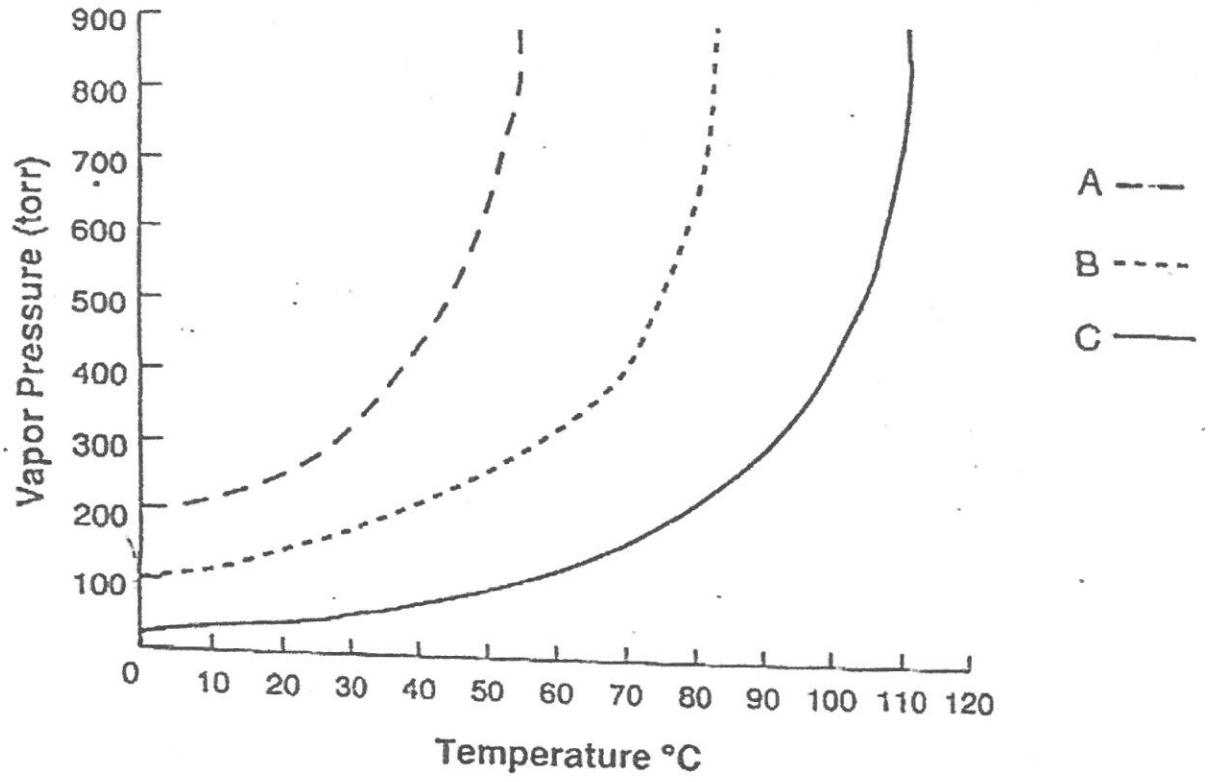
VAPOR PRESSURE AND BOILING

Name _____

A liquid will boil when its vapor pressure equals atmospheric pressure. Answer the questions following the graph.



1. At what temperature would Liquid A boil at an atmospheric pressure of 400 torr? _____
2. Liquid B? _____
3. Liquid C? _____
4. How low must the atmospheric pressure be for Liquid A to boil at 35° C? _____
5. Liquid B? _____
6. Liquid C? _____
7. What is the normal boiling point of Liquid A? _____
8. Liquid B? _____
9. Liquid C? _____
10. Which liquid has the strongest intermolecular forces? _____

Name: _____ Date: _____ Period: _____

Avogadro's Law

1. The formula for Avogadro's Law is:

2. If 0.40 mol of carbon dioxide occupies a volume of 8.40 L at STP, what volume does 1.6 mol of CO_2 occupy at STP?

3. If 0.80 g of helium has a volume of 12.6 L, how many grams of helium would occupy 15.5 L?

4. If 12.40 mol of CO_2 occupies a volume of 96.8 L, how many moles occupy 72.6 L?

5. If 22.0 g of nitrogen occupies a volume of 32.7 L, what volume will 83.0 g of nitrogen have?

BOYLE'S LAW

Name _____

Boyle's Law states that the volume of a gas varies inversely with its pressure if temperature is held constant. (If one goes up, the other goes down.) We use the formula:

$$P_1 \times V_1 = P_2 \times V_2$$

Solve the following problems (assuming constant temperature).

1. A sample of oxygen gas occupies a volume of 250. mL at 740. torr pressure. What volume will it occupy at 800. torr pressure?

_____

2. A sample of carbon dioxide occupies a volume of 3.50 liters at 125 kPa pressure. What pressure would the gas exert if the volume was decreased to 2.00 liters?

_____

3. A 2.0 liter container of nitrogen had a pressure of 3.2 atm. What volume would be necessary to decrease the pressure to 1.0 atm?

_____

4. Ammonia gas occupies a volume of 450. mL at a pressure of 720. mm Hg. What volume will it occupy at standard pressure?

_____

5. A 175 mL sample of neon had its pressure changed from 75 kPa to 150 kPa. What is its new volume?

_____

6. A sample of hydrogen at 1.5 atm had its pressure decreased to 0.50 atm producing a new volume of 750 mL. What was its original volume?

_____

7. Chlorine gas occupies a volume of 1.2 liters at 720 torr pressure. What volume will it occupy at 1 atm pressure?

_____

8. Fluorine gas exerts a pressure of 900. torr. When the pressure is changed to 1.50 atm, its volume is 250. mL. What was the original volume?

_____

CHARLES' LAW

Name _____

Charles' Law states that the volume of a gas varies directly with the Kelvin temperature, assuming that pressure is constant. We use the following formulas:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{or} \quad V_1 \times T_2 = V_2 \times T_1$$

$$K = °C + 273$$

Solve the following problems assuming a constant pressure.

1. A sample of nitrogen occupies a volume of 250 mL at 25° C. What volume will it occupy at 95° C?

_____

2. Oxygen gas is at a temperature of 40° C when it occupies a volume of 2.3 liters. To what temperature should it be raised to occupy a volume of 6.5 liters?

_____

3. Hydrogen gas was cooled from 150° C to 50° C. Its new volume is 75 mL. What was its original volume?

_____

4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?

_____

5. A sample of neon gas at 50° C and a volume of 2.5 liters is cooled to 25° C. What is the new volume?

_____

6. Fluorine gas at 300 K occupies a volume of 500 mL. To what temperature should it be lowered to bring the volume to 300 mL?

_____

7. Helium occupies a volume of 3.8 liters at -45° C. What volume will it occupy at 45° C?

_____

8. A sample of argon gas is cooled and its volume went from 380 mL to 250 mL. If its final temperature was -55° C, what was its original temperature?

_____

GAY-LUSSAC'S LAW

Gay Lussac's Law states that the pressure of a gas varies directly with the Kelvin temperature, assuming that volume is constant. We use the following formula's:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad \text{or} \quad P_1 \times T_2 = P_2 \times T_1$$

Solve the following problems, assuming constant volume.

1. A sample of nitrogen has a pressure of 3.5 atm at 25°C. What pressure will it have at 95°C?

2. Oxygen gas is at a temperature of 40°C when it has a pressure of 750 torr. To what temperature should it be raised to have a pressure of 770 torr?

3. A container of nitrogen had a pressure of 3.2 atm at 33°C. What pressure would be necessary to decrease the temperature to 20°C?

4. Chlorine gas has a temperature of 15°C at 720 torr. What temperature would it be if the pressure is increased to 790 torr?

5. Fluorine exerts a pressure of 900 torr. When the pressure is changed to 1.6 atm, its temperature is 50°C. What was the original temperature?

6. A sample of carbon dioxide has a temperature of 80°C at 125 kPa pressure. What pressure would the gas exert if the temperature was decreased to 20°C?

7. If the temperature of ammonia gas at STP is raised to 42°C, what will the final pressure be?

Combined Gas Law

The combined gas law shows the relationship between pressure, volume, and temperature: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Solve the following problems using the combined gas law:

1. A gas at 1.2 atm and 32°C occupies a volume of 45 mL. What volume will the gas occupy at STP conditions?

2. Oxygen gas at 50°C and 700 torr occupies a volume of 72 mL. What temperature would it be if the pressure changes to 600 torr and the volume changes to 57 mL?

3. A sample of hydrogen gas cooled from 65°C to 39°C, and the volume changed from 20mL to 41mL. What was the original pressure if the final pressure was 2.2 atm?

4. A sample of chlorine gas occupies a volume of 110 mL when the temperature is 44°C and the pressure is 1.9 atm. What would the volume be if the temperature rose to 61°C and the pressure increased to 2.4 atm?

5. A sample of gas at 12°C had a change in volume from 21 mL to 49 mL. If the final conditions of the gas were at STP, what was the original pressure?

6. Determine the original temperature of a gas that had a volume change of 120 mL to 80 mL and a pressure change of 820 torr to 750 torr. The final temperature was 80°C.

Ideal Gas Law

The ideal gas law: PV = nRT, where P = pressure (in torr or atm)
V = volume (in Liters)
n = number of moles
R = universal gas constant
(0.0821 L*atm/mol*K) or
(62.4 L*torr/mol*K)
T = temperature (in Kelvin)

1. How many moles of oxygen will occupy a volume of 25 liters at 1.2 atm and 25°C?

2. What volume will 2.0 moles of nitrogen occupy at 720 torr and 20°C?

3. What pressure will 1.1 moles of a gas have if its volume is 120 mL and it has a temperature of 30°C?

4. What would the temperature be if 0.8 moles of a gas has a pressure of 2.1 atm and a volume of 220 mL?

5. How many moles of nitrogen gas will occupy a volume of 347 mL at 6680 torr and 27°C?

6. How much space would 0.79 moles of a gas occupy if its temperature is 100°C and it has a pressure of 1.2 atm?

7. What would the pressure be for 0.09 moles of a gas that occupies 235 mL at a temperature of 50°C?

Modified Gas Laws

*** The ideal gas law (PV = nRT) can be modified to solve for molecular mass (M) according to this equation: PV = (mRT)/M, where (m) is the measured mass.**
*** It can also be modified for density according to this equation: PM = DRT.**

1. A 300 mL container contains 1.2 g of a gas at 200 torr and 55°C. What is the molar mass of the gas?

2. What is the density of a gas with a molar mass of 34 g/mol at 70°C and 2.1 atm?

3. What is the mass of a substance that has pressure of 680 torr, a temperature of 20°C, a molar mass of 74 g/mol, and occupies a volume of 200 mL?

4. A student measured the mass of a known substance to be 18 g. She already knew that the temperature was 25°C, the volume was 80 mL, and the molar mass was 110 g/mol. What was the pressure?

5. Find the molar mass of a substance that has a density of 12g/L at 62°C and a pressure of 102 kPa?

6. What is the volume of a substance with a mass of 28 g, a pressure of 2.4 atm, a temperature of 58°C, and a molar mass of 91 g/mol?

Name: _____ Date: _____ Period: _____

Dalton's Law and Graham's Law

1. A 5.0 liter container at 20.0°C has 4 gases pumped in. The total pressure of the gases is 5.20 atm. If the pressure of the first gas is 1.40 atm, and the pressure of the second gas is 0.470 atm, the pressure of the third gas is 0.780 atm, what is the pressure of the fourth gas in atmospheres?

2. Hydrogen gas is collected over water at 25.5°C. The total pressure of the hydrogen gas and water vapor is 691 mmHg. What is the pressure, in mmHg, exerted only by the hydrogen gas?

3. If 455 mL of oxygen gas was collected over water at a temperature of 75.0°C and the total pressure of the gases was 65.8 kPa, what was the pressure, in kPa, of the dry oxygen gas?

4. A mixture of neon and argon gases exerts a total pressure of 2.39 atm. The partial pressure of the neon alone is 1.84 atm. What is the partial pressure of the argon gas in kPa?

5. Circle the molecule in each pair that diffuses faster.

   H_2O or H_2S NH_3 or H_2O CO_2 or NO_2

6. Calculate the ratio of effusion rates or Ar and Kr.

7. Calculate the molar mass of a gas that effuses 2.5 times faster than carbon monoxide.

8. Calculate the ratio of effusion rates of NO and NO_2.

Name:_____ Date:_____ Period:_____

Water Vapor Pressure Table:

Temp (°C)	Pressure (mmHg)
0.0	4.6
5.0	6.5
10.0	9.2
10.5	9.5
11.0	9.8
11.5	10.2
12.0	10.5
12.5	10.9
13.0	11.2
13.5	11.6
14.0	12.0
14.5	12.4
15.0	12.8
15.5	13.2
16.0	13.6
16.5	14.1
17.0	14.5
17.5	15.0

Temp (°C)	Pressure (mmHg)
18.0	15.5
19.0	16.0
19.5	17.0
20.0	17.5
20.5	18.0
21.0	18.6
21.5	19.2
22.0	19.8
22.5	20.4
23.0	21.1
23.5	21.7
24.0	22.4
24.5	23.0
25.0	23.8
25.5	24.5
26.0	25.2
26.5	25.9
27.0	26.7

Temp (°C)	Pressure (mmHg)
27.5	27.5
28.0	28.3
28.5	29.1
29.0	30.0
29.5	30.9
30.0	31.8
35.0	42.4
40.0	55.3
45.0	71.9
50.0	92.5
55.0	118
60.0	149
65.0	188
70.0	234
75.0	289
80.0	355
81.0	370
82.0	384

Temp (°C)	Pressure (mmHg)
83.0	401
84.0	417
85.0	434
86.0	451
87.0	469
88.0	487
89.0	506
90.0	526
91.0	546
92.0	567
93.0	587
94.0	611
95.0	634
96.0	658
97.0	682
98.0	707
99.0	733
100.0	760.0