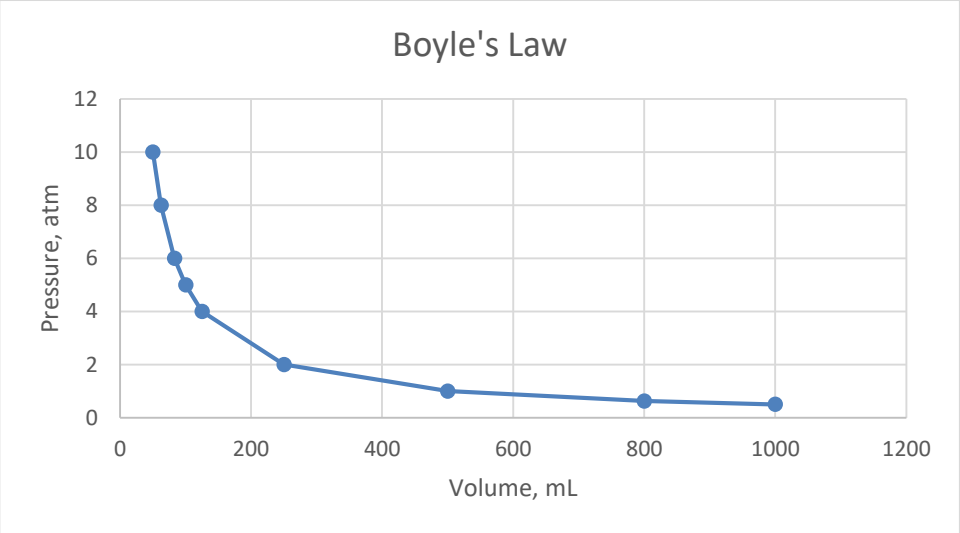


Figure 4. Boyle's Law Graph

If the same gas is brought into two different pressures, it will result to two distinct volumes, with the same value for k. Hence, the equation will become

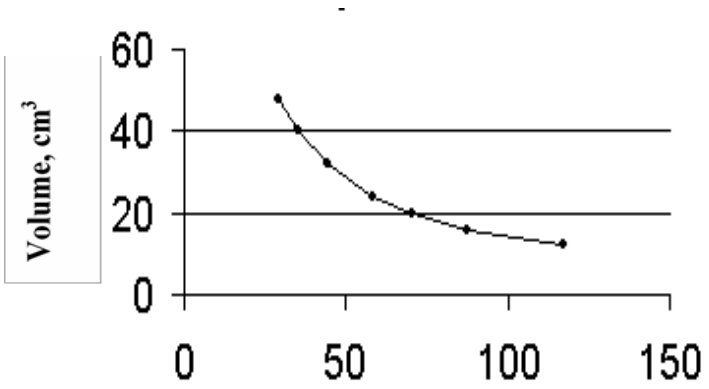
$$P_1V_1 = P_2V_2$$

where:

P_1 = initial pressure
V_1 = initial volume
P_2 = final pressure
V_2 = final volume

Any unit of pressure and volume may be employed. However, consistency of units must be observed.

Are you ready to experience Boyle's Law in action? Try the next activity on your own. Study the graph below and answer the questions that come after it.



1. What happened to the volume as you increase the pressure? _____

2. State the relationship between volume and pressure. _____

3. Two hundred milliliter (200 mL) of gas is contained in a vessel under a pressure of 800 mmHg. What will be the new volume of the gas if the pressure is changed to 1000 mmHg? Assume that the temperature remains constant.

   Given: V_1 = _____

   P_1 = _____ P_2 = _____

   Required: V_2

   Solution:

   Formula: $P_1V_1 = P_2V_2$

$$V_2 = \frac{P_1V_1}{P_2} =$$

4. A 2.50-liter sample of a gas is collected at a pressure of 1.50 atm. Calculate the pressure needed to reduce the volume of the gas to 1.00 liters. The temperature remains unchanged.

Assessment 3

Directions: Read carefully each item. Write only the letter of the correct answer for each question. Use a separate sheet for your answers.

1. What is the definition of 'k' in Boyle's Law?
   a. nV
   b. PV
   c. PT
   d. VT

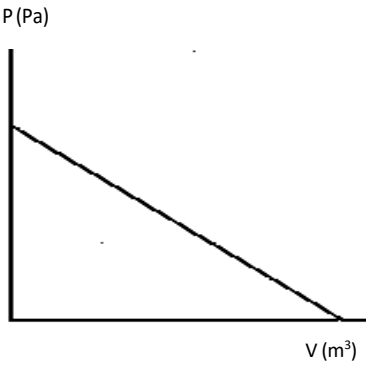
2. Which of the following is a correct equation for Boyle's Law?

   a. $P_1V_1 = P_2V_2$ c. $\frac{V1}{T1} = \frac{V2}{T2}$

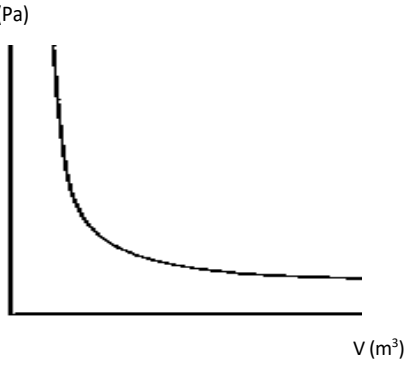
   b. $V_1T_1 = V_2T_2$ d. $\frac{P1}{T1} = \frac{P2}{T2}$

3. Which of the following graphs correctly represents the relationship between the pressure and the volume of an ideal gas that is held at constant temperature?

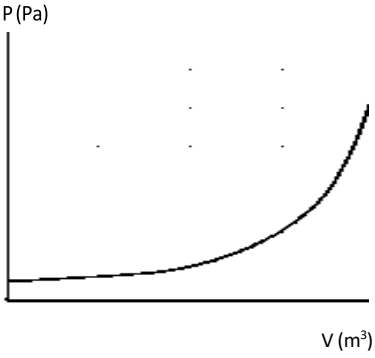
a.



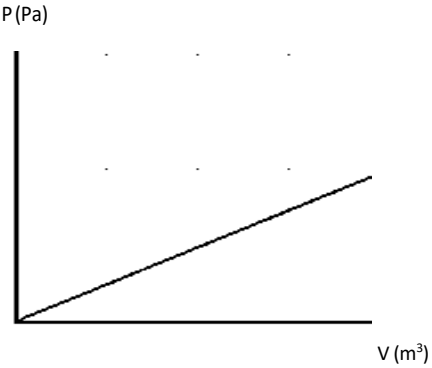
c.



b.



d.



4. A sample of neon has a volume of 225 cm^3 at 2 atm of pressure. What will be the pressure of the gas to have a volume of 500 cm^3?

   a. 0.2 atm c. 1 atm

   b. 0.9 atm d. 4 atm

5. A quantity of gas confined in a cylinder has a volume of 40 m^3 at 800 torr. If the pressure of the gas is raised to 1100 torr, what will be the new volume of the gas? The temperature remains constant.

   a. 0.018 m^3 c. 29 m^3

   b. 0.034 m^3 d. 55 m^3

What I Have Learned

Great job! You are almost done with this module. Let's summarize what you have learned from the lesson and activities by choosing the correct word inside the parentheses. Use a separate sheet of paper and write only your answer.

1-3. Gas particles have a very (strong, weak) intermolecular force of attraction, hence they move as (far, close) as possible from each other. They have the tendency to occupy all the spaces they are contained in. If the pressure is increased, the volume will be (decreased, increased) forcing the gas particles to move closer to one another.

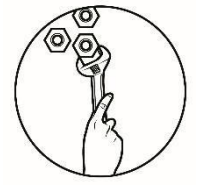
4-5. The volume of a gas is (directly, inversely) proportional to its pressure, if temperature and amount of a gas are held constant. This was stated by (Robert Boyle, Jacques Charles).

6-7. The (pressure, volume) of a gas is the force exerted by the gas on the walls of its container (divided, multiplied) by the surface area of the container.

8-10. Pascal is the standard unit of (pressure, volume). 101,325 Pa is equivalent to (1 atm, 2.5 atm) or (76 torr, 760 torr).

11-12. P_1 in Boyle's Law stands for (initial pressure, final pressure) while V_2 stands for (initial volume, final volume).

13-15. (Boyle's Law, Charles' Law) is important when using a syringe. When fully depressed, the syringe is at a neutral state with no air in the cylinder. When the plunger is pulled back, you are increasing the (pressure, volume) in the container and thus (increasing, reducing) the pressure.



What I Can Do

You have probably been well-acquainted with Boyle's law for most of your life without realizing it. How is Boyle's Law applied in the following real-life examples?

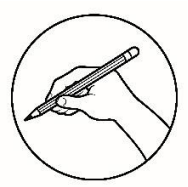
1. In your Grade 9, you have taken up respiratory system. Explain how does Boyle's Law can be applied in the lungs and diaphragm in breathing?
2. Have you observed the air exhaled by the fishes in the aquarium? Why does it get bigger and bigger as it rises?
3. In aerosols such as spray paints or deodorants, there are usually two components inside the can, i.e., the primary liquid product such as paint or perfume, and a gas which is sealed and kept in a highly pressurized state. It is kept at a liquid state even at its boiling point, which is usually below room temperature. How is Boyle's Law applied in aerosols?
4. While filling air in the tire of a vehicle, you will notice that the air pressure is kept to around 30 – 35 psi (pound force per square inch). How is Boyle's Law applied in vehicle tire?

Each of your answers will be rated according to the following criteria:

Rubric

Content (comprehensive, accurate and complete)	2 points
Organization (organized, coherently developed, and easy to follow)	2 points
Writing Conventions (grammar, spelling, and punctuation)	1 point

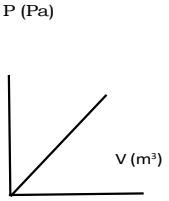
TOTAL - 5 points

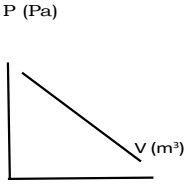


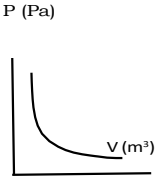
Assessment

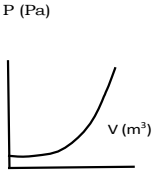
Directions: Read carefully each item. Use a separate sheet for your answers. Write only the letter of the correct answer for each question.

1. Why is a gas easier to compress than a liquid or a solid?
   a. Its volume increases more under pressure than an equivalent volume of liquid does.
   b. Its volume increases more under pressure than an equivalent volume of solid does.
   c. The space between gas particles is lesser than the space between liquid or solid particles.
   d. The volume of a gas's particles is small compared to the total volume of the gas.
2. Who was the English scientist who studied the relationship between the volume of a gas and its pressure?
   a. Amedeo Avogadro
   b. Gay-Lussac
   c. Jacques Charles Combine
   d. Robert Boyle
3. Which statement describes the volume-pressure relationship in gases at constant temperature?
   a. As pressure decreases, volume increases.
   b. As pressure increases, volume also increases.
   c. As pressure increases, volume remains constant.
   d. As pressure remains constant, volume increases.
4. Which of the following quantities are inversely proportional in Boyle's Law?
   a. number of moles and volume
   b. pressure and temperature
   c. volume and pressure
   d. volume and temperature
5. Which of the following quantities need to remain constant when using the Boyle's Law?
   a. mass and pressure
   b. mass and temperature
   c. volume and pressure
   d. volume and temperature
6. Which graph correctly represents Boyle's Law?

a. 

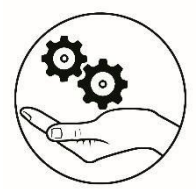
b. 

c. 

d. 

7. How many millimeters is exerted by the column of mercury when the pressure is standard?
   a. 76 b. 100 c. 760 d. 780
8. Air is pumped into a bicycle tire. Which of the following does **not** happen?
   a. The gas density increases.
   b. The gas molecules collide more frequently.
   c. The gas molecules move faster.
   d. The space between the molecules decreases.
9. If the volume of a container of gas is lessened, what will happen to the pressure inside the container?
   a. The pressure will increase.
   b. The pressure will not change.
   c. The pressure will decrease.
   d. The pressure will depend on the type of gas.
10. If a balloon is pressed, what happens to the pressure of the gas inside the balloon?
   a. It decreases.
   b. It increases.
   c. It stays the same.
   d. The pressure depends on the type of gas in the balloon.
11. The pressure of a gas is reduced from 4 atm to 0.5 atm while the temperature is held constant. How does the gas volume change?
   a. It increases by a factor of two. c. It increases by a factor of eight.
   b. It increases by a factor of four. d. It decreases by a factor of eight.
12. A gas occupies a volume of 4.8 L at 28.2 kPa. What volume will the gas occupy at 169.2 kPa? The temperature is kept constant.
   a. 0.40 L c. 1.3 L
   b. 0.80 L d. 29 L
13. A sample of hydrogen has a volume of 30 L under a pressure of 5 atm. What will be the pressure of this gas ~~be~~ if the volume is decreased to 5 L?
   a. 1 atm c. 30 atm
   b. 1.2 atm d. 750 atm
14. A balloon with a volume of 2.0 L is filled with a gas at 3 atmospheres. If the pressure is reduced to 1.2 atmospheres without a change in temperature, what will be the volume of the balloon?
   a. 1 L c. 4 L
   b. 2 L d. 5 L
15. A 10-liter sample of gas is held in a container under a pressure of 1.5 atm. The gas is then compressed to 7.5 liters. Find the pressure if the temperature is kept unchanged.
   a. 1.3 atm c. 2.0 atm
   b. 1.7 atm d. 50 atm

Congratulations for accomplishing this module! You may now look at the correct answers to all the activities and assessments. The Answer Key is found on page 18.



Additional Activity

Let us have another activity on real-life application of Boyle's Law.

The bends are decompression sickness experienced by scuba divers when they ignore Boyle's law. In this connection, your task is to discuss the relationship between the bend and Boyle's Law.

Your output on the activity will be rated by your teacher according to the following criteria:

Rubric

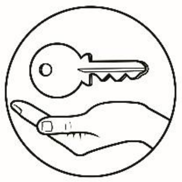
Content (comprehensive, accurate and complete)	10 points
Organization (organized, coherently developed, and easy to follow)	5 points
Writing Conventions (grammar, spelling, and punctuation)	5 points
TOTAL -	**20 points**

Did the activity give you a better understanding on the application of Boyle's Law in real-life situation? Congratulations for a job well done!

Before you return this module to your teacher, kindly copy and fill out the Self-Rating table adapted from Valdoz (2017). Check the appropriate column where your extent of knowledge falls.

How I Rate My Self...

How much did this module help you...	**Poor (1)**	**Fair (2)**	**Good (3)**	**Excellent (4)**
define the relationship between volume and temperature at constant temperature?				
derive the formula of Boyle's Law?				
solve problems involving Boyle's Law?				
relate real life situations to Boyle's Law?				



Answer Key

What I Know

1. d	6. b	11. a
2. c	7. b	12. d
3. c	8. c	13. a
4. a	9. d	14. b
5. b	10. c	15. b

What In

A.

Property	Symbol	Common Units
Pressure	P	atm, mmHg, cmHg, torr, Pa
Temperature	T	°C, °F, K
Volume	V	L, mL, m^3, cm^3

B.
1. Temperature
2. Pressure
3. Volume
4. Atmosphere
5. Liter

C.
1. X
2. √
3. √
4. √
5. X

What's New
Marvelous Marshmallow

4. The marshmallow has been squeezed making its size smaller.
6. The size of the marshmallow increases or swelled.

What's More
Activity 1. Getting to Know P, V, and T

A.	B.	C.
1. c	1. 836 torr	1. 1
2. d	2. 675 torr	2. 760
3. b	3. 1.2 atm	3. 760
4. e	4. 1.5 atm	4. 273.15
5. a	5. 190 cm Hg	5. 22.4

Assessment 1

1. pressure	4. volume
2. temperature	5. pressure
3. volume	

Activity 2. Gaze, Compare, and Conclude

1. Temperature
2. 4
3. 3

Assessment 2

1. c 2. c 3. a 4. b 5. c

Activity 3. Boyle's Law

1. Volume decreases
2. Volume is inversely related to pressure. As pressure increases, volume decreases and vice versa.
3. Given:
   V_1 = 200 mL
   P_1 = 800 mmHg P_2=1,000 mmHg
   Required: V_2
   Solution:
   $$V_2 = \frac{P_1V_1}{P_2} = \frac{800 \text{ mmHg } (200\text{mL})}{1{,}000 \text{ mmHg}}$$
   V_2 = 160 mL
4. P_2 = 3.75 atm

Assessment 3. Boyle's Law

1. b 2. a 3. c 4. b 5. c

What I Have Learned

1. weak	9. 1 atm
2. far	10. 760 torr
3. decreased	11. initial pressure
4. inversely	12. final volume
5. Robert Boyle	13. Boyle's Law
6. pressure	14. volume
7. divided	15. reducing
8. pressure	

What I Can Do

1. When a person breathes in, their lung volume increases and the pressure within decreases. Since air always moves from areas of high pressure to areas of low pressure, air is drawn into the lungs. The opposite happens when a person exhales. Since the lung volume decreases, the pressure within increases, forcing the air out of the lungs to the lower pressure air outside of the body.
2. The air exhaled by the fishes in the aquarium gets bigger and bigger as it rises because the pressure at the bottom of the aquarium is higher than the pressure near the surface.
3. When you push the nozzle of the aerosol can down, the seal on the liquid gas is opened, reducing the pressure, and giving it an escape route. The gas instantly starts to boil, changing into a gas of increasing volume, and pushing the perfume or paint out of the can in its efforts to move into an area with lesser pressure.
4. As you put more and more air into the tire, you are forcing all the gas molecules to get packed together, reducing their volume and increasing the pressure pushing on the walls of the tire.

1. d	4. c	7. c	10. b	13. c
2. d	5. b	8. c	11. c	14. d
3. a	6. c	9. a	12. b	15. c

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Department of Education. “*K to 12 Curriculum Guide Science (Grade 3 to 10).”* Accessed October 2019. "https://www.deped.gov.ph/wp-content/uploads/2019/01/Science-CG_with-tagged-sci-equipment_revised.pdf.

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