A – Z School's Preliminary Papers
4 Express
Chemistry

ANSWERS: Part I

A	Anderson Secondary School
B	Beatty Secondary School
C	Chung Cheng High School (Main)
D	Damai Secondary School
E	Edgefield Secondary School

ANDERSON SECONDARY SCHOOL

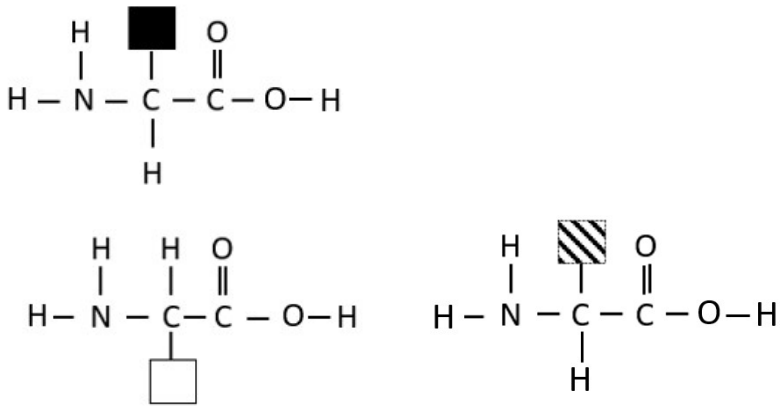
Paper 1

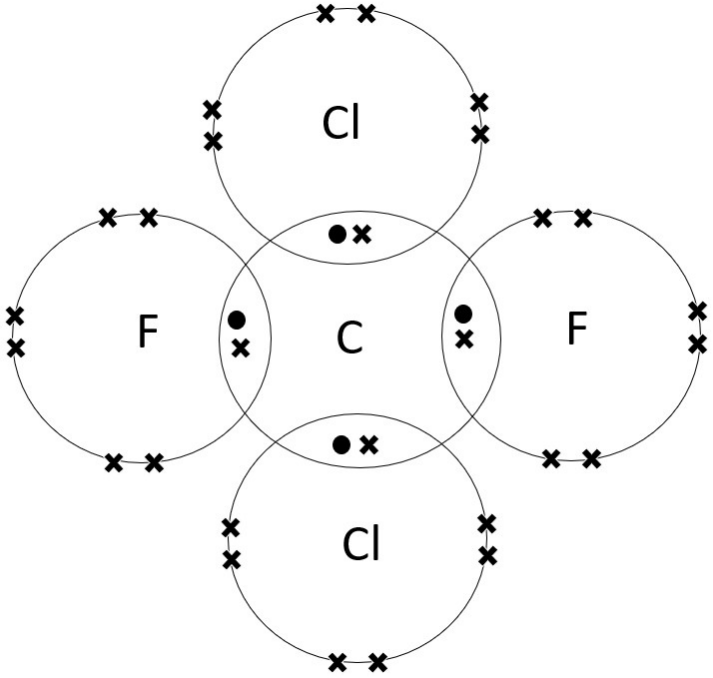
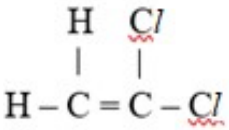
1	2	3	4	5	6	7	8	9	10
A	C	B	D	B	C	C	A	B	A
11	12	13	14	15	16	17	18	19	20
B	B	A	B	C	D	C	A	C	A
21	22	23	24	25	26	27	28	29	30
B	C	B	D	B	A	C	B	B	A
31	32	33	34	35	36	37	38	39	40
C	B	B	A	B	B	B	A	D	B

Paper 2

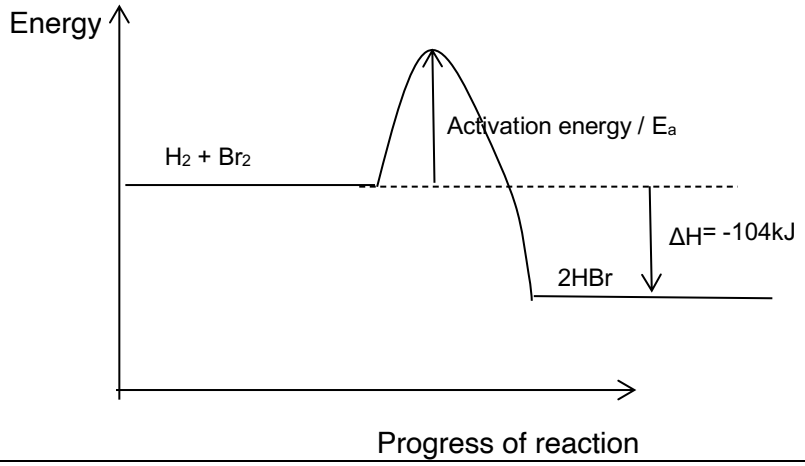
<table>
<tr><th>Qn</th><th>Answer</th><th>Marks</th><th>Comments</th></tr>
<tr><td>A1(a)(i)</td><td>A and F OR B and E</td><td>1</td><td></td></tr>
<tr><td>(a)(ii)</td><td>B and D OR C and D Or D and E</td><td>1</td><td></td></tr>
<tr><td>(a)(iii)</td><td>A and F</td><td>1</td><td></td></tr>
<tr><td>(a)(iv)</td><td>D</td><td>1</td><td></td></tr>
<tr><td>(b)</td><td>
<table>
<tr><th></th><th>true</th><th>false</th></tr>
<tr><td>Petroleum is separated by different density into different fractions.</td><td></td><td>✓</td></tr>
<tr><td>Alkanes used in diesel fuel have a lower boiling point than those used in motor cars.</td><td></td><td>✓</td></tr>
<tr><td>The fractions used as feedstock for making plastics is extracted from higher up the fractionating column than the fraction used for kerosene(paraffin).</td><td>✓</td><td></td></tr>
<tr><td>Each fraction contains a mixture of hydrocarbons.</td><td>✓</td><td></td></tr>
</table>
.
</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
</table>

A2(ai)	$C_2H_4 + H_2O \rightarrow C_2H_5OH$	1	
(a)(ii)	To increase the percentage yield of ethanol OR To conserve resources and cut down the cost of starting reactants	1	
(a)(iii)	Oxygen will oxidise ethanol to ethanoic acid / Ethanol formed may undergoes combustion hence reducing the yield of ethanol.	1	
(b)(i)	200°C, 80 atm	1	
(b)(ii)	Optimum temperature is higher so that the reaction between steam and ethene is faster. Optimum pressure is lower because special equipment would be required to maintain the higher pressure which is not cost efficient.	1 1	
A3(a)	Graphite is made up of many layers of carbon atoms covalently bonded in a hexagonal lattice structure. The layers of carbon atoms are held loosely by weak intermolecular forces of attraction hence the layers can be easily separated using a sticky tape.	1 1	
(b)	Each carbon atom in graphene has one outer electron that is not used to form covalent bonds. These electrons can move freely and carry electric charges hence graphene has high electrical conductivity. Each carbon atom is covalently bonded to three other carbon atoms. A lot of energy is needed to break these strong covalent bonds hence graphene is strong.	1 1 1 1	
(c)	Graphene is transparent as it is made up of only a single layer of atoms which is very thin.	1	
A4(a)(i)	A strong acid completely ionized/ dissociates in aqueous solution/ when dissolved in water while a weak acid partially ionized/ dissociates in aqueous solution/ when dissolved in water.	1	
(a)(ii)	Tartaric acid is the weaker acid. Universal indicator turns orange in tartaric acid and red in sulfuric acid showing that tartaric acid has a higher pH/ pH of 4-6 while sulfuric acid has a lower pH/ pH of 1-3. Volume of gas collected 10s after reacting with Magnesium is lower with tartaric acid indicating that the speed of reaction is slower. Both tests show that the concentration of hydrogen ions is lower in tartaric acid as compared to sulfuric acid.	1 1 1	

(b)	no. of mol of NaOH produced = $\frac{22}{1000}$ x 0.100 = 0.0022 mol by mol ratio, H_2T : NaOH = 1 : 2 0.011: 0.0022 Concentration of tartaric acid = 0.0011 / $\frac{25}{1000}$ = 0.044 mol/ dm^3	1 1 1	
A5(a)	A polymer is a macromolecule formed through the joining of many small molecules / monomers.	1	
(b)		1 1 1	
(c)	The component amino acids can be identified from its Rf value using chromatography with a suitable solvent and locating agent.	2	
(d)	<table><tr><th>Manufacture of proteins</th><th>Manufacture of poly(ethene)</th></tr><tr><td>monomers join together via <u>condensation</u> polymerisation</td><td>monomers join together via <u>addition</u> polymerisation</td></tr><tr><td><u>with the elimination of small molecules</u></td><td><u>without loss of any small molecules.</u></td></tr><tr><td>Monomers must have <u>2 different functional groups</u></td><td>Monomers must have <u>C = C bonds</u></td></tr></table>	2	Accept any other possible / reasonable difference(s).

A6(a)(i)		2	
(a)(ii)	It is described as substitution reaction because the hydrogen atoms in methane is replaced by halogen atoms. It is photochemical because it requires ultraviolet light to initiate the reaction.	1 1	
(b)		1	
(c)	The OC*l* particle produced in step 1 reacts with an oxygen atom in step 2 to produce another C*l* atom. This C*l* atom is then able to start step 1 again. This is a chain reaction.	1 1	
(d)	Ozone filters out excessive ultraviolet radiation that could lead to increased incidence of skin cancer.	1	
A7(a)	CO is poisonous/toxic as it combines with haemoglobin in red blood cells to form carboxyhaemoglobin which reduces the transport of oxygen to other parts of the body, leading to headaches / dizziness / breathing difficulties / suffocation / death. SO_2 irritates the eyes and lungs and cause breathing difficulties OR reacts with water to form acid rain which corrodes buildings/ harms aquatic life and plants. CO_2 is a greenhouse gas that absorbs radiation and leads to global warming.	2	
(b)	The oxidation state of Zn, O, C remains unchanged as +2, –2 and +4 respectively. Both oxidation and reduction has not occurred hence the reaction is not a redox reaction.	1 1	

(c)(i)	• The mixture is heated and vapourises. • Cadmium vapour with the lowest boiling point exits the condenser and distilled over first at 766°C. • After cadmium is collected, Zinc with the second lowest boiling distilled over at 907°C. • Lead and iron with much higher boiling point remains in the distillation flask/ distilled out last. OR • The mixture is heated and vapourises. • Vapours rise into the fractionating column and begins to cool and condense. • Fractions with a lower boiling points are collected at the top of the fractionating column and fractions with a higher boiling points are collected at the lower sections of the fractionating column. • Zinc is collected at the second lowest section.	4	
(c)(ii)	Zinc is more reactive than iron hence provides sacrificial protection by corroding in place of iron. OR Zinc is used in galvanization of iron where It acts as a protective barrier for iron against water and oxygen.	1 1 1 1	
B8(a)	The greater the number of bonds between two atoms, the smaller the bond length. The bond length decreases from 154pm to 120pm when the number of bonds increase from C-C to C≡C. As the bond energy decreases, the bond length increases. As bond energy decreases from 431kJ/mol to 299kJ/mol from H–Cl to H–I, bond length increases from 127pm to 161pm.	2	.
(b)	As the number of bonds between two atoms increases, the number of shared electrons increases and the forces of attraction between the shared electrons and nuclei of atoms increases. OR The larger the bond energy, the stronger the covalent bond is and the stronger the forces of attraction between the shared electrons and nuclei of atoms. Hence, the atoms are pulled closer together causing a shorter bond length.	1 1	

(c)(i)	ΔH = Energy absorbed during bond breaking – Energy released during bond forming = (435 + 193) – 2 x 366 = –104 kJ	1	
(c)(ii)		2	
(d)	Reaction of iodine with hydrogen is slower than the reaction of hydrogen with chlorine because chlorine is more reactive than iodine. Reaction of iodine with hydrogen is exothermic and the reaction of hydrogen with chlorine is endothermic because the energy absorbed for bond breaking is less than the energy released from bond forming when chlorine reacts with hydrogen/ the energy absorbed for bond breaking is more than the energy released from bond forming when iodine reacts with hydrogen. Reaction of iodine with hydrogen is reversible and the reaction of hydrogen with chlorine is not/ Reaction of iodine with hydrogen produced a halide which decomposes at high temperature while reaction of chlorine produced a halide that does not decompose at high temperature because hydrogen iodide is thermally less stable as compared to hydrogen chloride hence it breaks down easily to form hydrogen and iodine.	*1 marking pt*	
(e)	91 pm (accept 87 to 107pm)	1	
B9(a)	Any three: • In the 'plum pudding' model, there are no neutral charge particles/ neutrons but present idea of the atom has. • In 'plum pudding' model, electrons are spread out randomly in the sphere but electrons are arranged in electron shells in the present idea of the atom. • In 'plum pudding' model, there is no nucleus in the centre of the atom but present idea of the atom has. • In 'plum pudding' model, the positive charges /protons are not contained in the centre of the atom /in the nucleus but present idea of the atom is. • (Accept any other plausible answers)	3	

(b)	• x is negatively charged as it is attracted to the positive plate. • z is positively charged as it is attracted to the negative plate. • y is electrically neutral (no charge) as it move straight/ is not attracted to any of the plates. • x is much lighter than z as x deflects more to the positive plate than z to the negative plate.	2 1	.
(c)	For the atom with a proton number 11 to form an ion, it has to lose 1 electron to achieve an electronic configuration of a noble gas. However, the model drawn show a loss of 1 proton instead of electron.	1 1	
Either B10(a)	The experiment involving zinc and sulfuric acid only acts as a control and comparison between the time taken can be used to determine the effectiveness of the catalyst.	1	
(b)	Temperature affects the rate of reaction. Increased temperature causes particles to gain more kinetic energy and collide more frequently. When particles gained energy, the number of particles with energy equal or higher than the activation energy also increase. hence causing the frequency of effective collisions to increase and rate of reaction to increase.	1 1 1	
(c)	Similarities: Both experiments showed that the use of copper as a catalyst increase the speed of reaction. This is because copper provides the reaction with an alternative pathway where the activation energy required is lower / Copper is less reactive than zinc hence rate of zinc corrosion due to acid increased. A brown solid remained at the end of the reaction for both experiments. This is because copper, as a catalyst, remains chemically unchanged in a chemical reaction / Copper being unreactive does not react with acid. Difference: The use of copper powder in experiment 4 increases the rate more than when copper is used as lumps in experiment 5. This is because as powder has a higher contact area than lumps with the reactants.	1 1 1 1	
(d)	Zinc is more reactive than copper hence zinc displaced copper from copper(II) sulfate to form copper which is a brown solid and zinc sulfate which is a colourless solution.	1 1	
Or B10(a)	$Cu(s) \rightarrow Cu^{2+}(aq) + 2e$	1	

(b)	As the current double from 2.0A to 4.0 A, the mass of copper formed also double from 0.12g to 0.24g. As the time taken for electrolysis double from 180s to 360s, the mass of copper formed also double from 0.12g to 0.24g. As more current passes through and more time allowed for electrolysis to occur, there are more electrons flowing through the circuit hence more copper (II) ions will gain electrons/ discharged / reduced.	1 1 1	
(c)	Mass of copper deposited at cathode = 1.44 – 1.20 = 0.24g No. of mols of copper deposited = No. of mols of copper that was oxidized at anode Hence, mass of copper deposited at cathode = mass of copper oxidized at anode Mass of anode after electrolysis = 1.45 – 0.24g = 1.21g	 1 1	
(d)	At the anode: When carbon electrodes are used, there will be no decrease in mass in the anode as carbon is an inert electrode and does not participate in electrolysis. When copper electrodes are used, copper anode decreased in mass due to copper being oxidized to form copper ions. Electrolyte: When carbon electrode are used, blue aqueous copper(II) sulfate will turn colourless because copper ions are discharged at the cathode causing a decrease in concentration of copper ions. When copper electrodes are used, blue aqueous copper(II) sulfate remains colourless. There is no change in concentration of copper ions because copper ions discharged/ reduced at the cathode is replenished by the oxidation of copper at the anode.	 1 1 1 1	

BEATTY SECONDARY SCHOOL

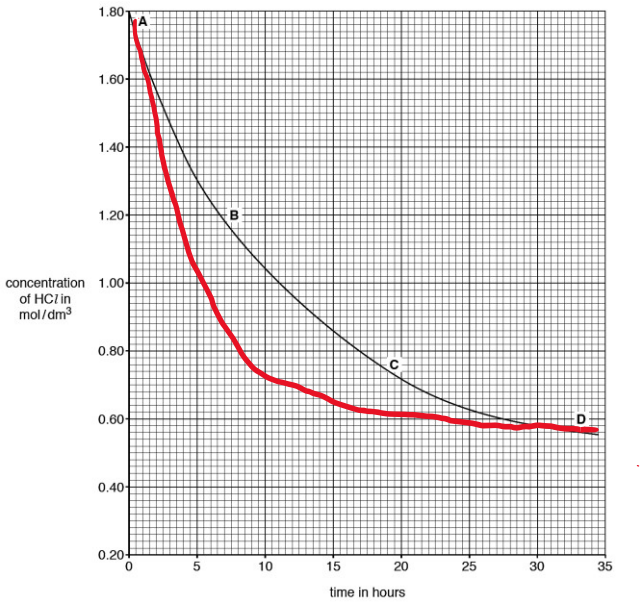
Paper 1

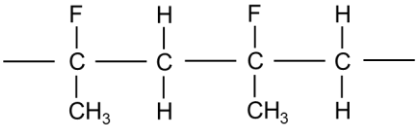
1	2	3	4	5	6	7	8	9	10
C	A	B	B	B	C	B	C	D	B
11	12	13	14	15	16	17	18	19	20
A	A	C	D	B	D	D	A	B	A
21	22	23	24	25	26	27	28	29	30
A	C	D	D	D	D	A	D	B	B
31	32	33	34	35	36	37	38	39	40
D	D	A	B	B	C	B	D	B	C

Paper 2

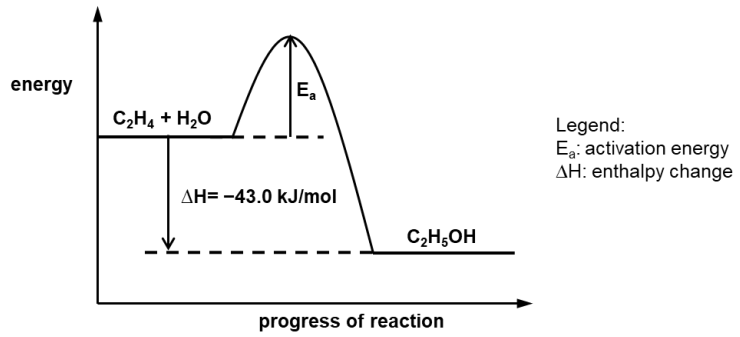
A1		**Total = 5**
a	magnesium	1
b	ozone or dichloroethane	1
c	iodine	1
d	copper(II) sulfate and magnesium / potassium manganate(VII) and magnesium / magnesium and iodine	1
e	iodine, ozone, magnesium, diamond	1
A2		**Total = 4**
a	$2Li + 2H_2O \rightarrow 2LiOH + H_2$	1
b	moles of Li = 0.2 ÷ 7 = 0.028571 [1] volume of H_2 = 0.028571 ÷ 2 × 24 = 0.343 dm^3 [1]	2
c	Description of observations: <u>No more effervescence</u> is observed and <u>no more solid darting</u> on the surface of water / all solid has completely reacted or *Clear description of the test for gas:* *Place a <u>lighted splint</u> at the mouth of test tube and if gas produced <u>do not extinguishes</u> a lighted splint with a 'pop' sound, reaction is completed / <u>connect a gas syringe</u> to the reaction test tube. Once the <u>volume of gas obtained remains unchanged</u>, reaction is completed.*	1

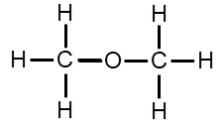
A3		Total = 14
a	Titration Method: 1. Pipette 10 / 20 / 25.0 cm^3 of the sample of acid into a conical flask. 2. Add a few drops of methyl orange indicator and swirl the conical flask. 3. Titrate the acid in the conical flask with a known concentration of aqueous NaOH / KOH / Na_2CO_3 / alkali / soluble carbonate in the burette 4. Record volume of alkali/carbonate added once the indicator changes colour / turns from red to orange 5. Use the volume of alkali to find the mole of hydrochloric acid used, before dividing it by the volume of acid used for titration or Mass Loss Method: 1. Pipette 10 / 20 / 25.0 cm^3 of the sample of acid into a conical flask. 2. Place the conical flask on electronic balance. 3. Use a measuring cylinder to add excess methanol into the conical flask. 4. Record the initial mass of the mixture and until a constant mass is obtained. 5. Calculate the number of moles of chloromethane by taking the mass lost of chloromethane divided by molar mass. Compare the mole ratio to find the mole of hydrochloric acid used, before dividing it by the volume of acid used. or Collection of Gas Method: 1. Pipette 10 / 20 / 25.0 cm^3 of the sample of acid into a conical flask. 2. Use a measuring cylinder to add excess methanol of a known concentration into the conical flask. 3. Connect the setup to a gas syringe. 4. Measure and collect volume of chloromethane gas until no more effervescence is observed. 5. Calculate the mole of gas by dividing the volume (dm^3) by 24. Compare the mole ratio to find the mole of hydrochloric acid used, before dividing it by the volume of acid used. 5 mk points – [3] 3-4 mk points – [2] 1-2 mk points – [1]	3
bi	1.38 mol/dm^3 [1].	1
bii	Methanol is the limiting reactant [1] As the reaction reaches completion / gradient reaches zero, there is still concentration of acid left in the reaction mixture [1] / concentration of acid left is not zero.	2
biii	Point A. Gradient of the graph is the steepest / largest	1
biv	Disagree with student. This is because the rate is constantly changing / not constant / nonlinear at each point / this formula only finds the average rate at the 4 points [1] Average rate of reaction should be (total loss / change in concentration ÷ total time) [1]	2

ci		1
cii	As the concentration of the acid increases, the number of reacting particles per unit volume of solution increases [1] As such, the particles collide more frequently and the frequency of effective collisions increases, increasing the rate of reaction [1]	2
ciii	Particles in the liquid state are close together in a disorderly manner. [1] There are little or no spaces available to be compressed, hence pressure does not affect the rate of reaction [1].	2
A4	**Total = 8**	
a	$CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g)$ [1] □H = +165 kJ/mol [1]	2
b	In Step 1, carbon monoxide gas is produced [1]. Carbon monoxide binds with haemoglobin in the blood to form stable carboxyhaemoglobin that prevents transport of oxygen to the rest of the body, leading to death [1]. In Step 1, the volume of hydrogen produced is lesser than the volume of hydrogen produced in both steps [1]. In step 1, one mole/volume of methane produces three moles/volumes of hydrogen, whereas in both steps, one mole/volume of methane produces four moles/volumes of hydrogen [1] Using both Steps 1 and 2, the reaction enthalpy is less endothermic / requires lower amount of heat energy as compared to Step 1 alone [1]. This results in a lower cost required as lesser amount of fuels need to be burnt [1].	4

c	explanation: water is a covalent molecule and is a poor conductor of electricity [1] modification: add small volumes of dilute acids / salt solutions / ionic compounds to water [1]	2
A5	**Total = 5**	
a	molecule A: addition polymerisation [1] molecule B: condensation polymerisation [1]	2
b		1

c	Polymers made from **A** have only <u>one type of linkage</u> [1] whereas polymers made from **B** have a <u>range of different linkages like ester linkages and amide linkages</u> [1] as B contains multiple functional groups, leading to a wider range of properties.	2
A6	**Total = 14**	
a	source of glucose: <u>sugarcane</u> source of ethene: (<u>catalytic) cracking of hydrocarbons</u>	1

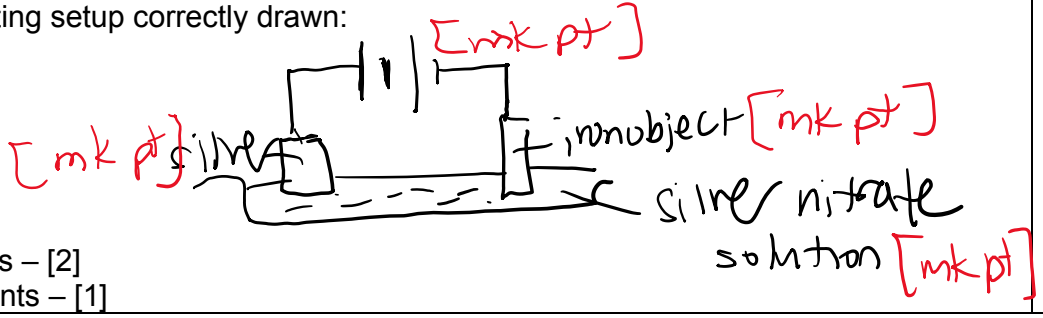
b	Fermentation is a <u>laborious process</u> as it requires <u>manpower</u> to start-stop to extract ethanol.	1
ci	As the <u>temperature increases</u> (from 250 □C to 350 □C), the <u>amount of ethanol formed decreases</u> (from 0.420 to 0.380).	1
cii	At <u>low temperatures of 250 □C</u>, the <u>rate of reaction</u> is <u>too slow</u>, while at higher <u>temperatures of 350 □C</u>, the <u>yield is lower.</u> Hence, optimum temperature of 300 □C is used.	1
ciii	<u>polyethene</u>	1
civ	moles of ethene = 40 ÷ 28 = 1.42857 mol moles of ethanol = 1.42857 × 0.550 = 0.78571 = <u>0.786 mol</u> [1] % yield = (0.78571 ÷ 1.42857) × 100% = <u>55.0%</u> [1]	2
d	Amount of energy absorbed for bond breaking = 1 × 612 + 4 × 412 + 2 × 463 = 3186 kJ [1] Amount of energy released for bond forming = 1 × 348 + 5 × 412 + + 1 × 358 + 1 × 463 = 3229 kJ [1] Enthalpy change = +3186 – 3229 = <u>–43.0 kJ/mol</u> [1] Peihao is correct that it is an exothermic reaction.	2
e	 correct shape (exothermic) – [1] correct formulae for products – [1] labeling of enthalpy change and activation energy – [1]	3

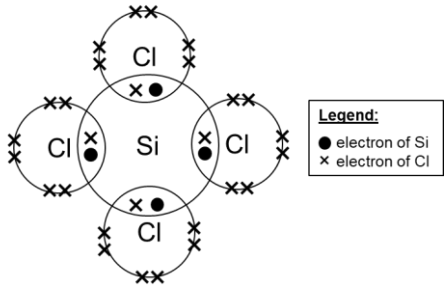
f		1

B7	**Total = 12**	
a	electronic configuration of Fe: $[Ar]4s^2 3d^6$ electronic configuration of Co: $[Ar]4s^2 3d^7$	2
bi	possible oxidation states of V: +1, +2, +3, +4, +5	1
bii	No. It is not possible for Mn to have an oxidation state of +8. Manganese has a maximum number of 7 electrons that can be lost from 3d and 4s orbitals.	1
ci	red	1
cii	green	1
ciii	When nickel reacts with chlorine, the d-orbitals are split into different energy levels [1], the electron in the lower energy d-orbitals absorb a wavelength (of about 395 nm) from the visible region of the electromagnetic spectrum, and the d electron to be excited (moved) to the higher energy level [1]. The remaining wavelength that are not absorbed will be emitted / complementary colour observed that is not absorbed [1] by nickel(II) chloride, which is the green colour observed.	3
d	Zinc has a fully filled d-orbital, hence excitation of electron cannot occur / absorption of wavelength is not within the visible light region of electromagnetic spectrum	1
ei	Vanadium(V) oxide is used / participated in the reaction in the first equation and is regenerated in the second equation.	1
eii	A catalyst provides an alternative reaction pathway with a lower activation energy for reacting particles.	1

B8	**Total = 8**	
ai	Concentration of carbon dioxide increases steadily from 1965 to 2014.	1
aii	Due to large scale deforestation [1] which reduces the uptake of CO_2 by plants for photosynthesis and the burning of fossil fuels [1] in the industry, the percentage of CO_2 has been increasing rapidly.	2
aiii	Concentration of carbon dioxide decreases yearly during June / summer, but increases during December / winter [1]. This is because during summer, rate of photosynthesis in plant is greater than rate of respiration [1] due to longer durations of sunlight. However during winter, the rate of respiration is greater than rate of photosynthesis in plants as plants are hibernating [1].	3

bi	Carbon dioxide is a greenhouse gas, which traps heat, causing an increase in average surface temperature, leading to global warming.	1
bii	- polar ice caps will melt, causing sea level to rise and flood low-lying lands - reduced rain fall can cause a decrease in crops yield and consequently, shortage of food - more occurrences of unusual weather conditions such as warm spells, droughts, unexpected storms and hurricanes, and floods in some parts of the world - rise in ocean temperature results in lesser volume of carbon dioxide being able to dissolve in the sea water and this leads to an increase in the amount of carbon dioxide in the atmosphere, aggravating global warming - loss of habitats for wild life leading to their extinction	1

B9E	**Total = 10**	
ai	A simple electric cell converts chemical energy to electrical energy, making it a potable battery.	1
b	positive electrode: $Ag^+(aq) + e^- \rightarrow Ag(s)$ [1] negative electrode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ [1]	2
c	Both zinc and iron are more reactive than silver [1]. Hence, both metals displace silver from the silver nitrate, which silver is the grey deposit observed [1]. or Silver ions are lower in the reactivity series than hydrogen ions, hence silver ions are preferentially/selectively discharged to form silver metal on the iron electrode [1]. As more silver is deposited, some silver metal sinks due to gravity [1].	2
d	The statement is true. Magnesium is more reactive than zinc, hence magnesium tends to lose electrons more readily / larger potential difference leading to faster current flow [1], leading to a faster rate. The number of moles of product formed is the same / each Mg and Zn atom loses 2 valence electrons to form M^{2+} ions, hence the yield will be the same [1].	2
e	Waste of zinc metal just to coat silver onto iron / replacement of silver nitrate electrolyte / replacement of zinc metal	1
f	Electroplating setup correctly drawn:  4 mk points – [2] 2-3 mk points – [1]	2

B9O		Total = 10
a	The type of anion affects the melting point. The melting point of the compounds increases from chlorides to fluorides then to oxides in all metals [1]. The electrostatic forces of attraction are the strongest between oxides and the metallic cations, followed by a decreasing trend between fluorides and the metallic cations, and between chlorides and the metallic cations [1] As such, the amount of energy required to overcome the strong electrostatic forces of attraction decreases from chlorides to fluorides then to oxides in all metals [1]	3
bi	A more reactive metal tends to lose electrons more readily to form positive ions, leading to stronger ionic bonds.	1
bii	The theory is not applicable. Reactivity decreases from sodium to magnesium to aluminium. However, there is no fixed trend of melting points based on the reactivity of the metals / compounds of magnesium and/or have a higher melting point than sodium.	1
ci	 correct number of bonding electrons – [1] correct number of valence electrons on rest of elements – [1]	2
cii	Silicon dioxide has a macromolecular/giant molecular/giant covalent structure but silicon tetrachloride has a simple molecular/covalent structure [1]. The atoms in substance silicon dioxide are held together by numerous strong covalent bonds. As such, a large amount of energy is required to break the strong covalent bonds [1]. On the other hand, a small amount of energy is required to overcome the weak intermolecular forces of attraction [1] between molecules in silicon tetrachloride. This results in substance Y having a low melting point whereas substance X has a high melting point.	3

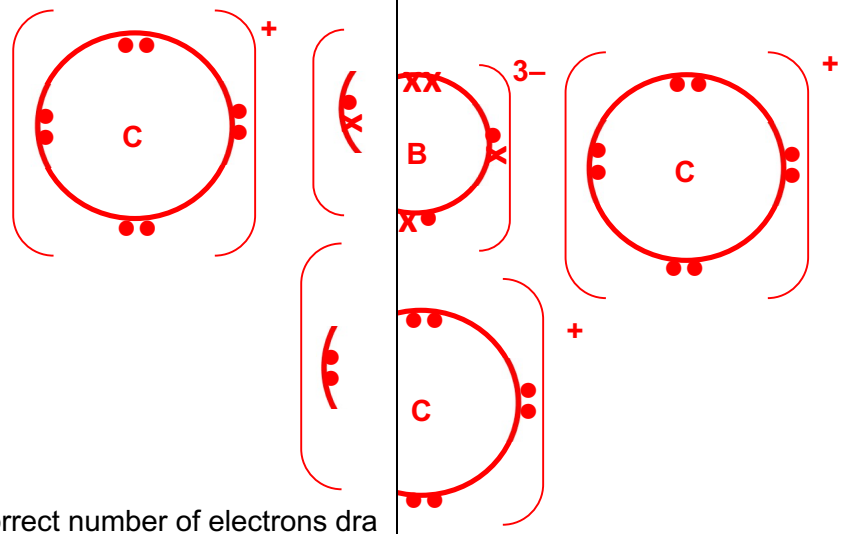
Paper 1

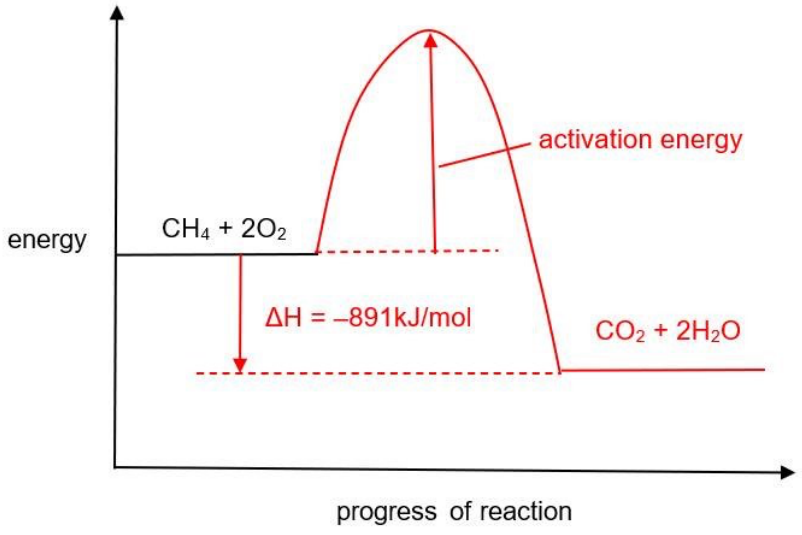
1	C	**11**	C	**21**	B	**31**	A
2	A	**12**	C	**22**	A	**32**	B
3	D	**13**	B	**23**	B	**33**	C
4	B	**14**	D	**24**	C	**34**	C
5	D	**15**	C	**25**	B	**35**	A
6	B	**16**	B	**26**	C	**36**	A
7	C	**17**	A	**27**	A	**37**	A
8	C	**18**	C	**28**	B	**38**	C
9	A	**19**	C	**29**	A	**39**	B
10	B	**20**	C	**30**	C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

Paper 2

Question	Mark Scheme	Mark
A1(a)	He, H_2, O_2, Cl_2 (any two)	1
A1(b)	NH_3 and Cl_2	1
A1(c)	CO_2 and O_2	1
A1(d)	CH_4	1
A1(e)	CO	1
A2(a)(i)	Number of neutrons = 48 Nucleon number = 56 [1] Both correct	1
A2a(ii)	2.8.8.1	1
A2(a)(iii)	$\mathbf{E}^{2-}$ Accept: O^{2-} as the assessment objective is to see if student know that E can form an anion with –2 charge.	1
A2(a)(iv)	**A** and **E**. Both **A** and **E** are atoms that have the same number of protons but different number of neutrons. [1] for correct identification of isotopes and explanation. No need 'atoms' since the question context has already stated. Accept: same proton number, atomic number (since these are scientific terms) Reject: neutron number (no such scientific term), nucleon number (need to break down what this term means and go back to the definition)	1
A2(b)(i)	**B**: nitrogen **D**: potassium **F**: iron	1
A2(b)(ii)	Highest melting point iron (**F**) potassium (**D**) Lowest melting point nitrogen (**B**) CAO. No ecf **b(i)**.	1

A2(b)(iii)	**B** has <u>weak intermolecular forces of attraction</u> / <u>weak forces of attraction between the molecules.</u> Hence, <u>less energy</u> is absorbed to overcome the bonds. **F** has <u>strong electrostatic forces of attraction / metallic bonds</u> between the <u>cations and 'sea' of delocalised electrons</u>. Hence, <u>more energy</u> is required to overcome the bonds. [1] Correct types of bonds and particles [1] Energy comparison only awarded if bonds and particles are correct. No ecf **(b)(ii)**.	1 1

Question	Mark Scheme		Mark
A2(c)	 [1] Correct number of electrons dra [1] Correct charges <u>and</u>	n for cation $\mathbf{C}^{+}$ and anion $\mathbf{B}^{3-}$. ratio anion (3:1)	2
A3(a)	Manganese has <u>variable oxidation states</u>, <u>+2 in Mn^{2+}/$Mn(OH)_2$ and</u> <u>+3 in $Mn(OH)_3$</u>. $MnSO_4$ acts as a catalyst as <u>$MnSO_4$ in step 1 is regenerated</u> <u>in step 3</u>.		1 1
A3(b)	$2Mn(OH)_3\,(s) + 2I^-\,(aq) + 6H^+\,(aq) \longrightarrow 2Mn^{2+}\,(aq) + I_2\,(aq) + 6H_2O\,(l)$ correct balanced equation (ignore state symbols)		1
A3(c)(i)	+2		1
A3(c)(ii)	I_2 is reduced as the oxidation of iodine decreases from 0 in I_2 to –1 in NaI. $Na_2S_2O_3$ is oxidised as the oxidation of sulfur increases from +2 in $Na_2S_2O_3$ to +2.5 in $Na_2S_4O_6$. *Ecf for oxidation state of sulfur in $Na_2S_2O_3$ only if the oxidation state is increased.*		1 1
A3(d)	Colour changes from <u>bluish-black/blue-black to colourless</u>. *Reject: Blue or black only.*		1

Question	Mark Scheme	Mark
A3(e)	Moles of $Na_2S_2O_3$ used = 0.0100 x (11.20/1000) = <u>0.000112 mol</u> Moles of I_2 = 0.000112 / 2 = 0.0000560 mol [1] *for showing* Moles of $Mn(OH)_3$ = 2 x 0.0000560 = 0.000112 mol *appropriate mole ratio working to get correct moles of O_2* Moles of O_2 present = 0.000112 / 4 = <u>0.0000280 mol</u> Concentration of O_2 = 0.0000280 ÷ (100/1000) = <u>0.000280 mol/dm^3</u> CAO	1 1 1
A4(a)(i)	Density = 16 / 24 = 0.667 g/dm^3 *Award for numerical answer only. Ignore units if missing.*	1
A4(a)(ii)	Energy per gram = 762 / 32 = 22.7 kJ/g *Award for numerical answer only. Ignore units if missing.*	1
A4(a)(iii)	Petrol is not a pure substance OR it consists of a mixture of hydrocarbons. Hence, there is no fixed enthalpy change of combustion.	1
A4(b)(i)	 Correct formulae of products. Ignore if equation is not balanced. [1] ΔH (with energy level) [1] activation energy [1]	1 1 1
Question	**Mark Scheme**	**Mark**

A4(b)(ii)	Methane has a higher percentage of carbon than methanol. For the same number of moles of fuel, methane requires more oxygen for complete combustion OR more likely to undergo incomplete combustion. Hence, methane is more likely to undergo incomplete combustion.	1 1
A4(c)	Complete combustion of hydrogen produces only water which is a non-pollutant. However, combustion of methane produces carbon dioxide which is a greenhouse gas that leads to global warming.	1 1
A4(d)(i)	$\Delta H = 3(410) + 360 + 463 - 2(436) - 1077$ $= 2053 - 1949$ $= +104$ kJ/mol CAO, must include a positive sign, ignore missing units	1 1
A4(d)(ii)	Step 1 is endothermic OR Energy is absorbed when methanol is converted from a liquid to a gas. *OWTTE to mention energy change due to the change in physical states*	1
A4(d)(iii)	The carbon monoxide produced is toxic as it binds to haemoglobin / prevents the blood to transport oxygen and leads to breathlessness and eventually death. *OWTTE about the inability to transport oxygen* OR The methanol used is toxic as it can lead to headache, dizziness or loss of consciousness.	1
A5(a)(i)	C_5H_{10}	1
A5(a)(ii)	Condition: uv light $C_4H_8 + Cl_2 \longrightarrow C_4H_7Cl + HCl$ No need state symbols. Multiple chlorine-substituted product must come with corresponding HC*l*.	1 1
A5(b)(i)	C_4H_8	1

<table>
<tr><th>Question</th><th>Mark Scheme</th><th>Mark</th></tr>
<tr><td>A5(d)</td><td>Let the mass of S be 100 g.

<table><tr><td></td><td>C</td><td>H</td><td>O</td><td>Br</td><td></td></tr><tr><td>Mass / g</td><td>100 – 68.7 = 31.3 g</td><td>5.9 g</td><td>10.5 g</td><td>52.3 g</td><td>includes assumption of mass above.</td></tr><tr><td>Mole /mol</td><td>31.3 / 12 = 2.61</td><td>5.9 /1 = 5.9</td><td>10.5 / 16 = 0.656</td><td>52.3 / 80 = 0.654</td><td>2 to 3 sf</td></tr><tr><td>Simplest mole ratio</td><td>4</td><td>9</td><td>1</td><td>1</td><td>No mark
To be awarded in EF</td></tr></table>
Empirical formula = C_4H_9BrO</td><td>1

1

1</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>B6(a)(i)</td><td>Electronegativity <u>decreases down Group II elements</u>.

As the <u>atomic size increases</u>, the <u>attraction between the nucleus and valence electrons is weaker</u>, making the atom less likely to attract electrons.</td><td>1

1</td></tr>
<tr><td>B6(a)(ii)</td><td>Any value between 0.82 to 0.98 (actual 0.93)</td><td>1</td></tr>
<tr><td>B6(b)</td><td>Helium, neon and argon have <u>fully filled valence electron shells</u> and they are <u>unable to form bonds</u> with other elements.</td><td>1
1</td></tr>
<tr><td>B6(c)</td><td><u>Σ of Al_2O_3</u> = 3.44 – 1.61 = <u>1.83</u> and <u>Σ of $AlCl_3$</u> = 3.16 – 1.61 = <u>1.55</u> CAO

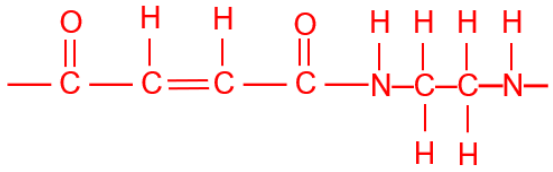
Σ value of Al_2O_3 does not support. Al_2O_3 is an <u>ionic compound but its Σ is less than 2.0.</u>

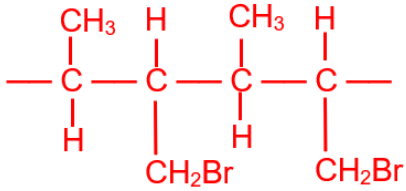
Σ value of $AlCl_3$ supports the bonding in $AlCl_3$. [no mark]</td><td>1

1</td></tr>
</table>

Question	Mark Scheme	Mark
B7(c)(i)	$Ag^+(aq) + e^- \longrightarrow Ag(s)$ Reject: If no or wrong state symbols are written.	1
B7(c)(ii)	The pH of the electrolyte decreases. OH^- is preferentially discharged at graphite electrode 2 and resulting in a lower OH^- concentration or concentration of OH^- becomes lower than concentration of H^+.	1 1
B7(d)	Oxide ions are discharged to give oxygen gas at graphite electrode 2. After a long period of time, the oxygen gas produced reacts / oxidises graphite electrode 2 to become carbon dioxide gas. Accept: equations written for the reactions at the electrode At graphite electrode 2: $2O^{2-}(l) \longrightarrow O_2(g) + 2e^-$ and $C(s) + O_2(g) \longrightarrow CO_2(g)$	1 1
Either B8(a)(i)	There is a higher concentration of hydrogen ions, H^+ in nitric acid than phosphoric acid. The frequency of effective collision between the hydrogen ions and metal in the alloy will be higher in nitric acid than phosphoric acid. Hence, the speed of reaction will be higher for nitric acid than phosphoric acid. [no mark]	1 1
B8(a)(ii)	18 ± 1 hours (± 5%) *Minus [1] for overall paper if no units.*	1
B8(b)(i)	$2CH_3COOH + Mg \longrightarrow (CH_3COO)_2Mg + H_2$	1
B8(b)(ii)	Add ethanoic acid in excess OR until no more effervescence is observed. Filter the mixture to obtain copper as the residue. Wash the residue with water to obtain pure copper.	1 1

Question	Mark Scheme	Mark
B7(c)(i)	$Ag^+(aq) + e^- \longrightarrow Ag(s)$ Reject: If no or wrong state symbols are written.	1
B7(c)(ii)	The pH of the electrolyte decreases. OH^- is preferentially discharged at graphite electrode 2 and resulting in a lower OH^- concentration or concentration of OH^- becomes lower than concentration of H^+.	1 1
B7(d)	Oxide ions are discharged to give oxygen gas at graphite electrode 2. After a long period of time, the oxygen gas produced reacts / oxidises graphite electrode 2 to become carbon dioxide gas. Accept: equations written for the reactions at the electrode At graphite electrode 2: $2O^{2-}(l) \longrightarrow O_2(g) + 2e^-$ and $C(s) + O_2(g) \longrightarrow CO_2(g)$	1 1
Either B8(a)(i)	There is a higher concentration of hydrogen ions, H^+ in nitric acid than phosphoric acid. The frequency of effective collision between the hydrogen ions and metal in the alloy will be higher in nitric acid than phosphoric acid. Hence, the speed of reaction will be higher for nitric acid than phosphoric acid. [no mark]	1 1
B8(a)(ii)	18 ± 1 hours (± 5%) *Minus [1] for overall paper if no units.*	1
B8(b)(i)	$2CH_3COOH + Mg \longrightarrow (CH_3COO)_2Mg + H_2$	1
B8(b)(ii)	Add ethanoic acid in excess OR until no more effervescence is observed. Filter the mixture to obtain copper as the residue. Wash the residue with water to obtain pure copper.	1 1

Question	Mark Scheme	Mark
B8(c)(i)	Pass the gas through acidified $KMnO_4$. Purple acidified $KMnO_4$ decolourises.	1 1
B8(c)(i)	 • Amide linkage clearly shown. • Correct number and type of atoms in polymer with the two ends of the polymer unbonded to any atoms. Bonding between atoms must be correct.	 1 1
Or B8(a)(i)	$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$	1
B8(a)(ii)	Y, X, Z More reactive metal forms more thermally stable metal compounds. Since the rate of decomposition of **Z**CO_3 is the greatest followed by **X**CO_3 and **Y**CO_3, **Z** is the least reactive metal followed by **X** and **Y** which is the most reactive metal. [no mark as this is awarded above] [1] Identify the correct relationship between metal reactivity and metal compound stability. [1] Use relationship above to link to data (i.e. rate of decomposition) given in the table.	1 1 1
B8(b)(i)	This is a reversible reaction. [no mark] When phosphorus reacts with bromine to form phosphorus tribromide, some phosphorus tribromide decomposes (breaks down, converted back) to give phosphorus and bromine. [1] awarded for the understanding of reactants converted to products and back with relevant context (i.e. identities of reactants of products stated).	 1
B8(b)(ii)	Chlorine is <u>more reactive</u> than bromine. The <u>rate of reaction</u> of phosphorus with chlorine should be <u>higher</u> than that with bromine.	1 1

Question	Mark Scheme	Mark
B8(c)(i)	 Note: No need to show displayed formula. All bonds must be correctly bonded e.g. C is bonded directly to C in $-CH_2Br$.	1
B8(c)(ii)	M_r of $CH_3CHCHCH_2Br$ monomer = 4(12) + 7 + 80 = 135 No. of monomer present in polymer = 33750 ÷ 135 = 250 CAO Since each monomer has 4 carbon atoms, no. of carbon atoms in polymer = 250 x 4 = <u>1000</u> CAO	 1 1

DAMAI SECONDARY SCHOOL

Paper 1

1	2	3	4	5	6	7	8	9	10
C	**B**	**C**	**A**	**B**	**B**	**C**	**A**	**C**	**D**

11	12	13	14	15	16	17	18	19	20
D	**B**	**C**	**D**	**A**	**D**	**B**	**A**	**B**	**B**

21	22	23	24	25	26	27	28	29	30
A	**B**	**A**	**C**	**D**	**A**	**B**	**C**	**B**	**D**

31	32	33	34	35	36	37	38	39	40
D	**B**	**D**	**D**	**B**	**C**	**C**	**B**	**B**	**D**

Paper 2

A1

(a) (i) chlorine [1]

(ii) aluminium [1]

(iii) strontium [1]

(iv) chlorine [1]

(v) manganese **OR** tin [1]

(b)

sub-atomic particle	number of particles
protons	37
neutrons	50
electrons	36

[2] – 3 correct
[1] – 2 correct
[0] otherwise

A2

(a) Diffusion is the movement of particles from a region of higher concentration to a region of lower concentration. [1]

(b) Gas particles have a higher kinetic energy than particles in solids and liquids. Hence, gas particles move at very high speeds and diffuses more quickly.

[1] for comparison of kinetic energy
[1] for stating speed.

(c) Position C.
PH_3 diffuses at a faster rate than HI as PH_3 has a lower relative molecular mass of 34, as compared to HI with a higher relative molecular mass of 128.

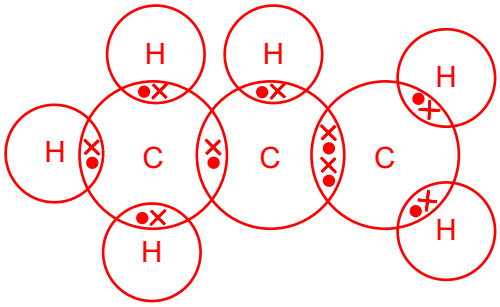
[1] for correct position.
[1] for stating the relative rate or speed of diffusion.
[1] for stating M_r – reject if M_r is wrong.

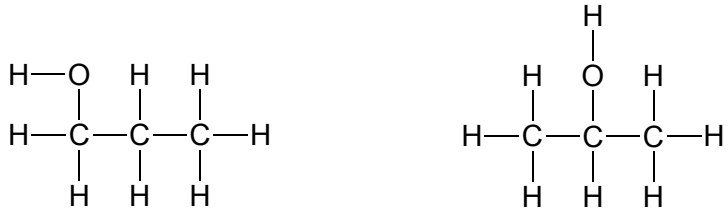
A3

(a)
1. Atmosphere of Mars contains 95.3% carbon dioxide while atmosphere of Earth contains only 0.03% of carbon dioxide.
2. Atmosphere of Mars contains only 2.7% nitrogen while atmosphere of Earth contains 78% nitrogen.
3. Atmosphere of Mars contains only 0.13% of oxygen while atmosphere of Earth contains 21% oxygen.

[1] for each difference, citing correct percentage of corresponding gases on Earth.

			Any 2, max [2]
(b)		The presence of plant life <u>would increase the percentage of oxygen and decrease the percentage of carbon dioxide.</u> Plants undergo <u>photosynthesis</u> in the day by taking in carbon dioxide and releasing oxygen. $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$ + energy	[1] for effect on both gases. Reject if only effect on 1 gas is mentioned. [1] for mention of photosynthesis [1] for correct equation. Condone if 'energy' omitted.
A4			
(a)		A strong acid is a substance that <u>ionises completely</u> in <u>water</u> to form <u>H^+ ions.</u>	[1] for all phrases underlined
(b)	**(i)**	$SO_3NH_3 + NaOH \rightarrow NaSO_3NH_2 + H_2O$	[1]
	(ii)	Sulfamic acid reacts with calcium carbonate to form calcium sulfamate, water and carbon dioxide gas. $2SO_3NH_3 + CaCO_3 \rightarrow Ca(SO_3NH_2)_2 + H_2O + CO_2$	[1] for naming products formed [1] for correct and balanced equation.
(c)		Ammonia. Ammonia gas turns moist red litmus paper blue.	[1] for gas. [1] for test and observation. Allow ecf for 2nd [1] if test is correct for gas.
A5			
(a)		In zirconium, the <u>zirconium cations and sea of delocalised electrons</u> are held together by <u>strong metallic bond in a giant metallic lattice structure</u>. <u>Large</u> amount of <u>heat energy</u> is required to overcome the <u>strong metallic bonds</u> in zirconium.	[1] for describing structure and bonding. [1] for stating energy required.
(b)	**(i)**	$Zr\ (s) + H_2O\ (g) \rightarrow ZrO_2\ (s) + H_2\ (g)$	[1] for correct reactant and products. [1] for balanced and correct state symbols.
	(ii)	<u>Hydrogen gas</u> is formed. Hydrogen gas is <u>flammable</u> OR the <u>build-up of pressure</u> in the nuclear reactor may result in an explosion.	[1] identifying that source of danger is hydrogen gas. [1] for reason on why hydrogen is dangerous.
A6			
(a)	**(i)**	Iron	[1] Reject chemical symbol.

(ii)	A catalyst speeds up a reaction by providing an alternative reaction pathway of lower activation energy. Number of particles colliding with energy equal to or higher than the activation energy increases. Frequency of effective collision increases.	[1] [1]
(b)	$N_2 + 3H_2 \rightleftharpoons 2NH_3$ The production of ammonia is a reversible process.	[1] equation (with reversible arrow) [1] Explanation
A7		
(a)	<table><tr><td></td><td colspan="2">anode (+)</td><td colspan="2">cathode (–)</td></tr><tr><td></td><td>name of product</td><td>observation</td><td>name of product</td><td>observation</td></tr><tr><td>molten magnesium chloride</td><td>chlorine</td><td>effervescence of yellow-green gas</td><td>magnesium</td><td>silvery liquid forms</td></tr><tr><td>concentrated magnesium chloride solution</td><td>chlorine</td><td>effervescence of yellow-green gas</td><td>hydrogen gas</td><td>effervescence of colourless gas</td></tr></table>	[1] for each pair of correct product and observations Max [4] If student mentions only effervescence, with missing colour of gas, less [1].
(b)	At anode: Universal indicator changes from green to red/orange At cathode: Universal indicator changes from green to blue/purple.	[1] each for correct colour change. Max [2]
A8		
(a)	A: fractional distillation B: catalytic cracking C: addition polymerisation	[2] – 3 correct [1] – 2 correct [0] otherwise Reject all other answers
(b)	Petroleum gas. Fuel for cooking / fuel for heating.	[1] for identifying and stating one use.
(c) (i)	 *Alternating 'dot-and-cross' symbols to show sharing of electrons between adjacent atoms.*	[1] correct bonding and number of electrons [1] general order and arrangement of atoms.

(ii)		[1] each. If both structures are correct but not all bonds expanded, less [1].
(iii)	Fractional distillation. The two products in (b)(ii) are isomers of each other and have different physical properties / different boiling points.	[1] for identifying method. [1] for explaining the difference in boiling point due to isomerism.

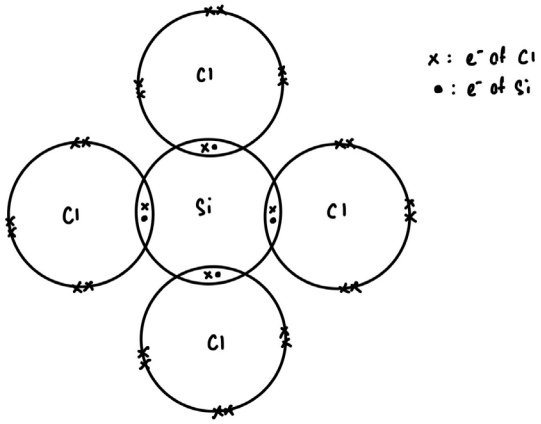
Paper 1

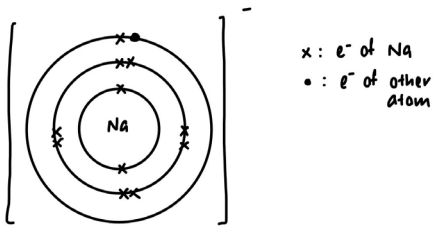
1	2	3	4	5	6	7	8	9	10
D	B	A	B	C	D	D	C	C	B
11	12	13	14	15	16	17	18	19	20
D	B	C	D	C	C	C	C	C	B
21	22	23	24	25	26	27	28	29	30
D	C	B	B	D	B	D	B	B	D
31	32	33	34	35	36	37	38	39	40
C	C	D	D	C	D	A	C	B	C

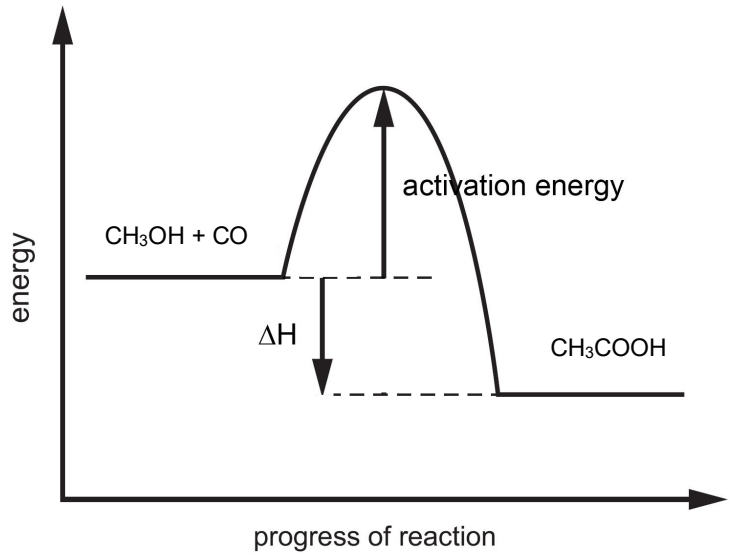
Paper 2

Paper 2 (80 marks)

Qn.		Answers	Marks	
A1	a)	**A**	1	5
	b)	**D**	1	
	c)	**B**	1	
	d)	**F**	1	
	e)	**I**	1	
A2	a)	water and salts have different boiling points (1) water evaporates AND salts / residues / impurities / solids left in flask (1) water condenses / turns to liquid in the condenser (1)	3	10
	b)	i) Mg^{2+} and Cl^- ii) 1.26/95 = 0.01325 mol (1) 0.01325 x 2 = 0.0265 mol/ dm^3 (1) iii) white ppt/ solid/ deposit	2	
	c)	i) $Ba^{2+}(aq) + SO_4^{2-}(aq)$ à $BaSO_4(s)$ (1) ii) conc of SO_4^{2-} = 1.24/96 = 0.0129 mol/dm^3 (1) mol of SO_4^{2-} = 0.129 x 50/1000 = 6.46 x 10^{-4} mol (1) mol of $BaSO_4$ = 6.46 x 10^{-4} mol mass of BaSO4 = 6.46 x 10^{-4} x 233 = 0.150 (1) mass of SO_4^{2-} in 50 cm^3 seawater = 1.24 x 50/1000 = 0.062 g (1) mol of SO_4^{2-} = 0.062/96 = 6.46 x 10^{-4} mol (1) mol of $BaSO_4$ = 6.46 x 10^{-4} mol mass of BaSO4 = 6.46 x 10^{-4} x 233 = 0.150 (1) - Many students failed to notice that the concentration is given in g/dm^3 so attempted to find moles of SO_4^{2-} by multiplying 1.24 x 50/1000.	3	

A3	a)	2.8.4	1	8
	b)	$Si + 2Cl_2 \rightarrow SiCl_4$ - Many students attempted to give the state symbols but got it wrong (not penalised) - Do note that state symbols are not required unless stated in qns. Wrong state symbols may be penalised.	2	
	c)	does not conduct electricity (1) low melting point / low boiling point (1) - Low density is not accepted since density depends on the actual state of the substance i.e. solid, liquid or gas. e.g. iodine has SMS but density is not low.	2	
	d)	 minus one mark for any mistake: missing legend/ non-bonding electrons	2	
A4	a)	Dividing % by mass by atomic mass N = 12.0/14 H = 3.4/1 O = 41.0/16 V = 43.6 /51 Dividing correctly by smallest to give correct ratio: N = 0.857 H = 3.4 O = 2.56 V = 0.855 Empirical formula: H_4NO_3V (order of elements not considered in marking)	1 1 1	8
	b)	coloured Accept: can act as catalysts	1	
	c)	NH_4^+ (1) VO_3^- (1)	2	
	d)	(**Y** is an) oxidising agent (1) the oxidation number of iodine increases / iodide loses electrons / **Y** gains electrons (1) Reject: Y is an OA since it reacts with KI which is an RA (need to elaborate) Y is an OA since it oxidises KI to I_2 (how do you know?)	2	

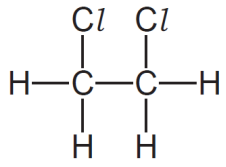
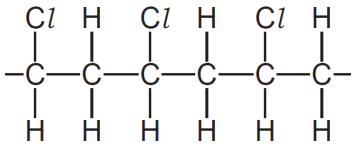
	e)	i) Ammonia (1) ii) $2NH_4VO_3 \rightarrow V_2O_5 + H_2O + 2NH_3$ (1)	2	
A5	a)	C_2H_4O (1) Reject $C_{12}H_{24}O_6$	1	9
	b)		1	
	c)	$2Na + Cl_2 \rightarrow 2NaCl$ - Many students attempted to give the state symbols but got it wrong (not penalised) - Do note that state symbols are not required unless stated in qns. Wrong state symbols may be penalised.		
	d)	sodium chloride has giant ionic lattice structure (1) a lot of energy required to overcome the strong electrostatic forces of attraction between oppositely charged ions. (1) chlorine has simple molecular structure (1) a small amount of energy is required to overcome the weak intermolecular forces of attraction between chlorine molecules.(1)	4	
	e)	At 600 °C it is solid so ions cannot move / at 600 °C ions are in fixed position in a solid (1) NOTE: reference needed to solid as well as lack of movement of ions At 1000 °C it is molten/ liquid so ions can move / at 1000 °C it is molten/ liquid so ions are mobile / At 1000 °C it is molten/ liquid because the ions are free (1) NOTE: reference needed to temperature, liquid/ solid as well as movement of ions	2	

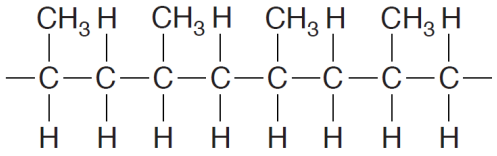
A6	a)	 - reactants labelled on left and products labelled on the right AND product level below reactant level (1) - enthalpy change labelled and shown by downward arrow value (1) - activation energy shown as upward arrow from left hand energy level to energy 'hump' above the highest energy levels of both products and reactants (1)	3	9
	b)	(i) CO binds irreversibly to haemoglobin in blood; blocks oxygen uptake in blood. Reject: death, breathing difficulties - Many students missed out on the keyword: irreversibly. (ii) H_2O (iii) Pd oxidation states +2 to 0; (1) C oxidation states +2 to +4; (1) (iv) palladium has been reduced since OS decreased (1) C has been oxidized since OS increased. (1) e.c.f. from (iii)	6	
	c)	- Extraction of iron	2	
B7	a)	sodium > barium > magnesium > nickel > copper (Nickel spelt wrongly - zero marks)	1	10
	b)	- the more reactive the metal, the more negative is the reduction potential OR - the less reactive the metal, the more positive is the reduction potential	1	

<table>
<tr><td></td><td>c i)</td><td>- +0.80 V (1)
- silver is less reactive than copper; hence reduction potential will be more positive than copper (1)</td><td>2</td><td></td></tr>
<tr><td></td><td>c ii)</td><td>$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$ (no state symbols - minus 1 mark)</td><td>2</td><td></td></tr>
<tr><td></td><td>d)</td><td><table><tr><th>metal</th><th>chromium</th><th>tin</th></tr><tr><td>aqueous solution of nickel(II) ions</td><td>✓</td><td></td></tr><tr><td>dilute nitric acid</td><td>✓</td><td>✓</td></tr></table>Each row - correct answer(s) - [1]</td><td>2</td><td></td></tr>
<tr><td></td><td>e i)</td><td>The more positive/ less negative the electrode potential, the lower is the ion in the electrochemical series.</td><td>1</td><td></td></tr>
<tr><td></td><td>ii)</td><td>positive: chlorine gas/ Cl_2
$2Cl^-(l) \rightarrow Cl_2(g) + 2e^-$

negative: iron/ Fe
$Fe^{3+}(l) + 3e^- \rightarrow Fe(l)$

Each row - correct answer(s) - [1]</td><td>2</td><td></td></tr>
<tr><td>B8</td><td>a i)</td><td>concentration of ethanoate = 0.45 mol / dm^3 (1)
mass = 0.45 × 59 × 200/1000 = 5.31 g (1)</td><td>2</td><td>10</td></tr>
<tr><td></td><td>a ii)</td><td>concentration of ethanoate ions at 300 s = 0.17 mol / dm^3 (1) [0.16 mol / dm^3 accepted]
average rate = 0.17/300 = 5.67×10^{-4} (mol/dm^3/ s) or 5.33×10^{-4} (mol/dm^3/ s) [1]</td><td>1</td><td></td></tr>
<tr><td></td><td>a iii)</td><td>rate of reaction decreases with time / reaction slows down (1)
gradient becomes less steep with time (1)</td><td>2</td><td></td></tr>
<tr><td></td><td>a iv)</td><td>concentration of reactants decreases (1)
no. of particles per unit volume decreases (1)
frequency of collision decreases
+ frequency of effective collision decreases (1)</td><td>3</td><td></td></tr>
<tr><td></td><td>b)</td><td>ethanol has a simple molecular structure (1)
Only stating covalent bond not accepted. Need to mention simple covalent bond.
no free mobile electrons (1)</td><td>2</td><td></td></tr>
<tr><td>B9 EITHER</td><td>a)</td><td>fractional distillation (1)
cracking (1)</td><td>1</td><td>10</td></tr>
</table>

	b)	Electrolysis of dilute aqueous sodium chloride solution will produce oxygen gas at the anode and not chlorine gas.	1	
	c)	 (1)	1	
	d)	hydrogen chloride [hydrochloric acid not accepted]	1	
	e)	 Accept: chlorine atoms at bottom. correct repeating unit (1) 3 repeat units with continuation bonds at ends (1) No ending lines from the carbon atoms on both ends - minus [1]	2	
	d i)	max mass = 2250 tonnes	1	
	d ii)	% yield = 2175/2250 x 100 (1) = 96.7% (1)	2	
B9 OR	a)	alcohol and carboxylic acid [both need to be correct to get 1 mark]	1	10
	b)	$2HOCH_2COOH + Na_2CO_3 \rightarrow 2HOCH_2COONa + CO_2 + H_2O$ correct products (1) correct coefficients (1)	2	
	c)	- oxygen has been removed from oxalic acid - hydrogen has been added to oxalic acid ALLOW oxidation number of carbon decreases	1	
	d i)	- condensation polymer Any of the following: - because water has been removed - monomer does not have a carbon-carbon double bond - has ester linkage which is formed by condensation) [both need to be correct to get 1 mark]	1	
	d ii)	- Terylene	1	
	e i)	- Less landfill/ pollution - Fewer air pollution/ less poisonous fumes - Small mammals/ birds not trapped/ harmed	1	

	e ii)	- plastic bags - any other valid answers Plastics not accepted	1	
	e iii)	 correct repeating unit (1) 3 repeat units with continuation bonds at ends (1) No ending lines from the carbon atoms on both ends - minus [1]	2	