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Mark Scheme January 2009

GCE

GCE Chemistry (8080/9080)

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January 2009

Publications Code UA020841

Contents

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Using the mark scheme

1 / means that the responses are alternatives and either answer should receive full credit.

2 ( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

3 [ ] words inside square brackets are instructions or guidance for examiners.

4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

5 OWTTE means or words to that effect

6 ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- show clarity of expression
- construct and present coherent arguments
- demonstrate an effective use of grammar, punctuation and spelling.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated "QWC" in the mark scheme BUT this does not preclude others.

6241/01

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Bromine: (red-) brown **and** liquid **(1)** Iodine: grey OR black **and** solid **(1)** IGNORE shiny/silvery	red OR orange any combination of these colours any combination of these colours	yellow on its own or in combination with these colours purple on its own or in combination with these colours blue-black	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	**1st mark** lower / weaker **and** dispersion / London / van der Waals' / induced dipole forces (between HBr) **(1)** *do not award this mark if the explanation is contradictory* **2ND mark conditional on some type of intermolecular force** fewer / smaller number electrons (in HBr/bromine/bromide **(1)**	reverse argument provided it clearly refers to HI	any answer with covalent bonding, ionic bonding or hydrogen bonding or any reference to breaking **bonds** scores **(0) overall** less/fewer dispersion etc forces just "weaker intermolecular forces" reference to mass or size fewer / smaller number electrons in bromide ion/Br^-	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	$HBr + H_2O \rightarrow H_3O^+ + Br^-$ must be an equation **(1)** Ignore state symbols		$HBr \rightarrow H^+ + Br^-$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Any number or range below 2 **(1)**	pH less than 4	Just 'acidic'	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Each mark is stand alone Area A: **ionisation (1)** Area B: **acceleration** (of positive ions by an electric potential) **(1)** Area C: **deflection** (of positive ions by a magnetic field) **(1)** Area D: **detection** (of positive ions) **(1)**	 bombardment by (high energy) electrons to create positive **ions -** may be given further down bent	 Just "vaporisation or atomisation" mention of negative ions, penalise once Just "identification or collection"	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	$10.8 = 10(1-x) + 11x$ **(1)** $\therefore x = 0.8$ = fraction of ^{11}B **(1)** $\therefore$ 80% ^{11}B + 20% ^{10}B **(1)** **OR** $10.8 = 10x + 11(1-x)$ **(1)** $\therefore x = 0.2$ = fraction of ^{10}B **(1)** $\therefore$ 20% ^{10}B + 80% ^{11}B **(1)** **OR** $10.8 = \frac{10x + 11(100-x)}{100}$ **(1)** $\therefore x = 20$ = % of ^{10}B **(1)** $\therefore$ 80% ^{11}B (+ 20% ^{10}B) **(1)** **OR** $10.8 = \frac{10(100-x) + 11x}{100}$ **(1)** $x = 80$ = % of ^{11}B **(1)** $\therefore$ 20% ^{10}B (+80%^{11}B) **(1)** **OR** $10.8 = \frac{10x + 11y}{100}$ **(1)** $x + y = 100$ **(1)** $\therefore$ 80% ^{11}B + 20% ^{10}B **(1)**	correct answers with some working **(3)** correct answers with no working **(1)** if candidates does not relate % with correct isotopes **(max 2)** If Br is used **(max 2)**		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	**1st mark** greater nuclear charge / more protons (in nucleus) **(1)** IGNORE effective **2nd mark** attracting the same number of (occupied) electron shells / energy levels / orbits **OR** outer electrons are in the same shell / energy level / orbits **OR** same amount of shielding of outer shell (of electrons) **OR** same amount of shielding by **same** inner shells **(1)**	No extra / little difference in shielding of outer shell (of electrons)	Any mention of ions scores **(0) overall** just "higher atomic number" same number of orbitals Just "same amount of shielding"	**2**

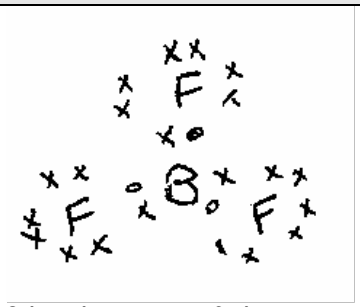
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	**1st mark** **although** greater nuclear charge / more protons **(1)** **2nd mark** electron in higher energy level in K than Na **OR** more / extra shells (of electrons) in K than Na **OR** electron in 4s in K and in 3s in Na **(1)** **3rd mark** outer electron experiences more shielding **(1)**	effective nuclear charge (approx) +1 **OR** more shells between outer electron and nucleus	greater effective nuclear charge	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	$(1s^2)2s^22p^63s^23p^1$ **OR** $(1s^2)2s^22p_x^{\ 2}2p_y^{\ 2}2p_z^{\ 2}3s^23p^1$ **(1)**	$1s^2$ repeated subscripts or superscripts capital or lower case letters		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Al^{3+} **(1)** smaller **and** due to loss of outer shell of electrons / loss of **all** outer electrons / loss of **3** outer electrons / loss of valence shell / loss of outer orbit **(1)**	$2Al^{3+}$ smaller as no electrons in outer shell	 Just "same number of protons attracting fewer electrons" lost 3 electrons loss of outer orbital / sub shell	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Ignore any reference to gaseous electrons or standard conditions **EITHER** Enthalpy/heat/energy change to **remove** 1 electron **(1)** from each atom in **one mole (1)** of **gaseous atoms (1)** **OR** the enthalpy change per mole **(1)** for $X(g) \rightarrow X^{+}(g) + e^{(-)}$ OR any specific example **(2)**	 required for change isolated atoms instead of gaseous $e^{(-)} + X(g) \rightarrow X^{+}(g) + 2e^{(-)}$	If incorrect equation after correct def -1 mark Just "gaseous element"	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**large** jump between 3rd and 4th ionisation energies (so 4th electron is in an inner shell) **(1)**	sketch showing gradual increase for first 3 I.E. then large jump	large jump between 1st and 2nd I.E.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	 3 bonding pairs of electrons **(1)** 3 lone pairs on each F **(1)** ignore Fl	All dots or all crosses Lone pair on B (1 max) If Cl used instead of F, **max (1)** if everything else correct If Br used instead of B max (1) for 3 bonding pairs and 3 lone pairs on each F	Ionic bonding **(0)**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	F is more electronegative than B **OR** (B and F have) different electronegativities **(1)**	F is very electronegative so bond is $B^{\delta+}$-$F^{\delta-}$ /pulls the electrons in the bond creating a dipole	Just "F is very electronegative" B polarises F	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	**1st mark** Shape drawn **OR** the BF_3 molecule is trigonal planar **(1)** **2nd mark** the dipoles/(individual) bond polarities /vectors cancel **OR** centres of positive and negative charges coincide **(1)**	BF_3 is symmetrical	charges cancel (polar) bonds cancel	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	covalent **(1)** dative (covalent) / co-ordinate **(1)** if one or both correct and mention of intermolecular forces **max (1)**		Ionic **(0) overall**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	**1st mark** tetrahedral **(1)** **2nd mark stand alone** 4 **pairs** of electrons (and no lone pairs) **OR** 4 bond **pairs** (and no lone pairs) **(1)** **3rd mark stand alone** which are as far apart as possible to minimise repulsion **OR** repel to give maximum separation **(1)**		Contradictory bond angle eg 120 degrees just "4 bonds" Atoms repel Just "repel equally"	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	mol **X** = 0.6/24 = 0.025 **(1)** molar mass **X** = 1.1/0.025 = 44 (g mol^{-1}) **(1)** conseq on mol X provided answer is ≥ 28 **OR** molar mass X = $\frac{1.1x24}{0.6}$ = 44 (g mol^{-1}) **(2)** ignore units	 Answer with no working (1)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	**X** = CO_2 / carbon dioxide **(1)** **Conditional** on 44 in (i)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	Check working and penalise cancelling errors mol Mg = $\frac{6}{24}$ = 0.25 **(1)** mol HCl needed = 2x0.25 **(1)** =0.5 conseq on mole Mg vol HCl = $\frac{0.5}{2}$ = 0.25 **dm^3** / 250 **cm^3** **(1)** conseq on mole HCl **unit essential**	Correct answer including unit but no working **(1)** Final answer of 18.25g HCl from mass ratios **(1)** for use of 1:2 ratio	250 or 0.25 with no unit and no working score **(0)** incorrect unit, including dm^{-3} and cm^{-3}	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	Ignore sig figs **EITHER** molar mass $MgCl_2$ = 24+(2x35.5) = 95(g mol^{-1}) **(1)** mass $MgCl_2$ = 0.25x95 = 23.75 / 23.8 **g (1)** **unit essential** conseq on mol of Mg in (b)(i) and their molar mass **OR** 24 g Mg gives 95 g of $MgCl_2$ **(1)** mass $MgCl_2$ = $\frac{95 \times 6}{24}$ = 23.75 /23.8 **g (1)** **Unit essential but do not penalise lack of units more than once**	Correct answer with or without working **(2)**	rounding errors eg 23.7g	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(i)	Yellow / orange **(1)** IGNORE words such as 'bright' or 'persistent' or 'lasting' or 'golden' or 'intense'	any combination of yellow and orange	any shade of red	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(ii)	(heat from flame) **electrons** promoted / excited (to a higher energy level/shell) **(1)** fall back down / return (to ground state) **(1)** emit (energy as) light/photon/radiation (of a particular frequency) **(1)** 2nd and 3rd mark **conditional** on previous marks		Any answer based on absorption **(0) overall** Atoms/ions/particles excited **(0) overall** Just "emit energy" Just "emit colour"	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	*Answer must identify ions as sodium ions / Na^+ and chloride / Cl- /chlorine ion* *Answer must describe **structure**.* *Ignore any references to the bonding.* 6 sodium ions around each chloride ion **(1)** and 6 chloride ions around each sodium ion **(1)** OR cubic structure/lattice or cube **(1)** with alternating sodium and chloride ions **(1)** OR two interlocking (face-centred) cubic lattices **(1)** of sodium and chloride ions **(1)** OR 6:6 (co-ordinate) lattice **(1)** of sodium and chloride ions **(1)**	a correctly labelled 3-dimensional diagram – minimum cube of 8 ions (2) If just labelled with + and – max (1) if unlabelled (0) a diagram showing just one layer of alternating Na^+ and Cl^- (1) if diagram is drawn, ignore relative sizes of ions	Any mention of atoms loses the mark that relates to ions. Any reference to covalency/molecules loses both the marks Closely packed does not mean cubic.	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	a lot of energy/heat is needed to overcome **(1)** **strong** forces between (oppositely charged) ions **(1)**	a lot of energy/heat is needed to break **(1)** **strong** ionic bonds /**strong** (ionic) lattice **(1)**	Any reference to atoms or molecules, covalent bonds, intermolecular forces, metallic bonds. **(0) overall**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	$Li_2CO_3 \rightarrow Li_2O + CO_2$ **(1)** ignore state symbols	multiples	$LiCO_3$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii)	**1st mark** Na^+ / sodium **ion** is larger (than Li^+ / lithium **ion** and has the same charge) **OR** Na^+ / sodium **ion** has lower charge density (than Li^+ / lithium **ion) (1)** **2nd mark** **ion** causes: less polarisation / distortion of CO_3^{2-} / carbonate **(ion)** **OR** **ion** causes: less weakening of (C-O) bonds in carbonate / anion **(1)** *must be a comparison for both marks*	reverse arguments for Li^+	sodium is larger than lithium/sodium has larger atomic radius/has a lower charge density atom causes polarisation **OR** ion causes less polarisation of CO_3 weakens ionic bonds	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)	MnO_4^- = (+)7 / VII Mn^{2+} = (+)2 / II **both** correct for **(1)**	7+ 2+		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (b)	2:5 ratio on lhs in final equation OR multiply half equations by 2 and 5 **(1)** everything else correct including electrons cancelled **conditional on 2:5 ratio (1)** $2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 5O_2 + 8H_2O$	 $16H^+$ on lhs and $10H^+$ on rhs multiples or fractions		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (c)	disproportionation **(1)** stand alone all correct oxidation numbers of oxygen in text or equation **(1)** relating **change** in oxidation numbers of oxygen to oxidation and reduction **(1)**	 may be described in words or numbers	"just" redox any change in oxidation number of hydrogen loses 2nd and 3rd marks just "explanation in terms of electron gain and loss"	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	Enthalpy change when 1 mol of **ammonia** (1) is formed from (0.5 mol) nitrogen & (1.5 mol) hydrogen in their most stable states/gas (1) at 1 atmosphere/100 kPa/10^5Pa/1 Bar and "a specified temperature"/298 K/25^{o}C (1)	"Heat/energy" instead of "enthalpy" "Released/given out" for change ..from its elements.. "standard" instead of " most stable"	"Required" instead of "change" Just "standard conditions"	**3**

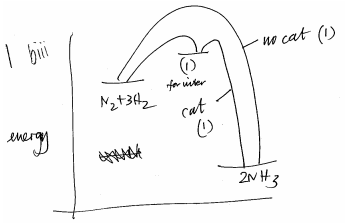
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	$\triangle H$ = 2 x −46.2 = −92.4 (kJ mol^{-1})			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	Bonds formed = (-)388 x 6 (= (−)2328) (kJ mol^{-1}) (1) Bonds broken = 944 + 3 x 436 (= (+)2252) (kJ mol^{-1}) (1) $\triangle H$ = 2252 −2328 = −76 (kJ mol^{-1}) (1) Third mark consequential. However, ensure that bonds formed are subtracted from bonds broken. Correct answer with some working (3) Correct answer with no working (2)	kJ per mol(e) (+)76 (kJ mol^{-1}) (2)	Incorrect units (e.g. kJ)	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iv)	**N—H** Bond enthalpies are average values (1) Whereas $\triangle H_f$ refers specifically to ammonia (1) 2nd mark can only be awarded if 1st mark scored.		Just "bond energies are average values" Any reference to N≡N or H-H bond energies being average values negates first mark	**2**

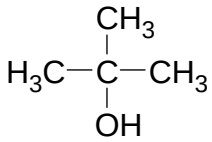
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	350 – 550 °C (1) 100 – 350 atm (1) any temp/pressure within this range Iron (1) ignore any promoters		Iron(II) / iron(III)	**3**

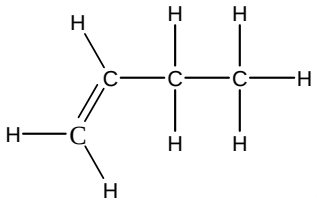
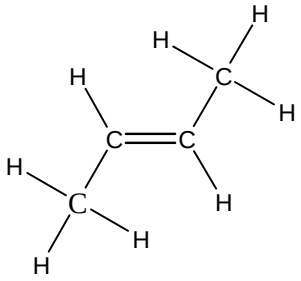
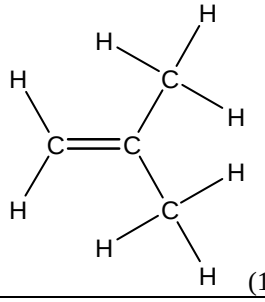
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Factors: **two** of (high cost due to) **high energy** required (to generate the pressure) **High pressure** plant required (is expensive) More maintenance cost Each correct answer scores (1) Advantage and explanation: (High pressure) increases yield (of ammonia) (1) Because 4 mol (of gas) on LHS give 2 mol on RHS (1) Both marks stand alone	 Equilibrium shifts to the right Number of moles (of gas) decreases from reactants to product	 Reaction shifts to right. High pressure increases rate/ favours rhs/ products Arguments based on volume/ pressure	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Two profiles with energy hump, one lower than the other.(1) Reaction profile at lower level labelled "with catalyst" OR Reaction profile at higher level labelled "no catalyst" Catalysed profile shows two steps (1)  	 Intermediate at an energy level between reactants and products	Answer with catalysed products at different energy to $2NH_3$ scores 0	**3**

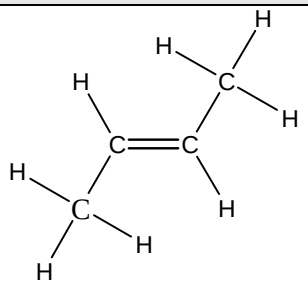
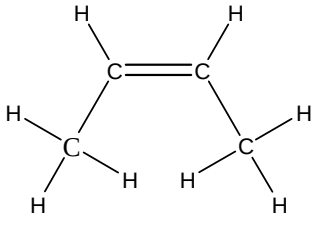
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iv)	Vertical lines to the right of the hump marked E_a & E_{cat} with E_a at a higher energy than E_{cat} (1) Area under curve to the right of E represents number or fraction of molecules with sufficient energy to react (on collision)(1) With catalyst more molecules/collisions have E greater than E_{cat} / enough energy to react (so rate increases) (1) OR a greater proportion/ more **of the** collisions are successful / lead to reaction (so rate increases) (1)	If candidate shades both areas under the curve this mark is scored. Ignore labelling	Just "more collisions" are successful	**3**

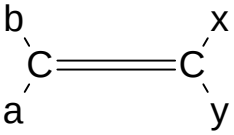
Question Number	Correct Answer					Acceptable Answers	Reject	Mark
2 (a)(i)		C	H	O		Calculation of % by mass from formula: % C =(100 x 4 x 12)÷74 =64.9 etc		**2**
	%	64.9	13.5	21.6				
	moles	64.9÷12 = 5.41	13.5÷1 = 13.5	21.6÷16 = 1.35	(1)			
	Ratio	5.41÷1.35	13.5÷1.35	1.35÷1.35	(1)			

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	 Or full structural formula Or $(CH_3)_3COH$ (1) W is (an alcohol that resists oxidation) tertiary (1) 2nd mark is not standalone	A combination of structural and full structural formula		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$CH_2=CHCH_2CH_3$ OR  (1) $CH_3CH=CHCH_3$ OR  cis or trans (1) $CH_2=C(CH_3)_2$ OR  (1)	C_2H_5 in place of CH_2CH_3 A combination of structural and full structural formula Penalise missing hydrogen(s) once only Skeletal formulae		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	(2-)methylpropene or formula or identified in (i) (1) Tertiary/branched alcohol gives branched alkene (1) OR alcohol and alkene must have the same carbon skeleton (1)	methyl propene methyl-propene second mark consequential on first, or near miss e.g. methylpropanene		**2**

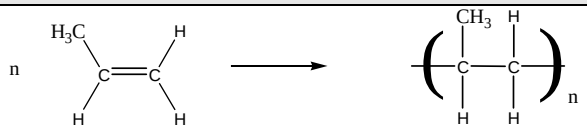
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	 (1)  (1) ignore bond angles	"CH_3" for a methyl group skeletal formulae		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Restricted rotation about C═C (1) **Two** different groups attached to **both/ each** C atoms (1) OR In the structure of the alkene  a≠b AND x≠y	pi-bond for double bond Barrier to free rotation about C═C No rotation about C═C Limited rotation "functional groups" for "groups" Two different groups attached to both ends of C=C		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	**Y** $(CH_3)_2CHCH_2OH$ (1) **Z** $(CH_3)_2CHCOOH$ (1) OR full structural formulae	A combination of structural and full structural formula CO_2H For 2nd mark accept $CH_3CH_2CH_2COOH$ cq on butan-1-ol	butan-1-ol	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	Species with an unpaired electron (1)	"Atom / molecule / particle" for "species"		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	Ultraviolet / UV (light) (1)	Sunlight	Heat	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	 Structure of propene (1) Structure of poly(propene) and continuation bonds (1) Propene and poly(propene) balancing 'n's (1) Ignore initiators and conditions	-$[CH(CH_3)CH_2]_n$- on RHS At least 2 repeat units shown with continuation bonds	3 carbon straight chain in repeat unit or any repeat unit containing a double bond loses 2nd and 3rd marks	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	π bond broken and σ bond formed (1) **σ** bond **stronger** than **π** (1) Bond formation is exothermic so more energy given out than taken in OWTTE (1) Standalone	Double bond broken and (two) single bonds formed Reverse argument	More bonds formed than broken Double bond weaker than single bond Energetically favourable	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	Reaction has high activation energy (1)	The **reactants** are kinetically stable (with respect to the activated complex/products) "because it is kinetically unfavourable"	The reaction is kinetically stable Just "Reaction slow." Initiator provides Ea	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Mol Al = $1.5x10^6 \div 27$ (= $5.56x10^4$ mol) (1) $\therefore$ Mol Al_2O_3 = mol Al/2 (= 2.78×10^4) (1) $\therefore 2.78 \times 10^4 \times 102g$ = $2.8(33) \times 10^6 g$ / 2.8(33) tonnes (1) OR M_r (Al_2O_3) = 102 (1) 108 tonnes of Al formed from 204 tonnes Al_2O_3 (1) 1.5 t Al from 1.5 x 204÷108 = 2.8(33) tonnes (1) 2nd and 3rd marks cq Answer in g or tonnes(t) but units essential Accept 2 or more sf Correct answer with correct units and some working(3)			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	$2.8(33) \times 10^6 g \times 100/54 = 5.25 \times 10^6$ g (1) OR 2.8(33) x 100/54 = 5.25 tonnes (1) CQ on 4(a)(i) Correct answer with correct units with no working (1)1 Answer in g or tonnes(t) but units essential. But do not penalise lack of/incorrect units if already penalised in 4 (a)(i) Accept 2 or more sf . But do not penalise use of 1sf if already penalised in 4 (a)(i)	Range 5.18 – 5.25 (5.2-5.3)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	(molten) cryolite / Na_3AlF_6 (1) 850−1000 °C (1) any temperature within the range			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Melting point of Al_2O_3 is too high (for the process to be economical) (1) OR Melting point of Al_2O_3 is (very) high **and** requires more energy to melt. OR Al_2O_3 requires too much energy to melt.		Melting point of Al_2O_3 is high	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	$Al^{3+} + 3e^- \rightarrow Al$ Al^{3+} on LHS (1) Rest of equation (1) no CQ If $Al^{3+}(aq)$ 1 max	e for e^-	$Al^{3+} \rightarrow Al$ — 3e for second mark	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iv)	$2O^{2-} \rightarrow O_2 + 4e^-$ OR $2O^{2-} - 4e^- \rightarrow O_2$ Species O^{2-}, O_2 ,e^- on correct sides (1) balance (1) no CQ If $O^{2-}(aq)$ 1 max unless already penalised in (iii)	e for e^- multiples	Equations with OH^-	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(v)	Oxygen reacts with / oxidises the carbon / anode (so the anodes wear away) (1) $C + O_2 \rightarrow CO_2$ (1)	….carbon monoxide…. $2O_2 + C \rightarrow CO_2 + 4e^-$ $2C+O_2 \rightarrow 2CO$		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(vi)	(Cost of generating) the electricity (1)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Observation Yellow **(1)** Inference Sodium/Na^+ **(1)**	Orange	 Na	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	Observations White precipitate **(1)** Dissolves/soluble/disappears/ clears/colourless solution **(1)** Inference Chloride / Cl^- **(1)**		 Clear solution Chlorine/Cl	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Observations Red to blue **(1)** **(**Blue-no change) Ignore smell Inferences Ammonia / NH_3 **(1)** Ammonium / NH_4^+ **(1)** Both must follow red to blue Each is stand alone		"Turns blue"	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)	**A** = NaCl **(1)** **B** = NH_4Cl **(1)** Ignore correct charges on ions. If charge(s) wrong **(0)**	Other formulae eg KCl, NaBr if follow earlier inferences		**2**

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>2 (a)</td><td>
Check subtractions and averaging arithmetic correcting if necessary.

All volumes recorded to 0.05 cm^3 (1)
Allow one slip but withhold this mark if any readings are in the wrong boxes.
Allow 0, 0.0, 0.00 as initial volume.
NOT 50 as initial volume.

All subtractions completed correctly (1)
[✔ ✔ top RHS of Table 1]

Mean titre
For correct averaging of chosen titres, correctly subtracted or for choosing identical titres and for recording the mean correct to 2 or 3 dp or to 0.05 cm^3
[unless already penalised in Table 1] (1)
[✔ by the mean in space or near the dotted line in paragraph below]
Accuracy
If the candidate has made an arithmetical error in Table 1 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.

Calculate the difference between the candidate's mean titre and that of the examiner or supervisor.
Examiner's titre = 23.30 cm^3. Write the "supervisors" titre on the script SV =
Record the difference as
d =…… on the script

Award marks for accuracy as follows

<table>
<tr><td>d =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.60</td><td>±0.80</td><td>±1.00</td></tr>
<tr><td>Mark</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>

Range
The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range on the corrected titres used by the examiner to calculate the mean.
<table>
<tr><td>r =</td><td>0.20</td><td>0.30</td><td>0.50</td><td>>0.50</td></tr>
<tr><td>Mark</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

Examiner to show the marks awarded for accuracy and range as
d = value r = value
✔ 6 MAX ✔ 3 MAX
</td><td></td><td></td><td>12</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$\frac{\text{Titre} \times 0.1}{1000}$ Answer to at least 3sf. If units given must be moles. Penalise incorrect units once only in (i) to (iv).	Allow one slip in SF in (i) to (iii**)** In (i) to (iv) allow loss of trailing zeros if correct arithmetically		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	½ x answer to (i) Answer to at least 3sf. If units given must be moles.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	Answer to (ii) $\times \frac{1000}{25}$ = concentration (mol dm^{-3}) Answer to at least 3sf. If units given must be mol dm^{-3}.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv)	Answer to (iii) x $\frac{1000}{3.0}$ = **(1)** Answer following correct method to 2 sf only **(1)** If units given must be mol dm^{-3}.			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Accuracy of measuring cylinder makes answer to more than 2sf invalid.	3.0cm^3 is only 2 sf		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Use pipette or burette to measure concentrated sulphuric acid.		weighing	**1**

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>3 (a)</td><td>Table 2
Both weighings recorded in correct spaces to at least 2 dp (1) [✔ in RHS of Table 2]

Weighings correctly subtracted (1)
Allow loss of trailing zeros-only in final row.
[✔ in bottom RHS box of Table 2]
Table 3
Both temperatures recorded in correct spaces (1)
Both to 1 dp only (1) [✔ ✔ RHS of Table 3]
Subtraction correct (1). Allow loss of trailing zeros – only in final row.
Ignore sign.
[✔ in bottom RHS box of Table 3]
The examiner ratio ΔT / mass A = 0.80
For the candidate calculate (mass E x examiner ratio) = expected ΔT

Compare candidate's expected ΔT with the actual ΔT and record the difference between the two as d = on the script.

Award marks for accuracy as follows.
<table><tr><td>d =</td><td>±0.50</td><td>±0.70</td><td>±1.00</td><td>±1.50</td></tr><tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td></tr></table>[4✔ below Table 3]</td><td></td><td></td><td>9</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Mass **E** 248 Units need not be given but penalise incorrect units. [To at least two SF BUT penalise SF once only in Q3]	Answer only		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	50 x 4.18 x ΔT J OR 50 x 4.18 x ΔT kJ 1000 [To at least two SF: ignore sign]	Answer only with units		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	Answer to (b)(ii) **(1)** Answer to (b)(i) Answer to 2 SF only and in kJ mol^{-1}**(1)** Positive sign ONLY-award independently. **(1)**	Answer cq on (b)(i) and (ii)	Answers that do not follow heat method. moles	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**1** ✓ Clean oil off Li (before weighing) **2** ✓ Weigh lithium **3** ✓ Transfer lithium (in one piece) to water underneath measuring cylinder/add Li to water in suitable separate apparatus. **4** ✓ Read volume in measuring cylinder (after reaction ends). **5** ✓ Volume H_2 = Moles H_2 (1) 24.0/24,000 units must match **6** ✓ Moles Li = 2 x Moles H_2 **7** ✓ Mass Li = Moles Li x 7.0 **and** % = calculated Mass Li x 100% Mass Li		Use of gas, syringe Repeat experiment	**7**

6243/01A - Materials

Apparatus and Materials

Apparatus

Each candidate will require:

1. two boiling tubes in a rack;
2. apparatus and materials for carrying out a flame test;
3. Bunsen burner;
4. test tube holder to fit boiling tube;
5. one 10 cm^3 measuring cylinder;
6. a supply of dropping pipettes;
7. spatula;
8. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
9. small beaker for draining burette;
10. 25.0 cm^3 pipette and safety filler;
11. white tile;
12. two 250 cm^3 conical flasks;
13. expanded polystyrene cup held securely in a 250 cm^3 beaker;
14. access to a balance weighing to 0.01 g;
15. one 50 cm^3 or 100 cm^3 measuring cylinder;
16. a thermometer, range 0−50 °C (or similar), graduated in at least 0.5 °C intervals (or a thermometer that can be read to an accuracy of at least 0.5 °C).

Materials

Each candidate will require:

(a)* 1.0 g of sodium chloride in a stoppered tube labelled **A**. The identity of this compound is **not** to be disclosed to candidates;

(b)* 1.0 g of ammonium chloride in a stoppered tube labelled **B**. The identity of this compound is **not** to be disclosed to candidates;

(c)* 200 cm^3 of aqueous sodium hydroxide of concentration 0.100 mol dm^{-3} labelled **Solution C**;

(d)* 200 cm^3 of aqueous sulphuric acid of concentration 0.0480 mol dm^{-3} labelled **Solution D**. The concentration of this solution is **not** to be disclosed to candidates;

(e)* between 7.0 and 7.3 g of powdered sodium thiosulphate, $Na_2S_2O_3.5H_2O$, in a stoppered specimen tube labelled **E**;

(f) 10 cm^3 of dilute sodium hydroxide; concentration approximately 0.5 mol dm^{-3};

(g) 2 cm^3 of dilute nitric acid; concentration approximately 2.0 mol dm^{-3};

(h) 2 cm^3 of aqueous silver nitrate; concentration approximately 0.05 mol dm^{-3};

(i) 10 cm^3 of dilute aqueous ammonia; concentration approximately 2.0 mol dm^{-3};

(j) methyl orange indicator (centres may use screened methyl orange if their candidates are more familiar with this indicator);

(k) a supply of distilled water;

(l) red and blue litmus paper.

For **home** centres (ONLY), the chemicals identified with an asterisk (*) will be sent by a firm of manufacturing chemists.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	**Gas evolved:** hydrogen/H_2 **(1)** hydrogen/H^+/H_3O^+/oxonium **(ions) (1)** **(Precipitate):** barium sulphate/$BaSO_4$/$Ba^{2+}SO_4^{2-}$ **(1)**	Hydroxonium / hydronium	H	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	**(Formula of liquid A):** H_2SO_4 **(1)**		No CQ on 1 (a)(i)	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	K^+ **(1)** I^- **(1)**		K /potassium I_2 / iodine / iodine ion /iodide	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	$Ag^+_{(aq)} + I^-_{(aq)} \rightarrow AgI_{(s)}$ **(1)** CQ on **halide** given in (b)(i)	Equation with spectator ions on both sides	If state symbols incorrect or omitted	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	**(Reagent): concentrated** ammonia (solution) **(1)** ignore aqueous **(Observation):** Precipitate does not dissolve/insoluble **(1)**	CQ on Cl^- or Br^- in 1(b)(i) Halide / Reagent / Obs Cl^- / Dil NH_3 / Dissolves Br^- / conc NH_3 / Dissolves Correct observation mark if 'ammonia' or 'ammonia gas' or dilute ammonia is the reagent **(Observation):** no change **(1)**	Ammonia No CQ on F^- or any other anion	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Any two from: • purple/violet/mauve gas or vapour • black/dark solid • steamy / misty / white fumes or fumes turn blue litmus red or fumes give white smoke with ammonia • bad egg smell • yellow solid • choking fumes or fumes turn (acidified) $K_2Cr_2O_7$ green or blue **(2)**	CQ on Cl^- or Br^- in 1(b)(i) • steamy / misty fumes or fumes turn blue litmus red or fumes give white smoke with ammonia CQ on Br^- in 1(b)(i) • choking fumes or fumes turn (acidified) $K_2Cr_2O_7$ green or blue • brown gas or fumes	No CQ on F^- or any other anion Black vapour Goes black Effervescence / fizzing / bubbling	

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)	**Either:** **Use a fume cupboard** as (toxic/poisonous) I_2 or H_2S (evolved) *CQ on anion in **B*** **If chloride:** (toxic **/** irritant) fumes of HCl **If bromide: (**toxic **/** irritant) fumes of HBr or Br_2 or SO_2 **Or:** **Wear gloves** as (liquid) **A**/H_2SO_4 corrosive **Or:** **Add slowly** as reaction is exothermic **(1)**	HI or SO_2 Acid corrosive	Lab coat, eye protection, tie hair back 'Reactants' or 'products' corrosive	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2(a)(i)	All points accurately plotted **(1)**	1 plotting error		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	Two straight best-fit lines **(1)**		Best-fit line that includes T = 29.3 ℃	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iii)	Suitable extrapolations to find maximum temperature **(1)** Value from candidate's graph **(1)** [N.B. Expected value is 11.1 – 11.5 °C]		30.7 — 20.2 = 10.5 °C scores zero Value not measured at time = 4 minutes Value obtained from a non-vertical line	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	Ignore SF (except 1 SF). Penalise 1 SF once in 2(b) Ignore units unless incorrect Penalise incorrect units once in 2(b)			
2 (b)(i)	Heat change = 25.0 x 4.18 x **their answer to (iii)** = For 11.1 rise: 1160 (J) For 11.2 rise: 1170 (J) For 11.3 rise: 1181 (J) For 11.4 rise: 1191 (J) For 11.5 rise: 1202 (J) For 10.5 rise: 1097 (J)		26.25 x 4.18 x $\triangle$T	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$\frac{1.25}{65.4}$ = 0.0191 (mol) **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	0.800 x $\frac{25.0}{1000}$ = 0.02(00) (mol)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv)	Copper(II) sulphate / $CuSO_4$ as there are more moles of this / reaction is 1:1 *OR* there is 0.0009/0.001 more moles of copper(II) sulphate / $CuSO_4$ than zinc **(1)**	CQ on calculation in (b) (ii) or (iii) but not on rounding 0.0191 to 0.02	$CuSO_4$ to ensure that all the Zn reacts	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(v)	$-\frac{(b)(i)/1000}{0.0191}$ = answer **(1)** (NB must use the smaller number of moles in 2(b) (iv) answer with negative sign **and** three sig figs **(1)** Expected answers: 11.1 rise:-60.7 (kJ mol^{-1}) 11.2 rise: -61.3 (kJ mol^{-1}) 11.3 rise: -61.8 (kJ mol^{-1}) 11.4 rise: -62.4 (kJ mol^{-1}) 11.5 rise: -62.9 (kJ mol^{-1}) 10.5 rise: -57.4 (kJ mol^{-1})	Moles CQ on 2 (b)(iv) e.g. 0.002 moles $CuSO_4$ Any **calculated** value to 3 SF and with negative sign scores second mark. Correct answer with no working scores full marks		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	**One of the following pairs:** **(Major source of error):** heat is absorbed by metal / copper / thermometer / container **(1)** **(Improvement):** include its mass and specific heat capacity in calculation **(1)** **OR** **(Major source of error):** heat not spread out uniformly or temperature not uniform **(1)** **(Improvement):** stir the mixture or use a magnetic stirrer **(1)** **OR** **(Major source of error):** uncertainty in (maximum) temperature rise **(1)** **(Improvement):** measure temperature more often or use a computer to record temperatures **(1)** **OR** **(Major source of error):** not all the zinc transferred **(1)** **(Improvement):** weigh zinc container /weighing bottle after transfer **(1)**	**(Major source of error):** time lag in thermometer **(1)** **(Improvement):** use more responsive thermometer **(1)** First mark **not** scored where the major source of error is just the reverse of the improvement but second mark may be awarded e.g. **(Major source of error):** Mixture not stirred **(0)** **(Improvement):** stir the mixture **(1)** Correct improvement without source or error Burette does **not** score as a major source of error but allow pipette for the improvement mark **(1)**	More accurate / precise /digital thermometer use a lid (on the polystyrene cup) OR put (calorimeter) in a (glass) beaker Or lagging polystyrene cup thermometer or balance or burette insufficiently accurate **(0)** uncertainty in (maximum) heat rise c ($CuSO_4$) is not 4.18 $Jg^{-1}℃^{-1}$ density of solution is not 1 g cm^{-3} Wash out zinc container	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	(+/-) $\frac{2 \times 0.01}{1.25} \times 100\%$ = 1.6% **(1)**	(+/-) $\frac{0.01}{1.25} \times 100\%$ = 0.8% Correct answer with no working		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	Moles of cyclohexanol $\frac{10.0}{100}$ = 0.1(00) (mol) **(1)** theoretical yield = 0.1 x 82 = 8.2(0) (g) **(1)** percentage yield = $\frac{4.10}{8.20}$ x 100% = 50(.0) % **(1)** OR Mol cyclohexene = $\frac{4.1}{82}$ = 0.05 **(1)** percentage yield = $\frac{0.05}{0.10}$ x 100 = 50(.0) % **(1)** correct answer with some working scores **(3)** correct answer alone scores **(2)**	Transposition of M_r values scores **(2)** for yield = 100 x $\frac{4.1}{10}$ x $\frac{82}{100}$ = 33.6 %	Values > 100 % score zero unless method steps correct 100 x $\frac{4.1}{10}$ = 41 % **(0)**	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Water/H_2O/cyclohexanol/$C_6H_{11}OH$ / H_2SO_4/sulphuric acid **(1)**	Conc. H_2SO_4/sulphuric acid		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Carbon/C **(1)**	graphite	Coke/charcoal/soot	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	**Either** (The carbon must come from) cyclohexanol so using it up/a competing reaction **Or** Idea of a breakdown of reactant so that not all the reactant converted to desired product **(1)**	side reaction(s) carbon (in element or from carbon compound given in 3(b) (ii)) not available to form cyclohexene	Incomplete reaction Reduces temperature or heating efficiency.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iv)	**Eliminate incorrect steps and steps out of sequence and credit remaining correct steps** (Step 1): wash with sodium hydrogencarbonate /carbonate / (1) (Step 2): wash with water (Step 3): dry with (anhydrous) calcium chloride or (anhydrous) sodium sulphate (1) (Step 4): (re-)distil (1)	 **Sodium carbonate or calcium carbonate** (anhydrous) $MgSO_4$ Fractional distillation	Recrystallisation scores zero. NaOH or KOH	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	**(Reagent):** $PCl_5/SOCl_2$ **(1)** **(Result):** steamy/misty fumes **(1)** **OR** **(Reagent):** Na / sodium **(1)** **(Result):** effervescence or positive test for H_2 **(1)** **OR** **(Reagent):** carboxylic acid + conc sulphuric acid (followed by neutralisation) **(1)** **(Result):** fruity smell **(1)** second mark depends on first for all the above Names or formulae for reagents	White/cloudy fumes OR Gas which turns damp blue litmus paper red or forms white smoke with ammonia. **(Reagent):** acidified potassium dichromate((VI)) **(1)** **(Result):** orange to green / blue **(1)**	PCl_5(aq) or solution but allow observation mark White smoke $KMnO_4$	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**Start & final colours needed** **(Reagent):** Add bromine (water) / Br_2 / bromine in a non-aqueous solvent/stated solvent such as hexane **(1)** **(Result):** brown/red-brown/orange solution decolourised/goes colourless **(1)** OR **(Reagent):** (Acidified or alkaline) potassium manganate(VII) / $KMnO_4$ **(Result):** purple to colourless / decolourised / brown (ppt)	 potassium permanganate Green if alkaline	White smoke $KMnO_4$ Yellow clear	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	**(From):** colourless **(To):** (pale) pink **(1)**	(Pale) red		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	**Route 1 (put solid into flask)** Dissolve in less than 500 cm^3 (distilled) water **(1)** In volumetric flask **(1)** Make up to the mark **(1)** mix/shake/invert **(1)** **Route 2 (solid dissolved first)** Dissolve in not more than 400 cm^3 (distilled) water **(1)** (Transfer to) volumetric flask (1) Wash the contents of the beaker into the flask **and** make up to the mark **(1)** mix/shake/invert **(1)**	 Small volume etc of water Graduated/standard flask Make up to the line or to 500 cm^3 **(1)** Small volume etc of water Graduated/standard flask …Make up to the line or to 500 cm^3 **(1)**	 Flask/measuring cylinder Flask/measuring cylinder Making up to 500cm^3 by adding (500 − V) cm^3 where V cm^3 added to dissolve acid Making up to the mark before dissolving	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	Ignore SF except 1 SF (penalise 1 SF once in 4 (c)) Ignore units unless incorrect. Penalise incorrect units once in 4 (c)			
4 (c)(i)	*(0.100 x $\frac{25.0}{1000}$)= 0.0025 (mol)*			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	*(0.5 x answer for (i) i.e. 0.5 x 0.0025)* = 0.00125 (mol) (1)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	*(20 x answer for (ii)* i.e. 20 x 0.00125) = 0.025 (mol) **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iv)	$\frac{2.95}{\textit{answer to (iii)}}$ = $\frac{2.95}{0.025}$ = *118 (g mol^{-1})* **(1)**		Wrong units	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)	Subtract 90 from answer to (c)(iv) (1) Divide remainder by 14 (1) Correct answer n = 2	Correct answer with some working or logic Answer alone **(1)**		**2**

6244/01

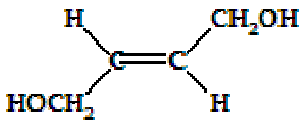
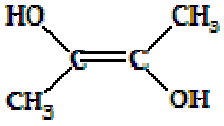
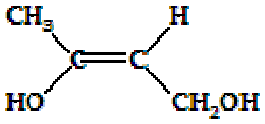
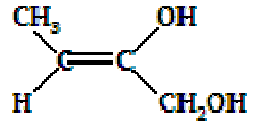
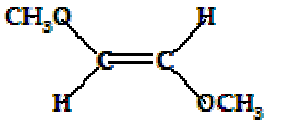
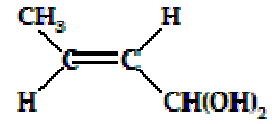
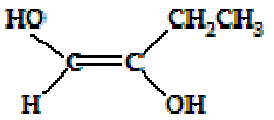
If more than the correct number of answers is given penalise (-1) for each wrong answer.
Answers can be A or a, etc.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	A (1) E (1)			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	B (1) F (1)			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	A (1) C (1) D (1)			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iv)	A (1) D (1)			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	*Cis* isomer **(1)** and *trans* isomer **(1)** of any of the following (*trans* isomer only shown):       	Isomers based on cyclobutane or methylcyclopropane Molecules with bond angles 90° provided that the *cis* and *trans* structures are clearly different. Allow any other structure that is plausible. Allow CH_3— etc	Bonds shown as: CH_2OH— —CH_3O —HO. Penalise once only if *cis* and trans otherwise correct. Any *cis* and *trans* isomers of molecules other than C_4H_8O.	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	*Dilute:* **small** amount of (ethanoic) acid in **large** volume of water/solvent **(1)** OR low concentration **(1)** *Weak:* slightly ionised **(1)** **OR** low concentration of hydrogen ions / H_3O^+/ H^+ **compared with** the concentration of the acid **(1)**		Low concentration of H_3O^+ or H^+ ions; less concentrated; water added to lower the concentration; high concentration of water; dissolved in excess water very dilute; not fully ionised; partially ionised; incompletely ionised; dissolved in excess water; any argument based on pH	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$K_a = \frac{[H_3O^+][CH_3COO^-]}{[CH_3COOH]}$ Ignore $K_a = \frac{[H_3O^+]^2}{[CH_3COOH]}$ if it appears after the correct expression. If it is the only answer given it scores **(0)**	$-CO_2^-$ for $-COO^-$ $[H^+]$ for $[H_3O^+]$	any expression including $[H_2O]$; [HA] instead of $[CH_3COOH]$.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	If an incorrect expression for K_a is used the last three marks cannot score. Ignore significant figures unless they are rounded to one s.f. anywhere during the calculation: penalise once only. Answer of 1.59×10^{-5} or with 1.592×10^{-5} and correct units of mol dm^{-3}, and working, scores **(4)** **First mark** $pH = -\log_{10}[H_3O^+] = 3.2$ $[H_3O^+] = 6.31 \times 10^{-4}$ **(1)** **Next three marks** **Approximate calculation:** $K_a = \frac{[H_3O^+]^2}{0.025}$ **(1)** OR $K_a = \frac{[H_3O^+]^2}{[CH_3COOH]}$ $K_a = 1.59 \times 10^{-5}$ **(1)** mol dm^{-3} **(1)** The unit mark can be awarded if the unit is given in (b)(i) rather than here but must be mol dm^{-3}. The last 3 marks can be awarded CQ on an incorrect value of $[H_3O^+]$ provided that $[H_3O^+] > 10^{-7}$ mol dm^{-3}, i.e. the solution **must** be acidic. **OR without approximation:** $K_a = \frac{[H_3O^+]^2}{0.025 - 6.31 \times 10^{-4}}$ **(1)** $K_a = 1.63 \times 10^{-5}$ **(1)** mol dm^{-3} **(1)**	Use of $[H^+]$ for $[H_3O^+]$ This can be credited if it appears in 2(b)(i) but is not given here. 1.592×10^{-5}		**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	**First mark** $[H_3O^+] = [CH_3COO^-]$ **because** all H_3O^+ is from the acid *or* none/insignificant amount of H_3O^+ comes from water **Second mark** In the denominator $6.31 \times 10^{-4} << 0.025$ (so can be ignored) OR because degree of ionisation is **very** small *or* negligible **then** $[CH_3COOH] = 0.025$ **(1)** If the answer to part (ii) uses $0.025 - 6.31 \times 10^{-4}$ in the calculation score this 2nd mark then ignore any other second assumption(s) suggested even if they are wrong. Ignore any references to 'standard temperature'.	Use of $[H^+]$ for $[H_3O^+]$	Just $[H_3O^+] = [CH_3COO^-]$ on its own	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	**1st mark** The mixture is a buffer **(1)** **2nd mark** there are large amounts of /a large reservoir of the acid **and** its conjugate base/anion/salt **(1)** **3rd mark** **EITHER** $CH_3COOH + OH^-$ $\rightarrow CH_3COO^- + H_2O$ **(1)** **OR both** of$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ $H^+ + OH^- \rightarrow H_2O$ **and** the equilibrium moves to RHS. **4th mark** and so the ratio of /the value of **both** $[CH_3COOH]$ and $[CH_3COO^-]$ hardly changes **(1)** Ignore any references to addition of H_3O^+	both equations in words	Not $\rightleftharpoons$ for $\rightarrow$	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	**First mark:** Refer to diagram. Both ranges shown so that the one for MO is between about pH 2 and 5 (**outside** the vertical section), the one for phenolphthalein is between about 7 and 10.3, and is **wholly within** the vertical section **(1)** The extent of the ranges within the above values is unimportant provided there is a range and not just a point at the quoted values. **Second mark** Methyl orange is already yellow/orange *or* has already changed colour **before the vertical section** *or* before/not on the vertical section **(1)** **Third mark** Phenolphthalein changes from colourless to red/magenta/pink/purple **(1)** **Fourth mark** over a range which is **within** the vertical part of the graph **(1)**	before the endpoint between pH 7 and 10.3	Methyl orange is the indicator for a strong acid and a weak base and ethanoic acid is a weak acid. 'clear' for 'colourless' Phenolphthalein is the indicator for a titration of a weak acid with a strong base.	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	Equilibrium moves to LHS **OR** Equilibrium moves to reactants **(1)** **pH** goes up/rises/increases **(1)** stand alone. If it is said that the equilibrium moves to RHS then score **(0)** overall.		Just 'becomes more alkaline', 'becomes less acidic' on its own.	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	$K_p = \frac{p(NH_3)^2}{p(N_2)p(H_2)^3}$ **(1)**	$K_p = \frac{P_{NH3}^2}{P_{N2}\,P_{H2}^3}$ $p^2(NH_3)$ etc Ignore the position of brackets.	Any use of square brackets [ ] $p^2(NH_3)^2$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	$p(NH_3) = \frac{0.2 \times 160}{3.8} = 8.42$ atm $p(N_2) = \frac{0.9 \times 160}{3.8} = 37.9$ atm $p(H_2) = \frac{2.7 \times 160}{3.8} = 114$ atm **(1)** for dividing moles of gas by 3.8 **(1)** for multiplying by 160 **(1)** for all three values, and the unit given at least once. Answers to 2 s.f. or more otherwise max **(2)** All three answers to 2 s.f. or more with the unit scores **(3)** whether working shown or not.	$\frac{160}{19}$ atm $\frac{720}{19}$ atm $\frac{2160}{19}$ atm x 160 atm for the unit mark even if not stated again		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	$K_p = \frac{(8.42)^2}{(37.9)(114)^3}$ $= 1.26 \times 10^{-6}$ (atm^{-2}) **(1)** unit not necessary, but if given must be correct to score the mark. CQ on values in (ii) and/or on an incorrect expression in (i).	1.26×10^{-6} (atm^{-2}) to 1.28×10^{-6} (atm^{-2}) depending on the number of s.f. used. CQ on K_p being the wrong way up in (i) leads to 781250 – 793650 (atm^2)		**1**

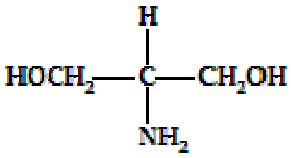
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	The reaction is exothermic **because** K_p increases with decrease in temperature **(1)** Argument consequential on value of K_p from (a)(iii).		Any answer not based on values of K_p. Just 'reaction is exothermic' alone	**1**

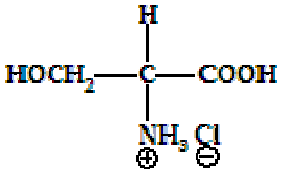
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Increases **(1)** Ignore any comment on yield	faster/quicker	sooner	**1**

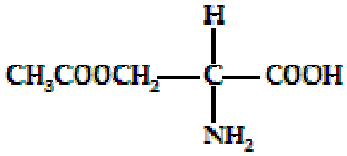
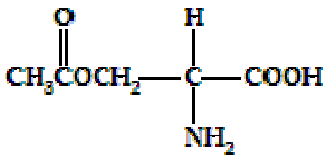
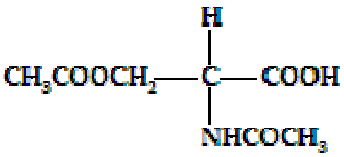
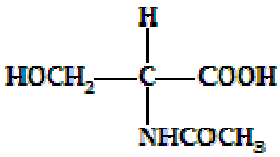
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	Increases **(1)** Ignore any comment on yield	faster/quicker; rate of forward and back reactions increase **equally**.		**1**

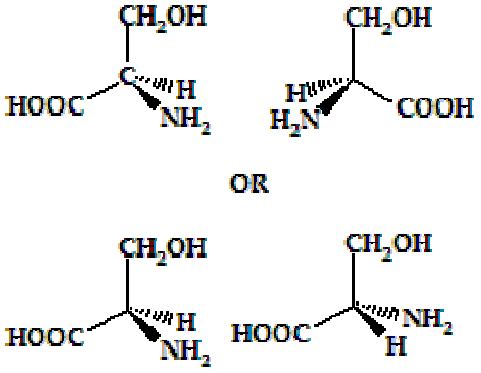
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	Any answer which states or implies that the value of *K* alters scores **zero** overall. **First mark:** K_p remains constant **(1)** **Second mark:** Increase of partial pressure increases the value of the denominator *or* decreases the value **of the fraction** (and causes the equilibrium to move to RHS *or* increases amount of product) **(1)** **Third mark:** Hydrogen partial pressure is raised to power 3 *or* is cubed but nitrogen is raised only to power 1 so the doubling has greater effect. **(1)**	 Maintain K_p	 ...decreases value of K_p. Any answer based on le Chatelier, i.e. not referring to K_p, does not score the second mark nitrogen partial pressure is raised to no power; nitrogen partial pressure is third order	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	2-amino-3-hydroxypropanoic acid **(1)**	3-hydroxy-2-amino-propanoic acid Allow 'ammino'	Any answer based on the name of an alcohol; propionic instead of propanoic.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)			CH_2OH- on left	**1**

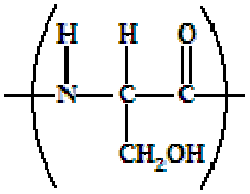
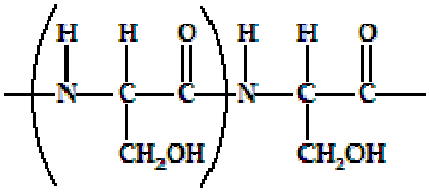
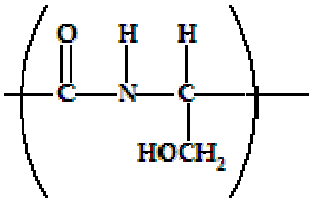
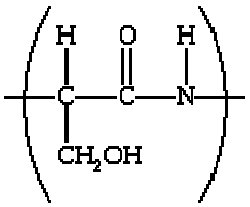
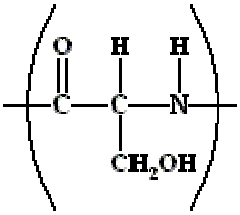
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)		NH_3^+ or $NH_3^+Cl^-$ or NH_3Cl	$-HOOC$	**1**

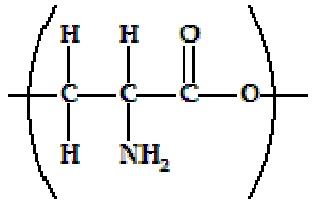
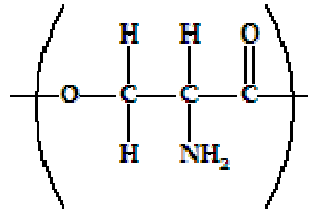
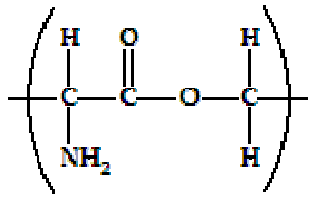
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	 **OR**  **(1)**		CH_3OCO- for CH_3COO- 	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	 OR exchange of any **two** substituent groups (not only H and NH_2) is acceptable. **(1)** for each isomer. The substituent groups can be in any order as long as the two isomers are mirror images. Structures that are clearly 3D score; it is not essential to use wedges. If the isomers are shown as mirror-imaged flat molecules (90° bond angles) then answer can score **(1)** only for **both** structures being correct.		Incorrect compound scores **(0)** overall	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	(Angle of) **rotation** of plane of (plane) polarised (monochromatic) light **(1)** See answer to (c)(iii)		Twisting *or* bending *or* refracting *or* reflecting	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	One would rotate (plane polarised light) to the left *or* anticlockwise and one to the right *or* clockwise. **OR** Rotate (plane polarised light) in opposite directions **(1)** This can also be allowed if answer appears in (c)(ii) Do not penalise twist/bend/refract/reflect if they have been penalised in (c)(ii). If **rotation** is mentioned here but not in (c)(ii) then the mark for (c)(ii) can be awarded there, unless (c)(ii) is wrong when it scores **(0)**	One rotates (plane polarised light) in positive direction, one in negative.		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i)	If structures have bonds to the atoms at each end score **(0)** Brackets are not essential if one repeat unit is shown.  **(2)** More of the chain than one repeat unit is allowable provided that the repeat unit is clearly shown, e.g.:  **(2)** Above structure with no, or incorrect, brackets scores (1) The C=O bond must be explicitly shown; if it is not but the structure is otherwise correct score **(1)** Also for **(1)** mark:  **OR** 	Allow inverse throughout, e.g.  etc.		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	 OR  **(2)** More of the chain than one repeat unit is allowable; the repeat unit need not be shown. If more units shown then: ester link **(1)** remainder of chain correct **(1) if** it is a whole number of repeat units The C=O bond must be explicitly shown; if it is not but the structure is otherwise correct score **(1)** Do not penalise here if already penalised in (d)(i). **For 1 mark only:** 	The methylene group can be shown as $-CH_2-$	ester link in a chain not derivable from serine	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)	The energy change when **one mol** of an ionic solid or ionic lattice **(1)** is formed from ions in the gaseous state **(1)** **OR** The energy change when **one mol** of solid/lattice is formed from its ions in the gaseous state **(2)** Ignore any reference to standard state.	enthalpy change, heat change, enthalpy *or* heat evolved formed from its gaseous ions	Energy *or* enthalpy *or* heat required formed from gaseous atoms; 1 mol of gaseous ions	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)	Answer -2053 (kJ mol^{-1}) with some working scores **(3)**, with no working **(2)**. Ignore wrong or no units. (-859) = (+180) + 2(+122) + (+1468) + 2(−349) + ΔH_{latt} OR ΔH_{latt} = (-859) – (+180) - 2(+122) - (+1468) - 2(-349) **(2)** $\therefore \Delta H_{latt}$ = − 2053 (kJ mol^{-1}) **(1)** The following errors may arise: Failure to multiply -349 by 2; answer of −1931 with some working scores **(2)**, no working **(1)** Failure to multiply +122 by 2; answer of −2402 with some working scores **(2)**, no working **(1)** Failure to multiply both the above by 2; answer of −2280 **(1)** Any algebraic or transcription error, penalise **(1)** each time.	Equivalent information using symbols for the energy changes, or words		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)	Theoretical model is based on 100% ionic bonding **(1)** If experimental Born Haber value is different *or* more exothermic/bigger this is due to some covalency *or* some covalent character in the bonding **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	Any answer based on atoms scores **(0)** overall. **First mark** Be^{2+} (ion) or beryllium **ion** is smaller (than the Ba^{2+} (ion)) or Barium **ion (1)** **OR** Cations get larger down the group (and have the same charge) **(1)** **Second mark** Be^{2+} ion polarises/distorts the chlor**ide** ion **more** (than Ba^{2+} does), leading to covalency/covalent character **(1)** The opposite argument starting from barium ions **(2)**	 Cation charge density decreases down the group.	 Be is smaller than Ba Atoms get larger down the group polarises the chlorine ion; polarises the chlorine; weakens the ionic bond; Be^{2+} ion being polarised. Any argument based on electronegativity differences	**2**

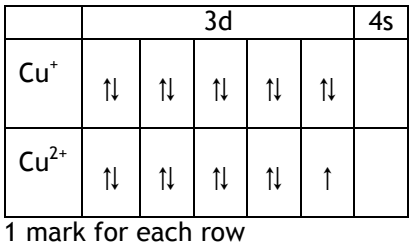
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6(a)	**First mark** For showing reaction of PbO with H_3O^+ or any acid and with OH^- or any alkali, equations correct or not **(1)** **Second mark:** any one of $PbO + 2H^+ \rightarrow Pb^{2+} + H_2O$ $PbO + 2H_3O^+ \rightarrow Pb^{2+} + 2H_2O$ $PbO + 2HNO_3 \rightarrow Pb(NO_3)_2 + H_2O$ $PbO + 2HCl \rightarrow PbCl_2 + H_2O$ $PbO + H_2SO_4 \rightarrow PbSO_4 + H_2O$ **(1)** **Third mark:** any one of $PbO + 2OH^- \rightarrow PbO_2^{2-} + H_2O$ $PbO + 2OH^- + H_2O \rightarrow [Pb(OH)_4]^{2-}$ **(1)** Ignore any state symbols Allow multiples	H^+ for H_3O^+ $PbO + 4HCl \rightarrow PbCl_4^{2-} + 2H^+ + H_2O$ $PbO + 2NaOH \rightarrow Na_2PbO_2 + H_2O$ $Pb(OH)_4^{2-}$ $PbO + 2NaOH + H_2O \rightarrow Na_2Pb(OH)_4$		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	$PbCl_2$ Ionic **(1)** $SnCl_4$ Covalent **(1)**	Electrovalent Convalent	 dative covalent	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	**EITHER** Lead (IV) is less stable than lead (II) so PbO_2 is an oxidising agent *or* is reduced **(1)** Tin (IV) is more stable than tin (II) so SnO_2 reacts as a base **(1)** **OR** Stability of (+4) state relative to (+2) state decreases down the group / from tin to lead **(1)** PbO_2 oxidising agent, SnO_2 a base. **(1)**	Lead (+2) etc for lead(II)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	HCl shown as a product in both equations **(1)** $PCl_3 + 3H_2O \rightarrow H_3PO_3 + 3HCl$ **(1)** $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$ OR $PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$ **(1)** Allow multiples Ignore any state symbols	$H^+ + Cl^-$ for HCl throughout $P(OH)_3$ for H_3PO_3		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii)	**First mark** NaCl pH 7 and PCl_3 pH any value $-1 \leq pH < 4$ **(1)** Credit pH values independently of any reasoning. **Second mark** NaCl dissolves to hydrated/aqueous ions **OR** $NaCl(s) (+aq) \rightarrow Na^+ (aq) + Cl^- (aq)$ **(1)** **Third mark** PCl_3 hydrolyses **(1)**	 reacts to produce acid(s)	Neutral for pH 7; acidic	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	 1 mark for each row	Half arrows or just vertical lines		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i) **QWC**	**ligands** split *d* orbitals **(1)** This first mark is stand alone **absorb** light in (part) of visible region/all colours except blue**(1) Stand Alone** causes electron to jump / be promoted to a new level **(1)**	If sequence in wrong order eg jump **then** absorb Or any implication that this is an emission spectra then **only first mark** (orbitals splitting) available		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	No ligands to split (d) orbitals **(1)** Implication that all d orbitals the same	No complex ion /water ligand present	Full so cannot jump	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	**X** CuCl OR Cu_2Cl_2 OR copper(I) chloride**(1)** allow cuprous chloride $CuCl_2 + Cu \longrightarrow 2CuCl$ or $CuCl_2 + Cu \longrightarrow Cu_2Cl_2$**(1)**	Allow HCl on both sides		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	Redox **(1)**	Reduction		**1**

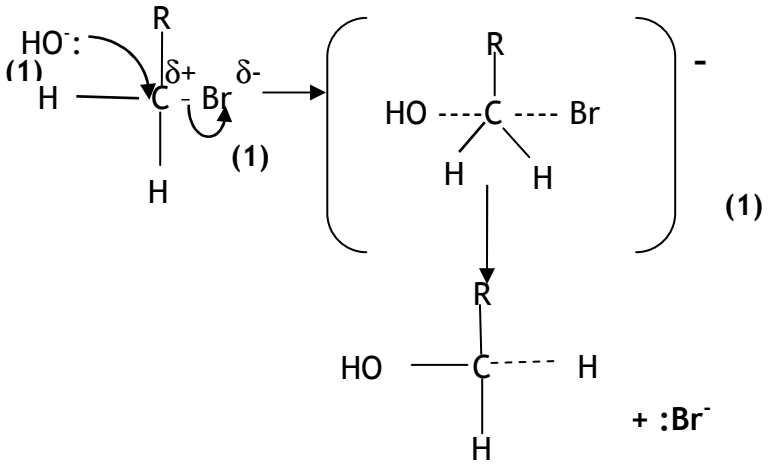
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iii)	$Cu(NH_3)_2^+$ **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iv)	The copper(I) ion has a full *d* (sub) shell/d^{10} OR All *d* orbitals are full **(1)** (so *d*-*d* transitions impossible) Or No partly filled d		*d* orbitals not splitting	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(v)	$Cu(NH_3)_4^{2+}$ Or $[Cu(NH_3)_4(H_2O)_2]^{2+}$ **(1)** [ ] not essential		$Cu(NH_3)_6^{2+}$ And $Cu(NH_3)_2^{+}$	**1**

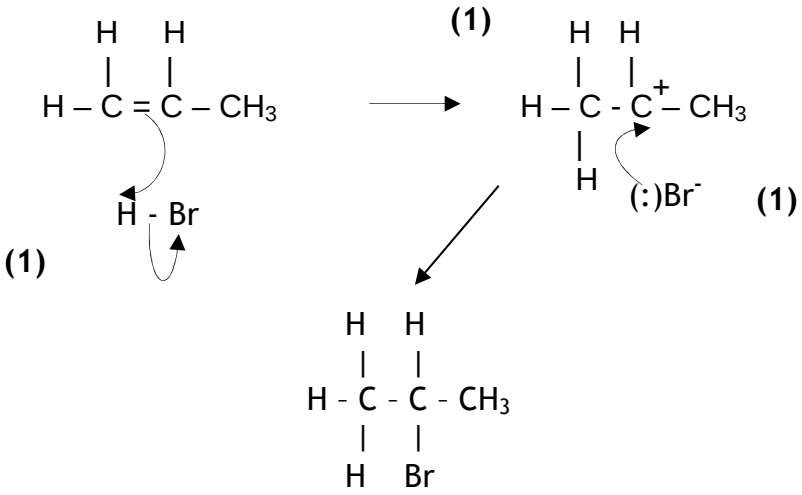
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Nucleophilic substitution **(1)**	Hydrolysis		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Expt 1 and 2/concentration of 1-brombutane constant Concentration of hydroxide trebled, rate x3 First order with respect to OH^- **(1)** Expt 2 and 3/concentration of hydroxide constant. Concentration of 1-bromobutane x4, rate x4. First order with respect to 1-bromobutane.**(1)** *If both orders given with no explanation 1 (out of 2)* Rate = *k*[1-bromobutane] [hydroxide] **(1)** *mark rate equation consequently.*			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	 Both arrows must be in first step Allow S_N1 if rate equation in 2(b)(i) is zero order in OH^- and first order wrt. RBr Allow arrow from negative charge ignore δ+ and δ- Lone pairs need not be shown	.		**3**

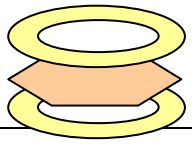
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	The S_N1 mechanism involves the production of a planar **intermediate (1)** which can be attacked from both sides(of the plane)**(1)** producing a racemic mixture/ equal amounts of both isomers/ both enantimorphs **(1)** **last mark stand alone** The S_N2 mechanism Either involves attack from opposite side to Br Or would produce a single (inverted) optical isomer or single enantiomorph Or Attack from one side only Or Intermediate not planar **(1)**			**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	The RDS is the slowest step (in a multi-step mechanism) **(1)** Breaking of bond between carbon and bromine/formation of carbocation / carbonium ion Or sketch to show this Or equation **(1)**	References to those species in the rate equation		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	 If charge on wrong carbon leading to 1-bromoproduct only the 1st mark may be awarded.			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	Secondary intermediate/carbocation is the more stable **(1)** Or reverse argument Or drawings		Secondary bromopropane is more stable	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	**EITHER only consider changes** **Bonds broken** 3 x C = C = 3 x 612 = (+)1836 3 x H – H = 3 x 436 = (+)1308 **(+)3144** **(1)** **Bonds formed** 3 x C – C = 3x 347 = (−)1041 6 x C – H = 6 x 413 = (−)2478 **(−)3519 (1)** Enthalpy change = 3144 +(−3519) =−375 kJ mol^{-1}**(1)** **OR break and make all bonds** **Bonds broken** 3 x C – C = 3 x 347 = (+)1041 3 x C = C = 3 x 612 = (+)1836 6 x C – H = 6 x 413 = (+)2478 3 x H – H = 3 x 436 = (+)1308 (+)**6663 (1)** **Bonds formed** 6 x C – C = 6x 347 = (−)2082 12 x C – H = 12 x 413 = (−)4956 (−)**7038 (1)** Enthalpy change = 6663 +(−7038) =−375 (kJ mol^{-1})**(1)**	+375 is worth 2 marks since only one error. mark the third mark consequentially		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	The unused p electron orbitals overlap (sidewayst to produce a π system that extends over the whole ring of carbon atoms) **(1)** Diagram **(1)** 		Any suggestion that sigma bond being formed	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**Addition** would disrupt the delocalised π system **(1)** **Substitution** restores or retains the delocalised π system and this has greater (energetic) stability **(1)**	Allow reverse argument		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(i)	One in which the solute shows high solubility in hot but low in cold **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(ii)	Firsthot filtration/ second step **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iii)	Soluble impurities will not crystallise out after cooling OR Soluble impurities remain in solution after cooling OR Cold solution is not saturated with the impurities **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iv)	To remove any impure solvent/solution on crystals **(1)** Must be idea of liquid not solid Allow remove any soluble impurities still in the solution			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(v)	Minimum (volume) of hot solvent OR wash with (ice-)cold solvent OR I st filtration so that crystals not removed. **(1)**	"Bullets 1, 2 or 5"		**1**

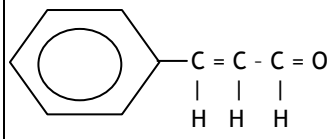
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**Diagram Stand alone** Lozenge drawn **(1)** At least 2 horizontal and 2 vertical tie bars starting at 50/50 mixture **(1)** **Explanation – stand alone** Vapour richer in the more volatile component/ hexane **(1)** (Evaporates,)condenses and reboils**(1)** Pure hexane distilled off **(1)** *If say heat at 69 °C and boil off hexane **NO** marks for explanation*			**5**

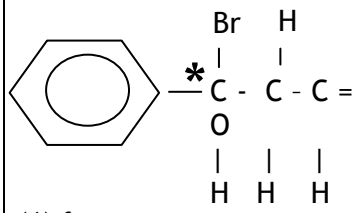
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5(a)	<table><tr><th>Carbon</th><th>Hydrogen</th><th>Oxygen</th></tr><tr><td>81.82 / 12 = 6.818</td><td>6.06 / 1 = 6.06</td><td>12.12 / 16 **(1)** = 0.7575</td></tr><tr><td>6.818 / 0.7575 = 9</td><td>6.06 / 0.7575 = 8</td><td>0.7575 / 0.7575 =1 **(1)**</td></tr></table> Empirical formula = C_9H_8O EF mass = 132 ∴ Molecular formula = C_9H_8O **(1)** **Marking** 1 mark for division by Ar 1 mark for division by smallest 1 mark for showing EF = MF **by use of 132** Note the third mark is for showing that their EF adds up to 132 OR % C = $\frac{9x12x100}{132}$ = 81.82 **(1)** % H = $\frac{8x1x100}{132}$ = 6.06 **(1)** % O = $\frac{16x100}{132}$ = 12.12 OR by difference for which ever one is not calculated**(1)**			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	Carbonyl group OR Aldehyde or ketone **(both needed)** OR C=O group **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	Aldehyde/CHO OR "Not a ketone" if mark awarded in (i) **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	Must have (one) C=C **(1)**	Alkene Ignore unsaturated group		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)			Side chain EXCLUDED BY QUESTION	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	 **(1)** for correct structure or with the bromine on carbon 2 **(1)** mark for indentification of chiral centre	If give side chain in 5(c)(ii) allow marks here consequentially		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(iii)	Substitution in the benzene ring **(1)** Addition to side chain **(1)** OR Substitution in the benzene ring **(1)** Different positions around the ring/multiple substitution **(1)**	Reacts by substitution and addition without clarification 1 mark only	Nucleophilic substitiution	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)	(dirty/grey) green ppt **(1)** (Then a dark) green solution **(1)** This mark does not depend on the colour of the ppt.	Any green		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	**1st mark** Both directions of change of position of equilibrium given **(1)** **2nd mark** Explanation involving H^+ in each case**(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	Oxidation number of Cr in $Cr_2O_7^{2-}$ **and** CrO_4^{2-} is +6. **(1)** Actual oxidation number of Cr must be stated		No change in ON of Cr	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	$2Cr^{3+} + Zn \rightleftharpoons 2Cr^{2+} + Zn^{2+}$ **(1)** Ignore state symbols	Multiples		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii)	$Cr^{2+} + Zn \rightleftharpoons Cr + Zn^{2+}$ **(1)** Ignore state symbols	Multiples		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6(c)(iii)	E^o for Zn reducing Cr^{3+} going to Cr^{2+} is+ 0.35 (V) **and** E^o for reducing Cr^{2+} to Cr = -0.14(V) **(1)** Both required for 1 mark because E^o for second reaction is negative / not feasible**(1)** Second mark consequential on figures in first part. Note If both E values correct final product is $\underline{Cr^{2+}}$ If E_1 and E_2 are both calculated as +ve - final product is Cr If E_1 and E_2 both calculated as negative final product is Cr^{3+}	Answers based on other use of the data eg. As cell diagrams and loss of electrons can score full marks Must be some reasoning for second mark		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (d)	Two possible routes ignore sig figs **1st mark** Amount of dichromate in used in titration = $\frac{19.00 \times 0.0136}{1000}$ **(1)** = 2.584×10^{-4} mol **2nd mark** Mols of iron = $\frac{\mathbf{6} \times 19.00 \times 0.0136}{1000}$ **(1)** = 0.00155 mol (1.550×10^{-3}) **3rd mark** Total amount in 250 cm^3 = $\frac{\mathbf{10} \times 6 \times 19.00 \times 0.0136}{1000}$ **(1)** = 0.0155 mol (1.55×10^{-2}) **OR** Conc of Fe^{2+} = $\frac{0.00155}{0.025}$ **(1)** = 0.0620 mol dm^{-3} **4th mark** Mass of iron(II) sulphate =$\frac{\mathbf{152} \times 10 \times 6 \times 19.00 \times 0.0136}{1000}$ **(1)** = 2.357 g **OR** Mass of $FeSO_4$ in 250 cm^3 = $\frac{0.0620 \times 152}{4}$ = 2.357 g dm^{-3} **5th mark** Percentage of iron sulphate $\frac{2.357 \times 100}{4.00}$ = 58.9% **(1)** allow 59	Alternative routes are possible for full marks Notes If use 56 (Fe) in place of 132 they get 21.7%.		**5**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (e) **QWC**	**Ist mark** Viable separation technique after reaction with heating with acidified potassium dichromate(VI) **(1)** **e.g.** If change in colour of dichromate from orange to green distil out product(as it is formed) **2nd mark** If no change in colour **tertiary** alcohol **(1)** **3rd mark** **Either** Test distillate of other two with Tollens' reagent If silver mirror aldehyde present and alcohol was primary **(1)** If no silver mirror ketone present and alcohol was secondary**(1)** **OR** Fehling's in place of Tollens' If answer just describes tests without chemical argument 1 out of the last two marks	If reflux to convert primary right through to acid and secondary to ketone. Allow dnp for ketone And a **positive** test for acid i.e not proof by elimination.		**4**

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1 (a)</td><td>
Table 1

Check subtractions and averaging arithmetic correcting if necessary.

All volumes recorded to 0.05 cm^3 or better.
Allow one slip but withhold this mark if any readings are in the wrong boxes.
Allow 0, 0.0, 0.00 as initial volume.
NOT 50 as initial volume.
All subtractions completed correctly (1)
[✔ top RHS of Table 1]

Mean titre
For correct averaging of chosen titres, correctly subtracted or for choosing identical titres and for recording the mean correct to 2 dp or to 0.05 cm^3 [unless already penalised in Table 1] (1)
[✔ by the mean in space or near the dotted line in paragraph below]

Accuracy
If the candidate has made an arithmetical error in Table 1 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.
Record the supervisor's value on the script as s=
Calculate the difference between the candidate's mean titre and that of the supervisor.
Record the difference as
d =…… on the script

Award marks for accuracy as follows
<table>
<tr><td>d =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.60</td><td>>0.60</td></tr>
<tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

Range
The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range on the corrected titres used by the examiner to calculate the mean.

<table>
<tr><td>r =</td><td>0.20</td><td>0.30</td></tr>
<tr><td>Mark</td><td>2</td><td>1</td></tr>
</table>

xaminer to show the marks awarded for accuracy and range as
d = value ✔ 4 MAX
r = value ✔ 2 MAX
</td><td></td><td></td><td>8</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	moles $S_2O_3^{2-}$ in mean titre = $\frac{\text{mean titre}}{1000}$ x 0.100 **(1)** moles oxidising agent in 25.0 cm^3 = $\frac{\text{above}}{6}$ **(1)** conc^n oxidising agent in **B** = above x $\frac{1000}{25}$ **(1)** [Ignore SF except in final conc^n] Answer must be to 3SF for 3rd mark. If units given must be correct.			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Molar mass = $\frac{3.20}{\text{answer to (i)}}$ [To at least 2 SF] IGNORE units.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	Error = $\frac{\text{uncertainty}}{\text{reading}}$ x 100% OR explanation making this point.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	KI (already) in excess	oxidising agent is limiting		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Observations Any green for **both C** and **D**. **(1)** Inference d-block **(1)**	 Transition (metals)	Any blue	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Observations Green precipitate (Insoluble in excess ammonia) **(1)** Brown precipitate **(1)** Inferences Iron(II) / Fe^{2+} **(1)** Iron(III) hydroxide / $Fe(OH)_3$ **(1)**	 $[Fe(OH)_3(H_2O)_3]$ / Fe_2O_3		**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	Observations Purple (solution) **(1)** Colourless / yellow (solution) **(1)** Inference Oxidation / redox**(1)**	 Decolourised / discharged 	 disappeared reduction	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	$Fe^{2+} \rightarrow Fe^{3+} + e^{(-)}$ Ignore state symbols			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Observations Green precipitate **(1)** Insoluble in excess NaOH **(1)** Inference $Ni(OH)_2$ / nickel(II) hydroxide **(1)**	 $[Ni(OH)_2(H_2O)_{2/4}]$		**3**

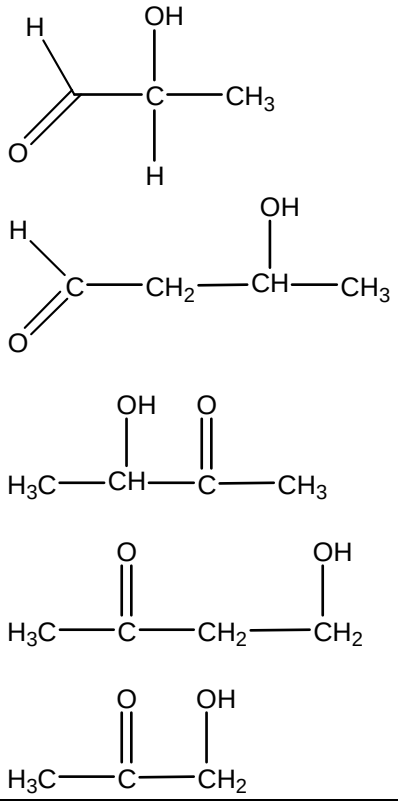
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Observation White precipitate **(1)** Inference Barium sulphate / $BaSO_4$ **(1)**		 Green ppte SO_4^{2-} / sulphate	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	**C** $FeSO_4$ **(1)** **D** $NiSO_4$ **(1)** Ignore water of crystallisation	 $Cr_2(SO_4)_2$ cq		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	Observation sweet / fruity/ glue smell **(1)** Inferences ester **(1)** **E** is alcohol **(1)**	 Allow ester smell as observation		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	Observation Green / blue **(1)** Inferences Primary or secondary alcohol **(1)** Alcohol oxidised / redox**(1)**	 Not tertiary alcohol Dichromate(VI) reduced		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	Observation Yellow precipitate **(1)** Inferences Iodoform / tri-iodomethane / CHI_3 **(1)** CH_3–CH(OH) **(1)**	Methyl secondary alcohol or ethanol(both)	Ethanal and / or methyl ketone	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	Compound 1 $CH_3CH(OH)CH_3$ **(1)** Compound 2 $CH_3CH(OH)CH_2CH_3$ **(1)** **Alternatives:** 	Full structural formula for each- showing all atoms and bonds.(Penalise omission of hydrogens once only) Skeletal formula	C-HO bond	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)	Propan-2-ol 6:1:1 OR Butan-2-ol 1:1:2:3:3 Allow cq from (d)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**1** ✓Make up equimolar solutions of transition metal ions. **2** ✓Mix same volumes of solutions. **3** ✓Same temperature. **4** ✓Add KI or $K_2S_2O_8$ last. **5** ✓Stir / mix and start timing as last solution added **6** ✓Stop timing when blue-black colour first appears. **7** ✓Shorter the time the more effective the catalyst	$\frac{\text{rate } Fe^{2+}}{\text{rate } Co^{2+}} = \frac{\text{time } Co^{2+}}{\text{time } Fe^{2+}}$		**7**

6246/01A - Materials

Apparatus and Materials

Apparatus

Each candidate will require:

1. six test tubes and two boiling tubes in a test tube rack;
2. one 10 cm^3 and two 25 cm^3 measuring cylinders;
3. a supply of dropping pipettes;
4. spatula;
5. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
6. small beaker for draining burette;
7. 25.0 cm^3 pipette and safety filler;
8. white tile;
9. two 250 cm^3 conical flasks;
10. one 100 cm^3 beaker;
11. a supply of hot water (about 70 °C) and a 250 cm^3 beaker for a water bath.

Materials

Each candidate will require:

(a) 200 cm^3 of aqueous sodium thiosulphate, $Na_2S_2O_3$, of concentration 0.100 mol dm^{-3} labelled **Solution A**;

(b) 200 cm^3 of aqueous potassium iodate, KIO_3, of concentration 0.0150 mol dm^{-3} labelled **Solution B**. The identity of this solution is **not** to be disclosed to candidates;

(c) 1.0 g of hydrated iron(II) sulphate, $FeSO_4.7H_2O$, in a stoppered tube labelled **C**. The identity of this compound is **not** to be disclosed to candidates;

(d) 1.0 g of hydrated nickel(II) sulphate, $NiSO_4.6H_2O$, in a stoppered tube labelled **D**. The identity of this compound is **not** to be disclosed to candidates;

(e) 5 cm^3 of propan-2-ol labelled **E**. The identity of this compound is **not** to be disclosed to candidates;

(f) 100 cm^3 of aqueous potassium iodide; concentration approximately 0.5 mol dm^{-3};

(g) 100 cm^3 of dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3};

(h) 2 cm^3 of ethanoic acid in a stoppered test tube labelled **ethanoic acid**;

(i) 10 cm^3 of dilute aqueous ammonia; concentration approximately 2.0 mol dm^{-3};

(j) 15 cm^3 of dilute sodium hydroxide; concentration approximately 0.5 mol dm^{-3};

(k) 5 cm^3 of dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3};

(l) 5 cm^3 of dilute hydrochloric acid; concentration approximately 2.0 mol dm^{-3};

(m) 5 cm^3 of aqueous barium chloride; concentration approximately 0.2 mol dm^{-3};

(n) 5 cm^3 of aqueous potassium manganate(VII); concentration approximately 0.02 mol dm^{-3};

(o) access to a bottle of concentrated sulphuric acid;

(p) 60 cm^3 of aqueous sodium carbonate; concentration approximately 1.0 mol dm^{-3};

(q) 5 cm^3 of aqueous potassium dichromate(VI); concentration approximately 0.20 mol dm^{-3};

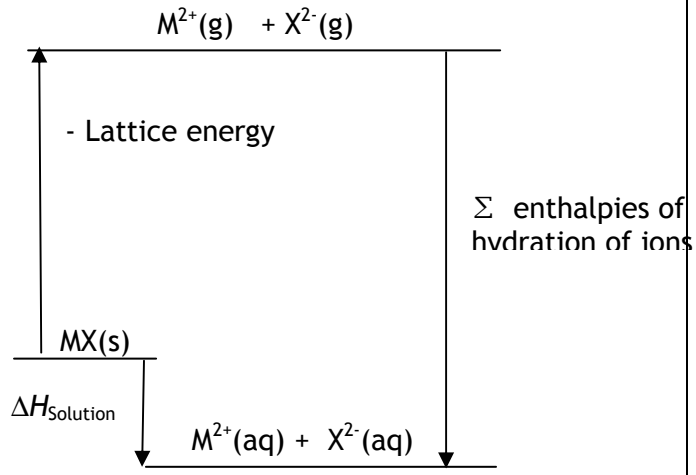
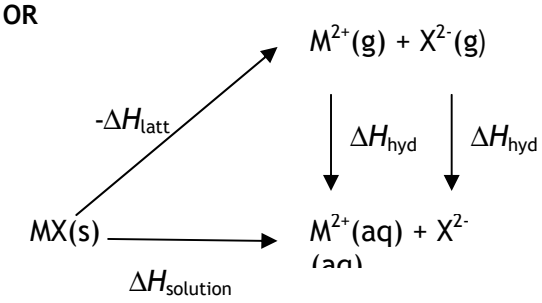
(r) 10 cm^3 of iodine/potassium iodide solution made up by adding 2 g iodine to 6 g potassium iodide dissolved in 100 cm^3 water and labelled **aqueous iodine**;

(s) 20 cm^3 of freshly prepared aqueous starch; concentration approximately 1%;

(t) a supply of distilled water.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Add starch when iodine colour almost disappeared / (pale) straw/pale yellow **(1)** Otherwise iodine-starch complex /black /blue-black solid precipitates /formed**(1)** Blue to colourless **(1)**	 Allow grey ppt. since in the experiment the flask will contain the white solid CuI		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	**In the calculation ignore significant figures unless the answers rounds to 1 during the calculation** **Silver** Mass of AgCl = 0.244g Mass of Ag = $\frac{0.244 \times 108}{143.5}$ **(1)** **= 0.183(6)g** % Ag = $\frac{0.1836 \times 100}{1.40}$ = **13.1(1)%(1)** **Copper** Moles of thio used = $\frac{38.45 \times 0.1}{1000}$ **(1)** **= 3.845 x 10^{-3}** Moles of Cu^{2+} = $\frac{38.45 \times 0.1}{1000}$ **(1)** **= 3.845 x 10^{-3}** Mass of Cu = $\frac{38.45 \times 0.1 \times 63.5}{1000}$ **(1)** **= 0.244(1)g** %Cu = $\frac{0.244 \times 100}{1.40}$ **= 17.4(4)% (1)** **Gold** Calculate percentage of gold by difference 100 – (13.1+ 17.4) = **69.5% (1)** Consequential on % of silver and copper no matter what the answers	Notes Allow error carried forward. Penalise an error only once in any part of the calculation if this is then carried forward correctly to give a percentage. Allow 69.4%		**7**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	 **OR**  Species with state symbols charge must be +2/-2 **(1)** $\Delta H_{Solution}$ labelled on arrow showing solid to aqueous ions **(1)** LE and enthalpies of hydration of ions labelled **(1)**	Allow lattice energy with arrow the other way and positive sign. I think we allow it as the question is not direction specific	$\Delta H_{solubility}$	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	**1st mark** EITHER Solubility is balance between lattice energy and hydration energy OR heat released on hydration must compensate for heat needed to break up lattice OR $\Delta H_{Solution}$ = -lattice energy + ∑hydration energies **(1)** This equation scores the mark and could be in quoted as part of the energy cycle **2nd mark** Both lattice energy and hydration energy decrease as cations get larger/ ionic radius increases **(1)** **3rd mark** But hydration energy decreases more /lattice energy decreases less / both decrease but ΔH_{LE} is less significant(because of large anion size) **(1)** **4th mark** So enthalpy of solution becomes more endothermic down the group / less exothermic (hence less soluble)**(1) Stand alone**	Ions (place of cations) Become less exothermic Reference to atoms not ions penalise once If no change in LE in second mark carry forward this error to third mark? This does not apply to hydration energy		**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	van der Waals / London / dispersion / induced dipole/instantaneous dipole - instantaneous dipole **(1)** Hydrogen bond**(1)** Ignore Dipole-dipole interactions but if give THREE answers one of which is wrong max 1			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	The acid /COOH group **(1)** Can form hydrogen bonds with the water**(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	Energy released on formation of intermolecular forces (between aspirin and water) **is less than** the energy required to overcome the existing intermolecular forces OWTTE Or Large hydrophobic benzene ring /non-polar ring/non-polar group leads to low solubility Or Hydrogen bonds formed fail to overcome the hydrophobic effect of the benzene ring **(1)**	"strength of forces" instead of "energy"	Any reference to breaking of molecule or bonds with molecules score zero	**1**

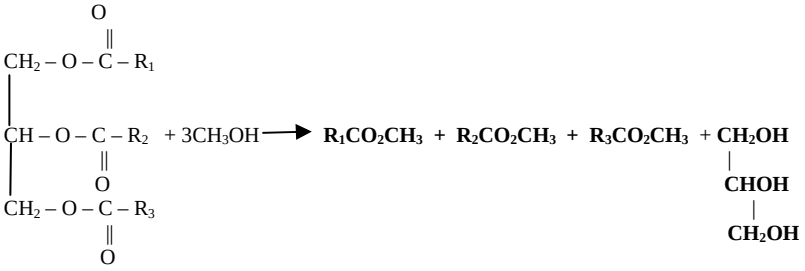
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv)	It is ionic and the ions can be hydrated providing enough energy to cause it to dissolve or Strong interaction between water and ions **(1)**			**1**

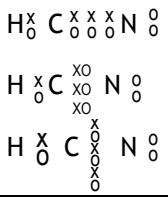
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Methanol / CH_3OH **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Ethanoyl chloride / CH_3COCl**(1)**	$(CH_3CO)_2O$ or name	CH_3COCl solution	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iii)	Sodium hydroxide / NaOH OR sodium carbonate / Na_2CO_3 OR sodium hydrogen carbonate/$NaHCO_3$ **(1)**			**1**

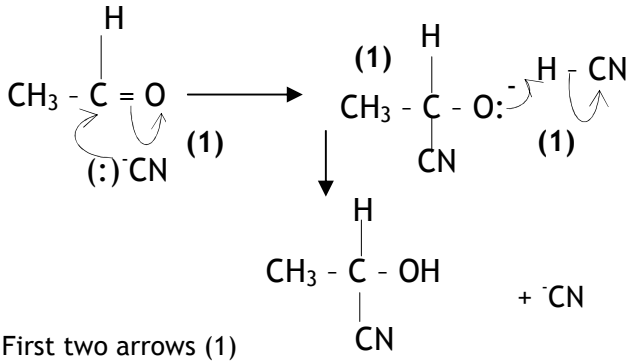
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	$CH_3COOC_6H_4CO_2Na + HCl \longrightarrow CH_3COOC_6H_4CO_2H + NaCl$**(1)** Salicylic acid is a weaker acid / HCl is a stronger acid / Salicylate ions are a base**(1)**		If draw benzene ring it must be correct	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (e)	 **1 mark for three esters + 1 mark for glycerol (stand alone)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)		Dots or crosses		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	$HCN \rightleftharpoons H^+ + CN^-$ $K_a = \frac{[H^+][CN^-]}{[HCN]} = \frac{[H^+]^2}{[HCN]}$ $\frac{[H^+]^2}{0.220} = 4.90 \times 10^{-10}$ **(1)** $[H^+] = \sqrt{4.90 \times 10^{-10} \times 0.220}$ $= 1.038 \times 10^{-5}$ **(1)** pH $= -\log_{10} 1.038 \times 10^{-5}$ $= 4.98(4)$ **(1)** Allow 5.00 Correct answer with no working **(3)**			**3**

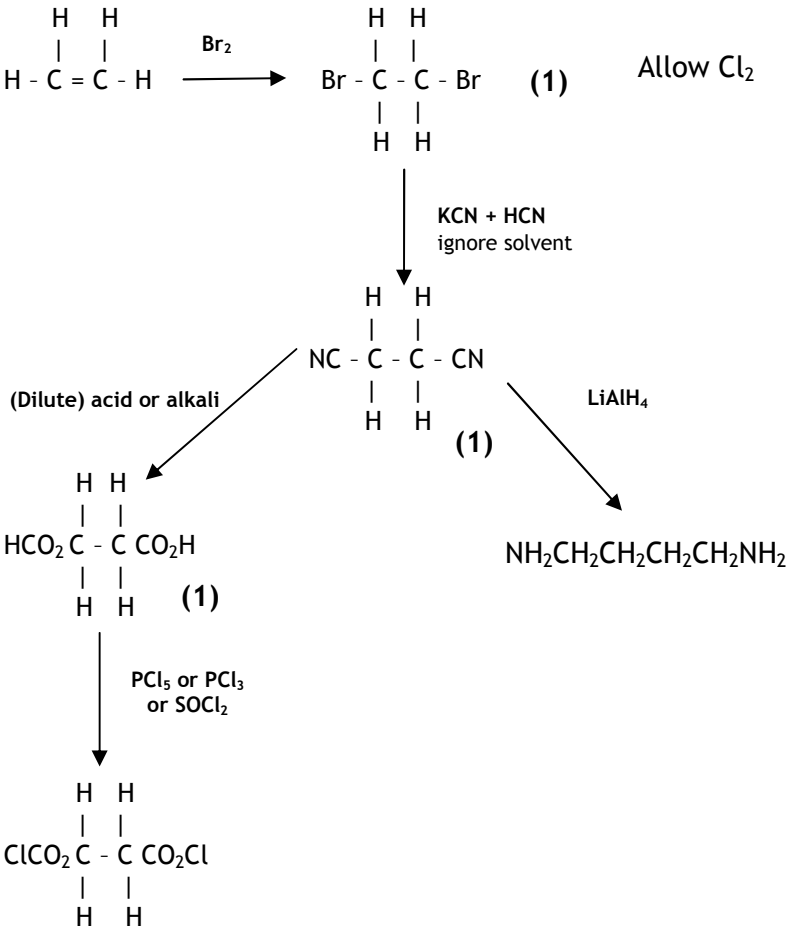
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	100 % dissociation would give 0.220 mol dm^{-3} Actual figure 1.038×10^{-5} mol dm^{-3} % dissociation = $\frac{1.038 \times 10^{-5}}{0.220} \times 100$**(1)** $= 4.72 \times 10^{-3}$ %**(1)** **Answer must be the 3 sig.figs** Cq on $[H^+]$ (i)	If use 1.04×10^{-5} then get 4.73×10^{-3} %		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	 **(1)** **(1)** **(1)** First two arrows (1) Intermediate (1) including charge Arrow **to** H of HCN/H^+ (1) Arrow can come from negative sign Arrow must go from bond to C of HCN not N Ignore δ+ and δ- unless wrong way round	H^+ in place of HCN		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	(A nucleophile is a) species that can donate a (lone) pair of electrons to form a covalent bond **(1).**		Just "species which attacks a postive / δ^+ site" A negative ion	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(iii)	cyanide ion / CN^-**(1)** HCN is a weak acid so CN^- removed CN^- reacts with H^+ CN^- is a base so reacts with H^+**(1)**	Equation and statement that equilibrium moves to LHS		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	$CH_3Cl + KCN \longrightarrow CH_3CN + KCl$ **OR** $CH_3Cl + CN^- \longrightarrow CH_3CN + Cl^-$ **(1)** **Ignore state symbols** Nucleophilic substitution**(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)	 **Marking** **1 mark** for each of the **three intermediate** compounds 5 reagents = **(3)** 3 reagents = **(2)** 2 reagents = **(1)** The reagent marks can only be awarded for parts of correct sequences	Other routes can score but they must go via a cyanide (in question) Correct route via a Grignard reagent to the acid chloride scores **Max 5** (it does not answer the question actually asked) Allow Na /ethanol Or Hydrogen/ Ni In place of $LiAlH_4$		**6**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Value of *K* will decrease **(1)** *This mark is stand alone* $\therefore[SO_3]$ must decrease so that the fraction equals the new /lower *K* **(1) Not stand alone**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii) QWC	No change in value of *K***(1)** *This mark is stand alone* the fraction gets smaller /decreases (because there are more molecules on the left) **(1)** Equilibrium moves to the right (so that the fraction equals the value of *K*) so concentration of SO_3 increases **(1)**			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	No change in value of *K* (or in the value of the fraction) No change in equilibrium yield of SO_3**(1)**	No change because catalysts only alter rate not yield OWTTE		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	Average KE of molecules increases/molecules move faster/molecules have more energy / **(1)** a greater fraction of collisions will have energy greater than activation energy**(1)** Greater **proportion** of collisions are successful **(1)**			**3**

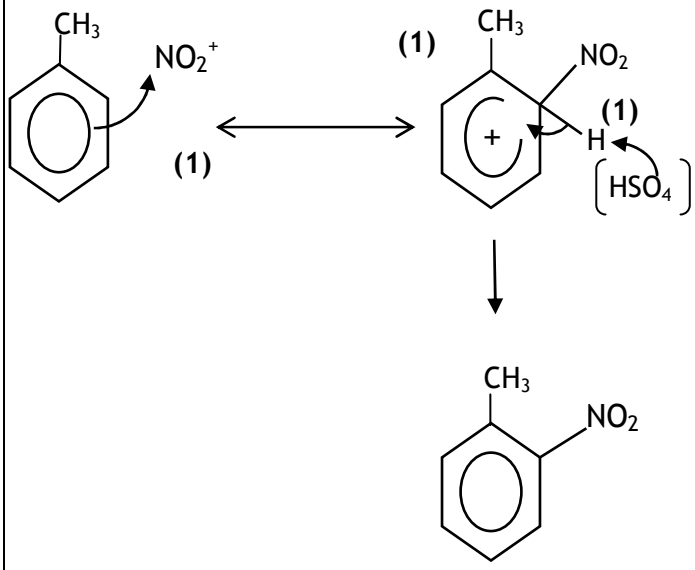
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	Temperature must be high enough to give a reasonable rate**(1)** Too high and yield would drop dramatically**(1)** **e.g.** High temp gives a low yield but low temp will slow the rate and so a compromise is chosen**"(2)**			**2**

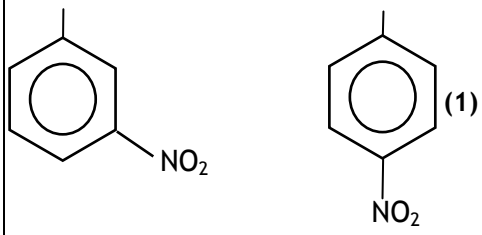
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	Higher pressure not necessary as conversion 425^{o}C and 2 atm is very high / ~98% **(1)** Ignore costs			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	Since reaction is exothermic the temperature will rise **(1)** Which would decrease the yield unless cooled **(1)**	Allow reference to equilibrium moving for second mark?		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i)	$2H_2SO_4 + HNO_3 \rightarrow H_3O^+ + NO_2^+ + 2HSO_4^-$ **OR** $H_2SO_4 + HNO_3 \rightarrow H_2O + NO_2^+ + HSO_4^-$ **(1)** **OR** both of: $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$ then $H_2NO_3^+ \rightarrow H_2O + NO_2^+$ **OR** $H_2NO_3^+ + H_2SO_4 \rightarrow H_3O^+ + NO_2^+ + HSO_4^-$			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	The sulphuric acid is a stronger acid and so protonates the nitric acid OR Nitric acid is a weaker acid and so is protonated **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(iii)	Mechanism  1 mark for arrow from ring on to N of the NO_2^+ 1 mark for intermediate with positive charge shown and delocalisation not extending over carbon attached to NO_2 but covering the other carbons 1 mark for arrow from C – H bond into ring			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(iv)	 OR drawn structure of any dinitromethyl benzene **OR** Any valid name for a dinitroderivative			**1**

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