**1** Give the formula of the following ionic substances.

a) potassium oxide   **K_2O**   d) magnesium hydroxide **$Mg(OH)_2$**

b) aluminium bromide **$AlBr_3$**   e) ammonium iodide   **NH_4I**

c) iron(III) sulfide   **Fe_2S_3**   f) calcium nitrate   **$Ca(NO_3)_2$**

2 Calculate the relative formula mass of the following substances.

a) chlorine, Cl_2 **2(35.5) = 71**

b) ammonium sulfate, $(NH_4)_2SO_4$ **2(14) + 8(1) + 32 + 4(16) = 132**

3 a) What mass of sodium reacts with 95 g of titanium chloride?

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$
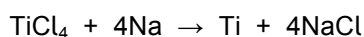
mol $TiCl_4$ = $\frac{95}{190}$ = 0.50 mol

mol Na = 4 x 0.50 = 2.0 mol

mass Na = 23 x 2.0 = 46 g

b) Calculate the percentage atom economy to make titanium in this reaction.

% atom economy = 100 x $\frac{48}{190+4(23)}$ = 17.0%

4 Ammonia is made by reaction of nitrogen with hydrogen.

$$N_2 + 3H_2 \rightarrow 2NH_3$$
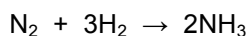
a) Calculate the maximum mass of ammonia that could be formed from reaction of 12 g of hydrogen reacting with nitrogen.

mol H_2 = $\frac{12}{2}$ = 6.0 mol

mol NH_3 = 4.0 mol

mass NH_3 = 17 x 4.0 = 68 g

b) In this reaction, only 15 g of ammonia was formed. Calculate the percentage yield.

% yield = 100 x $\frac{15}{68}$ = 22.1%

c) Suggest two reasons why the yield was less than 100%.

• reaction is reversible / incomplete

• some products lost

• other reactions may take place

5   In an experiment, 4.0 g of calcium was reacted with 4.0 g of chlorine. One of the chemicals was in excess. Determine which is the limiting reagent and then calculate the mass of calcium chloride formed.

$$Ca \ + \ Cl_2 \ \rightarrow \ CaCl_2$$
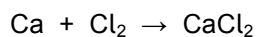
mol Ca $= \frac{4.0}{40} =$ 0.10 mol

mol Cl$_2$ $= \frac{4.0}{71} =$ 0.056 mol

∴ Ca is in excess and Cl$_2$ is the limiting reagent

∴ mol CaCl$_2$ = 0.056 mol

∴ mass CaCl$_2$ = 111 x 0.056 = 6.25 g

6   25.0 cm^3 of a solution of calcium hydroxide was titrated against a solution of 0.100 mol/dm^3 hydrochloric acid. 26.3 cm^3 of the hydrochloric acid was needed to neutralise the calcium hydroxide.

   a) Describe how the titration is done.

   • **calcium hydroxide measured with pipette**

   • **into conical flask**

   • **indicator added**

   • **acid added from burette**

   • **until colour changes**

   • **drop by drop at the end**

   • **record the result**

   • **repeat**

   b) Calculate the concentration of the calcium hydroxide in mol/dm^3. The equation for the reaction is shown.

$$2HCl + \ Ca(OH)_2 \ \rightarrow \ CaCl_2 + 2H_2O$$
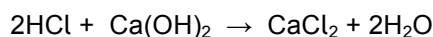
mol HCl = 0.100 x $\frac{26.3}{1000}$ = 0.00263 mol

mol Ca(OH)$_2$ = ½ x 0.00263 = 0.001315 mol

conc Ca(OH)$_2$ = $\frac{0.001315}{\frac{25.0}{1000}}$ = 0.0526 mol/dm^3

   c) Calculate the concentration of the calcium hydroxide in g/dm^3.

conc Ca(OH)$_2$ = 0.0526 x 74 = 3.89 g/dm^3

Area	Strength	To develop	Area	Strength	To develop	Area	Strength	To develop
Done with care and thoroughness			Can work out mass from moles			Work out moles for solutions		
Shows suitable working			Can work out % atom economy			Convert mol/dm³ to g/dm³		
Can write ionic formulae			Can work out % yield			Does not round too much		
Can work out M_r			Understands why yield < 100%			Can use sig figs		
Work out moles from mass			Understands limiting reagents			Gives units		
Use equation to find reacting moles			Can describe how to do a titration					