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Mark Scheme Summer 2009

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 OWTTE means or words to that effect

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

Quality of Written Communication

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

· show clarity of expression

· construct and present coherent arguments

· demonstrate an effective use of grammar, punctuation and spelling.

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

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Similarity: same number of protons OR same proton number OR 7 protons **(1)** Difference: different numbers of neutrons OR one has 7 and the other has 8 neutrons **(1)**	 varying number of neutrons	Just "same atomic number" OR Any mention of electrons negates first mark different mass number OR different number of nucleons	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	28, 29 and 30 OR +28, +29, +30 OR 28/1, 29/1, 30/1 OR 28:1, 29:1, 30:1 all 3 values correct **(2)** any 2 values correct **(1)**	28^+, 29^+, 30^+ OR $[28]^+$, $[29]^+$, $[30]^+$ OR $^{28}N_2^+$, $^{29}N_2^+$, $^{30}N_2^+$ all 3 correct **(1)**	If more than 3 values are given, deduct 1 mark for each additional incorrect value Eg 14, 15, 28, 29, 30 scores **(0)** 14, 28,29,30 scores **(1)**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	$^{14}_{7}N_2^+$ **(2)** N with 14 and 7 in correct places **(1)** 2 and + **(1)** IGNORE brackets	$(^{14}_{7}N\,^{14}_{7}N)^+$		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	3 bond pairs **and** 1 lone pair **(1)** **both** needed for the mark			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	Shape: (trigonal) pyramidal **CONDITIONAL** on 3bp and 1lp in (i) **(1)** Angle: 100-107° **(1)** any number or range within this range	 If shape is trigonal planar, allow 120° **(1)**	any other type of pyramidal just 'less than 107°'	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iii)	**1st mark** **pairs** of electrons as far apart as possible to minimise repulsion OR electron **pairs** repel to give maximum separation OR electron **pairs** adopt a position of minimum repulsion **(1)** IGNORE any specific number of pairs of electrons mentioned **2nd mark** lone pair-bond pair repulsion greater (than bond pair-bond pair which reduces the bond angle) **(1)**	bond / lone pairs for electron pairs lone pairs repel more than bond pairs **(1)** OR lone pair has greater repulsion **(1)** if candidate states there are no lone pairs allow 1 mark for 'angle is 120^{o}/as expected for trigonal planar'	atoms / bonds instead of pairs of electrons	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	**1st mark** too much energy is needed to promote a 2s electron on N to 3rd energy level OR N has no 2d orbitals OR N has no vacant orbitals in 2nd energy level/2nd energy level can hold max 8 electrons OR N cannot recoup the energy needed for electron promotion into next energy level/shell/orbit **(1)** **2nd mark** a 3s electron on P can be promoted into an empty 3d orbital (so can form 5 covalent bonds) OR P has vacant orbitals in 3rd energy level OR P can expand outer shell to accept extra electrons / 3rd energy level can hold 18 electrons OR P can recoup the energy needed for electron promotion (by forming 2 extra covalent bonds) OR P is large enough to accommodate 5 Cl (atoms) **(1)**	P can expand it's octet'	Any answer just based on: electronegativity difference, ions, dative covalent bonding **(0)** N or P **molecule** loses 1 mark N atom too small/smaller than P next orbital	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	**1st mark** nitrogen has weaker dispersion / van der Waals' / London forces / induced dipole / instantaneous dipole **(1)** **2nd mark** due to fewer electrons (in the molecule) **(1)** *conditional on 1st mark or 'near miss from reject column for 1st mark'*	reverse argument for phosphorus allow stronger/greater van der Waals' etc smaller electron cloud	any reference to dipole-dipole, hydrogen bonds, ionic bonds or breaking covalent bonds loses both marks **(0)** less/fewer/more van der Waals' etc OR van der Waals' bonds OR breaking bonds OR just 'weaker intermolecular forces' loses 1st mark smaller / lighter / lower mass molecule	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	**1st mark** ammonia has hydrogen bonding (and dispersion forces etc) **(1)** **2nd mark** phosphine has dispersion / van der Waals' / induced dipole-dipole / London forces **(1)** IGNORE permanent dipole-dipole **3rd mark** hydrogen bonding is **stronger** so more **energy** /**heat** is needed (to overcome hydrogen bonding than dispersion / van der Waals' forces) **(1)**	 allow 3rd mark even if phosphine has permanent dipole-dipole forces in 2nd mark	 **covalent** bonds broken loses 3rd mark only	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	$KCl + H_2SO_4 \rightarrow KHSO_4 + HCl$ OR $2KCl + H_2SO_4 \rightarrow K_2SO_4 + 2HCl$ **(1)** IGNORE any state symbols	multiples		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	hydrogen bromide / HBr bromine / Br_2 sulphur dioxide / SO_2 all three correct **(2)** any two correct **(1)**		Br if more than 3 given, deduct 1 mark for each additional incorrect gas but IGNORE steam / water	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	redox (reaction) OR reduction **and** oxidation OR reduction of sulphuric acid / H_2SO_4 OR oxidation of bromide (ion)/Br^-/hydrogen bromide/HBr **(1)**	acid-base both needed for the mark	just 'reduction' or 'oxidation' on their own displacement disproportionation	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iv)	**FIRST ALTERNATIVE** **1st mark** hydrogen bromide/ HBr is a better reducing agent (than HCl) OR more readily oxidised **(1)** **2nd mark** HBr bond weaker (than HCl bond) OR Br larger than Cl / outer shell is further from nucleus OR donates/loses outer electron more easily **(1)** **SECOND ALTERNATIVE** **1st mark** bromide ions / Br^- are better reducing agents OR more readily oxidised (than Cl^-) **2nd mark** Br^- larger/outer shell is further from nucleus(than Cl^-) OR donate/lose outer electrons more easily (than chloride ions) **(1)**	reverse argument for chloride **THIRD ALTERNATIVE** **1st mark** HBr/Br^- larger (than HCl/Cl^-) **(1)** **2nd mark** donates/loses outer electron more easily **(1)**	Cl^- ions are stronger oxidising agents than Br^- negates first mark Just 'bromides are larger than chlorides'	**2**

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	**C (1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	$(1s^2)2s^22p^63s^23p^64s^2$	$1s^2$ repeated subscripts capitals $p_x^2p_y^2p_z^2$ for p^6		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	**Type** metallic **(1)** **Explanation** attraction/attractive force **(1)** between Ca^{2+} **and** (surrounding) sea of electrons / delocalised electrons **(1)** Stand alone marks	 cations / positive ions / calcium ions	 'force/bonding between' if used instead of 'attraction' atoms / nuclei /ions protons	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	electrons are mobile / free to move /can flow (under an applied potential) **(1)**		'free' on its own OR carry the charge	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	Any two from: calcium 'bobs up and down' / sinks **(1)** effervescence / fizzing / bubbles **(1)** solution goes cloudy/milky OR (white) solid / ppt / suspension **(1)**		floats melts ignites pops moves on water just 'gas evolved'	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	amount (mol) Ca = $\frac{2.5}{40}$ = 0.0625 **(1)** vol H_2 = 24 x 0.0625 = 1.5 **dm^3** **(1)** conseq on their mol OR 40 g Ca produces 24 dm^3 H_2 **(1)** so 2.5 g Ca produces $\frac{24x2.5}{40}$ = 1.5 **dm^3** H_2 **(1)** unit is essential	 1500 **cm^3**	 incorrect units eg dm^{-3}, mol dm^{-3}, dm^3 mol^{-1} incorrect units eg dm^{-3}, mol dm^{-3}, dm^3 mol^{-1}	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i)	$Ca^{+}(g) \rightarrow Ca^{2+}(g) + e^{(-)}$ equation **(1)** state symbols **(1)** conditional on correct calcium species OR $Ca^{+}(g) - e^{(-)} \rightarrow Ca^{2+}(g)$ equation **(1)** state symbols **(1)** conditional on correct calcium species	$Ca^{+}(g) + e^{(-)} \rightarrow Ca^{2+}(g) + 2e^{(-)}$ equation **(1)** state symbols **(1)** conditional on correct calcium species OR a completely correct general equations including state symbols eg $M^{+}(g) \rightarrow M^{2+}(g) + e^{(-)}$ **(1)**		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	I.E decreases (down the group) **(1) – stand alone** **EITHER** outer electron further from the nucleus / electron in higher energy level / ionic radius increases **(1)** and electron better shielded / more (inner) shells of electrons **(1)** (more than) offsets larger nuclear charge / more protons **(1)** **OR** Increased shielding (and more protons) **(1)** results in similar effective nuclear charge **(1)** acting at a greater distance from outer electrons **(1)**	atomic radius increases		**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	$4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$ all species correct **(1)** balancing **(1)** conditional on all correct species $2NaNO_3 \rightarrow 2NaNO_2 + O_2$ correct species and balancing **(1)** IGNORE any state symbols	multiples or halves		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	**1st mark** Trend: (thermal stability) increases/ nitrates decomposes less readily (down the group) OR (thermal stability) decreases/nitrates decompose more readily **up the group (1)** If this mark is not awarded, 2nd and 3rd marks can still score Explanation: *Can be answered in terms of specific ions or down or up the group* **2nd mark** sodium **ion** and lithium **ion** have same charge OR group 1 ions have the same charge **(1)** **3rd mark** sodium ion is larger than lithium ion OR lithium ion is smaller than sodium ion OR group 1 ions increase in size down the group/decrease in size up the group **(1)** **4th mark** sodium / larger ion causes less polarisation / distortion of nitrate (ion) / NO_3^- / anion / negative ion OR lithium / smaller ion causes more polarisation / distortion of nitrate (ion) / NO_3^- / anion / negative ion **(1)**	Na^+ is larger than Li^+ scores 2nd and 3rd marks sodium is larger … if ion is stated for 2nd mark	just 'lithium ion has a higher charge density' for the 2nd mark elements get larger …. just 'NO_3^{2-}' OR any other incorrect formula for nitrate	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	amount (mol) Na_2O_2 = $\frac{1.0}{78}$ = 0.0128 **(1)** amount (mol) Na needed = 0.0128 x 2 = 0.0256 **(1)** mass Na needed = 0.0256 x 23 = 0.59 g **(1)** penalise incorrect unit *mark consequentially* OR 78 g **(1)** of Na_2O_2 produced from 46 g Na **(1)** 1.0g Na_2O_2 produced from $\frac{46}{78}$ = 0.59 g **(1)**	allow 2 or more s.f. in (i) and (ii) but only penalise 1 s.f. once		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	amount (mol) NaOH = 2 x 0.0128 = 0.0256 / 0.026 **(1)** *conseq on (i)*	78 g of Na_2O_2 gives 2 mol NaOH so 1 g gives 2/78 = 0.026 mol **(1)**	0.0256/0.026 g	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	conc NaOH = $\frac{0.0256 \times 1000}{50.0}$ **(1)** *conseq on (ii)* their answer, based on a calculation involving moles and volume, to 2 sf from 0.0256: 0.51 OR from 0.026: 0.52 (mol dm^{-3}) **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)	KIO_4 (+)7 OR VII **(1)** I_2O_5 (+)5 OR V **(1)**	7+ 5+		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	$2I^- \rightarrow I_2 + 2e^{(-)}$ OR $2I^- - 2e^{(-)} \rightarrow I_2$ **(1)** *IGNORE any state symbols*	multiples or half	2I	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	$2IO_3^- + 12H^+ + 10e^{(-)} \rightarrow I_2 + 6H_2O$ correct LHS **(1)** correct RHS **(1)** *IGNORE any state symbols*	multiples or half if only error $10e^{(-)}$ on wrong side **(1)**		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(iii)	$IO_3^- + 5I^- + 6H^+ \rightarrow 3I_2 + 3H_2O$ OR $2IO_3^- + 10I^- + 12H^+ \rightarrow 6I_2 + 6H_2O$ **(1)** stand alone *conditional on (i) correct and consequential on(ii) PROVIDED there are electrons on correct sides in both half-equations and correct species* *IGNORE any state symbols*	multiples or half		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	$\triangle H$reaction=$\Sigma\triangle H_f$products−$\Sigma\triangle H_f$reactants Or = [4 x 90.4 + 6 x −242]−[4 x −46.2] (1) = -905.6/-906 ($kJmol^{-1}$) (1) correct answer without working scores (2) incorrect answer without working scores (0) correct answer with any other units scores (1) (+)905.6/(+)906($kJmol^{-1}$) scores (1) Any answer omitting just one stoichiometric factor scores (1) -1176.8, (+)304.4, -1044.2 Any answer omitting more than one stoichiometric factor scores (0) e.g. -105 $kJmol^{-1}$	$\triangle H$reaction= products-reactants kJ 3 or 4 s.f.		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	H_2O is not most stable/ standard state (under standard conditions) Or combustion is not complete Or Involves 4/ more than 1 mol NH_3 (1)	Water should be in liquid state	Just "Not standard conditions"	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	(Reaction is exothermic &) heat/ energy produced can maintain **catalyst** temperature (1)		Just "Reaction is exothermic"	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Platinum /Pt (-rhodium /Rh alloy) (1)		Mention of Rb (0)	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Catalyst does not affect position of equilibrium (1) Ignore references to rate of forward and reverse reactions increasing equally	No effect / none		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	Peak to the right **and** lower (1) higher temperature asymptote approaches *x* axis above that of the lower temperature (asymptote) (1)		High temperature curve - turns up at end - flattening off significally above low temperature curve - cuts low temperature curve again	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	First mark (Average) molecular (kinetic) energy/ speed increases (1) Second mark Number of/ proportion of/ more molecules/collisions with E>Ea increases OR reference to graph (1) Third mark **proportion** of collisions with sufficient energy for reaction increases (1) Award third mark only if second mark awarded unless penalising "atoms"	 Particles for molecules Particles for molecules More **of the** collisions are effective(1) Or More successful collisions per second	 Atoms/reactants Just "more with enough energy to react" Atoms/reactants (penalise once only) Just 'more successful collisions'	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iii)	First mark Equilibrium moves to the left (1) Second mark Because reaction is exothermic (1) No CQ on incorrect calculation in (a) (i) Second mark is conditional on first mark	 More reactants or less products formed (at equilibrium) Because reverse reaction is endothermic Allow "endothermic reaction is favoured"	 Just "endothermic side" Just "reverse reaction is favoured"	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iv)	First mark Equilibrium moves to the left (1) Second mark Because 9 mol (of gas) on LHS and 10 mol on RHS (1) Second mark is conditional on first mark	More reactants or less products formed (at equilibrium) More moles (of gas) on RHS / less on LHS		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(i)	The enthalpy change when 1 mole of water is produced (1) by the reaction between an acid/ sulphuric acid /H^+ and an alkali/ammonia /OH^- (1) (Ignore references to standard conditions /concentrations)	"Heat / heat energy / energy" instead of "enthalpy" "released" instead of "change" Allow base for alkali provided that "solution/ stated concentration" in answer	'Required' instead of "change"	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(ii)	$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ or $NH_3 + H_2SO_4 \rightarrow NH_4HSO_4$ Correct formulae of NH_3, H_2SO_4 and ammonium salt(1) balanced equation(1)	Equations involving NH_4OH Equations including ionic salt $H^+ + NH_3 \rightarrow NH_4^+$ scores (2)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	Sodium chloride / NaCl (1)		salt	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	1.Chlorine or Cl_2 (1) 2. Hydrogen or H_2 (1) 3. Sodium hydroxide (solution) or NaOH (1)	Cl_2 and H_2 reversed scores 1 out of the 2	Cl H	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iii)	$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$ Species (1) balance (1) (no CQ on incorrect species)	$2Cl^- + 2H_2O \quad 2OH^- + Cl_2 + H_2$ Allow 2 Na^+ as spectator ions multiples	$2H^+ + 2Cl^- \quad H_2 + Cl_2$	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iv)	Recycled (and more NaCl is added to restore concentration) (1)	Re-used		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$2Cl^- \rightarrow Cl_2 + 2e^-$ (1)	$2Cl^- - 2e^- \rightarrow Cl_2$ $Cl^- \rightarrow Cl + e^-$ **and** $2Cl \rightarrow Cl_2$ e for e^-	$Cl^- \rightarrow Cl + e^-$ alone $2H^+ + 2e^- \quad H_2$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	Oxidation because electrons are lost (award mark only if Cl^- on left in b(i)) OR oxidation number of **chlorine** increases / goes from -1 to zero (1) (must be consistent with oxidation shown in b(i))		Oxidation alone	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Sodium (ions) / Na^+ (1)	Hydrogen (ions) / H^+ OR cations	Na H / H_2	**1**

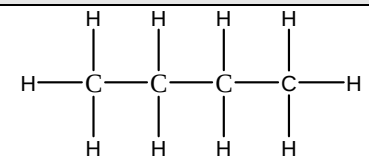
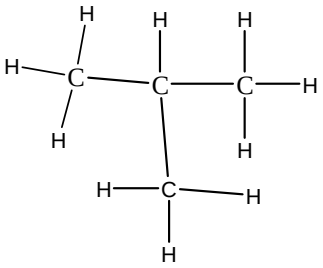
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Sodium chlorate(I) / NaOCl / NaClO (1)	Sodium hypochlorite	Sodium chlorate/$NaClO_3$ Sodium chloride / NaCl OCl^-	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	Any 2 of Water treatment Or **Disinfecting/sterilising** swimming pools (as a) bleach/ bleaching paper/ bleaching wood pulp in the **manufacture** of bleach disinfectants HCl poly(chloroethene) solvents herbicides pesticides trichloromethane tetrachloromethane high purity silicon dichloromethane CFC's **extraction** of bromine / Br_2	 PVC chloroform carbon tetrachloride methylene chloride Freons/ Halons	Just "as a disinfectant" Water purification Just "paper manufacture Removes bromine Br	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	<table><tr><td></td><td>C</td><td>H</td><td></td></tr><tr><td>%</td><td>82.8</td><td>17.2</td><td></td></tr><tr><td>Moles</td><td>82.8÷12 = 6.9</td><td>17.2÷1 = 17.2</td><td>(1)</td></tr><tr><td>Ratio</td><td>6.9/6.9 : 1: 2:</td><td>17.2/6. 9 2.49 5</td><td>(1)</td></tr></table>Either division through by 6.9 **or** the ratio of 1:2.49/1:2.5 must be shown to score second mark	% calculation: formula mass of C_2H_5 = 29 % C = 100 x 24÷29 = 82.8		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	(formula mass of) C_2H_5 = 29 (= 58 ÷ 2) (1) C_4H_{10} (1) standalone			**2**

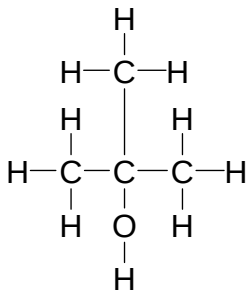
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	Alkanes		Alkene(s)	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iv)	  penalise CH_3 on structural formulae once only penalise "sticks" once only ignore any names (2)	$CH_3CH_2CH_2CH_3$ and $(CH_3)_3CH$ score (1) two correct skeletal formulae score (1)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	(Free) radical (1) substitution (1)			**2**

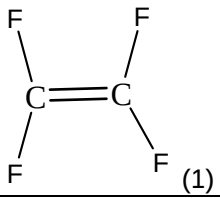
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Ultraviolet / UV (light) (1)	Sunlight or daylight or white light	Just "Light" or Just "heat"	**1**

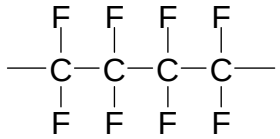
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Nucleophilic substitution (1) both words needed			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	 (1) Tertiary (1) standalone	"-OH" for "–O-H" 3^o / 3^y	CH_3 on structural formulae $(CH_3)_3COH$	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(i)	Ethanolic /alcoholic (solution) (1)	Alcohol /ethanol solvent or in alcohol /ethanol Anhydrous ethanol	Just "(in presence of)ethanol" / "alcohol"	**1**

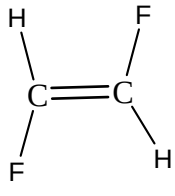
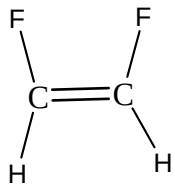
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(ii)	(Nucleophilic) Elimination (1)	Dehydrohalogenation	Dehydration Incorrect reagent descriptions e.g. electrophilic (elimination)	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Penalise use of "Fl" once only in (i) and (ii)  (1)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	 4 carbons with 8 fluorines(1) Continuation Bonds at each end (1) standalone (ignore brackets around repeating units and n)	Allow CQ on a tri-fluoroethene monomer only	Any polymer with a double bond between carbons scores 0 Just –C-C-C-C- does not score continuation bonds mark	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	Score 1 for correct use or property; second mark for property **linked** to given use			**2**

Use (1)	Property (1)	Reject
(non-stick) **Coating** for saucepans / frying pans/ garden tools	Low (coefficient of) friction or slippery	Just saucepans & frying pans
Valves / Bearings/ gears/ bushes/ (burette) taps	Low (coefficient of) friction or resistant to chemical attack	
printed circuit boards	Electrical Insulator	
Plumber's tape	Flows under compression or water repellent	Waterproof
Waterproof/ Gore-tex linings for boots / jackets/ socks	Water repellent	Waterproof

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	 (1)  (1) ignore bond angles ignore any cis/trans labels Do NOT penalise use of Fl for fluorine			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Restricted rotation about C C/ π bond It cannot rotate	Barrier to free rotation about C C/ π it No rotation about C C/ π it		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	1,1-difluoroethene has two identical groups/ atoms attached to the same carbon (while 1,2 difluorethene does not)	1,2-difluoroethene has two different groups/ atoms attached to each C atom (while 1,1-difluoroethene does not)(1)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	$CH_2CF_2 + H_2 \rightarrow CH_3CHF_2$ (1) OR Full structural formulae Do NOT penalise use of Fl for fluorine		$C_2H_2F_2 + H_2 \rightarrow C_2H_4F_2$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	(Very similar because) all (three) reactions involve breaking a C C /π bond **and** an H H (1) and forming 2 C H (1) bond enthalpies are similar (in the different compounds) (1) standalone	Same bonds broken and formed (1) out of the first two Both involve breaking C=C/π bond and forming C-H scores (1) Out of the first two	Energies of bonds same	**3**

6243/01A

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Observation Lilac**(1)** Inference Potassium / K^+**(1)**	Mauve / purple	K alone	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Observations Yellow precipitate **(1)** Insoluble (in NH_3) **(1)** Inference Iodide / I^- **(1)**		Iodine / I / iodine ion alone	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Observations Brown (solution)**(1)** Blue / Black / Blue-Black**(1)** Inference Iodine / I_2 **(1)**	Orange / yellow	I	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ **(1)** [Ignore state symbols]			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Black solid / purple vapour/ yellow solid / steamy fumes / misty / cloudy fumes	Fizzing / effervesence	Identity of products eg iodine Bad egg smell White smoke	**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>
Check subtractions and averaging arithmetic correcting if necessary.

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

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

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

Accuracy
If the candidate has made an arithmetical error in Table 1 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.

Calculate the difference between the candidate's mean titre and that of the examiner or supervisor.
Examiners' value = 25.40 cm^3
Record the difference as
d =…… on the script

<table>
<tr><td>d =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.60</td><td>±0.80</td><td>±1.00</td></tr>
<tr><td>Mark</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>
Award marks for accuracy as follows

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

<table>
<tr><td>r =</td><td>0.20</td><td>0.30</td><td>0.50</td><td>>0.50</td></tr>
<tr><td>Mark</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>
Examiner to show the marks awarded for accuracy and range as
d = value ✔ 6 MAX
r = value ✔ 3 MAX
</td><td></td><td></td><td>12</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$\frac{4.50}{90.0}$ = 0.0500 (mol dm^{-3}) If units given must be mol dm^{-3}. Penalise once only			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$\frac{25.0}{1000}$ x 0.050 = 1.25 x 10^{-3} / 0.00125 (mol) If units given must be moles.	Cq on (i)	0.0013	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	1.25 x 10^{-3} $\times$ 2 = 2.50 x 10^{-3} (mol) If units given must be moles.	Cq on (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv)	2.50 x 10^{-3} x $\frac{1000}{\text{Mean titre}}$ = concentration (mol dm^{-3}) Answer to 3SF. If units given must be mol dm^{-3}.	Cq on (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	It will halve it OR candidates mean titre divided by 2			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Less accurate because greater percentage/relative error			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	**Table 2** Full set of temperature readings **(1)** Readings to whole degree **(1)** (Penalise once only) [✔ ✔ Bottom RHS of Table 2]			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	**Graph** Temperature(y) scale - 2 cm at least 10° and allows for extrapolation if necessary **(1)** All points correctly plotted **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Correct extrapolation to 3 minutes **(1)** ΔT correctly follows from working **(1)** **Accuracy** Compare candidate's ΔT (corrected if necessary) with examiner's ΔT. Examiner's $\Delta T = 25^0C$ Show difference on script as d = Award accuracy marks as follows d = $\pm 2^0C$ | $\pm 3^0C$ | $\pm 5^0C$ **Mark** **3** | **2** | **1**	If no graph, $\Delta T = T_{MAX} - T_{MIN}$ for accuracy		**5**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	$\frac{50 \times 0.50}{1000} = 0.025$	Answer only		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(iii)	$50 \times 4.18 \times \Delta T$ J OR $\frac{50 \times 4.18 \times \Delta T}{1000}$ kJ [Cq on ΔT. Ignore sign]	Answer only with units		**1**

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	$CuSO_4$-higher concentration .		More/increase volume $CuSO_4$ More zinc.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**1** ✓ Add Zn to $CuSO_4$ (and stir) until blue colour disappears / reaction ends **2** ✓ Add H_2SO_4 to mixture. **3** ✓ Until no more bubbles / reaction ends **4** ✓ Filter off Cu. Wsh Cu **and** dry (until constant mass) **5** ✓ Weigh Cu **6** ✓ Moles Cu = $\frac{\text{mass Cu}}{63.5}$ **7** ✓ Conc^n $CuSO_4$ = moles $Cu(SO_4)$ x $\frac{1000}{50}$ **6** ✓**7** ✓ Stand alone OR **1** ✓ Weigh Zn **2** ✓ Add Zn to $CuSO_4$ and stir until blue colour disappears. **3** ✓ Add H_2SO_4 to mixture. **4** ✓ When no more bubbles / reaction ends measure volume H_2. **5** ✓ $\frac{\text{Volume } H_2}{24,000}$ = moles H_2 **6** ✓ Moles H_2 = moles Zn in excess and $\frac{\text{mass Zn at start}}{65.4}$ = moles Zn at start moles Zn that displace Cu = moles Zn at start – moles Zn in excess **7** ✓ Moles Zn that displace Cu = moles $CuSO_4$ Conc^n $CuSO_4$ = moles $CuSO_4$ x $\frac{1000}{50}$ **5** ✓**6** ✓**7** ✓ Stand alone			**7**

Group 1 (6243/01A): This practical test must be taken on the day specified on the official timetable, and is available to Home Centres, International Teaching Institutions and International Centres.

Apparatus and Materials

Apparatus

Each candidate will require:

1. two test tubes and one boiling tube in a test tube rack;
2. apparatus and materials for carrying out a flame test;
3. one 10 cm^3 measuring cylinder;
4. a supply of dropping pipettes;
5. spatula;
6. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
7. small beaker for draining burette;
8. 25.0 cm^3 pipette and safety filler;
9. white tile;
10. two 250 cm^3 conical flasks;
11. expanded polystyrene cup held securely in a 250 cm^3 beaker;
12. one 50 cm^3 or 100 cm^3 measuring cylinder;
13. timer;
14. a thermometer, range 0–100 °C (or similar), graduated in 1.0 °C intervals or a thermometer that can be read to an accuracy of at least 1.0 °C.

Materials

Each candidate will require:

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

(b)* 200 cm^3 of aqueous sodium hydroxide of concentration 0.0975 mol dm^{-3} labelled **Solution B**. The concentration of this solution is **not** to be disclosed to candidates.

(c)* 200 cm^3 of aqueous ethanedioic acid of concentration 0.0500 mol dm^{-3} labelled **Solution C** [this may be prepared by dissolving 6.30 g of solid ethanedioic acid dihydrate, $(COOH)_2.2H_2O$ per dm^3 of solution. Candidates will be given the mass of the **anhydrous** acid per dm^3 of solution.];

(d)* 70 cm^3 of aqueous copper(II) sulphate of concentration 0.50 mol dm^{-3} labelled **D**;

(e)* between 2.4 g and 2.5 g of powdered zinc in a stoppered container labelled **zinc**;

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

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

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

(i) access to a bottle of concentrated aqueous ammonia;

(j) 2 cm^3 of aqueous sodium chlorate(I) (approximately 5% available chlorine) labelled **aqueous chlorine**;

(k) 2 cm^3 of freshly prepared aqueous starch;

(l) phenolphthalein indicator;

(m) a supply of distilled water.

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

6243/01B

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Observations Yellow precipitate **(1)** Insoluble (in NH_3) **(1)** Inference Iodide / I^- **(1)**		 Iodine / I / iodine ion alone	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Observations Brown (solution)**(1)** Blue / Black / Blue-Black **(1)** Inference Iodine / I_2 **(1)**	Orange / yellow	 I	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	$Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$ [Ignore state symbols]			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Black solid /purple vapour / yellow solid / steamy fumes/ misty / cloudy fumes	Fizzing / effervesence	Identity of products eg iodine Bad egg smell White smoke	**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>
Check subtractions and averaging arithmetic correcting if necessary.

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

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

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

Accuracy
If the candidate has made an arithmetical error in Table 1 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.

Calculate the difference between the candidate's mean titre and that of the examiner or supervisor.
Examiners' value = 25.40 cm^3
Record the difference as
d =…… on the script

Award marks for accuracy as follows
<table>
<tr><td>d =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.60</td><td>±0.80</td><td>±1.00</td></tr>
<tr><td>Mark</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>

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

<table>
<tr><td>r =</td><td>0.20</td><td>0.30</td><td>0.50</td><td>>0.50</td></tr>
<tr><td>Mark</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$\frac{3.90}{40.0}$ = 0.0975 (mol dm^{-3}) If units given must be mol dm^{-3} Penalise once only			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$\frac{\text{Mean titre}}{1000}$ x 0.0975 = answer (mol) If units given must be mol	Cq on (i)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	$\frac{\text{Answer to (ii)}}{2}$ = answer (mol) If units given must be mol	Cq on (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv)	Answer to (iii) x $\frac{1000}{25.0}$ = concentration (mol dm^{-3}) Answer to 3sf. If units given must be mol dm^{-3}.	Cq on (iii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	It will halve it OR candidates mean titre divided by 2			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Less accurate because greater percentage/relative error			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	**Table 2** Full set of temperature readings **(1)** Readings to whole degree **(1)** (Penalise once only) [✔ ✔ Bottom RHS of Table 2]			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	**Graph** Temperature(y) scale - 2 cm at least 10º and allows for extrapolation if necessary **(1)** All points correctly plotted **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Correct extrapolation to 3 minutes **(1)** ΔT correctly follows from working **(1)** **Accuracy** Compare candidate's ΔT (corrected if necessary) with examiner's ΔT. Examiner's $\Delta T = 25^0C$ Show difference on script as d = Award accuracy marks as follows	If no graph, $\Delta T = T_{MAX} - T_{MIN}$ for accuracy		**5**

d =	$\pm2^0C$	$\pm3^0C$	$\pm5^0C$
Mark	**3**	**2**	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	$\frac{50 \times 0.50}{1000} = 0.025$	Answer only		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(iii)	50 x 4.18 x ΔT J OR $\frac{50 \times 4.18 \times \Delta T}{1000}$ kJ [Cq on ΔT. Ignore sign]	Answer only with units		**1**

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	No change since more heat but also more volume of solution			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**1**✓ Add Fe to $CuSO_4$ (and stir) until blue colour disappears / reaction ends **2**✓ Add HCl to mixture **3**✓ Until no more bubbles / reaction ends **4**✓ Filter off Cu. Wash Cu **and** dry (until constant mass) **5**✓ Weigh Cu **6**✓ Moles Cu = $\frac{\text{mass Cu}}{63.5}$ **7**✓ Conc^n $CuSO_4$ = moles $CuSO_4$ x $\frac{1000}{50}$ **6**✓**7**✓ Stand alone OR **1**✓ Weigh Fe **2**✓ Add Fe to $CuSO_4$ and stir until blue colour disappears **3**✓ Add HCl to mixture. **4**✓ When no more bubbles / reaction ends measure volume H_2. **5**✓ $\frac{\text{Volume } H_2}{24,000}$ = moles H_2 **6**✓ Moles H_2 = moles Fe in excess and $\frac{\text{mass Fe at start}}{56.0}$ = moles Fe at start moles Fe that displace Cu = moles Fe at start – moles Fe in excess **7**✓ Moles Fe that displace Cu = moles $CuSO_4$ Conc^n $CuSO_4$ = moles $CuSO_4$ x $\frac{1000}{50}$ **5**✓**6**✓**7**✓ Stand alone			**7**

Group 2 (6243/01B): This practical test must be taken on the day specified on the official timetable, and is available to Home Centres, International Teaching Institutions and International Centres.

Apparatus and Materials

Apparatus

Each candidate will require:

1. two test tubes and one boiling tube in a test tube rack;
2. apparatus and materials for carrying out a flame test;
3. one 10 cm^3 measuring cylinder;
4. a supply of dropping pipettes;
5. spatula;
6. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
7. small beaker for draining burette;
8. 25.0 cm^3 pipette and safety filler;
9. white tile;
10. two 250 cm^3 conical flasks;
11. expanded polystyrene cup held securely in a 250 cm^3 beaker;
12. one 50 cm^3 or 100 cm^3 measuring cylinder;
13. timer;
14. a thermometer, range 0–100 °C (or similar), graduated in 1.0 °C intervals or a thermometer that can be read to an accuracy of at least 1.0 °C.

Materials

Each candidate will require:

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

(b)* 200 cm^3 of aqueous sodium hydroxide of concentration 0.0975 mol dm^{-3} labelled **Solution F**;

(c)* 200 cm^3 of aqueous ethanedioic acid of concentration 0.0500 mol dm^{-3} labelled **Solution G** [this may be prepared by dissolving 6.30 g of solid ethanedioic acid dihydrate, $(COOH)_2.2H_2O$ per dm^3 of solution.]. The concentration of this solution is **not** to be disclosed to candidates.

(d)* 70 cm^3 of aqueous copper(II) sulphate of concentration 0.50 mol dm^{-3} labelled **H**;

(e)* between 2.4 g and 2.5 g of powdered zinc in a stoppered container labelled **zinc**;

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

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

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

(i) access to a bottle of concentrated aqueous ammonia;

(j) 2 cm^3 of aqueous sodium chlorate(I) (approximately 5% available chlorine) labelled **aqueous chlorine**;

(k) 2 cm^3 of freshly prepared aqueous starch;

(l) phenolphthalein indicator;

(m) a supply of distilled water.

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

6243/01C

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Observation Red / pink **(1)** Inference H^+/ H_3O^+ **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	Observation White ppte **(1)** Inference SO_4^{2-} / sulphate **(1)**		Suspension	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Observation Lilac **(1)** Inference Potassium / K^+ **(1)**	Mauve/purple	K	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)	Observation Limewater cloudy / milky / White ppte **(1)** Inferences Carbon dioxide / CO_2 **(1)** Carbonate / CO_3^{2-}**(1)**	Hydrogen carbonate / HCO_3^-		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (e)	K_2CO_3 + H_2SO_4 ▫ K_2SO_4 + CO_2 + H_2O / CO_3^{2-} + $2H^+$ ▫ CO_2 + H_2O [IGNORE state symbols]	Equivalent HCO_3^- equations.		**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>
Check subtractions and averaging arithmetic correcting if necessary.

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

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

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

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

Award marks for accuracy as follows
<table>
<tr><td>d =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.60</td><td>±0.80</td><td>±1.00</td></tr>
<tr><td>Mark</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>

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

<table>
<tr><td>r =</td><td>0.20</td><td>0.30</td><td>0.50</td><td>>0.50</td></tr>
<tr><td>Mark</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$\frac{\text{Mean titre}}{1000} \times 0.10$ = answer (mol) Answer to at least 3 SF. If units given must be mol Penalise once only			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$\frac{\text{Answer to (i)}}{2}$ = answer (mol) Answer to at least 3 SF. If units given must be mol	Cq on (i)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	Answer to (ii) $\times \frac{1000}{25.0}$ = concentration (mol dm^{-3}) Answer to at least 3 SF. If units given must be mol dm^{-3}.	Cq on (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv)	$\frac{4.29}{\text{Answer to (iii)}}$ = molar mass Units: g or g mol^{-1} Answer to at least 2SF	Cq on (iii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	It will halve it OR candidates mean titre divided by 2			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Less accurate because greater percentage/relative error			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	**Table 2** Full set of temperature readings **(1)** Readings to whole degree **(1)** [✔ ✔ Bottom RHS of Table 2]	Temps to 1 dp		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	**Graph** Temperature(y) scale – 2 cm at least 10^o and allows for extrapolation if necessary **(1)** [✔ Bottom LHS of grid] All points correctly plotted **(1)** [✔ on bottom LHS of grid]			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	ΔT working on graph correct **(1)** ΔT correctly follows from working **(1)** **Accuracy** Compare candidate's ΔT (corrected if necessary) with supervisor's ΔT. [default $\Delta T = 25^0C$] Show difference on script as d = Award accuracy marks as follows d = $\pm 2^0C$ | $\pm 3^0C$ | $\pm 5^0C$ **Mark** **3** | **2** | **1** [^{2}✔ on graph + ^{3}✔ in space below ΔT]	If no graph then $\Delta T = T_{max} - T_{min}$ for accuracy		**5**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	$\frac{50 \times 0.50}{1000} = 0.025$	Answer only		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(iii)	50 x 4.18 x ΔT J OR $\frac{50 \times 4.18 \times \Delta T}{1000}$ kJ [Cq on ΔT. To at least two SF: ignore sign]	Answer only with units		**1**

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

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	Use pipette / burette instead of measuring cylinder to measure $CuSO_4$ OR Lid on polystyrene cup/ more lagging	More accurate thermometer. OR Mechanical stirring		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**1**✓ Weigh **M (1)** **2**✓ Add **M** to $CuSO_4$ [and stir] **(1)** **3**✓ Filter off Cu **(1)** **4**✓ Wash Cu **and** dry (to constant mass) **(1)** **5**✓ Weigh Cu **(1)** **6**✓ Moles Cu = $\frac{\text{mass Cu}}{63.5}$ **(1)** **7**✓ M_r(**M**)= $\frac{\text{mass M}}{\text{moles M(Cu)}}$ **(1)** **6**✓ **7**✓ stand alone		…..until blue colour disappears	**7**

Group 3 (6243/01C): This practical test is only available to **International Teaching Institutions** and **International Centres**. The date of this practical test MUST be agreed in advance through submission of Form ES-F8-MJ2009 found in the International Information Manual.

Apparatus and Materials

Apparatus

Each candidate will require:

1. three test tubes in a test tube rack;
2. apparatus and materials for carrying out a flame test;
3. apparatus for carrying out a limewater test in 1(d) using the technique with which candidates are most familiar;
4. 10 cm^3 measuring cylinder;
5. a supply of dropping pipettes;
6. spatula;
7. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
8. small beaker for draining burette;
9. 25.0 cm^3 pipette and safety filler;
10. white tile;
11. two 250 cm^3 conical flasks;
12. expanded polystyrene cup held securely in a 250 cm^3 beaker;
13. one 50 cm^3 or 100 cm^3 measuring cylinder;
14. timer;
15. a thermometer, range 0–100 °C (or similar), graduated in 1.0 °C intervals or a thermometer that can be read to an accuracy of at least 1.0 °C.

Materials

Each candidate will require:

(a) 10 cm^3 of approximately 1.0 mol dm^{-3} dilute sulphuric acid labelled **P**. The identity of this solution is **not** to be disclosed to candidates;

(b) 1.0 g of anhydrous potassium carbonate in a stoppered tube labelled **Q**. The identity of this compound is **not** to be disclosed to candidates;

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

(d) 200 cm^3 of aqueous ethanedioic acid of concentration 6.00 g dm^{-3} labelled **Solution S**. [This is prepared by dissolving 6.00 g of solid ethanedioic acid dihydrate, $(COOH)_2.2H_2O$ per dm^3 of solution.] Candidates will be given the mass of the **anhydrous** acid per dm^3 of solution;

(e) 70 cm^3 of aqueous copper(II) sulphate of concentration 0.50 mol dm^{-3} labelled **T**;

(f) between 2.4 g and 2.5 g of powdered zinc in a stoppered container labelled **zinc**;

(g) access to a bottle of Universal Indicator solution;

(h) 2 cm^3 of aqueous barium chloride; concentration approximately 0.2 mol dm^{-3};

(i) access to a bottle of freshly prepared limewater;

(j) phenolphthalein indicator;

(k) a supply of distilled water.

6243/02

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Na^+ **(1)**	sodium	Na / NA^+	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	**(Gas evolved):** ammonia/NH_3 **(1)** **(Anion in B):** nitrate/NO_3^- /nitrate(V) **(1)** Allow nitrite / NO_2^- / nitrate(III)		NH_4^+ Ammonium NO_3 /NO_2	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Sulphate/SO_4^{2-}/sulphate(VI) Sulfate/ sulfate (VI)		SO_4	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)	**Test:** (dilute) nitric acid/HNO_3 **(1)** (aqueous) silver nitrate (solution)/$AgNO_3$ **(1)** accept Test reagents added in either order Mark test reagents separately If reagents react with each other this is +- and scores 0. E.g Silver nitrate plus sodium hydroxide scores zero If wrong reagent does not interfere score 1 mark Ignore ammonia and concentrated **(Formula of yellow precipitate):** AgI **(1)** **(Anion in D):** iodide / I^- **(1)**		**I_2 / iodine / iodine ion**	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (e)	**(Gas evolved):** carbon dioxide/CO_2 **(1)** **(Anion in E):** carbonate/CO_3^{2-} **(1)** **or** hydrogencarbonate / HCO_3^- / bicarbonate **(1)** **anions in either order**		 CO_3 HCO_3	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Note The first two marks are for how reflux works The third mark is for either why heat is needed or why heat under reflux is needed (Liquid boils and) gas/vapour/ fumes is condensed/ turns back to liquid **(1)** Runs back/ falls back/ returns to flask **(1)** **Third mark** (heating needed because) reaction is slow / reaction has a high activation energy /speed up the reaction OR prevent products boiling off/ to prevent loss of (volatile) substances **(1)**	 Loss of reactants/ products	If answer implies a closed system score MAX 2 To allow reaction to go to completion References to bond energy	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	Any two impurities from: Propan-2-ol Bromine Hydrogen bromide / hydrobromic acid Sulphur dioxide / sulphurous acid Sulphuric acid **(2)** Note 2- bromopropane is not an impurity	Propene 1.2 Dibromopropane correct formula in each case	<u>Conc</u> sulphuric acid	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Remove acid / neutralise (Allow correct named acid)		Remove impurities	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Lowest layer is the 2-bromopropane			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iii)	Drying agent/remove water **(1)**		dehydrate	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	Moles of propan-2-ol 7.8 = 0.13 (mol) **(1)** 60 theoretical yield = 0.13 x 123 = 16.0 (g) **(1)** percentage yield = 10.0 x 100% = 62.5(4) % **(1)** 16.0 correct answer with some working scores **(3)** correct answer alone scores **(2)** Wrong unit **-1** Calculations in moles not grams: 0.0813/0.13 x 100= 62.5 If moles switched allow 1 mark for 128% Ignore significant figures unless reduce to 1 sig. fig.	 15.99g/16g 63% 62.3% 80% and 61.5% (are working to 1 sig fig in calculation) Scores 2 marks	 15.9g 60%	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	(150 x 4.18 x 29.0 =) 18200 J/18.2 kJ **(1)**	18183 J/18.183 kJ	18000 Wrong units	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	Mass of ethanol burned = 0.92 (g) **(1)** 0.92 = 0.02 (mol) **(1)** 46	0.020/0.0200		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	– answer to (i) in kJ / answer to (ii) i.e. –18.2 / 0.02 = –909/-910 (kJ mol^{-1}) value **(1)** answer with negative sign (and correct units) **(1)** (standalone)	–909 (kJ mol^{-1})		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iv)	These are stand alone marks **(Identity of black solid):** carbon/C **(1)** **(Effect):** (Value is) lower/smaller/less exothermic/ less negative/ decrease **(1)** **(Reason):** (as) incomplete combustion /less CO_2 formed/fewer C=O bonds formed **(1)**	soot/graphite Allow reference to not enough oxygen Incomplete oxidation	coke/charcoal Incomplete reaction	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(v)	$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$ Correctly balanced equation **(1)** **State symbols (1)** The state symbol mark can also be awarded for an equation that has the correct species but is wrongly balanced.		**multiples** H_2O**(g)**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(vi)	Water is produced as a liquid under standard conditions whereas water is produced as a vapour in (a)(iii) (therefore releasing less energy)/ Water is not in its standard state (not liquid)		Note This is the only answer. 'Not standard conditions' will not do. References to heat loss	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	**Either** ethanal/volatile component/product can escape **Or** product can be distilled/ Distillation occurs **Or** ethanal/volatile component/product has a boiling point less than 60^{o}C		Incomplete oxidation Partial oxidation (occurs)	**1**

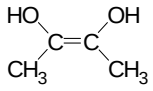
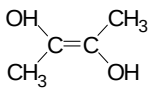
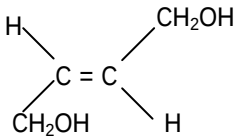
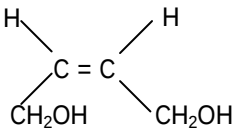
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Ethanal does not escape/ is not distilled of/is refluxed/ falls back into flask (1)		Full oxidation (occurs)	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	Orange to green / blue / brown **(1)** **Both colours required**	Orange to any combination of the colours given		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	(Moles C) $\frac{2.18}{12}$ **and** (Moles H) $\frac{0.36}{1}$ **and** (Moles O) $\frac{1.46}{16}$ = 0.18:0.36:0.09 **(1)** C_2H_4O **(1)**	Any other correct method		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	C_2H_4O = 44.0 **(1)** $\frac{88.0}{44.0}$ = 2(.00) **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	**(First inference):** (carbon)-carbon double bond/C=C/alkene **(1)** **(Second inference):** -OH/ alcohol / hydroxyl / hydroxy (group) **(1)**	Double bond/unsaturated	Carboxylic acid OH^- /hydroxide Hydroxyl followed by OH^- **(0)**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	*Any valid pair of cis and trans isomers of $C_4H_8O_2$ that contain at least one alcohol functional group.* **(2)** Possible examples  and   and  There is one mark for each isomer in the **pair** There must be two isomers drawn If the two isomers drawn are **both** compounds of $C_4H_8O_2$ that show *cis-trans* isomerism but are not a *cis-trans* pair score 1 mark		If they draw isomers of a compound that is not $C_4H_8O_2$ **(0)**	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5	✓1 Weigh crucible empty ✓2 Weigh crucible plus magnesium OR weigh magnesium separately ✓3 Add **excess (**dilute) nitric acid / add nitric acid till all dissolved / reacted ✓4 **Heat** (to decompose magnesium nitrate) **in a fume cupboard** (This mark may be spread across different parts of the question) ✓5 Weigh crucible plus residue/weigh crucible + MgO ✓6 Re-heat to constant mass *Note: This is only positive evidence for completion of the reaction.* Note; If candidate isolates the magnesium nitrate and transfers it to a new vessel for decomposition score. Reason: results will be inaccurate in terms of whole point of experiment. Max 5	Allow any sort of container generally used in the lab	If no mention of nitric acid in the answer can score only 1st two marks	**6**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	$Na_2O + H_2O \rightarrow 2Na^+ + 2OH^-$ OR $Na_2O + H_2O \rightarrow 2NaOH$ **(1)** Ignore state symbols even if wrong.		$O^{2-} + H_2O \rightarrow 2OH^-$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	$P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$ **(1)** for equation, **(1)** for states consequential on correct formulae. Accept for **(1)** $P_2O_5(s) + 3H_2O(l) \rightarrow 2H_3PO_4(aq)$ if completely correct.	H_3PO_4 shown as ions: $H^+(aq) + H_2PO_4^-(aq)$ **or** $2H^+(aq) + HPO_4^{2-}(aq)$ **or** $3H^+(aq) + PO_4^{3-}(aq)$		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	Na_2O ionic **(1)** P_4O_{10} covalent **(1)** **Third mark:** O^{2-} ions react with water molecules to remove H^+ OR O^{2-} ions polarise water molecules to form OH^- OR $O^{2-} + H_2O \rightarrow 2OH^-$ **(1)** **Fourth mark:** **polar** P–O bond attacked by (polar) water molecules OR $P^{\delta+}$ attacked by (polar) water molecules **(1)**	Equivalent answers in diagrams. P is less electronegative than O so is attacked…	Dative or giant covalent Hydrolysis alone Metallic oxide basic Non-metallic oxide acidic	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	Moles KO_2 = $\frac{1.2}{71}$ = 0.0169 **(1)** Vol O_2 = $\frac{24 \times 0.0169}{2}$ = 0.203 **dm^3 (1)** consequential on moles of KO_2 OR 142 g oxide gives 24 dm^3 oxygen **(1)** so volume of oxygen = (24 x 1.2) ÷ 142 dm^3 = 0.203 **dm^3 (1)** Ignore sf, but **unit needed** and it must agree with the value. Correct answer with no working **(2)**	0.017, giving 0.204 dm^3 Answer as fraction. 203 **cm^3** Thus 0.2, 0.20, 0.203, 0.204 can all score in dm^3	0.02 24 x 1.2	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2(a)(i)	The energy change when 1 mol of ionic solid/lattice/crystal/compound **(1)** is formed from **ions** in the **gaseous** state (infinitely far apart) OR $M^+(g) + X^-(g) \rightarrow MX(s)$ **(1)** If 'Ionic' is not stated in the first mark answer, the first mark can score if ions are mentioned in the answer for the second mark. Ignore any reference to standard states. Completely correct endothermic definition scores **(1)**	heat **or** heat energy **or** enthalpy; energy (etc) evolved	energy (etc) absorbed…. Compound, substance, molecule. formed from 1 mole of ions	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	The heat **or** energy change for the formation of **one mol** of **gaseous atoms (1)** from the element in its standard state **(1)** Second mark conditional on the first.	 Element at 298K and 1atm	one mol of gas; one mol of element	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	polarisation of the anion (by the cation) OR polarisation by the cation (of the anion) OR partial covalent bonding **(1)** Ignore any reference to any values of lattice energies.	 covalent character	Answers referring to molecules Intermediate bonding **alone**	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	MgF_2 as answer **(0)** irrespective of what follows. (MgI_2 because) the larger **iodide** ion **(1)** is more polarisable (than fluoride leading to greater covalence) **(1)** OR (MgI_2 because) the smaller **fluoride** ion in MgF_2 **(1)** is less polarisable (than iodide leading to ionic bonding) **(1)** Answer 'MgI_2' **alone** scores **(0)**	 iodine **ion** distorts the electron cloud fluorine **ion**	Answers based on electronegativity iodine, I_2 anion, I_2 polarisation of cation by anion fluorine, F_2 anion, F_2	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	A proton donor **or** hydrogen ion donor **or** H^+ donor **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	$K_a = \frac{[CH_3CH_2COO^-][H_3O^+]}{[CH_3CH_2COOH]}$	$[H^+]$ for $[H_3O^+]$ throughout	$\frac{(CH_3CH_2COO^-)(H_3O^+)}{(CH_3CH_2COOH)}$ Any expression with $[H_2O]$; [HA] and $[A^-]$	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	$[H_3O^+] = \sqrt{(K_a \times c)}$ $= \sqrt{(1.3 \times 10^{-6}\ (mol^2\ dm^{-6}))}$ $= 1.14 \times 10^{-3}\ (mol\ dm^{-3})$ Ignore units.	1.1×10^{-3}(mol dm $^{-3}$)	1×10^{-3}(mol dm $^{-3}$)	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	$[CH_3CH_2COOH]_{initial}$ = $[CH_3CH_2COOH]_{equilibrium}$ **(1)** assumption is justified since K_a is small OR $[H^+] << 0.10$ mol dm^{-3} **(1)** Conditional on first mark.	$[CH_3CH_2COOH]_{equilibrium}$ = 0.10 mol dm^{-3} A very small fraction/amount of the acid is dissociated (into ions) OWTTE. Conditional on first mark.	Non standard conditions Acid is partially dissociated; acid is very weak	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	$CH_3CH_2COO^- + H_2O \rightarrow CH_3CH_2COOH + OH^-$ Allow structural or partially structural formulae. Ignore state symbols.	Equilibrium arrow $CH_3CH_2COO^-Na^+ + H_2O \rightarrow CH_3CH_2COOH + OH^- + Na^+$	CH_3CH_2COONa on lhs Na^+OH^-	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**Either:** 14 = 8.94 + pOH **(1)** pOH = 5.06 $\therefore [OH^-] = 8.7 \times 10^{-6}$ **mol dm^{-3}** **(1)** unit required **Or:** $[H_3O^+] = lg^{-1}(-8.94)$ $= 1.15 \times 10^{-9}$ (mol dm^{-3}) **(1)** $\therefore [OH^-]$ $= \frac{1.00 \times 10^{-14}\ (mol^2\ dm^{-6})}{1.15 \times 10^{-9}\ (mol\ dm^{-3})}$ $= 8.70 \times 10^{-6}$ **mol dm^{-3}** **(1)** unit required. Accept 2 sf or more. Allow consequentially on rounding errors for $[H^+]$, but not otherwise. Correct answer with units but no working **(2)**	8.71×10^{-6} **mol dm^{-3}** 1.148×10^{-9} (mol dm^{-3}) giving final answer of 8.71×10^{-6} **mol dm^{-3}**	9×10^{-6} mol dm^{-3} 1.15×10^{-9} alone with no further answer 9×10^{-6} mol dm^{-3}	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(i)	**First mark:** $C_2H_5COOH + OH^- \rightarrow C_2H_5COO^- + H_2O$ OR $H^+ + OH^- \rightarrow H_2O$ **and** $C_2H_5COOH \rightarrow C_2H_5COO^- + H^+$ **(1)** **Second mark:** $C_2H_5COO^- + H_3O^+ \rightarrow C_2H_5COOH + H_2O$ **(1)** **Third mark:** large excess/reservoir/reserve/amount of **both** the acid and its anion **or** its salt **(1)** **Fourth mark:** the amount of H^+ or OH^- added is small(er) **(1)** If the candidate uses ethanoic acid, or HA/A^-, in the two equations but **all** of them are otherwise correct award **(1)** only.	NaOH for OH^- with Na^+ on rhs $C_2H_5COO^- + H^+ \rightarrow C_2H_5COOH$ Amount small compared with….		**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(ii)	**First mark:** [sodium propanoate] = 0.015÷ 0.300 (mol dm^{-3}) = 0.050 (mol dm^{-3}) **(1)** **Second mark:** [propanoic acid] = 0.0200÷ 0.300 (mol dm^{-3}) = 0.0667 (mol dm^{-3}) **(1)** Correct concentrations plus working score **(2)** **Third mark:** $[H_3O^+] = \frac{1.3 \times 10^{-5} \times 0.0667}{0.050}$ $= 1.73 \times 10^{-5}$ (mol dm^{-3}) OR pH = 4.89 + lg (0.050÷ 0.0667) = 4.89 − 0.127 **(1)** **Fourth mark:** ∴ pH = 4.76 **(1)** Third and fourth marks score consequentially on incorrect concentrations only if these are used in the correct expression. If no notice of volume change on mixing is taken, the answer is pH = 5.06 and this could score the last two marks. Two sf or more	0.15÷3 0.20÷3 4.77, 4.8 5.1	5	**4**

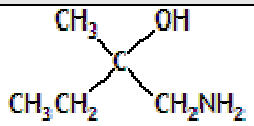
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iii)	[acid]÷ [salt] does not (significantly) change OR the acid : salt **ratio** does not (significantly) change **(1)**	[anion] for [salt]; $[HA]/\{A^-\}$	amounts do not change; acid and salt diluted equally on its own; concentrations do not change.	**1**

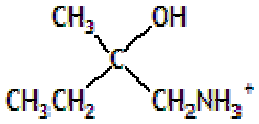
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	CH_3CH_2MgBr **or** $CH_3CH_2Mg–Br$ **or** $CH_3CH_2Mg^+ Br^-$ **(1)**	Other halogens; C_2H_5 for CH_3CH_2—; CH_3CH_2MgX	$CH_3CH_2Mg^- Br^+$ CH_3CH_2BrMg	**1**

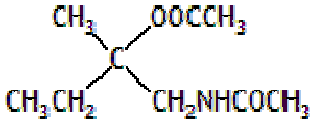
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	The oxidation state for dichromate is not necessary, but if there it must be (VI); the o.s. for manganate(VII) **is** necessary. potassium dichromate(VI) + sulphuric acid OR $K_2Cr_2O_7 + H_2SO_4$ **or** H^+ OR $Cr_2O_7^{2-} + H_2SO_4$ **or** H^+ OR potassium manganate(VII) + sulphuric acid OR potassium permanganate + sulphuric acid OR $KMnO_4 + H_2SO_4$ OR $MnO_4^- + H_2SO_4$ **or** H^+ **(1)** Ignore dilute or conc.	 acidified dichromate(VI) OR acidified manganate(VII) OR acidified permanganate. Hydrochloric **acid** or HCl**(aq)** with dichromate **only.**	Names and formulae which don't agree. HCl	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Any apparatus that cannot work (except for presence of a stopper) or is inappropriate, or is blocked between condenser and flask, scores **zero overall**. Ignore any substances/labels. **First mark:** condenser and flask (more or less) vertical **(1)**. Allow these to be shown without a joint. **Second mark:** heating mantle OR Bunsen burner OR sand bath OR oil bath **(1)** **Third mark:** reasonable **sectional** drawing that will work, and is not stoppered **(1).** Ignore any thermometer in the top of the condenser unless placed there in a bung.	 Ignore water flow direction 'heat' with an arrow	 an arrow alone; water bath	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	KCN + H_2SO_4 **or** H^+ **or** named acid; OR KCN + HCN OR HCN + NaOH **or** OH^- **or** base **(1)**	HCN **or** hydrogen cyanide		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	 **(1)**	No need to show all the bonds C_2H_5 for CH_3CH_2		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i)	The mark can be given for a correct structure here if (c)(ii) is wrong, **or** for correct protonation of the structure given in (c)(ii).  **(1)** Can show a chloride ion as well, or $-CH_2NH_3Cl$ without the charges. A fully displayed formula\ must have the + charge on the nitrogen atom.	No need to show all the bonds C_2H_5 for CH_3CH_2 Bonds from alkyl groups acceptable as shown.	-HO once only	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	 **(2)** **(1)** for reaction with OH, **(1)** for reaction with NH_2 Correct structure **or** one consequential on (c)(ii) scores.	C_2H_5 for CH_3CH_2 $-OCOCH_3$ No need to show all the bonds	$-CO_2CH_3$ $-CH_2CONHCH_3$	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(i)	Non−superimposable on its **mirror** image **(1)**	four different groups around a given atom OR Asymmetric carbon atom OR (molecule with) no centre or plane of symmetry	Four groups around a carbon molecule	**1**

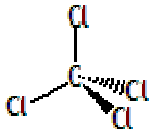
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(ii)	**Rotates** the plane of polarisation of (plane polarised monochromatic) light (in opposite directions) **(1)**	Plane polarised light is rotated…	bends, twists, turns, deflects, refracts; rotating molecules.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(iii)	**First mark:** Ethanal is (a) planar (molecule around the carbonyl group) **(1)** This mark must refer to ethanal. **Second mark:** attack from both **or** either side(s) **(1)** **Third mark:** Reaction gives an equimolar, **or** 50:50, **or** racemic, mixture (of the two enantiomers of butan−2−ol) **(1)**		linear (next two marks can score); intermediate carbocation **or** intermediate molecule	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	CO_2 acidic **(1)** PbO basic **or** amphoteric **(1)** PbO more basic than CO_2 OR Basic character increases down the group **(1) only.** Ignore any explanations.	**Correct** equations showing these properties.	Answers with incorrect formulae, e.g CO or PbO_2 Basic solution; alkali.	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	$SiCl_4$ covalent liquid **(1)** $PbCl_2$ ionic solid **(1)** **For (1):** Covalent and ionic alone **(1)** liquid and solid alone **(1)**		Giant covalent	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)	$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$ OR $SiO_2 + 2OH^- \rightarrow SiO_3^{2-} + H_2O$ **(1)** Ignore any state symbols even if wrong.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)	**First mark:**  **(1)** The drawing must be a reasonable attempt at 3D and recognisably tetrahedral. If bond angles are shown they must be close to 109°. If 90° or 120° this mark is lost even if the drawing is correct. **Second mark:** 4 bond pairs (of electrons and no lone pairs) **(1)** **Third mark:** repel as far apart as possible, **or** to maximum separation, **or** to **minimum** repulsion **(1)** Stand alone if referring to electron pairs.		Any structure with 90° bond angles. "4 bonds/atoms repel" loses 3rd mark. bond pairs repel equally	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	C^{4+} requires too much energy for its formation to be recovered via any sort of bonding **(1)** C^{4+} has high charge and small size OR C^{4+} has high charge density **(1)** it would be extremely polarising of Cl^- (giving polar covalent bonds) **(1)**	Recovered via lattice energy	High E_a Any answer based on electronegativity differences. Atoms polarised..	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(i)	acid−base **(1)**	neutralisation	protonation	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(ii)	Disproportionation or the idea of it scores **(0) overall.** **Either:** redox **(1)** because o.s. of lead changes from +4 to +2 **and** o.s. of chlorine changes from −1 to 0. **(1) stand alone.** **Or:** Reduction because Pb^{4+}/ Pb(IV) gives Pb^{2+}/Pb(II) **(1)** Oxidation because Cl^-/Cl(-1) gives Cl(0) **(1)**	Oxidation-reduction o.s. of lead goes down **and** o.s. of chlorine goes up OR lead(IV) has gained electrons **and** chloride has lost electrons		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(iii)	Tin o.s. is more stable as +4 but lead as +2 OR The +2 state becomes more stable than +4 down the group **(1)** so lead(IV) oxide is an oxidising agent **(1) stand alone**	 PbO_2 is reduced by HCl Pb^{4+}/Pb(IV) is oxidising		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(i)	$\frac{\text{amount of substance}}{\text{volume}}$ OR number of moles per dm^3 **(1)**	Amount of substance in (given) volume	Mass per unit volume OR ppm OR moles per unit volume **of solvent**	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6(a)(ii)	$K_c = \frac{[CH_3COOCH_2CH_3][H_2O]}{[CH_3CH_2OH][CH_3COOH]}$		round brackets	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	$\frac{2.43}{V}$ (mol dm^{-3}) If units given they must e correct.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	2.43 (moles) **(1)** Ignore units.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(iii)	**First mark:** amount of ethanoic acid (at equilibrium) = 5.00 – 2.43 = 2.57 mol **(1)** **Second mark:** amount of ethanol (at equilibrium) = 0.57 mol **(1)** If $[H_2O]$ is omitted in (a)(ii) only the 1st and 2nd marks can be awarded . **Third mark:** $K_c = \frac{(2.43\div V)(2.43\div V)}{(2.57\div V)(0.57\div V)}$ **(1)** V must be used to obtain the 3rd mark, either here or by giving the concentrations separately OR candidate states Vs cancel. **Fourth mark:** = 4(.03) **(1)** ignore sf.	Values only without working score. Third and fourth marks consequential on their values above.	Calculations based on the idea of mole fractions cannot score the 3rd and 4th marks.	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(iv)	Volumes **or** mol dm^{-3} cancel so no units Consequential on expression for K_c in (a)(ii)	Units cancel; Equal number of moles on each side		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	None/no effect/nil effect/zero effect/no change **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii)	None/no effect/nil			**1**

	effect/zero effect/no change **(1)**			

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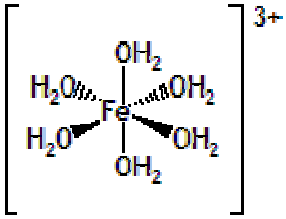
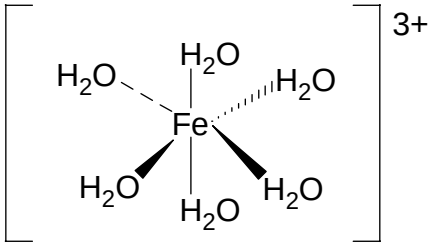
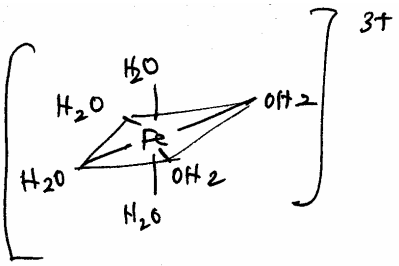
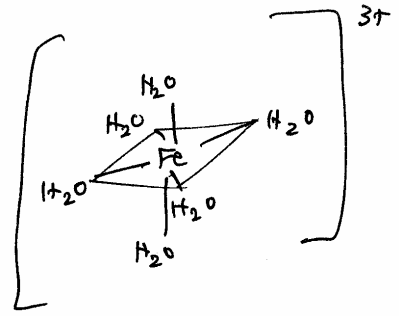
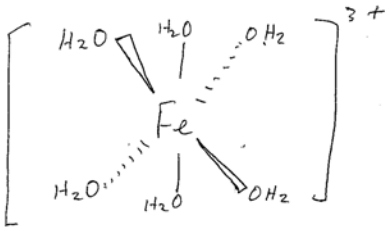
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	$3d^6$ $3d^5$ **(1) – both needed for mark**	Full electronic configuration from $1s^2$ OR separate 3d orbitals $4s^0$ before or after 3d		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii) **QWC**	Fe^{3+} because it has a half-filled ***d***-(sub-)shell **(1)**	5 x ½ filled (3)d orbitals Half filled set of 3d orbitals	Half-filled d orbitals	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii) **QWC**	*d*-orbitals split by ligands **(1)** *do not allow d-orbital - singular* absorption of light (of certain colour/frequencies)(s) **(1)** leads to electron transition from lower to higher energy level Must be clear that electron promotion is caused by absorption of light. If not only 1st mark available **(1)** If sequence is wrong only the 1st mark is available.	d sub shell for d orbitals	Any mention of **emitted** light results in 1st mark only being possible. Electron promoted causing absorption of light	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iv)	energy separation of the *d*-orbitals is different	Accept 'different splitting' if *d*-orbitals split in (iii).	e^-s are promoted to different energy levels.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1(b)(i)	Name hexaaquairon(III) OR hexaquairon(III) **(1)** Shape **and** charge **(1)** Some examples of correct answers  OR    Allow bond to H of the H_2O on right-hand equatorial ligands and axial ligands only.	Charge shown on the Fe itself.	Reject any other answers. 	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	$[Fe(H_2O)_6]^{3+} + H_2O$ ▫ $[Fe(H_2O)_5OH]^{2+} + H_3O^+$ **(1)**	"→" for "▫"	$[Fe(H_2O)_6]^{3+}$ ▫ $[Fe(H_2O)_5OH]^{2+} + H^+$ "aq" instead of "H_2O"	**1**

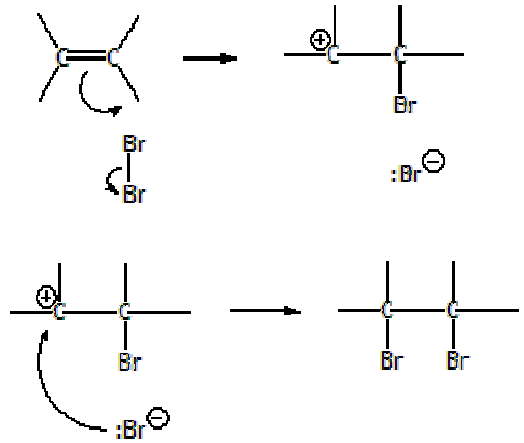
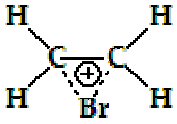
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Add (excess) acid/H_3O^+/H^+ Ignore any reference to concentration	Formula or named strong acid		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	(dirty/grey/dark) green precipitate **(1)** $[Fe(H_2O)_6]^{2+} + 2OH^- \rightarrow Fe(OH)_2 + 6H_2O$ **(1)** Square brackets not essential	Green ppt going brown $Fe(OH)_2(H_2O)_4$ + $2H_2O$ as product	Pale/light green $Fe^{2+}+2OH^- \rightarrow Fe(OH)_2$	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	It turns foxy-red/brown/red-brown/rusty **(1)** oxidation by oxygen **(1)**	Orange	Red/brick red OR mention of soln Oxidation by air OR redox	**2**

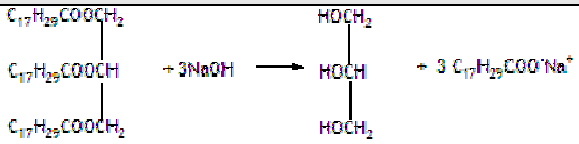
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(i)	**A**mount **R** reduced = (1.98 ÷ 198 mol) = 0.010 mol **(1)** Amount Fe^{2+} oxidised = (4.56 ÷ 152 mol) = 0.030 mol **(1)** **oxidation state** of R changes by 3/1 mole of R gains 3 moles of electron **(1)** Fe(VI)/+6/6+ **(1) stand alone**		 Just "ratio 1:3" Just "6"	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)(ii)	K_2FeO_4		FeK_2O_4	**1**

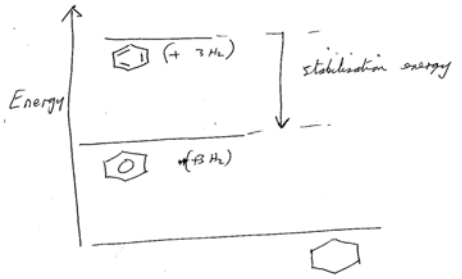
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	 both arrows initially – allow arrow from π bond towards /to bromine but not from sigma bond past bromine **(1)** Carbocation **(1)** arrow from bromide ion towards/to positive carbon atom **(1)** Lone pair on bromide ion is not necessary Arrow can come from negative charge Ignore partial charges on Br_2 Ignore product Ignore any groups on C=C	If use HBr max 2 bromonium ion intermediate 		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Amount linolenic acid = (100 ÷ 278 mol) = 0.360 mol **(1)** amount I_2 = (274 ÷ 254 mol) = 1.08 mol **(1)** Ignore sf for first 2 marks ▫ number of C=C bonds = (1.08 ÷ 0.360) = 3 **(1)** 3rd mark conditional on first 2 marks If 127 is used hence 6 double bonds max (2)		1.07	**3**

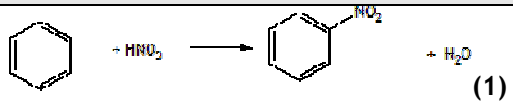
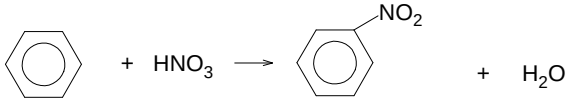
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$C_{17}H_{29}COOCH_2$ $C_{17}H_{29}COOCH$ $C_{17}H_{29}COOCH_2$ **(1)**	No need to show the -COO- structure in full. Allow $-CO_2-$ for -COO-	$C_{17}H_{29}OCO$	**1**

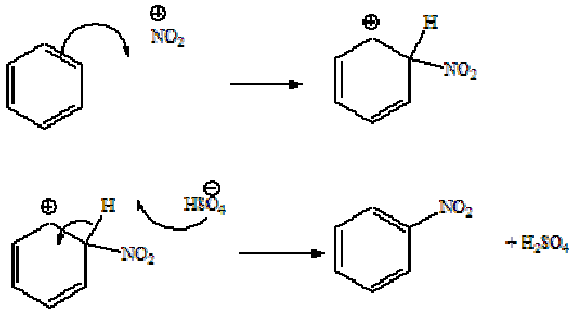
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	 OH⁻ for NaOH $C_{17}H_{29}COO^{(-)}Na^{(+)}/K^{(+)}$ **(1)** – stand alone Remainder of balanced equation **(1)** 2nd mark can be Cq on their ester in (ii)	KOH Charges not necessary	Covalent bond between O and Na	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	- 360 (kJ mol^{-1})	- 360 kJ	- 360 J mol^{-1}	**1**

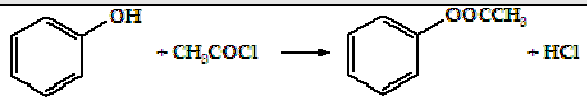
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	 Relative energy levels of the three compounds **(1)** Stabilisation energy/152 marked **(1)**	Omission of $3H_2$ - 152		**2**

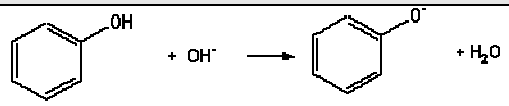
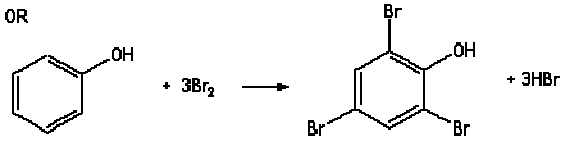
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii) **QWC**	Benzene has delocalised **π**-electrons/**π**-system **(1)** Cyclohexatriene would have (localised) double/π-bonds **(1)** **Either** this makes benzene less reactive to **electrophiles** **OR** this makes benzene have a higher activation energy with **electrophiles** **(1)**	Inverse argument	delocalised **π**-bond	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	 **(1)** OR 	C_6H_6 for benzene $C_6H_5NO_2$ for nitrobenzene ignore H_2SO_4 on both sides		**1**

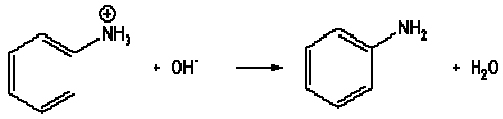
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	$2H_2SO_4 + HNO_3 \rightarrow H_3O^+ + NO_2^+ + 2HSO_4^-$ **OR** $H_2SO_4 + HNO_3 \rightarrow H_2O + NO_2^+ + HSO_4^-$ **(1)** or both of: $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$ then $H_2NO_3^+ \rightarrow H_2O + NO_2^+$ **OR** $H_2NO_3^+ + H_2SO_4 \rightarrow H_3O^+ + NO_2^+ + HSO_4^-$  **2nd mark** Curly arrow from double bond/ circle towards N of NO_2^+ (1) **3rd mark** Correct intermediate. (if a broken ring is used for the delocalised electrons it must extend over more than the 3 carbons and must be broken at the substituted C) (1) **4th mark** Curly arrow from C-H **bond** back into ring (1) Allow loss of H^+ Ignore arrow from HSO_4^- All marks stand alone			**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	Avoids formation of (1,3-) dinitrobenzene **(1)** Ignore numbers	Avoids further nitration/substitution *m*-dinitrobenzene for 1,3-dinitrobenzene	Avoids further **reaction.**	**1**

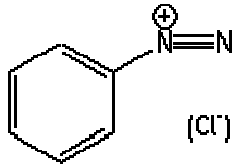
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	 $CH_3\ CH_2OH + CH_3COCl \longrightarrow CH_3CH_2OOCCH_3 + HCl$ Common reagent **and** both organic products **(1)** Both balanced **(1)** Conditional on 1st mark If $OCOCH_3$ in product only 2nd mark can be scored	Equations for the reaction with sodium/carboxylic acid/PCl_5 C_6H_5 for ring $CH_3COOCH_2CH_3$ for the ester $-O\bullet CO\bullet CH_3$		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	  or $3Cl_2$ reagent **(1)** remainder of balanced equation **(1)**	C_6H_5 in first equation Reaction with diazonium ion/nitric acid/halogenoalkane	Reaction with acid chloride Bromophenols other than the 2,4,6- isomer.	**2**

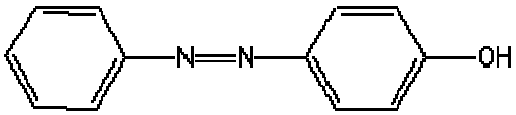
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(i)	Tin/Sn OR iron/Fe and **concentrated** hydrochloric acid/ **concentrated** HCl **(1)** Ignore reference to sodium hydroxide/NaOH/alkali			`

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(ii)	 cation or chloride salt (1) balanced equation with OH^- or NaOH (1)	C_6H_5 for ring		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iii)	< 0 °C too slow **(1)** > 10 °C product/nitrous acid decomposes **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(iv)	 **(1)** Must show + charge and the bonds around N	C_6H_5 for ring $C_6H_5N{=}N^+$ $(C_6H_5N{\equiv}N)^+$	Covalent bond between N and Cl	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(v)	(Strongly) alkaline OR pH ≥ 9 **(1)**	$NaOH/OH^-/Na_2CO_3$	Any reference to heat under reflux	**1**

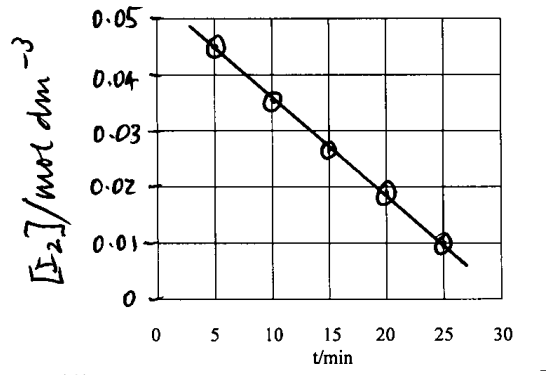
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(vi)	 N=N link between rings **(1)** for the remainder of the molecule **conditional on 1st mark (1)**	OH of the phenol can be in any position. Allow $-O^-$ for -OH	C_6H_5 or C_6H_4 for rings	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	*k*/rate constant changes with change in temperature		Just "rate changes with temperature"	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	$I_2 + 2S_2O_3^{2-} \rightarrow S_4O_6^{2-} + 2I^-$ **(1)** If equation is given: E^O = is positive/(+) 0.45 (V) **(1)** conditional on correct species on correct sides If equation not given: E^0 is (+)0.45 (V) scores 2nd mark. If equation reversed 0.	▫ E^0 for I_2/I^- is more positive than that for $S_4O_6^{2-}/S_2O_3^{2-}$		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Stops the reaction			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	$CH_3COCH_3+3I_2+4OH^-$ $\rightarrow CHI_3+3I^- +CH_3COO^- +3H_2O$ iodoform formula **(1)** remainder **(1)**	NaOH for OH^- NaI for I^- CH_3COONa for CH_3COO^-	C_3H_6O	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	 points **(1)** line **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	Zero **(1)** **because** the reaction rate is constant **(1)** *2nd mark conditional on 1st*		Just 'because it is a straight line/constant gradient'	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	One/1/1st/first **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4(c)(iv)	iodine (of order zero so) is not involved in rate-determining step **(1)** **Either** Propanone is first order so involved in RDS (or earlier) **OR** Iodine is a reactant/in the formula of the product **(1)** <u>If 1st or higher order in (ii)</u> Three species affect rate **(1)** Three body collision unlikely **(1)** (so there must be at least two steps)	Partial orders not equal to stoichiometry therefore must take place in more than one step scores (2)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)	Colorimeter **(1)** **Either** take readings over a period of time/specified times **OR** Monitor/take readings during the reaction **(1)** Conditional on 1st mark	calibrated with known concentrations of iodine	Any mention of starch scores 0. Not just "calibrated"	**2**

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>5 (a)</td><td>
<table>
<tr><td></td><td>CH_3CH_2CHO</td><td>CH_3COCH_3</td></tr>
<tr><td>Tollens' (1)</td><td>silver (1)</td><td>no change (1)</td></tr>
<tr><td>OR
ammoniacal silver nitrate
If no ammonia max 1
e.g. both 'silver' and 'no change' needed for 1 mark</td><td>silver</td><td>no change</td></tr>
<tr><td>OR
Fehling's</td><td>brown ppt /red ppt</td><td>no change/stays blue</td></tr>
<tr><td>OR
Benedict's</td><td>brown ppt /red ppt</td><td>no change/stays blue</td></tr>
<tr><td>OR
Iodine in alkali / Iodoform test
No alkali max 1</td><td>no change</td><td>yellow ppt</td></tr>
<tr><td>OR
Acidified dichromate(VI) if not acidified max 2</td><td>turns green</td><td>no change/stays orange</td></tr>
<tr><td>OR
Acidified manganate(VII) if not acidified max 2</td><td>turns colourless</td><td>no change/stays purple</td></tr>
</table>
</td><td>No visible reaction allowed for no change</td><td>Just "no reaction"</td><td>3</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)	<u>Propanal</u> 3 peaks **(1)** ratio 3:2:1 **(1)** <u>Propanone</u> 1 peak **(1)**	Ignore "6" for area		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)	Both show the same carbonyl absorption/peaks/ around 1700 cm^{-1} **(1)**		Just "same absorption"	**1**

6246/01A

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

Table 2

Check subtractions and averaging arithmetic correcting if necessary.

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

All subtractions completed correctly (1)
[✔ ✔ top RHS of Table 2]

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

Accuracy
If the candidate has made an arithmetical error in Table 2 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.
Home centres
For each candidate calculate
*mass B x 2.55 = expected titre
[*corrected if necessary]
International centres
For each candidate calculate
Supervisor's mean titre x candidate's mass B
Supervisor's mass B
= expected titre
Calculate the difference(d) between the candidate's mean titre and the expected titre.
Record the difference as
d =…… on the script

Award marks for accuracy as follows
<table>
<tr><td>d =</td><td>±0.30</td><td>±0.50</td><td>±0.70</td><td>±1.00</td><td>>1.00</td></tr>
<tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>
Range
The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range on the corrected titres used by the examiner to calculate the mean.
</td><td></td><td></td><td>12</td></tr>
</table>

	r =	0.20	0.30	0.50	
	Mark	**3**	**2**	**1**	
	Examiner to show the marks awarded for accuracy and range as d = value r = value ✔ 4 MAX ✔ 3 MAX				

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	moles **B** = mass **B** / 392 Ignore units Answer to at least 3 SF	Penalise SF once only in (i) and (ii) and allow loss of trailing zeros if correct arithmetically in (i) and (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Moles **B** in 25.0 cm^3 = answer to (b)(i) / 10 Ignore units Answer to at least 3 SF			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Moles MnO_4^- in mean titre = answer to (b)(ii) / 5 **(1)** Conc^n MnO_4^- = moles MnO_4^- in mean titre x 1000 / mean titre **(1)** Answer to 3 SF only e.g. 0.0200 **(1)** Ignore units			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Either $KMnO_4$ acts as own indicator or / excess unreacted $KMnO_4$ colours solution in flask or description of colour change in flask			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Observations Brown precipitate **(1)** Insoluble in excess **(1)** Inference $Fe(OH)_3$ / iron(III) hydroxide **(1)**	Foxy - red $[Fe(H_2O)_3(OH)_3]$		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Observations Brown / Orange / Red (solution) **(1)** Blue / Black / Blue-black **(1)** Ignore any ppts Inference Iodine / I_2 / KI_3 **(1)**		I	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$ *[Ignore state symbols]*	multiples		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	Observations Blue precipitate **(1)** Insoluble in excess NaOH **(1)** Ignore further observations Inference $Co(OH)_2$ / cobalt(II) hydroxide **(1)**	$[Co(H_2O)_4(OH)_2]$	Any Cu compounds	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)(i)	Observation Blue (solution) **(1)** Inference $[CoCl_4]^{2-}$**(1)**		$CoCl_2$ Any Cu complex / compound	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)(ii)	Ligand exchange /substitution **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (e)	Observation White precipitate **(1)** Inference $CoSO_4$ **(1)**	Allow $CuSO_4$ as a cq answer	Any coloured precipitate.	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	Observation (Orange to) green / blue **(1)** Inferences Oxidation **(1)** Primary, secondary alcohol, aldehyde; **all three** for **(1)**	Dichromate oxidises	Redox /reduction E is a reducing agent $Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	Observations Blue to red litmus and (red litmus no change) **(1)** White / misty / Steamy fumes /vapour **(1)** Inference (Primary or secondary) alcohol / 'not an aldehyde' if follows 3rd mark in (a) **(1)**		White smoke Any answer including carboxylic acid	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	Observation (Pale) yellow precipitate **(1)** Inferences Iodoform / tri-iodomethane / CHI_3**(1)** CH_3CHOH / methyl secondary alcohol (or ethanol) **(1)**		Any answer including methyl ketone / CH_3CO / ethanal	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	$CH_3CH(OH)CH_3$	Full structural / skeletal formula	—H—O bond	**1**

3 (c), (d)

If no ppt observed in (c) then may allow 3rd mark in (c) for e.g. 'not methyl secondary alcohol (or ethanol)' then allow propan-1-ol in (d).

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**T1** ✓ Candidate's test on all **four** compounds **R1** ✓ Observation and inference from test on all **four** compounds **T2** ✓ Candidate's second test **R2** ✓ Observation and inference from second test **T3** ✓ Candidate's third test **R3** ✓ Observation and inference from third test **L** ✓ Remaining compound is cyclohexane Tests and observations / inferences which can be done in any order. Each test and observation to maximum **(2)** • 2, 4 – DNP / Brady's reagent Observation + logical deduction • Iodoform test Observation + logical deduction • Fehling's / Tullens/ acidiefied dichromate (VI) Observation + logical deduction • Aqueous $AgNO_3$ – could be preceded by NaOH + HNO_3 Observation + logical deduction If identity of compound is assumed then each test (0) but observation (1). Ignore conditions throughout.			**7**

Group 1 (6246/01A): this practical test must be taken on the day specified on the official timetable, and is available to Home Centres, International Teaching Institutions and International Centres.

Apparatus and Materials

Apparatus

1. eight test tubes in a test tube rack;
2. 10 cm^3, 25 cm^3 or 50 cm^3, and 100 cm^3 measuring cylinders;
3. a supply of dropping pipettes;
4. spatula;
5. access to balance weighing to at least 0.01 g;
6. one 250 cm^3 beaker;
7. one 250 cm^3 volumetric flask with stopper;
8. funnel to fit volumetric flask;
9. glass rod;
10. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
11. small beaker for draining burette;
12. 25.0 cm^3 pipette and safety filler;
13. white tile;
14. two 250 cm^3 conical flasks;
15. a supply of hot water (about 70 °C) and a 250 cm^3 beaker for a water bath;
16. access to fume cupboard.

Materials

Each candidate will require:

(a)* 200 cm^3 of aqueous potassium manganate(VII), $KMnO_4$, of concentration 0.0200 mol dm^{-3} labelled **Solution A**. The concentration of this solution is **not** to be disclosed to candidates;

(b)* between 8.9 g and 9.1 g of ammonium iron(II) sulphate, $(NH_4)_2SO_4.FeSO_4.6H_2O$. in a stoppered weighing bottle or similar labelled **B**;

(c)* 10 cm^3 of aqueous iron(III) chloride of concentration 0.25 mol dm^{-3} labelled **C**. The identity of this solution is **not** to be disclosed to candidates;

(d)* 10 cm^3 of aqueous cobalt(II) sulphate of concentration 0.25 mol dm^{-3} labelled **D**. The identity of this solution is **not** to be disclosed to candidates;

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

(f) 200 cm^3 of dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3}, labelled **dilute sulphuric acid**;

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

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

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

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

(k) 5 cm^3 of aqueous potassium iodide; concentration approximately 0.5 mol dm^{-3};

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

(m) access to a bottle of concentrated hydrochloric acid;

(n) access to a bottle of phosphorus pentachloride;

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

(p) 5 cm^3 of freshly prepared aqueous starch; concentration approximately 1%;

(q) blue and red litmus paper;

(r) a supply of distilled water.

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

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

Table 2

Check subtractions and averaging arithmetic correcting if necessary.

All volumes recorded to 0.05 cm^3 (1)
Allow one slip but withhold this mark if any readings are in the wrong boxes.
Allow 0, 0.0, 0.00 as initial volume.
NOT 50 as initial volume.
All subtractions completed correctly (1)
[✔ ✔ top RHS of Table 2]

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

Accuracy
If the candidate has made an arithmetical error in Table 2 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.
Home centres
For each candidate calculate
*mass G x 2.55 = expected titre
[*corrected if necessary]
International centres
For each candidate calculate
Supervisor's mean titre x candidate's mass G
Supervisor's mass G
= expected titre
Calculate the difference(d) between the candidate's mean titre and the expected titre.
Record the difference as
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Award marks for accuracy as follows
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Range
The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range on the corrected titres used by the examiner to calculate the mean.
</td><td></td><td></td><td>12</td></tr>
</table>

	r =	0.20	0.30	0.50	
	Mark	**3**	**2**	**1**	

Examiner to show the marks awarded for accuracy and range as
d = value r = value
✔ 4 MAX ✔ 3 MAX

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Moles MnO_4^- in mean titre = mean titre x 0.0200 / 1000 Ignore units Answer to at least 3 SF	Penalise SF once only in (i) and (ii) and allow loss of trailing zeros if correct arithmetically in (i) and (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Moles Fe^{2+} = moles MnO_4^- in mean titre x 5 in 25.0 cm^3 Ignore units Answer to at least 3 SF			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Moles Fe^{2+} = answer to (b)(ii) x 10 **(1)** in 250 cm^3 Mass Fe^{2+} in 250 cm^3 = above answer x 55.9 **(1)** % Fe^{2+} by mass = above answer x 100% / Mass of **G** from Table 1 and to 3 SF only e.g. 14.6 % **(1)** Ignore units	Use of 56		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Excess / unreacted $KMnO_4$ (colours solution in flask)			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Observations Blue precipitate **(1)** Insoluble in excess **(1)** Inference $Cu(OH)_2$ /copper(II) hydroxide (**1**)	 $[Cu(H_2O)_4(OH)_2]$		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Observations (Goes) brown **(1)** Ignore any ppt Blue / Black / Blue-black **(1)** Ignore any ppt Inference Iodine /I_2 /copper(I) iodide/CuI **(1)**	 Cu_2I_2	 I	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$2Cu^{2+} + 4I^- \rightarrow 2CuI / Cu_2I_2 + I_2$ *[Ignore state symbols]*			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Observation Yellow / green (solution) **(1)** Inference $[CuCl_4]^{2-}$ **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Ligand exchange / substitution			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	Observations Green precipitate **(1)** Insoluble in excess **(1)** Inference $Ni(OH)_2$ / nickel hydroxide or $Fe(OH)_2$/iron (II) hydroxide **(1)**	 $[Ni(OH)_2(H_2O)_4]$ / $[Fe(OH)_2(H_2O)_4]$	 Any Cr compound	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (e)	Observation White precipitate **(1)** Inference $NiSO_4$ **(1)**	 Allow $FeSO_4$ as a cq answer	(Any) green ppte	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	Observation (Orange to) green / blue **(1)** Inferences Oxidation **(1)** Primary, secondary alcohol, aldehyde; **all three** for **(1)**	 Dichromate oxidises	 Redox /reduction K is a reducing agent $Cr_2O_7^{2-} \rightarrow 2Cr^{3+}$	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	Observation sweet / fruity/ glue smell **(1)** Inferences ester **(1)** **K** is (primary or secondary) alcohol / 'not an aldehyde' if follows 3rd mark in (a) **(1)**			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	Observation (Pale) yellow precipitate **(1)** Inferences Iodoform / tri-iodomethane /CHI_3**(1)** CH_3CHOH / methyl secondary alcohol (or ethanol) **(1)**		Any answer including methyl ketone / CH_3CO / ethanal	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	$CH_3CH(OH)CH_2CH_3$	Full structural / skeletal formula	—H—O bond	**1**

3 (c), (d)

If no ppt observed in (c) then may allow 3rd mark in (c) for e.g. 'not methyl secondary alcohol (or ethanol)' then allow butan-1-ol in (d).

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**T1** ✓ Candidate's test on all **four** compounds **R1** ✓ Observation and inference from test on all **four** compounds **T2** ✓ Candidate's second test **R2** ✓ Observation and inference from second test **T3** ✓ Candidate's third test **R3** ✓ Observation and inference from third test **L** ✓ Remaining compound is cyclohexane Tests and observations / inferences which can be done in any order. Each test and observation to maximum **(2)** • 2, 4 – DNP / Brady's reagent Observation + logical deduction • Iodoform test Observation + logical deduction • Fehling's / Tullens/ acidiefied dichromate (VI) Observation + logical deduction • Bromine water / solution Observation + logical deduction If identity of compound is assumed then each test (0) but observation (1). Ignore conditions throughout.			**7**

Group 2 (6246/01B): this practical test must be taken on the day specified on the official timetable, and is available to Home Centres, International Teaching Institutions and International Centres.

Apparatus and Materials

Apparatus

Each candidate will require:

1. seven test tubes in a test tube rack;
2. 10 cm^3, 25 cm^3 or 50 cm^3, and 100 cm^3 measuring cylinders;
3. a supply of dropping pipettes;
4. spatula;
5. one 100 cm^3 beaker;
6. access to balance weighing to at least 0.01 g;
7. one 250 cm^3 beaker;
8. one 250 cm^3 volumetric flask with stopper;
9. funnel to fit volumetric flask;
10. glass rod;
11. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
12. small beaker for draining burette;
13. 25.0 cm^3 pipette and safety filler;
14. white tile;
15. two 250 cm^3 conical flasks;
16. a supply of hot water (about 70 °C) and a 250 cm^3 beaker for a water bath.

Materials

Each candidate will require:

(a)* 200 cm^3 of aqueous potassium manganate(VII), $KMnO_4$, of concentration 0.0200 mol dm^{-3} labelled **Solution F**;

(b)* Between 8.9 g and 9.1 g of ammonium iron(II) sulphate, $(NH_4)_2SO_4.FeSO_4.6H_2O$, in a stoppered weighing bottle or similar labelled **G**. The identity of this compound is **not** to be disclosed to candidates;

(c)* 10 cm^3 of aqueous copper(II) sulphate of concentration 0.25 mol dm^{-3} labelled **H**. The identity of this solution is **not** to be disclosed to candidates;

(d)* 10 cm^3 of aqueous nickel(II) sulphate of concentration 0.25 mol dm^{-3} labelled **J**. The identity of this solution is **not** to be disclosed to candidates;

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

(f) 200 cm^3 of dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3}, labelled **dilute sulphuric acid**;

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

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

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

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

(k) 5 cm^3 of aqueous potassium iodide; concentration approximately 0.5 mol dm^{-3};

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

(m) access to a bottle of concentrated hydrochloric acid;

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

(o) 1 cm^3 of ethanoic acid in a stoppered test tube labelled **ethanoic acid**;

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

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

(r) 5 cm^3 of freshly prepared aqueous starch; concentration approximately 1%;

(s) a supply of distilled water.

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

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Weighings correctly subtracted (1)
[✔ ✔ RHS of Table 1]

Table 2

Check subtractions and averaging arithmetic correcting if necessary.

All volumes recorded to 0.05 cm^3 (1)
Allow one slip but withhold this mark if any readings are in the wrong boxes.
Allow 0, 0.0, 0.00 as initial volume.
NOT 50 as initial volume.
All subtractions completed correctly (1)
[✔ ✔ top RHS of Table 2]

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

Accuracy
If the candidate has made an arithmetical error in Table 2 or in averaging then the examiner must calculate a new average.
• For an averaging error simply calculate a new value using the candidate's chosen values
• If a wrongly subtracted titre has been used in the mean then choose any two identical titres or take an average of the closest two.
For each candidate calculate
Supervisor's mean titre x candidate's mass S = expected titre
Supervisor's mass S
Calculate the difference(d) between the candidate's mean titre and the expected titre.
Record the difference as
d =…… on the script

Award marks for accuracy as follows
<table>
<tr><td>d =</td><td>±0.30</td><td>±0.50</td><td>±0.70</td><td>±1.00</td><td>>1.00</td></tr>
<tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
</table>
Range
The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range on the corrected titres used by the examiner to calculate the mean.

<table>
<tr><td>r =</td><td>0.20</td><td>0.30</td><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
✔ 4_{MAX} ✔ 3_{MAX}
</td><td></td><td></td><td>12</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	Moles of Fe^{2+} salt used = mass **S** used / 392 Ignore units Answer to at least 3 SF	Penalise SF once only in (i) and (ii) and allow loss of trailing zeros if correct arithmetically in (i) and (ii)		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Conc^{n} Fe^{2+} salt = above answer x 1000 / 250 Ignore units Answer to at least 3SF			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Moles Fe^{2+} in 25.0 cm^3 = answer to (b)(ii) x 25.0 / 1000 **(1)** Moles MnO_4^- in mean titre = moles Fe^{2+} in 25.0 cm^3 / 5 **(1)** Conc^{n} MnO_4^- = moles MnO_4^- in mean titre x 1000 / mean titre **(1)** Answer to 3 SF only Ignore units			**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	Either $KMnO_4$ acts as own indicator or excess / unreacted $KMnO_4$ colours solution in flask or description of colour change in flask.			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Observations White precipitate **(1)** Soluble / dissolves in excess / colourless solution**(1)** Inferences $Al(OH)_3$/ $[Al(H_2O)_3(OH)_3]$ **(1)** $[Al(OH)_6]^{3-}$ / $[Al(OH)_4]^-$ **(1)** **2nd inference mark is conditional on 2nd observation.**	Goes clear AlO_2^- /$NaAlO_2$ / $NaAl(OH)_4$ / $Na_3Al(OH)_6$ Equivalent Pb / Sn species.	 Zn compounds	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	Observation White precipitate **(1)** Inference AgCl / silver chloride **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	$AlCl_3$		$PbCl_2$ Al_2Cl_6	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	Observations Brown precipitate **(1)** Insoluble in excess **(1)** Inference $Fe(OH)_3$ / Iron(III) hydroxide **(1)**	Foxy-red $[Fe(H_2O)_3(OH)_3]$		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (e)(i)	Observations Brown / orange / red (solution) **(1)** Blue / Black / Blue-black **(1)** Ignore any ppts Inference Iodine / I_2 / KI_3 **(1)**		 I	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (e)(ii)	$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$ *Ignore state symbols*			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (f)	$FeCl_3$			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	Observation (Orange to) green / blue **(1)** Inferences Oxidation **(1)** Primary, secondary alcohol, aldehyde; **all three** for **(1)**	Dichromate oxidises	Redox / reduction X is a reducing agent $Cr_2O_7^{2-} \longrightarrow 2Cr^{3+}$	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)	Observation effervescence / bubbles **(1)** Inference carboxylic / COOH / CO_2H acid **(1)**		Gas evolved	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	Observation sweet / fruity / glue smell **(1)** Inferences ester **(1)** **X** is (primary or secondary) alcohol / 'not an aldehyde' if follows 3rd mark in (a) **(1)**	.	Ester smell as observation	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	**X** CH_3CH_2OH **(1)** **Y** CH_3COOH **(1)**	Full structural / skeletal formula	—H—O bond	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4	**T1** ✔ Candidate's test on all **four** compounds **R1** ✔ Observation and inference from test on all **four** compounds **T2** ✔ Candidate's second test **R2** ✔ Observation and inference from second test **T3** ✔ Candidate's third test **R3** ✔ Observation and inference from third test **L** ✔ Remaining compound is hexane Tests and observations / inferences which can be done in any order. Each test and observation to maximum **(2)** • 2, 4 – DNP / Brady's reagent Observation + logical deduction • Iodoform test Observation + logical deduction • Fehling's / Tollens/ acidified dichromate (VI) Observation + logical deduction • NaOH + HNO_3 + Ag ✔ NO_3 Observation + logical deduction If identity of compound is assumed then each test (0) but observation (1). Ignore conditions throughout.			**7**

Group 3 (6246/01C): this practical test is only available to **International Teaching Institutions** and **International Centres**. The date of this practical test MUST be agreed in advance through submission of Form ES-F8-MJ2009 found in the International Information Manual.

Apparatus and Materials

Apparatus

Each candidate will require:

1. five test tubes in a test tube rack;
2. 10 cm^3, 25 cm^3 or 50 cm^3, and 100 cm^3 measuring cylinder;
3. a supply of dropping pipettes;
4. spatula;
5. one 100 cm^3 beaker;
6. access to balance weighing to at least 0.01 g;
7. one 250 cm^3 beaker;
8. one 250 cm^3 volumetric flask with stopper;
9. funnel to fit volumetric flask;
10. glass rod;
11. 50.0 cm^3 burette, in stand and clamp, with small funnel for filling;
12. small beaker for draining burette;
13. 25.0 cm^3 pipette and safety filler;
14. white tile;
15. two 250 cm^3 conical flasks;
16. a supply of hot water (about 70 °C) and a 250 cm^3 beaker for a water bath.

Materials

Each candidate will require:

(a) 200 cm^3 of aqueous potassium manganate(VII), $KMnO_4$, of concentration 0.0200 mol dm^{-3} labelled **Solution R**. The concentration of this solution is **not** to be disclosed to candidates;

(b) between 8.9 g and 9.1 g of ammonium iron(II) sulphate, $(NH_4)_2SO_4.FeSO_4.6H_2O$, in a stoppered weighing bottle or similar labelled **S**;

(c) 10 cm^3 of aqueous aluminium chloride of concentration 0.25 mol dm^{-3} labelled **V**. The identity of this solution is **not** to be disclosed to candidates;

(d) 10 cm^3 of aqueous iron(III) chloride of concentration 0.25 mol dm^{-3} labelled **W**. The identity of this solution is **not** to be disclosed to candidates;

(e) 5 cm^3 of ethanol labelled **X**. The identity of this compound is **not** to be disclosed to candidates;

(f) two 2 cm^3 portions of ethanoic acid; one in a stoppered boiling tube and one in a stoppered test tube, both labelled **Y**;

(g) 200 cm^3 of dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3}, labelled **dilute sulphuric acid**;

(h) 15 cm^3 of dilute sodium hydroxide; concentration approximately 1.0 mol dm^{-3};

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

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

(k) 5 cm^3 of aqueous silver nitrate; concentration 0.05 mol dm^{-3};

(l) 5 cm^3 of aqueous potassium iodide; concentration approximately 0.5 mol dm^{-3};

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

(n) access to a bottle of solid sodium hydrogencarbonate;

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

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

(q) 5 cm^3 of freshly prepared aqueous starch; concentration approximately 1%;

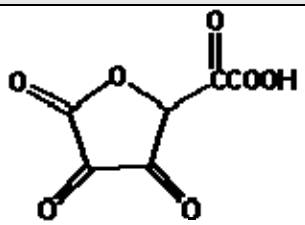
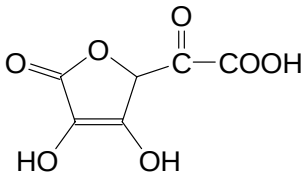
(r) a supply of distilled water.

6246/02

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	Cell potential = (+) 0.67(V) (so reaction is feasible) **(1)** ratio ascorbic:iodine = 1:1 **(1)**	E° for I_2/ I^- larger / more positive than for ascorbic acid Or vice versa Overall correct equation can score second mark	Just 'E is positive'	**2**

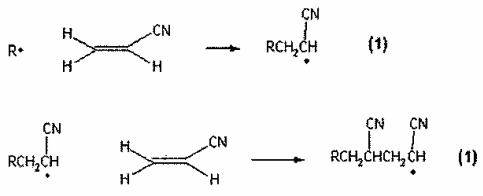
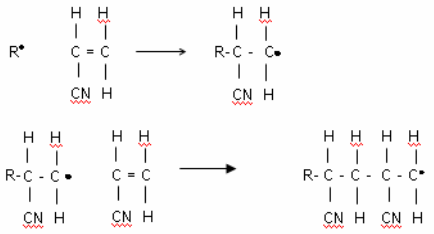
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	Amount iodate(V) used = 0.02083 dm^3 x 0.01 (mol dm^{-3}) = 2.083 x 10^{-4} (mol) **(1)** Ratio IO_3^- : ascorbic acid = 1:3 ∴ amount ascorbic acid = 6.249 x 10^{-4} (mol) **(1)** ∴ mass ascorbic acid = 6.249 x 10^{-4} x 176 **(1)** consequential on moles = 0.11 g **(1)** **Answer with unit to ≥ 2 sf** with no rounding errors Correct answer with no working (4) If fail to use correct ratio, penalise 1 mark e.g. 1:1 gives 0.0367 which then scores 3	Mark Cq on their ratio in (a)(i)	0.10	**4**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	First mark Identify hydrogen bond (1) Second mark Either δ^+ H on ascorbic acid attracted to lone pair/to δ^- oxygen atom on water Or δ^+ H on water attracted to lone pair/ δ^- oxygen of OH groups on ascorbic acid **(1)** Third mark **Many** places for hydrogen bonds (in ascorbic acid) **(1)**		2 places	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	 **(1)**			**1**

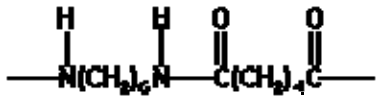
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	 **(1)** We must have the lone pairs on oxygen	All dots or all crosses or any combination		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	C=C electrophilic (addition) **(1)** C=O nucleophilic (addition) **(1)** Third mark C=O polar (but C=C not) Or C is δ+ in C=O Or C=C has high electron density (1) *Note: Third mark can be awarded from an explanation of the mechanism*		Substitution Substitution	**3**

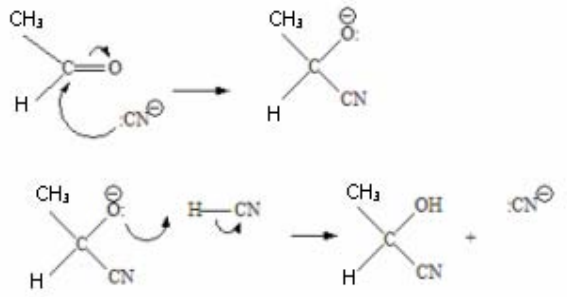
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	 (1) (1) *Note* *Ignore any use of half arrows* *Use of full arrows max 1* *Ignore termination step*	Accept attack on the other carbon in C=C, i.e. the one bearing the cyanide. 	Radical on the cyanide group. This scores zero as the result is not this polymer	**2**

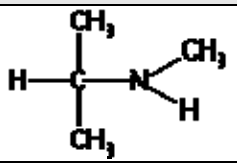
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	*Conditions mark conditional on correct reagent* $LiAlH_4$ **(1)** in dry ether **(1)** (followed by acid hydrolysis) OR $NaBH_4$ (1) in water/ alcohol(1) OR hydrogen **(1)** with platinum/ palladium (catalyst) **(1)** OR sodium **(1)** in ethanol **(1)**	Ni at 150^{o}C/heat		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Conditional on reagent in (i) If sodium chosen: **no,** because reagent too expensive **(1)** OR If $LiAlH_4$ or $NaBH_4$ chosen: **no**, because reagent too expensive **(1)** OR If H_2 chosen: **yes**, because reaction gives no other products / hydrogen is cheap/product is easily separated from the catalyst **(1)**		Just "batch process"	**1**

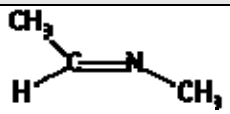
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iii)	 **(1)** for the repeating unit Allow if more than one given **(1)** for HCl / hydrogen chloride	Amide group may be represented as NHCO etc	hydrochloric acid, HCl(aq)	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	**Either:** Bonds broken 612 + 360 + 463/ =1435 Bonds made 412 + 348 + 743/ = 1503 ΔH = - 68 kJ mol^{-1} **(1)** Exothermic so reaction will take place/ vinyl alcohol thermodynamically unstable **(1)** Cq on their values as long as ΔH is negative **OR** adds up all the bond energies for vinyl alcohol to get 2671 kJ mol^{-1} and for ethanal to get 2739 kJ mol^{-1} ΔH = - 68 kJ mol^{-1} **(1)** Exothermic so reaction will take place/ vinyl alcohol thermodynamically unstable **(1)**	-68 with no working scores first mark	Any positive value scores 0 overall Kinetically unstable Kinetically unstable	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (e)	Each mark standalone  **both** curly arrows in 1st diagram, attack by cyanide, arrow must start from C or –ve charge on C **not** N and –ve charge must be present somewhere on ion; lone pair not essential. Arrow must start from bond between C and O and point towards the O **(1)** Intermediate – lone pair not essential but negative charge is essential **(1)** Arrow from O (lone pair not needed) or negative charge to HCN or H^+, this can be shown on the diagram of the intermediate **(1)** If HCN is used the arrow from H-CN bond is required Any other ketone or aldehyde, **max (2)**	curly arrow from O to H^+		**3**

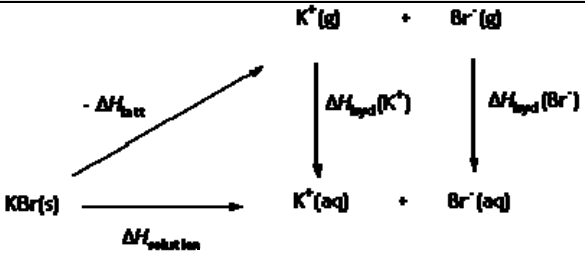
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (f)(i)	 **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (f)(ii)	Restricted rotation about the C=N/ double bond **(1)** N atom has a **lone pair** of electrons (and another group) **(1)**	No rotation (at rtp) about the C=N/ double bond		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (f)(iii)	 **(1)** Must be the trans / anti	90 degree bond angles around the carbon/ nitrogen	180 degree bond angle around nitrogen	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	Diagram Water drawn V-shaped with H-O-H bond angle marked between 106^o and 102^o. **(1)** Shape Explanation V-shape because Either 2 b.p. and 2 l.p. repel as far apart as possible / minimum repulsion / maximum sep**aration** or 4 electron pairs repel as far apart as possible / minimum repulsion / maximum sep**aration (1)** Ignore any reference to relative repulsions Polarity (standalone mark) Polar because individual bond polarities don't cancel **(1)**	 The number of lone pairs can be shown on diagram Bonds polar (could be shown on diagram) **and** molecule is not symmetrical	 4 bond pairs… Charges don't cancel	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	**EITHER** Polar water molecules attracted to/bond with the ions **OR** δ^+ H attracted to anion / δ^-O attracted to cation **(1)** which is an exothermic process which offsets the endothermic lattice energy **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	 First mark species with state symbols **(1)** **Allow one state symbol omitted** ignore aq on left Second mark labelling of lattice and hydration enthalpies **(1)** numbers or symbols if lattice energy arrow drawn downwards it must be labelled **(+)** ΔH_{latt} or -670 Third mark **Stand alone** $\Delta H_{solution}$ = (+670) + (-322) + (-335) = (+) 13 (kJ mol^{-1}) **(1)**	Drawn as energy-level diagram		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	2 $[Fe(H_2O)_6]^{2+}$ + ½ O_2 + $2H^+$ → 2 $[Fe(H_2O)_6]^{3+}$ + H_2O **(1)** E° = (+) 0.46(V) so feasible **(1)**	If use cyanide in equation, +0.87 scores second mark only E° for third reaction >/more positive than E° for first reaction		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	E° = + 0.87V so (thermodynamically) is more favoured **(1)**	E° for cyano overall reaction >/more positive than E° for aqua overall reaction so more likely		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ **(1)** Ignore any state symbols	$SiCl_4 + 4H_2O \rightarrow Si(OH)_4 + 4HCl$ (1) Allow $SiO_2.2H_2O$	Do not allow partial hydrolysis.	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**Common mark** Oxygen lone pair to attack the carbon atom **(1)** **Then** *If mix and match, mark the 'either' route out of 2 and mark 'or' route out of 2 and award the higher mark* **Either** Carbon has no 2*d*/energetically available orbitals **(1)** C-Cl bond would have to break first **(1)** **OR** Chlorine atoms larger than carbon atoms **(1)** (Water) sterically hindered from attacking **(1)**		References to Cl ions or Cl^- in place of Cl atoms max 2 C has no *d* orbitals CCl_4 has no 2*d* orbitals	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	Chloride ions deprotonate water (which has been polarised by magnesium ions) **(1)** residue is MgO /magnesium oxide/$Mg(OH)_2$ /magnesium hydroxide **(1) STAND ALONE**	$MgCl_2$ is hydrolysed by water (of crystallisation)		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)	Same amount of each halogenoalkane **(1)** Ignore references about adding alcohol Add $AgNO_3$ solution **(1)** Ignore references to nitric acid see which forms precipitate first **(1)**	Same volume	 Lose second and third marks if NaOH added Reference to weight of ppt.	**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Mass of acid in $1dm^3$ concentrated acid = 0.98 x 1800 g = 1764 (g) **(1)** Concentration of acid = 1764g ÷ 98 g mol^{-1} = 18 (mol dm^{-3}) **(1)** Correct answer with no working scores 2	Allow 1 mark for 1800 divided by 98 = 18.37		**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	First ionisation of sulphuric acid is complete **(1)** This **suppresses** second ionisation (therefore $[H_3O^+]$ is very similar to that in HCl so pH very similar) **(1)**			**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	$H_2SO_4 + NaCl \rightarrow NaHSO_4 + HCl$ **(1)**	$H_2SO_4 + 2NaCl \rightarrow Na_2SO_4 + 2HCl$		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	**First mark: Trend** $Cl^- < Br^- < I^-$ (or names) **(1)** **stand alone** **Second mark: evidence to support first mark** Either using numbers I^- reduces the S in SO_4^{2-} to the **lowest** o.s. of all whereas Br^- only to +4 and Cl^- not at all Or using amount of change I^- lowers the **oxidation number** of sulphur the most **(1)** **Third mark:** Either I^- is the largest of the ions and loses electrons most easily/attraction for outer electron is weakest Or Cl^- is the smallest of the ions and so attraction for outer electron is strongest **(1)**	Equivalent explanation based on $I^- > Br^- > Cl^-$ from 6 → 0 or -2	Cl < Br < I, or the names of the halogens. Decreases scores 0 overall. Just "Iodide reduces the sulphuric acid more"	**3**

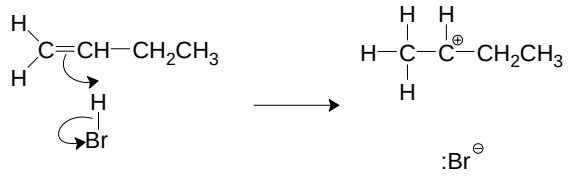
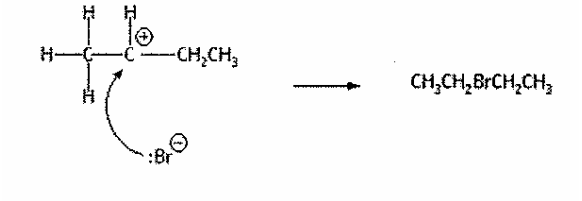
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	**Either** (Moist) **red** phosphorus **(1)** iodine **(1)** **Or** phosphoric acid **(1)** potassium/sodium iodide **(1)**		Just "phosphorus" Sulphuric acid and KI/NaI scores 0	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	If phosphorus + iodine or no answer in (i) PI_3 **Or** If phosphoric acid used or no answer in (i) HI **(1)**	PI_5	PI_3 from any other source. HI from any other source	**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i)	(It is unbranched because) **Either** m/e 29 is caused by the ion $CH_3CH_2^+$/ $C_2H_5^+$ *charge essential* **Or** m/e 29 means the molecule has a C_2H_5 group **(1)**			**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	Bromo (no mark for this alone) **Either** molecular ion has *m/e* 136 and/or 138 **Or** molecular ion peaks are two units apart **(1)** two peaks of same size (differing by 2 mass units which fits the 50/50 isotopic composition of bromine) **(1)**	Argument that it cannot be chloro or iodo on basis of *m/e* of molecular ion **(1)** and some isotopic justification **(1)**	Just "peak at 136 and/or 138"	**2**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(i)	KOH in ethanol (both needed) / ethanolic KOH **(1)**	"NaOH" for "KOH"		**1**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4(e)(ii)	 (1) for both arrows (1) for carbocation  Both arrows in step 1 **(1)** intermediate structure **(1)** arrow from bromide ion **(1)** Lone pair on Br^- is not required Wrong alkene max 2.	Arrow from negative charge		**3**

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (e)(iii)	(Formation of 2- isomer is via) a secondary carbocation **(1)** which is more stable (than the primary carbocation) **(1)**	Allow carbocation with more alkyl groups	Any argument based on stability of product Explanation in terms of Markovnikov's rule	**2**

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