

Chapter 13: Gas Laws

(Gen)

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

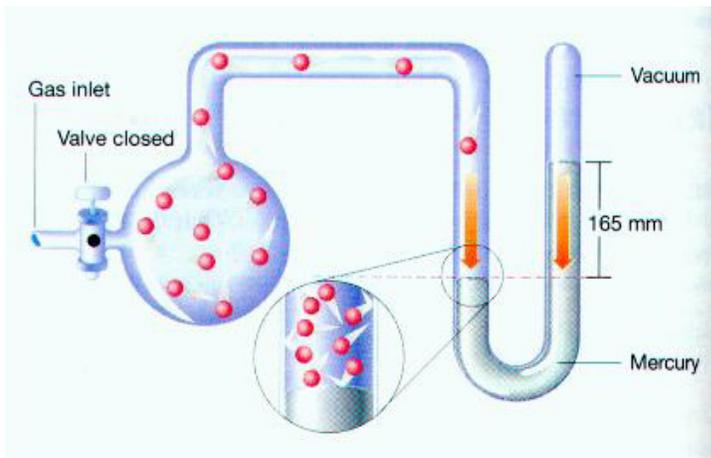
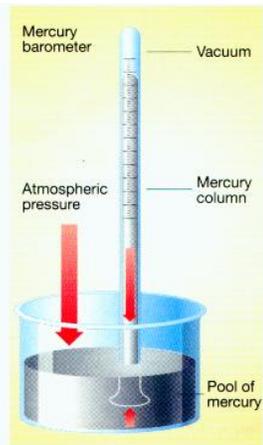
- 78% N₂
- 21% O₂
- 1% Ar
- <1% CO₂

Factors that can affect gases

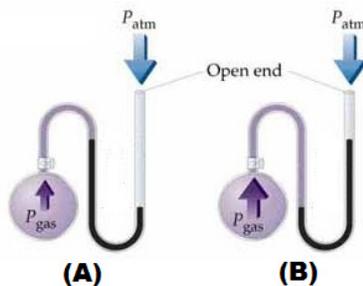
	Units
Temperature	must be in Kelvin (not in Celsius) $K = ^\circ C + 273$
Pressure	atmospheres (atm) kilopascals (kPa) millimeters of mercury (mm Hg)
Volume	1000 mL = 1 L 1 dm ³ = 1 L 1 cm ³ = 1 mL
number of particles	moles (If given grams, then you must convert to moles.)

Barometer/ Manometer

- Instruments to measure pressure



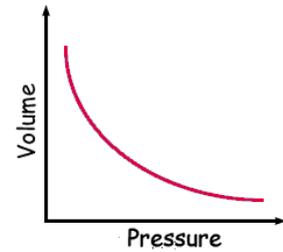
- In which manometer is the pressure of the gas in the flask greater than atmospheric pressure?



Boyle's Law

$$P_1V_1 = P_2V_2$$

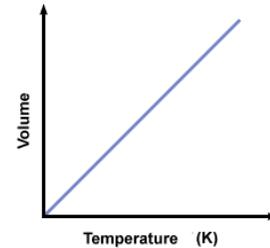
- Pressure and volume change
 - Temperature remains constant
- Inverse relationship
 - As pressure increases, volume decreases



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

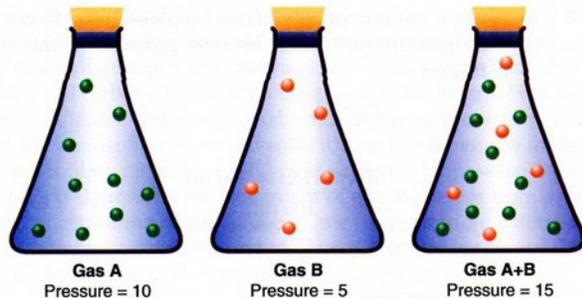
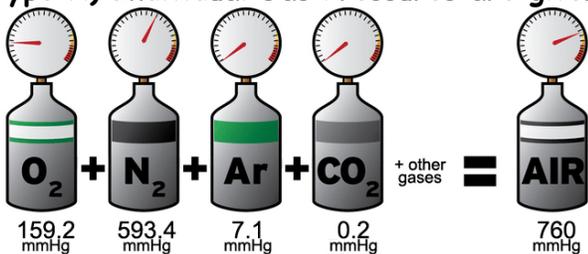
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

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."

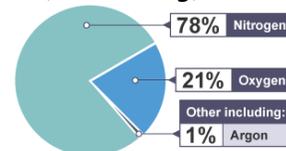
$$P_1 + P_2 + P_3 + \dots = P_{\text{Total}}$$

Type A) Individual Gas Pressures are given



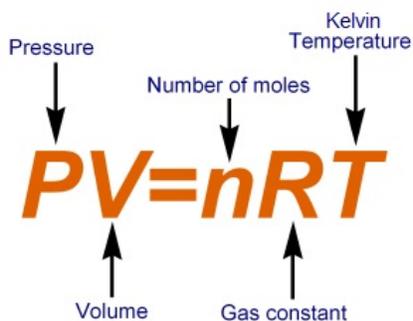
Type B) Percentages of Gases are given

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



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

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

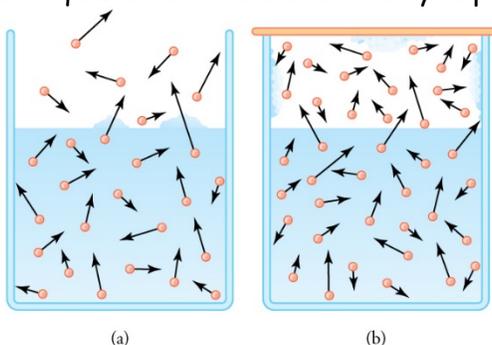
Assumptions of an Ideal Gas:

- 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.

Vapor Pressure

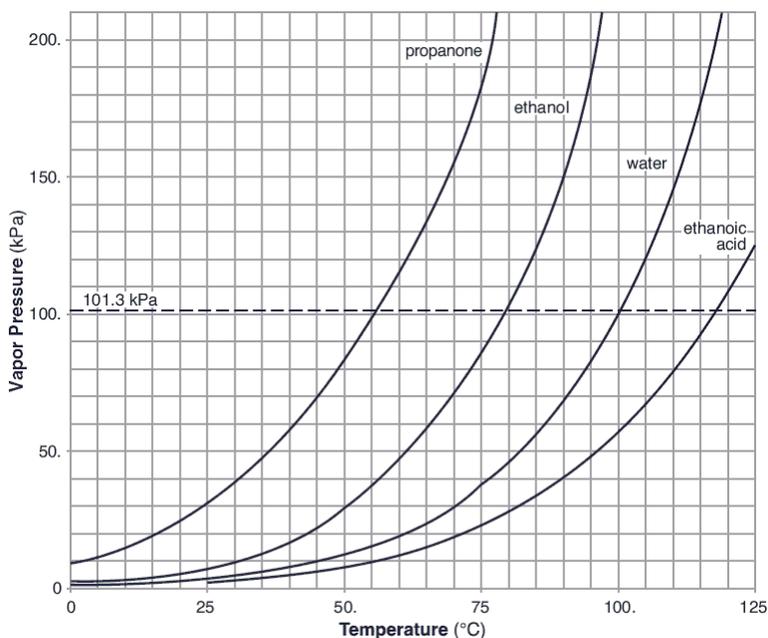
- The pressure exerted by a vapor over a liquid
- A substance boils when its vapor pressure equals atmospheric pressure

Ex 1) Why does a pot of water boil quicker on the stove when you put a lid on the pot?



Ex 2) 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

	Definition	Strength
Hydrogen Bonding	Between hydrogen and O, N, F It is a magnetic attraction (not an actual bond). 	<p style="text-align: center;">Strongest force</p> <p style="text-align: center;">Weakest force</p>
Dipole-Dipole	Attraction between two <u>polar</u> molecules. 	
London Dispersion Forces AKA "van der Waals Forces"	A temporary attraction. Present in <u>nonpolar</u> molecules. 	

δ^+ means "partial positive charge"

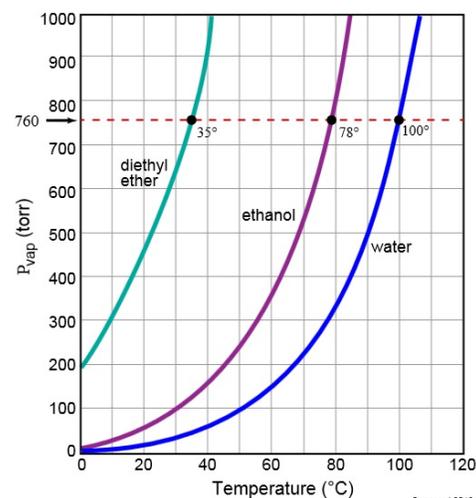
δ^- means "partial negative charge"

Relating Intermolecular Forces to Chemical Properties

Ex 3) Based on the given boiling point data, which liquid has the strongest intermolecular forces?

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

Ex 4) Based on the vapor pressure curves provided, which liquid has the strongest intermolecular forces?



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

(Gen)

Name: _____

Pressure, Volume, & Temperature Conversions

Conversion factors: 1 atm = 101.3 kPa = 760 mmHg

Perform the following conversions:

1) $43^{\circ}\text{C} = ? \text{ K}$

3) $2.3 \text{ L} = ? \text{ mL}$

2) $298\text{K} = ? ^{\circ}\text{C}$

4) $17500 \text{ cm}^3 = ? \text{ dm}^3$

(Hint: Look at your notes to see what more familiar units cm^3 and dm^3 represent.)

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 in liters 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?
(Hint: watch your volume units to make sure they cancel out!)
- 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 in kPa?

Charles's Law - relationship between volume and Kelvin temperature

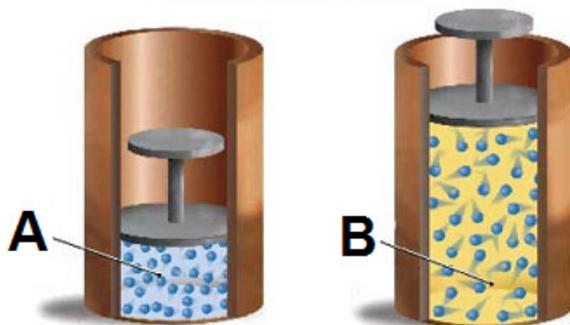
Write the equation for Charles's Law and label the variables:

- 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? (Hint: convert °C to Kelvin before calculating)
- 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?
(Hint: remember that temperature ALWAYS must be in Kelvin for gas law calculations!)
- 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

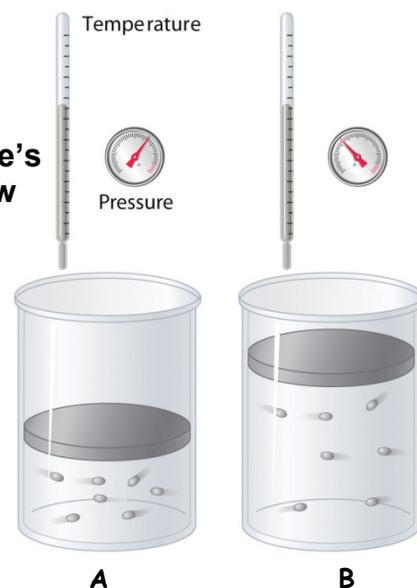
13) Which cylinder, A or B, contains a gas with the highest temperature? Explain the reasoning behind your choice.

Charles's Law



Boyle's Law

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



Chapter 13: Practice #1 (Gen)
Boyle's Law & Charles's Law

Name: _____

Pressure, Volume, & Temperature Conversions

Perform the following conversions:

1) $43^{\circ}\text{C} = ? \text{ K}$

316 K

3) $2.3 \text{ L} = ? \text{ mL}$

2300 mL

2) $298 \text{ K} = ? ^{\circ}\text{C}$

25°C

4) $17500 \text{ cm}^3 = ? \text{ dm}^3$

*(cm^3 is the same thing as mL;
 dm^3 is the same thing as L)*
 17.5 dm^3

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 (C₃H₈) 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?

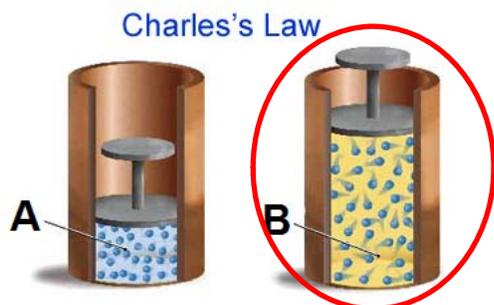
1290 mL

- 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

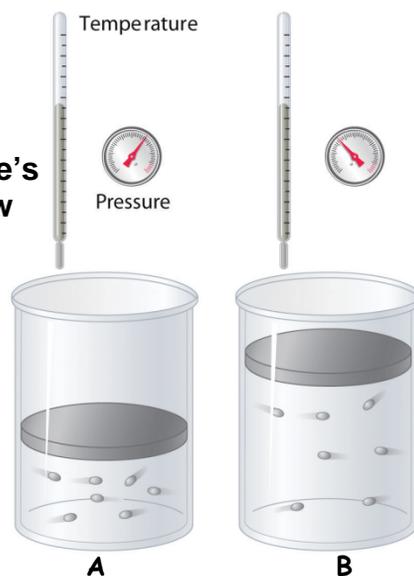
- 13) Which cylinder, A or B, contains a gas with the highest temperature? Explain the reasoning behind your choice.



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 sample of chlorine gas occupies 9.2 L at 45°C and 1.3 atm. What would be the pressure when the volume is reduced to 7.8 L at 38°C?
- 15) A gas at 110 kPa and 30.0°C fills a flexible container with an initial volume of 2.00 dm³. If the temperature is raised to 80.0°C and the pressure increases to 440 kPa, what is the new volume in dm³? (Hint: a dm³ is the same thing as a Liter)
- 16) 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?
- 17) A 5.00 L air sample has a pressure of 107 kPa at a temperature of -50°C. If the temperature is raised to 102°C and the volume expands to 7.00 L, what will the new pressure be?

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

- 18) A tank contains N₂ at 1.4 atm and O₂ 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?
- 19) The total pressure of an O₂-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 O₂?
- 20) Industrial deep-sea divers must breathe a mixture of He and O₂ 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?
- 21) A mixture of neon and argon gases exerts a total pressure of 189 kPa. The partial pressure of the neon alone is 82 kPa, what is the partial pressure of the argon?

Type B: Percentage of Gases Given

22) 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?

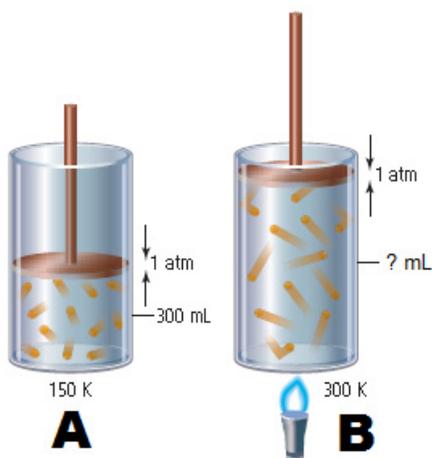
23) The air pressure in a greenhouse is 139.0 mmHg. What is the partial pressure of water vapor if it comprises 18% of the air mixture?

24) 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?

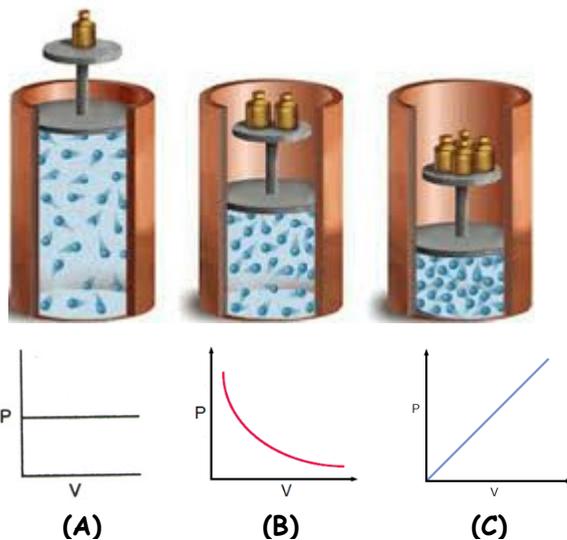
25) The barometer shows the atmospheric pressure to be 762 mmHg. What is the partial pressure of nitrogen if air is composed of 21% oxygen and 78% nitrogen?

Understanding Gases

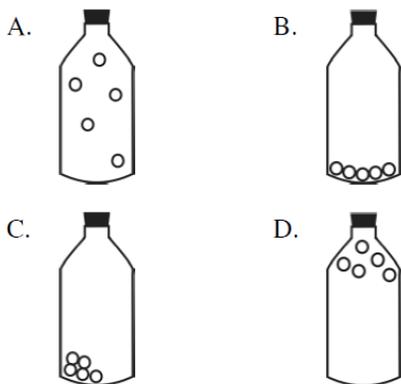
26) Cylinder A contains 300 mL of a gas. If the temperature of cylinder A is doubled and pressure remains constant at 1 atm, what will be the new volume of the gas (cylinder B)? _____



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



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



29) A sample of H₂ gas and a sample of N₂ 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 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:

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

P = Pressure of the gas

T = Temperature of the gas

V = Volume of the gas

- 1) A sample of chlorine gas occupies 9.2 L at 45°C and 1.3 atm. What would be the pressure when the volume is reduced to 7.8 L at 38°C?
1.5 atm
- 2) A gas at 110 kPa and 30.0°C fills a flexible container with an initial volume of 2.00 dm³. If the temperature is raised to 80.0°C and the pressure increases to 440 kPa, what is the new volume in dm³?
(Hint: a dm³ is the same thing as a Liter)
0.58 dm³
- 3) 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?
6179 mL
- 4) A 5.00 L air sample has a pressure of 107 kPa at a temperature of -50°C. If the temperature is raised to 102°C and the volume expands to 7.00 L, what will the new pressure be?
128.52 kPa

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

- 5) A tank contains N₂ at 1.4 atm and O₂ 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
- 6) The total pressure of an O₂-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 O₂?
86 mm Hg
- 7) Industrial deep-sea divers must breathe a mixture of He and O₂ 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
- 8) A mixture of neon and argon gases exerts a total pressure of 189 kPa. The partial pressure of the neon alone is 82 kPa, what is the partial pressure of the argon?
107 kPa

Type B: Percentage of Gases Given

9) 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) 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) 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?

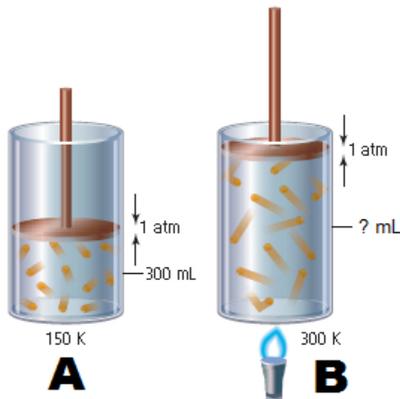
225.9 mmHg

12) 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

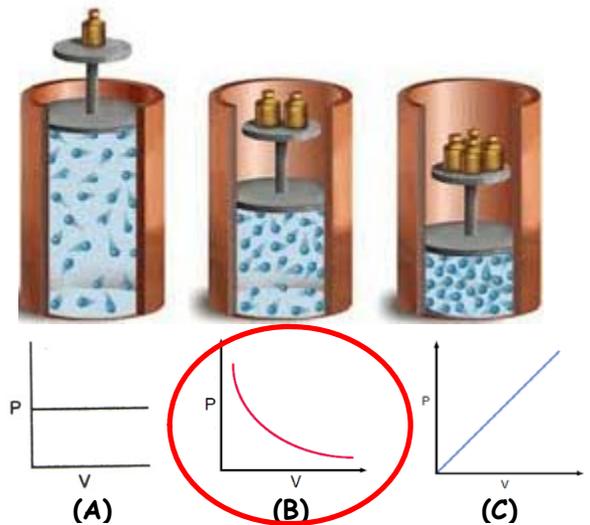
Understanding Gases

13) 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.

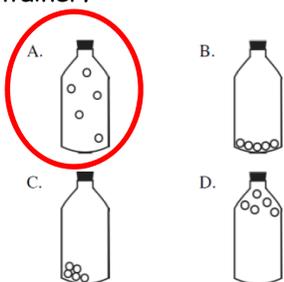
14) Which graph best represents the relationship between pressure and volume as represented in the graphic?



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

15) 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.)



16) A sample of H₂ gas and a sample of N₂ 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	$\frac{dm^3 \cdot kPa}{mol \cdot K}$
0.0821	$\frac{dm^3 \cdot atm}{mol \cdot K}$

30) What volume in liters would be occupied by 3.125 mol of oxygen gas at a pressure of 1.50 atm and a temperature of 298 K?

34) 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?

31) What pressure in atm is exerted by 0.625 mol of a gas in a 45.4 L container at -24°C?

35) A sample of 82.1 g nitrogen gas (N₂) occupies a balloon that has a volume of 0.640 dm³ at a temperature of 325 K. What is the pressure inside balloon in atm? (*Hint: you must convert grams to moles first*)

32) How many moles of SO₂ are there in a 39 dm³ sample of the gas at a pressure of 147 kPa and a temperature of 61°C? (*Hint: in your notes, look up what unit dm³ is the same as*)

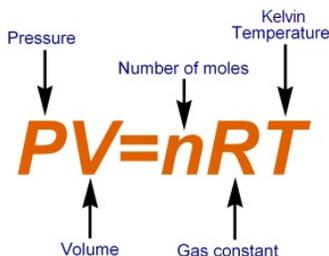
36) A sample of 124.6 g of Br₂ gas is loaded into a cylinder at 0°C and 1 atm (STP). What is the volume of the cylinder in mL?

33) A balloon is inflated with 6.23 mol of helium to a pressure of 7.26 atm. If the volume of the balloon is 26.5 L, what should the temperature of the balloon be in Kelvin?

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

- What volume in liters would be occupied by 3.125 mol of oxygen gas at a pressure of 1.50 atm and a temperature of 298 K?
50.97 L
- What pressure in atm is exerted by 0.625 mol of a gas in a 45.4 L container at -24°C ?
0.28 atm
- How many moles of SO_2 are there in a 39 dm^3 sample of the gas at a pressure of 147 kPa and a temperature of 61°C ? (Hint: in your notes, look up what unit dm^3 is the same as)
2.06 mol
- A balloon is inflated with 6.23 mol of helium to a pressure of 7.26 atm. If the volume of the balloon is 26.5 L, what should the temperature of the balloon be in Kelvin?
376.14 K
- 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?
23.65 mol
- A sample of 82.1 g nitrogen gas (N_2) occupies a balloon that has a volume of 0.640 dm^3 at a temperature of 325 K. What is the pressure inside balloon in atm? (Hint: you must convert grams to moles first)
122.16 atm
- A sample of 124.6 g of Br_2 gas is loaded into a cylinder at 0°C and 1 atm (STP). What is the volume of the cylinder in mL?
17480 mL

Chapter 13: Quiz Review

(Gen)

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.)

37) A gas occupies 0.105 dm^3 at 100 K . At what temperature will its volume be 0.140 dm^3 ?

Type: _____

Hint: what is a dm^3 the same as? (see notes)

40) A gas occupies a volume of 2.45 L at a pressure of 1.03 atm . What volume will the gas occupy if the pressure changes to 0.980 atm and the temperature remains unchanged?

Type: _____

38) A basketball filled with nitrogen has a volume of 5.3 L when at 25°C and 1 atm . What will the new volume of the basketball be if it heats up to 31°C and the pressure increases to 1.2 atm ?

Type: _____

41) What is the partial pressure of oxygen in a scuba tank if the total pressure is 6.3 atm and the air is 80% nitrogen and 20% oxygen?

Type: _____

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

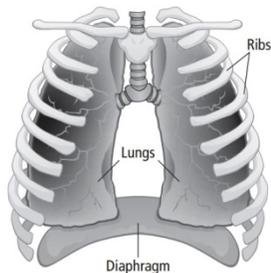
Type: _____

42) A sample of sulfur gas occupies 1500 mL at 44°C and 1.56 atm . What would be the volume in milliliters at 56°C and 0.76 atm ?

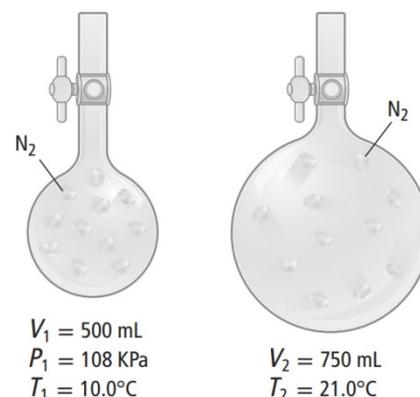
Type: _____

Understanding Gases

43) A sample of nitrogen gas is transferred to a larger flask, as shown in the graphic at right. What is the pressure of nitrogen in the second flask?



44) 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 (Gen)

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 dm^3 at 100 K . At what temperature will its volume be 0.140 dm^3 ?

Type: Charles's Law

Hint: what is a dm^3 the same as? (see notes)

A dm^3 is the same as a L ($1 \text{ dm}^3 = 1 \text{ L}$)

133.3 K

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

Type: Boyle's Law

2.57 L

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

Type: Combined Gas Law

4.51 L

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

Type: Partial Pressures

1.26 atm

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

Type: Partial Pressures

1003 mm Hg

- 6) A sample of sulfur gas occupies 1500 mL at 44°C and 1.56 atm . What would be the volume in milliliters at 56°C and 0.76 atm ?

Type: Combined Gas Law

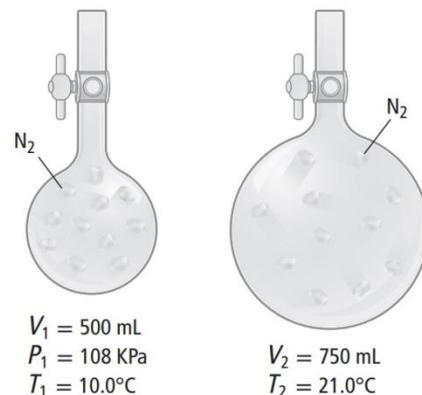
3195.5 mL

Understanding Gases

- 7) A sample of nitrogen gas is transferred to a larger flask, as shown in the graphic at right. What is the pressure of nitrogen in the second flask?

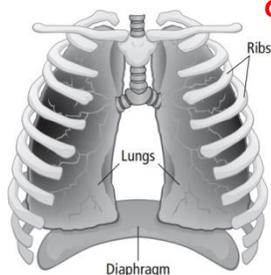
Explanation: Use the data in the graphic to set up a Combined Gas Law equation. You are solving for P_2 .

74.8 kPa



- 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)

- 1) $1960 \text{ cm}^3 = ? \text{ dm}^3$
1.96 dm³
- 2) $233 \text{ K} = ? \text{ }^\circ\text{C}$
-40°C
- 3) $120 \text{ kPa} = ? \text{ atm}$
1.18 atm
- 4) $43.2 \text{ L} = ? \text{ mL}$
43200 mL

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.
 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 volume if the pressure is decreased to 63 kPa and the temperature to 30°C?
Type: **Combined Gas Law**
5.87 L
- 6) A propane (C₃H₈) tank has a volume of 5.8 L. If the temperature of the environment is 21°C, how many grams of propane can we put in the container if we want to have a pressure of 35 atm?
Type: **Ideal Gas Law**
370.04 g
Hint: solve for "n" (moles) and then convert your answer from moles to grams using molar mass of C₃H₈
- 7) 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
- 8) 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
- 9) There are three gases in a system: N₂ has a pressure of 500 kPa, O₂ has a pressure of 150 kPa and Cl₂ has a pressure of 120 kPa. What is the total pressure of the system?
Type: **Partial Pressures**
770 kPa
- 10) 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 810.4 kPa and the temperature to 50°C? Type: **Combined Gas Law**
0.863 L
(Hint: did you convert your volume from mL to L?)
- 11) 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
(Hint: did you convert your volume from L to mL?)
- 12) 5.28g of dry ice (CO₂) is placed into a 2600 cm³ bottle at 45.1°C. What will be the pressure in kPa when the bottle explodes?
Type: **Ideal Gas Law**
122.06 kPa
(Hint: did you convert 5.28g to moles using the molar mass of CO₂?)