A – Z School's Preliminary Papers
4 Express
Chemistry

ANSWERS: Part 2

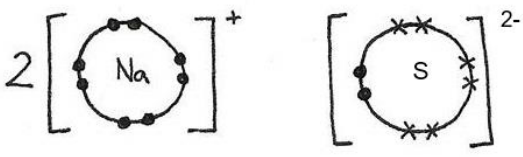
F	Fuhua Secondary School
G	Geylang Methodist School (Secondary)
H	Hua Yi Secondary School
I	Holy Innocents' High School
J	Juying Secondary School

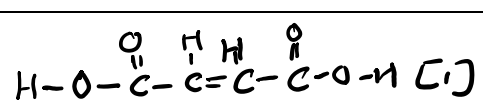
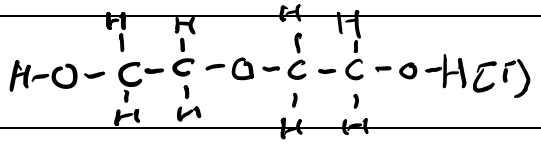
FUHUA SECONDARY SCHOOL

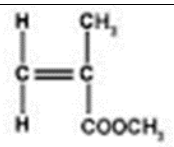
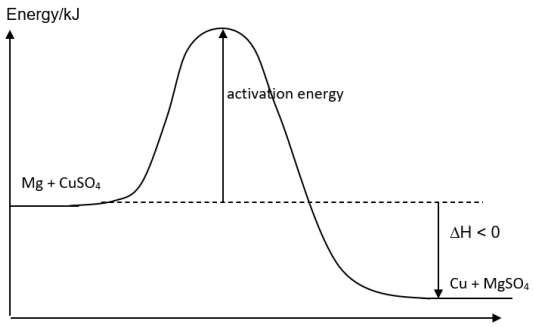
Paper 1

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

Paper 2

Q	Answer	Ma	Remarks
1a	Rb and F	1	
bi	Na and S	1	
bii	 two ions of Na^+ [1] and one ion of S^{2-} [1]	2	e.c.f from bi
c	Al and Zn	1	
d	Meting point decreases and reactivity increases down Group I. [1] Melting point increases and reactivity decreases down Group VII. [1]	2	
e	$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$	1	

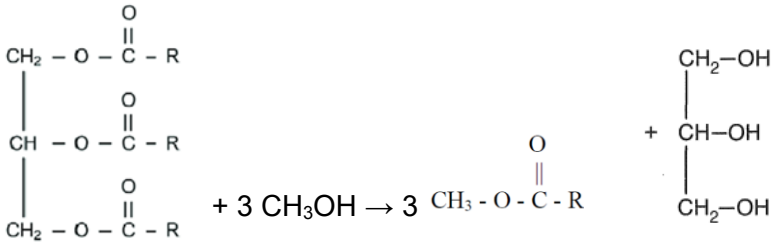
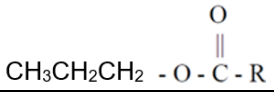
2ai	$6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$	1	
ii	Oxidation state of nitrogen increases from -3 in NH_3 to 0 in N_2. Hence ammonia is oxidised. [1] Oxidation state of nitrogen decreases from +2 in NO to 0 in N_2. Hence NO is reduced. [1]	2	
b	NO will react with oxygen to form NO_2, which reacts with water and oxygen to form nitric acid which **<u>dissolves in water; to form acid rain</u>** which erodes limestone buildings and corrodes metallic structures / kills aquatic life by lowering the pH of water bodies.[1]	1 1	
c	Any one of the following • Producing ammonia on-site is easier as minimum storage and transportation of ammonia is required. • Not producing ammonia on-site means ammonia, being a gas, must be stored in thick pressurised containers which are heavy and difficult to transport. • Do not need to burn fuels during transportation so less greenhouse gas pollution.	1	REJECT gas escapes/ recycled gases as other plants also can. time used for transportation
d	At high temperature, the urea and water have more kinetic energy and collide more frequently [;] More urea and water particles collide with energy greater than or equal to the activation energy [;] Leading to higher frequency of effective collisions between urea and water. [;]		3; [2] 1-2; [1]
e	Ammonia has a simple molecular structure [;] with weak intermolecular forces of attraction between molecules [;] hence little amount of energy taken in to overcome the forces. [;]	2	3; [2] 1-2; [1]
	Total	10 marks	
3a	1000	1	
b	Add aqueous bromine to samples of each polymer separately.[1] If reddish-brown aqueous bromine decolourises rapidly, sample is A. If aqueous bromine remains reddish-brown, then sample is C. [1]	2	
c	False, True, True, False	2	4 √ : [2] 2-3 √ : [1]
d	 	2	Must show all bonds

ei		1	
eii	Methanol, CH_3OH	1	
eiii	I disagree. Butanoic acid formula is C_3H_7COOH but this acid formula is C_3H_5COOH OR butanoic acid does not have C=C but this acid contains a C=C.	1	
f	Disadvantage: Polymer can only be disposed off by burying in landfills which will lead to land or air pollution.[1] Advantage: Polymer is durable and resistant to corrosion. [1]	2	
	Total	12 marks	
4a	Magnesium is less reactive than calcium and sodium. Hence magnesium cannot displace calcium and sodium from the corresponding salt solutions and there is no reaction.	1	
bi	> 14.0 °C and < 32.0 °C	1	
ii	$Mg (s) + Fe^{2+}(aq) \rightarrow Mg^{2+}(aq) + Fe(s)$	1	
iii	Less than 19.0 °C [;] Since ethanoic acid is monobasic, same concentration and volume of ethanoic acid gives **<u>half the no of moles of H^+ ions</u>**[;] compared to H_2SO_4 which is dibasic[;], Ethanoic acid is a weak acid and some heat energy is taken in to dissociate the ethanoic acid molecules that are reformed. amount of heat energy released is less than half that for sulfuric acid. [;]	3	4; [3] 2-3 [2] 1; [1]
c	activation energy (arrowhead upwards) ΔH(arrowhead downwards wards) Label reactants & products  	2	3;[2] 1-2; [1]
	Total	8 marks	
5ai	X: -ve, Y: +ve	1	
ii	$2H_2O \rightarrow 2H_2 + O_2$	1	
iii	Similarity: At R, Colourless and odourless hydrogen gas would be produced. [1] Difference: At S, oxygen gas would be produced for dilute magnesium chloride while chlorine gas would be produced for concentrated magnesium chloride. [1]	2	
bi	electrode P: $M^{2+}(aq) + 2e \rightarrow M(s)$ [1] electrode Q: $M (s) \rightarrow M^{2+}(aq) + 2e$ [1]	1	ecf from ai
ii	Reddish brown solid deposited at P.	2	ecf from ai
iii	Volume of hydrogen gas = 300 cm^3 Moles of hydrogen gas = $\frac{300}{24000} = 0.0125$ [1] $2H^+(aq) + 2e \rightarrow H_2(g)$ $Cu(s) \rightarrow Cu^{2+}(aq) + 2e$ Change in mass of Q = 0.0125 × 64 = 0.800 g [1]	2	

c			Cell 1	Cell 2	3	4; [3] 2-3;[2] 1; [1]
		pH	7	7		
		reasoning	Cu anode is selectively oxidised while Cu^{2+} ions are reduced at the cathode. Concentration of H^+ and OH^- remained unchanged. [;]	OH^- and H^+ ions are discharged at anode and cathode respectively. Volume of water decreases, however concentration of H^+ = concentration of OH^-. [;]		
				Total		12 marks

Section B [30 marks]

Q	Answer	M	Remarks
6ai	H^+ ion has one proton but no neutron or electron.	1	
ii	HNO_3 + H_2SO_4 ⇌ $H_2NO_3^+$ + HSO_4^- base conjugate acid CH_3NH_2 + H_2O ⇌ $CH_3NH_3^+$ + OH^- acid conjugate acid	2	*2 boxes 1 mark*
b	K_a increases from 6.4×10^{-4} for HF acid to 3.2×10^{9} for HI acid. Hence strength of acid increases from HF to HI. [1] The Σ decreases from 1.8 for H-F bond to 1.3 for H-I bond, indicating polarity of the bond decreases. [1] Hence, the more polar the H-X bond, the weaker the acid. Student 1 is incorrect. The bond energy decreases from 566 kJ/mol for H-F to 298 kJ/mol for H-I bond, less energy taken in to break the H-X bond. [1] Hence, the lesser energy taken in to break the H-X bond, the easier the acid ionises in aqueous solution and the stronger the acid. [1] Student 2 is correct.	4	
c	One factor is the number of oxygen atom present in the oxoacid. [1] HNO_3 (2.8×10^{1}) has a higher Ka then HNO_2 (4.5×10^{-4}). Hence HNO_3 has one more oxygen atom is stronger than HNO_2. [1] OR H_2SO_4 (1.0×10^{3}has a higher Ka then H_2SO_3 (1.4×10^{-2}). Hence H_2SO_4 has one more oxygen atom is stronger than H_2SO_3. The other factor is the position of the non-metallic element Y in the Periodic Table. [1] The strength of oxocids increases when the non-metallic element used is changed from Group V to VII. Across the period from P to C*l*, K_a increases from 7.1×10^{-3} for H_3PO_4 to 1.0×10^{10} for $HClO_4$. OR C to N increases for 4.5×10^{-7} for H_2CO_3 to 2.8×10^{1} for HNO_3 [1]	4	
	Total	11 marks	
7a	Mass of CO_2 given off = 0.25 g Moles of $PbCO_3$ = Moles of CO_2 = 0.25 / 44 = 0.0056818 [1] Mass of $PbCO_3$= 0.0056818 × (207 + 12 + 3 × 16) = 1.5170 g % purity of $PbCO_3$ sample = 1.517 / 2.00 × 100% = 75.9% [1]	2	
bi	steeper gradient but yield lower at above 125.75	1	.
ii	Lead (II) carbonate reacts with sulfuric acid to form **insoluble** lead(II) sulfate which **coats** around lead(II) carbonate **prevents it from further reaction** with acid, giving a low yield of carbon dioxide gas **AND** Sulfuric acid is a dibasic acid which will give twice the concentration of H^+ ions leading to a faster rate of reaction.	1	
ci	gentler gradient and yield same at 125.75.	1	
ii	Ethanoic acid dissociate partially in aqueous solution to produce H+ ions [;] Ethanoic acid produces a lower initial concentration of H^+ ions in aqueous solution than hydrochloric acid [;] Hence produces a slower initial rate of reaction. However, same mass/moles of the limiting reactant $PbCO_3$ is used and hence gives the same yield of gas. [;]	2	

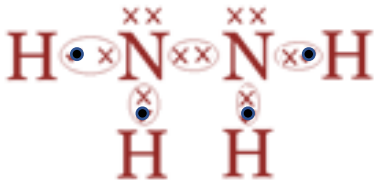
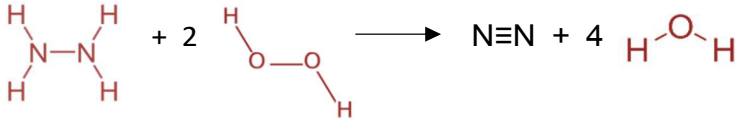
d	Add aqueous lead(II) nitrate to a fixed volume of aqueous sodium carbonate till no precipitate is formed. [1] Filter the mixture to remove lead(II) carbonate as residue. AND Wash the residue with distilled water and leave the precipitate to dry. [1]	2	
	Total	9 marks	
E 8ai	Cracking AND Mixture of aluminium oxide and silicon(IV) oxide / aluminium oxide / silicon(IV) oxide catalyst [1]	1	
ii	$C_4H_{10} \rightarrow CH_4 + C_3H_6$ [1]	1	
iii	Add acidified potassium manganate(VII) and warm the mixture [1] If acidified potassium manganate(VII) remains purple, C is 100% converted to D [1]	2	
bi	correct formula for all the structures [1] balanced chemical equation [1] 	2	
ii	A glycerol molecule contains 3 hydroxyl/-OH functional groups.	1	
iii		1	
iv	Advantage: The source of biodiesel is processed is vegetable oils / plants which are renewable resource while source of petrol diesel is non-renewable and would run out one day. Disadvantage: Biodiesel burns less easily which more lead to engine damage over time / releases more pollutants. [1] / longer ignition delay as more time is required to burn	2	
	Total	10 marks	
OR 8ai	In step 1, CFCs break down to produce chlorine atoms.[;] C*l* consumed when reacting with O_3 in the second step [;] is regenerated when C*l*O reacts with O• in the third step [;] There is no net loss of C*l* atom which will react with O_3 repeatedly. [1]	2	Explanation on reaction steps 3; [1]
ii	C-Cl has lower bond energy than C-F [1] Lesser energy taken in to break (one mole) of C-Cl bonds releasing Cl atoms in the atmosphere. [1]	2	
bi	Similarity [1]: Both metal oxides are reduced by carbon monoxide. Difference [1]: Zinc is collected as vapour / at the top of the furnace while iron is collected in molten state / at the bottom of the furnace.	2	
ii	$CaCO_3 \rightarrow CaO + CO_2$ $CaO + SiO_2 \rightarrow CaSiO_3$ [1] for both equations Calcium carbonate decomposes to form calcium oxide[;], a basic oxide [;], reacts with the impurity acidic oxide [;], SiO_2/ sand/ acidic impurities to form slag.[;] [1]	2	4; [1]
iii	Zinc is more reactive than iron, and loses / transfers electrons more readily than iron, and gets oxidised in place of iron. Zinc acts as a sacrificial metal. [1] Iron is more reactive than copper, hence iron loses / transfers electrons more readily and gets oxidised instead. [1]	2	
	Total	10 marks	

GEYLANG METHODIST SCHOOL (SECONDARY)

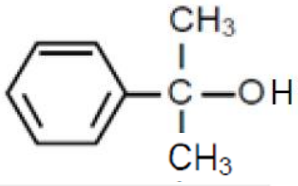
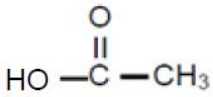
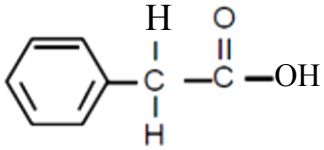
Paper 1

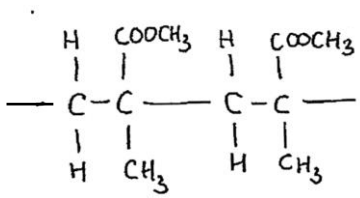
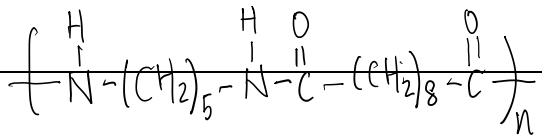
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
C	C	D	A	B	B	A	C	C	B
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	B	B	B	D	C	A	B	D	B
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
A	B	D	B	D	B	B	C	B	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**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

Paper 2

A1	**(a)**	A	**[1]**
	(b)	C	**[1]**
	(c)	E	**[1]**
	(d)	F	**[1]**
A2	**(a)**	Yellow and purple ***Both colours to state correctly to be awarded 1 mark.**	**[1]**
	(b)	R_f of blue dye = 0.72 Accept a range from 0.70 – 0.75	**[1]**
	(c)	Pure water is not suitable because in water, R_f value for yellow dye is 0. This means that the yellow dye may be insoluble in pure water and cannot be identified.	**[1]** **[1]**
A3	**(a)(i)**	Ammonia	**[1]**
	(a)(ii)	Place a moist / damp red litmus paper over the mouth of test tube, if gas is ammonia, it will turn from red to blue. Or The gas turns damp red litmus blue	**[1]**
	(b)	Aluminium chloride solution	**[1]**
	(c)(i)	Dilute nitric acid was added to **eliminate the possibility of the presence of carbonate ions** which might also give a white precipitate with the reagent.	**[1]**
	(c)(ii)	No visible observation indicates carbonate ions are absent.	**[1]**
A4	**(a)(i)**	 **[1]** for correct bonding **[1]** for correct number of valence electrons	**[2]**
	(ii)	H_2O_2 has a **simple covalent structure** consisting discrete molecules which are electrically neutral / all the valence electrons are used in bonding. There are **no mobile electrons/ions** for the conduction of electricity.	**[1]** **[1]**
	(b)(i)	The **energy taken in/absorbed** to break the bonds in **1 mole** of N_2H_4 and **2 moles** of H_2O_2 is **less than** the **energy released** to form the bonds in **1 mole** of N_2 and **4 moles** of H_2O. Hence energy is released to the surroundings.	**[1]** **[1]**
	(ii)	 $\Delta H = 4(+391) + 1(+160) + 4(+463) + 2(y) + 1(-941) + 8(-463)$ $-777 = 4(+391) + 1(+160) + 4(+463) + 2(y) + 1(-941) + 8(-463)$ y = 146 kJ/mol	**[1]** **[1]**

	(c)	N_2H_4 (*l*) + 2 H_2O_2 (aq) → N_2 (g) + 4 H_2O (g)	
	(i)	no. of mole of hydrazine = $\frac{100\,000}{2(14) + 1(4)}$ = 3125 mol	**[1]**
	(ii)	no. of mole of hydrogen peroxide = $\frac{200\,000}{1(2) + 2(16)}$ = 5882.4 = 5880 mol	**[1]** **[1]**
	(iii)	**Hydrogen peroxide** is the limiting reactant.	
	(iv)	Energy released = $\frac{5882.4}{2} \times 777$ = 2.29 X 10^6 kJ	**[1]**
A5	**(a)**	oxidizing agent: NO_3^- reducing agent: S	**[1]** **[1]**
	(b)	NO_3^- is reduced as the oxidation state of nitrogen decreases from +5 in NO_3^- to +2 in NO. S is oxidised as the oxidation state of sulfur increases from 0 in S to +4 in SO_2.	**[1]** **[1]**
A6	**(a)**	Cu^{2+} (aq) + $2e^-$ ⟶ Cu (s)	**[1]**
	(b)	Zn (s) + Cu^{2+} (aq) ⟶ Zn^{2+} (aq) + Cu (s)	**[1]**
	(c)	Zinc electrode / negative electrode/ (zinc) anode dissolves in cell **B**. Reddish-brown copper formed on zinc electrode in cell A. Reddish-brown copper formed on copper electrode in cell B. No effervescence in cell B, effervescence in cell A as oxygen is produced.	**[1]**
	(d)	Zinc is **more reactive** than iron / zinc is above iron in reactivity series; thus zinc is oxidised before iron / zinc acts as sacrificial metal /	**[1]** **[1]**

		zinc loses electrons more readily than iron.	
A7	**(a)(i)**	Solid	**[1]**
	(ii)	The temperature in the flask is 25°C, which is lower than the melting point of iron (III) chloride, which is 308 °C.	**[1]**
	(iii)	It's **cooler in the flask** than in the ceramic boat where it would have remained in gaseous state since the temperature is 1000°C, far above the boiling point of iron (III) chloride of 315 °C, which **would have existed as a gas.**	**[1]**
	(b)(i)	Reduction / Decomposition / Redox reaction	**[1]**
	(ii)	$FeCl_2$	**[1]**
A8	**(a)(i)**	It has a functional group named **ester**.	**[1]**
	(a)(ii)	Alcohol  Carboxylic acid 	**[1]** **[1]**
	(b)(i)	**Add acidified potassium manganate(VII) solution** to each sample of top note compound and middle note compound. If the acidified potassium manganate(VII) solution **turned from purple to colourless, the sample is middle note**. If the acidified potassium manganate(VII) solution remained purple, the sample is top note. OR **Add acidified potassium dichromate(VI) solution** to each sample, if the solution turned **from orange to green**, the sample is middle note or if the solution remained green, the sample is top note. (out of syllabus, but if student writes this answer, award them)	**[1]** **[1]**
	(b)(ii)	2-phenylethanoic acid 	**[1]** **[1]**
	(c)(i)	The end note compound has carbon-carbon double bonds.	**[1]**
	(c)(ii)	Temperature of **200°C** and the catalyst used is **nickel**.	**[1]**
	(c)(iii)	1 mol of end note reacts with 1 mol of iodine. No of moles of end note = 100/250 = 0.4 mol No of moles of iodine = 0.4 mol	**[1]**

		Mass of iodine =0.4 X 2 X127 =101.6 = 102 (3sf) Iodine value is **101.6/102.**	**[1]**
B9	**(a)**	The second ionization energy decreases down the Group II elements.	**[1]**
	(b)	Energy required to form 1 mole of Ca^{2+} ions = 589 + 1145 = 1734 kJ No. of moles of Ca atoms = 1/40 = 0.025 mol Energy required = 1734 x 0.025 = 43.4 kJ	**[1]** **[1]** **[1]**
	(c)	The relative molecular mass / molar mass of beryllium carbonate to calcium carbonate increases, the number of moles of the carbonate decreases, hence the volume of carbon dioxide decreases.	**[1]** **[1]**
	(d)	The temperature is not high enough to decompose the carbonates.	**[1]**
	(e)	No. of moles of CO_2 = 122/24000 = 0.0050833 mol No. of moles of XCO_3 = 0.0050833 mol Molar mass of XCO_3 = 1/0.0050833 = 196.72 g/mol Molar mass of X = 196.72 – (12 + 16 x 3) = 136.7 g/mol *accept even if it not 3 sf* ≈137 g/mol [Ar of Ba = 137]	 **[1]** **[1]** **[1]**
B10	**(a)**	methanol	**[1]**
	(b)	addition polymerization poly(methyl methacrylate)	**[1]** **[1]**
	(c)	 correct structure / bonding; [1] 2 repeat units [1] minus [1] if only show 1 repeat unit	**[2]**
	(d) (i)	The reddish-brown solution remains unchanged / reddish-brown solution observed.	**[1]**
	(ii)	Perspex is a <u>saturated</u> organic <u>molecule / compound / polymer.</u>	**[1]**
	(e)	 correct structure/bonding; [1]	**[2]**

<table>
<tr><td></td><td>(f)</td><td>• There is no mass loss in the polymerisation of Perspex while Nylon-5,10 has a lower mass than the monomers used in the polymerisation.
• No loss of water molecule in the polymerisation of Perspex while in that of Nylon-5,10 there was loss of water molecules.
• The linkages <u>formed between the monomers</u> are different.</td><td>[1]

[any one]</td></tr>
<tr><td>B11 E</td><td>(a) (i)</td><td>
<table>
<tr><th>solution</th><th colspan="2">name of products of electrolysis</th><th>ionic equation for reaction at each electrode</th></tr>
<tr><td rowspan="2">dilute copper (II) sulfate solution</td><td>at anode</td><td>oxygen</td><td>$4\ OH^-(aq) \rightarrow O_2\ (g) + 2\ H_2O(l) + 4e^-$</td></tr>
<tr><td>at cathode</td><td>copper</td><td>$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$</td></tr>
<tr><td rowspan="2">concentrated sodium chloride solution</td><td>at anode</td><td>chlorine gas</td><td>$2Cl\ (aq) \rightarrow Cl_2\ (g) + 2e-$</td></tr>
<tr><td>at cathode</td><td>hydrogen gas</td><td>$2H^+\ (aq) + 2e- \rightarrow H_2\ (g)$</td></tr>
<tr><td rowspan="2">silver nitrate solution</td><td>at anode</td><td>oxygen</td><td>$4\ OH^-(aq) \rightarrow O_2\ (g) + 2H_2O(l) + 4e^-$</td></tr>
<tr><td>at cathode</td><td>silver</td><td>$Ag^+\ (aq) + e^- \rightarrow Ag\ (s)$</td></tr>
</table>
</td><td>[1]

for each correct row of answers</td></tr>
<tr><td></td><td>(ii)</td><td>To identify solution A:
<u>Add aqueous sodium hydroxide</u> into the solutions. The solution that <u>produces a blue precipitate</u> of <u>copper(II) hydroxide</u> is the solution from Cell A.

OR

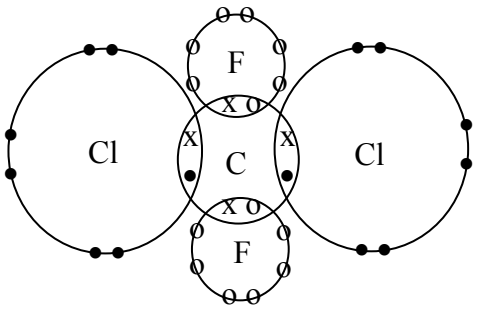
Add <u>acidified barium nitrate</u> into each solutions, and the solution that <u>produces a white precipitate</u> due to formation of <u>barium sulfate</u> is solution from Cell A. ;

To identify Solution B:
Add <u>acidified silver nitrate</u> into the remaining solutions. The solution that <u>forms a white precipitate</u> of <u>silver chloride</u> is <u>solution B</u>.

The last solution would be Cell C solution.</td><td>[1]

[1]

[1]</td></tr>
</table>

		The **last mark** goes **to student who correctly identified the <u>names of the precipitates</u>** formed from their process. **OR** **Displacement reaction:** Add copper into the 3 solutions. The mixture <u>silver deposit</u> is solution from cell **C**. Add zinc into the remaining 2 solutions. The mixture <u>with pink / reddish brown deposit</u> is solution from cell **A**. The last solution will be concentration sodium chloride from cell **B**.	**[1]** **[1]** **[1]**
	(b)	• Add <u>any soluble radium salt</u> e.g. <u>aqueous</u> radium nitrate to <u>any soluble sulfate salt</u> e.g. sodium sulfate. • <u>Filter</u> the mixture and <u>keep the residue</u>. • <u>Wash residue</u> with a <u>little deionised water</u>, and <u>press dry between sheets of filter paper</u>.	**[1]** **[1]** **[1]**
B11 OR	**(a)(i)**	 • = electron of chlorine x = electron of carbon o = electron of fluorine	**[2]** 1 (for every 2 correct atomic str)
	(a)(ii)	Substitution reaction	**[1]**
	(a)(iii)	In the presence of sunlight, CFCs decompose to form chlorine atoms. The chlorine atoms react with the ozone molecules to form chlorine oxide and oxygen, thus destroying the ozone layer.	**[1]** **[1]**
	(a)(iv)	It filters/shields/screens the earth from **<u>excessive</u>** UV radiation / light that could lead to increased incidence of skin cancer / genetic mutation / eye damage or cataract in man.	**[1]**

Paper 1

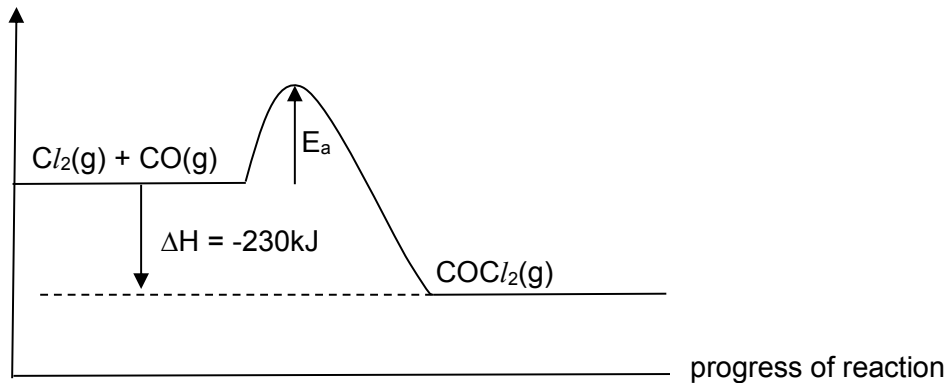
Q1	C
Q2	D
Q3	C
Q4	C
Q5	B
Q6	A
Q7	D
Q8	D
Q9	A
Q10	A
Q11	C
Q12	D
Q13	B
Q14	D
Q15	B
Q16	C
Q17	A
Q18	B
Q19	B
Q20	D

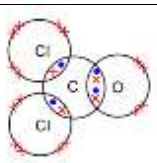
Q21	C
Q22	D
Q23	D
Q24	C
Q25	D
Q26	B
Q27	A
Q28	B
Q29	D
Q30	D
Q31	A
Q32	C
Q33	A
Q34	A
Q35	A
Q36	B
Q37	C
Q38	A
Q39	B
Q40	C

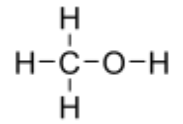
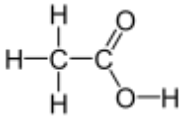
Paper 2

A1	**(ai)**	A*l*	1
	(aii)	C*l*	1
	(aiii)	Si or A*l*	1
	(aiv)	Ar	1
	(av)	Na	1
	(b)	Sulfur dioxide has a <u>simple molecular structure</u>, with <u>weak intermolecular forces of attraction</u> between molecules. Thus, <u>little energy is needed to overcome these forces of attraction</u>, therefore, it has a <u>low melting point</u>. However, silicon dioxide has a <u>giant molecular structure</u> with <u>strong covalent bonds</u> between a large number of silicon and oxygen atoms. <u>A large amount of energy is needed to break / overcome these strong covalent bonds</u>. Thus, it has a <u>high melting point</u>.	3

A2	**(a)**	The first ionisation energy decreases down Group I. [1] As the atomic radius for elements increases down Group I, the negatively charged valence electrons are further away from the (positive) nucleus, [1] thus, less energy is required for the atoms to lose one valence electron, as a weaker force of attraction between the nucleus and valence electrons. [1]	3
	(b)	Potassium is more reactive than sodium [1] as potassium has a lower ionisation energy of around 410 kJ/mol as compared to sodium of around 495 kJ/mol. Hence, it is easier/requires less energy for potassium to lose its valence electron. [1] [Reject if no mention of valence electrons]	2
	(c)	Yes, both isotopes have the same number of protons and electrons, thus, force of attraction between the valence electron and (positive) nucleus is the same.	1
	(d)	Neon has a fully filled valence shell, thus, is stable / unreactive and a great amount of energy is needed to remove a valence electron.	1
			total: 7
A3	**(ai)**	In a normal engine, temperatures are very high, thus, nitrogen combines with oxygen in the air to form nitrogen monoxide.	1
	(aii)	A 'lean burn' engine has a lower operating temperature, thus, the reaction between nitrogen and oxygen in the air is slower / lesser. Therefore, lesser volume of nitrogen oxides produced.	1

	(bi)	Carbon monoxide is formed due to the incomplete combustion of petrol / carbon containing fuels in car engines.	1
	(bii)	A lean burn engine has more air mixed with petrol, thus, having more oxygen for petrol / hydrocarbons to combust completely.	1
	(ci)	$2CO + 2NO \rightarrow 2CO_2 + N_2$	1
	(cii)	Carbon dioxide is a greenhouse gas, which contributes to global warming.	1
	(d)	Volume of SO_2 in 5 dm^3 of polluted air = 2.5/100 X 5 = 0.125 dm^3 No of moles of SO_2 = 0.125/24 = 0.0052083 mol [1] Mole ratio of SO_2 : MnO_4^- 5 : 2 0.0052083 mol : 0.0020833 mol [1] Volume of solution = 0.0020833/0.2 = 0.010416 dm^3 = 0.0104 dm^3 (3s.f) [1]	3
			total: 9
A4	**(a)**	The oxidation state of chlorine decreases from 0 in Cl_2 to -1 in $COCl_2$, thus, chlorine is reduced. [1] The oxidation state of carbon increases from +2 in CO to +4 in $COCl_2$, thus, carbon in CO is oxidised. [1] Since both oxidation and reduction happens simultaneously, this is a redox reaction.	2
	(b)	71g of chlorine → 230 kJ of energy released 1g of chlorine → 3.24 kJ of energy released Enthalpy change = -3.24 kJ	1
	(c)	energy  *1 mark for correct shape of graph* *1 mark for reactants and products* *1 mark for correct arrows for E_a and numeric labels of ΔH*	3
	(d)	This is a reversible reaction, thus, the backward reaction is happening at the same time OR This is a reversible reaction, thus, chlorine and carbon monoxides can be formed from phosgene gas OR some of phosgene gas will decompose/breakdown to form chlorine and carbon monoxide gas.	1

	(e)	 *1 mark for correct bonding (sharing of electrons)* *1 mark for correct electron arrangement and ratio of atoms*	2
	(f)	The rate of reaction for bromine and carbon monoxide would be lower / decreases. Bromine is below chlorine in Group VII, thus, it is less reactive than chlorine, and the rate of reaction decreases.	1
			total: 10
A5	**(ai)**	$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2SO_4^{2-}(aq)$	1
	(aii)	Fe^{2+} is added / is one of the reactants in stage 1 and is regenerated / is one of the products in stage 2, thus, it is not used up during the reaction.	1
	(b)	Comparing expt 1 and 2, when concentration is halved, time taken for reaction to complete is doubled. (or any comparison of experiments from the table). Higher concentration of peroxodisulfate ions increases the number of reacting particles per unit volume. [1] Frequency of collisions increases, thus frequency of effective collisions increases, increasing the rate of reaction, thus, time taken for reaction to complete decreases. [1]	2
	(c)	Add excess sodium hydroxide / aqueous ammonia, a dirty green precipitate of $Fe(OH)_2$ will be formed. [1] Filter out the dirty green precipitate. [1]	2
	(d)	0.075 mol/dm^3	1
			total: 7
A6	**(ai)**	copper electrode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$ [1] zinc electrode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ [1]	2
	(aii)	Magnesium and copper are further apart in the reactivity series [1] as compared to zinc and copper, thus, voltage increases [1].	2
	(bi)	Zinc electrode decreases in size in Fig. 6.1, but reddish brown deposits formed on zinc electrode in Fig. 6.2.	1
	(bii)	Blue solution fades / turns colourless. [1] Zinc is more reactive than copper, thus, displaces copper from copper(II) sulfate solution. [1]	2
	(c)	Negative electrode: copper / copper metal [1] Positive electrode: copper (II) ions [1]	2
			total: 9

B7	**(a)**	 [1]  [1]	2
	(b)	Propanoic acid and methyl ethanoate have the <u>same molecular formula of $C_3H_6O_2$ but different structural formula</u>. Propanoic acid has the functional group -COOH, while methyl ethanoate has an ester linkage linking the methyl groups together.	1
	(c)	Substance A: methyl ethanoate Substance B: propanoic acid [1] The IR spectrum for substance B <u>has a broad peak at wavenumber 3000 cm^{-1}</u>, which corresponds with the absorption range of the O-H bond in carboxylic acids. <u>There is an absence of a peak in the IR spectrum for substance A at wavenumber 3000 cm^{-1}.</u> [1] The IR spectrum for substance A <u>has a peak at wavenumber 1750 cm^{-1}, (accept 1745 – 1750 cm^{-1}) which corresponds with the absorption range of the C=O bond in esters</u>. The IR spectrum for substance B <u>has a peak at wavenumber 1710 cm^{-1}, (accept 1630 to 1725 cm^{-1}) which corresponds with the absorption range of the C=O bond in carboxylic acids.</u> [1]	3
	(d)	Compounds of the same homologous series has the <u>same functional group</u>. IR is used to determine functional groups in organic compounds, thus, cannot be used to differentiate compounds in the same homologous series as its <u>peaks/bands will appear with the same wavenumbers / same place in the IR spectrum.</u>	1
	(e)	Since B is an acid, it can be identified using acid reactions. Use <u>universal indicator / blue litmus paper / add magnesium ribbon / add calcium carbonate</u> [1] When universal indicator is added to substance A, it will <u>remain green,</u> however, when universal indicator is added to substance B, it will <u>turn orange / yellow</u> (Reject: red). [1] OR Add 2 drops of substance A onto a moist blue litmus paper, it will <u>remain blue,</u> however, 2 drops of substance B is added onto a moist blue litmus paper, it will <u>turn red.</u> [1] OR Add magnesium ribbon / calcium carbonate to test tubes containing substance A and B, <u>effervescence</u> observed for test tube containing substance B and <u>no effervescence</u> observed for test tube containing substance A. [1]	2

	(fi)		1
	(fii)	Mr of each nylon repeating unit = (12 x 6 + 8 + 16 x 2) + (14 x 2 + 12 x 6 + 14) = 226 [1] Number of repeat units =30058/226 = 133 [1] [Award ecf]	2
			total: 12
B8	**(a)**	If the protective layer is scratched, the exposed iron beneath will not rust as <u>zinc is more reactive than iron</u> and will <u>corrode in place of iron</u>. [1] If the paint layer is scratched, <u>the exposed iron beneath will start to rust</u> when in <u>contact with oxygen and water</u>.[1]	2
	(bi)	reaction 1: $2Zn + O_2 \rightarrow 2ZnO$ [1] reaction 2: $ZnO + CO_2 \rightarrow ZnCO_3$ [1]	2
	(bii)	No of moles of $ZnCO_3$ = 12.5/ 125 = 0.1 mol [1] Combined equations of reactions 1 and 2 $2Zn + O_2 + 2CO_2 \rightarrow 2ZnCO_3$ No of moles of Zn = 0.1 mol Mass of zinc = 0.1 mol x 65 = 6.5 g [1] [Award ecf]	2
	(c)	Both zinc and iron <u>electrodes may react with the acid</u> before the start of electro-galvanisation OR <u>Zinc/iron can react with the acid.</u>	1
	(d)	The coating of zinc carbonate is <u>not uniformed</u> for hot dip galvanisation, so it does not have a nice appearance as compared to the coating done by electro-galvanisation. OR Layer of zinc is <u>thicker</u> for hot dip galvanisation, which can <u>only</u> be used for bigger objects. Layer of zinc for electro-galvanisation is <u>thinner</u> and can be used to coat smaller objects. OR Electro-galvanisation is carried out at room temperature and <u>no heating is needed, requires less energy.</u> Hot-dip galvanisation is carried out at 460 °C and it may be costly as <u>energy is required to maintain it</u>. *Note: comparison must be made*	1
			total: 8

B9	**(ai)**	<table><tr><th>name of acid</th><th>K_a value</th><th>strength</th></tr><tr><td>hydrochloric acid</td><td>1.3×10^{6}</td><td>strong</td></tr><tr><td>methanoic acid</td><td>1.8×10^{-4}</td><td>weak</td></tr><tr><td>nitric acid</td><td>2.4×10^{1}</td><td>strong</td></tr><tr><td>nitrous acid</td><td>7.2×10^{-4}</td><td>weak</td></tr></table>	1
	(aii)	Strong acids ionises fully in water / fully dissociates in water to form H^+ ions, thus the concentration of H^+ ions is much larger. [1] Weak acids ionises partially / dissociates partially in water to form H^+ ions, thus the concentration of H^+ ions is much smaller. [1]	2
	(aii)	Hydrochloric acid is a strong acid which ionises fully in water / fully dissociates in water to form H^+ ions. [1] Methanoic acid is a weak acid which ionises partially / dissociates partially in water to form H^+ ions. Thus, hydrochloric acid has a higher concentration of hydrogen ions as compared to methanoic acid, hence, rate of reaction is faster. [1]	2
	(bi)	The pH increases gradually from around pH 1.2 to pH 5 when 0 to 30 cm^3 of NaOH added. There was a sudden increase from pH 5 to pH 12 when 30cm^3 of NaOH was added. It then increases gradually again from pH 12 to pH 13 when more NaOH is added. *1 mark for describing trend (increasing gradually → sudden increase → increasing gradually)* *1 mark for mentioning of increase in pH for each section*	2
	(bii)	$H_2X + 2NaOH \rightarrow Na_2X + 2H_2O$ No of mol of NaOH = 1.6 X 0.03 = 0.048 mol [1] No of mol of acid = 0.024 mol Concentration of acid = 0.024/0.025 = 0.96 mol/dm^3 [1]	2
	(ci)	Element C H O % mass 26.7 2.2 71.1 Mol 2.225 2.20 4.444375 [1] Ratio 1 1 2 empirical formula = CHO_2 [1]	2
	(cii)	Molecular formula: $C_2H_2O_4$	1
			total: 10
B9	**(a)**	To ensure that the metals do not react with oxygen. [reject: air]	1
	(b)	Black copper oxide will turn reddish-brown / pink.	1

	(ci)	Cu, Z, Y	1
	(cii)	The more stable the oxide, the more reactive its metal. / the more reactive its metal, the less likely its oxide can be reduced by hydrogen. [1] The mass of Y_2O remains unchanged. This shows that it is a (stable) oxide and cannot be reduced by hydrogen. [1] CuO is completely reduced at 8 minutes because there is no further change in mass at the end of the experiment, while Z_2O_3 continues to be reduced even after 8 minutes. Thus, Z_2O_3 is the more stable oxide. [1]	3
	(d)	Sodium / potassium / lithium	1
	(ei)	1.80 g	1
	(eii)	Mass of oxygen in oxide = 22.35 – 20.55 = 1.8g No of mol of oxygen = 1.8/16 = 0.1125 [1] Since Z:O has a ratio of 2:3, no of mol of Z = (0.1125/3)x2 =0.075 Ar of Z = 4.2/0.075 = 56 [1]	2
			total: 10

HOLY INNOCENTS' HIGH SCHOOL

Paper 1

Paper 2

JUYING SECONDARY SCHOOL

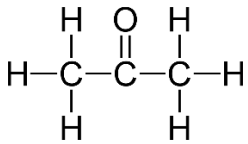
Paper 1

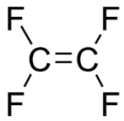
Question	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Answer	C	D	B	B	D	C	A	D	A	A
Question	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Answer	B	D	D	C	D	A	D	D	C	A
Question	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
Answer	C	D	B	D	B	C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

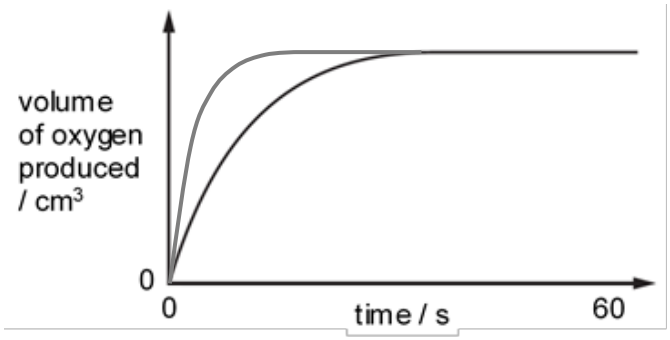
Paper 2

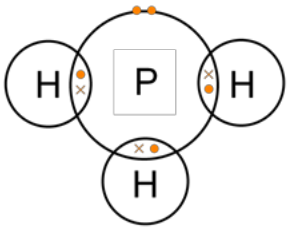
Question	Answer
A1	**(a) (i)** Ne [1] **(ii)** Br [1] **(iii)** C*l* [1] **(iv)** Cr [1] **(v)** Zn **OR** A*l* [1] **(b)** Period 3, Group IV [1] **(c)** 35.5 is the relative atomic mass of C*l* **OR** average mass based on percentages of isotopes present. [1] Find total/ add up number of protons and number of neutrons in the C*l* atom. [1]
A2	**(a) (i)** Hydrogen/ H^+ ions gain electrons **OR** are discharged at electrode **X** to form hydrogen gas. [1] Terminal **1** is negative as electrons flow/ move from the negative terminal to electrode **X**. [1] **(ii)** $4OH^-(aq) \longrightarrow O_2(g) + 2H_2O(l) + 4e^-$ [1] **(b) (i)** purple/ violet [1] **(ii)** Initially OH^- ions are discharged, leaving Cl^- ions which combine with H^+ ions to form hydrochloric acid **OR** a lower concentration of OH^- ions makes the solution more acidic, turning the indicator red. [1] Over time, the concentration of Cl^- ions becomes higher than OH^- ions. [1] Cl^- ions are then selectively/ preferentially discharged to form chlorine gas which bleaches the indicator. [1] **(c) (i)** Copper is more reactive than silver so electrons flow from copper to silver, generating electrical energy. [1]

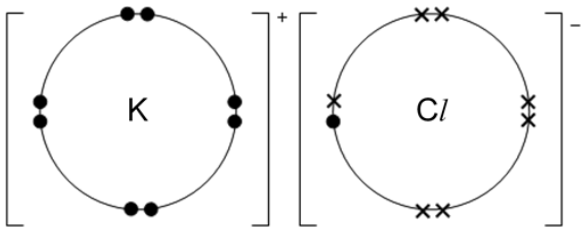
	(ii) [2] Any two: The electrolyte turns blue. The copper electrode dissolves/ decreases in mass/ becomes smaller in size. The silver electrode increases in mass/ becomes larger in size/ has silver deposited on it.
A3	**(a)** KI: solution turns from colourless to brown [1] $KMnO_4$: solution turns from purple to colourless [1] **(b)** MnO_4^- is reduced as the oxidation state of manganese decreased from +7 in MnO_4^- to +2 in Mn^{2+} [1]. Fe^{2+} is oxidised as the oxidation state of iron increased from +2 in Fe^{2+} to +3 in Fe^{3+}. [1] **(c)** Add aqueous sodium hydroxide **OR** aqueous ammonia in excess. [1] A green precipitate is formed for iron(II) chloride but a red brown precipitate is formed for iron(III) chloride. [1] [1] Any one: $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$ $Fe^{3+}(aq) + 3OH^-(aq) \rightarrow Fe(OH)_3(s)$
A4	**(a) (i)** No. of mol of H_2NSO_3H = mass / molar mass = 0.105 / 97 = 0.00108 mol (3 s.f.) [1] No. of mol of KOH = conc × vol = 0.100 × (10.8/1000) = 0.00108 mol [1] Mole ratio H_2NSO_3H : KOH 0.00108 : 0.00108 1 : 1 [1] **(ii)** Presence of water and oxygen [1] **(b)** Accept pH 8 to 11 [1] It is a weak base/ alkali as it ionises partially in aqueous solution to produce OH- ions. [1] **(c)** $2CH_3NH_2 + H_2SO_4 \rightarrow (CH_3NH_3)_2SO_4$ [1] Methylammonium sulfate/ di(methylammonium) sulfate [1]

A5	**(a) (i)** Carbonate of **S**, as volume of carbon dioxide produced in 5 minutes is the largest [1]. **(ii)** The lower the charge density, the higher the thermal stability [1] **OR** vice-versa. **(iii)** **S**, **P**, **Q**, **R** [1] **(iv)** Potassium/ sodium [1] Carbon dioxide is not produced when metal carbonate of **R** is heated, showing that it is very stable to heat [1]. Metal ion **R** has a charge of +1, showing that it is likely a Group I metal [1]. **(b) (i)** [2] for any two differences: High melting point Forms coloured compounds Multiple oxidation states Its compound acts as a catalyst **(ii)** [2] for two differences: Conductor of electricity Compounds are soluble in water
A6	**(a) (i)** Simple distillation [1] **(ii)** Water should enter from the bottom of the condenser and exit from the top [1] **(ii)** To prevent it from being oxidised into carboxylic acid by atmospheric oxygen [1] **(b)** methanal [1] C_4H_8O [1] **(c) (i)** They are isomers. [1] **(ii)** [1] correct structure 

Question	Answer
B7	**(a) (i)** amine and carboxyl **OR** $-NH_2$ and –COOH [1] **(ii)** The carboxyl/ –COOH group of the protein/ amino acid reacts with the pan as it is made of metal [1]. **(b)** Energy absorbed (bond-breaking) = 452 + 331 = 783 kJ [1] Energy released (bond-making) = 770 + 499 = 1269 kJ [1] Enthalpy change = energy (bond-breaking) – energy (bond-forming) = 783 – 1269 = – 486 kJ [1] **(c) (i)** [1] structure of monomer  **(ii)** In liquid/ molten state, Teflon molecules move freely throughout the liquid **OR** slide past one another and can flow into the spaces on the surface. [1] On cooling, the molecules settle into fixed positions as Teflon solidifies/ becomes a solid. [1] **(d)** Cooking oil contains the –COO– functional group **OR** ester linkage [1] as is made from the reaction between an alcohol (glycerol) and carboxylic acid (stearic acid). [1] **(e) (i)** $C_{10}H_{20}$ [1] **(ii)** A polymer has high melting point due to (**OR** large amount of energy is needed to overcome) strong (intermolecular) forces of attraction between the large/ macromolecules. [1]

B8	**(a)** Rate of reaction <u>decreases</u> as time increases, until it becomes <u>zero</u> **OR** the reaction <u>stops</u> [1]. As the reaction proceeds, the <u>concentration</u> of hydrogen peroxide <u>decreases</u>, so there are <u>fewer particles in the same volume</u>. [1] Hence, <u>frequency of effective collisions</u> between hydrogen peroxide and manganese(IV) oxide particles <u>decreases</u>. [1] The <u>reaction stops</u> **OR** <u>no more oxygen forms</u> when <u>all</u> the hydrogen peroxide has decomposed/ broken down. [1] **(b)** [1] graph with steeper gradient **AND** ends earlier  **(c)** No. of mol of O_2 = vol / molar vol = (60/1000) / 24 = <u>0.0025</u> mol [1] Mole ratio O_2 : H_2O_2 1 : 2 0.0025 : <u>0.005</u> [1] Conc. of H_2O_2 = mol / vol = 0.005 / (25/1000) = <u>0.2 mol/dm^3</u> [1], including unit

EITHER **B9**	**(a) (i)** Ionisation energy generally increases across the period. Metals have lower ionisation energy as they lose electrons to obtain fully-filled valence shells/ stable octet/ noble gas configuration [1], but atoms of non-metals have higher ionisation energy as they need to gain electrons instead. [1] **OR** [1] compare ionisation energy between metals and non-metals, [1] explain lose/ gain electrons to achieve fully-filled valence shell **(b) (i)** MgH_2 [1] **(ii)** [1] correct number of bonding electrons [1] correct number of outer electrons  **(iii)** Phosphorus hydride has lower melting point than magnesium hydride **/** vice-versa **OR** Phosphorus hydride has low melting point but magnesium hydride has high melting point. [1] Only a small amount of energy is required to overcome weak intermolecular forces of PH_3 [1], but a large amount energy of is required to overcome strong electrostatic forces of attraction between ions in MgH_2. [1] **OR** [1] energy, [1] forces PH_3 does not conduct electricity in any state as it does not have free-moving ions or electrons [1], but MgH_2 conducts electricity in molten and aqueous states as it has free-moving ions. [1]

OR **B9**	**(a) (i)** It <u>decomposes/ breaks down</u> before it can boil. [1] **(ii)** [1] for both: CuO: conducts in molten state O_2: does not conduct in <u>any state</u> **(iii)** <u>CuO and KC*l*</u> have <u>high</u> melting and boiling points but <u>O_2</u> has <u>low</u> melting and boiling points [1] **OR** The m.p./b.p. of <u>CuO and KC*l*</u> are much <u>higher</u> than <u>O_2</u>. Only a <u>small</u> amount of <u>energy</u> is required to <u>overcome weak intermolecular forces</u> of O_2 [1], but a <u>large</u> amount <u>energy</u> of is required to <u>overcome strong electrostatic forces of attraction</u> between <u>ions</u> in CuO and KC*l*. [1] **(b) (i)** [1] correct number of bonding electrons [1] correct number of outer electrons  **(ii)** Titrate <u>aqueous potassium hydroxide</u> with dilute <u>hydrochloric acid</u> [1] until <u>one drop</u> of the acid turns <u>methyl orange indicator orange</u>. [1] Repeat the titration with the <u>same volumes</u> of reactants used, <u>without adding the indicator</u>. [1]