Ideal Gas Law Problems

P V = n R T

1. Calculate the volume occupied by 0.50 mol of methane gas at 33.0 kPa and -35.0°C.

$n = 0.50\ mol$

$P = 33.0\ kPa$

$T = -35°C + 273.15$

$= 238.15\ K$

$V = ?$

$PV = nRT$

$V = \frac{nRT}{P}$

$= \frac{(0.5\ mol)(8.314\ \frac{kPa \cdot L}{mol \cdot K})(238.15\ K)}{33.0\ kPa}$

$= 30\ L$

2. How many moles of gas are there in a sample that occupies 570 mL at 78°C and 103 kPa? (0.020 mol)

Stoichiometry of Gases

Steps:

1. Write the balanced chemical equation
2. Convert amounts to moles (do LR if needed)
3. Use mole ratio to find moles of unknown
4. Convert moles to required units

Ex. What mass of oxygen gas reacts with hydrogen gas to produce 0.45 L of water vapour at 100.0 °C and 101.3 kPa?

$O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$

$m = ?$

$M = 31.998\ \frac{g}{mol}$

$V = 0.45\ L$

$T = 100°C + 273.15\ K$

$= 373.15\ K$

$P = 101.3\ kPa$

$n = \frac{PV}{RT}$

$= \frac{(101.3\ kPa)(0.45\ L)}{(8.314)(373.15)}$

$= 0.01469\ mol$

$m_{O_2} = 0.01469\ mol\ H_2O \times \frac{1\ mol\ O_2}{2\ mol\ H_2O} \times \frac{31.998\ g\ O_2}{1\ mol\ O_2}$

$= 0.24\ g$

SCH 3UI Gases Practice Quiz

1. 200 mL of a gas at 600 K is cooled to 300 K. Calculate the final volume, assuming pressure is constant.

$V_1 = 200\text{ mL}$
$T_1 = 600\text{ K}$
$T_2 = 300\text{ K}$
$V_2 = ?$

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$V_2 = \frac{V_1 T_2}{T_1} = \frac{(200\text{ mL})(300\text{ K})}{600\text{ K}} = 100\text{ mL}$

∴ V_2 is 100 mL

2. A sample of Ne has a volume of 6L at SATP. Calculate the volume of the gas if the pressure is increased to 325 kPa. Assume the temperature does not change.

$V_1 = 6\text{ L}$
$P_1 = 100\text{ kPa}$
$V_2 = ?$
$P_2 = 325\text{ kPa}$

$P_1 V_1 = P_2 V_2$

$V_2 = \frac{P_1 V_1}{P_2} = \frac{(100\text{ kPa})(6\text{ L})}{325\text{ kPa}} = 2\text{ L}$

∴ the volume is 2 L

3. A scuba tank with a 10 L capacity has a pressure of 1000 kPa at 10°C. What volume of air at 20°C and 110 kPa can be released from this tank?

$V_1 = 10\text{ L}$
$P_1 = 1000\text{ kPa}$
$T_1 = 10°C + 273.15 = 283.15\text{ K}$

$T_2 = 293.15\text{ K}$
$P_2 = 110\text{ kPa}$
$V_2 = ?$

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$V_2 = \frac{T_2 P_1 V_1}{T_1 P_2} = \frac{(293.15\text{ K})(1000\text{ kPa})(10\text{ L})}{(283.15\text{ K})(110\text{ kPa})} = 90\text{ L}$

∴ 90 L of air can be released from the tank.