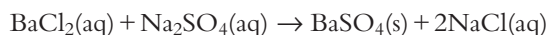


OVERALL CHEMISTRY CALCULATIONS WS 1

- 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?
 $2\text{CuFeS}_2 + 4\text{O}_2 \rightarrow \text{Cu}_2\text{S} + 3\text{SO}_2 + 2\text{FeO}$
A 7 B 8 C 11 **D** 12
- 4 Iron(III) oxide reacts with carbon monoxide according to the equation:
 $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
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
 $2\text{C}_3\text{H}_6(\text{g}) + 9\text{O}_2(\text{g}) \rightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$
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 $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ must be used to make up 200 cm^3 of a $0.100 \text{ mol dm}^{-3}$ 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 $0.100 \text{ mol dm}^{-3}$ sulfuric acid (H_2SO_4). The concentration of the potassium hydroxide is:
A $0.0670 \text{ mol dm}^{-3}$ **C** $0.268 \text{ mol dm}^{-3}$
B $0.134 \text{ mol dm}^{-3}$ D 1.34 mol dm^{-3}

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



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 $0.08000 \text{ mol dm}^{-3}$ C $0.001000 \text{ mol dm}^{-3}$
 B $0.04000 \text{ mol dm}^{-3}$ D $0.002000 \text{ mol dm}^{-3}$

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:



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:

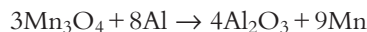
- A NO B NO₂ C N₂O₃ D N₂O₅

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



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.



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. *72 kg* [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 $88.8\% \text{ C}$. 0.201 g of the hydrocarbon occupied a volume of 98.3 cm^3 at 320 K and $1.00 \times 10^5 \text{ Pa}$.

a Determine the empirical formula of the hydrocarbon. *C₂H₃* [3]

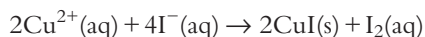
b Determine the molecular formula of the hydrocarbon. *C₄H₆* [3]

- 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 cm³ of carbon dioxide was collected at a temperature of 27 °C and a pressure of 1.10 × 10⁵ Pa.



- 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 cm³ of 0.100 mol dm⁻³ copper(II) nitrate solution is added to 15.0 cm³ of 0.500 mol dm⁻³ potassium iodide. The ionic equation for the reaction that occurs is:



- a Determine which reactant is present in excess. *KI* [3]
- b Determine the mass of iodine produced. *0.317 g* [3]

- 16 0.0810 g of a group 2 metal iodide, MI₂, was dissolved in water and made up to a total volume of 25.00 cm³. Excess lead(II) nitrate solution (Pb(NO₃)₂(aq)) was added to the MI₂ solution to form a precipitate of lead(II) iodide (PbI₂). 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(NO₃)₂ + MI₂ → PbI₂ + M(NO₃)₂* [1]
- c Determine the number of moles of MI₂ 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 (CuSO₄·xH₂O) is dissolved in water and made up to a total volume of 100.0 cm³ with distilled water. 10.00 cm³ of this solution is reacted with excess barium chloride (BaCl₂) solution. The mass of barium sulfate formed was 3.739 × 10⁻² g.

- 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. *CuSO₄ + BaCl₂ → BaSO₄ + CuCl₂* [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 CuSO₄ in 0.4000 g of hydrated copper sulfate. *1.602 × 10⁻³ mol.* [1]
- e Determine the value of x. *5.* [3]



$$\begin{array}{ccc} \downarrow & & \\ 2 & : & 1 \\ 224\text{cm}^3 & : & x \end{array}$$

$$x = 112\text{cm}^3$$

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

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

$$= 75\%$$

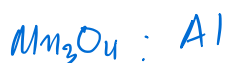
12/

Mr:

(a) $\text{Mn}_2\text{O}_4 = 3(54.9) + 4(16) = 228.7$

$$\text{Al} = 27$$

$$\text{Mn} = 54.9$$



$$\frac{100000}{228.7} : \frac{100000}{27}$$

$$437.2\text{mol} : 3703\text{mol} \quad \text{Provided amount of moles.}$$

$$1 : 8$$

1

L.F.

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

$$\text{mass} = 1311.59 \times 54.9 = 72\text{ Kg}$$

(b)

$$\eta \text{ of Mn} = \frac{200000}{54.9} = 3642.98\text{ mol}$$

$$\eta \text{ Mn}_2\text{O}_4 = \frac{3642.98}{9} \times 3 = 1214.3\text{ mol.}$$

$$\begin{aligned} \text{Mass} &= 1214.3 \times 228.4 \\ &= 277.3\text{ Kg} \end{aligned}$$

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

13/

(a)

$$\begin{array}{rcl}
 C & : & H \\
 88.8 & : & 11.2 \\
 \hline
 12 & : & 1 \\
 7.4 & : & 11.2 \\
 1 & : & 1.5 \\
 2 & : & 3 \quad \longrightarrow \quad C_2H
 \end{array}$$

(b)

$$98.3 \text{ cm}^3 \text{ @ } 320 \text{ K}$$

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

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

$$\begin{aligned}
 n &= \frac{105.56 \text{ cm}^3}{24000 \text{ cm}^3 \text{ mol}^{-1}} \\
 &= 4.398 \times 10^{-3} \text{ mol}
 \end{aligned}$$

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

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

M_r through : M_r C₂H₃
calc

$$45.7 : 27$$

$$1.7 : 1$$

$$2 \approx 1$$

$$\begin{aligned}
 \text{Molecular Formula} &= (C_2H_3)_3 \\
 &= C_6H_9
 \end{aligned}$$

14/

(a)

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

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

$$V_2 = 279.12 \text{ cm}^3$$

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

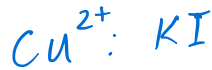
$$\begin{aligned} \text{(b) } \eta \text{ CaCO}_3 &= \eta \text{ CO}_2 \\ &= 11.6 \times 10^{-3} \text{ mol.} \end{aligned}$$

$$\begin{aligned} \text{Mass} &= \eta \times M_r \\ &= (11.6 \times 10^{-3})(60 + 40.1) \\ &= 1.16 \text{ g} \end{aligned}$$

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

15/
a. $\text{Cu}(\text{NO}_3)_2 = \frac{25}{1000} \times 0.1 = 0.0025 \text{ mol} = 2.5 \times 10^{-3} \text{ mol.}$

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



$2 : 1$

$2.5 : 5 \rightarrow \text{KI is in excess.}$

(b) $\text{Cu}^{2+} : \text{I}_2$
 $2 : 1$
 $2.5 \times 10^{-3} : 1.25 \times 10^{-3} \rightarrow \eta \text{ of } \text{I}_2 \text{ produced.}$

$\text{Mass of } \text{I}_2 = 1.25 \times 10^{-3} \times (127 \times 2) = 0.317 \text{ g}$

16/
Mass of $\text{PbI}_2 = 0.127 \text{ g}$

(a) $\eta \text{ of } \text{PbI}_2 = \frac{0.127}{127 \times 2 + 207} = 2.75 \times 10^{-4} \text{ mol.}$



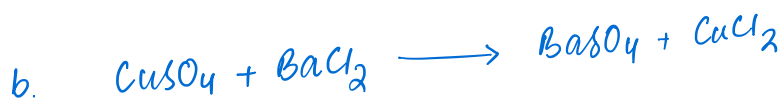
(c) $\eta \text{ of } \text{MI}_2 = 2.75 \times 10^{-4} \text{ mol}$

(d) $\eta = \frac{\text{mass}}{\text{Mr.}}$

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

$\text{M} + 2(127) = 294.5 = 40.5 \text{ Calcium.}$

$$a. \quad n \text{ BaSO}_4 = \frac{3.739 \times 10^{-2}}{137 + 32.1 + 4(16)} = 1.6 \times 10^{-4} \text{ mol.}$$



$$c. \quad n \text{ CuSO}_4 = 1.6 \times 10^{-4} \text{ mol}$$

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.

$$e. \quad M_r \text{ CuSO}_4 \cdot x\text{H}_2\text{O} = \frac{0.4}{1.6 \times 10^{-3}} = 250$$

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

$$x = 5.$$