AS 91161 Carry out a quantitative analysis

For some of the following calculations you will need the following molar masses of elements.

***M*(C) = 12.0, *M*(H) = 1.00, *M*(O) = 16.0, *M*(N) = 14.0, *M*(Fe) = 55.9; g mol^{-1}**

Answers (to 3 s.f. where appropriate)

Titration

Selecting 3 (or more concordant results) within a 0.2 mL range

A student carried out a titration and recorded the following titres (all in mL).

15.10, 14.85, 15.20, 15.10, 14.80. Which should they select "to be eligible" for Excellence? What is their average titre in mL?

15.10, 15.20, 15.10 mL

Average titre 15.1$\dot{3}$ mL

(1:1 ratio)

14.55 mL of 0.145 mol L^{-1} sodium hydroxide, NaOH are required to neutralise 20.00 mL of nitric acid solution, HNO_3. What is the concentration of the HNO_3 solution?

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$

0.105 mol L^{-1}

(2:1 or 1:2 ratio)

16.60 mL of 0.300 mol L^{-1} sulfuric acid, H_2SO_4 are required to neutralise 25.00 mL of sodium hydroxide solution, NaOH solution. What is the concentration of the NaOH solution?

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

0.398 mol L^{-1}

% composition

Calculate the percentage of carbon, hydrogen and oxygen in sucrose, $C_{12}H_{22}O_{11}$.

M($C_{12}H_{22}O_{11}$) = 342 g mol^{-1}.
% C = 42.1,
% H = 6.43,
% O = 51.5

Empirical and molecular formulae

Caffeine is a stimulant which has a mass composition of 49.5% carbon, 5.20% hydrogen, 28.9% nitrogen and 16.5% oxygen. Calculate the empirical formula of caffeine. If the molar mass of caffeine is 194 g mol^{-1}, use your answer for the empirical formula to determine the molecular formula of caffeine.

Empirical: $C_4H_5N_2O$
As 194/97.0 = 2
Molecular: $C_8H_{10}N_4O_2$

Quantities from equations

1. What mass of CO_2 is produced in the complete combustion of 36.5 g of ethanol according to the following equation? $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

69.8 g

2. What mass of iron can be produced if 50.0 g of carbon monoxide, CO, react with iron(III) oxide, Fe_2O_3, according to the following equation?
   $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

66.5 g