Worksheet 1.1: The Mole Concept & Mass Calculations ChemistrySheets

Specification: GCSE Chemistry (AQA 5.3.1.2 / Edexcel SC14 / OCR Gateway C4.1)

Core Formula:
Moles (mol) $= \frac{\text{Mass (g)}}{M_r}$
Rearranged Forms:
Mass (g) = Moles (mol) $\times M_r$
$M_r = \frac{\text{Mass (g)}}{\text{Moles (mol)}}$
Units:
Moles: mol (mole)
Mass: g (gram)
M_r **(Relative formula mass):** No units
Relative Atomic Masses (A_r) for calculations:
H=1, C=12, N=14, O=16, Na=23, Mg=24, S=32, Cl=35.5, K=39, Ca=40, Fe=56, Cu=63.5, Zn=65, Br=80, Ag=108, I=127, Ba=137.

Section A: Understanding the Formula & Conversions

1. Complete the table below for the variables in the mole formula.

Variable	Unit Name	Unit Symbol
Moles	**mole**	**mol**
Mass	**gram**	**g**
Relative formula mass (M_r)	**no unit**	**no symbol**

2. Rearrange the core formula to make Mass and M_r the subject.
   a) Mass (g) = **Moles (mol) $\times M_r$**
   b) $M_r = \frac{\textbf{Mass (g)}}{\textbf{Moles (mol)}}$

3. Perform the following conversions or calculations.
   a) Convert 250 mg to grams (g): **0.25 g**
   b) Convert 0.075 kg to grams (g): **75 g**
   c) Calculate the M_r of H_2O: **18**
   d) Calculate the M_r of $Mg(OH)_2$: **58**
   e) Calculate the M_r of $Ca(NO_3)_2$: **164**

Section B: Practice Calculations

1. Calculate the number of moles in 10 g of calcium carbonate ($CaCO_3$).

Model Answer:
A_r: Ca=40, C=12, O=16
M_r of $CaCO_3 = 40 + 12 + (3 \times 16) = 40 + 12 + 48 = 100$
Moles $= \frac{\text{Mass}}{M_r} = \frac{10\text{ g}}{100} = 0.1$ mol

2. How many moles are present in 24.5 g of sulfuric acid (H_2SO_4)?

Model Answer:
A_r: H=1, S=32, O=16
M_r of $H_2SO_4 = (2 \times 1) + 32 + (4 \times 16) = 2 + 32 + 64 = 98$
Moles $= \frac{\text{Mass}}{M_r} = \frac{24.5\text{ g}}{98} = 0.25$ mol

3. What is the mass of 0.05 mol of sodium hydroxide (NaOH)?

Model Answer:
A_r: Na=23, O=16, H=1
M_r of NaOH = 23 + 16 + 1 = 40
Mass = Moles $\times M_r$ = 0.05 mol × 40 = 2 g

4. A sample of an unknown compound has a mass of 15.6 g and contains 0.12 mol. Calculate its relative formula mass (M_r).

Model Answer:
$M_r = \frac{\text{Mass}}{\text{Moles}} = \frac{15.6\text{ g}}{0.12\text{ mol}} = 130$

Section C: Challenge Context

1. Copper reacts with oxygen to form copper oxide.

$$\underset{\text{copper}}{2\text{Cu(s)}} + \underset{\text{oxygen}}{\text{O}_2\text{(g)}} \longrightarrow \underset{\text{copper oxide}}{2\text{CuO(s)}}$$

Figure 1: Simplified representation of copper reacting with oxygen.

If 12.7 g of copper (Cu) reacts completely, calculate the number of moles of copper involved in the reaction.

Model Answer:
A_r of Cu = 63.5
Moles of Cu = $\frac{\text{Mass of Cu}}{A_r \text{ of Cu}} = \frac{12.7\text{ g}}{63.5} = 0.2$ mol

2. A student performs a titration to neutralise 25.0 cm^3 of 0.10 mol/dm^3 sodium hydroxide (NaOH) solution with hydrochloric acid (HCl).

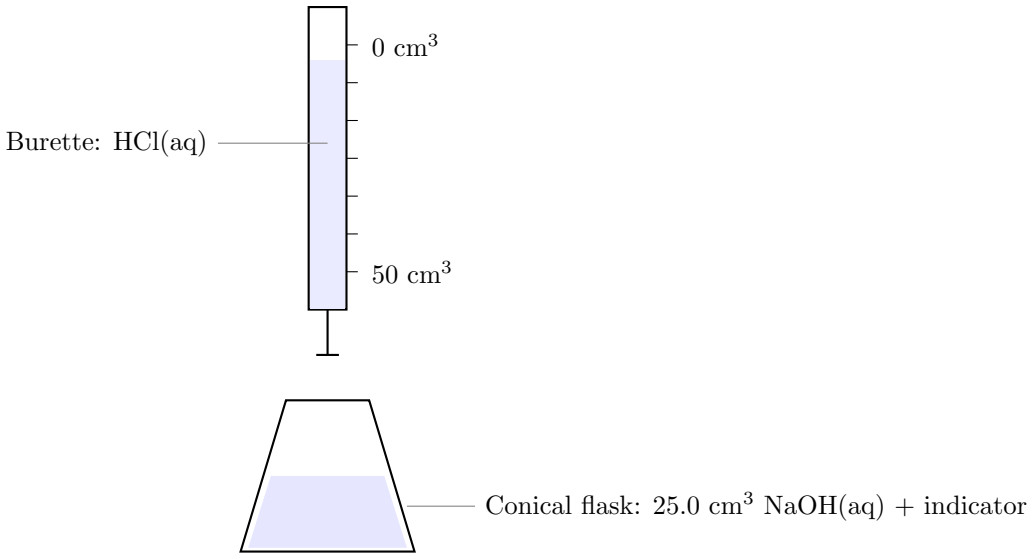

Figure 2: Simplified titration setup.

Calculate the mass of sodium hydroxide (NaOH) present in the 25.0 cm^3 sample.

Model Answer:
A_r: Na=23, O=16, H=1
M_r of NaOH = 23 + 16 + 1 = 40
Volume of NaOH = 25.0 cm^3 = $\frac{25.0}{1000}$ dm^3 = 0.025 dm^3
Moles of NaOH = Concentration × Volume = 0.10 mol/dm^3 × 0.025 dm^3 = 0.0025 mol
Mass of NaOH = Moles $\times M_r$ = 0.0025 mol × 40 = 0.1 g