



Secondary 4E  
Chemistry

Mark Scheme

**Paper 1 (20 marks)**

<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
B	B	D	C	C	A	C	A	C	D
<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>	<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>
B	A	C	B	C	D	B	C	C	B
<b>21</b>	<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>	<b>29</b>	<b>30</b>
D	A	D	B	B	D	B	B	A	B
<b>31</b>	<b>32</b>	<b>33</b>	<b>34</b>	<b>35</b>	<b>36</b>	<b>37</b>	<b>38</b>	<b>39</b>	<b>40</b>
B	A	D	D	C	A	D	A	D	C

**Paper 2**

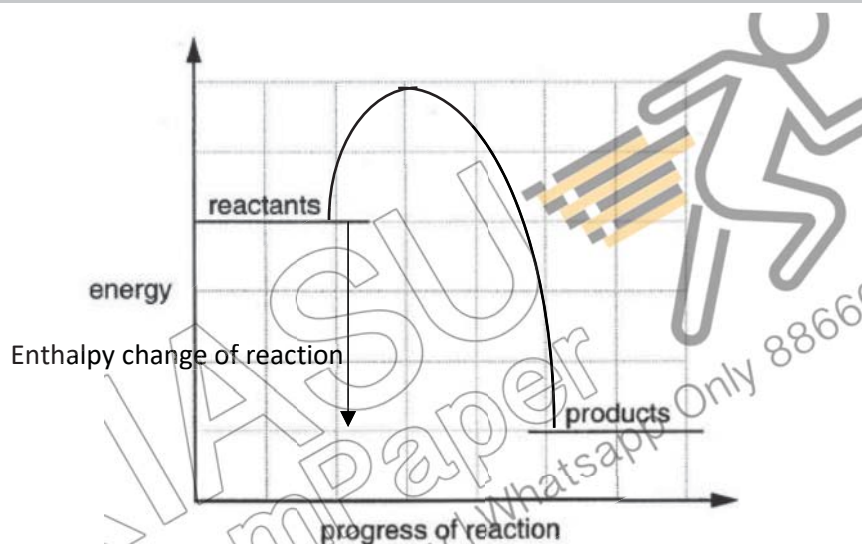
**Section A (50 marks)**

<b>A1</b>	Helium nucleus contains 2 protons, 2 neutrons Neon nucleus contains 10 protons, 10 neutrons	1
	Helium – 2 electrons in 1 <sup>st</sup> shell Neon – 2 electrons in 1 <sup>st</sup> shell, 8 electrons in 2 <sup>nd</sup> shell (correct number of electrons in each shell)	1
		Total: 2
<b>A2 (a)</b>	White precipitate will be observed.	1
	$\text{CO}_2 + \text{Ca(OH)}_2 \rightarrow \text{CaCO}_3 + \text{H}_2\text{O}$	1
<b>2(b)</b>	Carry out <u>fractional distillation</u> . [Rej. Simple distillation]	1
	<u>Heat the mixture</u> fractional distillation setup. When the temperature of solution reaches the <u>ethanol boiling point of 78 °C</u> , ethanol will <u>vapourise in the flask</u> and <u>cool down the condenser</u> . Pure drops of ethanol will be collected in the collecting flask.	2 (1 mark for 2 points)
		Total: 5
<b>A3 (a)</b>	Fullerene can conduct electricity but diamond cannot	1
	Fullerene: <u>1 carbon atom is covalently bonded to 3 other carbon atoms, leaving 1 electron to be unbonded and free to move</u> . This mobile electron helps to conduct electricity.	2 (1m for 2 pts)
	Diamond: <u>Carbon uses all 4 valence electron to bond with 4 other carbon atoms</u> . Thus <u>no free electron</u> to conduct electricity.	
<b>3(b)</b>	Add octane to soot and stir to dissolve the fullerenes.	1
	Pass the mixture through filter paper to remove insoluble residue.	1
	Evaporate / heat/ warm till saturated and leave it to cool to obtain crystals of fullerene.	1
		Total: 6

- A4 (a)(i)** - at high temperatures in the engines of jet engines,  
nitrogen and oxygen in air will react to form nitrogen monoxide 1  
1
- (a)(ii)** - lightning activity for nitrogen and oxygen in the air to form oxides of nitrogen 1
- (b)(i)** Nitric acid, HNO<sub>3</sub> 1
- (b)(ii)**  $\text{CaCO}_3(\text{s}) + 2\text{HNO}_3(\text{aq}) \longrightarrow \text{Ca}(\text{NO}_3)_2(\text{aq}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$  1 – eqn  
1 -  
symbols
- (b)(iii)** - kills aquatic plants and animals when lakes and rivers becomes too acidic **or** 1  
- destroys metal structures

Total: 7

**A5 (a)**



- (b)** No. of moles of CO<sub>2</sub> produced =  $\frac{48}{24}$  1  
= 2
- From equation, 1 mole C<sub>8</sub>H<sub>18</sub> produces 8 mole CO<sub>2</sub>,
- Energy released =  $\frac{2}{8} \times 10900 = 2725$  kJ (accept 2730 kJ) 1

Total: 4

- A6(a)** CuO / copper in CuO / Cu in CuO / copper(II) / copper(II) oxide is reduced and H<sub>2</sub> is oxidised 1
- Cu in CuO, oxidation state decreases from +2 to 0 1  
H in H<sub>2</sub>, oxidation state increases from 0 to +1 in H<sub>2</sub>O 1
- Reject copper oxidise / copper ions oxidise  
Reject 2+ and 1+

Total: 3

A7(a)(i)	electrode	name of gas	name of the electrode at which gas is produced	
	X	hydrogen	cathode	Any 2 – 1M
	Y	oxygen	anode	

Allow ECF for name of electrodes

- (a)(ii) electrode X -  $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$  1  
 electrode Y -  $4\text{OH}^-(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) + 4\text{e}^-$  1  
 Allow ECF for equations  
 Reject missing state symbols
- (b) Solution turn blue and bubbles of gas observed. 2

Total: 6

- A8(a) Silver has the lowest or least abundance/ highest or most cost 1  
 Reject less abundant / more cost / expensive
- (b)(i) Tin prevents oxygen and water / moisture to come in contact with iron, preventing iron from rusting. 1  
 Reject corrosion / corroding
- (b)(ii) Iron will oxidise / rust if the tin coating is scratched 1  
 Or tin has high costs / expensive
- (c)(i) Energy required for extraction of aluminum is a lot more / Energy required for the extraction of aluminium is more than recycling it. 1
- (c)(ii) Aluminium is a more reactive metal compared to iron / aluminium is high in the reactivity series thus it is extracted through electrolysis. 1  
Electrolysis process uses more energy, time and resources as shown in the table it requires 95 kWh.
- (c)(iii) reduces energy from (any one) 1
- sourcing and mining the ores;
  - extracting the metals from the ores
  - recycled metals are made of pure metals but metals extracted from ore contains impurities that needs to be removed
- (c)(iv) social/enviromental impact (any one) 1
- conserve natural resources for future generations;

- Mining causes deforestation and destruction of natural habitat
- Recycling helps to reduce air pollution caused by waste in landfills and incinerator.

Total: 9

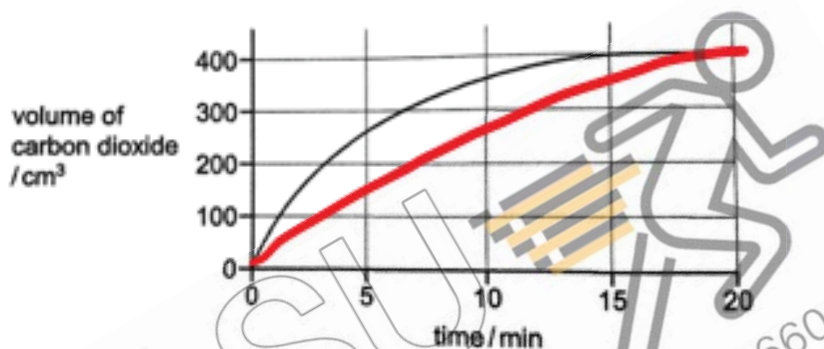
**A9(a)(i)** Reaction starts at high speed 2 m - 3 pts  
 Reaction slows down and stops / rate decreases and stops. 1 m – 1 or 2 pts  
 (Reject: Rate becomes slower)

**(a)(ii)** Since as the reaction progresses, the concentration of H<sup>+</sup> ions in the reaction mixture decreases, 1

and as the frequency of effective collision between H<sup>+</sup> ions and calcium carbonate particles decreases, thus the speed of reaction decreases. 1

\*The reacting particles in the reaction must be identified. Deduct once only. **Accepted HCl particles**

**(b)(i)** 1



**(b)(ii)** The initial reaction rate is slower in graph 2. 1

Thus, the graph 2 is gentler at the start

Lower concentration of acid 1

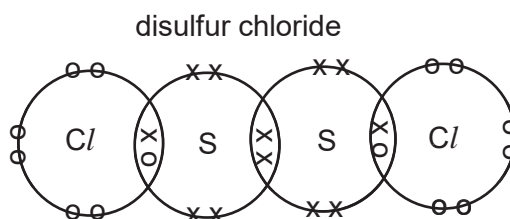
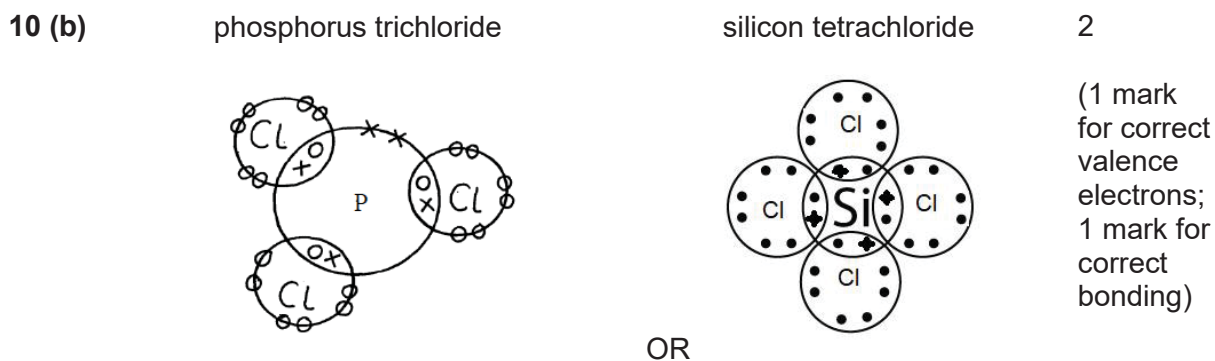
Total: 8

**Section B (30 marks)**

**B10 (a)** Metallic chlorides generally has high melting and boiling points. Non-metallic chlorides have low melting and boiling points. 1

**(a) (ii)** Metallic chlorides are ionic compounds with strong electrostatic forces of attraction between ions. Thus high heat energy is required to overcome these forces of attractions. Thus they have high melting point. 3 (1 mark for every 2 points)

Non-metallic chlorides are simple covalent compounds. There is weak intermolecular forces of attraction / van der waals' force of attraction. Thus low heat energy is required to overcome these forces of attractions. Thus they have low melting point



- |               |   |                    |
|---------------|---|--------------------|
| <b>10 (c)</b> | Molten magnesium chloride has <u>mobile ions that carry electric charges</u> . (reject mobile electrons)                                      | 2<br>(2 m - 3 pts) |
|               | Liquid disulfur chloride has <u>simple molecules</u> which have <u>no free moving electrons or ions</u> , hence cannot carry electric charges | 1 m – 1 or 2 pts)  |
| <b>10 (d)</b> | Ratio of element to <u>sulfur increases from Na to Si</u> i.e. <u>1:1 to 1:4</u>  | 2                  |
|               | Ratio of element to <u>sulfur decreases from P to S</u> i.e. <u>1:3 to 1:1</u>  | (1m – every 2 pts) |
| <b>10 (e)</b> | Add <u>barium chloride</u> or <u>barium nitrate</u> to the solution.  | 1                  |
|               | If a <u>white precipitate</u> is formed, the other acid is sulfuric acid as it contains sulfate, $\text{SO}_4^{2-}$ ions                      | 1                  |

		Total: 12
<b>B11</b>	$\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2$	1
<b>(a)(i)</b>	<b>Reject if wrong state symbols.</b>	
<b>(a)(ii)</b>	No. of moles of Mg = $0.12/24 = 0.005$ mol	
	No. of moles of $\text{H}_2$ = 0.005 mol (ecf from ai)	1
	Volume of $\text{H}_2$ = $0.005 \times 24 = 0.12 \text{ dm}^3$ or $120 \text{ cm}^3$ (ecf from ai)	1

- (b) The total volume of hydrogen would decrease or be much lower than 120 cm<sup>3</sup>. 1
- Since magnesium is a more reactive metal, 1
- and it will react by displacing copper from copper(II) sulfate instead of reacting with the H<sup>+</sup> ions from the acid. 1
- Therefore, there is less magnesium to react with acid to produce less gas.
- (c) The acid is more concentrated in experiment 4. 1 (both answers must be correct)
- The initial temperature of acid is higher.
- (d) There is a layer of oxide on magnesium which prevents the metal from reacting with the acid. 1

Total: 8

**EITHER**

- B12(a)** F: any copper (II) salt solution (reject concentrated halides) 1
- H: any concentrated chlorides solution of reactive metals / concentrated hydrochloric acid 1

For F, copper is less reactive than hydrogen, then the copper itself will be deposited. 1

The hydroxide ions will be preferentially discharge over other anions in dilute solution to liberate oxygen gas thus F is copper (II) salts. 1

For H, at the cathode if the cations come from metal above hydrogen in the reactivity series then hydrogen will be liberated. 1

If a concentrated solution of halides are used, the halides will be preferentially discharge thus H is a concentrated reactive metal salts or concentrated hydrochloric acid. 1

- (b) Hydrogen gas extinguish a lighted splint with a 'pop' sound. 1

Chlorine gas bleaches moist blue litmus paper. 1

- (c) Agree with student A. Mercury is not an electrolytic conductor 2 – any 2 pts
- There is no discharge at either electrodes.

No ions present in the liquid hence it comprises metal atoms

Does not decompose when electric current is passed through it

Total: 10

**OR**

**B12 (a)** 1 – for all **correct** answers in each table

2

element	number of shells of electrons in atom	atomic radius /pm	number of shells of electrons in +1 ion	ionic radius /pm
lithium	2	152	<b>1</b>	68
sodium	3	185	<b>2</b>	98
potassium	4	227	<b>3</b>	133

element	number of shells of electrons in atom	atomic radius /pm	number of shells of electrons in -1 ion	ionic radius /pm
fluorine	2	71	<b>2</b>	133
chlorine	3	99	<b>3</b>	181
bromine	4	115	<b>4</b>	196

**12 (b)** Atomic radii of Group I elements increases down the group. 1

Number of electron shells occupied increases by 1 when moving down from one element to the next 1

**12 (c)** 180 to 196 pm (any value within the range) 1

strontium ion will have the same number of electron shells as bromide ion and hence should be similar in size. It is slightly smaller because it has more protons compared to bromide ions 1

OR

Strontium ion is similar in size to rubidium ion as same of shells.

**12 (d)** - form coloured compounds (reject: they are coloured) 1

**(i)** - has variable oxidation states 1  
- high melting and boiling point

**12 (d)** -\_by increasing the speed of reaction, catalysts cut down reaction time and this will result in savings in energy costs 1

**(ii)**

OR

- use of catalysts can enable reactions to be carried out at lower temperatures/pressure and this will result in further savings in energy and equipment costs

Total: 10

