

## Unit 10: Gas Laws

(PreIB)

Name: \_\_\_\_\_

### Characteristics of Gases

- 1) Have mass & occupy space.
- 2) Separated by relatively large distances.
- 3) Are in constant, rapid, random motion.
- 4) Exert pressure when collide with walls of container.
- 5) Easy to compress.
- 6) Gases with lightest mass travel fastest.

### Gases in the Atmosphere

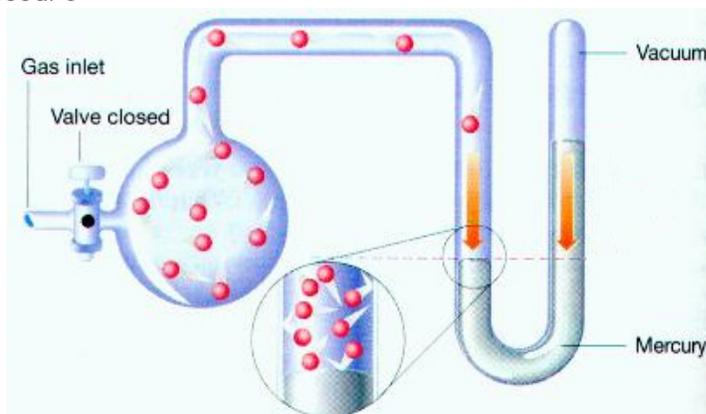
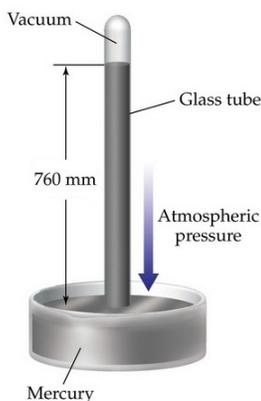
- 78%  $N_2$
- 21%  $O_2$
- 1% Ar
- <1%  $CO_2$

### Factors that can affect gases

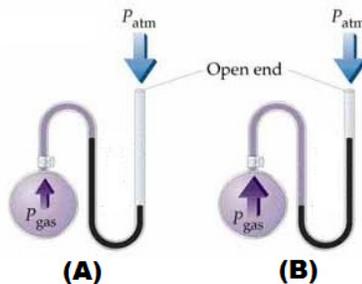
	Units
Temperature	must be in Kelvin (not in Celsius) $K = ^\circ C + 273$
Pressure	atmospheres (atm) kilopascals (kPa) millimeters of mercury (mm Hg) torr $1 \text{ atm} = 101.3 \text{ kPa} = 760 \text{ mm Hg} = 760 \text{ torr}$
Volume	$1000 \text{ mL} = 1 \text{ L}$ $1 \text{ dm}^3 = 1 \text{ L}$ $1 \text{ cm}^3 = 1 \text{ mL}$
number of particles	moles (If given grams, then you must convert to moles.)

### Barometer/ Manometer

- Instruments to measure pressure



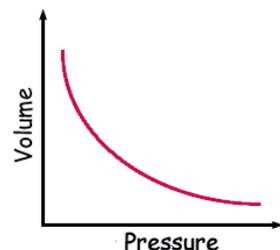
- In which manometer is the pressure of the gas in the flask greater than atmospheric pressure?



## Boyle's Law

$$P_1V_1 = P_2V_2$$

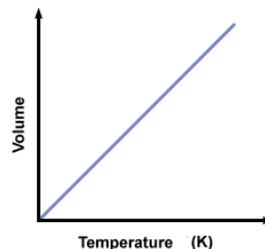
- Pressure and volume change
  - Temperature remains constant
- Inverse relationship
  - As pressure increases, volume decreases



## Charles's Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

- Volume and Kelvin temperature change
  - Pressure remains constant
- Direct relationship
  - As temperature increases, volume increases



## Combined Gas Law

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

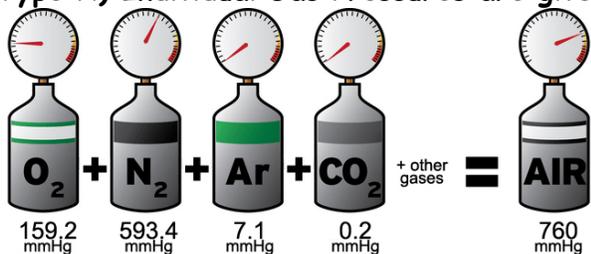
- Pressure, volume, and Kelvin temperature change
  - Number of particles remains constant

## Dalton's Law of Partial Pressures

- Long definition: "the total pressure exerted by a mixture of gases is equal to the sum of the partial pressures of the individual gases"
- Paraphrase: "If I add up the pressure of individual gases, then I get the total pressure of them mixed together."

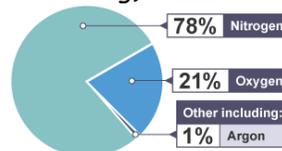
$$P_1 + P_2 + P_3 + \dots = P_{\text{Total}}$$

### Type A) Individual Gas Pressures are given



### Type B) Percentages of Gases are given

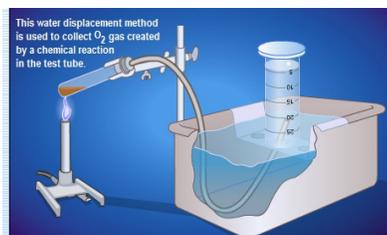
Ex) What pressure does nitrogen exert if it composes 78% of the atmospheric pressure at sea level (760 mm Hg)?



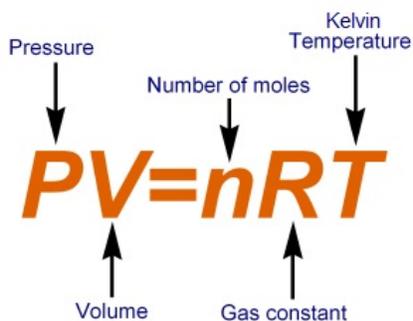
$$\frac{78}{100} \times 760 \text{ mm Hg} = 593 \text{ mm Hg}$$

"collecting a gas over water"

- a gas displaces water in a cylinder



## Ideal Gas Law



### Ideal Gas Law Constant "R"

Value of R	Units of R
8.314	$\frac{dm^3 \cdot kPa}{mol \cdot K}$
0.0821	$\frac{dm^3 \cdot atm}{mol \cdot K}$

### Assumptions of an Ideal Gas:

- Gas particles have random, constant motion & travel in straight lines (not curved)
- Gas particles have negligible volume and are separated by large distances.
- There are no attractions between gas particles.
- Energy is transferred between colliding gas particles (an elastic collision)
- A "real gas" behaves most like an "ideal gas" at high temperatures and low pressures.

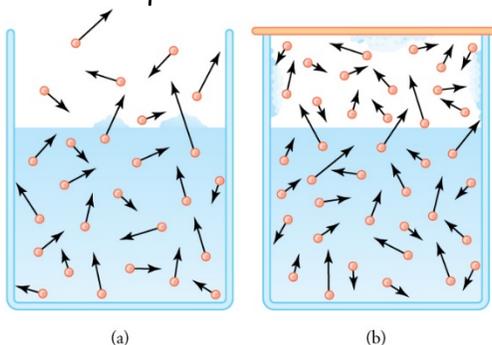
### Standard Temperature & Pressure (STP)

Pressure	Temperature
1 atm	0°C or 273 K

### Vapor Pressure

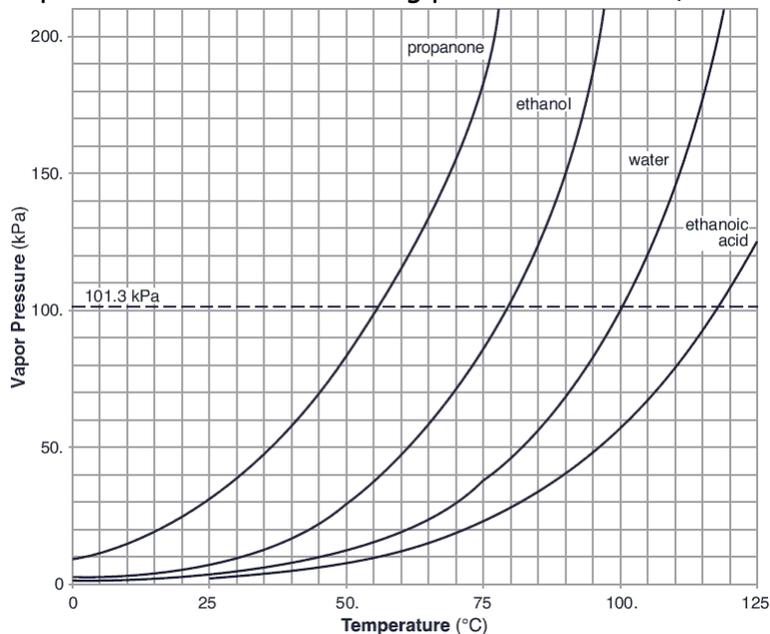
- The pressure exerted by a vapor over a liquid
- A substance boils when its vapor pressure equals atmospheric pressure

Ex) Why does a pot of water boil quicker on the stove when you put a lid on the pot?



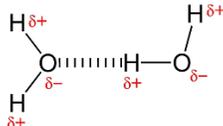
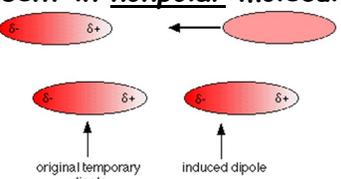
Ex) Based on the vapor pressure curve provided, what is the boiling point at sea level (101.3 kPa) of

- Propanone \_\_\_\_\_
- Ethanol \_\_\_\_\_
- Water \_\_\_\_\_
- Ethanoic acid \_\_\_\_\_



## Intermolecular Forces - attractions between neighboring molecules

- due to differences in electronegativity
- $\delta^+$  means "partial positive charge"
- $\delta^-$  means "partial negative charge"

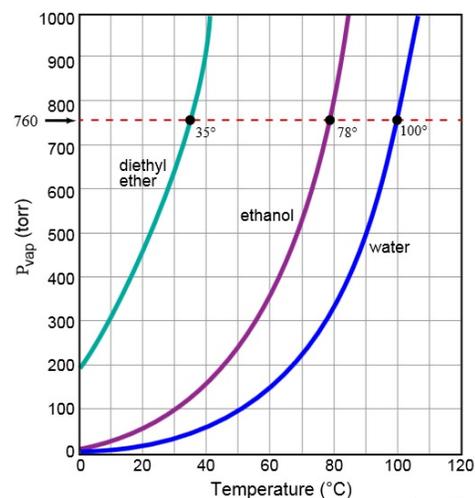
	Definition	Explanation	Strength
<b>Hydrogen Bonding</b>	<p><b>Between hydrogen and O, N, F</b> It is a strong magnetic attraction (not an actual bond).</p> 	<p>★ Very similar to dipole-dipole, except the partially negative and partially positive attractions are much stronger because H, O, N, F are such electronegative elements (meaning they pull electrons to themselves A LOT!)</p> <p>★ In a glass of water, there is an entire network of hydrogen bonding that occurs between neighboring molecules. This contributes to many of water's unique properties. Ex) surface tension</p>	<p><b>Strongest force</b></p>  <p><b>Weakest force</b></p>
<b>Dipole-Dipole</b>	<p><b>Attraction between two <u>polar</u> molecules.</b></p> 	<p>★ Chlorine is more electronegative than hydrogen. The electrons in the bond are pulled towards chlorine, giving it a partially negative charge. Hydrogen has fewer electrons (because chlorine is pulling them away from hydrogen), giving hydrogen a partially positive charge.</p> <p>★ The partially negative chlorine is attracted to a partially positive hydrogen in a nearby molecule.</p>	
<p><b>London Dispersion Forces</b> AKA "van der Waals Forces"</p>	<p><b>A temporary attraction. Present in <u>nonpolar</u> molecules.</b></p> 	<p>★ In nonpolar molecules, electrons are unevenly distributed for a split second and a temporary partial charge is created. When a neighboring nonpolar molecule comes closer, the original partial charge "induces" or causes another temporary partial charge for a split second in the neighboring molecule.</p> <p>★ Technically London Dispersion Forces are present in ALL molecules, including molecules with hydrogen bonding and dipole-dipole attractions.</p>	

## Relating Intermolecular Forces to Chemical Properties

Ex 1) Based on the boiling point data provided, which liquid has the strongest intermolecular forces?

Pentane	36.1°C
Tetrachloromethane	76.5°C
Water	100°C

Ex 2) Based on the vapor pressure curves provided, which liquid has the strongest intermolecular forces?



Ex 3) Based on the heat of vaporization provided, which has the strongest intermolecular forces?

H <sub>2</sub> O	40.7 kJ/mol
NH <sub>3</sub>	23.4 kJ/mol

Ex 4) As heat is added to a substance undergoing a phase change, the temperature remains constant because the energy is being used to \_\_\_\_\_.

Ex 5) If substance X is a liquid, substance Y is a gas, and substance Z is a solid, and all are at the same temperature and pressure, then the order of increasing strength of their intermolecular forces would be \_\_\_\_\_ < \_\_\_\_\_ < \_\_\_\_\_.

**Chapter 13: Practice #1**  
**Boyle's Law & Charles's Law**

(PreIB)

Name: \_\_\_\_\_

**Pressure, Volume, & Temperature Conversions**

**Conversion factors:** 1 atm = 101.3 kPa = 760 mmHg

*Perform the following conversions:*

- |                      |                      |
|----------------------|----------------------|
| 1) 5396 mmHg = ? atm | 3) 0.076 mL = ? L    |
| 2) 43°C = ? K        | 4) 2090 kPa = ? mmHg |

**Boyle's Law** - relationship between volume and pressure

**Write the equation for Boyle's Law and label the variables:**

- 5) A balloon has a volume of 250 mL at a pressure of 202.6 kPa. What will be the new volume of the balloon in mL if the pressure is changed to 810.4 kPa?
- 6) A balloon starts off with a volume of 8.0 L and a pressure of 12 atm. What will be the new volume if the pressure is increased to 348 atm?
- 7) A cylinder contains 12 L of a gas at a pressure of 834 mm Hg. What will be the new pressure in mmHg if the volume is decreased to 842 mL?
- 8) A gas occupies a volume of 387 mL at a pressure 2.02 kPa. When the pressure is changed, the volume becomes 433 mL. What is the new pressure?

## Charles's Law - relationship between volume and Kelvin temperature

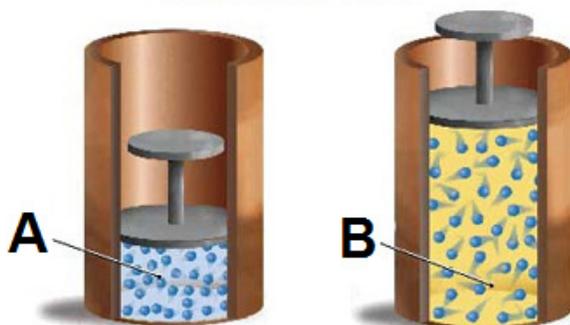
Write the equation for Charles's Law and label the variables:

- 9) A car tire has a volume of 15 L at a temperature of 22°C. What will be the new volume in liters if the temperature increases to 34 °C?
- 10) A propane ( $C_3H_8$ ) tank has a volume of 2.8 L. If the temperature of the environment is 305 K, what volume in mL will the gas occupy if the temperature is decreased to 299 K?
- 11) A balloon has a volume of 1.25 L at a temperature of 298 K, What will be the new volume in milliliters if the room is heated up to 35 °C?
- 12) A balloon has a volume of 1.5 L at a temperature of 35 °C. What will be the new volume in liters if it is heated to 42 °C?

## Understanding Gases

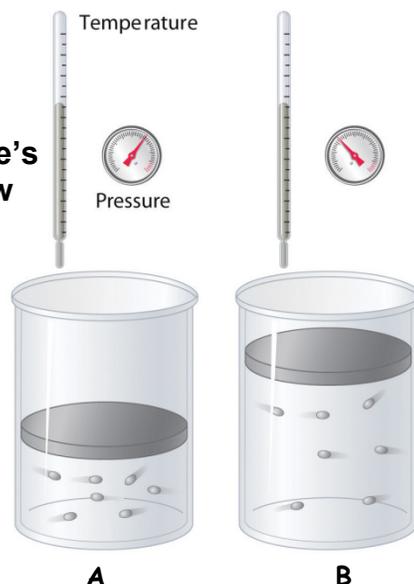
13) Which cylinder, A or B, contains a gas with the highest temperature? Explain the reasoning behind your choice.

### Charles's Law



### Boyle's Law

14) Why would cylinder A have a greater pressure than cylinder B?



**Chapter 13: Practice #1**  
**Boyle's Law & Charles's Law**

(PreIB)

Name: \_\_\_\_\_

**Pressure, Volume, & Temperature Conversions**

**Conversion factors:** 1 atm = 101.3 kPa = 760 mmHg

*Perform the following conversions:*

1) 5396 mmHg = ? atm

7.1 atm

3) 0.076 mL = ? L

$7.6 \times 10^{-5}$  L or 0.000076 L

2) 43°C = ? K

316 K

4) 2090 kPa = ? mmHg

15680.16 mmHg

**Boyle's Law** - relationship between volume and pressure

**Write the equation for Boyle's Law and label the variables:**

$$P_1V_1 = P_2V_2$$

P = Pressure of the gas

V = Volume of the gas

Temperature must be constant

- 5) A balloon has a volume of 250 mL at a pressure of 202.6 kPa. What will be the new volume of the balloon in mL if the pressure is changed to 810.4 kPa?

62.5 mL

- 6) A balloon starts off with a volume of 8.0 L and a pressure of 12 atm. What will be the new volume if the pressure is increased to 348 atm?

0.28 L

- 7) A cylinder contains 12 L of a gas at a pressure of 834 mm Hg. What will be the new pressure in mmHg if the volume is decreased to 842 mL?

11885.99 mmHg

- 8) A gas occupies a volume of 387 mL at a pressure 2.02 kPa. When the pressure is changed, the volume becomes 433 mL. What is the new pressure?

1.81 kPa

## Charles's Law - relationship between volume and Kelvin temperature

Write the equation for Charles's Law and label the variables:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

T = Temperature of the gas

V = Volume of the gas

Pressure must be constant

- 9) A car tire has a volume of 15 L at a temperature of 22°C. What will be the new volume in liters if the temperature increases to 34 °C?

15.61 L

- 10) A propane (C<sub>3</sub>H<sub>8</sub>) tank has a volume of 2.8 L. If the temperature of the environment is 305 K, what volume in mL will the gas occupy if the temperature is decreased to 299 K?

2744.9 mL

- 11) A balloon has a volume of 1.25 L at a temperature of 298 K, What will be the new volume in milliliters if the room is heated up to 35 °C?

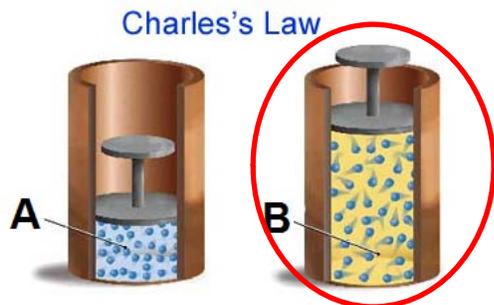
1290 mL

- 12) A balloon has a volume of 1.5 L at a temperature of 35 °C. What will be the new volume in liters if it is heated to 42 °C?

1.53 L

## Understanding Gases

- 13) Which cylinder, A or B, contains a gas with the highest temperature? Explain the reasoning behind your choice.



**Explanation:** Cylinder B has the greatest volume. Because volume increases as temperature increases, Cylinder B must also have the greatest temperature. The speed of the molecules is greater with higher temperatures, causing the volume of the cylinder to expand.

## Boyle's Law

- 14) Why would cylinder A have a greater pressure than cylinder B?



**Explanation:** The temperature in each cylinder is the same (see thermometer graphic). As volume decreases, pressure increases. Cylinder A has a smaller volume, so the particles collide with the walls of the container more frequently, therefore exerting more pressure.

Combined Gas Law & Dalton's Law of Partial Pressures

**Combined Gas Law:** relationship between volume, Kelvin temperature, & pressure

Write the equation for the Combined Gas Law and label the variables:

14) A gas at 110 kPa and 30.0°C fills a flexible container with an initial volume of 2.00 dm<sup>3</sup>. If the temperature is raised to 80.0°C and the pressure increases to 440 kPa, what is the new volume in dm<sup>3</sup>?

15) A balloon containing 6200 mL helium rests in a room at 56°C and 812 mmHg. What would be volume of the balloon in mL if the temperature of the room was increased to 67°C and the pressure to 842 mmHg?

**Dalton's Law of Partial Pressures:** the total pressure exerted by a mixture of gases is equal to the sum of the partial pressures of the individual gases

Write the equation for Partial Pressures and label the variables:

**Type A: Individual Gas Pressures Given**

16) A tank contains N<sub>2</sub> at 1.4 atm and O<sub>2</sub> at 2.2 atm. Helium is added to this tank until the total pressure is 5.9 atm. What is the partial pressure of the helium?

17) The total pressure of an O<sub>2</sub>-Ar-He gas mixture is 644 mmHg. If the partial pressure of Ar is 183 mmHg and the partial pressure of He is 375 mmHg, what is the partial pressure of O<sub>2</sub>?

18) Industrial deep-sea divers must breathe a mixture of helium and oxygen to prevent a disorienting condition known as nitrogen narcosis. If a diver's tank is filled with a helium-oxygen mixture to a pressure of 184 atm and the partial pressure of helium is 129 atm, what is the partial pressure of the oxygen?

**Awkward wording SOL problems:**

19) A sample of nitrogen is collected over water at 20°C. The vapor pressure of water at 20°C is 18 mmHg. What is the partial pressure of the nitrogen if the total pressure is 21 mmHg?

20) A sample of oxygen gas is collected over water at 22 °C and a total pressure of 85.41 kPa. If the partial pressure of the water is 5.64 kPa, what is the partial pressure of the oxygen?

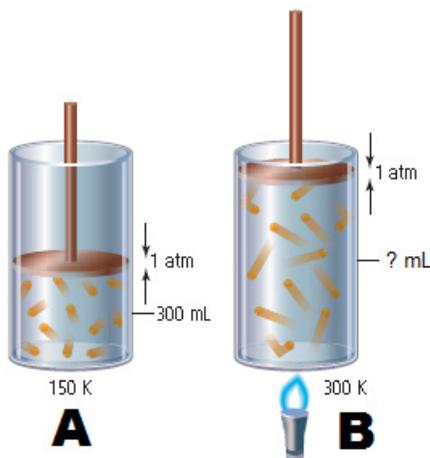
**Type B: Percentage of Gases Given**

- 21) What partial pressure of oxygen is a scuba diver breathing if the total pressure is 5.8 atm and 34% of the air is oxygen?
- 22) The air pressure in a greenhouse is 139.0 mmHg. What is the partial pressure of water vapor if it comprises 18% of the air mixture?

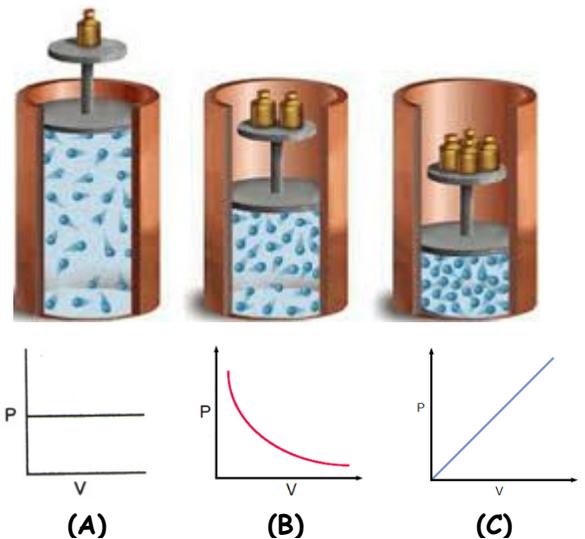
- 23) A mixture of gases with a pressure of 753.0 mmHg contains 70% nitrogen and 30% oxygen by volume. What is the partial pressure of oxygen in this mixture?
- 24) The barometer shows the atmospheric pressure to be 762 mmHg. What is the partial pressure of nitrogen if air is composed of 21% oxygen and 78% nitrogen?

**Understanding Gases**

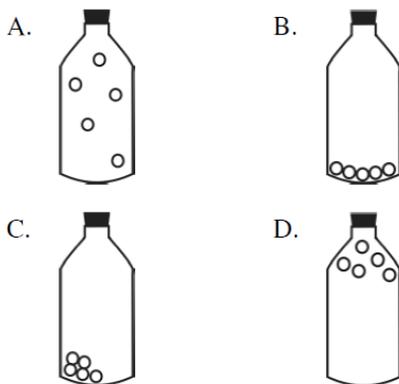
- 25) Cylinder A contains 300 mL of a gas. If the temperature of cylinder A is doubled and pressure remains constant at 1 atm, what will be the new volume of the gas (cylinder B)? \_\_\_\_\_



- 26) Which graph best represents the relationship between pressure and volume as represented in the graphic?



- 27) Which diagram best represents a gas in a closed container?



- 28) A sample of  $H_2$  gas and a sample of  $N_2$  gas at STP contain the same number of molecules. Each sample must have...
- A) the same volume, but a different mass  
 B) the same mass, but a different volume  
 C) both the same volume and the same mass  
 D) neither the same volume nor the same mass

Why?

## Combined Law &amp; Dalton's Law of Partial Pressures

**Combined Gas Law:** relationship between volume, Kelvin temperature, & pressure

Write the equation for the Combined Gas Law and label the variables:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

P = Pressure of the gas  
T = Temperature of the gas  
V = Volume of the gas

- 1) A gas at 110 kPa and 30.0°C fills a flexible container with an initial volume of 2.00 dm<sup>3</sup>. If the temperature is raised to 80.0°C and the pressure increases to 440 kPa, what is the new volume in dm<sup>3</sup>?
- 2) A balloon containing 6200 mL helium rests in a room at 56°C and 812 mmHg. What would be volume of the balloon if the temperature of the room was increased to 67°C and the pressure to 842mmHg?

Remember: 1 dm<sup>3</sup> = 1 L (AKA they are the same thing)

**0.58 dm<sup>3</sup>**

**6179 mL**

**Dalton's Law of Partial Pressures:** the total pressure exerted by a mixture of gases is equal to the sum of the partial pressures of the individual gases

Write the equation for Partial Pressures and label the variables:

$$P_{\text{Total}} = P_1 + P_2 + P_3 + \dots$$

**Type A: Individual Gas Pressures Given**

- 3) A tank contains N<sub>2</sub> at 1.4 atm and O<sub>2</sub> at 2.2 atm. Helium is added to this tank until the total pressure is 5.9 atm. What is the partial pressure of the helium?  
**2.3 atm**
- 4) The total pressure of an O<sub>2</sub>-Ar-He gas mixture is 644 mmHg. If the partial pressure of Ar is 183 mmHg and the partial pressure of He is 375 mmHg, what is the partial pressure of O<sub>2</sub>?  
**86 mmHg**
- 5) Industrial deep-sea divers must breathe a mixture of helium and oxygen to prevent a disorienting condition known as nitrogen narcosis. If a diver's tank is filled with a helium-oxygen mixture to a pressure of 184 atm and the partial pressure of helium is 129 atm, what is the partial pressure of the oxygen?  
**55 atm**

Awkward wording SOL problems:

6) A sample of nitrogen is collected over water at 20°C. The vapor pressure of water at 20°C is 18 mmHg. What is the partial pressure of the nitrogen if the total pressure is 21 mmHg?

**3 mmHg**

7) A sample of oxygen gas is collected over water at 22 °C and a total pressure of 85.41 kPa. If the partial pressure of the water is 5.64 kPa, what is the partial pressure of the oxygen?

**79.76 kPa**

Type B: Percentage of Gases Given

8) What partial pressure of oxygen is a scuba diver breathing if the total pressure is 5.8 atm and 34% of the air is oxygen?

**1.97 atm**

10) A mixture of gases with a pressure of 753.0 mmHg contains 70% nitrogen and 30% oxygen by volume. What is the partial pressure of oxygen in this mixture?

**225.9 mmHg**

9) The air pressure in a greenhouse is 139.0 mmHg. What is the partial pressure of water vapor if it comprises 18% of the air mixture?

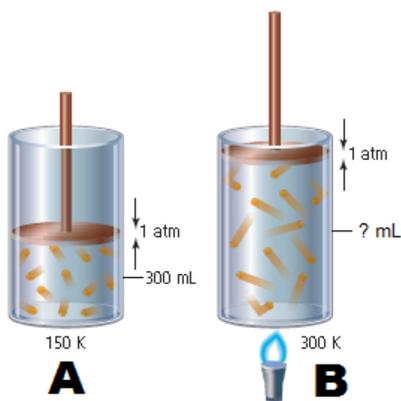
**25.02 mmHg**

11) The barometer shows the atmospheric pressure to be 762 mmHg. What is the partial pressure of nitrogen if air is composed of 21% oxygen and 78% nitrogen?

**594.36 mmHg**

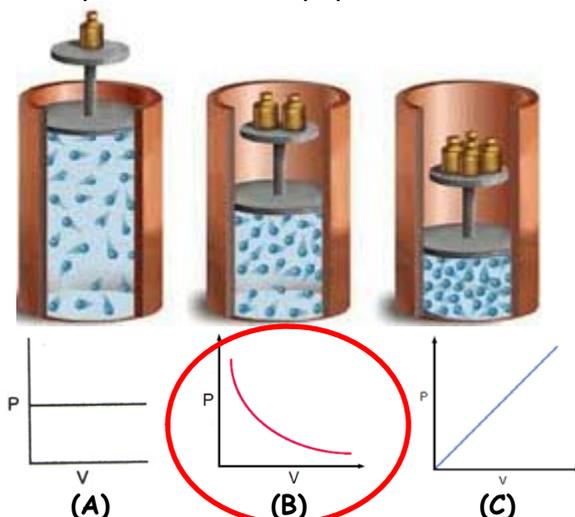
**Understanding Gases**

12) Cylinder A contains 300 mL of a gas. If the temperature of cylinder A is doubled and pressure remains constant at 1 atm, what will be the new volume of the gas (cylinder B)?         **600 mL**        



**Explanation:** As temperature increases, volume increases. Because T and V have a direct relationship, if temperature doubles, then volume doubles also.

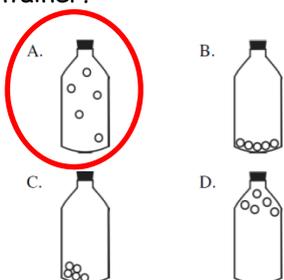
13) Which graph best represents the relationship between pressure and volume as represented in the graphic?



**Explanation:** As pressure increases, volume decreases (inverse relationship).

14) Which diagram best represents a gas in a closed container?

**Explanation:** Gases are in constant, rapid, random motion. They diffuse or spread to fill their containers. (They do NOT settle to one end of their container.)



15) A sample of H<sub>2</sub> gas and a sample of N<sub>2</sub> gas at STP contain the same number of molecules. Each sample must have...

- A) the same volume, but a different mass**
- B) the same mass, but a different volume
- C) both the same volume and the same mass
- D) neither the same volume nor the same mass

**Explanation:** Avogadro said that 1 mole of any gas at STP will have a volume of 22.4L. BUT different gases have a different molar mass.

## Ideal Gas Law

**Ideal Gas Law:** the relationship between volume, pressure, Kelvin temperature, moles of gas, and a constant.

Write the equation for the Ideal Gas Law and label the variables:

Value of R	Units of R
8.314	$\frac{\text{dm}^3 \cdot \text{kPa}}{\text{mol} \cdot \text{K}}$
0.0821	$\frac{\text{dm}^3 \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

- 29) In a closed system, 12.8 mol of helium occupies a volume of 2500 mL at a temperature of 55°C. What is the pressure of this system in kilopascals?
- 30) In a closed system, 56g of fluorine (F<sub>2</sub>) at a temperature of 35°C has a pressure of 207.5 kPa. What is the volume of this system in cm<sup>3</sup>?
- 31) 5.28g of dry ice (CO<sub>2</sub>) is placed into a 2.6 dm<sup>3</sup> bottle at 45.1°C. What will be the pressure in atm when the bottle explodes?
- 32) A container of laughing gas (N<sub>2</sub>O) has a volume of 225 cm<sup>3</sup>. If the temperature of environment is 20°C, how many grams of N<sub>2</sub>O are there if the pressure is 303.9 kPa?
- 33) A 9430 cm<sup>3</sup> car tire is filled with 45 g of O<sub>2</sub>. What is the temperature of the tire in °C if the pressure becomes 428 kPa?
- 34) How many grams of argon would it take to fill a light bulb with a volume of 475 mL at STP?  
(Hint: look in your notes for the P and T of STP)
- 35) During a winter camping trip, a queen size air mattress is filled to a volume of 95 dm<sup>3</sup> with 84g of nitrogen gas (N<sub>2</sub>). Yet the night is so cold that it can only support the campers with 0.75 atm of pressure. How cold is the temperature outside in degrees Celsius?

**Chapter 13: Practice #3**

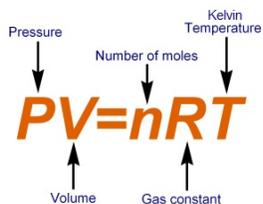
(PreIB)

Name: \_\_\_\_\_

**Ideal Gas Law**

**Ideal Gas Law:** the relationship between volume, pressure, Kelvin temperature, moles of gas, and a constant.

Write the equation for the Ideal Gas Law and label the variables:



Value of R	Units of R
8.314	$\frac{\text{dm}^3 \cdot \text{kPa}}{\text{mol} \cdot \text{K}}$
0.0821	$\frac{\text{dm}^3 \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

- 1) In a closed system, 12.8 mol of helium occupies a volume of 2500 mL at a temperature of 55°C. What is the pressure of this system in kilopascals?

13962.2 kPa

- 5) A 9430 cm<sup>3</sup> car tire is filled with 45 g of O<sub>2</sub>. What is the temperature of the tire in °C if the pressure becomes 428 kPa?

71.29°C

- 2) In a closed system, 56g of fluorine (F<sub>2</sub>) at a temperature of 35°C has a pressure of 207.5 kPa. What is the volume of this system in cm<sup>3</sup>?

18140 cm<sup>3</sup>

- 6) How many grams of argon would it take to fill a light bulb with a volume of 475 mL at STP? (Hint: look in your notes for the P and T of STP)

0.847 g

- 3) 5.28g of dry ice (CO<sub>2</sub>) is placed into a 2.6 dm<sup>3</sup> bottle at 45.1°C. What will be the pressure in atm when the bottle explodes?

1.21 atm

- 7) During a winter camping trip, a queen size air mattress is filled to a volume of 95 dm<sup>3</sup> with 84g of nitrogen gas (N<sub>2</sub>). Yet the night is so cold that it can only support the campers with 0.75 atm of pressure. How cold is the temperature outside in degrees Celsius?

16.28°C

- 4) A container of laughing gas (N<sub>2</sub>O) has a volume of 225 cm<sup>3</sup>. If the temperature of environment is 20°C, how many grams of N<sub>2</sub>O are there if the pressure is 303.9 kPa?

1.232 g

## Chapter 13: Quiz Review

(PreIB)

Name: \_\_\_\_\_

**Directions:** The following problems are a mixture of Boyle's Law, Charles's Law, Combined Gas Law, and Dalton's Law of Partial Pressures questions. Identify the type of problem and solve. Show your work! (not required on partial pressures questions.)

36) A gas occupies  $0.105 \text{ dm}^3$  at  $100 \text{ K}$ . At what temperature will its volume be  $140 \text{ cm}^3$ ?

Type: \_\_\_\_\_

39) A gas occupies a volume of  $2.45 \text{ L}$  at a pressure of  $1.03 \text{ atm}$ . What volume will the gas occupy if the pressure changes to  $0.980 \text{ atm}$  and the temperature remains unchanged?

Type: \_\_\_\_\_

37) A basketball filled with nitrogen has a volume of  $5.3 \text{ L}$  when at  $25^\circ\text{C}$  and  $1 \text{ atm}$ . What will the new volume of the basketball be if it heats up to  $31^\circ\text{C}$  and the pressure increases to  $1.2 \text{ atm}$ ?

Type: \_\_\_\_\_

40) What is the partial pressure of oxygen in a scuba tank if the total pressure is  $6.3 \text{ atm}$  and the air is  $80\%$  nitrogen and  $20\%$  oxygen?

Type: \_\_\_\_\_

38) The gases carbon dioxide, oxygen, and argon are mixed in a container. The partial pressure of oxygen is  $485 \text{ mmHg}$  & argon is  $512 \text{ mmHg}$ . What is the partial pressure of carbon dioxide if the total pressure exerted is  $2000 \text{ mmHg}$ ?

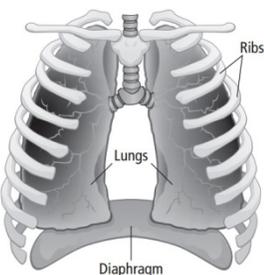
Type: \_\_\_\_\_

41) A sample of sulfur gas occupies  $1500 \text{ mL}$  at  $44^\circ\text{C}$  and  $1.56 \text{ atm}$ . What would be the volume in liters at  $56^\circ\text{C}$  and  $0.76 \text{ atm}$ ?

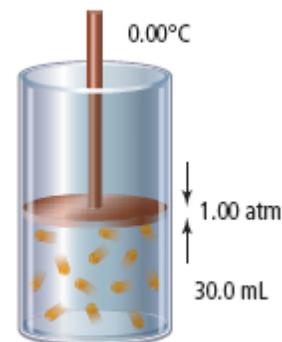
Type: \_\_\_\_\_

### Understanding Gases

42) If the temperature in the gas cylinder in the figure increases to  $30^\circ\text{C}$  and the pressure increases to  $1.20 \text{ atm}$ , will the cylinder's piston move up or down?



43) Apply Boyle's Law to explain why air enters your lungs when you inhale and leaves when you exhale.



## Chapter 13: Review for Ch 13 Quiz #1 (PreIB)

Name: \_\_\_\_\_

**Directions:** The following problems are a mixture of Boyle's Law, Charles's Law, Combined Gas Law, and Dalton's Law of Partial Pressures questions. Identify the type of problem and solve. Show your work! (not required on partial pressures questions.)

- 1) A gas occupies  $0.105 \text{ dm}^3$  at  $100 \text{ K}$ . At what temperature will its volume be  $140 \text{ cm}^3$ ?

Type: Charles's Law

*Remember from your notes:*

$$1 \text{ dm}^3 = 1 \text{ L}$$

$$1 \text{ cm}^3 = 1 \text{ mL}$$

*(HINT: did you make sure your volume units matched??)*

**133.3 K**

- 2) A basketball filled with nitrogen has a volume of  $5.3 \text{ L}$  when at  $25^\circ\text{C}$  and  $1 \text{ atm}$ . What will the new volume of the basketball be if it heats up to  $31^\circ\text{C}$  and the pressure increases to  $1.2 \text{ atm}$ ?

Type: Combined Gas Law

**4.51 L**

- 3) The gases carbon dioxide, oxygen, and argon are mixed in a container. The partial pressure of oxygen is  $485 \text{ mmHg}$  & argon is  $512 \text{ mmHg}$ . What is the partial pressure of carbon dioxide if the total pressure exerted is  $2000 \text{ mmHg}$ ?

Type: Partial Pressures

**1003 mm Hg**

- 4) A gas occupies a volume of  $2.45 \text{ L}$  at a pressure of  $1.03 \text{ atm}$ . What volume will the gas occupy if the pressure changes to  $0.980 \text{ atm}$  and the temperature remains unchanged?

Type: Boyle's Law

**2.57 L**

- 5) What is the partial pressure of oxygen in a scuba tank if the total pressure is  $6.3 \text{ atm}$  and the air is  $80\%$  nitrogen and  $20\%$  oxygen?

Type: Partial Pressures

**1.26 atm**

- 6) A sample of sulfur gas occupies  $1500 \text{ mL}$  at  $44^\circ\text{C}$  and  $1.56 \text{ atm}$ . What would be the volume in liters at  $56^\circ\text{C}$  and  $0.76 \text{ atm}$ ?

Type: Combined Gas Law

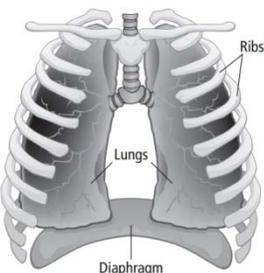
*(HINT: did you convert your answer from mL to L??)*

**3.20 L**

### Understanding Gases

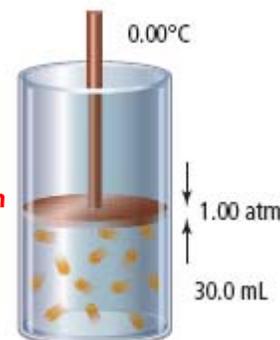
- 7) If the temperature in the gas cylinder in the figure increases to  $30^\circ\text{C}$  and the pressure increases to  $1.20 \text{ atm}$ , will the cylinder's piston move up or down?

**Explanation:** Use the data in the problem & the graphic to set up a Combined Gas Law calculation. Solve for  $V_2$  (the unknown volume of the cylinder after the conditions change from those in the graphic to those described in the text).  $V_2 = 27.75 \text{ mL}$  which is a smaller volume than the initial volume of the gas in the graphic. Therefore, the cylinder will move down.



- 8) Apply Boyle's Law to explain why air enters your lungs when you inhale and leaves when you exhale.

**Explanation:** When you inhale, you increase the volume of your lungs. As volume increases in your lungs, pressure decreases and air moves in. When you exhale, lung volume decreases, pressure increases, and air moves out.



**Volume & Pressure Conversions Review****Conversion factors:** 1 atm = 101.3 kPa = 760 mmHg (do NOT memorize)

44)  $1960 \text{ cm}^3 = ? \text{ dm}^3$

46)  $450 \text{ mm Hg} = ? \text{ kPa}$

45)  $233 \text{ K} = ? \text{ }^\circ\text{C}$

47)  $120 \text{ kPa} = ? \text{ atm}$

**Ideal Gas Law Constant "R"**

Value of R      Units of R

8.314       $\frac{\text{dm}^3 \cdot \text{kPa}}{\text{mol} \cdot \text{K}}$

0.0821       $\frac{\text{dm}^3 \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

**Gas Law Calculations**

- Label the type of problem and solve. Include a unit with your final answer.  
 Be cautious of your units canceling out. I purposefully made the units tricky to give you practice! Be alert.  
 The problems are Boyles, Charles, Partial Pressures, Combined Gas Law, or Ideal Gas Law.

48) A balloon with a volume of 5.0 L has a pressure of 75 kPa at a temperature of 34°C. What is the temperature in °C if the pressure decreases to 63 kPa and the volume increases to 5870 mL?  
 Type: \_\_\_\_\_

53) A truck tire has a volume of 78000 mL at a temperature of 25°C. If the volume decreases to 73.5 L, what is the new temperature in Celsius?  
 Type: \_\_\_\_\_

49) There are three gases in a system: N<sub>2</sub> has a pressure of 500 kPa, O<sub>2</sub> has a pressure of 150 kPa and Cl<sub>2</sub> has a pressure of 120 kPa. What is the total pressure of the system?  
 Type: \_\_\_\_\_

54) A container has a pressure of 191.9 kPa, a volume of 3400 mL, and a temperature of 28°C. What will the new volume be in liters if we change the pressure to 6080 mmHg and the temperature to 50°C? Type: \_\_\_\_\_

50) A welder uses a tank of acetylene with a volume of 7500mL. It is stored at a temperature of 23.2°C and pressure of 7667 kPa. How many moles of acetylene are in the tank? Type: \_\_\_\_\_

55) A propane (C<sub>3</sub>H<sub>8</sub>) tank has a volume of 5800 mL. If the temperature of the environment is 21°C, how many grams of propane can we put in the container to achieve a pressure of 35 atm?  
 Type: \_\_\_\_\_

51) A mixture of gases with a pressure of 753.0 mmHg contains 80% sulfur and 20% oxygen by volume. What is the partial pressure of sulfur in this mixture? Type: \_\_\_\_\_

52) A weather balloon starts off with a volume of 65 L at pressure of 760 mmHg. What will be the new volume in mL if pressure increases to 890 mmHg?  
 Type: \_\_\_\_\_

56) A container enclosing equal numbers of nitrogen and oxygen molecules has a total pressure of 0.8 atm. What is the partial pressure due to the nitrogen molecules? Type: \_\_\_\_\_

**Volume & Pressure Conversions Review****Conversion factors:** 1 atm = 101.3 kPa = 760 mmHg (do NOT memorize)

- 1)  $1960 \text{ cm}^3 = ? \text{ dm}^3$   
**1.96 dm<sup>3</sup>**
- 2)  $233 \text{ K} = ? \text{ }^\circ\text{C}$   
**-40°C**
- 3)  $450 \text{ mm Hg} = ? \text{ kPa}$   
**59.98 kPa**
- 4)  $120 \text{ kPa} = ? \text{ atm}$   
**1.18 atm**

**Ideal Gas Law Constant "R"**

Value of R	Units of R
8.314	$\frac{\text{dm}^3 \cdot \text{kPa}}{\text{mol} \cdot \text{K}}$
0.0821	$\frac{\text{dm}^3 \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

**Gas Law Calculations**

- Label the type of problem and solve. Include a unit with your final answer.
- Be cautious of your units canceling out. I purposefully made the units tricky to give you practice! Be alert.
- The problems are Boyles, Charles, Partial Pressures, Combined Gas Law, or Ideal Gas Law.

- 5) A balloon with a volume of 5.0 L has a pressure of 75 kPa at a temperature of 34°C. What is the temperature in °C if the pressure decreases to 63 kPa and the volume increases to 5870 mL?  
Type: Combined Gas Law  
**29.75°C**
- 6) There are three gases in a system: N<sub>2</sub> has a pressure of 500 kPa, O<sub>2</sub> has a pressure of 150 kPa and Cl<sub>2</sub> has a pressure of 120 kPa. What is the total pressure of the system?  
Type: Partial Pressures  
**770 kPa**
- 7) A welder uses a tank of acetylene with a volume of 7500 mL. It is stored at a temperature of 23.2°C and pressure of 7667 kPa. How many moles of acetylene are in the tank? Type: Ideal Gas Law  
**23.35 mol**
- 8) A mixture of gases with a pressure of 753.0 mmHg contains 80% sulfur and 20% oxygen by volume. What is the partial pressure of sulfur in this mixture? Type: Partial Pressures  
**602.4 mm Hg**
- 9) A weather balloon starts off with a volume of 65 L at pressure of 760 mmHg. What will be the new volume in mL if pressure increases to 890 mmHg?  
Type: Boyle's Law  
**55505 mL**
- 10) A truck tire has a volume of 78000 mL at a temperature of 25°C. If the volume decreases to 73.5 L, what is the new temperature in Celsius?  
Type: Charles's Law  
**7.81 °C**
- 11) A container has a pressure of 191.9 kPa, a volume of 3400 mL, and a temperature of 28°C. What will the new volume be in liters if we change the pressure to 6080 mmHg and the temperature to 50°C? Type: Combined Gas Law  
**0.86 L**
- 12) A propane (C<sub>3</sub>H<sub>8</sub>) tank has a volume of 5800 mL. If the temperature of the environment is 21°C, how many grams of propane can we put in the container to achieve a pressure of 35 atm?  
Type: Ideal Gas Law  
**370.04 g**
- 13) A container enclosing equal numbers of nitrogen and oxygen molecules has a total pressure of 0.8 atm. What is the partial pressure due to the nitrogen molecules? Type: Partial Pressures  
**0.4 atm**  
*Explanation: If the container holds equal numbers of both gases (both are diatomic), then that means that the container has equal number of moles of both gases. They would both be at the same temperature, and therefore exert the same amount of pressure:  $P_{\text{N}_2} + P_{\text{O}_2} = P_{\text{total}}$  half of 0.8 atm is 0.4 atm*