OVERALL CHEMISTRY CALCULATIONS WS 1

1 What is the total number of atoms in 1.80 g of water (H_2O)?

A 6.02×10^{22} **B** 6.02×10^{23} **C** 1.80×10^{23} **D** 1.80×10^{24}

2 88 kg of CO_2 contains

A 2.0 mol **B** 2000 mol **C** 0.50 mol **D** 3872 mol

3 What is the sum of the coefficients when the following equation is balanced with the smallest possible whole numbers?

$2CuFeS_2 + 4O_2 \rightarrow 1Cu_2S + 3SO_2 + 2FeO$

A 7 **B** 8 **C** 11 **D** 12

4 Iron(III) oxide reacts with carbon monoxide according to the equation:

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

How many moles of iron are produced when 180 mol of carbon monoxide react with excess iron(III) oxide?

A 120 mol **B** 180 mol **C** 270 mol **D** 360 mol

5 Propene undergoes complete combustion to produce carbon dioxide and water

$$2C_3H_6(g) + 9O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$$

What volume of CO_2 is produced when 360 cm^3 of propene reacts with 360 cm^3 of oxygen at 273 K and 1 atm pressure?

A 120 cm^3 **B** 240 cm^3 **C** 540 cm^3 **D** 1080 cm^3

6 What mass of $Na_2S_2O_3.5H_2O$ must be used to make up 200 cm^3 of a 0.100 mol dm^{-3} solution?

A 3.16 g **B** 4.96 g **C** 24.8 g **D** 31.6 g

7 20.00 cm^3 of potassium hydroxide (KOH) is exactly neutralised by 26.80 cm^3 of 0.100 mol dm^{-3} sulfuric acid (H_2SO_4). The concentration of the potassium hydroxide is:

A 0.0670 mol dm^{-3} **C** 0.268 mol dm^{-3}
B 0.134 mol dm^{-3} **D** 1.34 mol dm^{-3}

8 Barium chloride solution reacts with sodium sulfate solution according to the equation

$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$

When excess barium chloride solution is reacted with 25.00 cm^3 of sodium sulfate solution, 0.2334 g of $BaSO_4$ (molar mass 233.4 g mol^{-1}) is precipitated.

The concentration of sodium ions in the sodium sulfate solution was:

A 0.08000 mol dm^{-3} **C** 0.001000 mol dm^{-3}
B 0.04000 mol dm^{-3} **D** 0.002000 mol dm^{-3}

9 When potassium chlorate(V) (molar mass 122.6 g mol^{-1}) is heated, oxygen gas (molar mass 32.0 g mol^{-1}) is produced:

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

When 1.226 g of potassium chlorate(V) is heated, 0.320 g of oxygen gas is obtained. The percentage yield of oxygen is:

A 100% **B** 66.7% **C** 26.1% **D** 17.4%

10 Elemental analysis of a nitrogen oxide shows that it contains 2.8 g of nitrogen and 8.0 g of oxygen. The empirical formula of this oxide is:

A NO **B** NO_2 **C** N_2O_3 **D** N_2O_5

11 Nitrogen can be prepared in the laboratory by the following reaction:

$2NH_3(g) + 3CuO(s) \rightarrow N_2(g) + 3H_2O(l) + 3Cu(s)$

If 224 cm^3 of ammonia, when reacted with excess copper oxide, produces 84 cm^3 of nitrogen, calculate the percentage yield of nitrogen. All gas volumes are measured at STP. 75% **[3]**

12 Manganese may be extracted from its ore, hausmannite, by heating with aluminium.

$3Mn_3O_4 + 8Al \rightarrow 4Al_2O_3 + 9Mn$

a 100.0 kg of Mn_3O_4 is heated with 100.0 kg of aluminium. Work out the maximum mass of manganese that can be obtained from this reaction. 72Kg **[4]**

b 1.23 tonnes of ore are processed and 200.0 kg of manganese obtained. Calculate the percentage by mass of Mn_3O_4 in the ore. 22.5% **[3]**

13 A hydrocarbon contains 88.8% C. 0.201 g of the hydrocarbon occupied a volume of 98.3 cm^3 at 320 K and 1.00×10^5 Pa.

a Determine the empirical formula of the hydrocarbon. C_2H_3 **[3]**

b Determine the molecular formula of the hydrocarbon. C_4H_6 **[3]**

14 Limestone is impure calcium carbonate. A 1.20 g sample of limestone is added to excess dilute hydrochloric acid and the gas collected; 258 cm^3 of carbon dioxide was collected at a temperature of 27 °C and a pressure of 1.10×10^5 Pa.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

a Calculate the number of moles of gas collected. 0.0114 mol **[3]**

b Calculate the percentage purity of the limestone (assume that none of the impurities in the limestone react with hydrochloric acid to produce gaseous products) 95% **[3]**

15 25.0 cm^3 of 0.100 mol dm^{-3} copper(II) nitrate solution is added to 15.0 cm^3 of 0.500 mol dm^{-3} potassium iodide. The ionic equation for the reaction that occurs is:

$$2Cu^{2+}(aq) + 4I^-(aq) \rightarrow 2CuI(s) + I_2(aq)$$

a Determine which reactant is present in excess. KI **[3]**

b Determine the mass of iodine produced. 0.317g **[3]**

16 0.0810 g of a group 2 metal iodide, MI_2, was dissolved in water and made up to a total volume of 25.00 cm^3. Excess lead(II) nitrate solution ($Pb(NO_3)_2(aq)$) was added to the MI_2 solution to form a precipitate of lead(II) iodide (PbI_2). The precipitate was dried and weighed and it was found that 0.1270 g of precipitate was obtained.

a Determine the number of moles of lead iodide formed. 2.755×10^{-4} mol **[2]**

b Write an equation for the reaction that occurs. $Pb(NO_3)_2 + MI_2 \longrightarrow PbI_2 + M(NO_3)_2$ **[1]**

c Determine the number of moles of MI_2 that reacted. 2.755×10^{-4} mol. **[1]**

d Determine the identity of the metal, M. Calcium. **[3]**

17 0.4000 g of hydrated copper sulfate ($CuSO_4.xH_2O$) is dissolved in water and made up to a total volume of 100.0 cm^3 with distilled water. 10.00 cm^3 of this solution is reacted with excess barium chloride ($BaCl_2$) solution. The mass of barium sulfate formed was 3.739×10^{-2} g.

$CuSO_4 + BaCl_2 \rightarrow BaSO_4 + CuCl_2$

a Calculate the number of moles of barium sulfate formed. 1.602×10^{-4} mol **[2]**

b Write an equation for the reaction between copper sulfate solution and barium chloride solution. **[1]**

c Calculate the number of moles of copper sulfate that reacted with the barium chloride. 1.602×10^{-4} mol **[1]**

d Calculate the number of moles of $CuSO_4$ in 0.4000 g of hydrated copper sulfate. 1.602×10^{-3} mol. **[1]**

e Determine the value of x. 5. **[3]**

11/ $2NH_3 + 3CuO \rightarrow N_2 + 3H_2O + 3Cu$

$2 : 1$

$224cm^3 : x$

$x = 112cm^3$

$224cm^3$ of NH_3 should give me $112cm^3$ of N_2 but we got about $84cm^3$

$$Yield = \frac{84}{112} \times 100\%$$

$$= 75\%$$

12/

(a) Mr:

$Mn_3O_4 = 3(54.9) + 4(16) = 228.7$

$Al = 27$

$Mn = 54.9$

$Mn_3O_4 : Al$

$\frac{100\,000}{228.7} : \frac{100\,000}{27}$

437.2 mol : 3703 mol Provided amount of moles.

$1 : 8$

L.F.

$$n\ Mn = \frac{437.2}{3} \times 9 = 1311.59\ mol$$

$$mass = 1311.59 \times 54.9 = 72\ Kg$$

(b)

$$n\ of\ Mn = \frac{200000}{54.9} = 3,642.98\ mol$$

$$n\ Mn_3O_4 = \frac{3,642.98}{9} \times 3 = 1,214.3\ mol.$$

$$Mass = 1214.3 \times 228.4$$
$$= 277.3\ Kg$$

$$\%\ Mass = \frac{277.3}{1230} \times 100 = 22.5\%$$

13/

(a)

C	:	H
$\frac{88.8}{12}$	:	$\frac{11.2}{1}$
7.4	:	11.2
1	:	1.5
2	:	3

$\longrightarrow C_2H$

(b) 98.3 cm^3 @ 320 K

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

$$V_1 = \frac{98.3 \times 320}{298} = 105.56\,cm^3$$

$$n = \frac{105.56\,cm^3}{24000\,cm^3mol^{-1}}$$

$$= 4.398 \times 10^{-3}\,mol$$

$$Mr = \frac{0.201}{4.398 \times 10^{-3}} = 45.7$$

$$Mr \text{ of } C_2H_3 = 2(12) + 3 = 27$$

Mr through calc	:	Mr C_2H_3
45.7	:	27
1.7	:	1
2	$\approx$	1

Molecular Formula = $(C_2H_3)_2$

$= C_4H_6$.

14/

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

$\frac{(258)(110000)}{300} = \frac{V_2(101000)}{298}$

$V_2 = 279.12\ cm^3$

$n = \frac{279.12\ cm^3}{24000\ cm^3 mol^{-1}} = 11.629 \times 10^{-3}\ mol$

(b) $n\ CaCO_3 = n\ CO_2$

$= 11.6 \times 10^{-3}\ mol.$

Mass $= n \times Mr$

$= (11.6 \times 10^{-3})(60 + 40.1)$

$= 1.16g$

Purity $= \frac{1.16}{1.20} \times 100\% = 96.7\ \%$

15/

a. $Cu(NO_3)_2 = \frac{25}{1000} \times 0.1 = 0.0025\ mol = 2.5 \times 10^{-3}\ mol.$

$KI = \frac{15}{1000} \times 0.5 = 7.5 \times 10^{-3}\ mol.$

$Cu^{2+} : KI$

$2 : 1$

$2.5 : 5 \rightarrow$ KI is in excess.

(b) $Cu^{2+} : I_2$

$2 : 1$

$2.5 \times 10^{-3} : 1.25 \times 10^{-3} \rightarrow$ n of I_2 produced.

Mass of $I_2 = 1.25 \times 10^{-3} \times (127 \times 2) = 0.317g$

16/ Mass of $PbI_2 = 0.127g$

(a) n of $PbI_2 = \frac{0.127}{127 \times 2 + 207} = 2.75 \times 10^{-4}\ mol.$

(b) $Pb(NO_3)_2 + MI_2 \longrightarrow PbI_2 + M(NO_3)_2$

(c) n of $MI_2 = 2.75 \times 10^{-4}\ mol$

(d) $n = \frac{Mass}{Mr.}$

$Mr = \frac{0.081}{2.75 \times 10^{-4}} = 294.5$

$M + 2(127) = 294.5 = 40.5$ Calcium.

17/

a. $n\ BaSO_4 = \frac{3.739 \times 10^{-2}}{137 + 32.1 + 4(16)} = 1.6 \times 10^{-4}$ mol.

b. $CuSO_4 + BaCl_2 \longrightarrow BaSO_4 + CuCl_2$

c. $n\ CuSO_4 = 1.6 \times 10^{-4}$ mol

d. 1.6×10^{-4} mol of $CuSO_4$ was in $10\ cm^3$, in $100\ cm^3$ will have 1.6×10^{-3} mol.

e. $Mr\ CuSO_4 \cdot xH_2O = \frac{0.4}{1.6 \times 10^{-3}} = 250$

$63.5 + 32.1 + 4(16) + 18x = 250$

$x = 5.$