A – Z School's Preliminary Papers
4 Express
Chemistry

ANSWERS: Part 3

K	CHIJ Katong Convent School
L	Loyang View Secondary School
M	Montfort Secondary School
N	Nanyang Girls' High School
O	Orchid Park Secondary School

CHIJ KATONG CONVENT SCHOOL

Paper 1

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

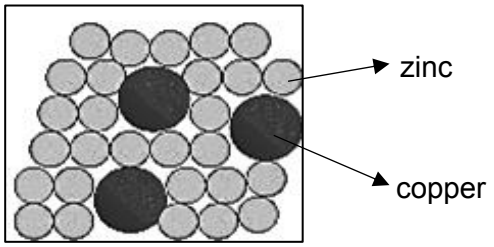
11	12	13	14	15	16	17	18	19	20
B	C	D	A	C	C	A	D	B	D

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

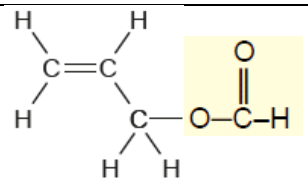
31	32	33	34	35	36	37	38	39	40
D	A	D	D	A	C	A	B	A	D

Paper 2

Qn	Correct Response	Marks
A1a	nitrogen dioxide	1
A1b	iron(III) oxide	1
A1c	lithium oxide	1
A1d	calcium oxide	1
A1e	silicon dioxide	1
	Total	**5**
A2a	F	1
A2b	A	1
A2c	B	1
A2d	D	1
	Total	**4**
A3a	H_2 and $CrCl_2$	1
A3b	Aluminium has an <u>oxide layer</u> / <u>aluminium oxide</u> on the surface. This forms a <u>protective barrier/ layer</u> around the wire, preventing the acid from reacting with it.	1 1

Qn	Correct Response	Marks
A3c	 labelling, lesser copper atoms than zinc atoms [1] disrupted arrangement of atom layers [1]	2
	Total	**5**
A4a	no. of mol of H_2SO_4 $=\frac{45}{1000} \times 0.20$ = 0.009 mol [1] no. of mol of KOH $=\frac{0.78}{39+16+1}$ = 0.0139 mol (3 sf) [1] From equation, mole ratio of KOH:H_2SO_4 = 2:1 sulfuric acid is in excess because (2 × 0.009 = 0.018 mol) is greater than 0.0139 mol [1] / sulfuric acid is in excess because ($\frac{0.0139}{2}$ = 0.00695 mol) is less than 0.009 mol	3
A4b	ammonia (gas)	1
	Total	**4**
A5a	Higher pressure of (gaseous) reactant(s)/ H_2 and Cl_2 / H_2/ Cl_2 There are <u>more reactant particles/ H_2 and Cl_2 molecules per unit volume</u> of the gas and they <u>collide more frequently and there is an increase in frequency of effective collision.</u>	1 1
A5b(i)	Energy released = 184 x 2 = 368 kJ	1
A5b(ii)	<u>Energy taken in to break bonds</u> in reactants/ hydrogen and chlorine <u>is less than energy given out to form bonds</u> in products/ hydrogen chloride.	1 1
	Total	**5**
A6ai	The percentage yield of ammonia decreases with increasing temperature.	1
A6aii	Percentage yield of ammonia increases with increasing pressure.	1
A6aiii	Catalyst speeds up the reaction / lowers activation energy. <u>Less energy</u> is used and <u>lowers energy cost.</u>	1 1

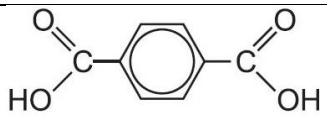
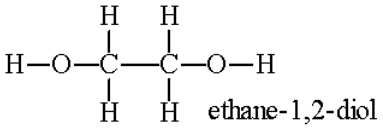
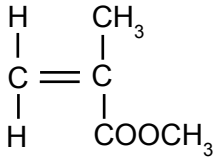
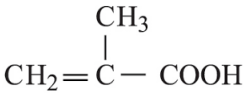
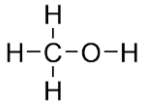
<table>
<tr><th>Qn</th><th>Correct Response</th><th>Marks</th></tr>
<tr><td>A6b</td><td>$NH_3 + 2O_2 \rightarrow HNO_3 + H_2O$</td><td>1</td></tr>
<tr><td></td><td>Total</td><td>5</td></tr>
<tr><td>A7a</td><td>Viscosity.</td><td>1</td></tr>
<tr><td>A7b(i)</td><td><u>Substitution reaction</u>.</td><td>1</td></tr>
<tr><td>A7b(ii)</td><td><u>Chlorine</u> (or any halogen)</td><td>1</td></tr>
<tr><td>A7c</td><td>any one from:
$C_{13}H_{28} \rightarrow C_4H_8 + C_9H_{20}$
$C_{13}H_{28} \rightarrow 2C_4H_8 + C_5H_{12}$
$C_{13}H_{28} \rightarrow 3C_4H_8 + CH_4$</td><td>1</td></tr>
<tr><td>A7d</td><td>
<table>
<tr><td></td><td>C</td><td>H</td></tr>
<tr><td>% by mass</td><td>88.9</td><td>100 - 88.9 = 11.1</td></tr>
<tr><td>no. of moles</td><td>$\frac{88.9}{12}$ = 7.41</td><td>$\frac{11.1}{1}$ = 11.1</td></tr>
<tr><td>mole ratio</td><td>$\frac{7.41}{7.41}$ = 1</td><td>$\frac{11.1}{7.41}$ = 1.5</td></tr>
<tr><td>simplest mole ratio</td><td>2</td><td>3</td></tr>
<tr><td>empirical formula</td><td colspan="2">C_2H_3</td></tr>
</table>
[1]

[1]
</td><td>2</td></tr>
<tr><td></td><td>Total</td><td>6</td></tr>
<tr><td>A8a</td><td>Acidified potassium manganate(VII) / acidified potassium dichromate(VI)</td><td>1</td></tr>
<tr><td>A8b</td><td>  </td><td>1</td></tr>
<tr><td>A8c</td><td>H^+</td><td>1</td></tr>
<tr><td>A8d</td><td>$2HCOOH + Zn \rightarrow (HCOO)_2Zn + H_2$ /
$2HCOOH + Zn \rightarrow Zn(HCOO)_2 + H_2$

correct chemical formulae [1]
balance correctly [1]</td><td>2</td></tr>
<tr><td></td><td>Total</td><td>5</td></tr>
<tr><td>A9a</td><td>Number of repeat units
$= \frac{14\,000}{4(12)+1\,(8)}$
= 250

Number of C atoms
= 250 x 4
=1000</td><td>1

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

Qn	Correct Response	Marks
A9b	<table><tr><th></th><th>true</th><th>false</th></tr><tr><td>Polymer D is a polyester.</td><td></td><td>√</td></tr><tr><td>Water is formed as a by-product when monomers react to form polymers A and B.</td><td>√</td><td></td></tr><tr><td>The empirical formula of polymer C is the same as its monomer.</td><td>√</td><td></td></tr><tr><td>One of the monomers that react to form polymer B is an alcohol.</td><td></td><td>√</td></tr></table>	4 corr – 2 2 – 3 corr – 1 1 corr – 0
A9c	  / $HO-(CH_2)_2-OH$	1 1
A9di		1
A9dii	 	1 1
A9e	Advantage: The polymers are <u>durable</u>/ <u>resistant to corrosion</u>. Disadvantage: These polymers when disposed cause land pollution as they take up space in landfills / These polymers when burnt in incinerator produce greenhouse gases which causes climate changes Reject: The polymers will cause <u>environmental problems</u> when they are <u>improperly disposed</u>.	1 1
	Total	**11**

Qn	Correct Response	Marks
B10a(i)	Anhydrous copper(II) sulfate changes from white to blue.	1
B10a(ii)	By heating to dryness / evaporating to dryness the hydrated copper(II) sulfate.	1
B10a(iii)	By determining the boiling point which is 100 °C for pure water. / By determining the freezing point which is 0 °C for pure water.	2
B10b(i)	number of moles of $Cu(NO_3)_2$ used $= \frac{4.7}{64 + 2(14) + 6(16)}$ = 0.025 mole ratio = $Cu(NO_3)_2$: NO_2 1 : 2 number of moles of NO_2 formed = 0.025 x 2 = 0.050 [1] volume of NO_2 formed = 0.050 × 24 = 1.2 dm^3 [1]	2
B10b(ii)	mole ratio = $Cu(NO_3)_2$: O_2 2 : 1 number of moles of O_2 formed = 0.025 ÷ 2 = 0.0125 [1] mass of O_2 formed = 0.0125 × 2(16) = 0.4 g [1]	2
B10c	$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$ correct chemical formulae [1] correct state symbols and balance correctly [1]	2
	Total	**10**

Qn	Correct Response	Marks
B11a	Cell 1. The electrodes are made up of <u>two (different) metals</u> / The electrodes are <u>not inert</u>.	1 1
B11b	Copper(II) ions, nitrate ions, hydrogen ions, hydroxide ions *[Must get all the name of ions correct]*	1
B11c	At zinc electrode: $Zn(s) \rightarrow Zn^{2+}(aq) + 2e^-$ At copper electrode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	1 1
B11di	Chlorine/ Cl_2 gas is produced at electrode Y. Due to the <u>higher concentration of chloride ions compared to hydroxide ions</u>, <u>chloride ions</u> are <u>preferentially discharged/discharged in preference/ preferentially oxidised</u>.	1 1
B11dii	<u>Disagree</u>. The <u>volume/number of moles</u> of hydrogen <u>gas</u> produced at <u>electrode X</u> should be the <u>same</u> as the volume of chlorine <u>gas</u> produced at <u>electrode Y</u>. / The <u>volume/number of moles</u> of <u>gas</u> produced should be the <u>same</u> at <u>both electrodes</u>.	1
B11diii	Oxygen gas is produced at electrode Y. Since <u>concentration of chloride ions is lower than hydroxide ions,</u> <u>hydroxide ions</u> are <u>preferentially discharged/ discharged in preference / preferentially oxidized.</u> Reject: concentration of Cl^- ions decreased.	1 1
	Total	**10**

<table>
<tr><th>Qn</th><th>Correct Response</th><th>Marks</th></tr>
<tr><td colspan="3">EITHER</td></tr>
<tr><td>B12a</td><td>Nitrogen makes up 78% of air.</td><td>1</td></tr>
<tr><td>B12b</td><td>Carbon dioxide.
Reject: other greenhouse gases

Average global temperature increases/
More occurrences of unusual weather conditions/
Melting of icebergs that causes ocean levels to rise and cause flood. /
AVP</td><td>1

any 1 - 1</td></tr>
<tr><td>B12ci</td><td>Temperature of the gases from engine is <u>high</u>. The reactant particles have more kinetic energy and <u>move faster</u>.
The powdered catalyst. Increasing total surface area / surface area to volume ratio.
Increasing collision and effective collision frequency.</td><td>1

1</td></tr>
<tr><td>B12cii</td><td>Oxygen/ unburnt hydrocarbons
$2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$

Carbon monoxide
$2CO + O_2 \rightarrow 2CO_2$
$2CO + 2NO \rightarrow 2CO_2 + N_2$
$4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

Nitrogen oxides / nitrogen monoxide / nitrogen dioxide
$2CO + 2NO \rightarrow 2CO_2 + N_2$
$4CO + 2NO_2 \rightarrow 4CO_2 + N_2$

Do not award full marks if both substances are oxides of nitrogen.

Carbon monoxide and oxygen/ unburnt hydrocarbons are removed by <u>complete combustion</u>.

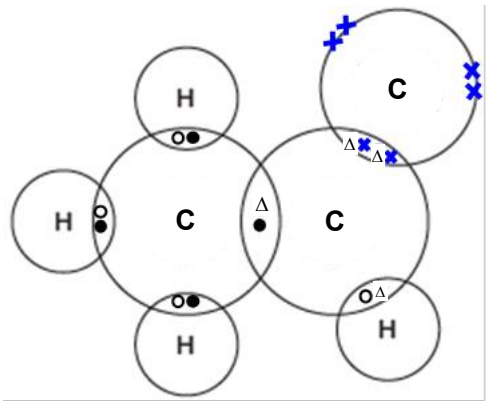
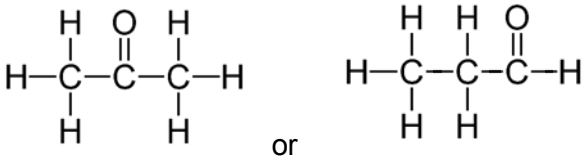
Nitrogen oxides / nitrogen monoxide / nitrogen dioxide are removed by <u>reduction</u>.</td><td>2 gases - 1

1 for one correct equation of chosen substance

explanation - 1</td></tr>
<tr><td>B12ciii</td><td>Nitrogen is produced when carbon monoxide reacts with nitrogen oxides/ NO / NO_2.
Oxygen is used when unburnt hydrocarbons burn completely/ undergoes complete combustion in the catalytic converter.</td><td>1

1</td></tr>
<tr><td></td><td>Total</td><td>10</td></tr>
<tr><td colspan="3">OR</td></tr>
<tr><td>B12a</td><td>Some ethanal have <u>vapourised/ boiled</u> because it is in room temperature.

Reject: evaporate / volatile liquid</td><td>1</td></tr>
<tr><td>B12b(i)</td><td><table><tr><td>name</td><td>methanal</td><td>ethanal</td><td>propanal</td><td>butanal</td></tr><tr><td>molecular formula</td><td>CH_2O</td><td>C_2H_4O</td><td>C_3H_6O</td><td>C_4H_8O</td></tr></table></td><td>1</td></tr>
</table>

Qn	Correct Response	Marks
B12b(ii)	general formula of aldehydes: $\mathbf{C_nH_{2n}O}$	1
B12c(i)	Functional group.	1
B12c(ii)	 Key o hydrogen electron • carbon electron Δ carbon electron x oxygen electron 4 C-H bonds and 1 C-C bond [1] 1 C=O bond [1] 2 non-bonding electron-pair on oxygen [1]	3
B12d(i)	Isomers A: Isomerism	1
B12d(ii)	 or 6 C-H bonds, 2 C-C bond and 1 C=O bond [1] correct position of each atom [1]	2
	Total	**10**

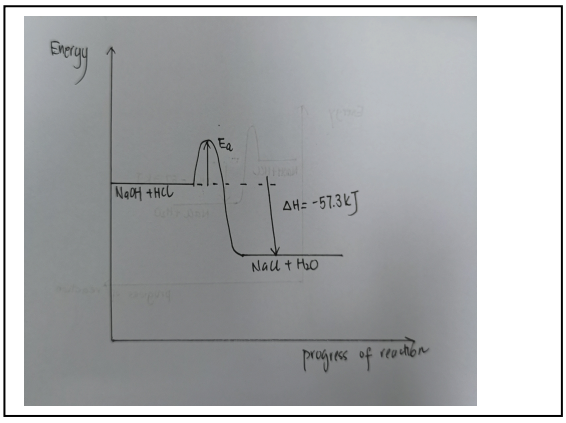
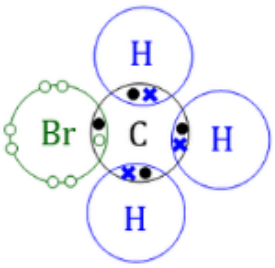
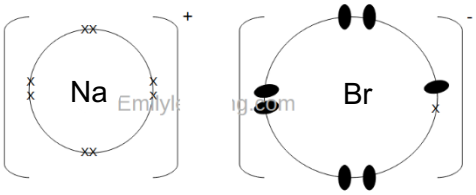
LOYANG VIEW SECONDARY SCHOOL

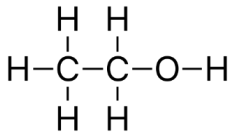
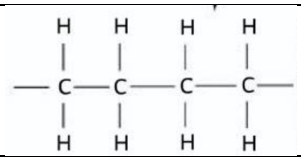
Paper 1

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

Paper 2

1	ai	E	1
	aii	B	1
	aiii	D or E	1
	b	Group IV and Group V elements form either acidic or neutral oxide that cannot neutralise the acids in the soil.	1
2	a	Student B Aqueous lead(II) nitrate will react with aqueous sodium hydroxide to form a white precipitate which is soluble in excess to form a colourless solution. Aqueous lead(II) nitrate will react with aqueous ammonia to form a white precipitate which is insoluble in excess aqueous ammonia. Aqueous zinc nitrate will form a white precipitate that is soluble in an excess of both aqueous sodium hydroxide and aqueous ammonia to form a colourless solution. Hence cannot be used. [Must state the observations in lead(II) nitrate and zinc nitrate]	1 1
	b	Calcium hydroxide reacts with ammonium nitrate to produce ammonia gas which escapes to the surrounding. This causes a loss of nitrogen from ammonium nitrate.	1 1
3	a	The atoms have the same number of protons (7) but different number of neutrons, 7, 8 and 9 respectively.	1
	b	Isotopes 1,2,3 have 5 valence electrons each.	1
	ci	X: nitrogen Y: iodine Z: strontium	1
	cii	X Y Z X: has the lowest melting point as it has simple molecular structure, with weak intermolecular forces of attraction between molecules, little energy is required to separate them. Y : is a bigger molecule with stronger intermolecular forces of attraction between molecules, more energy is required than X to separate them. Z: has the highest melting point because it has a giant metallic structure, strong electrostatic forces of attraction between ions and electrons, large amount of energy required to separate them.	1 1 1
	ciii	Z	1

		Z is a <u>metal</u> which reacts with acids.	
4	a	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$	1
	bi	No of mole of HCl = (200/1000) X 0.2 = 0.040 No of mole of NaOH = (100/1000)X 0.15 = 0.0150 <u>NaOH is the limiting reactant</u> $\triangle$H= 0.015 x -57.3 = -0.860kJ	1 1
	bii	No effect NaOH is <u>the limiting reactant</u> so the <u>number of moles of water</u> produced is the <u>same</u> hence overall enthalpy change of the reaction would not be affected	1 1
	c	Label • value of the enthalpy change in the diagram • energy level of reactants and products, formulae of reactants and products • activation energy  	1 1 1
A5	a	Outer shell electrons : correct  Ratio of C,H,Br : 1:3:1	1 1
	b	<table><tr><th></th><th>True</th><th>False</th></tr><tr><td>Bromomethane has a low boiling point.</td><td>√</td><td></td></tr><tr><td>Bromomethane has good electrical conductivity when molten.</td><td></td><td>√</td></tr><tr><td>Bromomethane could be obtained through substitution reaction of methane and bromine.</td><td>√</td><td></td></tr></table>	1 1 1
	c	Correct value of charges and ratio Outer shell electrons of eight with correct number of dots and crosses.  	1 1

6	a	Methoxybutane $CH_3OC_4H_9$	1 1
	bi	30 °C to 45 °C range	1
	bii	Down the group, melting point increases as the size of molecules increases. More energy required to overcome the stronger intermolecular forces of attraction between molecules.	1 1
	c	Solubility decreases Flammability decreases Viscosity increases Density increases	1
	d	Each successive member differ by CH_2 Or same functional group $-OCH_3$ [Must use the data from the table to explain]	1
	e	ethanol 	1 1
7	ai	2	1
	aii	Blue and red dyes in the black ink are not separated as they have the same R_f value of 0.6	1
	bi	Total volume in the mixture= 200cm^3 Volume of ethanol = 32cm^3 Percentage = (32/200) x100%= 16%	 1
	bii	R_f= 0.72 (allow ECF)	1
8	a	Element is pure substance that cannot be broken down into any simpler substances by chemical means.	1
	b	No Aluminium is more reactive than zinc and the electrical conductivity of 37.7 x 10^6 is higher than zinc which has electrical conductivity of 16.9 x 10^6. Copper is less reactive than zinc, but the electrical conductivity of copper 59.8 x 10^6 is more than electrical conductivity of zinc which is 16.9 x 10^6.	 1 1
	c	It is expensive as extracted by electrolysis	1
	d	Zinc atoms have different size compared to aluminium atoms . This disrupts the orderly arrangement of aluminium atoms Layers of aluminium atoms cannot slide over each other easily thus making it less malleable and stronger.	1 1
9	ai	Bigger and less useful molecules are cracked to form smaller and more useful molecules such as petrol which is higher in demand.	1
	(ii)	Less heat or energy of 500 °C for catalytic cracking is required compared to 800 °C for thermal cracking.	 1
	bi		1
	bii	Used to make plastics, pipes etc	
	c	Greater number of branches results in lowering the boiling points. 2,3 dimethyl butane containing 2 branches and has a boiling point of 58 ºC compared to 2-methypentane which has 1 branch. It has a boiling point of 60 ºC OR 2-methyl pentane has a lower boiling point than hexane 68 ºC which has no branch.	1 1

		The branched isomer is more compact and has a smaller contact area, hence less energy needed to overcome the intermolecular forces of attraction. or less energy is required to separate molecules.	1
	d	Result: Reddish-brown aqueous bromine decolourises in ethene [1] but remains reddish-brown in hexane. [1]	2
	e	Carbon coating on the catalyst prevents the contact of catalyst and the reactants hence reduce the rate of reaction.	1
	f	Ethanol could be obtained from fermentation of sugars in sugar cane. Sugar cane undergo photosynthesis which removes carbon dioxide that is produced when ethanol is burnt, Hence there is no net gain or loss of carbon dioxide.	1 1
10	a	Vanadium form coloured compounds VI_2 : red violet $VB_{3:}$ red brown	1
	b	No They form compounds with different chemical formula/ do not have similar chemical formula.	1
	ci	The oxidation state of V in VF_6 is +6 The oxidation state of V in VCl_4 is +4 The oxidation state of V in VBr_3 is +3 The oxidation state of V in VI_2 is +2 As the halogen decreases down the group the oxidation state decreases (+6 to +2) hence it oxidising strength decreases.	1 1
	cii	The size of iodine is bigger than fluorine hence the ability to gain electron decreases hence its oxidising power decreases.	1
	d	VAt_5 / VA_4 / VAt_3 / VAt_2 [any one]	1
	ei	Zinc has a fixed oxidation state or compounds of zinc are not coloured. or zinc has a relatively low melting point	1
	eii	Amphoteric oxide reacts with acids and bases to form salt and water.	1
11	a	TiO_2 (s) + 4e $\rightarrow$ $2O^{2-}(l)$ + Ti(s) state symbol	1 1
	b	To keep calcium chloride in molten state. or a lot of energy required to break ionic bonds in calcium chloride.	1
	c	To act as a solvent	1
	(d)	$2O^{2-}$ (l)$\rightarrow$ O_2(g) + 4e state symbol :1	1 1
	(e)	No of mole of titanium oxide= $(4.8x10^6)$ / 80= 60,000 Mass of titanium= 60000 x 48 g/mol = 2.88 tonnes	1 1
	(f)	Chlorine gas Chloride ions are present in higher concentration Hence preferentially discharged	1 1

Paper 1

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

Paper 2

A1

	Process	Method of separation
(a)	To obtain iodine from a mixture of iodine and sodium chloride.	**sublimation**
(b)	To obtain petrol from a mixture of water and petrol.	**separating funnel**
(c)	To obtain the salt formed when hydrochloric acid reacts with sodium hydroxide.	**evaporation to dryness**
(d)	To obtain butane from crude oil.	**fractional distillation**
(e)	To obtain the product formed when carbon dioxide is bubbled into calcium hydroxide.	**filtration**

4 m – all correct; 3 m – 1 error; 2m – 2 errors; 0 m – 3 or more errors.
No credit if wrong spelling.

A2(a)(i) C **(ii)** A **(iii)** D

1 m for each correct answer.

(b)(i) ionic bonding **1m**
(ii) Ionic compounds have high melting and boiling points. **(1m)** Ionic compounds conduct electricity when molten when the ions become mobile.**(1 m)**

A3(a)

Method Number	Type of Method	Reagent 1	Reagent 2	Soluble Salt Formed
1	Reacting an acid with a metal	**zinc metal, Zn**	sulfuric acid, H_2SO_4	**zinc sulfate, $ZnSO_4$**
2	Reacting an acid with an insoluble base	**copper (II) oxide, CuO**	**sulfuric acid, H_2SO_4**	copper (II) sulfate, $CuSO_4$
3	Reacting an acid with an insoluble carbonate	Magnesium carbonate, $MgCO_3$	**hydrochloric acid, HCl**	**magnesium chloride, $MgCl_2$**
4	**Reacting an acid with a soluble base, titration method**	**sodium hydroxide, NaOH**	**hydrochloric acid, HCl**	sodium chloride, NaCl

1m each for method 1, 2 and 3 only if both name and formulae is correct.
1m type of method for method 4 and 1 m for the correct name and formulae for the two reagents.
Accept other plausible answers.
(b)

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$

$CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$
$CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$

$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + CO_2 + H_2O$
$MgCO_3(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l) + CO_2(g)$

$NaOH + HCl \rightarrow NaCl + H_2O$
$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$

1m if formulae given correctly and balanced in the ionic equation. No marks if state symbols omitted.
(c) Copper metal is not reactive and will not react with the acid. **1m**
Sodium metal will react violently with acid and the preparation will be dangerous. **1m**

A4(a) No of moles of hydrochloric acid

= Volume of solution X concentration of solution

= 22.5/1000 dm^3 X 0.1 mol/dm^3

= 0.00225 moles

No of moles of sodium hydroxide in 25 cm^3 of solution H

= 0.00225 moles **1 m**

No of moles of sodium hydroxide in 100 cm^3 of solution H

= 0.00225 X 4 moles

= 0.009 moles **1 m**

(b)(i) Acid titration: methyl orange changes from yellow in sodium hydroxide to orange at end point.

Redox titration: purple colour is decolourised at end point.

1 m each;

(b)(ii) No of moles of potassium manganate (VII)

= Volume of solution X concentration of solution

= 10/1000 dm^3 X 0.02 mol/dm^3

= 0.0002 moles

No of moles of hydrogen peroxide in 25 cm^3 of solution H

= 5/2 X 0.0002 moles

= 0.0005 moles **1 m**

No of moles of hydrogen peroxide in 100 cm^3 of solution H

= 0.0005 X 4 moles

= 0.002 moles **1 m**

(c) No of moles of sodium peroxide

= No of moles of hydrogen peroxide

= 0.002 moles **1 m**

No of moles of sodium hydroxide formed from sodium peroxide

= 0.002 X 2 moles

= 0.004

Hence, number of moles of sodium hydroxide formed from sodium oxide

= 0.009 – 0.004 moles

= 0.005 moles

Hence, number of moles of sodium peroxide

= 0.005/2 moles

= 0.0025 moles **1 m**

(d)

oxide	**oxidation state of oxygen**
sodium oxide, Na_2O	**-2**
sodium peroxide, Na_2O_2	**-1**

1m each

A5(a) An acid is a substance that produces hydrogen ions in aqueous solution. Sodium dihydrogen phosphate has two hydrogen atoms in its chemical formula and hence **can produce hydrogen ions in solution** and hence is an acid.**(1m)**

A salt is an ionic compound formed when a metallic ion or an ammonium ion replaces one or more hydrogen ions of an acid. **Sodium has replaced one of the hydrogen ions in phosphoric acid** to form the salt, sodium dihydrogen phosphate. **(1m)**

Also accepted: Acid will react with a base to form a salt and water only. Sodium dihydrogen phosphate reacts with sodium hydroxide to form a salt and water only.

Salt is formed as a result of a neutralization reaction between acid and alkali. Phosphoric acid reacts with sodium hydroxide to form dihydrogen phosphate. Hence sodium dihydrogen phosphate is also a salt. But must mention the reactants by name to get full credit.

(b)(i) H^+ (aq) + OH^- (aq) → H_2O (l)

1m for correct formulae and balancing.

(ii) sodium phosphate, Na_3PO_4 **(1 m each)**

(c)(i) Sulfuric acid is a strong acid which **completely ionizes** in aqueous solution. Hence, the effective concentration of hydrogen ions in this example is, 1 mol/dm^3.
Ethanedioic acid is a weak acid which only **partially ionizes** in aqueous solution. Hence, the effective concentration of hydrogen ions from ethanedioic acid in this solution will be much less than 1.0 mol/dm^3.
The **concentration of hydrogen ions of weak acids will be much lower** than the given concentration of the acid, while that for strong acids, will be the same as the given concentration.

(The concentration is lower and will affect the rate of reaction. But the number of moles of hydrogen ions which may participate in the reaction will be the same for both acids as the weak acid will dissociate more as hydrogen ions are used up during the reaction.)
1m for complete and partial ionization. 1 m for reference to lower concentration of hydrogen ions.

(ii) **Approach (2m) :** Add 30 cm^3 of 1.0 mol/dm^3 **sodium hydroxide** into a styrofoam cup using a measuring cylinder. Record the **initial temperature** ,T_i. Measure 20 cm^3 of sulfuric acid using a measuring cylinder and add to the sodium hydroxide in the styrofoam cup. Observe and record the **highest temperature reached** , T_h. Determine the **temperature change** by subtracting T_i from T_h. **Repeat** the experiment but this time replace the sulfuric acid with ethanedioic acid.
Results (1m) : The sulfuric acid will show a **much greater temperature change** as there is much more heat produced during the neutralization

reaction between the sodium hydroxide solution which is in excess and the two acids, as the concentration of hydrogen ions which can react with the hydroxide ions from sodium hydroxide is much higher for the sulfuric acid.

Also accept, reaction between metals/carbonates and the two acids provided the reaction rate was monitored and not just the volume of product formed per se.

No credit was given for any method which did not work. Hence, using titration will not work as more hydrogen ions will be formed as the hydrogen ions are used up during the neutralization.

A6

(a) The melting points of the elements increases down Group I. [**F**]

The melting points of the elements decreases down Group I.

(b) The compounds of Group I elements are all ionic. [**T**]

(c) Bromine displaces iodine from aqueous potassium iodide. [**T**]

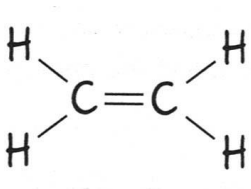
(d) The density of the elements becomes increases down Group VII. [**T**]

(e) When moving across a period from left to right, the oxide changes from acidic to basic. [**F**]

When moving across a period from left to right, the oxide changes from basic to acidic.

Three true statements identified correctly – 1m
Each false statement identified and corrected – 1m each

A7(a)



Ethene

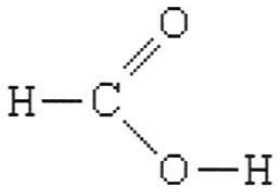
1 m for name; 1 m for correctly drawn structural formulae.

(b) Solution turns from reddish brown to colourless. **1m**

(c) $C_2H_5OH\ (l) \longrightarrow C_2H_4\ (g) + H_2O\ (l)$

1m for correctly balanced equation with correct formulae.

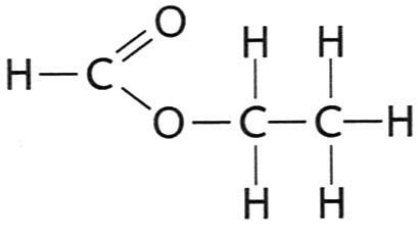
(d)(i)



methanoic acid

1 m for name; 1 m for correct structural formula.

(ii)



1m for correct structural formula of ethyl methanoate.

(iii) water;
Since water is formed in the reaction, reaction is called condensation reaction/ When two compounds combine with the removal of a small molecule such as water, it is called condensation.
1m awarded only if both product is given and explanation is correct.

(iv) Esters are used in perfumes, as artificial food flavourings, as a solvent for cosmetics and glues. **1m**

B9(a) An element is a pure substance that cannot be broken down into two or more simpler substances by chemical processes. **1m**
A compound is a pure substance containing two or more elements that are chemically combined in a fixed ratio. **1m**

(b) sodium carbonate (Na_2CO_3) or sodium hydroxide (NaOH).
1m for if both name and formulae correct.

(c) The sodium and chloride ions are held in **fixed positions** in the lattice structure by **strong electrostatic forces of attraction between the oppositely charged ions (1 m)**./The lattice structure is due to the strong forces of attraction between the oppositely charged sodium and chloride ions which prevents the movement of the ions.
A lot of energy is required to overcome these forces of attractions; hence the ions are not able to move.
Since the ions are held in fixed positions and are not able to move, **the ions do not slide past each other when a force is applied (1m)**. Hence, the crystal is hard.

The lattice structure shows that the **ions are held in a cubic shape (1m)**; hence the regular shapes of the crystals.

The **ions in the crystal are not able to move**; hence, the salt cannot conduct electricity (**no mobile ions**). **(1 m)**

Maximum of 3 m for any of the marking points.

(d) Pure water freezes at 0 °C. As given in the website, when salt is added to water, the freezing point drops to -21.12 °C. The salt dissolves into the liquid water and **lowers its freezing point**. So the ice melts. **(1m)**
(When added to ice, salt first dissolves in the film of liquid water that is always present on the surface, thereby lowering its freezing point below the ices temperature. Ice in contact with salty water therefore melts, creating more liquid water, which dissolves more salt, thereby causing more ice to melt, and so on.)

(e)(i) Sterilising drinking water/swimming pool water/Manufacture of PVC/poly(chloroethene). **(1m)**

(ii) Both hydroxide and chloride ions are present in aqueous solution of sodium chloride. However, in the electrolysis of dilute sodium hydroxide, hydroxide ions are preferentially discharged at the anode and chlorine will not be obtained.

$4OH^-(aq) \rightarrow 2H_2O(l) + O_2(g) + 4e^-$ **1m**

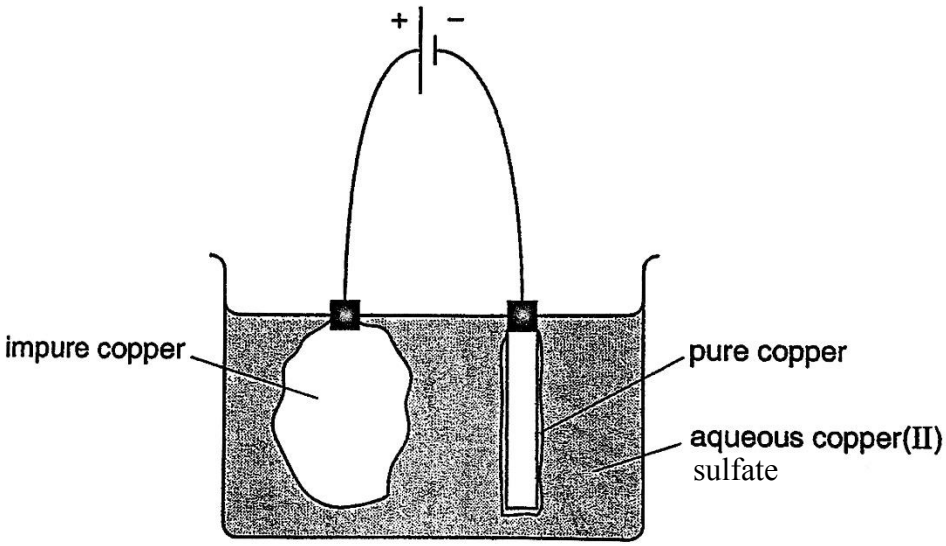
When concentrated sodium chloride is electrolyzed, chloride ions are discharged instead.

$2Cl^-(aq) \rightarrow Cl_2(g) + 2e^-$ **1m**

Chlorine is formed in this reaction.

B10(a) The copper sulfides are reduced by heating with carbon during smelting. Hence, carbon impurities are present in the copper metal.**(1m)**

(b) Pure copper is made by electrolysis, using aqueous copper (II) sulfate as an electrolyte.



(i) Anode of impure copper ; cathode of pure copper **(1 m)**

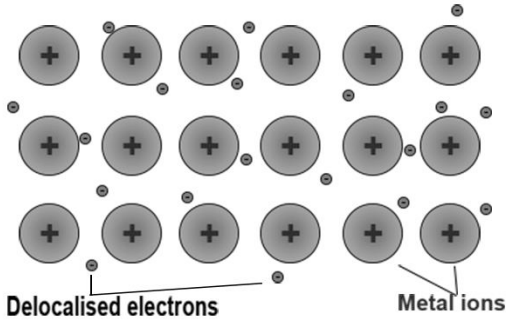
Cathode: $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$
Anode: $Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$

1 m; no credit if state symbols are omitted.

The mass of the cathode decreases; the mass of the anode increases.**(1m)**
Layer of reddish brown copper metal deposits at the cathode.**(1 m)**
Impurities can be found at the bottom of the electrolytic cell as 'anode slime'. **(1 m)**
The blue colour of the copper (II) sulfate solution remains.**(1m)**
Maximum of 4 m awarded for any of the marking points.

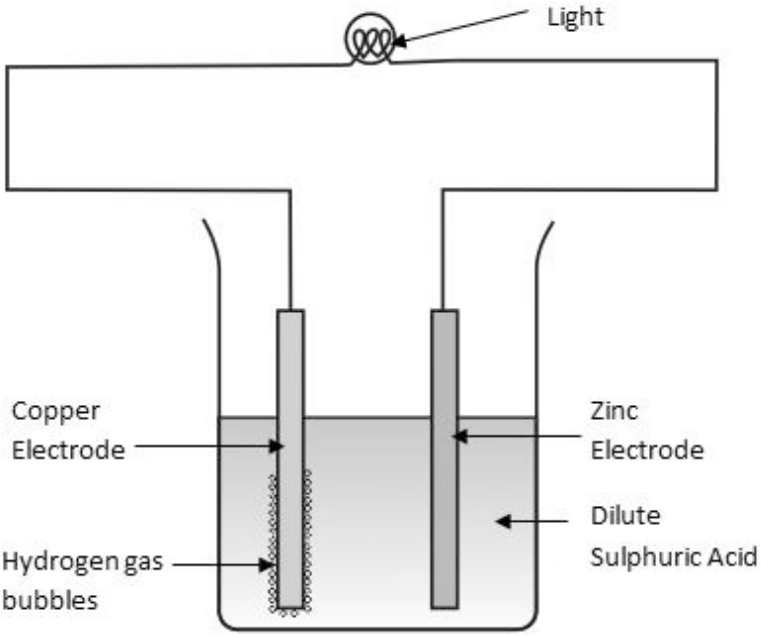
(ii) The concentration of the copper (II) sulfate solution **does not change** as the number of moles of copper (II) ions which are discharged at the cathode are replaced by the same number of moles of copper (II) ions which go into solution at the anode.
(2m only if the explanation is correct.)

(c)(i)



1m for labelled diagram.

(ii)



1m for labels including sulfuric acid.

1m for direction of flow of electrons.

Accept other answers including if copper is the negative electrode.

B11(a) 450 °C, 250 atmospheres, finely divided iron. **1m only if all given**

(b) nitrogen from the **fractional distillation** of liquefied air. **(no credit if liquefied omitted.)**
hydrogen from **cracking** of petroleum/crude oil fractions. **1 m**

(c) $N_2(g) + 3H_2(g) \leftrightarrows 2NH_3(g)$
1m only if correct formulae, reversible symbol, balanced and correct state symbols.

From the equation, one mole of nitrogen reacts with 3 moles of hydrogen. At the same temperature and pressure, the mole ratio is equivalent to the volume ratio. Hence, by mixing in this ratio, there is no excess or limiting reactant, and maximum yield is obtained without wastage of the reactant gases. **1m**

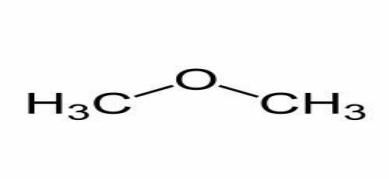
(d)(i) At a lower pressure, the number of gas molecules per unit volume, decreases. **(1m)** Hence, the frequency of collisions and hence the frequency of effective collisions decreases. This leads to lower rate of reaction.**(1m)**
(ii) From the graph, when pressure decreases, at all the temperatures shown, the yield of ammonia also decreases.**(1m)**
Hence, the amount (volume) of ammonia produced will decrease.
Since, less ammonia is produced, the amounts (volumes) of hydrogen and nitrogen which leave unreacted will increase.**(1m) (not a closed system)**
(iii) If a fixed amount of nitrogen and hydrogen is reacted at a lower pressure, the number of moles of ammonia produced will not change.**(1m)** This is because the number of moles of ammonia formed is determined by the number of moles of hydrogen and nitrogen which react.**(1m) (closed system, as the number of moles of hydrogen and nitrogen is fixed).** (The same number of moles of ammonia will be formed but at a slower rate.)

OR

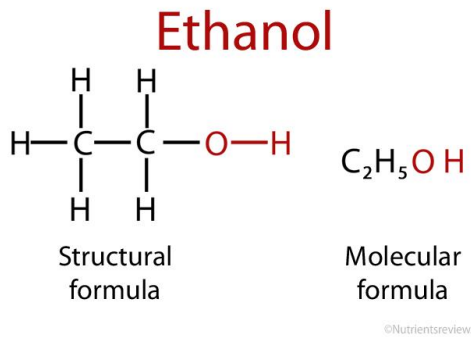
B11(a) methoxybutane; $CH_3OC_4H_{10}$ **1 m only if both correct**

(b)(i) 39.0 °C (accept 35 to 45 °C) (sketch to obtain answer) **1m**
(ii) As you go down the series, chain length increases. As the molecules become bigger, the forces of attraction between the molecules increases. Hence more energy is required to overcome the forces of attraction between the molecules leading to an increase in boiling point down the series.**(1m)**

(c)(i)



(ii)



(d) The brown bromine water is not decolourised./Bromine water remains brown. **(Do not accept no visible change) (1m)**
Methoxymethane is saturated/contains only single carbon carbon bonds. **(1m)**

(e) $C_2H_5OC_2H_5(l) + 6O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$

1 m for correct formulae and for correct balancing. State symbols not required.

Paper 1

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

Paper 2

Go to: https://drive.google.com/file/d/1jAx8HzXJ95eTTOun0aoiktHsTqqGI6MJ/view?usp=sharing

Paper 1

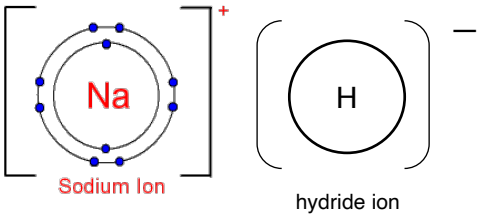
Qn 1	Qn 2	Qn 3	Qn 4	Qn 5	Qn 6	Qn 7	Qn 8	Qn 9	Qn 10
D	D	D	D	D	D	B	B	B	B

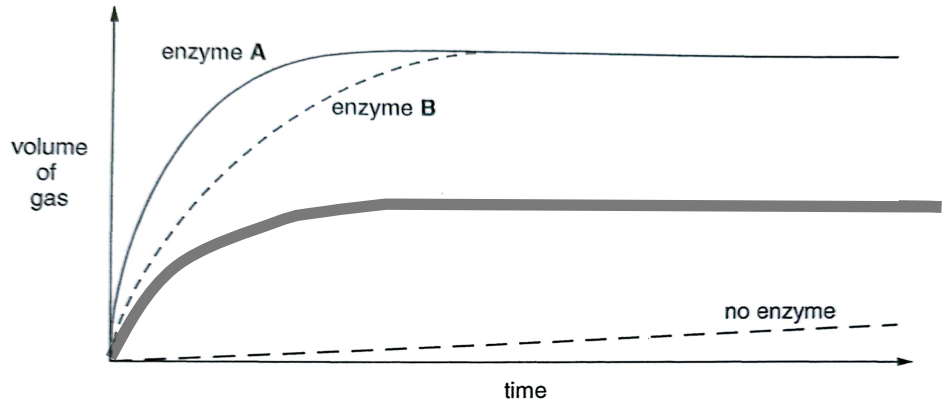
Qn 11	Qn 12	Qn 13	Qn 14	Qn 15	Qn 16	Qn 17	Qn 18	Qn 19	Qn 20
B	D	A	C	A	A	B	A	A	A

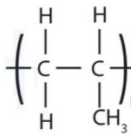
Qn 21	Qn 22	Qn 23	Qn 24	Qn 25	Qn 26	Qn 27	Qn 28	Qn 29	Qn 30
A	D	B	A	D	B	D	C	C	B

Qn 31	Qn 32	Qn 33	Qn 34	Qn 35	Qn 36	Qn 37	Qn 38	Qn 39	Qn 40
D	A	C	A	A	D	C	C	C	C

Paper 2

A1	**(a)**	**(i)**	[0.5] each	[3]
		(ii)	One outermost electron	[1]
	(b)	**(i)**	Gain 3 electrons [0.5] To form electronic configuration of 2, 8 [0.5] chemical symbol $\mathbf{M^{3-}}$ [1]	[2]
		(ii)	element **L** has isotopes. [0.5] 32.1 is the calculated average relative atomic mass based on abundance. [0.5]	[1]
	(c)		 [1] [1] Minus [1] if charges are wrong or missing.	[2]
A2	**(a)**		iron has positive ions and delocalised electrons [1] the electrons are free /mobile to move [0.5] moving electrons is an electric current [0.5]	[2]
	(b)		high carbon steels are strong / harder [0.5] but are brittle [0.5] low carbon steels are soft / more malleable or are more easily shaped [1]	[2]
	(c)	**(i)**	conditions are air (oxygen) and water	[1]
		(ii)	magnesium is above iron in the reactivity series [0.5] hence magnesium is more reactive [0.5] Magnesium loses electrons more easily [0.5] and hence it corrodes before the iron [0.5]	[2]
	(d)		Working must be shown in the calculation: dividing by correct A_r [0.5]: K 0.547/39 = 0.0140 Fe 0.195/56 = 0.00348 C 0.252/12 = 0.0210 N 0.294/14 = 0.0210 dividing by the smallest [0.5]: K 0.0140/ 0.00348 = 4 Fe 0.00348/ 0.00348 = 1 C 0.0210/ 0.00348 = 6 N 0.0210/ 0.00348 = 6 i.e. empirical formula = $K_4FeC_6N_6$ or $K_4Fe(CN)_6$ [1]	[2]

A3	**(a)**	Group 0 [1]		[1]
	(b)	Any two differences: • Mendeleev's table has: Groups and periods reversed • no Ar / no atomic numbers stated • no transition metals • In periods 4 / 5, a specific group has two elements • group numbers Arabic rather than Roman		[2]
	(c)	Any two observations: fizzes / runs on the surface / dissolves / explodes [1] Chemical equation: $2\ Rb + 2\ H2O \rightarrow 2\ RbOH + H2$ Equation [1], balanced [1]		[3]
A4	**(a)**	**(i)**	Improve the appearance. [1]	[1]
		(ii)	$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ [2]	[2]
	(b)	In platinum electrode the concentration of zinc ions will decrease. [1] In zinc electrode the concentration of zinc ions will remain constant. [1] Hence zinc brushed need replacing regularly but platinum brushes do not.[1]		[3]
A5				
	(a)	**(i)**	$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$	[1]
		(ii)	H_2O_2 is reduced to H_2O by losing oxygen. [1] H_2O_2 is oxidised to oxygen by losing hydrogen.[1] Accept if candidate uses oxidation number to explain.	[2]
	(b)	Use a gas syringe [1] to measure volume of oxygen produced at regular time interval. [1] or Use a electronic balance [1] to measure the mass of hydrogen peroxide solution at regular time intervals.[1]		[2]
	(c)	**(i)**	both enzymes [1] increase [1] the rate of reaction. Do not accept 'A is faster than B'.	[2]
		(ii)	the shape of the graph for no enzyme shows the reaction was very slow[1] with a 'very high activation energy' [1]	[2]
	(d)	Refer to graph. Sketch a curve on the graph to show: a shallower gradient [1] and ended at half the volume of gas [1], compared to B.		[2]
A6	**(a)**	answer …… poly(propene) ……[1] reasons …… useable temp. is above 100 °C [0.5] insoluble in oil [0.5]		[2]
	(b)	two advantages: lighter[0.5], less likely to break when dropped to ground [0.5] DO NOT ACCEPT more durable		[1]
	(c)	Problems of the disposal of waste polymers: non-biodegradable litter filling / creating landfill sites burning gives toxic gases		[2]

	(d)	**(i)**	structure of the repeating unit of the polymer:  [1] name of polymer …… poly(propene) ……[1]	[2]
		(ii)	A sample of the polymer was analysed and found to have an average relative molecular mass of 10500. How many carbon atoms are present in an average chain? One repeat unit of polymer = 36 + 6 = 42 [0.5] Number of repeat units = 10500 / 42 = 250 [0.5] Number of carbon atoms = 250 x 3 = 750 number of carbon atoms ……750…[1]	[2]
B7	**(a)**	**(i)**	one other advantage of using less bauxite: bauxite has a finite supply or reduces the need for mining. [1] one other advantage of using less electricity: to conserve / save finite fuel reserves or less greenhouse gas is producing during generation of electricity [1]	[2]
		(ii)	To extract aluminium from bauxite, ELECTROLYSIS [0.5] is required. The process uses lots of energy in order to melt the ore.[0.5]	[1]
		(iii)	The article states the recycling of 1 kg of used aluminium saves 8 kg of bauxite. Do you agree with the statement? Explain your reasoning. Mr of $Al_2O_3 \cdot 2H_2O$ = 54 + 48 + 36 = 138 138 g of bauxite gives 54 g of aluminium 8000 g of bauxite gives 3.130kg [1] Or 1000 g of aluminium can be obtained from 2.56kg of bauxite. No. The mass recovered is less than actual amount of aluminium present (i.e. 3.130 kg) [1]	[2]
	(b)		Copper is low in the reactivity series. [0.5] Hence it is an unreactive metal / do not corrode easily.[0.5]	[1]
	(c)		Accept drawing of irregular aluminium metal lattice, and around 1 atom or max. 2 atoms in 20 is copper. Do not accept drawing the same, regular structure with tiny atoms in the spaces	[2]
	(d)		aluminium oxide can react with both hydrochloric acid and sodium hydroxide.[1] copper(II) oxide has no reaction with sodium hydroxide.[1]	[2]
B8	**(a)**		By fractional distillation [0.5] Petroleum (crude oil) is heated in a furnace. [0.5] Passes up the fractionating column [0.5] The different fractions come out of the column at different heights depending on their boiling points.[0.5]	[2]
	(b)	**(i)**	carbon monoxide [1]	[1]

		(ii)	Diesel oil. [1] It produces more sulfur dioxide and oxides of nitrogen than petrol.[1]	[2]
		(iii)	$N_2 + 2O_2 \rightarrow 2\ NO_2$	[1]
		(iv)	Use of the catalytic converters: to convert pollutants from engine [0.5] into relatively harmless products.[0.5] Carbon dioxide [0.5] and nitrogen. [0.5]	[2]
	(c)	M_r of octane = 114 [0.5] 114 g of octane releases 5518 kilojoules of energy [0.5] 1.14 g of octane releases 5.518 (5.52) kilojoules of energy [1]		[2]
B9	**(a)**	**(i)**	$2\ NiS + 3\ O_2 \rightarrow 2\ NiO + 2\ SO_2$	[1]
E		**(ii)**	91 kg NiS forms 64 kg SO_2 [1] 182 kg NiS forms 182x64/91 = 128 kg SO_2 mass of sulfur dioxide formed = 128kg [1]	[2]
		(iii)	Check that it has the same fixed melting point of nickel.	[1]
	(b)	it is covalent [1] because of its low b.p. [1].		[2]
	(c)	Must mention both the compound formed and its problem: SO_2 causes acid rain CO_2 causes greenhouse effect / an effect of warming CO is toxic		[1]
	(d)	Hydrogenation of alkenes.		[1]
	(e)			

	aqueous zinc nitrate	aqueous nickel(II) nitrate	aqueous copper(II) nitrate
nickel	**no reaction**	no reaction	**Blue solution went green and nickel coated with a pink solid**
copper	no reaction	**no reaction**	no reaction

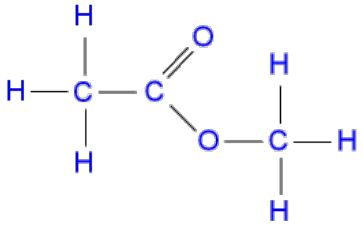
Minus [0.5] for each error

Ionic equation for **one** of the reactions that takes place.

$Zn(s) + Ni^{2+}(aq) \rightarrow Zn^{2+}(aq) + Ni(s)$

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

$Ni(s) + Cu^{2+}(aq) \rightarrow Ni^{2+}(aq) + Cu(s)$ [1] [2]

B9 O	**(a)**	**(i)**	$CH_3OH + CO \rightarrow CH_3COOH$ [0.5] M_r of methanol = 32 M_r of ethanoic acid = 60 32 tonnes methanol should produce 60 kg ethanoic acid [0.5] 8 tonnes methanol should produce 15 kg ethanoic acid percentage yield of ethanoic acid = (15/60) x 100% = 25% [1]	[2]
		(ii)	methyl ethanoate [1]  [1]	[2]

	(b)	2 $CH_3COOH + CaCO_3 \rightarrow (CH_3COO)_2Ca + CO_2 + H_2O$ Reactants [1], products [1]. Minus [1] if not balanced.		[2]
		Hydrochloric acid is a strong acid, ethanoic is a weak acid.		
	(c)	**(i)**	**Simple** test: to test pH using a meter or indicator paper [1]: Strong acid will show a pH of 0 or 1 from the meter or based on the colour of the indicator paper.[0.5] Weak acid will show a pH of slightly below 7.[0.5] Accept use a metal less reactive than magnesium, example zinc / iron. Strong acid will react much faster than a weak acid.	[2]
		(ii)	strong acids – **ionise/ dissociate completely** to produce hydrogen ions. weak acids - ionise/ dissociate **partially** to produce hydrogen ions.	[1]
		(iii)	hydrochloric acid, a strong acid will react with the pipes. Do not accept the acid will damage the pipes.	[1]