

GCSE Chemistry A (Gateway Science)
J248/04 Chemistry A C4-C6 and C7 (Higher Tier)

Question Set 16

1 (a) A student dissolves 0.6 g of zinc sulfate in 250 cm³ of water.

(i) Calculate the volume of the water in dm³.

$$\frac{250}{1000} = \frac{1}{4} = 0.25 \text{ dm}^3$$

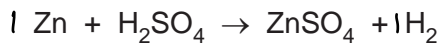
Answer =0.25..... dm³ [1]

(ii) Use your answer to part (a)(i) to help you calculate the concentration of the zinc sulfate in g/dm³.

$$C = \frac{m}{V} = \frac{0.6}{0.25} = 2.4$$

Answer =2.4..... g/dm³ [1]

(b) Zinc reacts with sulfuric acid. Zinc sulfate and hydrogen gas, H₂, are made.



(i) Calculate the amount of **hydrogen gas**, in mol, that could be made from 3.27 g of **zinc**.

$$n_{\text{zinc}} = \frac{m}{M_r} = \frac{3.27}{65.4} = 0.05 \text{ mol}$$

1:1 mole ratio

Answer =0.05..... mol [2]

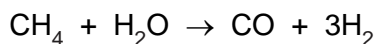
(ii) Use your answer to part (b)(i) to calculate the **volume** of hydrogen gas produced at room temperature and pressure.

One mole of any gas occupies 24 dm³ at room temperature and pressure.

$$V = n V_m = 0.05 \times 24 = 1.2 \text{ dm}^3$$

Answer =1.2..... dm³ [2]

(c) Hydrogen can be made by reacting methane with steam.



The **atom economy** for this process is 17.6%.

Hydrogen can also be produced by the decomposition of ammonia.

This reaction requires a catalyst.



- (i) Calculate the atom economy for the production of hydrogen from ammonia.
Give your answer to 3 significant figures.

$$\frac{3 \times 2}{(3 \times 2) + (14 \times 2)} \times 100 = 17.6\%$$

Answer =17.6.....% [3]

- (ii) Suggest other factors, apart from atom economy, that must be considered when deciding which reaction pathway to choose for the manufacture of hydrogen. [3]

- (.ii.) - Reaction conditions \rightarrow one method may require e.g. a high temperature or pressure, which would be more costly and dangerous.
- Sustainability of reactants \rightarrow methane comes from crude oil, which is not sustainable.
 - Emission of harmful gases \rightarrow carbon monoxide is toxic.
 - percentage yield where least of material wasted

Total Marks for Question Set 16: 12

Resource Materials

The Periodic Table of the Elements

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(0)										
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H hydrogen 1.0	2 He helium 4.0	3 Li lithium 6.9	4 Be beryllium 9.0	5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2	11 Na sodium 23.0	12 Mg magnesium 24.3	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57-71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium	85 At astatine	86 Rn radon
87 Fr francium	88 Ra radium	89-103 actinoids	104 Rf rutherfordium	105 Db dubnium	106 Sg seaborgium	107 Bh bohrium	108 Hs hassium	109 Mt meitnerium	110 Ds darmstadtium	111 Rg roentgenium	112 Cn copernicium	113 Nh nihonium	114 Fl flerovium	115 Mc moscovium	116 Lv livermorium	117 Ts tennessine	118 Og oganeson

Key
atomic number
Symbol
name
relative atomic mass

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