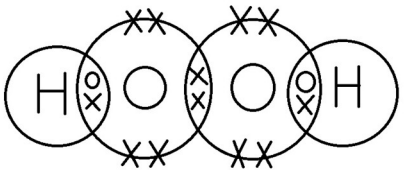
Assumption English School
Science Department – Preliminary Examination 2024
4E Chemistry 6092
Marking Scheme

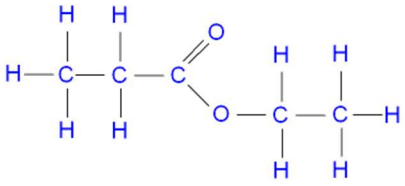
Paper 1: Multiple-Choice Questions [40 m]

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

Paper 2:
Section A: Structured Questions [70 m]

1	**(a)**	Silicon dioxide	**[1]**
	(b)	Lead(II) oxide	**[1]**
	(c)	Zinc bromide	**[1]**
	(d)	Potassium iodide	**[1]**
	(e)	Copper(II) oxide	**[1]**
2	**(a)**	$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$ (state symbols not required)	**[1]**
	(b)	 Bonding electrons-[1]; Non-bonding electrons of Oxygen- [1]	**[2]**
	(c)	When it is warmed, particles gain energy and move faster. More particles have the minimum activation energy to react and collide [1], which leads to a higher frequency of effective collisions between the reacting molecules. [1]	**[2]**
	(d)	Oxygen in H_2O_2 is oxidised as the oxidation state of oxygen increases from -1 in H_2O_2 to 0 in O_2. [1]	**[2]**

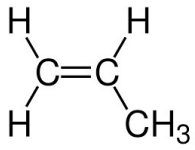
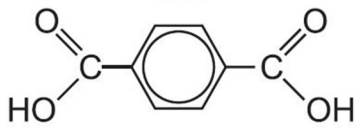
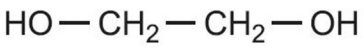
		Oxygen in H_2O_2 is also reduced as the oxidation state of oxygen decreases from -1 in H_2O_2 to -2 in H_2O. [1] Hence, since oxygen simultaneously undergoes oxidation and reduction, decomposition of hydrogen peroxide is a disproportionation reaction.	
3	**(a)**	• Soft, can be cut easily with a knife • Low melting point/ low boiling point • Low density Any 1- [1]	**[1]**
	(b)	As the atomic radius increases increases down the group from 152 pm in Lithium to 244 pm in Rubidium, the valence electrons are further away from the nucleus [1] The weaker attraction between the nucleus and the valence electron makes it easier for the electron to be lost, increasing the metal's reactivity. [1]	**[2]**
	(c)	Upon losing one electron to form a positively charged ion, lithium ion has one less electron shell (2) compared to lithium atom (3), hence it has a smaller radii.	**[1]**
	(d)(i)	The rapid production of hydrogen gas from the reaction creates bubbles, thereby pushing the sodium around the water surface and causing it to skid.	**[1]**
	(d)(ii)	Potassium will react more vigorously with water and catch fire [1] as it is more reactive than sodium, hence causing a faster reaction. [1]	**[2]**
4	**(a)**	Copper conducts electricity through mobile electrons whereas copper(II) sulfate conducts electricity through mobile ions. [1] Copper conducts electricity in solid (and molten) whereas copper(II) sulfate conducts electricity in aqueous and molten states. [1]	**[2]**
	(b)(i)	$Cu^{2+}(aq) + 2e \rightarrow Cu(s)$ [1] Copper is less reactive than hydrogen/ Cu^{2+} ions are below H^+ ions in the reactivity series, hence Cu^{2+} ions are selectively discharged over H^+ ions to form a coating/ copper atoms on the cathode, hence increasing its mass. [1] [1]- Half equation, [1]- Explanation	**[2]**
	(b)(ii)	0.92g	**[1]**
	(c)(i)	$4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e^-$ Need to include state symbols	**[1]**
	(c)(ii)	Copper solid is deposited at the cathode in both experiments.	**[1]**
	(c)(iii)	Universal indicator will turn red. [1] The net discharge of OH^- ions at the anode causes the electrolyte to be acidic due to more H^+ ions than OH^- ions being left in solution. [1]	**[2]**

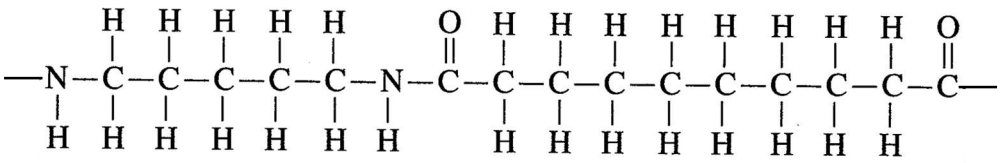
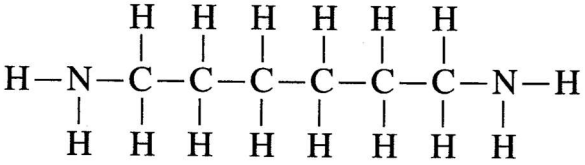
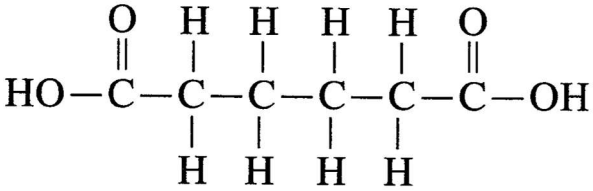
<table>
<tr><td>5</td><td>(a)</td><td>Isomers are molecules that have the <u>same molecular formula but different structural formula</u>. [1]
<u>Compounds E and F</u> are isomers of each other as they have the <u>same molecular formula of C_4H_{10}</u> but the carbons and hydrogens in their compounds are arranged differently. [1]</td><td>[2]</td></tr>
<tr><td></td><td>(b)(i)</td><td>Compound B. [1]
Reagent and conditions: Water (vapour), 300 °C, 60atm, phosphoric(V) acid [1]</td><td>[2]</td></tr>
<tr><td></td><td>(b)(ii)</td><td>Insert a damp blue litmus paper into the test tube. [1]
Damp blue litmus paper will turn red if D is oxidised. [1]
OR
Add a drop of universal indicator into the test tube. [1]
Uindicator indicator will turn from green to orange/ yellow if D is oxidised. [1]
OR
Add a reactive metal (e.g. magnesium ribbon)/ metal carbonate (e.g. sodium carbonate) into the test tube. [1]
Effervescence/ bubbles of gas produced if D is oxidised. [1]</td><td>[2]</td></tr>
<tr><td></td><td>(c)(i)</td><td>Ethyl propanoate. [1]
 
[1]</td><td>[2]</td></tr>
<tr><td></td><td>(c)(ii)</td><td>Pour the mixture into a <u>separating funnel</u>. [1]
The ester can be collected as the top fraction as <u>ester is insoluble in water</u> and forms a separate layer from water/ <u>ester is immiscible with water</u>. [1]</td><td>[2]</td></tr>
<tr><td>6</td><td>(a)</td><td>
<table>
<tr><td></td><td>C</td><td>H</td><td>N</td><td>O</td></tr>
<tr><td>Mass in 100g/ g</td><td>63.6</td><td>5.9</td><td>9.3</td><td>21.2</td></tr>
<tr><td>Ar</td><td>12</td><td>1</td><td>14</td><td>16</td></tr>
<tr><td>No. of moles/ mol</td><td>63.6/12
= 5.3</td><td>5.9/1
= 5.9</td><td>9.3/14
= 0.664</td><td>21.2/16
1.325</td></tr>
<tr><td>Simplest ratio</td><td>8</td><td>9</td><td>1</td><td>2</td></tr>
</table>
The empirical formula is $C_8H_9NO_2$.
Correct calculation of no. of moles for all 4 elements- [2]; any mistake minus 1 mark
Correct simplest ratio- [1]
</td><td>[3]</td></tr>
</table>

	(b)(i)	Only one of the <u>two intermediate products (2-nitrophenol and 4-nitrophenol) produced in step 1</u> is used for the synthesis of paracetamol.	**[1]**
	(b)(ii)	Reducing agent. [1] 4-nitrophenol ($C_6H_5NO_3$) is reduced as it <u>loses oxygen/ gains hydrogen</u> to form 4-aminophenol (C_6H_7NO). [1] [Accept: change in oxidation state of N]	**[2]**
	(b)(iii)	Mass of paracetamol in 10 tablets = 10 x 0.5 = 5g [1] No. of moles of paracetamol = 5/ [8(12) + 9 + 14 + 2(16)] = 5/ 151 = 0.033113 mol [1] No. of moles of 4-aminophenol = 0.033113 mol Mass of 4-aminophenol = 0.033113 x [6(12) + 7 + 14 +16] = 0.033113 x 109 = 3.6093g = 3.61g [1]	**[3]**
	(b)(iv)	Verify that melting point is fixed/ check that paracetamol sample produces only one spot using paper chromatography.	**[1]**
	(c)	Paracetamol has a <u>larger molecular size</u> than ethanoic acid so the <u>intermolecular forces of attraction between paracetamol molecules are stronger</u> than that between ethanoic acid molecules. [1] <u>More energy is required to overcome the stronger intermolecular forces of attraction</u>, hence paracetamol has a <u>higher melting point</u> than ethanoic acid and exist as a solid while ethanoic acid exist as a liquid. [1]	**[2]**
7	**(a)(i)**	Photosynthesis: $6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$ Respiration: $C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ Each equation- [1]	**[2]**
	(a)(ii)	Rate of removal of atmospheric carbon dioxide by photosynthesis is balanced by/ equal to rate of carbon dioxide added to the atmosphere by respiration.	**[1]**
	(b)	<u>Excessive combustion of fossil fuels</u> in power generators and vehicles lead to an increase in the amount of atmospheric carbon dioxide. [1] OR <u>Deforestation leads to a reduction in plants and trees which can absorb CO_2</u> from the atmosphere during photosynthesis. [1] An increase in the amount of CO_2 <u>enhances the greenhouse effect</u> by <u>increasing the amount of heat trapped</u> and <u>reducing the amount of heat energy escaping into space</u>, hence causing the <u>earth's surface to warm up</u> and resulting in global warming. [1]	**[2]**

	(c)(i)	18%	**[1]**
	(c)(ii)	No. B100 released 26% carbon dioxide [1] and this will not all be offset by photosynthesis/ growing plants for biodiesel/ farming also uses machinery which require fossil fuels and release carbon dioxide. [1]	**[2]**
8	**(a)**	The general trend for majority of ionic compounds shown in Fig. 8.1 is that solubility increases as temperature increases. [1] NH_3 and $Ce_2(SO_4)_3$ are exceptions to the trend as they have solubility that decreases as temperature increases. [1] OR NaCl is an exception since its temperature dependence is fairly flat, meaning that the solubility of NaCl changes very little as the temperature changes. [1]- General trend; [1]- Exception	**[2]**
	(b)	$Ce_2(SO_4)_3$	**[1]**
	(c)	At 50°C, ratio of solute to solvent is 4:5. Mass of KNO_3 crystals in a 200 g saturated solution at 50°C = 4/9 x 200 = 88.9 g (3 s.f.)	**[1]**
	(d)	As the solvent is water, temperatures above 100°C would have caused water to be boiled off. [Reject: evaporation of water]	**[1]**
	(e)	Lattice enthalpy is positive/ endothermic as energy is absorbed to break the solid crystal lattice into its separate constituent ions.	**[1]**
	(f)(i)	Enthalpy of solution of $MgSO_4$= +2874 – 1920 – 995 = – 41 kJ/ mol [1] Enthalpy of solution of $SrSO_4$= +2484 – 1480 – 995 = + 9 kJ/ mol [1]	**[2]**
	(f)(ii)	$MgSO_4$ is soluble in water as it has a negative enthalpy of solution. [1] More energy is being released on hydration than absorbed to break up the ionic solid lattice, thus resulting in a net release of energy and favouring solubility in water. [1]	**[2]**
	(f)(iii)	• Add excess strontium carbonate to nitric acid and filter to obtain a solution of strontium nitrate as the filtrate. [1] • Add strontium nitrate solution to sulfuric acid and filter to obtain strontium sulfate as the residue/ white precipitate. [1] • Wash the precipitate with distilled water/ cold water and allow it to dry on a piece of filter paper. [0]- Reject answers that suggest adding sulfuric acid to strontium carbonate Optional to include final washing and drying step for second mark.	**[2]**

Section B: Free Response Questions [10]

9	**(a)**	• Addition polymers are formed from the joining of monomers without the loss of any small molecules whereas condensation polymers are formed through the joining of monomers with the loss of a small molecule for every linkage formed. • Monomers of addition polymers must have a C=C double bond while monomers of condensation polymers must have two functional groups at both ends. Each point- [1]	**[2]**
	(b)(i)		**[1]**
	(b)(ii)	Mr of repeating unit (C_3H_6) = 3x12 + 6 = 42 No of monomers = 231 000/ 42 = 5500 [1] No of carbon atoms = 5500 x 3 = **16 500** [1]	**[2]**
	(b)(iii)	Aqueous bromine would remain reddish brown.	**[1]**
	(c)(i)	Depolymerisation is a process in which polymers are broken down into their monomers.	**[1]**
	(c)(ii)	acid  alcohol  Each momomer- [1]	**[2]**
	(c)(iii)	Chemical recycling methods, such as depolymerisation, require complex and often costly processes to break down PET into its monomers. OR Chemical recycling is time intensive as sorting and pre-treatment has to be done to remove contamination before the actual recycling process. Accept any other plausible answers.	**[1]**
10	**(a)(i)**	Condensation polymer. [1] There would be an amide linkage formed from the removal of a small molecule H_2O from the monomers. [1]	**[2]**

		Either: amide linkage or removal of a smaller molecule H_2O can be awarded 1 mark for explanation	
	(a)(ii)	 Accept condensed formula for the C & H atoms in between amide linkages.	**[1]**
	(b)(i)	The repeat unit of nylon-5,10 has a <u>longer carbon chain</u> than in nylon-6,6.	**[1]**
	(b)(ii)	Monomer 1  Monomer 2  Each momomer- [1]	**[2]**
	(b)(iii)	Mr of 1 repeat unit = 12(12) + 22 + 2(16) + 2(14) = 226 [1] No. of repeat units in polymer of Mr (12 000) = (12 000)/226 $\approx$ 53 No. of repeat units in polymer of Mr (24 000) = (24 000)/226 $\approx$ 106 Range: between 53 to 106 [1]	**[2]**
	(b)(iv)	• Plastics are non-biodegradable. They do not decompose, thus taking up space in landfill sites, reducing the amount of land available for agriculture and development, causing land pollution. • Incomplete combustion of plastics in insufficient oxygen will produce toxic gases such as carbon monoxide, causing air pollution. • Ingestion of plastic mistaken as food by marine animals can cause them to choke and die Any 2; [1] each	**[2]**