DALTON'S LAW OF PARTIAL PRESSURES

Name _____

Dalton's Law says that the sum of the individual pressures of all the gases that make up a mixture is equal to the total pressure or : $P_T = P_1 + P_2 + P_3 + \ldots$ The partial pressure of each gas is equal to the mole fraction of each gas x total pressure.

$$P_T = P_1 + P_2 + P_3 + \ldots \quad \text{or} \quad \frac{\text{moles gas}_x}{\text{total moles}} \times P_T = P_x$$

Solve the following problems.

1. A 250. mL sample of oxygen is collected over water at 25° C and 760.0 torr pressure. What is the pressure of the dry gas alone? (Vapor pressure of water at 25° C = 23.8 torr)

_____

2. A 32.0 mL sample of hydrogen is collected over water at $2\bar{0}$° C and 750.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at $2\bar{0}$° C = 17.5 torr)

_____

3. A 54.0 mL sample of oxygen is collected over water at 23° C and 770.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 23° C = 21.1 torr)

_____

4. A mixture of 2.00 moles of H_2, 3.00 moles of NH_3, 4.00 moles of CO_2 and 5.00 moles of N_2 exerts a total pressure of $80\bar{0}$ torr. What is the partial pressure of each gas?

_____

5. The partial pressure of F_2 in a mixture of gases where the total pressure is 1.00 atm is 300. torr. What is the mole fraction of F_2?

_____

GRAHAM'S LAW OF EFFUSION

Name _____

Graham's Law says that a gas will effuse at a rate that is inversely proportional to the square root of its molecular mass, MM. Expressed mathematically:

$$\frac{\text{rate}_1}{\text{rate}_2} = \sqrt{\frac{MM_2}{MM_1}}$$

Solve the following problems.

1. Under the same conditions of temperature and pressure, how many times faster will hydrogen effuse compared to carbon dioxide?

_____

2. If the carbon dioxide in Problem 1 takes 32 sec to effuse, how long will the hydrogen take?

_____

3. What is the relative rate of diffusion of NH_3 compared to He? Does NH_3 effuse faster or slower than He?

_____

4. If the He in Problem 3 takes 20 sec to effuse, how long will NH_3 take?

_____

5. An unknown gas diffuses 0.25 times as fast as He. What is the molecular mass of the unknown gas?

_____

ANSWER KEY

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?
   310 mL
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?
   880 K or 610° C
3. Hydrogen gas was cooled from 150° C to 50° C. Its new volume is 75 mL. What was its original volume?
   98 mL
4. Chlorine gas occupies a volume of 25 mL at 300 K. What volume will it occupy at 600 K?
   50. mL
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?
   2.3 L
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?
   180 K or -93° C
7. Helium occupies a volume of 3.8 liters at 45° C. What volume will it occupy at 45° C?
   5.3 L
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?
   331 K or 58° C

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COMBINED GAS LAW

Name _____

In practical terms, it is often difficult to hold any of the variables constant. When there is a change in pressure, volume and temperature, the combined gas law is used.

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2} \quad \text{or} \quad P_1V_1T_2 = P_2V_2T_1$$

Complete the following chart.

	P_1	V_1	T_1	P_2	V_2	T_2
1	1.5 atm	3.0 L	20° C	2.5 atm	1.9 L	30° C
2	720 torr	256 mL	25° C	800 torr	250 mL	50° C
3	600 mmHg	2.5 L	22° C	760 mmHg	1.8 L	-4° C
4	1.2 atm	750 mL	0.0° C	2.0 atm	500 mL	25° C
5	95 kPa	4.0 L	22° C	101 kPa	6.0 L	471 K or 198° C
6	650. torr	275 mL	100° C	900. torr	225 mL	150° C
7	650 mmHg	1.5 mL	15° C	540 mmHg	2.5 L	30° C
8	125 kPa	125 mL	544 K 271° C	100 kPa	100 mL	75° C

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DALTON'S LAW OF PARTIAL PRESSURES

Name _____

Dalton's Law says that the sum of the individual pressures of all the gases that make up a mixture is equal to the total pressure or : $P_t = P_1 + P_2 + P_3 + \ldots$ The partial pressure of each gas is equal to the mole fraction of each gas x total pressure.

$$P_t = P_1 + P_2 + P_3 + \ldots \quad \text{or} \quad \frac{\text{moles gas}_x}{\text{total moles}} \times P_t = P_x$$

Solve the following problems.

1. A 250. mL sample of oxygen is collected over water at 25° C and 760.0 torr pressure. What is the pressure of the dry gas alone? (Vapor pressure of water at 25° C = 23.8 torr)
   736. torr
2. A 32.0 mL sample of hydrogen is collected over water at 20° C and 750.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 20° C = 17.5 torr)
   28.7 mL
3. A 54.0 mL sample of oxygen is collected over water at 23° C and 770.0 torr pressure. What is the volume of the dry gas at STP? (Vapor pressure of water at 23° C = 21.1 torr)
   49.1 mL
4. A mixture of 2.00 moles of H_2, 3.00 moles of NH_3, 4.00 moles of CO_2 and 5.00 moles of N_2 exerts a total pressure of 800 torr. What is the partial pressure of each gas?
   H_2 = 114 torr, NH_3 = 171 torr, CO_2 = 229 torr
5. The partial pressure of F_2 in a mixture of gases where the total pressure is 300. torr. What is the mole fraction of F_2?
   0.395
   N_2 = 286 torr

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IDEAL GAS LAW

Name _____

Use the Ideal Gas Law below to solve the following problems.

$PV = nRT$ where P = pressure in atmospheres
V = volume in liters
n = number of moles of gas
R = Universal Gas Constant
.082 L•atm/mol•K
T = Kelvin temperature

1. How many moles of oxygen will occupy a volume of 2.5 liters at 1.2 atm and 25° C?
   0.12 moles
2. What volume will 2.0 moles of nitrogen occupy at 720 torr and 20° C?
   51 liters
3. What pressure will be exerted by 25 g of CO_2 at a temperature of 25° C and a volume of 500 mL?
   28 atm
4. At what temperature will 5.0 g of Cl_2 exert a pressure of 900. torr at a volume of 750 mL?
   154 K or -119° C
5. What is the density of NH_3 at 800 torr and 25° C?
   0.73 g/L
6. If the density of a gas is 1.2 g/L at 745. torr and 20° C, what is its molecular mass?
   29 g/mol
7. How many moles of nitrogen gas will occupy a volume of 347 mL at 6680 torr and 27° C?
   0.124 moles
8. What volume will 454 grams (1 lb) of hydrogen occupy at 1.05 atm and 25° C?
   5290 L
9. Find the number of grams of CO_2 that exert a pressure of 785 torrs at a volume of 32.5 L and a temperature of 32° C.
   59.0 g
10. An elemental gas has a mass of 10.3 g. If the volume is 58.4 L and the pressure is 758 torrs at a temperature of 2.5° C, what is the gas?
    helium

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ANSWER KEY

RAHAM'S LAW OF EFFUSION

Name _____

ham's Law says that a gas will effuse at a rate that is inversely proportional to the uare root of its molecular mass, MM. Expressed mathematically:

$$\frac{rate_1}{rate_2} = \sqrt{\frac{MM_2}{MM_1}}$$

ve the following problems.

1. Under the same conditions of temperature and pressure, how many times faster will hydrogen effuse compared to carbon dioxide?

   4.7

2. If the carbon dioxide in Problem 1 takes 32 sec to effuse, how long will the hydrogen take?

   6.8 sec

3. What is the relative rate of diffusion of NH_3 compared to He? Does NH_3 effuse faster or slower than He?

   2.09 0.49, slower

4. If the He in Problem 3 takes 20 sec to effuse, how long will NH_3 take?

   41 sec

5. An unknown gas diffuses 0.25 times as fast as He. What is the molecular mass of the unknown gas?

   64 g/mole

ELEMENT SYMBOLS

Name _____

An element symbol can stand for one atom of the element or one mole of atoms of the element. (One mole = 6.02×10^{23} atoms of an element.)

Write the symbol for the following elements.

1. oxygen	O	11. plutonium	Pu
2. hydrogen	H	12. americium	Am
3. chlorine	Cl	13. radium	Ra
4. mercury	Hg	14. germanium	Ge
5. fluorine	F	15. zinc	Zn
6. barium	Ba	16. arsenic	As
7. helium	He	17. lead	Pb
8. uranium	U	18. iron	Fe
9. radon	Rn	19. calcium	Ca
10. sulfur	S	20. cobalt	Co

Write the name of the element that corresponds to each of the following symbols.

21. Kr	krypton	31. Cu	copper
22. K	potassium	32. Ag	silver
23. C	carbon	33. P	phosphorus
24. Ne	neon	34. Mn	manganese
25. Si	silicon	35. I	iodine
26. Zr	zirconium	36. Au	gold
27. Sn	tin	37. Mg	magnesium
28. Pt	platinum	38. Ni	nickel
29. Na	sodium	39. Br	bromine
30. Al	aluminum	40. Hg	mercury

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TOMIC STRUCTURE

Name _____

atom is made up of protons and neutrons (both found in the nucleus) and electrons the surrounding electron cloud). The atomic number is equal to the number of protons. e mass number is equal to the number of protons plus neutrons. In a neutral atom, the mber of protons equals the number of electrons. The charge on an ion indicates an balance between protons and electrons. Too many electrons produces a negative rge, too few, a positive charge.

s structure can be written as part of a chemical symbol.

Example: $^{15}_{7}N^{+3}$ (mass number: 15; atomic number: 7; charge: +3)

7 protons
8 neutrons (15 − 7)
4 electrons

mplete the following chart.

Element/ Ion	Atomic Number	Atomic Mass	Mass Number	Protons	Neutrons	Electrons
H	1	1.0079	1	1	0	1
H^+	1	1.0079	1	1	0	0
$^{12}_{6}C$	6	12.011	12	6	6	6
$^{7}_{3}Li^+$	3	6.941	7	3	4	2
$^{35}_{17}Cl^-$	17	35.453	35	17	18	18
$^{39}_{19}K$	19	39.0983	39	19	20	19
$^{24}_{12}Mg^{2+}$	12	24.305	24	12	12	10
As^{3+}	33	74.9216	75	33	42	36
Ag	47	107.868	108	47	61	47
Ag^{+1}	47	107.868	108	47	61	46
S^{-2}	16	32.06	32	16	16	18
U	92	238.029	238	92	146	92

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ISOTOPES AND AVERAGE ATOMIC MASS

Name _____

Elements come in a variety of isotopes, meaning they are made up of atoms with the same atomic number but different atomic masses. These atoms differ in the number of neutrons.

The average atomic mass is the weighted average of all the isotopes of an element.

Example: A sample of cesium is 75% ^{133}Cs, 20% ^{132}Cs and 5% ^{134}Cs. What is its average atomic mass?

Answer: .75 × 133 = 99.75
.20 × 132 = 26.4
.05 × 134 = 6.7
Total = 132.85 amu = average atomic mass

Determine the average atomic mass of the following mixtures of isotopes.

1. 80% ^{127}I, 17% ^{126}I, 3% ^{128}I — 126.86 amu
2. 50% ^{197}Au, 50% ^{198}Au — 197.5 amu
3. 15% ^{55}Fe, 85% ^{56}Fe — 55.85 amu
4. 99% ^{1}H, 0.8% ^{2}H, 0.2% ^{3}H — 1.012 amu
5. 95% ^{14}N, 3% ^{15}N, 2% ^{16}N — 14.07 amu
6. 98% ^{12}C, 2% ^{13}C — 12.04 amu

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