

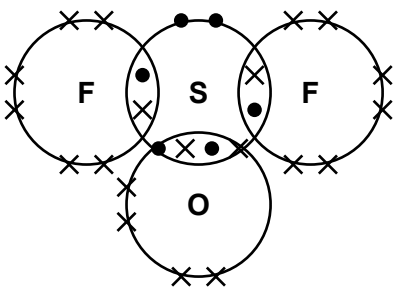
4E Chemistry 6092 – Set III
Marking Scheme

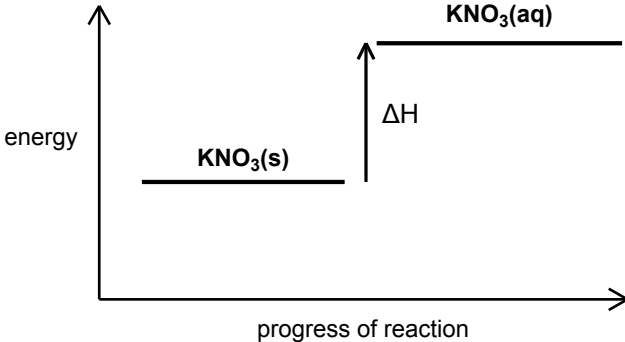
Paper 1

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

Paper 2

Qn	Marking Scheme			Remarks	Mks
1ai	Calcium oxide			CaO	1
1aii	Nitrogen monoxide			NO	1
1aiii	Aluminium oxide			Al ₂ O ₃	1
1aiv	Sulfur dioxide			SO ₂	1
1av	Iron(II) oxide			FeO	1
1b		true	false	1 mark for every 2 ticks	2
	They all float on water.		✓		
	They lose electrons more easily down the group.	✓			
	They rapidly tarnish in air.	✓			
	They react with water to form two alkaline products.		✓		
2a	Average mass of one atom of that element relative to 1/12 the mass of an atom of carbon-12.			Specify 1/12 the mass of a carbon-12 atom	1
2b	Σ isotope mass $\times$ isotope abundance $\div$ 100 Let x be the relative abundance of Mg-24. Let y = 0.9 – x be the relative abundance of Mg-26. $A_r(\text{Mg}) = 24.3$ $A_r(\text{Mg}) = (24 \times x) + (25 \times 0.1) + [26 \times (0.9 - x)]$ $24.3 = 24x + 2.5 + 23.4 - 26x$ $2x = 1.6$ $x = 0.8$ $y = 0.9 - 0.8 = 0.1$ relative abundance of Mg-24 = 80% relative abundance of Mg-26 = 10%			1 mark for each relative abundance in %	2

2c	Mg-24 will diffuse the fastest, followed by Mg-25, and Mg-26 will diffuse the slowest. OR Mg-24 will diffuse the fastest. Mg-25 will diffuse slower than Mg-24, but faster than Mg-26. Mg-26 will diffuse the slowest. OR Mg-24 will diffuse faster than Mg-25 and Mg-26. Mg-25 will diffuse faster than Mg-26.	Need to compare and order all 3 isotopes	1																								
2d	<table border="1"> <tr> <td>element</td><td>Mg</td><td>B</td><td>O</td></tr> <tr> <td>mass / g</td><td>18.9</td><td>5.8</td><td>25.3</td></tr> <tr> <td>A_r</td><td>24</td><td>11</td><td>16</td></tr> <tr> <td>mol</td><td>0.7875</td><td>0.52727</td><td>1.58125</td></tr> <tr> <td>÷</td><td>1.4935</td><td>1</td><td>2.9989</td></tr> <tr> <td>mole ratio</td><td>3</td><td>2</td><td>6</td></tr> </table> empirical formula, Mg₃B₂O₆	element	Mg	B	O	mass / g	18.9	5.8	25.3	A_r	24	11	16	mol	0.7875	0.52727	1.58125	÷	1.4935	1	2.9989	mole ratio	3	2	6	1 mark for finding moles 1 mark for Mg₃B₂O₆	2
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2e	x = 7 and y = 4	cao	1																								
3a	In SF₄, sulfur atom has 10 valence electrons. In XeF₄, xenon atom forms single bonds with fluorine atoms, despite xenon being a noble gas.	1 mark for S 1 mark for Xe	2																								
3b		1 mark for bonding electrons 1 mark for lone pairs	2																								
3c	These fluoride compounds are covalent substances with simple molecular structure. Little energy is needed to overcome weak intermolecular forces of attraction between molecules.	1 mark for structure 1 mark for energy and bonding	2																								
4a	$2\text{Ca}(\text{NO}_3)_2 \rightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$ Calcium nitrate is reduced as the oxidation state of nitrogen decreases from +5 in calcium nitrate to +4 in nitrogen dioxide. Calcium nitrate is oxidised as the oxidation state of oxygen increases from -2 in calcium nitrate to 0 in oxygen.	1 mark for changes to N 1 mark for changes to O	2																								
4b	Place a glowing splint near the gas. If the glowing splint relights, the gas is oxygen.	Describe test and result	1																								
4ci	Lead(II) nitrate will take the shortest time for nitrogen dioxide to appear, as it will be the first or fastest or easiest to decompose. In the reactivity series, calcium is the most reactive metal, followed by zinc, and lead is the least reactive metal. Lead forms the least thermally stable metal nitrate.	1 mark for Pb(NO₃)₂ 1 mark for explanation	2																								

4cii	Zinc oxide	ZnO	1
5a	Titration	cao	1
5b	$\text{KOH(aq)} + \text{HNO}_3\text{(aq)} \rightarrow \text{KNO}_3\text{(aq)} + \text{H}_2\text{O(l)}$ OR $\text{K}_2\text{CO}_3\text{(aq)} + 2\text{HNO}_3\text{(aq)} \rightarrow 2\text{KNO}_3\text{(aq)} + \text{H}_2\text{O(l)} + \text{CO}_2\text{(g)}$	1 mark for formulae and coefficients 1 mark for state symbols	2
5c	Heat the aqueous solution until it is saturated . Allow the saturated solution to cool so that the salt can crystallise. Filter to collect the crystals. Wash the crystals with a little cold distilled water . Dry the crystals between a few sheets of filter paper .	1 mark for heat, cool 1 mark for wash, dry	2
5di	Endothermic	cao	1
5dii	ΔH $= c \times m \times \Delta T$ $= 4.2 \times 0.050 \times (20.4 - 18.7) = 4.2 \times 0.050 \times 1.7$ $= + 0.357 \text{ kJ}$	Show working	1
5diii		Product $\text{KNO}_3\text{(aq)}$ at higher level and arrow head for positive ΔH , no need show value or unit	1
6a	Experiment 1, dilute $\text{CuSO}_4\text{(aq)}$, graphite electrodes At negative electrode: $\text{Cu}^{2+}\text{(aq)} + 2\text{e}^- \rightarrow \text{Cu(s)}$ At positive electrode: $4\text{OH}^-\text{(aq)} \rightarrow \text{O}_2\text{(g)} + 2\text{H}_2\text{O(l)} + 4\text{e}^-$ Experiment 2, dilute $\text{CuSO}_4\text{(aq)}$, copper electrodes At negative electrode: $\text{Cu}^{2+}\text{(aq)} + 2\text{e}^- \rightarrow \text{Cu(s)}$ At positive electrode: $\text{Cu(s)} \rightarrow \text{Cu}^{2+}\text{(aq)} + 2\text{e}^-$	1 mark for 1 ionic equation, must show state symbols	3
6b	In graphite, each carbon atom is bonded to three other carbon atoms. This leaves 1 unbonded electron per carbon atom, which is free and mobile to conduct electricity.	1 mark for bonding 1 mark for mobile electron(s)	2
6c	In experiment 1, colour of electrolyte changes or slowly fades from blue to colourless , and its pH becomes more acidic . In experiment 2, there is no change in the colour and pH of the electrolyte / the colour and pH of electrolyte remain the same.	Mention changes to colour and pH	1

6d	Increase in mass of Cu $= 53 - 50$ $= 3 \text{ g}$ Number of moles of Cu $= 3 \div 64$ $= \mathbf{0.046875 \text{ mol}}$ $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$ Number of moles of electrons $= 0.046875 \times 2$ $= 0.09375 \text{ mol}$ $= \mathbf{0.0938 \text{ mol (3 s.f.)}}$	1 mark for moles of Cu 1 mark for moles of e^{-} in 3 s.f.	2
7a	Property of transition metals: • They have high melting points. • They have high densities. • They form ions with variable or different oxidation states. • They form coloured compounds.	Any 1 property	1
7bi	A reversible reaction can go both forward and backward at the same time.	Mention both directions	1
7bii	Pressure of 250 atm and temperature of 450 °C	Values and units	1
7c	Using powdered form increases surface area of catalyst. With more surface area in contact with reactant particles, the rate of reaction increases.	More surface area + faster reaction rate	1
7d	An increase in temperature results in an increase in rate of reaction. At a higher temperature, reacting particles have more kinetic energy. They gain energy and move faster. More reacting particles possess energy that is greater than or equal to activation energy. Frequency of effective collisions between reacting particles increases.	1 mark for energy $> E_a$ 1 mark for increase frequency of effective collisions and rate	2
7e	Reasons to not increase temperature: • If reaction is slow due to low temperature, catalyst added can help to increase reaction rate / speed up reaction • Decrease or lower yield of product / product yield / yield • Incur higher operational / energy / production costs • Increase energy consumption and greater environmental impact (more industrial emissions) • Need to purchase specialised materials that are heat-resistant / able to withstand high temperatures as well as schedule regular maintenance to keep equipment in optimal condition • Pose safety concerns when too high temperatures cause too fast uncontrolled reactions, or increase the risk of explosions, fires and other hazardous conditions • Promote unwanted side reactions / formation of by-products, affecting purity and quality of desired product	1 mark for 1 reason	2

8a	Petroleum (crude oil) is first heated in a furnace and the vapour is passed into the fractionating (distillation) column. The fractions with lower boiling points rise up the column, cool and condense, and are collected at the top of the column. The fractions with higher boiling points condense at higher temperatures and are collected at the lower levels or sections or bottom of the column.	1 mark for processes and states (heat to vapour, cool to liquid) 1 mark for different boiling points and collection positions	2								
8bi	Use of kerosene: • Fuel for aircraft / jet engines • Fuel for cooking using oil stoves Use of diesel: • Fuel for diesel engines (in buses, lorries, trains) • Fuel for power generation, e.g. power heavy machinery	Both uses, 1 use each	1								
8bii	Other fractions: • Bitumen • Lubricating oil • Petroleum gas	Any 1 fraction name	1								
8ci	<table><tr><td>product</td><td>propene, C₃H₆</td><td>ethene, C₂H₄</td><td>methane, CH₄</td></tr><tr><td>full structure</td><td>$\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{C} = & \text{C} - & \text{C} - \text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$</td><td>$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{C} = & \text{C} \\ & \\ \text{H} & \text{H} \end{array}$</td><td>$\begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array}$</td></tr></table>	product	propene, C ₃ H ₆	ethene, C ₂ H ₄	methane, CH ₄	full structure	$\begin{array}{c} \text{H} & \text{H} & \text{H} \\ & & \\ \text{C} = & \text{C} - & \text{C} - \text{H} \\ & & \\ \text{H} & & \text{H} \end{array}$	$\begin{array}{c} \text{H} & \text{H} \\ & \\ \text{C} = & \text{C} \\ & \\ \text{H} & \text{H} \end{array}$	$\begin{array}{c} \text{H} \\ \\ \text{H} - \text{C} - \text{H} \\ \\ \text{H} \end{array}$	Any 1 structure	1
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8cii	Process A circle reforming Process B circle cracking	Both circles	1								
8d	Reasons for choosing poly(propene) • Its useable temperature is above 100 °C • It is insoluble in oil	1 mark for 1 reason	2								
8e	$\left[\begin{array}{c} \text{H} & \text{CH}_3 \\ & \\ -\text{C} - & \text{C}- \\ & \\ \text{H} & \text{H} \end{array} \right]_n$	Repeat unit and brackets, subscript n	1								
8f	Plastics / polymers are macromolecules. Each polymer molecule consists of covalent bonding or strong covalent bonds between atoms.	Structure and bonding	1								
8gi	Physical (mechanical) method of recycling: • Small pieces of plastics are melted, cooled, pulled into long, thin strands, and cut into pellets • These pellets can then be made into new products Chemical method of recycling: • Plastic waste can undergo cracking to form short chains of alkanes and alkenes, which are different raw materials that can be used to make other useful chemicals • Plastic polymer can undergo depolymerisation to form back into its monomers to be converted to other useful chemicals	Any 1 method, describing how and product	1								

8gii	Challenges of recycling plastics: - Plastic recycling processes can be labour-intensive and energy-intensive, as all the processes involved in recycling plastic waste require manpower, machines and energy - Recycling plastic waste can cost much more than disposal in landfills or incineration, due to cost of transporting the waste to the processing plant, costs of sorting and cleaning the waste, and carrying out either physical or chemical recycling methods, plastic recycling technologies are expensive - Recycling plastics may not be worthwhile or economically viable or profitable / Difficult for plastic recycling businesses to survive, as recycled plastics have lower market value than virgin plastics / recycled plastics are sold at a lower value than virgin plastics - Degradation of plastic quality after multiple recycling cycles, which can restrict the range of uses for the recycled material / lower market demand for recycled plastics - It takes time and effort for communities to adopt recycling plastics as a lifestyle, as many people find it more convenient to throw all their plastic waste away / Many people are not aware of the proper way to recycle plastic, increasing time and effort and slowing down recycling process - Wastewater generated from the plastic recycling processes is not treated properly before being discharged into water bodies, contaminating the water and causing water pollution	Any 1 challenge / issue, providing elaboration or example	1
9a	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ OR $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$	Formulae and coefficients No need state symbols	1
9b	Volume of oxygen = Volume of hydrogen ÷ 2 = 250 ÷ 2 = 125 dm³	Answer in dm ³	1
9c	Reduction takes place at the positive electrode, due to gain of electrons .	Reduction and explain	1
9d	The electrolyte, aqueous sodium hydroxide , conducts electricity due to mobile ions .	Name electrolyte + mobile ions	1
9e	Disadvantages of hydrogen fuel: Obtaining hydrogen from electrolysis is expensive / more expensive than other fuels It is difficult to store and transport hydrogen, as hydrogen is very light / has a low energy density by volume and requires a larger storage volume or tanks / high pressures and/or low temperatures to store sufficient amounts for practical use / specialised insulated containers to store liquid hydrogen / heavy expensive high-pressure tanks to store compressed gas - It is difficult to handle and store hydrogen safely / Special precautions or stringent safety measures must be taken in the handling and storing hydrogen, as hydrogen is a highly flammable or extremely explosive / hydrogen is often transported in high-pressure cylinders which can be dangerous to handle	1 mark for 1 disadvantage	2

9f	error	corrections to error	1 mark for correcting 1 error	2
	Biofuels, derived from inorganic materials such as plastic waste and metals	Biofuels are derived from plants, algae, and organic waste		
	Biofuels involve practices that exhaust natural resources and cause ecological damage	Biofuels are considered more environmentally sustainable		
	Biofuels increase greenhouse gas emissions	Biofuels can potentially reduce greenhouse gas emissions		
	Biofuels do not require oxygen to burn	Biofuels require oxygen to burn		
10a	Alcohols are a homologous series: • Melting and boiling points of members increase • Miscibility or solubility in water of members decreases • Down the series, the size of molecules increases		Any 1 evidence from information	1
10b	$C_nH_{2n+1}OH$			1
10c	Propan-1-ol and propan-2-ol $ \begin{array}{ccccccc} & H & & H & & H & \\ & & & & & & \\ H & -C- & C- & C- & O- & H & \\ & & & & & & \\ & H & & H & & H & \end{array} \quad \begin{array}{ccccccc} & H & & H & & H & \\ & & & & & & \\ H & -C- & C- & C- & H & & \\ & & & & & & \\ & H & & O & & H & \\ & & & & & & \\ & & & H & & & \end{array} $		1 mark for 1 structure	2
10di	Ethyl ethanoate and water		Name products	1
10dii	$M_r(C_2H_5OH) = 46$ Number of moles of ethanol = $5 \div 46$ = 0.10870 mol (5 s.f.) $M_r(CH_3COOH) = 60$ Number of moles of ethanoic acid = $5 \div 60$ = 0.083333 mol (5 s.f.) Limiting reactant is ethanoic acid Mole ratio ethanoic acid : ethyl ethanoate = 1 : 1 $M_r(CH_3COOC_2H_5) = 88$ Theoretical mass of ethyl ethanoate = 0.083333×88 = 7.3333 g (5 s.f.) Actual mass of ethyl ethanoate = $7.3333 \times (60 \div 100)$ = 4.4 g		1 mark for finding moles / limiting reactant 1 mark for multiply 88 1 mark for 60% of mass in g	3

10e	Hydrolysis of amide produces carboxylic acid and amine. Hydrolysis of compound X produces carboxylic acid and ammonia. $\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3\text{CH}_2\text{CH} - \text{C} - \text{OH} \\ \\ \text{CH}_3 \end{array} \quad \text{and} \quad \begin{array}{c} \text{H} - \text{N} - \text{H} \\ \\ \text{H} \end{array}$	1 mark for 1 structure	2
11a	$\text{C}_4\text{H}_9\text{CO}_2\text{H}$, 102	Formula and M_r value	1
11b	It is easier to predict the boiling point. There is an increasing trend for boiling points of members, however there is no trend for their melting points.	1 mark for boiling point 1 mark for explain	2
11c	$\begin{array}{c} \text{H} & \text{H} & \text{O} \\ & & \parallel \\ \text{H} - \text{C} - & \text{C} - & \text{C} \\ & & \\ \text{H} & \text{H} & \text{O} \\ & & \\ & & \text{H} \end{array}$	Full structure; show all bonds between all atoms	1
11d	By heating a mixture of ethanol and acidified potassium manganate(VII) solution. The solution turns from purple to colourless.	1 mark for ethanol, acidified KMnO_4, heat 1 mark for colour change	2
11ei	Add aqueous bromine to two separate test tubes containing sample of each fatty acid. If aqueous bromine remains red-brown, the test tube contains saturated fatty acid. If aqueous bromine turns red-brown to colourless, the test tube contains unsaturated fatty acid.	1 mark for $\text{Br}_2(\text{aq})$ 1 mark for comparison of results and conclusion	2
11eii	$\text{HO} - \overset{\text{O}}{\parallel} \text{C} - (\text{CH}_2)_{14}\text{CH}_3$ AND $\text{HO} - \overset{\text{O}}{\parallel} \text{C} - (\text{CH}_2)_{16}\text{CH}_3$	1 mark for 1 structure	2