

**WOODLANDS SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
MARKING SCHEME FOR PAPER 2**

Level:	Secondary Four	Marks:	80
Stream:	Express	Date:	20 August 2024
Subject:	Pure Chemistry	Day:	Tuesday

Section A – Structured Questions (70 marks)

1		Total = 5
(a)	Magnesium oxide, zinc oxide	1
(b)	Silicon dioxide	1
(c)	Zinc oxide	1
(d)	Sulfur dioxide, carbon dioxide	1
(e)	Carbon monoxide	1
2		Total = 4
(a)	Aqueous ammonia and concentrated hydrochloric acid evaporate respectively to form ammonia gas and hydrogen chloride gas. The gases diffuse towards each other to form ammonium chloride (white fume) nearer to the watch-glass of hydrochloric acid. This is because ammonia has a lower relative molecular mass of 17 as compared to hydrogen chloride with a relative molecular mass of 36.5	1 1 1 max 2
(b)		2

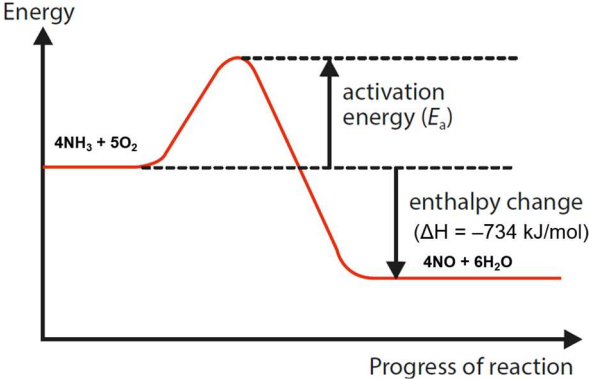
3		Total = 8
(a)	Hydrogen fluoride has a low melting and boiling point / does not conduct electricity in any states.	1
(b)	$\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^-$	1
	Hydrofluoric acid dissociates partially in water to form a low concentration of hydrogen ions.	1
(c)(i)	$2\text{HF} + \text{Mg} \rightarrow \text{MgF}_2 + \text{H}_2$	1
(c)(ii)	No. of moles of HF = $0.200 / (1 + 19) = 0.01 \text{ mol}$	1
	Compare mole ratio of HF : $\text{H}_2 = 2 : 1 = 0.01 \text{ mol} : 0.005 \text{ mol}$	
	Volume of hydrogen gas = $0.005 \times 24 = \mathbf{0.12 \text{ dm}^3}$	1
(d)	Magnesium fluoride is an ionic compound with a giant ionic crystal lattice structure held by strong electrostatic forces of attraction between the positive and negative ions / oppositely charged ions which require a large amount of energy to overcome. Hence, it has a high melting point.	1
		1

4		Total = 6
(a)(i)	Hydrogen gas / H_2	1
(a)(ii)	Ammonia gas / NH_3	1
(a)(iii)	Iron	1
(b)	Add excess zinc oxide to dilute nitric acid and stir until no more zinc oxide can dissolve. Filter the mixture to remove the excess unreacted zinc oxide as the residue . Collect the filtrate (aqueous zinc nitrate).	1
	Heat the filtrate to evaporate most of the water to obtain a saturated solution of zinc nitrate. Allow the saturated solution to cool so that the salt can crystallise .	1
	Filter to collect the crystals as the residue . Wash the crystals with a little cold distilled water to remove any water-soluble impurities. Dry the crystals between a few sheets of filter paper.	1

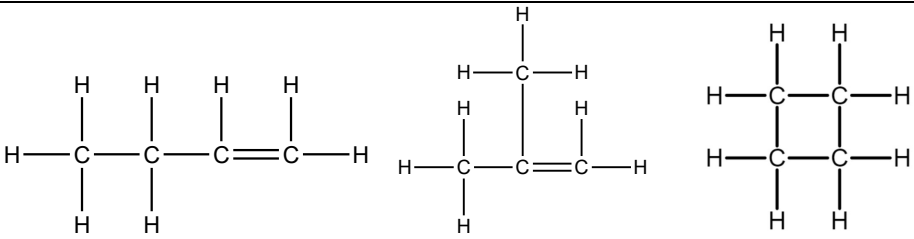
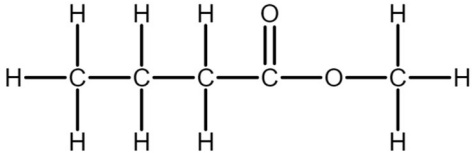
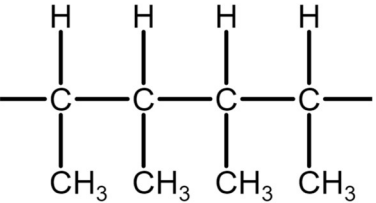
5		Total = 4
(a)	The colourless solution will turn brown .	1
	Chlorine is more reactive than iodine. Hence, it will displace iodine from aqueous potassium iodide, forming potassium chloride and iodine solution (brown).	1
(b)	The oxidation state of oxygen increases from -1 in H_2O_2 to 0 in O_2 . Hence, oxidation takes place.	1
	The oxidation state of chlorine decreases from 0 in Cl_2 to -1 in HCl . Hence, reduction takes place.	1
	Since both oxidation and reduction take place at the same time, it is a redox reaction.	

6		Total = 7
(a)	A reddish-brown / pink solid is formed.	1
	The blue solution turns green .	1
(b)(i)	The colourless solution turns green .	1
(b)(ii)	The larger the volume of gas produced, the greater the reactivity of the metals.	1
	The loss in mass will be too small as molar mass of hydrogen is only 2 g/mol .	1
(b)(iii)	The volume of gas produced for a fixed duration of reaction will be smaller .	1
	Ethanoic acid is a weak acid so the concentration of hydrogen ions will be lower . The rate of reaction will be slower .	1

7		Total = 9
(a)	Mole ratio = volume ratio	1
	Hence, mole ratio of $\text{NH}_3 : \text{O}_2 = 4 : 5 = 4.80 \text{ dm}^3 = 6.00 \text{ dm}^3$	1
(b)	Volume of air = $6.00 / 21 \times 100 = 28.6 \text{ dm}^3$ (3 s.f.)	1
(c)(i)	Energy taken in = $12(391) + 5(498) = 7182 \text{ kJ}$	1
	Energy released = $4(587) + 12(464) = 7916 \text{ kJ}$	1
	$\Delta H = 7182 - 7916 = -734 \text{ kJ/mol}$	1

(c)(ii)	 1 mark for correct shape of diagram with reactants and products 1 mark for correct label of activation energy 1 mark for correct label of enthalpy change	3
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8		Total = 7
(a)	The rate of reaction is the highest at the start of the reaction because the gradient is the steepest. As the reaction proceeds, the gradient of the graph decreases. Hence, the rate of reaction decreases with time. At the end of the reaction, the gradient is zero, indicating that the reaction has stopped.	1 1 1
(b)	Graph Y should have a gentler gradient but end off at the same concentration as the original graph.	1
(c)	When the temperature is decreased, the reactant particles lose energy, move slower and collide with each other less often. Less reactant particles have energy greater than or equal to the activation energy. The frequency of effective collisions between reactant particles decreases. Hence, the rate of reaction decreases.	1 1 1

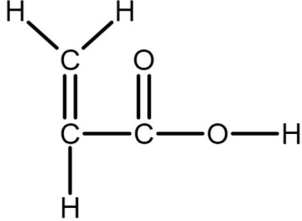
9		Total = 10
(a)(i)	The reddish-brown aqueous bromine turns colourless.	1
(a)(ii)		1
(b)(i)	C ₂ H ₄ O	1
(b)(ii)	methyl butanoate	1
(b)(iii)		1
(c)		1
(d)	The polymer is non-biodegradable . Hence, it cannot be broken down by bacteria and other living organisms in the soil.	1
(e)	In physical method of recycling, small pieces of the polymer are melted, cooled, pulled into long thin strands, and cut into pellets. These pellets can then be made into new products. OR In chemical method of recycling, the polymer can be converted into different raw materials through cracking, producing alkanes and alkenes.	1
(f)	Bioethanol is considered a carbon neutral fuel because as sugarcane grows, it absorbs carbon dioxide during photosynthesis, which offsets the carbon dioxide produced when the bioethanol is burnt during combustion. Hence, there is no net gain or loss of carbon in the atmosphere when it undergoes combustion.	1

10		Total = 10
(a)	$\text{Sn} + 2\text{H}_2\text{O} \rightarrow \text{SnO}_2 + 2\text{H}_2$	1
(b)	Zinc: $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$	1
	Copper: $2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$	1
(c)	Magnesium and silver OR zinc and silver OR magnesium and copper	1
	The difference between the reactivities of the two metals is larger as compared to zinc and copper. Hence, the voltage produced will also be larger.	1
(d)	It is dangerous to use for long duration of time as hydrogen gas is a flammable gas / Zinc plates would have to be replaced regularly as they are used up in the reaction / Sodium chloride solution dries up quickly and battery stops working. (Any other reasonable answers)	1
(e)(i)	Electrode Y	1
(e)(ii)	Place a glowing splint towards the gas. The gas relights the glowing splint.	1
(e)(iii)	At the cathode, H^+ ions are selectively discharged to form hydrogen gas at the cathode as H^+ ions gain electrons more readily than K^+ ions.	1
	Hence, K^+ ions will remain in the solution and will not form potassium metal.	1

Section B – Structured Questions (10 marks for 1 question)

11		Total = 10
(a)	The concentration of Na ⁺ ions and the concentration of OH ⁻ ions will increase as the volume of water decreases.	1
(b)(i)	From the negative electrode to the positive electrode	1
(b)(ii)	$2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$	1
(c)(i)	During complete combustion of petrol, carbon dioxide is produced and excessive levels of carbon dioxide can cause global warming which causes glaciers and polar ice caps to melt, leading to rising sea levels and disrupting ocean currents. <i>Accept carbon monoxide production as well but need to say incomplete combustion of petrol</i>	1 1
(c)(ii)	Cracking of petroleum is required to produce hydrogen gas. The process requires burning of fossil fuels which is expensive. <i>Any other reasonable answers</i>	1 1
(c)(iii)	In both types of car engines, the temperature is very high . Hence, nitrogen and oxygen in air can react together in the internal combustion engines of cars to form nitrogen oxides.	1 1
(c)(iv)	There is no carbon monoxide present for a car powered by hydrogen fuel cell as the only product formed is water. Carbon monoxide is required for the reduction of nitrogen oxides to nitrogen gas.	1

12		Total = 10
(a)	Ester	1
(b)	$ \begin{array}{c} \text{CH}_3 \quad \text{O} \\ \quad \\ \text{H}-\text{O}-\text{C}-\text{C}-\text{O}-\text{H} \\ \\ \text{H} \end{array} $	1
(c)	The molecular formula of the monomer is C ₃ H ₆ O ₃ . As the molecule differs from the monomer by a -CH₂ unit , it is possible that it belongs to the same homologous series if it contains one hydroxyl group and one carboxylic acid group.	1

(d)		1
(e)(i)	The reagent is acidified potassium manganate(VII). The condition is warm.	1 1
(e)(ii)	It is not suitable because both hydroxyl groups will be oxidised by KMnO_4. However, to make the monomer, only one of the hydroxyl group can be oxidised to form a carboxylic acid.	1 1
(f)(i)	$\text{C}_9\text{H}_{20} \rightarrow \text{C}_3\text{H}_8 + \text{C}_6\text{H}_{12}$	1
(f)(ii)	Cracking is the breaking up of large-chain alkanes into useful smaller-chain alkenes and smaller-chain alkanes or hydrogen gas. Smaller-chain alkenes can be used to make ethanol and plastics while smaller-chain alkanes such as petrol is in high demand as a fuel in motor vehicles. Hydrogen gas can be used in the manufacture of ammonia. (Any one of the reasons above)	1