Worksheet 5.2 Gas calculations	

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Gas calculations

NAME: **CLASS:**

INTRODUCTION

This worksheet provides practice in stoichiometry problems involving gases at standard conditions (SLC and STP) and non-standard conditions. The relevant formulas for calculations are:

$n = \frac{PV}{RT}$ and $n = \frac{V}{V_M}$ where $V_M = 24.5$ L mol^{-1} at SLC ($T = 25°$C, $P = 101.3$ kPa) and

$V_M = 22.41$ L mol^{-1} at STP ($T = 0°$C, $P = 101.3$ kPa)

The second half of the worksheet looks at problems relating to gas densities, where the following ideas are used. A very useful extension of $PV = nRT$ is $PV = \frac{m}{M}RT$.

Since density (d) = $\frac{m}{V}$, this equation can be rearranged to give $d = \frac{PM}{RT}$.

For two gases at the same conditions of temperature and pressure, we can see that $\frac{d_1}{d_2} = \frac{M_1}{M_2}$,

that is, the ratio of densities of the two gases is equal to the ratio of their molar masses (at the same temperature and pressure).

No.	Question	Answer
1	Ammonium sulfate, an important fertiliser, can be prepared by the reaction of ammonia with sulfuric acid according to the equation: $2NH_3(g) + H_2SO_4(l) \rightarrow (NH_4)_2SO_4(aq)$ Calculate the volume of NH_3 needed at 87°C and 310 kPa to react with 19.56 g of 98% m/m H_2SO_4.	
2	If 150 mL of carbon monoxide reacts with 150 mL of oxygen (at SLC) according to the following equation, what is the composition of the gas mixture after reaction? $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$	

3	When an electric current is passed through molten sodium chloride, sodium metal and chlorine gas are produced. The equation for the reaction is: $2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$ Calculate the volume of chlorine gas at SLC that would be produced from 5.00×10^2 mol of molten sodium chloride.	
4	When magnesium carbonate is heated strongly, it decomposes to magnesium oxide and carbon dioxide gas. The equation for this reaction is: $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$ What volume of carbon dioxide would be produced at STP if 100 g of magnesium oxide was generated in this reaction?	
5	HCN is a highly poisonous gas. The lethal dose for humans is 300 mg per kg of air. HCN can be produced by the following reaction: $2NaCN(g) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2HCN(g)$ **a** If the air density at 26°C and 101.3 kPa is 0.00118 g mL^{-1}, what mass of HCN would be present per mL at the lethal dose? **b** If 8.80 g of NaCN is added to 100 mL of 0.475 mol L^{-1} H_2SO_4, what volume of HCN gas is produced at 100 kPa and 20°C?	
6	A sample of nitrogen (N_2) is in a fixed volume container at 750 mmHg pressure and 20°C. Calculate its density.	

7	Calculate the molar mass of a gas if a mass of 2.04 g occupies 1.56 L at a temperature of 25°C and a pressure of 102 kPa.	
8	A sample of carbon monoxide (CO) occupies 56 L at 400 kPa and 16°C. What is its density?	
9	A gaseous alkane, C_xH_y, has a density of 1.22 g L^{-1} at SLC. Determine the molecular formula of C_xH_y.	
10	A compound with a molecular formula of N_xH_y is 87.4% nitrogen by mass. A gaseous sample of N_xH_y has a density of 0.977 g L^{-1} at 100°C and 0.93 atm. Determine the molecular formula of N_xH_y.	