Name:

Regents Chemistry:

Practice Packet Unit 8: Gases

Vocabulary:

Absolute Zero: ____

Avogadro's Hypothesis: ____

(Normal) Boiling Point: ____

Direct Relationship: ____

Evaporating: ____

Gas: ____

Ideal Gas: ____

Indirect Relationship: ____

Kinetic Molecular Theory (KMT): ____

Pressure: ____

Temperature: ____

LESSON 1: KINETIC MOLECULAR THEORY: IDEAL VS REAL GASES

Objective:

- ***Describe the behavior of ideal gases based on the Kinetic Molecular Theory***
- ***Differentiate between ideal and real gases***
- ***Determine when real gases behave most like ideal gases.***

KMT is the study of how ___________ gases behave.

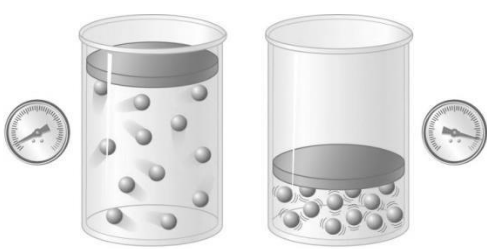
Major Understandings of KMT (YOU MUST MEMORIZE!!!)

1. Particles of an ideal gas move in **random, constant**, ______________________________ motion.
2. Particles of an ideal gas are separated by **great distances** relative to their size; the volume of gas particles is considered _______________________.
3. Particles of an ideal gas have _______________ **attractive force** between them.
4. Particles of an ideal gas have collisions that may result in a **transfer of energy** between particles, but the **total energy** of the system ____.

Real gases behave most like ideal gases under _______ pressure and _______ temperature. To help you remember use the acronym _________________

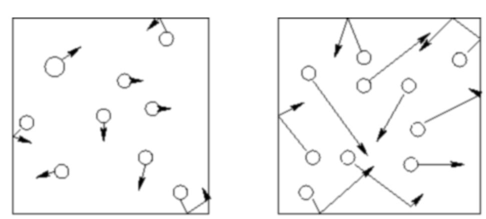
Identify the conditions that are most ideal, A or B:

1. A B



(a) Low pressure (b) High pressure

2. A B



Cool gas, fewer and less energetic collisions

Hot gas, more and more energetic collision

2. How can you get a real gas to behave the *least* like an ideal gas?

3. Of the following: H_2, He, CO_2, which would behave *least* like an ideal gas and why?

4. Which of the gases in question 3 behaves the *most* like ideal gases/ Why?

5. Why do gases behave least like ideal gases at low temperatures and high pressures?

Regents Questions:

1. Two basic properties of the gas phase are
   (1) a definite shape and a definite volume
   (2) a definite shape but no definite volume
   (3) no definite shape but a definite volume
   (4) no definite shape and no definite volume

2. According to the kinetic molecular theory, the molecules of an ideal gas

   (1) have a strong attraction for each other
   (2) have significant volume
   (3) move in random, constant, straight-line motion
   (4) are closely packed in a regular repeating pattern

3. According to the kinetic molecular theory, which assumption is correct?
   (1) Gas particles strongly attract each other.
   (2) Gas particles travel in curved paths.
   (3) The volume of gas particles prevents random motion.
   (4) Energy may be transferred between colliding particles.

4. Helium is most likely to behave as an ideal gas when it is under

   (1) high pressure and high temperature
   (2) high pressure and low temperature
   (3) low pressure and high temperature
   (4) low pressure and low temperature

5. Under which conditions of temperature and pressure does oxygen gas behave *least* like an ideal gas?

   (1) low temperature and low pressure
   (2) low temperature and high pressure
   (3) high temperature and low pressure
   (4) high temperature and high pressure

6. Under which conditions of temperature and pressure would a real gas behave most like an ideal gas?

   (1) 200. K and 50.0 kPa
   (2) 200. K and 200.0 kPa
   (3) 600. K and 50.0 kPa
   (4) 600. K and 200.0 kPa

LESSON 2: GAS LAWS

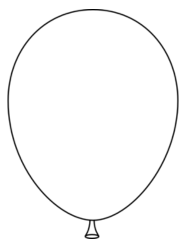
Objective:

- ***Determine the relationship between pressure, temperature and volume***
- ***Compare different gases in reference to Avogadro's hypothesis***

Avogadro's Hypothesis states that ______________ volumes of different gases as the __________ temperature and pressure contain ______________________________________.

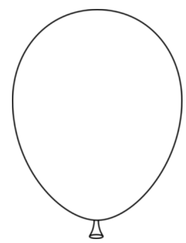
1. Balloon A contains carbon dioxide gas. An identical Balloon B contains Neon gas. The diagram below represents these balloons and the conditions of pressure, volume, and temperature of the gas in each balloon.

Balloon A



Carbon dioxide gas
P = 150. kPa
V = 4.25 L
T = 298K

Balloon B



Neon Gas
P = 150. kPa
V = 4.25 L
T = 298K

Compare the total number of gas particles in balloon A to the total number of gas particles in balloon B.

HINT: In writing your response to question 1, write a complete sentence and use the phrase "greater than", "less than" or "equal to".

2. The table below shows data for the temperature, pressure, and volume of four gas samples.

Gas Sample	Temperature (K)	Pressure (atm)	Volume (mL)
A	100.	2	400.
B	200.	2	200.
C	100.	2	400.
D	200.	4	200.

Which two gas samples have the same total number of molecules?

Boyle's Law relates pressure and volume. When pressure is increased on a gas at constant temperature, the volume ___________________. This is a(n) __________________ relationship.

FILL IN THE BLANKS WITH INCREASE(S) OR DECREASE(S).

3. Pilots suffer from intestinal pain when they fly because at higher altitudes, the pressure is decreased so the air volume in their body _____________________.
4. Your lungs suck in air when the diaphragm is enlarged. When the diaphragm opens, the lung expands, the volume ______________ and the pressure _______________ which allows air in. When the diaphragm collapsed, there is less room so the volume __________ and the pressure ____________.
5. Scuba divers need to be careful when checking their air tanks. When they descend in the water the water pressure increases and pushes on the tank. The tank air pressure increases and the volume of the air ______________. When they ascend to the surface, the pressure decreases and the volume of the gas in their tank and body _____________________.

6. Why do you ears pop on an airplane? (Hint: the air pressure decreases at high altitudes.) explain in terms of pressure and volume.

Charles' Law relates volume and temperature. When temperature is increased on a gas at constant pressure, the volume ____________________. This is a(n) ________________ relationship.

FILL IN THE BLANKS WITH INCREASE(S) OR DECREASE(S).

7. Hot air balloons work based on density changes affected by Charles law. To rise, the temperature is _________________ and the volume ___________________ to make the density low. To come back down the fire is turned off so the temperature ______________ and volume _______________ so the density increases. The balloon is always inflated so the pressure is relatively constant.

8. To un-dent ping pong balls submerge them in hot water. Explain this phenomenon in terms of volume and temperature.

9. A balloon outside in the winter seems to deflate but inside it re-inflates. However the number of gas molecules stays constant. How does that happen? Explain in terms of volume and temperature.

Gay Lussac's Law relates pressure and temperature. When temperature is increased on a gas at constant volume (in a rigid container), the pressure _____________ because the gas molecules move more. This is a(n) ____________________ relationship.

FILL IN THE BLANKS WITH INCREASE(S) OR DECREASE(S).

10. Drivers need to check the air pressure on their tires during change of seasons. In the winter the temperatures are decreased, the pressure inside the tires is ___________________ and the tires are flat. In the summer temperatures are increased and pressures are_________________ so the tires are swollen. But the volume the tires air can occupy stays the same.

11. Don't put aerosol spray cans in direct heat or flames because they explode. Explain this phenomenon in terms of pressure and temperature.

12. Which sample at STP has the same number of molecules as 5 liters of NO_2(g) at STP?
    (1) 5 grams of H_2(g)
    (2) 5 liters of CH_4(g)
    (3) 5 moles of O_2(g)
    (4) 5 x 10^{23} molecules of CO_2(g)

13. At the same temperature and pressure, 1.0 liter of CO (g) and 1.0 liter of CO_2 (g) have
    (1) Equal volumes and the same number of molecules
    (2) Equal masses and the same number of molecules
    (3) Different masses and a different number of molecules
    (4) Different volumes and a different number of molecules

14. At the same temperature and pressure, which sample contains the same number of moles of particles as 1 liter of O_2 (g)?
    (1) 1 L Ne (*g*)
    (2) 0.5 L SO_2 (*g*)
    (3) 2 L O_2 (*g*)
    (4) 1 L of H_2O (l)

LESSON 3: COMBINED GAS LAW

Objective:

- ***Solve gas law problems using the combined gas law equation***
- ***Convert from Celsius temperatures to Kelvin***
- ***Convert between pressure units (atm and kPa)***

Copy the combined gas low formula here:

Remember temperature must be in Kelvin.

1. If the temperature of a 50mL sample of a gas is changed from 200K to 400K under constant pressure, what is the new volume of the gas?

   P_1 = P_2 =

   V_1 = V_2 =

   T_1 = T_2 =

2. The volume of a gas is 204mL when the pressure is 925kPa. At constant temperature, what is the final pressure if the volume increases to 306ml?

   P_1 = P_2 =

   V_1 = V_2 =

   T_1 = T_2 =

3. A balloon has a volume of 1.75L at a temperature of 298K. What will be the volume of the balloon if you take it out into the winter cold air at 258K? Assume pressure is constant.

   P_1 = P_2 =

   V_1 = V_2 =

   T_1 = T_2 =

4. An aerosol spray can with a volume of 456mL contains 3.18g of propane gas as a propellant. If the can is at 23°C, and 50. atm, what volume would the propane occupy at STP?

P_1 =	P_2 =
V_1 =	V_2 =
T_1 =	T_2 =

5. Divers get "the bends" if they come up too fast because gas in their blood expands, forming bubbles in their blood. If a diver has 5.0 mL of gas in his blood under a pressure of 250. atm, then rises instantaneously to a depth where his blood has a pressure of 50.0 atm, what will the volume of gas in his blood be?

P_1 =	P_2 =
V_1 =	V_2 =
T_1 =	T_2 =

6. A gas has a volume of 2.00 L at 323 K and 3.00 atm. What will be the new volume if the temperature is changed to 273 K and the pressure is changed to 1 atm?

P_1 =	P_2 =
V_1 =	V_2 =
T_1 =	T_2 =

7. A gas at STP has a volume of 1.00 L. If the pressure is doubled and the temperature remains constant, what is the new volume of the gas?

P_1 =	P_2 =
V_1 =	V_2 =
T_1 =	T_2 =

8. A 2.5 L sample of gas is at STP. When the temperature is raised to 373°C and the pressure remains constant what will the new volume of the gas be?

P_1 =	P_2 =
V_1 =	V_2 =
T_1 =	T_2 =

9. A sample of gas is held at constant pressure. Increasing the kelvin temperature of this gas sample causes the average kinetic energy of its molecules to
   a. decrease and the volume of the gas sample to decrease
   b. decrease and the volume of the gas sample to increase
   c. increase and the volume of the gas sample to decrease
   d. increase and the volume of the gas sample to increase

10. Air bags are an important safety feature in modern automobiles. An air bag is inflated in milliseconds by the explosive decomposition of $NaN_3(s)$. The decomposition reaction produces $N_2(g)$, as well as Na(s), according to the unbalanced equation below.

$$\_\_\_ \ NaN_3(s) \rightarrow \_\_\_ \ Na(s) + \_\_\_ \ N_2(g)$$

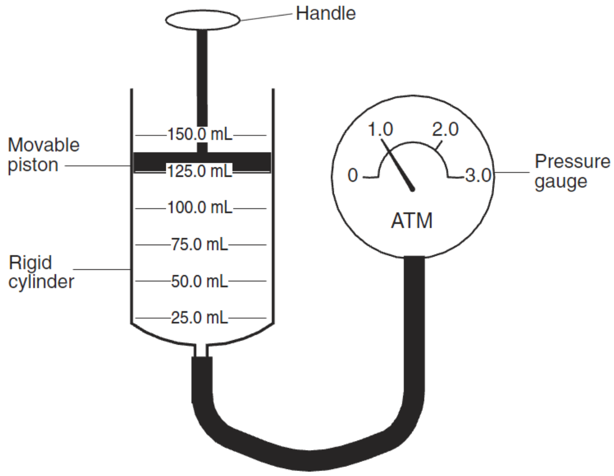
   a.) Balance the above equation using the smallest whole-number coefficients.

   b.) When the air bag inflates, the nitrogen gas is at a pressure of 1.30 atmospheres, a temperature of 301 K, and has a volume of 40.0 liters. Calculate the volume of the nitrogen gas at STP.

P_1 = P_2 =
V_1 = V_2 =
T_1 = T_2 =

Review Questions:

1. A rigid cylinder is fitted with a movable piston. The cylinder contains a sample of helium gas, He(g), which has an initial volume of 125.0 milliliters and an initial pressure of 1.0 atmosphere, as shown below. The temperature of the helium gas sample is 20.0°C.



a.) Express the initial volume of the helium gas sample, in liters.

b.) The piston is pushed further into the cylinder. Show a correct numerical setup for calculating the volume of the helium gas that is anticipated when the reading on the pressure gauge is 1.5 atmospheres. The temperature of the helium gas remains constant.

c.) Helium gas is removed from the cylinder and a sample of nitrogen gas, $N_2(g)$, is added to the cylinder. The nitrogen gas has a volume of 125.0 milliliters and a pressure of 1.0 atmosphere at 20.0°C. Compare the number of particles in this nitrogen gas sample to the number of particles in the original helium gas sample.

LESSON 4: VAPOR PRESSURE

Objective:

- ***Differentiate between evaporation and boiling***
- ***Determine effects of vapor pressure on boiling point***

DEMO:

What happens to the water when the pressure inside the chamber decreases?_____________________

What is the relationship between atmospheric pressure and boiling pt?___________________________

____.

Based upon the demo, why does it take longer to cook food such as pasta at extremely high altitudes?
____

____.

1. Liquids evaporate when they are left in the open air. This is also known as ___________________. Liquids also go through this phase change in closed containers. The vapor that is produced in either container exerts a pressure on top of the liquid phase. This pressure is known as ________________ ___________________.
2. In order for the vapor to escape its original liquid phase completely its pressure must overcome the regular atmospheric pressure above it. As temperature of the liquid increases, the number of particles evaporating ___________________ and the vapor pressure ___________________. Therefore, temperature and vapor pressure have a direct correlation.
3. Under high atmospheric pressure, the liquid will have a harder time escaping the liquid phase so the temperature at which it boils is higher than normal. Under low atmospheric pressure, the liquid will have an easier time escaping the liquid phase so the temperature at which it boils is________________ than normal.

Use Table H to answer these questions:

1. Which substance has the lowest boiling point? ________________
2. Which substance has a normal boiling point of 100.°C? ________________
3. What is the normal boiling point of propanone? ________________
4. Which substance has the highest vapor pressure at 40.°C? ________________
5. At what pressure will water boil at 90.°C? ________________
6. At what pressure will propanone boil at 20.°C? ________________
7. What temperature will ethanoic acid boil at 48kPa? ________________
8. What temperature will water boil at 110.kPa? ________________

1. The stronger the intermolecular forces of attraction (particle attractions or IMF's) the____________________ *(more or less?)* energy required to break them.
2. The stronger the IMF's, the ________________*(higher or lower?)* the vapor pressure at any given temperature. Explanation: ____

   ____

   ____

   The weaker the IMF's, the ______________________ *(harder or easier?)* it is for a liquid to evaporate. Explanation: ____

   ____
3. If water is boiling at 70.°C, what is the vapor pressure? ___________ kPa
4. What is the vapor pressure of ethanol at 90.°C? ___________ atm
5. What is meant by "normal" boiling point?
6. What is the normal boiling point of ethanoic acid? ___________ °C
7. Which of the 4 substances evaporates most rapidly at 50.°C? ________________
8. Which substance has the *weakest* IMF's between its molecules? ________________