Skill level test.

Name _____

All solutions given to the correct number of significant figures

1. A sample of oxygen gas (O_2) is placed in 10.0 L vessel at a pressure of 100 kPa and temperature of 23.0 °C. Calculate the mass , in grams, of oxygen in the sample.

2. If 0.16 grams of a pure gas occupies 0.124 L at SLC. Identify the gas?

3. A 2.0 mole sample of nitrogen gas (N_2) is contained in a 50.0 L vessel at 298 K. Calculate the pressure, in atm, exerted by the gas. (Use R = 0.0821 L·atm/mol·K)

4. A gas sample has a mass of 44.00 g and contains 1 mole of gas. Calculate the molar mass of the gas.

5. 2.35 grams of propane burns, at SLC, according to the equation below.

   $$C_3H_8(g) + 5O_2 \rightarrow 3CO_2(g) + 4H_2O(l)$$

   What volume of oxygen gas is needed at SLC to completely combust the propane gas?

6. A sample of ethane (C_2H_6) gas occupies 0.496 L at SLC. Calculate the:

    i. number of moles of gas present.

    ii. mass, in grams, of the gas sample.

7. A 500.0 mL container contains a mixture composed of 1.00 mole of oxygen and 1.00 mole of nitrogen gas at 298 K. Calculate the total pressure, in kPa, inside the vessel.

8. If the total pressure of a gas mixture (1.0 mole O_2 and 1.0 mole N_2) is 1.00 atm at 298 K, calculate the:

    i. volume, in litres, occupied by the gas mixture.

    ii. partial pressure, in kPa, of the nitrogen gas.

9. A 10 g sample of carbon dioxide gas (CO_2) is in a 10 L container at 298 K. Calculate the pressure, in atm, of the gas.

10. Concentration conversions

i. Convert 100 ppm to %(m/m).

ii. Convert 20.0% (m/v) NaOH solution to molarity (M).

iii. Convert 0.23% (m/v) lead (Pb^{2+}) solution to ppm.

iv. A bottle of wine is labelled as having an ethanol concentration of 13.0% (v/v). Given the density of ethanol is 0.789 g/mL, calculate the concentration of ethanol in the wine in:

- %(m/v)

- mol/L

Solutions

1. Mass of O_2

Given: P = 100 kPa, V = 10.0 L, T = 23.0 °C = 296 K, R = 8.31 J/mol·K

Calculate moles (n)

$$n = \frac{PV}{RT} = \frac{100\text{ kPa} \times 10.0\text{ L}}{8.31 \times 296} = \frac{1000}{2457.76} = 0.407\text{ mol}$$

Mass = n × molar mass

$$0.4068 \times 32.0 = 13.0\,g\ (3\ sig\ figs)$$

2. Identify gas from mass and volume

Given: mass = 0.16 g, volume = 0.124 L at SLC (molar volume = 24.8 L/mol)

Calculate moles:

$$n = \frac{0.124}{24.8} = 0.00500\text{ mol}$$

Calculate molar mass:

$$\frac{0.16}{0.00500} = 32.0\text{ g/mol}$$

Gas is oxygen (O_2).

3. Pressure of N_2

Given: n = 2.0 mol, V = 50.0 L, T = 298 K, R = 8.31

Calculate pressure in kPa:

$$P = \frac{nRT}{V} = \frac{2.0 \times 8.31 \times 298}{50.0} = \frac{4951.56}{50} = 99.0\text{ kPa}$$

Convert kPa to atm

$$P = 99.0 \times \frac{0.987}{100} = 0.977\text{ atm}$$

4. Molar mass

Given: mass = 44.00 g, moles = 1.00 mol

$$\text{Molar mass} = \frac{44.0}{1.00} = 44.0 \text{ g/mol}$$

5. Volume of O_2 to combust propane

Given: mass C_3H_8 = 2.35 g, molar mass = 44.0 g/mol

Calculate moles propane

$$\frac{2.35}{44.0} = 0.0534 \text{ mol}$$

Moles O_2 needed = 5 × 0.0534 = 0.267 mol

Volume O_2 at SLC:

$$0.267 \times 24.8 = 6.62 \text{ L}$$

6. Ethane gas

i. Number of moles:

$$n = \frac{0.496}{24.8} = 0.0200 \text{ mol}$$

ii. Mass:

$$0.0200 \times 30.0 = 0.600 \text{ g}$$

7. Total pressure of gas mixture

Given: n = 2 mol, V = 0.500 L, T = 298 K, R = 8.31

Calculate pressure in kPa

$$P = \frac{2.00 \times 8.31 \times 298}{0.500} = \frac{4951.56}{0.5} = 9.90\ X\ 10^3\ kPa$$

Convert kPa to atm

$$9903 \times \frac{0.987}{100} = 97.7 \text{ atm}$$

8. Gas mixture volume and partial pressure

i. Volume at 1 atm using R = 0.0821:

$$V = \frac{nRT}{P} = \frac{2.0 \times 8.31 \times 298}{101.3} = 49 \text{ L}$$

ii. Partial pressure of N_2:

$$P_{N_2} = \frac{1}{2} \times 1.00 = 0.5 \; atm$$

Convert atm to kPa

$$0.5 \times \frac{100}{0.987} = 50.7 \text{ kPa}$$

9. Pressure of CO_2

Given: mass = 10 g, molar mass = 44, T = 298 K, V = 10 L, R = 8.31

Calculate moles:

$$\frac{10}{44} = 0.23 \; mol$$

Calculate pressure in kPa:

$$P = \frac{0.23 \times 8.31 \times 298}{10} = 57 \; kPa$$

Convert to atm:

$$57 \times \frac{0.987}{100} = 0.56 \text{ atm}$$

10. Concentration conversions

i. 100 ppm to % (m/m):

$$100 \text{ ppm} = 100 \text{ mg/kg} = 0.01\%(m/m)$$

ii. 20.0% (m/v) NaOH to molarity:

20.0 g NaOH / 100 mL = 200 g/L

Molar mass NaOH = 40 g/mol

$$\text{Molarity} = \frac{200}{40} = 5.00 \text{ M}$$

iii. 0.23% (m/v) Pb^{2+} to ppm:

$$0.23 \text{ g/100 mL} = 2.3 \text{ g/L} = 2.3 \; X \; 10^3 \text{ ppm}$$

iv. Ethanol in wine:

- %(m/v):

$$13.0\ \text{mL} \times 0.789\ \text{g/mL} = 10.26\ \text{g/100 mL} = 10.3\%(m/v)$$

- mol/L:

$$10.26 \times 10 = 102.6\ \text{g/L}$$

Molar mass ethanol = 46 g/mol

$$\frac{102.6}{46} = 2.23\ \text{M}$$