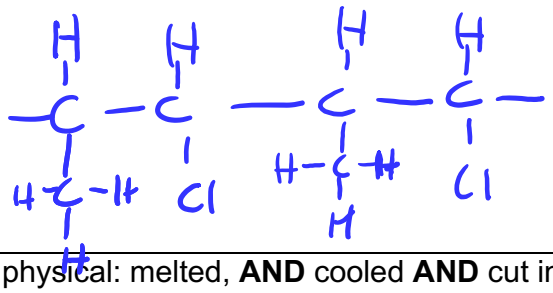
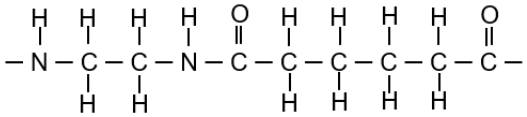
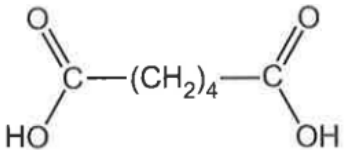
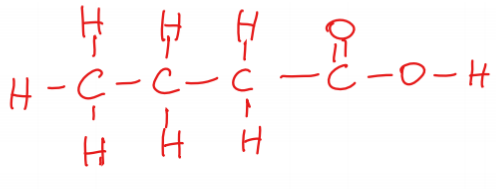
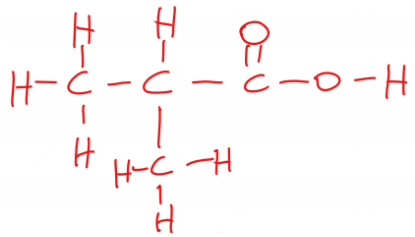
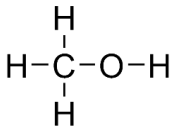
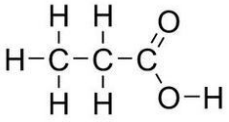
2024 Class Preliminary Examination
Chemistry
Secondary 4 Express
Suggested answers

Section A

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

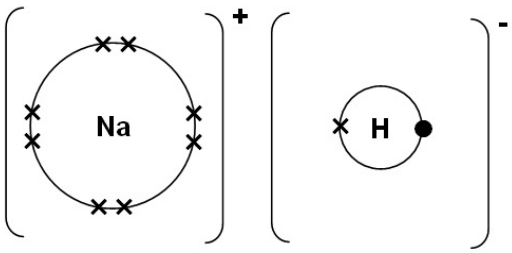
Section B

Qn	Answer	Mark
1(a)	acid: hydrochloric acid other reactant: lead(II) nitrate	[1] [1]
1(b)	nitric acid	[1]
1(c)	Iron(II) carbonate is added in excess to ensure all the acid is completely reacted / used up.	[1]
	TOTAL	**[4]**
2(a)		[1]
2(b)	physical: melted, **AND** cooled **AND** cut into pellets chemical: cracking to break into smaller molecules	[1] [1]
2(c)(i)		[1]
2(c)(ii)	similarity: The monomer 2 used to make both the polymers is the same dicarboxylic acid,  difference: The other monomer used to make this polymer is a diol but the other monomer in **(c)(i)** is a diamine.	[1] [1]
2(c)(iii)	**(c)(i)**: amide (linkage) **AND** Fig. 2.3: ester (linkage)	[1]
	TOTAL	**[7]**
3(a)	Same empirical formula **AND** M_r **AND** different arrangement of atoms / different units present.	[1]

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark</th></tr>
<tr><td>3(b)</td><td>isomer A:
 
isomer B:
  </td><td>[2]</td></tr>
<tr><td>3(c)</td><td>alcohol:
 
carboxylic acid:
  </td><td>[1]

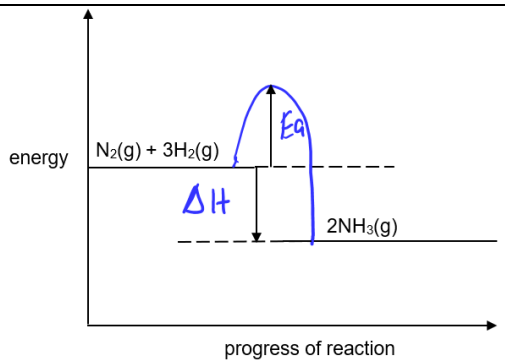
[1]</td></tr>
<tr><td>3(d)</td><td><table>
<tr><td></td><td>C</td><td>H</td><td>O</td></tr>
<tr><td>Percentage by mass</td><td>62.1</td><td>10.3</td><td>27.6</td></tr>
<tr><td>No. of moles</td><td>$\frac{62.1}{12}=5.175$</td><td>$\frac{10.3}{1}=10.3$</td><td>$\frac{27.6}{16}=1.725$</td></tr>
<tr><td>Mole ratio</td><td>$\frac{5.175}{1.725}=3$</td><td>$\frac{10.3}{1.725}\approx 6$</td><td>$\frac{1.725}{1.725}=1$</td></tr>
</table>
empirical formula: C_3H_6O</td><td>[2]</td></tr>
<tr><td></td><td>TOTAL</td><td>[7]</td></tr>
</table>

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark</th></tr>
<tr><td>4(a)</td><td>
<table>
<tr><th></th><th>true</th><th>false</th></tr>
<tr><td>Atoms lose electrons more easily down group 1.</td><td>✓</td><td></td></tr>
<tr><td>Melting point decreases from fluorine to iodine.</td><td></td><td>✓</td></tr>
<tr><td>The strongest non-metal oxidising agent is at the top of the group.</td><td>✓</td><td></td></tr>
<tr><td>Metallic character increases across Period 3.</td><td></td><td>✓</td></tr>
</table>
</td><td>[2]</td></tr>
<tr><td>4(b)</td><td>Comparison of structure:
lithium: giant metallic structure
graphite: giant molecular structure (consisting of huge network of C atoms)
oxygen: simple molecular structure consisting of discrete molecules</td><td>[1]</td></tr>
<tr><td></td><td>Comparison of bonding:
lithium: strong electrostatic forces between lithium cations and sea of electrons
graphite: strong covalent bonds between carbon atoms
oxygen: weak intermolecular forces between discrete molecules</td><td>[1]</td></tr>
<tr><td></td><td>comparison between the melting points:
Most energy needed to overcome the strong covalent bonds between carbon atoms; hence graphite has the highest melting point AND
Least energy needed to overcome weak intermolecular forces in oxygen.</td><td>[1]</td></tr>
<tr><td></td><td>Electrical conductivity comparison:
lithium: presence of delocalised / free moving / mobile electrons to conduct electricity
AND
oxygen: exist as molecules and no mobile charge carriers / no free moving electrons or ions to conduct electricity</td><td>[1]</td></tr>
</table>

Qn	Answer	Mark
	graphite: each C atom is bonded to 3 other atoms and 1 free / non-bonded electron per C atom and there are free moving electrons to conduct electricity.	[1]
	TOTAL	**[7]**
5(a)	$NaH + H_2O \rightarrow NaOH + H_2$	[1]
5(b)	If the pH of the mixture is less than 10, it is a non-metal hydride; **AND** If the pH of the mixture is more than 10, it is a metal hydride;	[1]
5(c)		[2]
5(d)	In solid state, ions held in fixed position / no free moving ions to conduct electricity.	[1]
	In molten state, giant (crystal)/ (ionic) lattice structure breaks down **AND** free moving ions to conduct electricity.	[1]
5(e)	Student 1 is correct. **AND** SiH_4 has the most number of H atoms; % by mass of hydrogen in SiH_4 = 4/28 x 100% = 12.5% This is the highest compared to the rest: Eg: 3/30 = 10% for H in AlH_3 Student 2 is wrong. **AND** Given the same number of H atoms, Eg: % of H in PH_3 = 3/34 x 100% = 8.8% % of H in AlH_3 = 3/30 x 100% = 10%	[1] [1]
	TOTAL	**[8]**
6(a)(i)	200 s	[1]
6(a)(ii)	average rate = 65/90 = <u>0.722 cm^3 / s</u>	[1]
6(b)	Gradient is larger than original / steeper **AND** Volume of gas produced is half – levels off at 45 cm^3	[1]

Qn	Answer	Mark
6(c)	Particles <u>gain energy</u> and move faster **OR** Greater fraction / more particles have energy greater than or equal to activation energy ;	[1]
	Frequency of effective collisions increases, increasing rate of reaction ;	[1]
	TOTAL	**[5]**
7(a)	6.8 **AND** Comparing experiments 1 and 4, when concentration of $S_2O_8^{2-}$ ions is constant, concentration of I^- is doubled, rate of reaction is also doubled. **AND** comparing expt 4 and 5, concentration of iodide is doubled, rate from expt 4 to 5 should be 3.4 x 2 = 6.8	[1]
7(b)	amount $S_2O_8^{2-}$ ions in both experiments = 20/1000 x 0.008 = 0.00016 mol **AND** amount of I^- ions in expt 4 = 10/1000 x 0.04 = 0.0004 mol **AND** amount of I^- ions in expt 5 = 10/1000 x 0.08 = 0.0008 mol Mole ratio: $S_2O_8^{2-}$: I^- 1 : 2 0.00016 : 0.00032 needed Since only 0.00032 mol needed to react with 0.00016 mol of $S_2O_8^{2-}$, I^- ions in excess in both experiments, hence **$S_2O_8^{2-}$ ions is the limiting reactant.**	[1] [1]
	TOTAL	**[3]**
8(a)(i)	Reacts / dissolves in rain water to form acid rain **AND** Corrodes metal and limestone buildings	[1]
8(a)(ii)	equation in stage 1: $SO_2 + H_2O \rightarrow H_2SO_3$ equation in stage 2: $H_2SO_3 + CaCO_3 \rightarrow CaSO_3 + H_2O + CO_2$	[1] [1]

Qn	Answer	Mark
8(b)(i)	As air to fuel ratio is higher, • higher concentration of O_2 in air • occurrence of incomplete combustion of petrol is less **AND** • lead to less carbon monoxide formed. As the temperature of the internal combustion engine is lower, • O_2 and N_2 from air will less likely combine to form nitrogen monoxide. • lead to less nitrogen monoxide formed.	[1] [1] [1]
8(b)(ii)	$2CO + 2NO \rightarrow N_2 + 2CO_2$	[1]
8(b)(iii)	Oxidation state of carbon increases from +2 in CO to +4 in CO_2; hence carbon undergoes oxidation. Oxidation state of nitrogen decreases from +2 in NO to 0 in N_2; hence nitrogen undergoes reduction.	[1] [1]
	TOTAL	**[9]**
9(a)	propyne	[1]
9(b)	C_nH_{2n-2}	[1]
9(c)(i)	Energy absorbed to break 1 mole of C≡C bond, 2 moles of C – H bonds and 2.5 moles of O=O bonds is <u>less</u> than the energy released to make 2 moles of O – H bonds and 4 moles of C=O bonds.	[2]
9(c)(ii)	Amount of C_2H_2 = 1000/24 = 41.67 / 41.7 mol Energy released = 41.67 x 1410 = 58 750 kJ / 58 800 kJ	[1] [1]
9(d)(i)	$C_2H_2Br_2$ / $C_2H_2Br_4$	[1]
9(d)(ii)	Reddish-brown aqueous bromine turns colourless.	[1]
	TOTAL	**[8]**
10(a)	Forward reaction rate decreases over time, while backward reaction rate increases. Eventually, both forward and backward reaction rates are equal/same.	[1] [1]

Qn	Answer	Mark
10(b)		[3]
10(c)	turned yellow/ orange	[1]
	idea of hydroxide ions reacting with hydrogen ions **AND** increase / shift towards the forward reaction / more $Meor^-$ is present in equilibrium	[1]
10(d)	3 moles of gaseous reactant and 1 mole of gaseous product / counteract the decrease in pressure / to increase pressure;	[1]
	shift towards the backward reaction **AND** less methanol produced as pressure decreases	[1]
10(e)(i)	percentage of PCl_3 increases as temperature increases;	[1]
10(e)(ii)	increase temperature, more PCl_3 formed hence shift towards the forward reaction to remove the heat "disturbance"	[1]
	forward reaction must be endothermic, (as reaction mixture absorbs heat)	[1]
	TOTAL	**[12]**

Section C

Qn	Answer	Mark
11(a)	**similarity at negative electrodes:** At the negative electrode: H^+ ions selectively discharged (over K^+) in both electrolytes as hydrogen is below potassium in the reactivity series; **AND** $2H^+(aq) + 2e^- \rightarrow H_2(g)$	[1]
	Electrolysis of dilute potassium chloride: **At the positive electrode:** OH^- ions selectively discharged (over Cl^- ions), forming oxygen gas; **AND** $4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$	[1]
	electrolysis of concentrated potassium chloride: **At the positive electrode:** Cl^- ions selectively discharged over OH^- ions as higher concentration of chloride ions, forming chlorine gas. **AND** $2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$	[1]
	Electrolysis of dilute potassium chloride: **Electrolyte:** K^+ and Cl^- ions remain in the electrolyte, Universal Indicator remains green.	[1]
	electrolysis of concentrated potassium chloride: **Electrolyte:** K^+ and OH^- ions remain in the electrolyte, increase in concentration of OH^- ions over H^+ ions. Universal Indicator changes from green to violet / purple / blue.	[1]
11(b)(i)	negative electrode: iron structure / iron / support **AND** positive electrode: metal brush	[1]
11b(ii)	$Cu^{2+} + 2e^- \rightarrow Cu$	[1]
11(b)(iii)	effect: concentration of Cu^{2+} ions remains the same / unchanged	[1]
	effect: concentration of Cu^{2+} ions decreases	[1]

Qn	Answer	Mark
11(b)(iv)	Copper brush will be oxidised to form Cu^{2+} ions and will dissolve. **AND** Platinum is inert and will not be oxidised.	[1]
	TOTAL	**[10]**
12(a)	zinc electrode: zinc is more reactive than copper and hence is preferentially oxidised. **AND** $Zn \rightarrow Zn^{2+} + 2e^-$	[1]
	H^+ ions are selectively discharged as hydrogen is below zinc in the reactivity series, at the copper electrode. **AND** $2H^+ + 2e^- \rightarrow H_2$	[1]
	observation at zinc rod: zinc dissolves / decreases in mass / size	[1]
	observation at copper rod: bubbles of gas observed	[1]
12(b)(i)	Volume of ethanol = (12 x 2 + 5 + 16 + 1) / 789 = 0.0583 dm^3 Mass of 1 mole of H_2 = 2 g 1 g produces 143 kJ 2 g (1 mol) = 143 x 2 = 286 kJ produced –286 kJ/mol Mass of 1 mole of ethanol = 46 g 1 g of ethanol produces 1367/46 = –29.7 kJ / g	[1] [1] [1]
12(b)(ii)	Burning the same mass of hydrogen produces / releases more energy than burning ethanol; 143 kJ for 1 g hydrogen compared to 29.7 kJ for 1 g of ethanol. **OR** Burning the same amount of hydrogen produces less energy than burning ethanol; 286 kJ for 1 mol of hydrogen compared to 1367 kJ for 1 mol of ethanol	[1]
	At r.t.p, ethanol is a liquid while hydrogen exist as a gas. H_2 will occupy a larger volume for storage of 24 dm^3 compared to ethanol of 0.0583 dm^3 for 1 mol of each fuel.	[1]

Qn	Answer	Mark
	OR Density of hydrogen of 0.083 g/dm^3 is smaller than density of ethanol of 789 g/dm^3, indicating less mass of hydrogen can be stored in fixed volume.	
12(b)(iii)	Ethanol obtained from glucose **AND** glucose is obtained from plants which can be regrown and replaced within a short period of time.	[1]
	TOTAL	**[10]**