Mark Scheme January 2008

GCE

GCE Chemistry (8080/9080)

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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 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)(i)	Copper …….$3d^{10}4s^1$	Subscripts/ignore capitals 4s inside 3d	$3d^9 4s^2$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(ii)	Bromide ion …….$3d^{10}4s^2 4p^6$	Subscript/ignore capitals 4s inside 3d	4p inside 3d	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	The **average mass** (taking into account the abundance of each isotope) of the **atoms** (of that element) **(1)** relative to 1/12th the (mass of a) carbon 12 atom Or relative to ^{12}C = 12 (exactly) **(1)** *second mark stand alone*	Weighted/mean in place of average Atoms must be mentioned at least once to score **(2)** Average mass of a mole of atoms of an element relative to 1/12th mole of C^{12} / relative to one mole of ^{12}C = 12 (exactly) **(2)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	$\frac{[62.93 \times 69.17] + [64.93 \times 30.83]}{100}$ **(1)** = 63.55 **(1)** must be to 2 decimal places cq only on transcription error e.g. 69.71 provided answer to 2 d.p.	63.54 with some working scores **(1)** Correct answer alone scores **(2)** Answer should have no unit, but allow unit of "g mol^{-1}" but **not** "grams" or "g"		2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1.(d)(i)</td><td>
<table>
<tr><td>Cu</td><td>C</td><td>O</td><td>H</td></tr>
<tr><td>$\frac{57.5}{63.5}$</td><td>$\frac{5.40}{12}$</td><td>$\frac{36.2}{16}$</td><td>$\frac{0.900}{1}$</td></tr>
<tr><td>0.906</td><td>0.450</td><td>2.26</td><td>0.900</td></tr>
<tr><td>2.01</td><td>1</td><td>5.02</td><td>2.00</td></tr>
</table>
Empirical formula $Cu_2CO_5H_2$
(1) for dividing by atomic mass
(1) stating empirical formula</td><td>Correct answer without working scores (2)</td><td>Use of atomic number scores 0</td><td>2</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(ii)	Empirical formula mass = 221 = M_r Molecular formula $Cu_2CO_5H_2$ *Must show use of 221*	If use atomic number in(i) allow mark for Cu_2CO_5H and 220 Allow any formula that adds up to the correct molecular formula		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)	(Highest = $^{65}Cu + 2\ ^{37}Cl$) = 139 **(1)** (Lowest = $^{63}Cu + 2\ ^{35}Cl$) = 133 **(1)** Ignore units			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	Lithium carmine/ red/ magenta/ crimson Any combination of these or prefaced by deep or dark Potassium: lilac Sodium: yellow **All three correct 2 marks** **Two correct 1 mark**	scarlet mauve or purple orange or yellow-orange	Brick-red	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	Electrons (absorb heat energy and) are promoted (to higher level) **(1)** They drop back **and** emit light/radiation (of characteristic colour) **(1)**	'Excited' any phrase that implies **movement** to higher level ignore references to shells, sub-shells, etc.	If answer based on absorption spectra **scores zero** Colour or energy	2

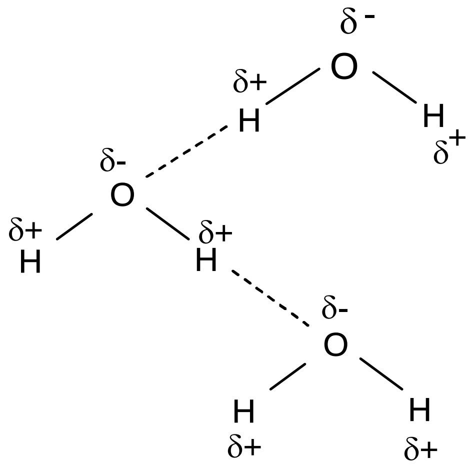
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(i)	$LiCl + H_2SO_4 \rightarrow LiHSO_4 + HCl$ Ignore state symbols	Multiples $2LiCl + H_2SO_4 \rightarrow Li_2SO_4 + 2HCl$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(ii)	$K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2O + CO_2$ $CO_3^{2-} + 2H^+ \rightarrow H_2O + CO_2$ / H_2CO_3 $CO_3^{2-} + H^+ \rightarrow HCO_3^-$ Ignore state symbols and spectator ions	Multiples $K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2CO_3$ $K_2CO_3 + HNO_3 \rightarrow KNO_3 + KHCO_3$		1

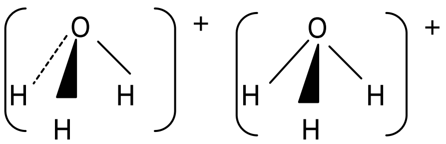
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(iii)	$NaI + AgNO_3 \rightarrow AgI + NaNO_3$ Ignore state symbols and spectator ions	Multiples $Ag^{+} + I^{-} \rightarrow AgI$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)(i)	The beryllium ion would be (very) small **(1)** and would polarise chloride **ions** (producing sharing of electrons / covalency) **(1)** OR Difference in electronegativity small /similar (1) Therefore **share** (pair of) electrons / no electron transfer (1) *If both routes given. Mark both out of 2 and then score higher hark.*	Allow Be^{2+} has a large charge to size ratio/large charge density Distort for polarise Anion for chloride ion	Answers that refer to polarisation of atoms score zero Answers that refer to electronegativity of ions score zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)(ii)	.. .. :Cl : Be: Cl: .. .. Ignore shape and inner electrons if correct	All dots or all crosses or mixture of both Polymer with continuation bonds	Dimer Ionic formula	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	• Diagram showing correct covalent and hydrogen bonds **(1)** • Linear around at least two H and water shown as 'v' shaped **(1)** • δ^+ H and δ^- O **(1)** must be shown across at least one hydrogen bond 	If only two water molecules shown max 2 marks Blobs for O and H provided correct δ^+/δ^- shown Ignore a slip in partial charges provided not part of hydrogen bond	If use O_2H allow third mark only If any H bond shown between two oxygens or two hydrogens	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	Each water can form **more** hydrogen bonds (than each hydrogen fluoride molecule) **(1)** So more energy is needed to break the hydrogen bonds in water/separate molecules (hence higher boiling temperature) **(1)** 2nd mark is stand alone unless wrong intermolecular force identified in first part e.g. vdw	Each water molecule can form two hydrogen bonds, HF can only form one Each water molecule can form four hydrogen bonds HF can only form two "Intermolecular force" for "hydrogen bond"	Just 'H bonds in water are stronger' Is not good enough to score the mark Any reference to breaking covalent bonds/bonds in the molecule scores zero.	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(i)	 Must attempt to draw as a pyramid – wedge or dash or both. If three lines drawn must not look planar Ignore name unless "planar"	Ignore omission of + sign in diagram		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(ii)	Any number from 105 to 108 inclusive. Mark independently of (c)(i)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(iii)	Repulsion between the H_3O^+ and the H^+	They are both cations so repulsion OR They are both positive so repulsion		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	Substance that can lower/reduce the oxidation number (of an element in another substance) Ignore references to loss or gain of electrons unless contradictory.	Substance containing an element whose oxidation number is increased (in a reaction) OR Causes a decrease in the oxidation number of the molecule/species it reacts with OR The reducing agent's oxidation number increases	The oxidation number goes down A definition of redox	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(i)	$2ClO^{-} + 4H^{+} + 2e^{(-)} \rightarrow Cl_2 + 2H_2O$ Ignore state symbols and $\rightleftharpoons$	Or multiples "$-2e^{(-)}$" on RHS		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(ii)	$2Cl^{-} \rightarrow Cl_2 + 2e^{(-)}$ Ignore state symbols and $\rightleftharpoons$	Or multiples "$-2e^{(-)}$" on LHS		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	$ClO^{-} + Cl^{-} + 2H^{+} \rightarrow Cl_2 + H_2O$ Stand alone not consequential on (b) Ignore state symbols and $\rightleftharpoons$	Or multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)	White/misty/steamy fumes Mauve/purple/violet/ (iodine) vapour/gas/fumes Black solid **Any two of above** Ignore any yellow solid/ bubbling/fizzing Ignore non-visible observations e.g. getting hot	 lilac (shiny) grey solid	White smoke Just 'dark solid' precipitate	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(i)	$2KClO_3 \rightarrow 2KCl + 3O_2$	Or multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(ii)	Oxidation numbers all correct **(1)** Cl O Start +5 -2 End -1 0 Chlorine reduced as oxidation number decreases/ changes from +5 to -1 **(1)** Oxygen oxidised as oxidation number increases/changes from -2 to 0 **(1)** Oxidation number mark may be awarded if included within explanations. Penalise omission of reference to oxidation or reduction once 2nd and 3rd marks are consequential on stated oxidation numbers.	Allow 5+, 2-, 1- Allow V, -II, -I Correct identification of O as oxidised and Cl as reduced scores **(2)** provided oxidation number change is in the correct direction for both even if actual numbers wrong.	Cl^{5+} , Cl^{-1} , O^{-2}	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(i)	The ability of an atom/element/ species to attract the electrons **(1)** in a covalent bond/bond pair/shared electrons **(1)**	"Power/extent" instead of "ability" "pulls toward/draws" instead of "attract"	Molecule	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(ii)	The molecule is symmetrical / tetrahedral **(1)** So bond polarity/dipoles cancels OR centres of positive and negative charge coincide **(1) - stand alone**	Diagrams showing vectors	Too small a difference in electronegativity Charge cancels	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(iii)	Dispersion/Induced dipole /London OR temporary/instantaneous dipole	van der Waals/vdw	Dipole-dipole Hydrogen bond	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(i)	Ignore sig. figs UNLESS rounded to 1SF 700 g TMP $= \frac{700}{114}$ **(1)** = 6.14 mol Moles of oxygen = 12.5 x 6.14 **(1)** = 76.75 Volume of oxygen = 12.5 x 6.14 x 24 =1842 dm^3 **(1)** Units essential Working must be checked i.e. 3.07 x 25 x 24 = 1842 dm^3 (**2**) 3.07 x 12.5 x 24 = 921 dm^3 (**1**) OR 228 g of TMP need 25 x 24 dm^3 of oxygen **(1)** ∴ 700 g of TMP need $\frac{25 \times 24 \times 700}{228}$ of oxygen**(1)** = 1842 dm^3**(1)** Units essential [Working must be checked]	1840/1800 dm^3 1830 if 6.14 rounded to 6.1	Moles $2C_8H_{18} = \frac{700}{228}$ = 3.07	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(ii)	Ignore sig. figs UNLESS rounded to 1SF Moles of CO_2 = 8 x6.14 **(1) =** 49.12 Mass of CO_2 = 8 x6.14 x44 = 2161 g **(1)** Units essential but don't penalise if already penalised in (i) OR 228 g of TMP give 44 x 16 g CO_2 **(1)** ∴ 700g of TMP give $\frac{44 \times 16 \times 700}{228}$ g of CO_2 = 2161 g **(1)** Could be consequential on (i)	2160/2200 or 2147 / 2150 / 2100 if 6.14 rounded to 6.1		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(a)	Energy/Enthalpy/heat change **per mole** for the **(1)** Removal of **one electron** (per atom) **(1)** From 1 mole of **gaseous atoms (1)** If wrong equation given with a correct definition **(max 2)**	"Required" instead of "change" $X(g) \rightarrow X^{+}(g) + e^{-}$ can score last 2 marks		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)	Increase in shielding/screening **(1)** Increase in nuclear charge/more protons/atomic number **(1)** Increase in distance (of outermost electron)/larger atomic radius OR (increase in) shielding outweighs nuclear charge (increase) **(1)** Ignore references to: effective nuclear charge OR nuclear attraction	Electron at higher energy level		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(i)	Na:Mg:Al metallic (structure) Si giant atomic (structure) P:S:Cl:Ar simple molecular **All three correct 1 mark**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(ii)	strong covalent bonds **(1)** (throughout the lattice and lots of energy) need to break **many** bonds **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(iii)	Aluminium supplies more electrons (per atom)/Al ion is more highly charged/Al ion is smaller/ Al ion has a higher charge density **(1)** The (attractive) forces between the aluminium ions and the electrons are stronger/require more energy to break than in the case of sodium. **(1)**	Reverse for Na	Any reference to bonding **other than** metallic bond/ sea of electrons/ delocalised system	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	bauxite			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	electrodes	Anode / cathode	A reducing agent Just "to form carbon dioxide"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(i)	Al^{3+} + $3e^{(-)}$ → Al Ignore state symbols unless (aq)	Multiples Al^{3+} → Al – $3e^{(-)}$	Equilibrium	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(ii)	Oxidation **(1)** Stand alone loss of electrons (from O^{2-} ions) **(1)** Conditional on first mark	oxidisation	Oxidising / redox in terms of ox. no. Oxygen molecules or O_2 or wrong formula for ion	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)	900 (^{0}C)	800 - 1000 (^{0}C) any range or number within this range (inclusive) value in kelvin (1073 – 1273) provided unit given		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)	to dissolve the aluminium oxide/alumina/Al_2O_3 Or As a solvent		To dissolve bauxite. Just "lowers melting point (of aluminium oxide)". Any reference to catalysts scores 0.	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)	(Generation of) electricity/or electrical energy. Ignore any reference to heat.			1

Question Number	Correct Answer		Acceptable Answers	Reject	Mark
1.(g)	Any one correct use linked to appropriate property:				1
	<u>Use</u> Planes:	<u>Property</u> low density high strength to weight ratio(1)	(Superstructure of) ships	"light" if used instead of "low density" "Light and strong"	
	bicycle frames/parts	low density (1)	Light for its strength	"Light but strong"	
	car bodies/engines	low density /does not corrode/oxidise (1)	Protected by oxide layer	Rust if used instead of corrode	
	window/ greenhouse frame	does not corrode/ easily extruded (1)	protected by oxide layer		
	cans	do not corrode/ do not react with contents/ acids high strength to weight ratio.	Protected by oxide layer	Do not react with water Easy to recycle	
	pans	good **heat** conductor (1)			
	(cooking) foil	good **heat** conductor / good reflector (1)			
	power cables	high/good conductivity / low density (1)		Electric wiring	

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	N/N_2 goes from 0 to –3 = reduction (1) H/H_2 goes from 0 to (+)1 = oxidation (1)	If "the oxidation number of N goes down hence reduced and the oxidation number of H goes up and hence oxidised" (**max 1**) If all O.N. correct but fails to state which is oxidation and which is reduction scores 1.	If all O.N. correct but both reactions misclassified, scores zero. Any answer not referring to nitrogen or hydrogen scores zero.	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(i)	Calculation of bonds broken 463×3+944/ (=2252) (1) Calculation of bonds made 388×6/ (=2328) (1) ΔH = -76 (kJ mol^{-1}) (1) mark consequential on numerical values calculated above	Correct answer with some working scores 3 marks Correct answer alone scores 2 marks		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(ii)	Average / mean bond enthalpy used for **N-H bond / ammonia**		Just "average bond enthalpies used"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iii)	Thermodynamic: energy level of products lower than that of reactants OR energy released in bond formation > energy used to break bonds (1) kinetic: **high** activation energy (1) because strong N≡N (1) [confusion between thermodynamic and kinetic loses first 2 marks].	ΔH negative / reaction exothermic because N≡N is 944/ total bond breaking energy is high/2252(kJmol^{-1})		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(i) **Q** **W** **C**	<u>One way</u> temperature increase therefore molecules have greater (average kinetic) energy (1) more molecules/collisions have $E \geq E_{act}$ (1) Therefore a greater **proportion** of/ more **of the** collisions are successful (1) Ignore greater frequency of collision <u>Another way</u> addition of (iron) catalyst (1) provides alternative route of lower activation energy (1) EITHER: A greater proportion of /more of the molecules/collisions have $E \geq E_{cat}$/a greater proportion of collisions are successful OR provides (active) sites (where reactant molecules can bond / be adsorbed) (1) Ignore any answers referring to pressure or concentration. Do not penalise just "more collisions are successful" more than once	moving faster $E > E_{act}$ particles for molecules greater frequency of successful collisions/ more successful conditions per unit time platinum catalyst	just "more successful collisions" incorrect catalyst just "more successful collisions"	6

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(ii) **Q** **W** **C**	Decrease temperature(1) because (forward) reaction exothermic (1) increase pressure (1) because more moles (of gas) on left (1)	Low temperature ΔH is negative High pressure Molecules for moles	Answer based on endothermic reaction scores 0	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)(i)	(cool to) condense / liquefy OR cool to below **critical temperature**		Just "cool"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)(ii)	Recycle (the unreacted gases) OWTTE			1

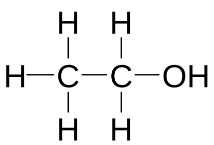
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(i)	2-bromobutane the "2" must be in front of "bromo" Ignore punctuation and capitals			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(ii)	$CH_3CHBrCH_2CH_3 + KOH \rightarrow$ $CH_3CHOHCH_2CH_3 + KBr$ OR $CH_3CHBrCH_2CH_3 + OH^- \rightarrow$ $CH_3CHOHCH_2CH_3 + Br^-$	C_2H_5 instead of CH_2CH_3 Allow K^+ as spectator ion	eqns with NaOH	1

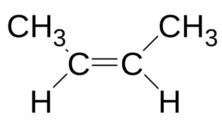
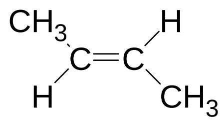
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(iii)	water / H_2O / aqueous ethanol	C_2H_5OH (aq) / aqueous alcohol/KOH(aq)/aqueous Do not penalise use of NaOH(aq) again	just "ethanol / ethanolic / alcoholic (KOH)"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(iv)	nucleophilic substitution (both needed)	reasonable phonetic spelling		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	$CH_3CHBrCH_2CH_3 + OH^- \rightarrow CH_3CH{=}CHCH_3 + H_2O + Br^-$ OR $CH_3CHBrCH_2CH_3 + OH^- \rightarrow$ $CH_2{=}CHCH_2CH_3 + H_2O + Br^-$ Double bond need not be shown	C_2H_5 instead of CH_2CH_3 Ignore spectator ions		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	Ethanol / C_2H_5OH / CH_3CH_2OH / 	Alcohol OR Ethanolic/alcoholic KOH/NaOH	C_2H_6O Any mention of water/aqueous	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iii)	elimination ignore "nucleophilic"		electrophilic elimination	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(i)	 	bond to H of CH_3 on left carbon structure with 90^o bond angles		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(ii)	no / restricted rotation around double bond / C=C / π – bond (1) has two different groups joined to **each** C (of double bond) OR each (carbon of C=C) has a CH_3 and a H (1)	limited rotation	on the carbon	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(i)	nickel / Ni OR platinum / Pt OR palladium / Pd			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(ii)	butane / $CH_3CH_2CH_2CH_3$	C_2H_5 for CH_3CH_2	JUST "C_4H_{10}"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(e)(i)	$CH_3CHBrCH_2CH_3 + 2NH_3 \rightarrow CH_3CHNH_2CH_2CH_3 + NH_4Br$ OR $CH_3CHBrCH_2CH_3 + NH_3 \rightarrow CH_3CHNH_3^+CH_2CH_3 + Br^-$	$CH_3CHBrCH_2CH_3 + NH_3 \rightarrow CH_3CHNH_2CH_2CH_3 + HBr$		1

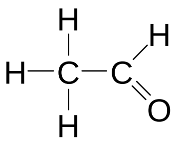
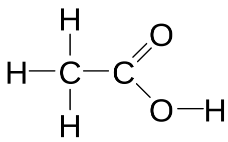
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(e)(ii)	excess / concentrated / ethanolic ammonia	heat in sealed tube	Just "heat" Just "sealed tube"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(e)(iii)	$\frac{74.4}{12} : \frac{14.7}{1} : \frac{10.9}{14}$ (1)(= 6.2: 14.7: 0.779) $\frac{6.2}{0.779} : \frac{14.7}{0.779} : \frac{0.779}{0.779}$ = 8:19:1 so $C_8H_{19}N$ (1)	Correct answer alone scores (2)	dividing by atomic number scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(i)	$\Sigma\Delta H_f$ (products) - $\Sigma\Delta H_f$ (reactants) / [(-394) + (2 x –242)] – (-75) (1) = -803 (kJ mol^{-1}) (1)	correct answer without working scores (2) -561 (kJ mol^{-1}) scores (1)	any positive value scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(ii)	(under standard conditions) water condenses / is a liquid (more heat evolved)	Reverse argument **Water** is not in its standard state	Any answer in terms of average bond energies Just "conditions are not standard"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(iii) **Q** **W** **C**	Any 4 of: H_2 better because: cheaper per kJ (1) more energy per gram / less weight/mass to carry for same energy (1) no CO_2 /only H_2O produced (at point of use) (1) H_2 worse because: gas storage needs pressurised/large containers (1) which are heavy (1) needs to be cooled to very low temperature to be liquefied (1) Ignore problems with refuelling	 converse argument	 Just "cheaper" Just "more energy" Just "hard to store" Hydrogen is flammable/ dangerous/explosive	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(i)	 (1)  (1)	-OH for –O — H		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(ii)	structural formula of any tertiary alcohol (1) and its name (1) - must not contradict the formula and conditional on tertiary alcohol	2nd mark can be awarded if minor slip in formula or no formula given		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	(concentrated) sulphuric acid / H_2SO_4 OR phosphoric acid / H_3PO_4 OR aluminium oxide/Al_2O_3	pumice	Dilute H_2SO_4 Or $H_2SO_4(aq)$ Or Dilute H_3PO_4 50% H_2SO_4	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)(i)	$-CH_2CH_2-$ (1)	$-(-CH_2-CH_2-)_n-$	$-CH_2-$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)(ii)	bags / bottles / packaging / (food) containers / buckets / bowls	Electrical insulation /cling film/water pipes	Clothing, light fittings, ropes	1

6243/01A

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	Observation (white) solid (re-)forms higher up tube / white smoke (1) Inferences sublimes / sublimation (1) Ammonium / NH_4^+ (1) Ignore NH_3 /HCl	 Can be awarded if given in observation White sublimate (2)	White fumes/misty/ Gas/ precipitate NH_4Cl	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Observation red → blue (1) (and blue-no change) Inferences ammonia / NH_3 (1) - must follow obs. ammonium / NH_4^+ (1) – must follow obs/NH_3		 Ignore NH_4CL Just alkaline gas NO_3^- / NO_2^-	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	Observations white ppt / white suspension (1) dissolves / soluble / colourless solution (in ammonia) / disappears (1) Inference Cl^-/ chloride (1)	Goes cloudy/milky Goes clear	Cream / yellow ppt Any "solution" Partially soluble Chlorine Just "AgCl" Ignore NH_4CL	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)	It prevents other anions forming a precipitate OR (Nitric) acid destroys interfering anions.	Destroys carbonate /hydroxide/sulphite	Just "makes it acidic"	1

<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>
Table 1
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 as initial volume NOT 50 as initial volume
All subtractions correct (1)

[✓✓top RHS of Table 1]

Mean titre
For correct averaging of chosen values / choosing identical values and for recording the average correct to 2 or 3 dps or to nearest 0.05 cm^3 (1)
Do not penalise lack of 2nd d.p. in mean if this has been penalised in Table 1.
Allow loss of 2nd d.p. if zero

[✓by the mean in space <u>or</u> near the dotted line in paragraph below]
Accuracy
If the candidate has made an arithmetical error in the Table 1 volumes used in the mean or in averaging the examiner must calculate a new average.

For an averaging error simply calculate a new value using the candidate's chosen titres.
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 titres.

Calculate the difference between the candidate's mean titre and that of the examiner or supervisor.

Examiner's titre = 26.20 cm^3 (to be confirmed at standardisation)

Award marks for accuracy as follows.
<table>
<tr><td>Difference d =</td><td>±0.30</td><td>±0.40</td><td>±0.50</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
Award a mark on the range of titres used by the candidate to calculate the mean. 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 mark on the corrected titres used by the examiner to re-calculate the mean
<table>
<tr><td>Range of titres/cm^3</td><td>0.20</td><td>±0.30</td><td>±0.50</td></tr>
<tr><td>Mark</td><td>3</td><td>2</td><td>1</td></tr>
</table>
Examiner to show the marks awarded for accuracy and range as

d= value   r = value
✓6max   ✓3 max

Then the mark out of 12 written in margin.
[Overseas scripts: examiner to write "SR = titre value" on each script]
</td><td></td><td></td><td>12</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(i)	$\frac{\underline{\text{Mean titre}} \times 0.100}{1000}$ Mark is for answer to > 2sf. [Penalise sf once only in (i)-(iii)] Allow loss of 3rd s.f. if it would be a zero Ignore units even if wrong	Answer with no working.		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(ii)	Moles HCl in 25 cm^3 = Answer to (i) Moles HCl in 250 cm^3 = above moles x 10 Mark is for answer to > 2sf. [Penalise sf once only in (i)-(iii)] Allow loss of 3rd s.f. if it would be a zero Ignore units even if wrong	Answer with no working.		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iii)	1st answer to (ii) $\times \frac{1000}{2.5}$ (1) or 2nd answer to (ii) $\times \frac{1000}{25}$ (1) Correct value to > 2sf And units (if given) correct (1)	Correct value with no working (2) $^{1}/_{10}$ of correct value with no working (1)		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(i)	Titre will be very low / about $^{1}/_{10}{}^{th}$ of value obtained by student.(1) % error increases (1) Must follow 1st mark		Any indicator colour change reference. Less accurate	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(ii)	Water in pipette and/or burette would dilute solution/alter concentration (1) Water added to flask anyway so no effect on concentration of solution. (1)	Water does not affect amount HCl present.	Alter titre	2

<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
Three temperatures recorded in correct spaces.(1)

Each to at least 1 dp (1)

Change in temperature correctly calculated to at least 1 d.p. but allow loss of d.p's if zero (1)
Award marks for accuracy as follows.

<u>Home Centres</u>

Compare candidate's temperature change (corrected if necessary) with table
<table>
<tr><td>Range r =</td><td>6.0 – 7.5</td><td>5.5 -8.0</td><td>5.0 – 8.5</td></tr>
<tr><td>Marks</td><td>✓3</td><td>✓2</td><td>✓1</td></tr>
</table>
<u>International Centres</u>
Write supervisor's value "s=" on script
Compare candidate's temperature change (corrected if necessary) with table
<table>
<tr><td>Range</td><td>$\pm$ 0.8</td><td>$\pm$ 1.3</td><td>$\pm$ 1.8</td></tr>
<tr><td>Marks</td><td>✓3</td><td>✓2</td><td>✓1</td></tr>
</table>
</td><td></td><td>Negative value</td><td>6</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	$\frac{25 \times 1.0}{1000}$ = 0.025 ONLY	Answer with no working.		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	$\frac{50 \times 4.18 \times \Delta T}{1000}$ (kJ) OR 50 x 4.18 x ΔT (J) Mark is for method IGNORE sf, sign both of ΔT and answer and units (even if wrong)	Correct answer with no working		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iii)	$\frac{\text{Answer to (ii)}}{\text{Answer to (i)}}$ Value consequential on (ii). (1) If units given, must be kJ mol^{-1} or kJ Sign – negative only – stand alone (1) 2 sf – only award if correct method (1)			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iv)	any two Use pipette / burette not measuring cylinder. (1) Use a more precise /more accurate / / digital thermometer (1) Use more concentrated solutions (1)	Add NaOH in small volumes & plot volume /temp graph Lid on polystyrene cup	Repeat expt. Larger volumes	2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4.</td><td>Method 1
✔ 1 Collect gas in gas syringe/over water/diagram (1)

✔ 2 Mix $CaCO_3$ + HCl/reagents (1)

✔ 3 When no more bubbles evolved / syringe stops moving/reaction complete(1)

✔ 4 Record volume of gas collected (1)
✔ 5 Moles $CO_2 = \frac{\text{volume } CO_2 (cm^3)}{24{,}000}$
OR
Moles $CO_2 = \frac{\text{volume } CO_2 \ dm^3}{24}$ (1)
✔ 6 Moles HCl = 2 x moles CO_2 (1)
✔ 7 Concentration HCl $= \frac{1000 \text{ x moles HCl}}{\text{Vol HCl used}}$ (1)</td><td>

No more CO_2 evolved

Record syringe volume (at start and end) for 2 marks</td><td>Unworkable diagram negates 1st mark

Adding a little at a time</td><td>7</td></tr>
<tr><td></td><td>Method 2
✔ 1 Weigh $CaCO_3$ (1)
✔ 2 Mix $CaCO_3$ + HCl / reagents (1)

✔ 3 When reaction is complete / no more bubbles evolved / no more effervescence. (1)
✔ 4 Filter off, dry and weigh $CaCO_3$ (1)
✔ 5 Moles $CaCO_3$ reacted $= \frac{\text{mass } CaCO_3 \ \textbf{reacted}}{\text{100 or RMM}}$ (1)
✔ 6 Moles HCl = 2 x moles $CaCO_3$ (1)
✔ 7 Concentration HCl $= \frac{1000 \text{ x moles HCl}}{\text{Vol HCl used}}$ (1)</td><td>

No more CO_2 evolved</td><td>Adding a little at a time</td><td></td></tr>
<tr><td></td><td>Method 3
✔ 1 Mix $CaCO_3$ + HCl / reagents (1)

✔ 2 Weigh immediately / tare balance (1)

✔ 3 When reaction is complete / no more bubbles evolved / no more effervescence / no more weight loss (1)
✔ 4 Re-weigh flask + reaction mixture / record loss of mass if tared (1)
✔ 5 Moles $CO_2 = \frac{\text{mass } CO_2 \text{ loss in mass}}{44/\text{RMM}}$ (1)
✔ 6 Moles HCl = 2 x moles CO_2 (1)
✔ 7 Concentration HCl $= \frac{1000 \text{ x moles HCl}}{\text{Vol HCl used}}$ (1)</td><td>

No more CO_2 evolved</td><td>Adding a little at a time</td><td></td></tr>
</table>

Materials

Each candidate will require:

(a)* 1.5 g of ammonium chloride labelled **A**. The identity of this compound is **not** to be disclosed to candidates;

(b)* 100 cm^3 of aqueous hydrochloric acid of concentration 1.050 mol dm^{-3} labelled **Solution B for Questions 2 and 3**. The concentration of this solution 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)* 50 cm^3 of aqueous sodium hydroxide of concentration 1.00 mol dm^{-3} labelled **Solution E**;

(e) 6 cm^3 of dilute sodium hydroxide; concentration approximately 0.5 mol dm^{-3};

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

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

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

(i) Phenolphthalein indicator;

(j) Red and blue litmus paper;

(k) A supply of distilled water.

6243/02

Reject all titration methods

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	From orange to green or blue	to blue-green or green-blue	Yellow	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(i)	Sulphur dioxide/sulphur(IV) oxide/SO_2	Sulfur dioxide Sulfur(IV) oxide		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(ii)	any two of Butan-1-ol or $CH_3CH_2CH_2CH_2OH$ (1) Butan-2-ol or $CH_3CH(OH)CH_2CH_3$ (1) 2-methylpropan-1-ol or $(CH_3)_2CHCH_2OH$ (1) or Full structural formulae	C_2H_5 for CH_3CH_2 Partial names with correct formulae methylpropan-1-ol Penalise full structural formulae without H's once only in (b)(ii) and (iii) Penalise incorrect linkage (e.g. C-H-O) once in (b)(ii) and (b)(iii)	Butanol p-alcohol s-alcohol	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(iii)	2-methylpropan-2-ol OR full structural formula	$(CH_3)_3COH$ methylpropan-2-ol Penalise full structural formulae without H's once only in (b)(ii) and (iii) Penalise incorrect linkage once in (b)(ii) and (b)(iii)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(i)	Nitrate or NO_3^- OR Nitrite or NO_2^-	nitrate(V OR nitrate(III)	NO_3 and NO_2	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(ii)	Ammonia/NH_3 ECF on NH_4^+ only			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(iii)	(gas) turns (damp red) litmus blue No ECF, not standalone	White smoke with HCl (Universal) indicator/pH paper goes blue	White fumes or white mist	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d) **Q** **W** **C**	Dip a nichrome or platinum or flame-testing wire or silica rod (1) in (conc.) hydrochloric acid then the solid and then into a (hot Bunsen) flame. (1) Lithium (gives) crimson (flame) (1) Sodium (gives) yellow (flame) (1)	Dissolve salt in HCl and then put in flame carmine or red or magenta or scarlet orange	Spatula chromium (wire) glass rod Into yellow or luminous (Bunsen) flame Heat	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a) **Q** **W** **C**	(Transfer solid to a beaker &) dissolve in distilled or deionised water (1) Use of volumetric flask (1) Add washings from **weighing bottle** (and beaker) (1) Make up solution to the mark (1) Mix **final** solution (1) If dissolved in 250 cm^3 **3 max** rinse weighing bottle (1) Use of volumetric flask (1) Mix **final** solution (1)]	Dissolve in volumetric flask rather than beaker Standard or graduated flask Rinse weighing bottle to 250 cm^3 or line Invert flask	Just ‘water’ Flask Up to the meniscus	5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	M_r (Na_2CO_3) = 106 (1) Amount (Na_2CO_3) = $\frac{2.45}{106}$ Conc. = $\frac{2.45}{106}$ ÷ 0.250 (1) = 0.0925 (mol dm^{-3}) (1) *Answer must be to 3* SF	ECF for wrong M_r or amount Correct answer with some working 0.0924 and ECF		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(i)	From yellow to orange	Yellow to salmon pink Yellow to peach	Pink alone and any other colours	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(ii)	$\frac{(28.60 + 28.70)}{2}$ = 28.65 (cm^3)	Correct answer without working	28.80 and 28.7 (cm^3)	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(iii)	Amount of Na_2CO_3 = 0.0925 x $\frac{25.0}{1000}$ (1) Moles HCl in titre = 2 x 0.0925 x $\frac{25.0}{1000}$ (1) Conc HCl = $\frac{2 \times 25.0 \times 0.0925}{28.65 \text{ or value from (ii)}}$ = 0.161 (mol dm^{-3}) (1) [*Penalise 1 SF only)*] If alternative conc used: Amount of Na_2CO_3 = $\frac{1.50 \times 25.0}{1000}$ (1) Moles HCl in titre = 2 x 1.50 x $\frac{25.0}{1000}$ (1) Conc. HCl = $\frac{2\text{x}25.0\text{x}1.50}{28.65 \text{ or value from(ii)}}$ = 2.62 (mol dm^{-3}) (1)	Correct answer with some working and ecf ('M' for mol dm^{-3})		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(i)	Reaction exothermic or Reactants might evaporate	Prevent oxidation of HBr or Br^- (to bromine or Br_2)	Vigorous or violent or Side reactions occur	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(ii)	Heated round or pear-shaped flask (1) Correct vertical condenser inc. water direction (1) Gas-tight joint & open apparatus (1)	↑ Heat Horizontal lines on flask (at joint) Just arrows to indicate water direction	Just ↑ or just 'heat' or direct heating with a Bunsen or conical flask Horizontal lines at the top of condenser Distillation	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(iii)	Immiscible (with water) or do not mix	Immiscible with aqueous solution Insoluble in water	"Different densities" on its own	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(iv)	Drying agent or to dry product	To remove water	Dehydrate or Dehydrating agent	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(v)	**Either** Use electrical heater or sand bath (1) 1-bromopropane is flammable (1) **Or** wear gloves (1) 1-bromopropane harmful by skin absorption (1) 2nd mark conditional on 1st	 Water bath Flammable mixture OR propan-1-ol flammable sulphuric acid corrosive (1)	 Keep away from naked flame as 1-bromopropane is flammable Organic liquids flammable 1-bromopropane is harmful to skin	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	Moles propan-1-ol = $\frac{7.55}{60.0}$ (1) Mass 1-bromopropane = $\left(123 \times \frac{7.55}{60.0}\right)$ = 15.5 g (1) IGNORE SF	$7.55 \times \frac{123}{60.0} = 15.5$ g scores full marks Correct answer with some working	15.4 (from 7.5/60 or truncated)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	$100 \times 8.3 \div 123 \times \frac{7.55}{60.0} = 53.6$ % IGNORE SF	$100 \times \frac{8.3}{15.5} = 53.5\%$ ECF	Yield > 100%	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iii)	Transfer losses or other products formed or side reactions or (reaction) not complete		Experimental error or spillages Evaporation (from reflux)	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(i)	To determine the (minimum) volume of acid needed (for complete neutralisation of the alkali)	Amount of acid needed To ensure equal moles of acid & alkali used	To find [HCl]	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(ii)	Temperature equilibration or steady temperature	Same or settled or room temperature		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(i)	Mass = 25 + 22.75 = 47.75 (1) or in equation below 47.75 x 4.18 x 10.5 = 2096 (J) (1) (=2100 (J)) consequential on calculated mass	Correct answer with some working (2) Use of incorrect mass (e.g. m = 1 g) can gain 2nd mark Answer changed to kJ		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(ii)	Moles (water)= $\frac{25 \times 1.5}{1000}$ = 0.0375 (1) $\triangle H = (-)\frac{2096}{(1000 \times .0375)}$ (1) = –55.9 (kJ mol^{-1}) (1) both value, in kJ mol^{-1}, and sign needed [ignore SF]	Correct answer -55.9 or -56.0 kJ mol^{-1} with some working (3) $\triangle H = (-)\frac{2100}{(1000 \times .0375)}$ (1) = –56.0 (kJ mol^{-1})(1) scores full marks Conversion to kJ can be at final stage		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	Any one of No heat is lost (to the surroundings) OR Polystyrene cup or thermometer have negligible heat capacity OR All the acid was transferred (from the beaker) to the polystyrene cup	Takes up negligible heat		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5. **Q** **W** **C**	Stated volume (25 – 100 cm^3) or equal volume (of solutions) **used in each reaction** (1) Calculated mass or equal mass of **Mg used in each reaction** (1) Mix and **stir** (1) Measure initial and final temperature (1) Bigger $\triangle T$ (therefore bigger $\triangle H$), therefore bigger **difference** in reactivity (1)	10 –150 cm^3 amount Temperature rise OR highest temperature References to specific reaction(s) (but these must be correct) e.g. biggest ΔT with $CuSO_4$ or smallest ΔT with $Zn(NO_3)_2$	Just 'excess Mg'	5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(i)	Ionic	Giant ionic or electrovalent		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(ii)	Covalent	Giant covalent	Co<u>n</u>valent	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(i)	Basic	Base or alkali or alkaline		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(ii)	Acidic	Acid Weakly acidic Weak acid		1

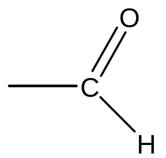
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(i)	$3Na_2O + 2H_3PO_4 \rightarrow 2Na_3PO_4 + 3H_2O$ OR $Na_2O + H_3PO_4 \rightarrow Na_2HPO_4 + H_2O$ OR $Na_2O + 2H_3PO_4 \rightarrow 2NaH_2PO_4 + H_2O$ (1) Ignore state symbols			1

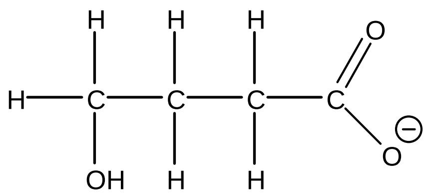
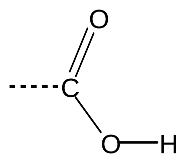
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)(ii)	$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$ **(1)** Ignore state symbols	$SiO_2 + 2OH^- \rightarrow SiO_3^{2-} + H_2O$		1

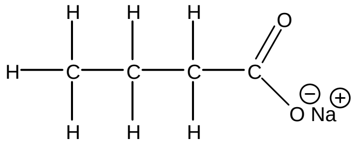
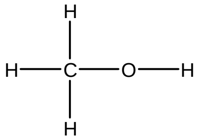
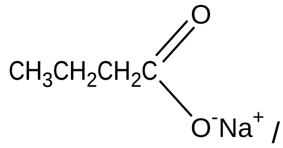
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)	**First mark:** $Al_2O_{3(S)} + 6H^+_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 3H_2O_{(l)}$ **(1)** *This mark is for correct species and balancing* **Second mark:** $Al_2O_{3(S)} + 2OH^-_{(aq)} + 3H_2O_{(l)} \rightarrow 2Al(OH)^-_{4\,(aq)}$ OR $Al_2O_{3(S)} + 6OH^-_{(aq)} + 3H_2O_{(l)} \rightarrow 2Al(OH)^{3-}_{6\,(aq)}$ OR $Al_2O_{3(s)} + 2OH^-_{(aq)} \rightarrow 2AlO^-_{2\,(aq)} + H_2O(l)$ **(1)** *This mark is for correct species and balancing* **Third mark is for the state symbols** **(1)** Correct state symbols in **either** equation, *but all species must be correct.* *This mark may be awarded from an unbalanced equation.*	Two correct 'molecular' equations with correct state symbols scores (2)		3

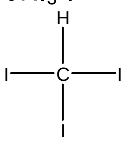
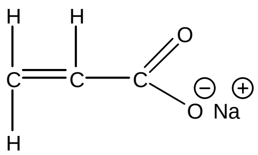
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)	$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$ Ignore state symbols	$PbO_2 + 6HCl \rightarrow H_2PbCl_4$ $Cl_2 + 2H_2O$		1

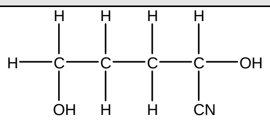
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)	**First mark**: Tin more stable in the +4 oxidation state (than the +2 oxidation state) whereas lead more stable in the +2 oxidation state (than in the +4 oxidation state) OR +2 oxidation state becomes more stable **relative to +4** oxidation state as group descended. **(1)** **Second Mark:** (So) I_2 **reduced** to I^- (by Sn^{2+}) OR $Sn^{2+} + I_2 \rightarrow Sn^{4+} + 2I^-$ OR Therefore tin(II) is a strong(er) reducing agent (than lead(II)) **(1)**	redox reaction between Sn^{2+} and I_2 OR Sn^{2+} oxidised (to Sn^{4+}) OR Sn(II) acts as (a strong) reducing agent	Sn^{2+} ions less stable than Pb^{2+} OR Pb(II) is more stable than Sn(II)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	*IGNORE 'alkane'* in any answer X : ester **(1)** Y : **both** alkene **and** alcohol or hydroxyl **(1)** Z : **both** alcohol or hydroxyl **and** aldehyde **(1)**	 carbon-carbon double bond "hydroxy" "hydroxy"	 carbonyl ***OH****⁻* or "hydroxide" ***OH****⁻* or "hydroxide" or "carbonyl" Just the formula 	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	X : no reaction **(1)** Y : no reaction **(1)** Z :  **(1)** do not award if the bond from the carbon atom is **clearly** to the H of the OH group	 $-O^- Na^+$ or -ONa	Any formula with the alcohol group oxidised	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(i)	$CH_3CH_2CH_2COONa$ / $CH_3CH_2CH_2COO^-Na^+$ /  **(1)** Allow C_3H_7 / $C_2H_5CH_2$ CH_3OH /  **(1)**	 / $CH_3CH_2CH_2COO^-$ / $CH_3CH_2CH_2CO_2Na$ / $CH_3CH_2CH_2CO_2^-Na^+$	Carboxylic acid Or ...O^-—Na^+	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(ii)	CHI_3 /  **(1)**  / $CH_2CHCOONa$ / CH_2CHCO_2Na / /$CH_2CHCOO^-Na^+$ / $CH_2CHCO_2^-Na^+$ /CH_2=$CHCOONa$ /CH_2=$CHCO_2Na$ /CH_2=$CHCOO^-Na^+$ /CH_2=$CHCO_2^-Na^+$ **(1)**	CH_2CHCOO^- Allow carboxylic acid as product e.g. $CH_2CHCOOH$		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)(iii)	 /$CH_2(OH)CH_2CH_2CH(CN)OH$ / $CH_2(OH)CH_2CH_2CH(OH)CN$ **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(i)	To slow down the reaction/to stop the reaction OR to quench the reaction OR to freeze the (position of) equilibrium *OWTTE* **(1)** so that the (equilibrium) concentrations/amounts do not change **(1)**	To stop equilibrium shifting to the left		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(ii)	**First mark:** $\left[H_{2(g)}\right]=\left[I_{2(g)}\right]$ OR Use of $(5.0\times10^{-4})^2$ **(1)** **Second mark:** $\left[HI_{(g)}\right]^2=\frac{\left(5.0\times10^{-4}\right)^2}{0.019}$ OR $0.019 = \frac{(5.0\times10^{-4})^2}{[HI_{(g)}]^2}$ OR $[HI(g)] = \sqrt{\frac{(5.0 \times 10^{-4})^2}{0.019}}$ **(1)** **Third mark:** $\left[HI_{(g)}\right] = 3.6 \times 10^{-3}$ (mol dm^{-3}) **(1)** Correct answer scores 3 marks. Ignore state symbols. Ignore units unless wrong. Ignore s.f.	If [HI] not squared, first mark only.	If first mark not awarded, total **(0)**.	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	$K_p = \dfrac{p_{HI}^2}{p_{H_2} \times p_{I_2}}$ Ignore position of any **( )**		**[ ] scores (0)**	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	*Each step of this calculation must be looked at.* 1st mark is for calculating equilibrium moles $H_2 = 0.2$ $I_2 = 0.2$ $HI = 1.6$ **(1)** 2nd mark is for dividing these by 2 (to get mole fractions) $x_{H_2} = \dfrac{0.2}{2.0} = 0.1$ $x_{I_2} = \dfrac{0.2}{2.0} = 0.1$ $x_{HI} = \dfrac{1.6}{2.0} = 0.8$ **(1)** 3rd mark is for multiplying by 1.1 (to get partial pressures) $P_{H_2} = \dfrac{0.2}{2.0} \times 1.1$ $= 0.11$ (atm) $P_{I_2} = \dfrac{0.2}{2.0} \times 1.1$ $= 0.11$ (atm) $P_{HI} = \dfrac{1.6}{2.0} \times 1.1$ $= 0.88$ (atm) **(1)** 4th mark is for substituting into their expression and calculating K_p $K_P = \dfrac{(0.88)^2}{(0.11) \times (0.11)}$ $= 64$ **(1)** *Ignore s.f.* *Correct answer with no working scores (1)*	Mark consequentially Mark consequentially Mark consequentially If moles HI given as 0.8, K_p = 16 max **(3)**		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iii)	Same number of moles on each side OR (Total) pressure cancels OR (Pressure) units cancel (May be shown by crossing out etc. in b(ii))	'Powers cancel' OR 'They cancel' OR 'Same number of molecules on each side'	'**Partial** pressures cancel' OR 'mol dm^{-3} cancel'	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(i)	ΔH_6			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)(ii)	$\frac{\Delta H_5}{2} OR \frac{1}{2}\Delta H_5$		ΔH_5	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)	Either $\Delta Hf = \Delta H_2 + \Delta H_3 + \Delta H_4 + \Delta H_5 + \Delta H_6$ OR ΔHf = (+178)+(1735)+2×(+218)+2×(-73) + (-2389) $= -186$ (kJ mol^{-1}) (1) Correct answer with no working (2) *Ignore kJ*	[First mark only if doubles both ΔH_{at} and electron affinity for hydrogen] [2nd mark is only consequential on failure to multiply either ΔHat or electron affinity or both giving: —404 / —113 /—331 (kJ mol-1)]	+186 scores **(0)** +404 / +113 /+331 scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	**EITHER** **First mark:** Magnesium/Mg **ion** smaller (radius) than calcium/Ca **ion** Or the sum of the ionic radii in MgH_2 smaller (than in CaH_2) **(1)** **Second mark:** but charges the same **(1)** **Third mark:** (so) stronger (forces of) **attraction** between **ions** (in MgH_2) **(1)** [Correct reverse arguments can score both marks] **OR** **First and second mark combined:** $Mg^{2+}(ion)$ or $Mg^{2+}(cation)$ smaller (radius) than Ca^{2+} **(2)** **Third mark:** (so) stronger (forces of) **attraction** between **ions** (in MgH_2) **(1)** [Correct reverse arguments can score both marks] Ignore references to polarisation of the hydride ion or "covalent character" in the hydrides. Ignore references to "energy required to separate ions/break bonds"	Magnesium ion has greater charge density than calcium ion for first mark. "stronger **ionic** bonding" for 3rd mark in either case.	Reference to 'atoms' or 'molecules' or 'H_2' scores zero **overall**. If "H^+ ions" or "hydrogen ions" referred to, 3rd mark cannot be awarded in either case If just "stronger bonding in MgH_2", 3rd mark cannot be awarded in either case	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)(i)	Enthalpy/energy/heat change when 1 mol of **gaseous ions** (1) Is dissolved in (a large) excess of water Or Is dissolved until further dilution causes no further heat change (1) Ignore any reference to "standard conditions" Mark independently	Heat released….. $X^+(g) + aq \rightarrow X^+(aq)$ **and** statement of energy change per mole for first mark. "Added to water" or "reacts with water " instead of "dissolved" "Infinitely dilute solution" "Is completely surrounded by water molecules"	Any implication of endothermic, do not award 1st mark "Dissolves completely"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)(ii)	δ^-O (in water) attracted to positive ions/cations (1) δ^+H (in water) attracted to negative ions/anions (1)	'forms (dative) bonds' instead of 'attracted' Just "attraction between water (molecules) and ions" (1 max)	Reference to full charges on water molecules scores zero overall "energy required" or implication of an endothermic process scores (0) overall. Dipole-dipole attractions and/or "polarisation" scores zero overall	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(i)	One acid: $CH_3CH_2COOH(aq)$ Conjugate base: $CH_3CH_2COO^-(aq)$ (1) Other acid: $H_3O^+(aq)$ Conjugate base: $H_2O(l)$ (1) Ignore state symbols	Accept correct acids with conjugate bases in either order		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(ii)	WEAK: dissociates/ionises to a small extent (1) OWTTE ACID: proton donor (1)	'Few molecules dissociate' 'Incomplete' or 'partial' dissociation "Does not fully dissociate" Produces H_3O^+ / hydrogen / H^+ ions	"ions partially dissociate" Just "contains H_3O^+ ...."	2

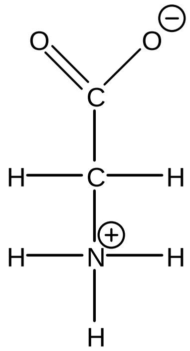
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(i)	$Ka = \frac{[CH_3CH_2COO^-][H_3O^+]}{[CH_3CH_2COOH]}$	$[H^+]$ instead of $[H_3O^+]$	Any expression containing $[H_2O]$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)(ii)	($[H^+]$ =) 3.63×10^{-4} (mol dm^{-3}) (1) Or $10^{-3.44}$ $[CH_3CH_2COOH] = \frac{[H^+]^2}{1.30 \times 10^{-5}}$ Or $[CH_3CH_2COOH] = \frac{(3.63 \times 10^{-4})^2}{1.30 \times 10^{-5}}$ (1) = 0.010 (1) (mol dm^{-3}) (1) <u>ASSUMPTIONS:</u> **First assumption mark:** negligible $[H^+]$ from ionisation of water Or $[CH_3CH_2COO^-] = [H^+]$ (1) **Second assumption mark:** Ionisation of the (weak) acid is negligible Or $x - [H^+] \approx x$ where x is initial concentration of CH_3CH_2COOH Or [H+]<<[HA] (1)	If K_a expression incorrect in (b)(i) or $[H^+]$ not squared, only 1st mark available "No other source of H^+ ions" "**Very** slight ionisation ..." "the initial [HA] = equilibrium [HA]"	**Just** "$CH_3CH_2COO^- = H^+$" (ie no square brackets) Any mention of non-standard conditions or 'temperature not at 298 K'	5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(c)	$CH_3CH_2COO^- + H_2O \rightleftharpoons / \rightarrow CH_3CH_2COOH + OH^-$ Or $CH_3CH_2COONa + H_2O \rightleftharpoons / \rightarrow CH_3CH_2COOH + NaOH$ (1) OH^- ions **produced** cause the solution to be alkaline (1) Mark independently	$CH_3CH_2COO^- + H^+ \rightleftharpoons CH_3CH_2COOH$ **and** causes the following eqm to shift to the right $H_2O \rightleftharpoons H^+ + OH^-$ Causing an **excess** of OH^- ions (1)	"OH^- ions from water"	2

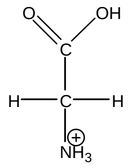
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(d)(i)	Ignore "A solution of known pH which…." maintains **nearly** constant pH OR resists change in pH (1) OWTTE on adding **small amounts** of acid or alkali **(1)** Mark independently			2

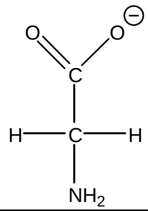
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(d)(ii)	Working MUST be checked **First mark:** $[H^+] = K_a \times \frac{[acid]}{[salt]}$ (1) **Second mark:** Correct [acid] = 0.0025 and [salt] = 0.00375 (1) **Third mark:** Calculation of pH correct consequential on [acid] and [salt] used. $[H^+] = 1.30 \times 10^{-5} \times \frac{0.0025}{0.00375}$ $= 8.67 \times 10^{-6}$ (mol dm^{-3}) pH = 5.06 (1) Ignore sig fig OR **First mark:** $pH = pK_a - \log_{10}\frac{[acid]}{[salt]}$ (1) **Second mark:** Correct [acid] = 0.0025 and [salt] = 0.00375 (1) **Third mark:** Calculation of pH correct consequential on [acid] and [salt] used. $pH = 4.89 - \log_{10}\frac{[0.0025]}{[0.00375]}$ (1) $= 4.89 - (-0.18)$ $= 5.07$ (1) Ignore sig fig	$K_a = \frac{[H^+] \text{x} [salt]}{[acid]}$ If [salt] and [acid] inverted, pH is 4.71 (2 marks) Inverted with the original concentrations, pH = 5.19 (1 mark) In both cases, if [acid] = [0.0100] and [salt] = [0.00500], pH = 4.59 (2 marks) 5.06		3

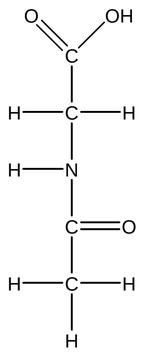
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(a)(i)	 Positive charge must be on the N atom The minus charge must be on the O in the C—O if no delocalisation shown	Delocalised carboxylate group with a negative charge shown	Compressed structural formula	1

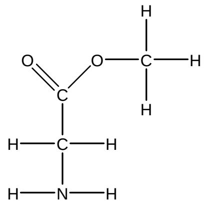
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(a)(ii)	(H^+ from) COOH (group) protonates the $-NH_2$(group)	Transfer of H^+ from COOH to NH_2 Or “self-protonation”	Just “protonation” Just “acid-base reaction”	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(a)(iii)	**Read the whole answer!** **High energy** needed to overcome (strong) **ionic** attractions (1) **between** zwitterions (1) Ignore reference to “molecules” if clearly used in the context of attraction between ions	“ionic bonds” or “ionic lattice” instead of “ionic attractions” **between** adjacent species	**Just** “intermolecular forces” Or H bonding Or van der Waals’ forces etc award zero overall	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(i)	$^{+}NH_3CH_2COOH$ / $^{+}H_3NCH_2COOH$ / $^{+}H_3NCH_2COOH$ OR written right to left OR 	$-CO_2H$ OR $-NH_3^{+}Cl^{-}$ Or $-NH_3Cl$	Molecular formula	1

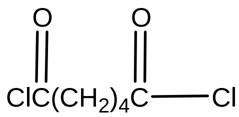
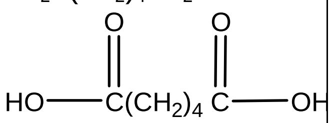
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(ii)	$NH_2CH_2COO^{-}$ / $NH_2CH_2CO_2^{-}$ / 	$-COONa$ or $-COO^{-}Na^{+}$	Molecular formula	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(iii)	$CH_3CONHCH_2COOH$/ 	$CH_3CONHCH_2CO_2H$ OR 'no reaction' **(1)**	Molecular formula	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(b)(iv)	$NH_2CH_2COOCH_3$ / 	$NH_2CH_2CO_2CH_3$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(i)	(Glutamic acid molecule) has four different groups attached to a C (atom) Or (Glutamic acid molecule) has four different groups attached to a chiral centre OR has mirror images which are not superimposable	Contains an asymmetric carbon (atom) Or molecule has no plane of symmetry	**Just** "has a chiral centre" Or **Just** "the molecule is asymmetrical"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(c)(ii)	(the isomers) rotate the plane (or polarisation) of (plane-) polarised light (1) in **opposite** directions (1) Ignore any reference to polarimeter	"….rotate plane polarised light"	Just "in different directions"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6.(d)	$H_2N(CH_2)_6NH_2$ (1) $ClOC(CH_2)_4COCl$ /  (1) [Monomers can be given in either order]	$NH_2(CH_2)_6NH_2$ $HOOC(CH_2)_4COOH$ / $HO_2C(CH_2)_4CO_2H$ /  $COOH(CH_2)_4COOH$ Or $COCl(CH_2)_4COCl$		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(i)	Cr [Ar] $3d^5 4s^1$ **and** Cr^{3+} [Ar] $3d^3$ OR $4s^1 3d^5$ **and** $3d^3$ OR $3D^5 4S^1$ **and** $3D^3$ OR $4S^1 3D^5$ **and** $3D^3$ OR $3d_5 4s_1$ **and** $3d_3$ OR $4s_1 3d_5$ **and** $3d_3$ OR $3D_5 4S_1$ **and** $3D_3$ OR $4S_1 3D_5$ **and** $3D_3$ ALLOW $1s^2 2s^2$…etc for [Ar] provided it is complete and correct			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(ii)	octahedral **(1)** 6 electron pairs around Cr (ion) **(1)** these repel to a position of minimum repulsion / maximum separation **(1)**	diagram for name 6 bonds, could be drawn on diagram	bonds/atoms repelling	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(iii)	(gelatinous) green ppt **(1)** (dissolves) to green solution **(1)**	green solid any shade of green		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)(iv)	$[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow Cr(OH)_3(H_2O)_3 + 3H_2O$ OR $[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow Cr(OH)_3 + 6H_2O$ **(1)** $Cr(OH)_3(H_2O)_3 + 3OH^- \rightarrow [Cr(OH)_6]^{3-} + 3H_2O$ OR $Cr(OH)_3 + 3OH^- \rightarrow [Cr(OH)_6]^{3-}$ **(1)** Ignore state symbols	equations with NaOH eg 3NaOH on LHS $3Na^+$ on RHS If $3H_2O$ is missing from RHS of both equations, allow **(1)** for both correct Cr species on RHS	Cr^{3+}(aq)	2

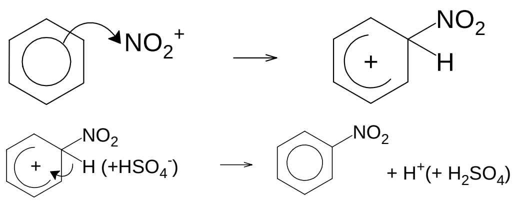
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(i)	**Reactant (1)** **Product (1)** Formula of a: Formula of a: primary alcohol → aldehyde primary alcohol → carboxylic acid secondary alcohol → ketone aldehyde → carboxylic acid		molecular formulae names with no formulae COH for aldehyde, unless structure shown as well	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(ii)	$E\,cell^{\theta}$ for MnO_4^- reacting with Cl^- = (+) 0.15 (V) **(1)** $E\,cell^{\theta}$ for $Cr_2O_7^{2-}$ reacting with Cl^- = - 0.03 (V) OR E^o_{cell} for Cr^{3+} reacting with Cl_2 = (+)0.03(V)**(1)** MnO_4^- will oxidise Cl^-/HCl so HCl cannot be used OR $2MnO_4^- + 16H^+ + 10Cl^- \rightarrow 2Mn^{2+} + 8H_2O + 5Cl_2$ so HCl cannot be used **(1)** $Cr_2O_7^{2-}$ will not oxidise Cl^-/HCl so HCl can be used **(1)**			4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(iii)	oxidation number of Cr remains at **+6** ALLOW this mark if the oxidation numbers are written under the species in the equation		gain or loss of electrons oxidation number does not change if it is not specified or is incorrect	1

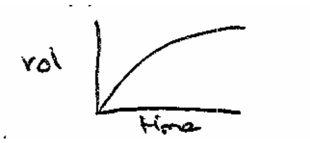
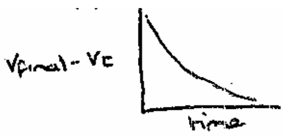
2.	ACCEPT NAMES OR FORMULAE FOR REAGENTS IF BOTH ARE GIVEN, BOTH MUST BE CORRECT. CONDITION MARKS ARE ONLY AVAILABLE FOR CORRECT REAGENTS

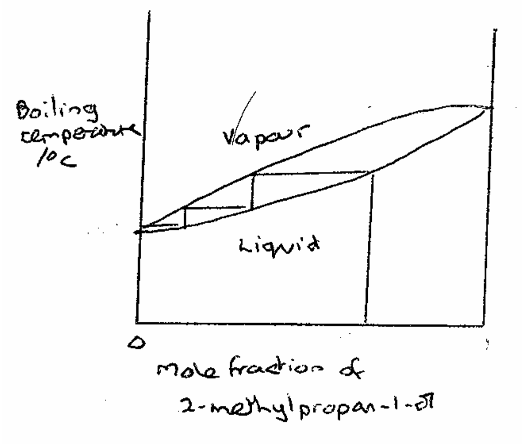
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)(i)	concentrated nitric acid **(1)** concentrated sulphuric acid **(1)** [penalise lack of "concentrated" once] temperature 40-60^oC **(1)** stand alone	concentrated + formulae "c" for concentrated any temperature or range of temperatures within this range	 more than 40^oC less than 60^oC	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)(ii)	$HNO_3 + H_2SO_4 \longrightarrow H_2O + HSO_4^- + NO_2^+$ **(1)** Can be shown in two stages OR $HNO_3 + 2H_2SO_4 \longrightarrow H_3O^+ + 2HSO_4^- + NO_2^+$ **(1)**  Curly arrow from ring towards (space between C in ring and) N in NO_2^+ **(1)** Correct intermediate **(1)** Curved arrow from C – H bond back into ring **(1)**	arrow to or from charges Kekule structures if HSO_4^- is used in the last step, arrow must come from O curly arrow from within ring		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	tin and **conc** hydrochloric acid **(1)** IGNORE heat or any stated temperature reduction OR loss of oxygen and gain of hydrogen **(1)**	Fe or Zn and **conc** HCl H_2 + Pt/Ni/Pd	$LiAlH_4$ redox	2

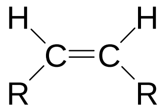
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	sodium nitrite/ $NaNO_2$ **and** hydrochloric acid/HCl (aq) **(1)** 0-10^oC **(1)** benzene diazonium chloride **(1)**	sodium nitrate(III) dilute or concentrated acid any temperature or range of temperatures within this range	just "HCl" temperature value qualified by "below"/ "above"	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	collect gas in gas syringe/over water in graduated apparatus or diagram **(1)** measure volume of gas at regular time intervals **(1)** label volume and time on axes **(1)** sketch including horizontal finish/final volume **(1)**  1st half life is time taken to half final volume, 2nd half life is time from half to ¾ these could be shown on graph **(1)** Half lives constant (therefore 1st order) **(1)** STAND ALONE ALTERNATIVE FOR LAST 4 MARKS measure final volume and calculate $(V_{final}-V_t)$ **(1)** Label $(V_{final}-V_t)$ and time on axes **(1)** sketch **(1)**  find at least 2 half lives, first order if half lives are constant **(1)** **OR** collect gas in gas syringe/over water in graduated apparatus or diagram **(1)** find volume of gas after fixed time and calculate rate = vol/time **(1)** repeat for different values of [X] **(1)** label rate and [X] on axes **(1)** sketch straight line **(1)** rate proportional to [X], so first order **(1)** Mass loss method could be applied to any of above	If [BDC] measured only the following marks are available: Label [BDC] and time on axes **(1)** Sketch **(1)** find at least 2 half lives, first order if half lives are constant **(1)** For pH method only the following marks are available: use a pH probe **(1)** measure pH at regular time intervals **(1)** half lives constant **(1)** If candidate mixes answers, mark them as if separate and award the highest mark		6

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	 vapour and liquid lines reasonably drawn with no maximum or minimum **(1)** Sloping up to the right **(1)** areas labelled **(1)**	If diagram slopes up to left, could still score other two marks If 109°C labelled at lower temp than 82°C, can only score liquid and vapour mark	Straight liquid or vapour line	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	draws more than 1 tie line, starting at 0.75, connected by verticals (and heading correctly towards the lower bp component) **(1)** states that (equilibrium) vapour is richer in the more volatile component / propan-1-ol **(1)** STAND ALONE describes repeated distillations (with correct reference to tie lines) **(1)** give rise to (first) distillate of pure propan-1-ol / 2-methylpropan-1-ol left in the flask **(1)**			4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	Ester(s) **(1)**	triester(s) triglyceride(s)	Ether(s) lipid(s)	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(i)	Any example e.g. **(1)**  [R can be any group/atom other than hydrogen, R can be the same or different] both hydrogen atoms on the same side OR both larger groups on the same side **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)(ii)	saturates pack more closely together than unsaturates (due to cis isomers) **(1)** saturates have higher/stronger dispersion/Van der Waals' forces than unsaturates (so more energy is required to melt) **(1)**		breaking single / double / σ / π bonds	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)(i)	3 RCOONa / $RCOO^- Na^+$**(1)** $CH_2OHCH(OH)CH_2OH$ **(1)**	RCO_2Na Full structural formulae	Covalent bond shown between O and Na. RCOOH $C_3H_8O_2$	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)(ii)	Making/manufacture of: soap/soapy detergents or soap production **(1)**		saponification	1

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4.(d)(i)</td><td>Any one from:
<table>
<tr><th>Reagent
(1)</th><th>2-methylpropan-2-ol
obs (1)</th><th>propanoic acid
obs(1)</th></tr>
<tr><td>$NaHCO_3$</td><td>no change</td><td>effervescence</td></tr>
<tr><td>Na_2CO_3</td><td>no change</td><td>effervescence</td></tr>
<tr><td></td><td></td><td></td></tr>
</table>
Observation marks conditional on correct reagent

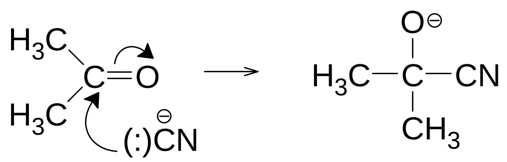
IGNORE references to heat</td><td>Answer involving formation of an ester, identified by smell, for either acid or alcohol

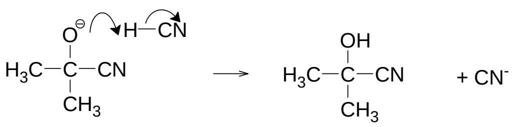
Description of test for CO_2 instead of effervescence</td><td></td><td>3</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4.(d)(ii)</td><td>Any one from:
<table>
<tr><th>Reagent
(1)</th><th>Propanal
obs (1)</th><th>Propanone
obs (1)</th></tr>
<tr><td>Fehlings’</td><td>blue to red ppt</td><td>no change</td></tr>
<tr><td>Tollens’</td><td>silver mirror/ppt</td><td>no change</td></tr>
<tr><td>$Cr_2O_7^{2-}/H^+$</td><td>orange to green/blue/ brown</td><td>no change</td></tr>
<tr><td>I_2 + NaOH</td><td>no change</td><td>yellow ppt</td></tr>
</table>
Observation marks conditional on correct reagent
IGNORE references to heat</td><td>Benedicts

Ammoniacal $AgNO_3$

MnO_4^-/H^+ with correct colour changes</td><td></td><td>3</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4.(e)(i)</td><td>

Each arrow (1) (1)


(1) both arrows</td><td>CN^- or ^-CN
arrows start from negative charge on O or C

arrow to H^+ or to HCN in 2nd step</td><td></td><td>4</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>4.(e)(ii)</td><td>higher $[H^+]$ (1)

(so) lower $[CN^-]$ and rate slower (1)</td><td></td><td></td><td>2</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(i)	electrode – platinum/Pt **(1)** Fe^{2+} and Fe^{3+} **(1)** 1 mol dm^{-3} **(1)** conditional on both ions being present			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(ii)	to bring the solutions to the same potential/connect solutions without setting up a p.d. **(1)**	to allow the movement of ions OR to complete the circuit	to allow flow of electrons	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(iii)	(saturated) potassium chloride OR (saturated) potassium nitrate **(1)**	Formulae Sodium nitrate or chloride		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(iv)	x – 0.34 = 0.43 **(1)** x = +0.77 V **(1)** Correct answer with some working **(2)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(v)	$Fe^{3+} + e^- \rightarrow Fe^{2+}$ OR $Fe^{3+} + e^- \rightleftarrows Fe^{2+}$ **(1)** $Cu \rightarrow Cu^{2+} + 2e^-$ OR $Cu \rightleftarrows Cu^{2+} + 2e^-$ OR $Cu - 2e^- \rightarrow Cu^{2+}$ OR $Cu - 2e^- \rightleftarrows Cu^{2+}$ **(1)** [not cq on (iv)]	e for electron		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(a)(vi)	$Cu + 2Fe^{3+} \rightarrow 2Fe^{2+} + Cu^{2+}$ **(1)**	$2Fe^{2+} + Cu^{2+} \rightarrow Cu + 2Fe^{3+}$ if both half equations in opposite direction in (v)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(b)	½ O_2 +2e^- +H_2O ⇄/→ 2OH^- species **(1)** balance **(1)** ignore state symbols	multiples		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5.(c)	Moles $S_2O_3^{2-}$ = $\left(\frac{16.5}{1000}\right)$x0.1 = 1.65x$10^{-3}$ **(1)** (Moles I_2 = $\frac{1.65\text{x}10^{-3}}{2}$ = 8.25x10^{-4}) Moles Cu^{2+} = 1.65x10^{-3} **(1)** Conc $CuSO_4$ = 1.65x10^{-3} x$\left(\frac{1000}{25}\right)$ = 0.066(mol dm^{-3}) **(1)** Penalise incorrect unit			3

6246/01A

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	Observation: green (1) Inference: d-block (1)	Transition series/metals		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Observation: white ppt in limewater (1) black (residue) (1) Inference: Carbon dioxide/CO_2 (1) Carbonate/CO_3^{2-} (1)	Goes cloudy/milky hydrogencarbonate /bicarbonate/ HCO_3^-		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	green solution **and** effervescence		**CO_2** evolved	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(i)	Observation: Any blue ppt (1) (Deep/Dark) blue solution (1) Inference: copper(II)/ Cu^{2+}/ copper (2+) (1)		Copper/copper (II) hydroxide	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(ii)	Observation: Brown (precipitate) (1) Black (coloration) (1) Inference: Iodine / I_2(1) Redox (1)	Blue/black Oxidation/reduction of **S**/Cu^{2+}	Blue alone **I** Just “reduction”	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)(i)	$CuCO_3$	$Cu(HCO_3)_2$ cq on 1(b)	Copper carbonate	1

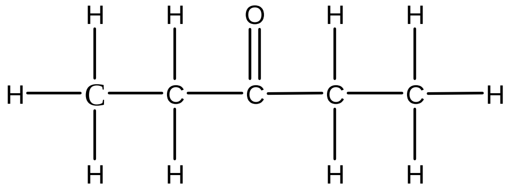
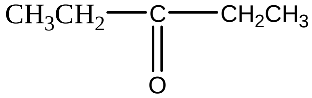
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)(ii)	O.N. in S: +2 (1) O.N. in product of test (d) (ii): +1 (1)	II/2/2+/Cu^{2+} I/1/1+/Cu^+		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	Observation: Orange/yellow ppt (1) Inference: Carbonyl/>C=O/C=O/aldehyde or ketone (Both needed) (1)	Orange/yellow solid	Goes orange/goes yellow	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	Observation: Remains orange (1) Inference: Not oxidised (1) Ketone (1) No consequential marking	No change No (observable) reaction Not oxidisable/ not a reducing agent Allow "not aldehyde" if BOTH are given in (a)	"nothing"	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	M^+= 86 (1)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	2 environments for protons/hydrogen (atoms) (1)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)(i)	 (1)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)(ii)	Because there are 6 H atoms in one environment and 4 in the other the ratio of H atoms in different environments is 6:4 (1) Dependent on 2 (e) (i)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	Check subtractions and averaging arithmetic, correcting if necessary All volumes read to 0.05 cm^3 (1) All subtractions complete (1) ✓✓top RHS of Table 1 **Mean titre** For correct averaging of chosen values/choosing identical values and for recording the average correct to 2 or 3 dps or to nearest 0.05 cm^3 [unless already penalised] Allow loss of 2nd dp if zero ✓ by the mean titre (1) **Accuracy** If the candidate has made an arithmetical error in Table 1 volumes used in the mean or in averaging, the examiner must calculate a new average. • For an averaging error simply calculate a new value using the candidate's chosen titres • 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 titres Calculate the difference between the candidate's mean titre and that of the examiner or supervisor Record the difference on the scripts as d = *** Examiner's titre TO BE CONFIRMED BY LOCAL SUPERVISOR Examiner to write SR= titre value on each script Award marks for accuracy as follows:	 Allow 1 slip but withhold this mark if any readings are in the wrong boxes Accept 0; 0.0; 0.00 as initial volume	 Reject 50 as initial volume	10

	Difference ± 0.20 (4) Difference ± 0.30 (3) Difference ± 0.40 (2) Difference ± 0.60 (1) Difference >0.60 (0) **Range** Award a mark on the range of titres used by the candidate to calculate the mean. 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 mark on the corrected titres used by the examiner to recalculate the mean. Range ± 0.20 (3) Range ± 0.30 (2) Range ± 0.50 (1) Range > 0.50 (0) Examiner to show the marks awarded for accuracy and range as d = ✓4 *max* r= ✓3 *max*			

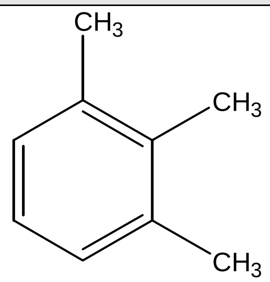
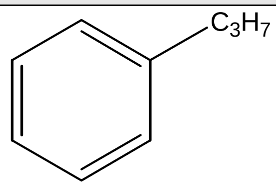
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	**Calculations** Moles MnO_4^- = 5.00 X10^{-4} (mol) (1) Moles of NO_2^-= 1.25 X 10^{-3} (mol) (1) Molar conc.= $\frac{1.25 \text{ X } 10^{-3}}{\text{titre}/1000}$ mol dm^{-3} (1) Mass conc. = molar conc. X 69 g dm^{-3} (1) [cq. on third mark]	Final answers to > 2 sig fig		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(i)	Blue solution (1) Brown gas (1)			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)(ii)	titre value too low (1) Because NO_2 lost / sodium nitrite decomposed (by acid) (1) Dependent on 3 (c) (i)	goes down/becomes smaller	Reject "titre wrong/ inaccurate"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	low hydrogen:carbon ratio	It is not C_nH_{2n+2} / Too few hydrogen atoms.		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)	equal masses/amounts (of C_9H_{12}) (1) react with bromine water/solution (1) expect equal volumes/amounts (1) for bromine colour to remain/until no more decolourisation (1)	Allow equal volumes		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	 Or other isomers			1

Materials

Each candidate will require:

(a) 1 g of basic copper carbonate, $CuCO_3.Cu(OH)_2$ labelled S. The identity of this must **not** be disclosed to candidates;

(b) 1 cm^3 of aqueous potassium iodide; concentration approximately 0.5 mol dm^{-3};

(c) 200 cm^3 of aqueous potassium manganate(VII), labelled **Solution R**; concentration 0.0200 mol dm^{-3};

(d) 200 cm^3 of aqueous sodium nitrite, labelled **Solution Q**; concentration 4.00 g dm^{-3}. The concentration of this must **not** be disclosed to candidates;

(e) 200 cm^3 of dilute sulphuric acid; concentration approximately 1 mol dm^{-3}. This is to be used in both Question 2 and Question 3;

(f) 5 cm^3 of limewater;

(g) 2 cm^3 of aqueous potassium dichromate(VI); concentration approximately 0.2 mol dm^{-3};

(h) 4 cm^3 of propanone, labelled **P**. The identity of this must **not** be disclosed to candidates. **P** is being used to represent another ketone;

(i) 15 cm^3 of dilute hydrochloric acid; concentration approximately 1 mol dm^{-3};

(j) 10 cm^3 of dilute aqueous ammonia; concentration approximately 2 mol dm^{-3};

(k) a supply of distilled water;

(l) 1 cm^3 of aqueous starch indicator; concentration approximately 1% w/v;

(m) 2 cm^3 of 2,4-dinitrophenylhydrazine reagent. This may be made as follows: Suspend the powdered 2,4-dinitrophenylhydrazine (1 g) in a mixture of concentrated hydrochloric acid (80 cm^3) and water (100 cm^3). Warm gently on a water bath. Cool the solution and add water (120 cm^3). Filter if necessary. Centres may use an alternative preparation provided the reagent gives a precipitate with the propanone.

NOTES

Materials S, **R**, **Q** and **P** must be measured into dry, stoppered containers. Further quantities may be issued to candidates without penalty.

Containers should be labelled with the name, but not necessarily the concentration, of the reagent unless otherwise instructed.

Candidates may be supplied with laboratory reagent bottles containing these solutions if these are available.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	$CH_3COOH + C_2H_5OH \rightleftarrows CH_3COOC_2H_5 + H_2O$ **(1)**	CH_3CO_2H $\rightarrow$ CH_3CH_2 for C_2H_5	$CH_3OCOC_2H_5$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	catalyst /speed up reaction **(1)**		dehydrating agent	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	flask with still head **(1)** condenser and a receiver **(1)** thermometer at correct place **(1)** penalty of (1) if apparatus sealed or open at the wrong place or doesn't work for some other reason.			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)	mol ethanoic acid = $\frac{12.6(0)}{60}$ = 0.21 **(1)** (mol ethyl ethanoate = 0.21) theoretical mass ethyl ethanoate = 0.21 x 88 = 18.48 g or 18.5g **(1)** % yield = $\frac{10.60}{18.48}$ x 100 = 57 **(1)** Allow 57.29 or 57.36 or 57.4 OR Theoretical mol ethanoic acid = $\frac{12.60}{60}$ = 0.21**(1)** (mol ethyl ethanoate = 0.21) actual moles of ethyl ethanoate = $\frac{10.6}{88}$ = 0.12 **(1)** % yield = $\frac{0.12}{0.21}$ x100 = 57 **(1)** Allow 57.1 or 57.14 CQ ON FORMULAE IN (a) but these must be possible compounds. IGNORE S.F.			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)(i)	C_2H_5OH + CH_3COCl $\rightarrow$ $CH_3COOC_2H_5$ + HCl **(1)**	CH_3CH_2 for C_2H_5 $\rightleftharpoons$	$CH_3OCOC_2H_5$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)(ii)	Reaction with ethanoic acid reaches equilibrium/is reversible OR Reaction with ethanoyl chloride is not reversible/goes to completion **(1)**		Reaction with ethanoic acid is incomplete	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(i)	(Phenyl benzoate) must be soluble in the hot solvent and less/almost insoluble in cold solvent **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(ii)	to remove **insoluble/un-dissolved** impurities **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(iii)	to remove solid from soluble impurities **(1)**		Just 'collect the product'.	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(iv)	to wash away remaining solution/soluble impurities /remove surface impurity. **(1)**			1

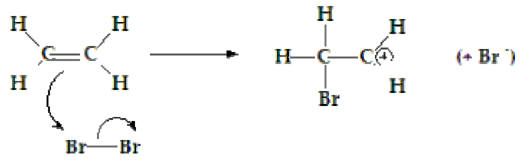
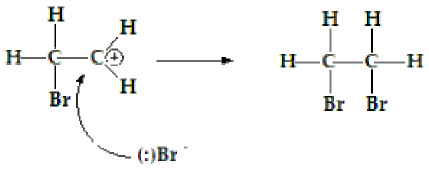
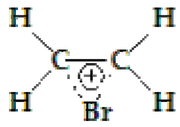
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)(v)	measure melting temperature **(1)** check value same as data book/sharp melting point **(1)** OR Use gas-liquid chromatography **(1)** Showing only one peak **(1)**		Mix with known sample and measure melting temperature. Any other instrumental method.	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	ionic lattice **(1)** Na^+ ions have 6 nearest neighbours of Cl^- ions and vice-versa / 6:6 co-ordination **(1)**	Labelled sketch can score both marks but must have some 3D extension.		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	electrostatic attractions (in solid NaCl) overcome **(1)** by the attractions between the ions and dipoles in water **(1)** ; this can be shown in a diagram. OR Water has a high dielectric constant/relative permittivity **(1)** which reduces the forces of attraction between ions in the solution **(1)**	Attractions overcome by solvation of ions scores **(1)** only		2

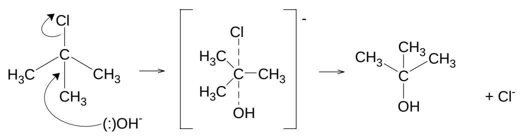
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	$NaCl(s)\ (+aq) \rightarrow Na^+(aq) + Cl^-(aq)$ $Na^+(g) + Cl^-(g)\ (+aq)$ Cycle **(1)** Arrows labelled with names or values **(1)** *Check arrow direction agrees with label/sign of the value* ΔH_{soln} = -406-364-(-771) = +1 (kJ mol^{-1}) **(1)** **+** sign not essential		Negative value	3

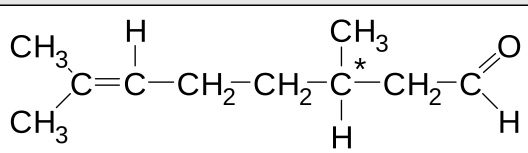
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	sodium hydroxide/NaOH **(1)** hydrogen / H_2 **(1)** anode $2Br^- \rightarrow Br_2 + 2e^{(-)}$ OR $2Br^- - 2e^{(-)} \rightarrow Br_2$ **(1)** or halved.		H Br	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)(i)	 both arrows **(1)** carbocation structure **(1)**  arrow **(1)**	 as intermediate lone pair not essential, arrow can start at – on Br^- and go to + on C		3

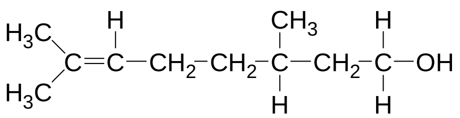
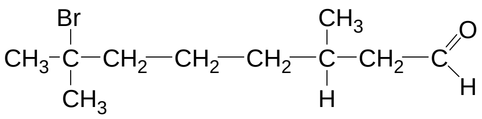
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)(ii)	initial attack (on ethene) is by an electrophile/$Br^{\delta+}$ **(1)** no Cl^+ / $Cl^{\delta+}$ available as the electrophile (so no dichloroethane formed) **(1)** then (nucleophilic) attack by Br^- **(1)** Cl^- can replace Br^- (as nucleophile, so 1-bromo-2-chloroethane is formed) **(1)**			4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(i)	$[(CH_3)_3CCl]$ increases by 1.5 while $[OH^-]$ remains constant, rate increases by 1.5 OR In expts A and B, $[(CH_3)_3CCl]$ increases by 1.5 and rate increases by 1.5 **(1)** so first order **(1)** $[OH^-]$ zero order, with some explanation **(1)**			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)(ii)	$(CH_3)_3C{-}Cl \longrightarrow (CH_3)_3C^+ + Cl^-$ (1) arrow (1) both ions $(CH_3)_3C^+ \; (:)OH^- \longrightarrow (CH_3)_3C{-}OH$ (1) arrow Must be S_N2 mechanism if 1st order wrt OH^- in (i)**:**  each arrow (1) x 2 intermediate (1)		S_N1 mechanism if $[OH^-]$ first order	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	 (1)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	**alkene** (aqueous) bromine **(1)** orange to colourless**(1)** OR (aqueous) potassium manganate(VII) (ignore alkaline/acid) **(1)** purple to colourless/brown **(1)** **aldehyde** any one matching pair from: reagent **(1)** observation **(1)**: Fehling's solution — blue (soln) to red/brown ppt Tollens' reagent — silver mirror or black ppt	 Benedict's, same observation. Ammoniacal $AgNO_3$, same obs.	 Purple to green. 2,4 DNP	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iii)	(with $NaBH_4$)  (1) (with HBr)  (1)			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(iv)	$C_{10}H_{18}O + 14O_2 \rightarrow 10CO_2 + 9H_2O$ **(1)** Ignore any state symbols Moles citronellal = 1.0/154 **(1)** = 6.49×10^{-3} Moles CO_2 = 10x 6.49×10^{-3} **(1)** = 6.49×10^{-2} Volume CO_2 = 24 x 6.49 $\times 10^{-2}$ = 1.56 dm^3 **(1)** allow 1.6 Allow cq from incorrectly balanced equation. Ignore sf OR 154g citronellal gives 240dm^3 CO_2 **(1)** Vol CO_2 from 1 g = 240/154 **(1)** = 1.56 dm^3 **(1)**			4

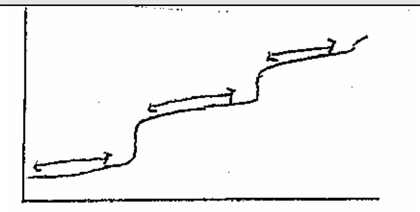
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(a)	silicon - giant atomic/ giant covalent /giant molecular/macromolecular **(1)** phosphorus **and** chlorine – (simple) molecular **(1)** covalent bonds broken in Si are stronger than intermolecular/dispersion/ Van der Waals'/ London/ induced dipole forces **(1)** phosphorus is P_4 and chlorine is Cl_2 **(1)** P_4 has more electrons (per molecule) so stronger dispersion (etc) forces **(1)**			5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(b)	PCl_4^+ tetrahedral **(1)** PCl_6^- octahedral **(1)** 4 or 6 pairs of electrons as far apart as possible to minimise repulsion **(1)**	correct 3-D diagrams		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(c)	name of any **specific** alcohol (**1**) $ROH + PCl_5 \rightarrow RCl + HCl + POCl_3$ **(1)** [R must apply to the specific alcohol] OR name of any **specific** carboxylic acid **(1)** $RCOOH + PCl_5 \rightarrow RCOCl + HCl + POCl_3$ (**1**) [R must apply to the specific acid]	equation with 'R' if mark lost for not giving a specific example	Just 'alcohol' Just 'acid'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(d)	$PCl_5 \rightleftharpoons PCl_3 + Cl_2$ eqm moles: 0.33 0.67 0.67 **(1)** mole fraction: $\frac{0.33}{1.67}$ $\frac{0.67}{1.67}$ $\frac{0.67}{1.67}$ **(1)** partial pressures: $\frac{0.33x4}{1.67}$ $\frac{0.67x4}{1.67}$ $\frac{0.67x4}{1.67}$ **(1)** = 0.79 =1.605 =1.605 $K_p = \frac{pPCl_3 \text{ x } pCl_2}{pPCl_5}$ **(1)** = 3.26 **and** atm**(1)** OR $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ 1/3 2/3 2/3 eqm moles **(1)** 0.2 0.4 0.4 mole fraction **(1)** 0.8 1.6 1.6 partial press **(1)** $K_p = \frac{pPCl_3 \text{ x } pCl_2}{pPCl_5}$ **(1)** = 3.2 atm **(1)**	If eqm moles PCl_5 = 0.67 and PCl_3=Cl_2=0.33 answer = 0.5 and can score last 3 marks If 1.6 used here then final answer is 3.24		5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(i)	$H_3PO_4 + 2NaOH \rightarrow Na_2HPO_4 + 2H_2O$ **(1)** OR $H_3PO_4 + 2OH^- \rightarrow HPO_4^{2-} + 2H_2O$ **(1)**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.(e)(ii)	 any point between ⟷			1

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