edexcel
advancing learning, changing lives

Mark Scheme Summer 2008

GCE

GCE Chemistry (8080/9080)

Edexcel Limited. Registered in England and Wales No. 4496750
Registered Office: One90 High Holborn, London WC1V 7BH

A PEARSON COMPANY

Edexcel is one of the leading examining and awarding bodies in the UK and throughout the world. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers.

Through a network of UK and overseas offices, Edexcel's centres receive the support they need to help them deliver their education and training programmes to learners.

For further information please call our Customer Services on 0870 240 9800, or visit our website at www.edexcel.org.uk.

Summer 2008

Publications Code UA 020042

Contents

General Marking Guidance

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

Using the mark scheme

1 / means that the responses are alternatives and either answer should receive full credit.
2 ( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
3 [ ] words inside square brackets are instructions or guidance for examiners.
4 Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
5 OWTTE means or words to that effect
6 ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

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

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

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

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

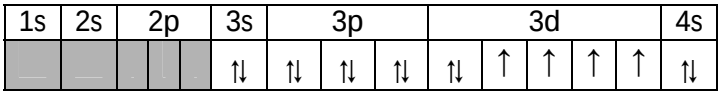
6241/01

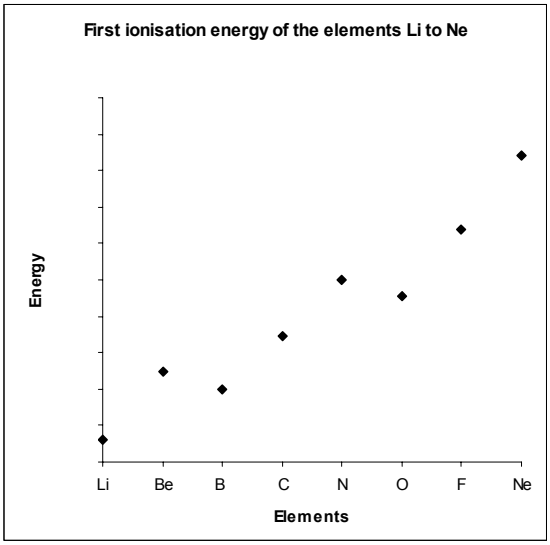
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	High energy/fast/gun electrons **hit/strike** *OR* bombarded by electrons **(1)** Removes/knocks out /causes loss of electron *OR* equation e.g. $X \rightarrow X^{+} + e^{(-)}$ OR $X + e \rightarrow X^{+} + 2e$ **(1)** *IGNORE state symbols* *If knock out is mentioned, hit/strike is not required in 1st mark*		Any suggestion that a negative ion is produced score zero overall If just "forms a cation/positive ion", not sufficient for second mark	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	Mass **(1)** Charge **(1)** *Ignore the following:* *speed* *kinetic energy* *size/volume* *radius* *charge density* *density*	Weight Mass: charge ratio OR *m/e* OR *m/z* **(1)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	**1st mark** (stand alone) The mass of an **atom** (of the isotope) **(1)** **2nd mark** (stand alone) Relative to $^{1}/_{12}^{th}$ the mass of a ^{12}C (atom) OR Relative to ^{12}C = 12(exactly) OR On a scale where C^{12} has a mass of 12 **(1)** **If 'atom' missing from 1st mark it can score if mentioned in 2nd mark**	**1st mark** The mass of a mole of the **isotope (1)** **2nd mark** Relative to $^{1}/_{12}^{th}$ the mass of a **mole** of ^{12}C OR On a scale where a **mole** of C^{12} has a mass of 12 g **(1)** **Must mention the word 'mole' at least once in these definitions** **Answer must be either consistently atoms or moles in order to be awarded both marks**	Average mass/ weighted average/ Element instead of isotope	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)	[(49.95 x 4.345)+(51.94 x 83.79)+(52.94 x 9.501)+(53.94 x 2.364)]/100 **(1)** = 51.9958 = 52.00 *must be to 4 SF* **(1)** Correct answer to 4SF with no working **(2)** Should not have units but allow g mol^{-1} Allow error carried forward only on transcription error of mass or percentage	51.99 scores (1) not (2)	52 52.0 52.00 g	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)	 **2 marks** for fully correct configuration **1 mark** if 26 electrons with 2 in 4s but the 3d electrons shown as pairs Ignore the way the arrow heads point in the singly occupied 3d boxes. Allow half arrows ↿⇂ or | or ↑ or any combination in any box	Vertical lines in place of arrows **1 max**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	 General increase, starting with carbon above boron **(1)** Dip from N to O only **(1)**	Lines joining points do not need to be drawn in. a very small drop from N to O		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)	• The **nuclear** charge/proton number increases / becomes more positive **(1)** • The (inner shell) shielding is the same/same number of inner shell electrons/ no or little increase in shielding **(1)** **Either** • **Outer** electron closer to nucleus /**atomic** radius decreases /size of atom decreases **Or** • electrons being removed are in same shell **Or** • **Outer** electrons are in same shell **(1)**		Atomic Number increasing	3

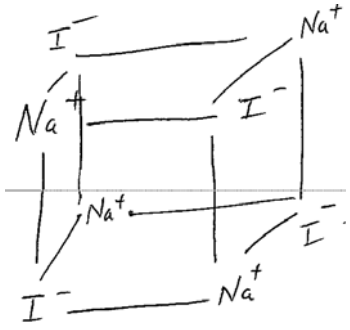
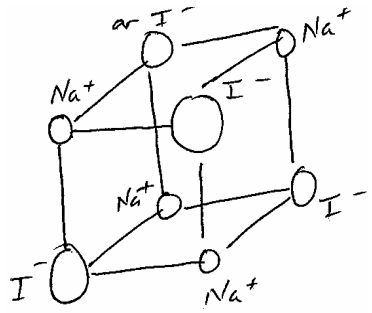
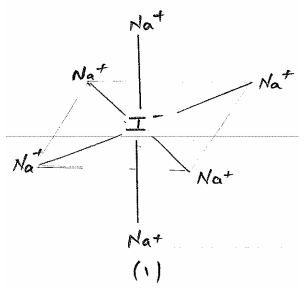
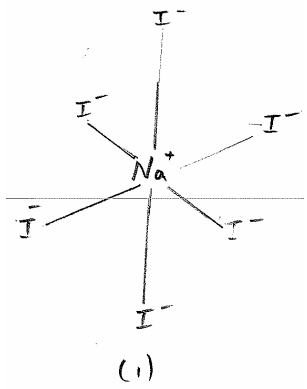
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	In boron the extra electron is in a p orbital /new sub-shell **(1)** **Either** Which has extra shielding (by the s orbital electrons) **OR** Which is at a higher energy (level than the s orbital in Be) **(1)**	Reverse argument for beryllium	Shell for sub-shell Answers that refer to full shell being left do not score second mark Further from the nucleus	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	$Mg^{+}(g) \rightarrow Mg^{2+}(g) + e^{(-)}$ $Mg^{+}(g) - e^{(-)} \rightarrow Mg^{2+}(g)$ Species **(1)** State symbols **(1)** Ignore (g) as state symbol for e^{-}	$X^{+}(g) \rightarrow X^{2+}(g) + e$ Or any other symbol can score SS mark only	Any other equations score zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Dative /dative co**v**alent/co-ordinate	"dative co**n**valent"	Just "covalent"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Co**v**alent	Polar covalent	Any reference to hydrogen bonding	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	*Please read complete answer first* **1st mark Stand alone** The Mg^{2+}/cation/Mg ion has (the same charge but) smaller size OR Mg^{2+}/cation has larger charge density **(1)** **2nd Mark** Mg^{2+}/cation /Mg ion is more polarising OR Carbonate anion more polarised **(1)** **3rd mark We are looking for some effect on the carbonate ion of the above** Carbon to oxygen bond weakened OR Weakens (covalent) bonds **in** the carbonate OR electrons in anion pulled towards the cation OR Distorts the electron cloud (around the carbonate)	Reverse argument based on Ba^{2+} Mg^{2+}/cation /Mg ion has greater polarising power	Mention of molecules and atoms throughout answer scores **(0)** Penalise omission of ions only once Mention of covalency between metal and carbonate/ electronegativity/ vdW or other intermolecular forces / polarising power of the carbonate ion scores zero for last 2 marks Weakens IONIC BONDS	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	Diagram with Layer made of alternate identified Na^+/sodium ion **and** I^-/iodide ion **(1)** Extended to more than one layer **(1)**   Also allow  (1)  (1)	Correct structure with + for Na^+ and – for I^- scores (2) Correct unlabelled structure or with omission of charges scores (1)		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	Ionic radius /Size of ion **(1)** Charge **(1)**	Size and charge scores (2) Charge density scores (1)	Any reference to size of element, atoms or molecules loses first mark Nuclear charge	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	Iod**ide** (ion) larger than chlor**ide** (ion) (but has same charge) larger ionic radius **(1)** *Note* *References to iodine and/or chlorine loses 1st mark* (So increase distance between centres of charge means)forces of attraction are less/ weaker ionic bond OR Cl^- has higher charge density so stronger attraction to Na^+ **(1)**	Reverse argument	References to atoms, molecules or other forces such as vdW or covalent bonding scores zero overall	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	In molten (NaI) the ions are free to move **(1)** (and carry the current) In solid (NaI) the ions are in fixed lattice / fixed position /cannot move**(1)** Both stand alone	 In the solid, there are no mobile charge carriers	Electron movement scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)	**Strong** attraction between **ions** (in liquid) OR **Strong** forces/bonds/ionic bonds (in liquid) Or Lots of energy needed to overcome the ionic attraction or Needs a lot of energy to break ionic bonds (in liquid) **(1)**		Any reference to lattice/melting	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	$Cl_2 + 2NaBr \rightarrow Br_2 + 2NaCl$ OR $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Ignore state symbols	multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	Disproportionation **(1)** (Bromine oxidised from 0) goes to +1 and (reduced from 0) goes to -1 **(1)** **These could be shown as annotation on the equation** Answer must be in terms of change of oxidation number. Correct references to gain and loss of electrons are non-scoring points	Redox Any reasonable spelling	A general definition of disproportionation i.e. no reference to bromine	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iii)	SO_2 + 4 etc **(1)** H_2SO_4 + 6 etc **(1)** If both S^{4+} and S^{6+} given award **1 (out of 2)**	4+ IV +IV Four 6+ VI +VI six	S^{4+} S^{6+}	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iv)	The oxidation number of S is increasing (so bromine is acting as an oxidising agent) Or oxidation number of Br is decreasing so it must be acting as an oxidising agent ecf but do not award this mark if the ON of S in H_2SO_4 is shown as less than or equal to that in SO_2 in (iii)	(The oxidation number of) S goes from +4 to +6	If say oxidation number of bromine goes from 0 to -2 score zero	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	$SO_2+2H_2O \rightarrow SO_4^{2-}+4H^+ +2e^{(-)}$ **OR** $SO_2 +2H_2O - 2e^{(-)} \rightarrow SO_4^{2-} + 4H^+$	multiples		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	**Correct balanced equation** **$2\ IO_3^- + 5\ SO_2 + 4H_2O \rightarrow I_2 + 5\ SO_4^{2-} + 8H^+$** **(2)** If candidate gives this equation with one omission in balancing numbers or one ionic charge, check rest of working to see if this is a transcription error in final answer. If so, award one mark Also allow 1 mark for: $2IO_3^- + 12H^+ + 5SO_2 + 10H_2O \rightarrow I_2 + 5SO_4^{2-} + 20\ H^+ + 6H_2O$ **(1)** [There is no consequential marking from (i)]	multiples		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(i)	(pale) green	apple green yellow(y) green	blue green	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(ii)	Crimson	Red Scarlet Carmine Depth of red colour e.g. Dark red Deep red Pale red Light red Bright red	Red with any other colour e.g. Brick-red Orange-red Yellow-red Magenta	1

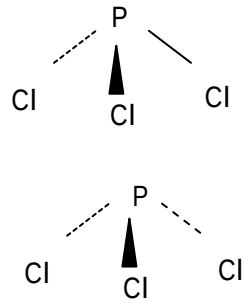
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)	Ba O 81.1 / 137 = 0.592 / 1 18.9 / 16 = 1.18 / 2 **(1)** Correct working leading to answer BaO_2 **(1)** Working must be shown and final formula given for 2 marks BaO_2 without working 1 mark	Dividing by 32 scores **(0) unless** their table is headed by O_2, then answer BaO_2 scores **(1)** but if this is the case BaO scores **(0)**	Any answer dividing by atomic number **(0)** This leads to Ba_2O	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(i)	$Ba + 2H_2O \rightarrow Ba(OH)_2 + H_2$ Ignore state symbols even if they are wrong	Multiples	Equations based on BaO	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(ii)	• Gets warm • Effervescence/fizzing/ bubbles/mist • Ba sinks/moves up and down /Does not float *Give one mark for observation from each bullet point to max of 2* 3 answers given, one wrong scores (1) 3 answers given, two wrong scores zero Ignore mention of Steam/steamy fumes Ba gets smaller Ba disappears Goes cloudy / precipitate Gas/hydrogen evolved is not an observation	Heat produced Bubbles of hydrogen	Reference to flame Melts Dashes about on surface are wrong answers	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (c)(iii)	*Red litmus* (goes) blue/ "(→) blue" **and** *blue litmus* unchanged/stays blue/no effect/nothing			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)(i)	:Cl : P : Cl: :Cl: 8 electrons around each Cl **(1)** three shared pairs and one lone pair around P **(1)** *If symbols omitted max 1*	All dots or all crosses		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)(ii)		Must be an attempt to draw as a pyramid. Wedge, dashes, both. If draw 3 lines must not look planar Ignore name unless they say planar Ignore indicated bond angles unless it is written as 120^{o}	Planar triangular even if no lone pair shown in part (i)	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (a)(iii)	**Mark consequentially on part (a)(ii)** **1st mark** PCl_3 has 4 pairs of electrons/3 bond and 1 lone pair **(1)** **2nd mark** The electron pairs repel to a position of maximum separation /minimum repulsion OR lp-bp repulsion > bp-bp **(1)** **3rd mark** CH_4 has 4 bonding pairs of electrons so angle **less** in PCl_3 or more in CH_4 OR CH_4 has no lone pairs so angle **less** in PCl_3 or more in CH_4 **(1)** **If in part (ii) they give a structure which <u>is planar triangular</u> they can score full marks for a correct description of why it is planar triangular i.e.** PCl_3 has 3 pairs of electrons **(1)** The electron pairs repel to a position of maximum separation /minimum repulsion **(1)** So the angles are 120 ^{o} for PCl_3 and CH_4 has 4 bonding pairs of electrons, so 109(.5) ^{o} for CH_4 **(1)**	Phosphorus in PCl_3 has a lone pair but carbon in CH_4 has no lone pairs scores first mark	Repulsion of atoms or bonds	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (b)(i)	Ignore sig figs unless they round to 1 sig.fig during calculation Incorrect /absent units in final answer penalise only once in part (i)/(ii) 7.19 g of PCl_5 = $\frac{7.19}{208.5}$ mol **(1)** (= 0.03448) (1 mol of PCl_5 from 1 mol of P) Mass of P = 0.03448 x 31 = 1.07 g **(1)** Penalise use of Atomic Number only once Answer with no working scores 2	2 x 31 g of P produce 2 x 208.5 g of PCl_5 **(1)** 7.19 g of PCl_5 from $\frac{2 \times 31 \times 7.19}{2 \times 208.5}$ =1.07g **(1)** Allow 0.034 but NOT 0.035		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
7 (b)(ii)	Mark consequentially on part (i) Moles of chlorine needed = 0.03448 x 2.5 **(1)** Volume = 24 x 0.03448 x 2.5 = 2.07 dm^3 **(1) –** Value **and** unit necessary Value consequential on their calculated/stated moles of chorine x 24 Answer with no working scores 2	2 x 208.5 g of PCl_5 produced from 5 x 24 dm^3 of Cl_2 **(1)** 7.19 g PCl_5 produced from $\frac{5 \times 24 \times 7.19}{2 \times 208.5}$ = 2.07 dm^3 **(1)**	Just 24 x 2.5 = 60 dm^3 scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	anode: titanium **(1)** cathode: steel/Nickel/Ni **(1)** If both correct but in wrong place max 1		graphite	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	**Anode** $2Cl^- \rightarrow Cl_2 + 2e^{(-)}$ $2Cl^- - 2e^{(-)} \rightarrow Cl_2$ **Cathode** $2H_2O + 2e^{(-)} \rightarrow H_2 + 2OH^{(-)}$ **(1)** If both correct but in wrong place max 1	Multiples $2H^+ + 2e^{(-)} \rightarrow H_2$		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iii)	$2H_2O + 2Cl^- \rightarrow H_2 + Cl_2 + 2OH^-$	multiples	$2H^+ + 2Cl^- \rightarrow H_2 + Cl_2$ Equation with $2e^{(-)}$ on both sides	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(iv)	treatment of (drinking) water Or to kill bacteria in water/swimming pools Or sterilisation of water Or as a disinfectant Or in **production/manufacture/making** of any one of: PVC bleaches herbicides insecticides/pesticides HCl/hydrochloric acid/hydrogen chloride named chlorinated solvents bromine titanium paper chloroethene poly(chloroethene) CFCs/HCFCs Silicon	as a bleach Or in bleach Or bleach	water purification Or swimming pools Or cleaning anything Or anything else	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	<u>species oxidised</u> chlorine/Cl_2 <u>oxidation product</u> sodium chlorate(I) / NaOCl / OCl^- /chlorate(I) (ions) **(1)** both required for mark <u>species reduced</u> chlorine / Cl_2 <u>reduction product</u> (sodium) chloride / NaCl / chloride ion/Cl^- **(1)** both required for mark	Species oxidised Cl (in Cl_2) ox. prod. sodium hypochlorite Species reduced Cl (in Cl_2)	Just "chlorate" and "sodium chlorate"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	IGNORE SF unless rounded to 1SF moles NaOCl = $\frac{100}{74.5}$ = 1.342 **(1)** (= moles Cl_2) volume Cl_2 = 1.342 x 24 = 32.2 **dm^3** - unit essential **(1)** 2nd mark consequential on moles To get the 2nd mark, must show attempt to calculate moles ie 100 ÷ x Correct answer with no working **(2)**	Method using mass: volume ratio 74.5 (g) gives 24 (dm^3) **(1)** ∴100 (g) gives 32.2 **dm^3** **(1)** <u>Some</u> common acceptable answers are: 32.16/32/31.2/31 dm^3		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a) QWC	enthalpy/heat/energy **change** when 1 mole (of a substance) **(1)** is completely burned in oxygen / burned in excess oxygen **(1)** (all species) at 1 atm/100 kPa/10^5Pa/ 1 Bar **and** "a specified temperature" **(1)**	"evolved" instead of "change" "sulphur" or "element" or "species" instead of "substance" ….298 K/ 25 °C /101 kPa Or "…..**a specified temperature** e.g. any value"	Heat/energy required "compound" instead of "substance" reacts completely with oxygen Any mention of specific products or specific amounts of products, other than SO_2, negates 2nd mark Just "273 K" Any mention of concentration negates third mark	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	<u>Temperature</u> 400 to 500 (^{0}C) or any value or range within this range inclusive **(1)** <u>Pressure</u> >1 to 5 atm or any value or range within this range inclusive **(1)** <u>Catalyst</u> Vanadium(V) oxide / V_2O_5 **(1)**	673 - 773 K or any value or range within this range vanadium pentoxide	1 atm or any range that includes 1 atm Just "vanadium oxide"	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii) QWC	<u>Temperature</u> More molecules/collisions/ particles have $E \geq E_{act}$ /sufficient energy to react **(1)** $\therefore$ a greater **proportion** of collisions are successful Or More **of** the collisions are successful **(1)** IGNORE greater frequency of collision 2nd mark dependent on 1st mark UNLESS 1st mark is not awarded through use of "atoms" <u>Catalyst</u> EITHER: provides alternative route of lower activation energy **(1)** more molecules have $E > E_{cat}$ / a greater proportion of collisions are successful **(1)** 2nd mark dependent on mention of lowered activation energy Do not penalise use of "atoms" again OR: provides (active) sites **(1)** where reactant molecules can bond/be adsorbed **(1)**	$E > E_{act}$ "energy barrier" instead of "E_{act}/activation energy" Collisions more **likely** to be successful Greater chance of successful… More successful collisions per second "energy barrier" instead of "E_{act}/activation energy" Collisions more **likely** to be successful Greater chance of successful… More successful collisions per second	More atoms…. just "more successful collisions" "..fruitful collisions" just "more successful collisions" N.B. Penalise "more collisions are successful" only once "..fruitful collisions" Where reaction can take place	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii) **QWC**	reaction exothermic **(1)** equilibrium shifts to the left decreasing the yield **(1)** 2nd mark is dependent on the 1st and is not consequential. IGNORE Le Chatelier explanations	ΔH negative/reverse reaction is endothermic	Just "equilibrium shifts to the left" Just "yield decreases"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iv) **QWC**	fewer (gaseous) molecules /particles/moles on the right **(1)** equilibrium shifts to the right increasing the yield **(1)** 2nd mark is dependent on the 1st and is not consequential. IGNORE Le Chatelier explanations N.B do not penalise omission of either 'equilibrium shifts' or change of yield if already penalised in (iii)		Just "equilibrium shifts to the right" Just "yield increases" Arguments based on volume	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	$\Delta H = \Delta H_f$ (products) − ΔH_f (reactants) Or (−814×2) − (−286×2) **(1)** = −1056 (kJ mol^{-1}) **(1)** IGNORE units Correct answer with no working **(2)** Omission of either or both of ×2 **max 1.** Hence -242 with some working **(1)** -1342 with some working **(1)** -528 with some working **(1)** (+)1056 with some working **(1)**		ΔH_f vaues added scores zero overall	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	any one of: **making** fertiliser/ detergents/ paint/ pigment inc TiO_2/ dyes/ fibres/ plastics/ pharmaceuticals/ explosives OR (in) car batteries OR pickling iron OR anodising Al OR electrolytic refining of copper		Making soap	1

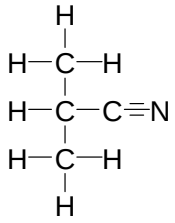
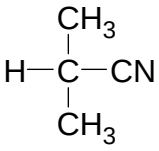
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	Any two of • (same) general formula • (successive) members differ by CH_2 • (same) functional group/ (similar/same) chemical properties/reactions • regular trend in physical properties IGNORE "same properties"	(Same) **general** molecular formula	(Same) molecular formula Same physical properties Reference to a specific reaction e.g. same reaction with chlorine	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	alk**e**ne(s)		C=C alk**a**ne	1

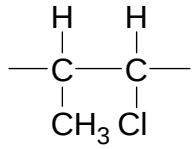
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	electrophilic addition **(1)** both needed IGNORE heterolytic and penalise homolytic hydrogen chloride/HCl **(1)**		 (Dilute) hydrochloric acid/dilute HCl /HCl(aq)	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	<u>Classification</u> nucleophilic substitution **(1)** <u>Reagent</u> potassium cyanide/KCN Or sodium cyanide/NaCN **(1)** <u>Condition</u> (Heat under reflux in) aqueous ethanol/ethanol / alcohol (solvent) **(1)** 3rd mark dependent on (a) cyanide as reagent 3rd mark can be awarded in reagent line	 Cyanide ions/CN^-	 Cyanide Aqueous alone	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	same **molecular** formula **(1)** different structural formulae/ displayed formulae/ arrangement of atoms **(1)**	Same numbers of each atom different structure	 different arrangement in space	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	There are many possibilities e.g.  Or structures including rings / multiple bonds /isonitriles	Accept CH_3 and/or CN e.g. 		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	1-bromopropane faster **(1)** Stand alone	Reverse statement	Any answer which gives 1-chloropropane as faster scores zero overall	3
	because **C-Br** bond weaker (than C-Cl) **(1)**	Reverse argument	If no reference to carbon-halogen bond	
	IGNORE attempted explanations of why C-Br bond weaker			
	therefore lower activation energy/E_{act} **(1)** [Lower E_{act} must be related to C-X bond]	Reverse argument		

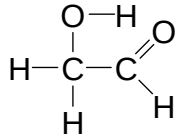
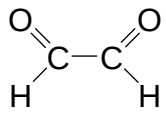
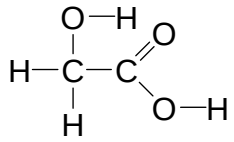
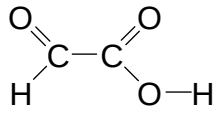
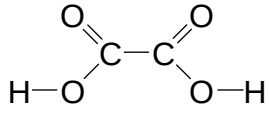
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)	 2 carbon chain with continuation bonds in repeat unit **(1)** All other atoms correct **(1)** IGNORE subscript n IGNORE where the bond to the CH_3 goes e.g.  CH_3 is fine	If more than one repeat unit given and number of repeat units stated or the repeat unit identified **(2)** If repeat unit not stated or identified can score 2nd mark only	3 carbon chain Or Any repeat unit containing a double bond scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)	Restricted rotation around double bond **(1)** 1-chloropropene has two different groups on **both** carbons/**each** carbon (in the double bond)(but propene does not) **(1)**	No rotation/double bond cannot rotate (at room temperature) Propene has two identical groups on **one** carbon (of the double bond) (but 1-chloropropene does not)		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	$KMnO_4$ /potassium manganate(VII) / potassium permanganate IGNORE any acid or alkali	Sodium analogues Or O_2 **followed** by aqueous acid	Just "Potassium manganate"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	1,2(-)dibromoethane			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	EITHER: sodium bromide/NaBr /potassium bromide/KBr **(1)** (50 %) sulphuric acid/H_2SO_4 / phosphoric acid/H_3PO_4 **(1)** OR: (Moist) red phosphorus/P **(1)** Bromine/Br_2 **(1)** 2nd mark is conditional on the 1st	HBr with concentrated/50 % sulphuric **(1 only)** concentrated H_2SO_4 PBr_3 alone **(1 only)**	 Dilute/aqueous sulphuric acid/H_2SO_4 PBr_3 plus any other reagent **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iv)	<u>Colour change</u> from orange to green/blue **(1)** <u>Oxidation products</u> **(2)** any 2 of:      Bonding from C must be to O of OH groups – penalise once only IGNORE any names	OH instead of O–H If any **two** of the following given **(1 out 2)** CH_2OHCHO $CH_2OHCOOH$ CHOCHO Or OHCCHO CHOCOOH Or OHCCOOH COOHCOOH Or $(COOH)_2$ Or HOOCCOOH Allow CO_2H for COOH in the above	…to brown CH_2OHCOH CHOCOH Or OHCCOH	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(v)	C_2H_2/CH≡CH/ethyne Or CH_2=CHBr /CH_2CHBr/bromoethene	1-bromoethene 2-bromoethene	CH_2BrCH C_2H_3Br	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	C_2H_5Br/bromoethane **(1)** (only) monosubstitution occurs **(1)** Or 1,1-dibromoethane/CH_3CHBr_2 **(1)** isomer of **B** / substitutes onto same carbon/Br (radical) can remove H from either carbon **(1)** Or 1,1,2-tribromoethane etc. **(1)** substitution continues/ polysubstitution/reaction continues **(1)** Or Butane/C_4H_{10} **(1)** Combination of two C_2H_5 radicals **(1)** The 1st mark is stand alone in each case.		Side reactions Reaction reaches equilibrium	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	$C_2H_6 + 3½\ O_2 \rightarrow 2CO_2 + 3H_2O$ Species **(1)** Balancing **(1)** IGNORE state symbols	Multiples CH_3CH_3 instead of C_2H_6	If incorrect hydrocarbon e.g. ethene scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	simplest (whole number) ratio of the different **atoms** in a compound/molecule	…..ratio of moles of **atoms**….	"elements" for "atoms"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iv)	CH_3			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(v)	Any alkane formula with odd no. of C atoms other than CH_4 This can be a structural, full structural or molecular formula IGNORE names even if incorrect			1

6243/01A

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	Obs: Lilac (1) Inf: Potassium/ K^+ (1)	Purple/ mauve	Violet K	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(i)	Obs: White precipitate (1) Inf: sulphate/SO_4^{2-} (1)	Cloudy/milky hydrogen sulphate/HSO_4^-	Goes misty SO_4 / HSO_4	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(ii)	To **prevent** the precipitation with other ions (1) Any correct ion specified	**Destroy** any ion which would interfere with the test. Any correct ion specified So that only sulphate will precipitate	Dissolve precipitate of ions or compounds	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	K_2SO_4 Conditional on correct (a) and (b)	$K(HSO_4)_2$	Potassium sulphate No charges allowed	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(i)	Grey brown **precipitate** [observation only requested]		Brown **solid** Not "just" brown without precipitate	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(ii)	Obs: Litmus turns blue (1) Inf: Ammonia/ NH_3 (1) Nitrate/ NO_3^-	 Nitrite/NO_2^-		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)	Obs: (Pale) yellow precipitate (1) Inf: Ag^+ (1) AgI (1)	 Silver/Pb^{2+}/lead PbI_2	Cream Ag/Pb	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	Check subtractions and averaging arithmetic, correcting if necessary All volumes read to 0.05 cm^3 (1) All subtractions complete (1) ✓✓ *top RHS of Table 1* **Mean Titre** For correct averaging of chosen values/ choosing identical values and for recording the average correct to 2 or 3 dps or to the nearest 0.05 cm^3 [unless already penalised] ✓ by the mean titre (1) **Accuracy** If the candidate has made an arithmetical error in Table 1 volumes used in the mean or in averaging, the examiner must calculate a new average. • For an averaging error simply calculate a new value using the candidate's chosen 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 titres Calculate the difference between the candidate's mean titre and that of the examiner or supervisor Record the difference on the scripts as d = ** Examiner's titre 22.80 cm^3 Award marks for accuracy as follows: Difference ±0.20 (6) Difference ±0.30 (5) Difference ± 0.40 (4) Difference ± 0.60 (3) Difference ± 0.80 (2) Difference ± 1.00 (1) Difference >1.00 (0)	Allow 1 slip but withhold this mark if any readings are in the wrong boxes. Accept 0; 0.0; 0.00 as initial reading	Reject 50 as initial reading	12

	Range Award a mark on the range of titres used by the candidate to calculate the mean. The range (r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range mark on the corrected titres used by the examiner to calculate the mean. Range ± 0.20 (3) Range ± 0.30 (2) Range ± 0.50 (1) Range > 0.50 (0) Examiner to show the marks awarded for the accuracy and range as d = ✓ 6 *max* r = ✓ 3 *max* then the mark out of 12 written in the margin			

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(i)	$\frac{0.150 \times \text{titre}}{1000}$ S.F. i) ii) iii) Penalise rounding to 2 s.f. once unless trailing zero iv) Ignore s.f.			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(ii)	answer (i)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iii)	answer (ii) x 40			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iv)	13.5/ answer (iii)	Ignore unit		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(v)	Titre would be too low/smaller/lower/too small (1) Because some alkali remains in the flask (1) Stand alone marks	No difference because quantity of excess alkali is within experimental error.	Just “small” Just “low” Stops too quickly or too soon	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	Table 2 Weighings in correct spaces to at least 2 dp (1) Correct subtractions (1) Table 3 Two temps recorded in correct spaces (1) BOTH to 0.5 ° C or better (1) ΔT correct with neg. sign (1) EXPECTED VALUE TO BE -6.2 for [4.95 – 5.05]g ± 0.8°C (3) ± 1.2°C (2) ± 1.6°C (1) > 1.6°C (0)			8

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	For correct substitution and evaluation (1) positive sign (1) Answer to 2 sig figs (1)			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	No because it has the same systematic errors/same errors with measuring cylinder/thermometer/heat loss/impure sample (1)		Same error in balance	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	Weigh crucible (1) ✓m1 Weigh with sample (1) ✓m2 Heat (1) ✓m3 to **constant** weight (1) ✓m4 Either Calculate mass (of gas) lost (1) ✓c1 Moles CO_2 = mass lost = moles $MgCO_3$ (1) 44/Mr ✓c2 Mass $MgCO_3$ = moles x 84 Mr (hence %) (1) ✓c3	Take known mass/stated mass (1)		7

6243/01A - Materials

Apparatus and Materials

Apparatus

Each candidate will require:

1. apparatus for a flame test;
2. spatula;
3. 10 cm^3 measuring cylinder;
4. 50 cm^3 measuring cylinder;
5. 5 test tubes and 1 boiling tube in a rack;
6. 1 stopper to fit a test tube;
7. supply of dropping pipettes;
8. test tube holder;
9. Bunsen burner;
10. 50 cm^3 burette, stand and clamp, with small funnel for filling, white tile and a small beaker for draining burette;
11. 2×250 cm^3 conical flasks;
12. 25 cm^3 pipette with safety filler;
13. expanded polystyrene cup held securely in a 250 cm^3 beaker;
14. a thermometer of range from at least room temperature to 50 °C (e.g. 0 to 50 °C or –10 to +110 °C), able to be read to ±0.5 °C or better;
15. access to a balance reading to at least 2 decimal places.

Materials

Each candidate will require:

(a)* approximately 0.5 g of potassium sulphate, labelled **X**. The identity of this must **not** be revealed to candidates;

(b)* 3 cm^3 of aqueous silver nitrate: concentration approximately 0.05 mol dm^{-3}, labelled **Y**. The identity of this must **not** be revealed to candidates;

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

(d) 1 cm^3 of aqueous barium chloride: concentration approximately 0.1 mol dm^{-3};

(e) 2 cm^3 of dilute aqueous sodium hydroxide: concentration approximately 2 mol dm^{-3};

(f) aluminium foil, approximately 2×2 cm;

(g) red litmus paper;

(h) 1 cm^3 of aqueous potassium iodide: concentration approximately 0.1 mol dm^{-3};

(i)* 200 cm^3 of aqueous sodium hydroxide: concentration 0.150 mol dm^{-3}, labelled **B**;

(j)* 200 cm^3 of aqueous sulphamic acid (NH_2SO_3H): concentration 13.5 g dm^{-3}, labelled **C**. The identity of the solute must **not** be revealed to candidates;

(k) phenolphthalein indicator;

(l)* specimen tube containing 5.0 ± 0.05 g of sodium nitrate, labelled **D**. The identity of this must **not** be revealed to candidates;

(m) 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)	Obs: yellow (1) Inf: sodium/ Na^+ (1)	Orange/Golden	 Na	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Obs: (effervescence and) white ppt (1) Inf: carbon dioxide / CO_2 (1)	Milky; cloudy	misty	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	Na_2CO_3 / $NaHCO_3$ (1) Conditional on correct (a) and (b)		Just name	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(i)	(Grey)-Brown precipitate [observation only requested] (1)		Brown solid Not just "brown"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(ii)	Obs: Litmus turns blue (1) Inf: Ammonia/ NH_3 (1) Nitrate/ NO_3^- (1)	 Nitrite/NO_2^-,		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(e)	Obs:White ppt (1) soluble in ammonia (1) Inf: Ag^+ (1)	Goes clear/precipitate disappears silver	 Ag	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(f)	White or brown/precipitate [observation only requested] (1)	Cream coloured ppt	Misty/cloudy	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	Check subtractions and averaging arithmetic, correcting if necessary All volumes read to 0.05 cm^3 (1) All subtractions complete (1) ✓✓*top RHS of Table 1* **Mean Titre** For correct averaging of chosen values and for recording the average correct to 2 or 3 dps or to the nearest 0.05 cm^3 [unless already penalised] ✓ by the mean titre (1) **Accuracy** If the candidate has made an arithmetical error in Table 1 volumes used in the mean or in averaging, the examiner must calculate a new average. • For an averaging error simply calculate a new value using the candidate's chosen 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 titres Calculate the difference between the candidate's mean trite and that of the examiner or supervisor Record the difference on the scripts as d= ** Examiner's titre 23.55 cm^3 Award marks for accuracy as follows: Difference ± 0.20 (6) Difference ± 0.30 (5) Difference ± 0.40 (4) Difference ± 0.60 (3) Difference ± 0.80 (2) Difference ± 1.00 (1) Difference > 1.00 (0)	Allow 1 slip but withhold this mark if any readings are in the wrong boxes. Accept 0 ; 0.0 ; 0.00 as initial readings	Reject 50 as initial reading	12

	Range Award a mark on the range of titres used by the candidate to calculate the mean. The range (r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range mark on the corrected titres used by the examiner to calculate the mean.# Range ± 0.20 (3) Range ± 0.30 (2) Range ± 0.50 (1) Range > 0.50 (0) Examiner to show the marks awarded for the accuracy and range as d = ✓ 6 *max* r = ✓ 3 *max* then the mark out of 12 written in the margin			

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(i)	$\frac{0.150 \times \text{titre}}{1000}$ S.F. i) ii) iii) Penalise rounding to 2 s.f. once uless trailing zero iv) Ignore s.f. ignore unit			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(ii)	$\frac{\text{answer (i)}}{2}$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iii)	answer (ii) x 40			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iv)	6.43 / answer (iii)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(v)	titre would be too large/larger/too big/ bigger (1) Because some alkali is neutralised with acid remaining in burette (1) Stand alone marks	Conc of alkali reduced (1)	Just "big" Just "large" Reject just "wrong" Takes too long	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	<u>Table 2</u> Weighings in correct spaces to at least 2 dp (1) Correct subtractions (1) <u>Table 3</u> Two temps recorded (1) BOTH to 0.5 ^{o} C or better (1) ΔT correct with negative sign (1) EXPECTED VALUE -7.6^{o}C For [4.95 – 5.05] ± 1.0^{o}C (3) ± 1.5^{o}C (2) ± 2.0^{o}C (1) > 2.0^{o}C (0)			8

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	For correct substitution and evaluation (1) positive sign (1) Answer to 2 sig figs (1)			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	(ΔT more negative) Either More accurate because % of error in ΔT smaller (1) OR: Less accurate because error due to heat gain is more (1)	(bigger)	Heat loss	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	Weigh crucible (1) ✓m1 Weigh with sample (1)✓m2 Heat (1) ✓m3 to **constant** weight (1) ✓m4 Either Calculate mass (of gas) lost (1) ✓c1 Moles O_2 = <u>mass lost</u> = ½ moles $NaNO_3$ (1) ✓c2 32/Mr Mass $NaNO_3$ = moles x 85 Mr [hence %] (1) ✓ c3	Take known mass/stated mass (1) ✓m2		7

6243/01B – Materials

Apparatus and Materials

Apparatus

Each candidate will require:

1. apparatus for a flame test;
2. spatula;
3. 10 cm^3 measuring cylinder;
4. 50 cm^3 measuring cylinder;
5. 5 test tubes and 1 boiling tube in a rack;
6. 1 stopper to fit a test tube;
7. supply of dropping pipettes;
8. test tube holder;
9. Bunsen burner;
10. 50 cm^3 burette, stand and clamp, with small funnel for filling, white tile and a small beaker for draining burette;
11. 2×250 cm^3 conical flasks;
12. 25 cm^3 pipette with safety filler;
13. expanded polystyrene cup held securely in a 250 cm^3 beaker;
14. a thermometer of range from at least room temperature to 50 °C (e.g. 0 to 50 °C or −10 to +110 °C), able to be read to ±0.5 °C or better;
15. access to a balance reading to at least 2 decimal places;
16. apparatus for testing gas with limewater e.g. delivery tube or dropper pipette.

Materials

Each candidate will require:

(a)* approximately 0.5 g of sodium carbonate, anhydrous, labelled **J**. The identity of this must **not** be revealed to candidates;

(b)* 3 cm^3 of aqueous silver nitrate: concentration approximately 0.05 mol dm^{-3}, labelled **K**. The identity of this must **not** be revealed to candidates;

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

(d) 10 cm^3 of limewater;

(e) 2 cm^3 of dilute aqueous sodium hydroxide: concentration approximately 2 mol dm^{-3};

(f) aluminium foil, approximately 2×2 cm;

(g) red litmus paper;

(h) 1 cm^3 of aqueous sodium chloride: concentration approximately 0.1 mol dm^{-3};

(i)* 200 cm^3 of aqueous sodium hydroxide: concentration 0.150 mol dm^{-3}, labelled **L**;

(j)* 200 cm^3 of aqueous ethanedioic acid: concentration 9.00 g dm^{-3} of $(COOH)_2.2H_2O$, labelled **M**. The identity of the solute and this concentration must **not** be revealed to candidates;

(k) phenolphthalein indicator;

(l)* specimen tube containing 5.0 ± 0.05 g of potassium nitrate, labelled **E**. The identity of this must **not** be revealed to candidates;

(m) distilled water;

(n) 5 cm^3 of aqueous ammonia: concentration approximately 2 mol dm^{-3}.

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

6243/01C (overseas practical test)

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(a)	Obs: yellow (1) Inf: sodium/ Na^+ (1)	Orange/golden	 Na	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Obs: (Effervescence and) white ppt (1) Inf: Carbon dioxide / CO_2 (1) Carbonate / CO_3^{2-}(1) hydrogen carbonate/ HCO_3^- (1) ions are conditional on CO_2	Goes milky/cloudy		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	Na_2CO_3 /$NaHCO_3$ Conditional on correct (a) and observation in (b)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(i)	Obs: white precipitate (1) Inf: any two of Sulphate/ SO_4^{2-} (1) Sulphite /SO_3^{2-} (1) Carbonate /CO_3^{2-} (1) Hydrogensulphate/ HSO_4^- (1)	Cloudy/milky		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(d)(ii)	Conditional on two ions in (i) Substances: dilute hydrochloric acid/HCl (aq) (1) Observations: consequential two from (Barium)Carbonate: effervescence (and ppt dissolves) (1) (Barium)Sulphate: Ppt insoluble/Stays/no change (1) (Barium)Sulphite: ppt dissolves (without effervescence) (1) Hydrogensulphate: Add blue litmus HSO_4^- goes red SO_4^{2-} stays blue	HCl / HNO_3		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	Check subtractions and averaging arithmetic, correcting if necessary All volumes read to 0.05 cm^3 (1) All subtractions correct (1) ✓✓ *top RHS of table 1* **Mean titre** For correct averaging of chosen values/choosing identical values and for recording the average correct to 2 or 3 dps or to the nearest 0.05 cm^3 [unless already penalised] ✓ by the mean titre (1) **Accuracy** If the candidate has made an arithmetical error in table 1 volumes used in the mean or in averaging, the examiner must calculate a new average. • For an averaging error simply calculate a new value using the candidate's chosen 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 titres Calculate the difference between the candidate's mean titre and that of the examiner or supervisor Record the difference on the script as d = ** Examiner's titre 22.00 cm^3 or s/v value Award marks for accuracy as follows: Difference ± 0.20 (6) Difference ± 0.30 (5) Difference ± 0.40 (4) Difference ± 0.60 (3) Difference ± 0.80 (2) Difference ± 1.00 (1) Difference > 1.00 (0)	Allow 1 slip but withhold this mark if any readings are in the wrong boxes. Accept 0 ; 0.0 ; 0.00 as initial readings	Reject 50 as initial reading	12

	Range Award a mark on the range of titres used by the candidate to calculate the mean. The range (r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range on the corrected titres used by the examiner to calculate the mean. Range ± 0.20 (3) Range ± 0.30 (2) Range ± 0.50 (1) Range > 0.50 (0) Examiner to show the marks awarded for accuracy and range as d = ✓ 6 *max* r = ✓ 3 *max* then the mark out of 12 written in the margin			

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(i)	$\frac{0.150 \times \text{titre}}{1000}$ S.F. i) ii) iii) Penalise rounding to 2 s.f. once unless trailing zero iv) Ignore s.f. ignore unit			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(ii)	answer (i) / 2			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iii)	answer (ii) x 40			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(iv)	5.94 / answer (iii)			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)(v)	titre would be too big/bigger/too large/larger (1) Because some alkali is neutralised with acid remaining in burette (1) Stand alone marks	[Conc of alkali reduced (1)]	Reject just "wrong"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	<u>Table 2</u> Weighings in correct spaces to at least 2 dp (1) Correct subtractions (1) <u>Table 3</u> Two temps recorded (1) BOTH to 0.5 ° C or better (1) ΔT correct with negative sign (1) EXPECTED VALUE -7.6°C or s/v value ± 1.0°C (3) ± 1.5°C (2) ± 2.0°C (1) > 2.0°C (0)			8

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(i)	For correct substitution and evaluation(1) positive sign (1) Answer to 2 sig figs (1)			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)(ii)	Either less accurate because % of error (in ΔT) greater (1) OR: More accurate because error due to heat gain is less (1)		Heat loss	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	Weigh crucible (1) ✓m1 Known mass/stated mass (1) ✓m2 Heat in crucible(1) ✓m3 To **constant** weight (1) ✓m4 Calculate mass (of gas) lost (1) ✓c1 Moles CO_2 = <u>mass lost</u> = moles $CaCO_3$ (1) 44/Mr ✓c2 Mass $CaCO_3$ = moles x 100 Mr (hence %) (1) ✓c3	If gas collection method Moles CO_2 = vol/molar volume ✓C1		7

6243/01C – Materials

Apparatus and Materials

Apparatus

Each candidate will require:

1. apparatus for a flame test;
2. spatula;
3. 10 cm^3 measuring cylinder;
4. 50 cm^3 measuring cylinder;
5. 3 test tubes in a rack;
6. supply of dropping pipettes;
7. Bunsen burner;
8. 50 cm^3 burette, stand and clamp, with small funnel for filling, white tile and a small beaker for draining burette;
9. 2×250 cm^3 conical flasks;
10. 25 cm^3 pipette with safety filler;
11. expanded polystyrene cup held securely in a 250 cm^3 beaker;
12. a thermometer of range from at least room temperature to 50 °C (e.g. 0 to 50 °C or −10 to +110 °C), able to be read to ±0.5 °C or better;
13. access to a balance reading to at least 2 decimal places;
14. apparatus for testing gas with limewater e.g. delivery tube or dropper pipette.

Materials

Each candidate will require:

(a) approximately 0.5 g of anhydrous sodium carbonate, labelled **F**. The identity of this must **not** be revealed to candidates;

(b) 3 cm^3 of aqueous potassium sulphate: concentration approximately 0.1 mol dm^{-3}, labelled **G**. The identity of this must **not** be revealed to candidates;

(c) 2 cm^3 of aqueous barium chloride: concentration approximately 0.1 mol dm^{-3};

(d) 10 cm^3 of limewater;

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

(f) 200 cm^3 of aqueous sodium hydroxide: concentration 0.150 mol dm^{-3}, labelled **T**;

(g) 200 cm^3 of aqueous ethanedioic acid: concentration 8.32 g dm^{-3} of $(COOH)_2.2H_2O$, labelled **U**. The identity of the solute and this concentration must **not** be revealed to candidates;

(h) phenolphthalein indicator;

(i) specimen tube containing 5.0 ± 0.05 g of potassium nitrate, labelled **B**. The identity of this must **not** be revealed to candidates;

(j) distilled water.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(i)	Lighted/burning splint (1) Pops/explodes/squeaky pop (1) 2nd mark conditional on 1st being correct (see above) or a near miss (glowing splint, smouldering splint, burn, ignite are near misses)	Lit/flaming flint/spill flame	Near misses do not score 1st mark Just 'splint' Correct result without test or near miss scores zero	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)(ii)	Glowing splint (1) Reignites/relights (1) 2nd mark conditional on 1st OR Burning splint burns more brightly (2)	Smouldering Burning splint relights scores 1	Splint alone No test	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	White precipitate / solid (1) Insoluble in (hydrochloric) acid / HCl (1)	Solution turns cloudy/milky ppt or ppte for precipitate No change/ reaction with HCl or acid	Just 'No reaction with HCl' 'Precipitate' Turns white	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	Precipitate dissolves/ disappears **in** (hydrochloric) **acid**	effervescence with (hydrochloric) **acid** or Pungent gas evolved with **acid** or Gas evolved with **acid** which turns (potassium) dichromate green/blue	Just 'precipitate dissolves' or 'Effervescence' or 'Gas evolved' or (blue) litmus/pH paper turns red	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	Add sodium hydroxide (solution), (warm) (1) Gas evolved turns red litmus blue (1) 2nd mark conditional on 1st being correct (see above) or a near miss (alkali, hydroxide (ions) or just 'warm' or 'heat', alkali with Zn/ Al/ Devarda's alloy are near misses)	Potassium hydroxide White fumes with HCl Universal indicator /pH paper turns blue	Near misses do not score 1st mark Alkaline gas/gas Incorrect chemistry for test scores zero (e.g. 'add acid' or add NaOH followed by acid	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	Lilac	Purple		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	Potassium flame masked (by strong sodium flame colour)	Sodium (yellow) flame persistent /strong Yellow flame seen instead of lilac Potassium flame not seen (clearly)	Both colours seen Colours mix Flame is yellow	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	Moles of 2-methylpropan-2-ol = $\frac{7.9}{74}$ (1) = 0.10676 Either Theoretical mass of 2-chloro-2-methylpropane = 92.5 x $\frac{7.9}{74}$ (1) = 9.875 (g) 100 x $\frac{5.8}{9.875}$ = 58.7% (1) Or actual moles of 2-chloro-2-methylpropane = $\frac{5.8}{92.5}$ (1) = 0.0627 100 x $\frac{0.0627}{0.10676}$ = 58.7/59 % (1) [ignore s.f. except 1 s.f.]	Correct answer some working scores 3 Correct answer, no working (1) Ecf on moles = 92.5 x $\frac{7.9}{74}$ (1) = 9.9 g 100 x $\frac{5.8}{9.9}$ = 58.6% (1) Or actual moles of 2-chloro-2-methylpropane = $\frac{5.8}{92.5}$ (1) = 0.0627 100 x $\frac{0.0627}{0.107}$ = 58.6 % (1)	100 x $\frac{5.8}{7.9}$ =73.4% scores zero	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	Transfer / handling losses, or specific examples of these eg 'product left in aqueous layer', or 'other products formed'	Side reactions occur Or reaction incomplete Or by-products	experimental error or spillages or evaporation or equilibrium	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	Sensible separating funnel with tap (1) Organic layer on top (1) – stand alone		Conical/filter or Buchner funnel with tap	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	To prevent pressure building up due to formation of carbon dioxide or gas	To release the carbon dioxide/gas formed/pressure	To release vapour	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	50 — 52 (°C)	49 or 50 – 52 or 53		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	Add PCl_5 (1) (or $SOCl_2$) Any one of No steamy/misty/white fumes(1) no gas turns (damp) blue litmus / UI / pH paper red (1) no white smoke with ammonia (1)	Na (1) Any one of No bubbles (1) No pop with a lit splint (1) Positive result if alcohol present	PCl_3 White smoke with PCl_5 Any physical test Any oxidant No reaction	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	(glass/volumetric/ graduated/25cm^3) pipette		Burette / measuring cylinder/teat pipette	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	With (the) sodium hydroxide (solution) Ignore **initial** rinsing with (distilled) water	Solution to be used in the burette Alkali	Solution to be used / final rinsing with (distilled) water	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(iii)	Colourless (1) to Pink (1) Pink to colourless (1)	…to permanent pink/pale pink	Red or purple or magenta	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Titres agree to within 0.2 (cm^3)	0.05 – 0.20 (cm^3)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	$\frac{26.35 + 26.45}{2}$ = 26.40 (1)	26.4 correct answer with no working (1)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iii)	$\frac{0.205 \times 26.40}{1000} = 5.41 \times 10^{-3}$	Ecf from (ii) 5.412×10^{-3}	If the factor of 1000 is omitted penalise on each occasion	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(iv)	$\frac{5.41 \times 10^{-3} \times 1000}{25}$ (1) = 0.216 (mol dm^{-3})(1) Ignore s.f. except 1 s.f. If 26.40 & 25 transposed in 3 (b)(iii) and 3 (b)(iv) penalise once	Ecf from (iii)	If the factor of 1000 is omitted penalise on each occasion	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(v)	$100 \times \frac{0.216}{2.25}$ = 9.6 %	Ecf from (iv) 9.62 % (if left on calculator)	10 % values > 100%	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	(Indicator) colour change cannot be seen/is masked (because of the colour of the wine)		Just 'end-point cannot be seen'	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)	Bromine (water/solution) (1) Orange/yellow/red-brown solution decolourised/goes colourless (1) OR Acidified potassium manganate(VII) (1) Purple/pink solution decolourised/goes colourless (1) OR alkaline/neutral potassium manganate(VII) (1) Purple/pink solution to green or brown (ppt)	 brown solution goes……. Potassium permanganate	 Discoloured Goes clear Initial colour omitted	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)	Compare measured boiling point/boiling temperature to (data) book value Compare IR/mass spectrum/NMR spectrum to reference data	IR/mass spectrum/NMR spectrum (Measure) boiling point /boiling temperature Melting point /melting temperature		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)	Initially $CuSO_4$ in excess so amount of reaction depends on amount of Zn or More $CuSO_4$ reacts (as more Zn added) (1) Graph levels off because all $CuSO_4$ used up (1)	$CuSO_4$ in excess More Zn reacts Zn now in excess	Reaction is exothermic Just 'Reaction is complete'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	Heat capacity (of metal) low (compared with that of solution)	Metal has negligible/low specific heat capacity Metal absorbs (much) less heat (than solution/ water)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	q = 50 x 63.5 x 4.18 = 13271.5 J Units, if given, must be correct Ignore signs	13300/13270/13272 Answer in kJ only if units stated	13271	1

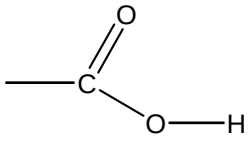
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	Moles $CuSO_4$ = 50 x $\frac{1.25}{1000}$ = 0.0625 (1) $\triangle H$ = (-) $\frac{13271.5}{0.0625 \times 1000}$ (1) = - 212 (kJ mol $^{-1}$) 1 mark for negative sign 1 mark for answer to 3 SF Units, if given, must be correct	Correct answer with some working scores full marks Ecf from moles Ecf from (ii) gives -213/-212/ -212		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)	Extra precision negligible compared with approximations in calculations/heat loss	Measuring cylinder is least accurate measuring instrument		1

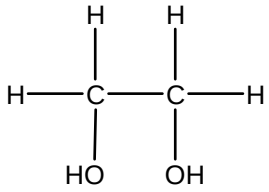
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	Use a lid on the cup (to reduce heat loss)	Extra insulation for cup Weigh $CuSO_4$ solution Use burette/ pipette to measure volumes	Repeat experiments OR use more accurate balance OR Smaller mass intervals	1

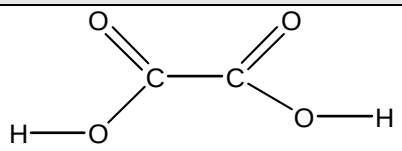
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6	**Strategy**: Statement or diagram of method (1) Measurement (1) Deduction (1) Equal moles (1) One other measure to ensure consistent results (1) <u>Examples of method and measurement</u> Heating and detecting CO_2 with limewater (any valid method) (1) Time for lime water to turn milky (1) Heating and measuring volume of CO_2 (any valid method) (1) Volume in a fixed time or time for a fixed volume (1) Heating and measuring mass loss (any valid method) (1) Mass loss in a fixed time (1) Heating to constant mass or complete decomposition can only score equal moles and measure to ensure consistent results marks (max 2)	 Shorter time or faster rate = less stable (1) Equal amounts Consistent heating (e.g. position of crucible/tube or same Bunsen setting (stating 'blue flame' or same height flame can gain this mark)) Or same volume or concentration of lime water. Valid methods include • bubbling into limewater • transferring CO_2 to limewater using a teat pipette Amount of CO_2 provided a valid volume-measurement method used	 Equal mass Use of water bath to control temperature time for a fixed mass loss	5

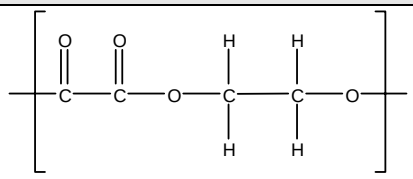
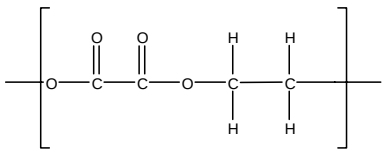
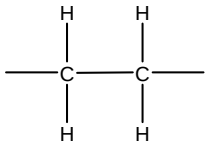
Same for all methods

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	**Can be given in either order** **1st functional group** alkene or C=C or carbon-carbon double bond **(1)** bromine water/Br_2 turns (from orange/brown etc. to) colourless/decolorised **(1)** *INITIAL COLOUR NOT REQUIRED* **2nd functional group** carboxylic (acid)  **(1)** on addition of Na_2CO_3 or $NaHCO_3$ or $CaCO_3$ or Mg , fizzing occurs **(1)** **OR** (warm with) a **named** alcohol plus **conc. acid** (as catalyst), pleasant/fruity smell Ignore references to testing with PCl_5	 $KMnO_4$ Acidified decolorised Alkaline green carboxyl gas evolved which turns limewater milky OR or universal indicator/ blue litmus turns red	 **Just** 'double bond' or just 'carbon double bond' 'clear' instead of 'colourless' "carbonyl" Just "a gas/CO_2/H_2 evolved" for fizzing	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(i)	**W** as it contains an aldehyde group / -CHO group OR **W** can be oxidised (whereas **X** cannot) OR **X** cannot be oxidised OR **W** as **X** is a ketone (which cannot be oxidised)		W with no reason or an incorrect reason **(0)** Contains C=O	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(ii)	CH_2OHCH_2OH **OR**  **OR** Ethan(e)-1-2-diol	$(CH_2OH)_2$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)(iii)	 **OR** HOOCCOOH **OR** Ethanedioic acid/oxalic acid	$(COOH)_2$ ethan(e)-1,2-dioic acid or ethandioic acid	Any other name	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	 **OR**  **(2)** for a correct structure *IF STRUCTURE IS INCORRECT, BUT A CORRECT ESTER LINKAGE IS FULLY DRAWN* **(1)** the correct repeat unit **must contain** only 4 carbon and 4 oxygen atoms	CQ polyester on basis of monomers in 1(b)(ii) and (iii) $-CH_2CH_2-$ instead of  in relevant part of structure **only (1)** if STRUCTURE IS CORRECT, BUT the ester linkage has been written as COO/CO_2		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	Condensation			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)	Na_2O **(1)** P_4O_{10} or P_2O_5 or P_4O_6 or P_2O_3 **(1)** SO_2 or SO_3 **(1)**	Na_2O_2 **(1)**		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$Na_2O + H_2O \rightarrow 2NaOH$ Ignore state symbols	..... $2Na^+OH^-$ **OR** ..... $2Na^+ + 2OH^-$ **OR** $Na_2O_2 + 2H_2O \rightarrow 2NaOH + H_2O_2$ **OR** $Na_2O_2 + H_2O = 2NaOH$ **+ ½O_2**		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	$P_4O_6 + 6H_2O \rightarrow 4H_3PO_3$ **OR** $P_2O_3 + 3H_2O \rightarrow 2H_3PO_3$ **OR** $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ **OR** $P_2O_5 + 3H_2O \rightarrow 2H_3PO_4$ Ignore state symbols		$P(OH)_3$ **instead of** H_3PO_3	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	$SO_2 + H_2O \rightarrow H_2SO_3$ **OR** $SO_3 + H_2O \rightarrow H_2SO_4$ Ignore state symbols			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)	**First mark:-** **EITHER** Tin more stable at +4 (than at +2) whereas lead more stable at +2 (than at +4) **OR** +2 (oxidation state) becomes more stable **relative to +4** down the group (OWTTE) **(1)** **Second mark:-** (so) Fe^{3+} reduced to Fe^{2+} (by Sn^{2+}) **OR** (2) $Fe^{3+} + Sn^{2+} \rightarrow Sn^{4+} + (2)\ Fe^{2+}$ **OR** tin(II) stronger reducing agent (than lead(II)) **OR** redox reaction between Sn^{2+} and Fe^{3+} **OR** Sn^{2+} oxidised to Sn^{4+} / $Sn^{2+} \rightarrow Sn^{4+} + 2e^-$ **OR** tin(II) acts as a (strong) reducing agent **OR** tin(II) reduces Fe^{3+} **(1)**		"Sn^{2+} less stable than Pb^{2+} ions" **OR** "Pb(II) is more stable than Sn(II)"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (d)	$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$ Species **(1)** Balancing **(1)** Ignore state symbols	...$\rightarrow SiO_2.xH_2O$ **OR** ...$\rightarrow SiO_2.2H_2O$ **OR... + $4H_2O$** ...$\rightarrow Si(OH)_4 + 4HCl$		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	$K_p = \dfrac{p_{NO_2}^2}{p_{N_2O_4}}$ *IGNORE UNITS HERE*		**[ ]**	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	$p_{NO_2} = 0.8 \times 1.1$ $= 0.88(atm)$ **and** $p_{N_2O_4} = 0.2 \times 1.1$ $= 0.22(atm)$ **(1)** $K_p = \dfrac{(0.88)^2}{(0.22)}$ $K_p = 3.52$ **(1)** *atm* **(1)** *SECOND MARK IS CQ ON PARTIAL PRESSURES AS CALCULATED*			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	**First mark:** $X_{N_2O_4} = 0.10$ $X_{NO_2} = 0.90$ **(1)** **Second mark:** K_p constant or use of K_p = 3.52 or use of K_p calculated in 3(b)(i) **(1)** **Third mark:** Value of P_T with some working e.g. $3.52 = \dfrac{(X_{NO_2} \times P_T)^2}{X_{N_2O_4} \times P_T}$ $3.52 = \dfrac{0.81}{0.10} \times P_T$ P_T = 0.435(atm) **(1)** *THIRD MARK NOT AVAILABLE IF K_p EXPRESSION DOES NOT CONTAIN A p^2 TERM*	Mark CQ on first and second answers to 3(b)(ii) in range 0.43 to 0.44	B	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(i)	Increases / gets larger/ gets bigger/ goes up/greater		more	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)(ii)	**First mark:** Fraction/quotient/ $\frac{p^2_{NO_2}}{p_{N_2O_4}}$ /numerator has to increase (to equal new K_p) **(1)** **Second mark (can only be awarded for an answer that refers to the fraction/quotient above):** **EITHER** so shifts to **RIGHT** hand side (as $p_{NO_2} \uparrow$ and $p_{N_2O_4} \downarrow$) / goes in forward direction (as $p_{NO_2} \uparrow$ and $p_{N_2O_4} \downarrow$) **OR** so (more) N_2O_4 changes to NO_2 **OR** so (equilibrium) yield of NO_2 increases **(1)**	Mark consequentially on "decreases" in (i)	Le Chatelier argument **scores (0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	**BOX A** $Ag_{(g)}$ **(1)** **BOX B** $F_{(g)}$ **(1)** **C**: enthalpy (change) of formation (of AgF) / ΔH_f / $\Delta H_{formation}$ **(1)** IGNORE reference to 'standard'	 'heat of formation'		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	**EITHER** $-205 = (+285) + (+731) + (+79) + EA + (-958)$ **OR** EA = (-205) – (+285) – (+731) – (+79) – (-958) **(1)** $= -342$ (kJ mol^{-1}) **(1)** *CORRECT ANSWER ALONE* **(2)**		Any algebraic expression for EA that would give an incorrect value **(0).** Any algebraic expression for EA that would give a **+ve** value for EA scores **(0).**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	**<u>EITHER</u>** **FIRST MARK:** **EITHER** iodide (ion) larger than fluoride (ion) **OR** Sum of ionic radii in AgI larger (than in AgF) **OR** halide ion or X^- or anion increases in size down group **(1)** **SECOND MARK:** Charges (on anions) same **(1)** **THIRD MARK:** (so) weaker (forces of) **attraction** between **ions** (in AgI) **(1)** *CORRECT REVERSE ARGUMENTS CAN SCORE ALL THE MARKS* **<u>OR</u>** **First and second marks combined by stating** I^- (ion) larger than F^- **(2)** **THIRD MARK:** (so) weaker (forces of) **attraction** between **ions** (in AgI) **(1)** *IGNORE ANY REFERENCES TO POLARISATION OF IONS ANYWHERE IN (b)(i)*	**Just '**iodide has smaller charge density than fluoride' scores first mark "atomic radius of halide ion/X^- /anion increases (down group)" "weaker ionic bonding" **(1)** **Just** iodide has smaller charge density than fluoride scores only one mark "weaker ionic bonding" **(1)**	Reference to "atoms" or "molecules" or "F_2" or "I_2" scores **(0)** overall Ag—X scores **(0)** overall **Just** "weaker bonding (in AgI)" **Just** "weaker bonding (in AgI)"	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	Theoretical value (assumes) 100% ionic OR no covalent character **(1)** (Experimental value is different) due to covalency **OR** covalent character **OR** polarisation **of anion(1)**		Mention of "Ag—X" OR "molecules" scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(iii)	(as) **size of anion increases** (down group) **(1)** (anions) **more easily polarised** (down group) **OR** more distortion **of anion** (down group) **(1)** *MARK THESE POINTS INDEPENDENTLY*	"atomic radius of halide ion/X^- /anion increases (down group)" "more covalent character"/ "more covalent" for second mark	Mention of "Ag—X" OR "molecules" scores **(0) unless already penalised in 4 (b)(ii)** "more covalent **bonding**" **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	$\Delta H_{SOLN} = -\Delta H_{LATT} + \Delta H_{HYD}$ **OR** $= -(-958) + (-464) + (-506)$ **(1)** $= -12$ (kJ mol^{-1}) **(1)** *CORRECT ANSWER ALONE SCORES 2*	 —12 kJ	+12 scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	AgF soluble / AgF slightly soluble **(1)** as ΔH_{SOLN} exothermic / negative **(1)** *MARK INDEPENDENTLY* Mark CQ on sign and magnitude of answer in (c)(i)	If +12 (kJ mol^{-1}) in (c)(i), AgF insoluble **(1)** because endothermic / positive **(1)**		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(i)	$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$ **OR** $2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$ *IGNORE STATE SYMBOLS*		if a **full** arrow is shown in the equation	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	$K_W = [H^+_{(aq)}][OH^-_{(aq)}]$ **OR** $K_W = [H_3O^+_{(aq)}][OH^-_{(aq)}]$ *IGNORE STATE SYMBOLS*		If $[H_2O]$ included **(0).** $K_w = [H^+]^2$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iii)	$pH = -\log_{10}[H^+]$ **OR** $pH = -\log_{10}[H_3O^+]$ **OR** in words	pH = lg 1/$[H^+]$		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(iv)	$K_w = [H^+][OH^-]$ $5.48\times10^{-14} = [H^+]^2$ **(1)** $[H^+] = \sqrt{5.48\times10^{-14}}$ $[H^+] = 2.34\times10^{-7}$ (mol dm^{-3}) $pH = 6.6(3)$ **(1)** correct answer with no working **(2)**		pH = 13.3 /13.6 scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(v)	(In pure water) $[H^+] = [OH^-]$ **OR** equal **concentrations** of H^+ and OH^-			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	12.5			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	4.8 / 4.9 [no consequential marking from (i)]		5 or 5.0	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$ **OR** $K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$		expressions containing $[H_2O]$ OR "HA" generic equations	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iv)	(at half-neutralised point so) pK_a = 4.8 OR pH = pK_a **(1)** Ka = antilog$_{10}$ (-4.8) Ka = 1.6 x 10^{-5} (mol dm^{-3}) **(1)** **Must be to two sig figs** *CORRECT ANSWER WITH OR WITHOUT WORKING* (2)	Mark CQ on (ii) Mark CQ on pKa If pKa = 4.9, Ka = 1.3 x 10^{-5}	**Just** pH = 4.8 as already credited in 5 (b)(ii) Answers to other than 2 s.f. 2.5 x 10^{-9} scores **(0)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)	**Phenolphthalein:** changes colour (OWTTE) in vertical part of the graph **OR** changes colour within a stated range anywhere from 7 to 11 **(1)** **Methyl orange** changes colour at a low(er) pH **OR** has already changed colour **OR** changes colour before the vertical (section) **(1)** **[NB** There must be a statement about methyl orange for second mark]	Allow range for methyl orange of 3 to 6 or colour change takes place below pH = 7	If colour change "pink to colourless" **Just** 'methyl orange changes colour outside the vertical range'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(i)	$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ for **both** (acids) **OR** $H_3O^+_{(aq)} + OH^-_{(aq)} \rightarrow 2H_2O_{(l)}$ for **both** (acids) **OR** Both (acids) fully ionised/fully dissociated **(1)**	State symbols not essential.	Equations shown as equilibria	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (d)(ii)	**EITHER** HCN weak (acid) **OR** HCN ionises to (only) a small extent **OR** HCN equilibrium lies to the left **(1)** Energy taken in OR energy required for dissociation / ionisation (of HCN) **(1)** *MARK INDEPENDENTLY*	"HCN not fully ionised" or "HCN partially dissociates / ionises" "endothermic dissociation of HCN"	Any idea that only partial **neutralisation** occurs negates first mark	2

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>6 (a)(i)</td><td>

First two marks:

For correct **reagent** (ignore all state symbols) **(1)**
For correct **condition(s)**, but only if with matching reagent **(1)**

<table>
<tr><td>Reagent</td><td>Condition</td></tr>
<tr><td>HCN</td><td>Catalyst of CN^-</td></tr>
<tr><td>HCN</td><td>KCN</td></tr>
<tr><td>KCN</td><td>HCN</td></tr>
<tr><td>HCN or KCN</td><td>any stated pH or pH range between 5 and 9</td></tr>
<tr><td>KCN</td><td>+ (named) acid / H^+</td></tr>
<tr><td>HCN</td><td>+ (named) base / OH^-</td></tr>
</table>

[**Note:** The intermediate compound $CH_3CH(OH)CN$
does not have to be identified.]

Hydrolysis of –CN group to –COOH group:

IGNORE MENTION OF "HEAT / REFLUX"

Second two marks (only available if correct reagent has previously been given):

EITHER
Name or formula of a mineral acid **(1)**
Boil or heat **(1)**
Second mark dependent on first mark being awarded

IGNORE MENTION OF "REFLUX"

OR
Name or formula of correct alkali **AND** boil/heat **(1)**
"Acidify" / H^+ or name/formula of any acid **(1)**

IGNORE MENTION OF "REFLUX"

</td><td>"H^+"
"warm"

OH^- AND boil /heat/warm (1)</td><td>conc H_2SO_4 (0)</td><td>4</td></tr>
</table>

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (a)(ii)	$CH_3CH(OH)CH_2CH_3$ **OR** $CH_3CH(OH)C_2H_5$ **OR** Full structural formula of the above	$CH_3CHOHCH_2CH_3$ **OR** $CH_3CHOHC_2H_5$ -O-H can be represented as -OH		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(i)	W: ethanamide **(1)** X: methylamine **(1)** Y: ethanenitrile **(1)**	acetamide (1-)aminomethane 'methyl cyanide'	Formulae methanamine 'ethanitrile'	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(ii)	**Reaction 1** Bromine/Br_2 **and** sodium hydroxide/NaOH/potassium hydroxide/KOH **(1)** *IGNORE CONC OR DILUTE OR AQUEOUS BEFORE NaOH / KOH* **Reaction 2** phosphorus(V) oxide **OR** phosphorus pentoxide **OR** P_4O_{10} **(1)** **Reaction 3** lithium aluminium hydride (in dry ethoxyethane) **OR** $LiAlH_4$ (in dry ethoxyethane) **OR** lithium tetrahydridoaluminate((III)) (in dry ethoxyethane) **(1)** *MARK INDEPENDENTLY*	 P_2O_5 $LiAlH_4$ **followed by** water or acid **OR** H_2 **and** Ni/Pt/Pd (catalyst) **OR** Na **and** C_2H_5OH	 'bromine water' OR 'aqueous bromine' phosphorus oxide $LiAlH_4$ in water **(0)** $NaBH_4$	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
6 (b)(iii)	**Reaction 2** dehydration **(1)** **Reaction 3** reduction/redox **(1)**	 'hydrogenation'	'elimination (of water)'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	e.m.f. of a **half** cell relative/compared to a (standard) hydrogen electrode OR voltage produced from a **half** cell joined to a hydrogen electrode **(1)** (solutions at) 1 mol dm^{-3} concentration, (gases at) 1 atm/100 kPa/10^5Pa/ 1 Bar pressure and stated temperature **(1)** all 3 conditions needed STAND ALONE	Potential (difference) /voltage for emf emf of a cell with standard hydrogen as the left electrode A description of the half cell e.g. a metal dipping into a solution of its ions 101 kPa 298 K or 25 ^oC If any other temperature is quoted it must be as an example of a stated temperature	SHE 'constant' pressure "STP" Room temperature Just "273 K"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	Can only measure a potential **difference**/emf (if a reference electrode is present) OR voltmeter needs 2 connections OR Cannot measure the potential difference between a metal and a solution of its ions		Just "electron source and sink" to make comparisons between half cells	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	**1st mark** (simultaneous) oxidation and reduction of a (single) species/ substance/ reactant/compound/chemical **Or** the oxidation state/number is both increased and decreased of a (single) species/ substance/ reactant/ compound/chemical **Or** a (single) species/ substance/ reactant/compound/chemical both loses and gains electrons **(1)** **2nd mark** For a given type of **atom** within an ion/ molecule **Or** Illustrated by a suitable example in which the individual atom is identified **(1)**		oxidation and reduction occur at the same time oxidation state**s** are …	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii)	$2H_2O_2 \rightarrow 2H_2O + O_2$ **(1)** E_{cell} = (+) 1.09 (V) **(1)** E_{cell} is positive/greater than 0 so the reaction is feasible **(1)** 3rd mark must be cq on sign of E_{cell}		$2H^+$ on both sides of equation Greater than any other stated number	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(iii)	activation energy of the reaction may be high OR reaction too slow to be observed		Just "Not enough energy to overcome the activation energy" Conditions are non-standard Just "kinetically stable"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	second order **(1)** rate proportional to the square of the (partial) pressure of NO OR the rate doubles as the square of the (partial) pressure of NO doubles **(1)** Conditional on correct order			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	as (partial) pressure (of O_2) doubles rate doubles, so first order OR gradient of line is $k\ p(O_2)^x$ so if this doubles the order (w.r.t. O_2) must be 1	Concentration of O_2 instead of (partial) pressure		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iii)	rate = $k\ p(NO)^2 p(O_2)$ Cq on orders in (i) and (ii)	rate = $k[NO]^2[O_2]$ "R" for "rate" "K" for lower case "k"	Any equation without k rate = $k\ p[NO]^2 p[O_2]$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(iv)	$atm^{-2}\ s^{-1}$ ALLOW this mark, even if $p[\ ]$ used in (iii) Cq on (iii) [if overall second order, unit is $atm^{-1}s^{-1}$. If overall first order unit is s^{-1}]	$mol^{-2}\ dm^6\ s^{-1}$ if concs used in (iii)		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(v)	partial pressure/concentration of NO is very small (so the collision frequency with O_2 molecules is very low)	chance of a 3-body collision is slight	Equilibrium reaction Temp is too low	1

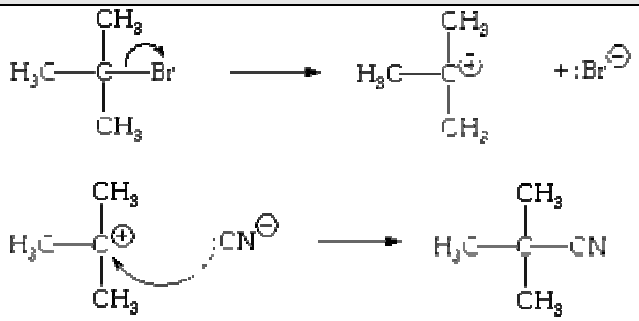
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	plot ln *k* vs 1/T **(1)** giving straight line of gradient – E_a/R OR E_a = -gradient x R **(1)** STAND ALONE MARKS [2nd mark could be scored from (ii) if no reference to gradient here in (i) provided a clear expression is stated]	If plot 1/T vs ln *k* **and** gradient is -R/E_a **(2)** If plot ln *k* vs 1/RT **and** gradient – E_a **(2)**	"log"	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark 2
2 (b)(ii)	E_a = 2.95x10 ^{4} x 8.314 **(1)** (= 245,145 J mol^{-1}) = 245 (kJ mol^{-1}) **(1)** Correct answer with no working **(2)** Answers **not** to 3 SF can only score the 1st mark Note: —245 (kJ mol^{-1}) **(1)** but must be 3SF 245,000 **kJ** (mol^{-1}) **(1)** but must be 3SF —245,000 **kJ** mol^{-1} **(0)** If 245 or —245 is given, units are **not** needed If 245,000 is given, units are **essential** DO **NOT** PENALISE K^{-2} OR K^{-1} **in any unit**	245,000 **J** (mol^{-1}) **(2)** [Note to examiners: give credit if candidate uses 2.95 x10^{-4} or 1/2.95 x10^4]		

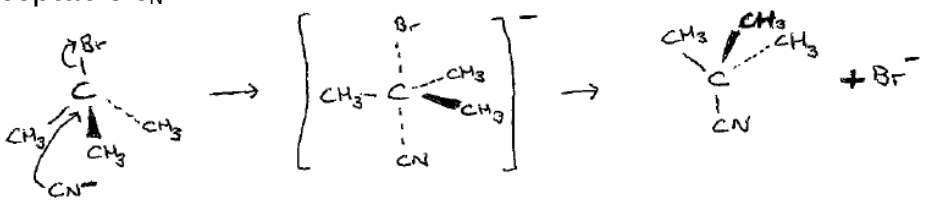
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(iii)	**B**			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)	(aqueous) ethanol /ethanolic solution	ethanol alcohol propanone		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	**1st Mark** S_N1 **Or** must be (at least) two steps **(1)** **2nd Mark** **only** the halogenoalkane is involved in the r.d.s. **OR** CN^- is **not** involved in rds **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	 first arrow must start from bond, not the carbon atom and not end past the bromine atom **(1)** structure of carbocation **(1)** Br^- not essential 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 **(1)** IGNORE any references to rates of the steps	$(CH_3)_3C$-Br completely correct S_N2 version scores **(1)** **See below**		3

Acceptable S_N2



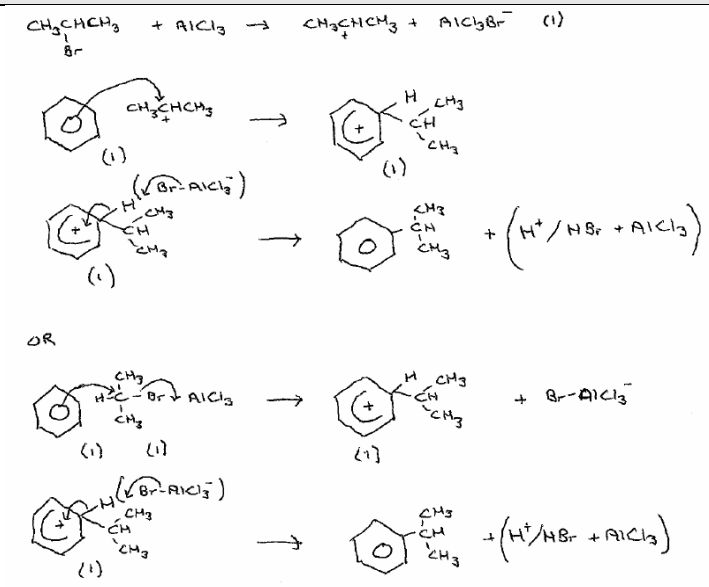
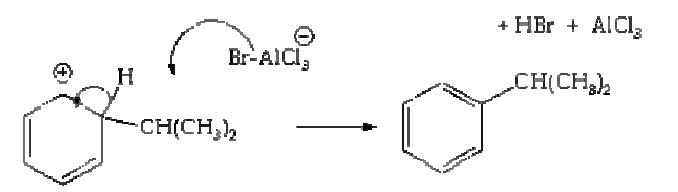
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c)	yes, because the CN group will cause a different chemical shift **(1)**	no, because the proton/ H atom environment has not changed (so the nmr spectra will be the same)	Just 'No' any mention of more than one peak	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d) **QWC**	**1st mark** (heat with) NaOH / sodium hydroxide (solution) OR heat to red heat with sodium and drop into water **(1)** **2nd mark** acidify / add excess / neutralise with nitric acid / HNO_3 **(1)** If HCl is added here, only the 1st mark can score **3rd mark** add silver nitrate (solution) /$AgNO_3$ **(1)** **4th mark** cream ppt **(1)** IGNORE reference to ammonia unless incorrect (e.g. soluble in dilute ammonia) Note: If no NaOH used only the 2nd, 3rd and 4th marks can score If no acid is added, or if it is added before NaOH, only 3rd and 4th marks can score If order of addition is NaOH, $AgNO_3$, excess HNO_3, can score all marks If no NaOH and no HNO_3, can score 3rd and 4th marks If any reagent other than $AgNO_3$, including ammoniacal $AgNO_3$, is used, only 1st and 2nd marks can score. **OR** Mass spectroscopy **(1)** A doublet **(1)** of equal heights **(1)** in molecular ion peak **(1)** **OR** Mass spectroscopy **(1)** loss of m/e of 79 **(1)** and 81 **(1)** from molecular ion **(1)** **OR** Infrared spectroscopy **(1)** Measure/record wavenumber **(1)** Absorption due to C-Br stretch **(1)** Compare wavenumber with data book **(1)**	Names or formulae can be used, but if both used both must be correct Dilute sulphuric acid for nitric	add HNO_3 concentrated HNO_3 Yellow /off-white ppt	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)(i)	**dilute** acid/(dilute) hydrochloric acid/**dilute** sulphuric acid / **dilute** nitric acid OR aqueous NaOH followed by dilute acid **(1)** $(CH_3)_3CCOOH$ **(1)** STAND ALONE	$H_3O^+(aq)/H^+(aq)$ $(CH_3)_3CCO_2H$; displayed formulae	concentrated acid OR Just "water" $C_3H_{10}O_2$	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (e)(ii)	$(CH_3)_3CCOOH+CH_3CH_2OH \rightleftharpoons (CH_3)_3CCOOCH_2CH_3+H_2O$ **(1)** for ethanol provided it is reacting with a carboxylic acid or acid chloride **(1)** for remainder of equation correct ALLOW $(CH_3)_3CCOCl+CH_3CH_2OH \rightarrow (CH_3)_3CCOOCH_2CH_3+HCl$ **(2)** if acid chloride is produced in first step	"$-CO_2-$" for "–COO-"; "$\rightarrow$" for "$\rightleftharpoons$" full structural formulae "C_2H_5" for "CH_3CH_2"	$CH_3CH_2\underline{HO}$	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	(anhydrous) aluminium chloride [Name or formulae]	Al_2Cl_6 $AlBr_3$ $FeBr_3$ $FeCl_3$	Fe	1

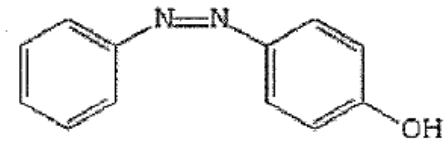
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	 OR OR    Equation for formation of electrophile **(1)** IGNORE if incorrect arrows added at this point First arrow must be from C=C or from or within ring to C with + and can point to + **(1)** Correct intermediate as shown in mechanism above **(1)** Second arrow from C-H bond into ring **(1)**	either a delocalised or Kekule ring If $CH_3CHBrCH_3 \rightarrow CH_3CH^+CH_3 + Br^-$ loses 1st mark but can score 2nd, 3rd and 4th marks		4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(i)	$CH_3CH_2CH_2^+$	$C_2H_5CH_2^+$	$C_3H_7^+$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b)(ii)	secondary carbocation is more stable than primary **(1)** primary carbocation ($CH_3CH_2CH_2^+$) rearranges to produce a secondary carbocation OR primary carbocation ($CH_3CH_2CH_2^+$) turns into a secondary carbocation OR a description of the rearrangement e.g. a hydrogen atom moves from the middle to the end **(1)**		any reference to stability of intermediate /product	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	**First mark** sodium nitrite /sodium nitrate(III)/$NaNO_2$ **(1)** **Second mark** hydrochloric acid / HCl(aq) **(1)** IGNORE concentration of acid 2nd mark is conditional on $NaNO_2$ or HNO_2		HNO_2 HCl/hydrogen chloride	2

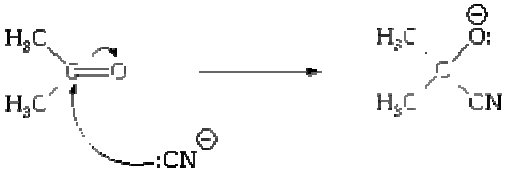
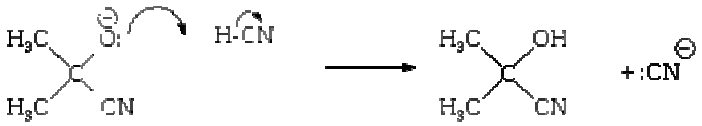
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	below 0 ^oC reaction is too slow **(1)** above 10 ^oC the product/benzenediazonium ions decomposes /hydrolysed **(1)**	 HNO_2 decomposes		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	 N=N link, can be shown linear **(1)** IGNORE other atoms Remainder correct **(1)**	IGNORE position of OH group. —ONa or O^- instead of OH	—N=N—O—	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iv)	the bonds around the —N=N— bond are not linear (because of lone pairs) **(1)** Note: this could be shown on the diagram restricted rotation/no (free) rotation **around** the —N=N— **(1)**		different groups on each N atom	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i) QWC	**First two marks** add 2,4-dinitrophenylhydrazine/Brady's reagent **(1)** orange/yellow ppt **(1)** Allow this second mark if the name of the reagent is slightly incorrect e.g. 2,4-diphenylhydrazine OR IR absorption due to C=O stretch **(1)** at 1700 cm^{-1} **(1)** **Third mark** Does not give a silver mirror with ammoniacal silver nitrate (or Tollens' reagent) OR no red ppt/stays blue with Fehling's or Benedict's solution OR $H^+/Cr_2O_7^{2-}$ does not change from orange to green/stays orange OR H^+/MnO_4^- does not change from purple to colourless/stays purple **(1)**	2,4-dnp(h) Any combination of yellow and orange Must be ppt No change with Tollens'	Just "Red ppt" "solid" for "ppt" Iodoform	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	the C=O group is polar **and** the nucleophile attacks the δ^+ carbon **(1)** whereas C=C is non-polar/electron-rich, the double bond/π-bond is attacked by electrophiles **(1)** OR C=O is polar **and** C=C is non-polar **(1)** Nucleophile attacks the δ^+ carbon in C=O **and** electrophiles attack the π/double bond in C=C, which is electron rich/non-polar **(1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(iii)	  **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
5 (a)(i)	Cr: [Ar] $3d^5 4s^1$ Cu: [Ar] $3d^{10} 4s^1$ **Both needed for the mark**	$4s^1 3d^5$ $4s^1 3d^{10}$ [Ar] written in full		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (a)(ii)	all the others are $4s^2$ / have full 4s orbital **(1)** The d subshell is more stable when either half or fully filled OR A specific example of chromium having half-filled or copper having filled d sub-shell/**set** of d orbitals which is more stable **(1)**	Cr and Cu/they do not have a full 4s orbital sub-energy levels d shell	Just 'only have one electron in 4s' OR Have incomplete 4s orbital Half-filled or filled d-**orbital(s)**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(i)	Octahedral drawn must be 3-D IGNORE any or no charge	$-H_2O$ (bond to H) except on water molecules on left of Cr		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(ii)	Dative bond formed from electron pair/lone pair on oxygen (of the water molecule) to the ion This could be shown on a diagram	A clear description of the dative bond	'dative' alone or from water Just "dative bond formed from oxygen"	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iii)	$[Cr(H_2O)_6]^{3+} + OH^- \rightarrow [Cr(H_2O)_5OH]^{2+} + H_2O$ OR $[Cr(H_2O)_6]^{3+} + 2OH^- \rightarrow [Cr(H_2O)_4(OH)_2]^{+} + 2H_2O$ OR $[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow Cr(OH)_3 + 6H_2O$ OR $[Cr(H_2O)_6]^{3+} + 3OH^- \rightarrow [Cr(H_2O)_3(OH)_3] + 3H_2O$ **First mark** is for the correct Cr product **Second mark** is conditional on the first and is for the rest of the equation correct and balanced			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(iv)	Forms a **green precipitate (1)** IGNORE initial colour of solution (which reacts or dissolves or changes to) a **green solution** (with excess reagent) **(1)** 2nd mark is conditional on an initial ppt	any shade of green		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (b)(v)	acid / acidic	Amphoteric/able to be deprotonated	Coloured ions/ligand exchange/ deprotonation /partially filled d orbitals	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(i)	**Check working – correct answer can be obtained by not dividing by 2 for 2nd mark and not multiplying by 2 for 4th mark** amount thiosulphate in titre = 0.0372 dm^3 x 0.100 mol dm^{-3} = 3.72 x 10^{-3} mol **(1)** amount I_2 = $\frac{3.72 \times 10^{-3}}{2}$ **(1)** =1.86 x10^{-3} mol 2nd mark cq on amount thiosulphate amount dichromate in 25 cm^3 = $\frac{1.86 \times 10^{-3}}{3}$ **(1)** = 6.2 x10^{-4} mol 3rd mark cq on amount I_2 Total mass Cr = 6.2 x10^{-4} mol x 2 x 10 x 52 g mol^{-1} **(1)** = 0.645 g 4th mark cq on amount dichromate % of Cr = 64.5 % **(1)** IGNORE SF unless rounded to 1 SF cq on mass Cr, provided less than 1 g OR amount thiosulphate for whole sample = 0.0372 dm^3 x 0.100 mol dm^{-3} x 10 = 3.72 x 10^{-2} mol **(1)** amount I_2 = 1.86 x10^{-2} mol **(1)** amount dichromate = 6.2 x10^{-3} mol **(1)** mass Cr = 6.2 x 10^{-3} mol x 2 x 52 g mol^{-1} **(1)** = 0.645 g % of Cr = 64.5% **(1)** IGNORE SF unless rounded to 1sf Mark consequentially, as above **Note:** Correct answer with no working **(3)**	64.48 %		5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
5 (c)(ii)	Colour at the end point would be green which would prevent the loss of iodine colour being seen OR colour change at end point would be disguised by the colour of Cr^{3+}	Chromium instead of Cr^{3+}	end point disguised by colour of $Cr_2O_7^{2-}$ /orange	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
Check subtractions and averaging arithmetic, correcting if necessary.
All volumes recorded to 0.05 cm^3 (1)
ALLOW one slip but withhold this mark if any readings are in the wrong boxes.
ALLOW 0 as initial volume NOT 50 as initial volume
All subtractions correct (1)

[✓✓top RHS of Table 1]

Mean titre
For correct averaging of chosen values / choosing identical values and for recording the average correct to 2 or 3 dps or to nearest 0.05 cm^3 (1)

Do not penalise missing 2/3rd dp if already penalised in Table 1.

[✓by the mean in space <u>or</u> near the dotted line in paragraph below]

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

Examiner's titre = 22.70 cm^3 (to be confirmed at standardisation)

Award marks for accuracy as follows.

<table>
<tr><td>Difference (d) =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.50</td></tr>
<tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>
</td><td></td><td></td><td>10</td></tr>
</table>

	Range Award a mark on the range of titres used by the candidate to calculate the mean. The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range mark on the corrected titres used by the examiner to re-calculate the mean Range(r) of titres/cm^3: ±0.20	±0.30	±0.50 Mark: **3**	**2**	**1** Examiner to show the mark awarded for accuracy and range as d= value ✓ 4 max r = value ✓ 3 max Then the mark out of 10 written in margin. [Overseas scripts: examiner to write "SR = titre value" on each script]		

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Moles MnO_4^- in 25.0 cm^3 = $\frac{25 \times 0.020}{1000}$ (1) moles $S_2O_3^{2-}$ in mean titre = moles MnO_4^- x 5 (1) concentration $Na_2S_2O_3$ = $\frac{\text{moles } S_2O_3^{2-} \text{ in mean titre}}{\text{mean titre} \div 1000}$ to 3 sf (1) Ignore units. Do not penalise loss of trailing zeros.	Correct answer from any method for **(3)** Ignore sf except on final conc^n.	Final conc^n if not to 3 sf. ∴ max (2)	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	Yellow to colourless	Straw (colour) to colourless	Colourless alone Any purple/brown	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	**Observations** White precipitate (1) Dissolves / disappears (in excess NaOH) / colourless solution (1) **Inference** Zinc / Zn^{2+}, aluminium / Al^{3+}, lead(II) / Pb^{2+} any two (1) Ignore Cd^{2+} / Sn^{2+} / Sn^{4+} / Sb^{3+}	Soluble in excess/ goes clear	Symbols Zn, Al, Pb.	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	**Observations** White precipitate (1) Dissolves / disappears (in excess NH_3) / colourless solution (1) **Inferences** Zinc (ions) / Zn^{2+} (1) $Zn(OH)_2$ / $[Zn(H_2O)_4(OH)_2]$ (1) $[Zn(NH_3)_4]^{2+}$ (1)	Soluble in excess/ goes clear Allow equivalent Cd species if Cd given in (a) $[Zn(NH_3)_4(H_2O)_2]^{2+}$		5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	Observation White precipitate (1) Inference Sulphate / SO_4^{2-} (1)	hydrogensulphate/ HSO_4^-	Barium sulphate	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	$ZnSO_4$	$CdSO_4$		1

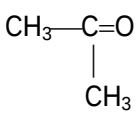
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)	**Observations** (any) green precipitate (1) Dissolves/ disappears (in excess) / green solution (1) Any yellow / any brown solution (1) **Inferences** $Cr(OH)_3$ / $[Cr(H_2O)_3(OH)_3]$ (1) $[Cr(OH)_6]^{3-}$ (1) CrO_4^{2-} (1)	Soluble in excess/ goes clear		6

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(f)	$Cr_2(SO_4)_3$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	**Observation** Yellow / orange precipitate (1) **Inference** Carbonyl / C=O/>C=O/ both of aldehyde or ketone (1)	Yellow-orange		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	**Observation** Stays orange / no change (1) **Inferences** Ketone / not aldehyde if follows A or K in (a) (1) Not oxidised / no redox / does not reduce $Cr_2O_7^{2-}$ (1)	No reaction	Just "nothing" Tertiary alcohol Reject cq on wrong colour	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)	**Observation** (pale) Yellow precipitate (1) **Inferences** Triiodomethane / Iodoform / CHI_3 (1) Methyl ketone / CH_3CO (1)	Cream ppte	CH_3I Methyl secondary alcohol / ethanol / ethanal	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(i)	*m/e* 58 (1) Structure  (1) Ignore positive charge		CH_3COCH_3 Species with negative charge	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(ii)	CH_3CO^+		Formula with no positive charge $C_2H_3O^+$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add NaCl to all five); the one that gives white ppte is $AgNO_3$ **2** ✔ Add $AgNO_3$ to new samples of remaining four. **3** ✔ Solution that gives yellow ppte is KI. **4** ✔ Solution that gives brown ppte or no ppte is NH_3. **5** ✔ Solution that give white ppts are KCl and $AlCl_3$. **6** ✔ Add NH_3 to remaining two unknown solutions. **7** ✔ Solution that gives white ppte is $AlCl_3$.	No white ppte with NH_3		7

OR

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add NaCl to all five); the one that gives white ppte is $AgNO_3$ **2** ✔ Add four solutions to (AgCl) ppte. **3** ✔ Ppte dissolves in NH_3. **4** ✔ Add NH_3 to remaining three solutions. **5** ✔ White ppts $AlCl_3$. **6** ✔ Add $AgNO_3$ to remaining solutions. **7** ✔ Yellow ppte with KI and white ppte with KCl.			7

OR

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add NaCl to all five); the one that gives white ppte is $AgNO_3$ **2** ✔ Add four solutions to (AgCl) ppte. **3** ✔ Ppte dissolves in NH_3 **4** ✔ Add $AgNO_3$ to remaining three solutions. **5** ✔ White ppts with $AlCl_3$ + KCl and yellow ppte with KI. **6** ✔ Add NH_3 to solutions of $AlCl_3$ + KCl **7** ✔ White ppte with $AlCl_3$.			7

6246/01A – Materials

Apparatus and Materials

Apparatus

Each candidate will require:

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

Materials

Each candidate will require:

(a)* 200 cm^3 of aqueous sodium thiosulphate of concentration 0.110 mol dm^{-3} labelled **Solution A**. The concentration of this solution is **not** to be disclosed to candidates;

(b)* 200 cm^3 of aqueous potassium manganate(VII) of concentration 0.020 mol dm^{-3} labelled **Solution B**;

(c)* 10 cm^3 of approximately 0.25 mol dm^{-3} aqueous zinc sulphate labelled **Solution of C**. The identity of this solution is **not** to be disclosed to candidates;

(d)* 5 cm^3 of approximately 0.10 mol dm^{-3} aqueous potassium chromium(III) sulphate, labelled **Solution of D**. The identity of this solution is **not** to be disclosed to candidates;

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

(f) 100 cm^3 of dilute sulphuric acid of concentration approximately 1.0 mol dm^{-3}, labelled **Dilute sulphuric acid**;

(g) 100 cm^3 of aqueous potassium iodide of concentration approximately 0.50 mol dm^{-3} labelled **Aqueous potassium iodide**;

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

(i) 15 cm^3 of dilute aqueous ammonia; concentration approximately 2.0 mol dm^{-3};

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

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

(l) 10 cm^3 of freshly-prepared aqueous hydrogen peroxide; concentration approximately 10 vol;

(m) 5 cm^3 of 2,4-dinitrophenylhydrazine solution. This may be made by adding 0.1 g of the solid reagent to 45 cm^3 of water and 5 cm^3 of concentrated hydrochloric acid, stirring and filtering if necessary. Alternatively centres may prepare this reagent using their own procedure providing the reagent gives a positive test with propanone;

(n) 5 cm^3 dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3} (for Question 3);

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

(p) 10 cm^3 of aqueous sodium hydroxide; concentration approximately 0.50 mol dm^{-3}. Label this solution **0.50 mol dm^{-3} sodium hydroxide for Q3(c)**;

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

(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.

6246/01B

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1.(a)</td><td>
Table 1
Check subtractions and averaging arithmetic, correcting if necessary.
All volumes recorded to 0.05 cm^3 (1)
ALLOW one slip but withhold this mark if any readings are in the wrong boxes.
ALLOW 0 as initial volume NOT 50 as initial volume
All subtractions correct (1)

[✓✓top RHS of Table 1]

Mean titre
For correct averaging of chosen values / choosing identical values and for recording the average correct to 2 or 3 dps or to nearest 0.05 cm^3 (1)
Do not penalise missing 2/3rd dp if already penalised in Table 1.

[✓by the mean in space <u>or</u> near the dotted line in paragraph below]

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

Examiner's titre = 22.70 cm^3 (to be confirmed at standardisation)

Award marks for accuracy as follows.
<table>
<tr><td>Difference (d) =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.50</td></tr>
<tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>
</td><td></td><td></td><td>10</td></tr>
</table>

Range

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

Range(r) of titres/cm^3	±0.20	±0.30	±0.50
Mark	**3**	**2**	**1**

Examiner to show the mark awarded for accuracy and range as

d= value ✓ 4 max

r = value ✓ 3 max

Then the mark out of 10 written in margin.
[Overseas scripts: examiner to write "SR = titre value" on each script]

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)	Moles $S_2O_3^{2-}$ in mean titre = $\frac{\text{mean titre x } 0.110}{1000}$ (1) moles MnO_4^- in 25.0 cm^3 = $\frac{\text{moles } S_2O_3^{2-}}{5}$ (1) concentration MnO_4^- = $\frac{\text{moles } MnO_4^- \text{ in } 25.0\ cm^3}{0.0250\ (dm^3)}$ to 3 sf (1) Ignore units Do not penalise loss of trailing zeros	Correct answer from any method for **(3)** Ignore sf except on final conc^n.	Final conc^n if not to 3 sf. ∴ max (2)	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(c)	Yellow to colourless	Straw (colour) to colourless	Colourless alone Any purple / brown	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	**Observations** White precipitate (1) Dissolves / disappears (in excess NaOH) / colourless solution (1) **Inference** Zinc / Zn^{2+}, aluminium / Al^{3+}, lead(II) / Pb^{2+} any two (1) Ignore Cd^{2+} / Sn^{2+} / Sn^{4+} / Sb^{3+}	Soluble in excess/ goes clear	Symbols Zn, Al, Pb.	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	**Observation** Any red (1) **Inferences** Aluminium / Al^{3+} (1) Acidic (since only 3+ ion of Al, Zn, Pb) Acidic – Stand alone mark (1)			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	**Observations** White precipitate (1) Insoluble in excess NH_3 (1) **Inference** $Al(OH)_3$ / $[Al(H_2O)_3(OH)_3]$/aluminium hydroxide (1)			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	**Observation** White precipitate (1) **Inference** chloride / Cl^- (1)		Chlorine / Cl	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)	$AlCl_3$	Al_2Cl_6		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(f)	**Observations** (any) blue precipitate (1) Dissolves/ disappears in excess (1) Deep(er) blue solution (1) **Inferences** $Cu(OH)_2$ / $[Cu(H_2O)_4(OH)_2]$ (1) $[Cu(H_2O)_2(NH_3)_4]^{2+}$ (1)	Soluble in excess/ goes clear $[Cu(NH_3)_4]^{2+}$	$[Cu(NH_3)_6]^{2+}$	5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(g)	$CuCl_2$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	**Observation** Yellow / orange precipitate (1) **Inference** Carbonyl / C=O/>C=O/ both of aldehyde or ketone (1)	Yellow-orange		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	**Observation** Stays orange / no change (1) **Inferences** Ketone /not aldehyde if follows A or K in (a) (1) Not oxidised / no redox / does not reduce $Cr_2O_7^{2-}$ (1)	No reaction	Just "nothing" Reject cq on wrong colour	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)	**Observation** (pale) Yellow precipitate (1) **Inferences** triiodomethane / Iodoform / CHI_3 (1) Methyl ketone / CH_3CO (1)	Cream ppte	CH_3I Methyl secondary alcohol / ethanol / ethanal	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(i)	*m/e* 72 (1) Structure $CH_3—CH_2—\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}=O$ / $C_2H_5—\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}=O$ (1) Ignore positive charge		$CH_3COCH_2CH_3$ Species with negative charge	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(ii)	$CH_3CH_2CO^+$ / $CH_2\ COCH_3^+$		Formula with no positive charge $C_3H_5O^+$	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add Na_2SO_4 to all five): the one that gives white ppte is $BaCl_2$ **2** ✔ Add $BaCl_2$ to other four solutions. White ppte with $AgNO_3$ **3** ✔ Add $AgNO_3$ to remaining three solutions **4** ✔ White ppts with NaCl and $ZnCl_2$ **5** ✔ Brown ppte with NH_3/ remaining one is NH_3 **6** ✔ Add NH_3 to NaCl and $ZnCl_2$ **7** ✔ White ppte with $ZnCl_2$	No white ppte with NH_3		7

OR

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add Na_2SO_4 to all five): the one that gives white ppte is $BaCl_2$ **2** ✔ Add $BaCl_2$ to other four solutions. White ppte with $AgNO_3$ **3** ✔ Add remaining three solutions to AgCl ppte **4** ✔ AgCl dissolves in NH_3 **5** ✔ Add $AgNO_3$ to remaining two solutions **6** ✔ White ppte with both $ZnCl_2$ and NaCl **7** ✔ Add excess NH_3 : $ZnCl_2$ ppt disolves			7

OR

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add Na_2SO_4 to all five): the one that gives white ppte is $BaCl_2$ **2** ✔ Add $BaCl_2$ to other four solutions. White ppte with $AgNO_3$ **3** ✔ Add remaining three solutions to AgCl ppte **4** ✔ AgCl dissolves in NH_3 **5** ✔ Add NH_3 to NaCl and $ZnCl_2$ **6** ✔ White ppte with $ZnCl_2$ **7** ✔ No ppte with NaCl/ NaCl remaining			7

OR

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ (Add Na_2SO_4 to all five): two white ppts – $BaCl_2$ and $AgNO_3$ **2** ✔ Distinguish between ppts **3** ✔ Add $AgNO_3$ to remaining three solutions **4** ✔ White ppts with NaCl and $ZnCl_2$ **5** ✔ Brown ppte with NH_3/ remaining one is NH_3 **6** ✔ Add NH_3 to NaCl and $ZnCl_2$ **7** ✔ White ppte with $ZnCl_2$	No white ppte with NH_3		7

6246/01B - Materials

Apparatus and Materials

Apparatus

Each candidate will require:

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

Materials

Each candidate will require:

(a)* 200 cm^3 of aqueous sodium thiosulphate of concentration 0.110 mol dm^{-3} labelled **Solution F**;

(b)* 200 cm^3 of aqueous potassium manganate(VII) of concentration 0.020 mol dm^{-3} labelled **Solution G**. The concentration of this solution is **not** to be disclosed to candidates;

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

(d)* 5 cm^3 of approximately 0.25 mol dm^{-3} aqueous copper(II) chloride, labelled **Solution of I**. The identity of this solution is **not** to be disclosed to candidates;

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

(f) 100 cm^3 of dilute sulphuric acid of concentration approximately 1.0 mol dm^{-3}, labelled **Dilute sulphuric acid**;

(g) 100 cm^3 of aqueous potassium iodide of concentration approximately 0.50 mol dm^{-3} labelled **Aqueous potassium iodide**;

(h) 10 cm^3 of dilute sodium hydroxide; concentration approximately 1.0 mol dm^{-3};

(i) access to a small bottle of Universal Indicator solution;

(j) 20 cm^3 of dilute aqueous ammonia; concentration approximately 2.0 mol dm^{-3};

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

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

(m) 5 cm^3 of 2,4-dinitrophenylhydrazine solution. This may be made by adding 0.1 g of the solid reagent to 45 cm^3 of water and 5 cm^3 of concentrated hydrochloric acid, stirring and filtering if necessary. Alternatively centres may prepare this reagent using their own procedure providing the reagent gives a positive test with butanone;

(n) 5 cm^3 dilute sulphuric acid; concentration approximately 1.0 mol dm^{-3} (for Question 3);

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

(p) 10 cm^3 of aqueous sodium hydroxide; concentration approximately 0.50 mol dm^{-3}. Label this solution **0.50 mol dm^{-3} sodium hydroxide for Q3(c)**;

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

(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.

6246/01C (overseas practical test)

<table>
<tr><th>Question Number</th><th>Correct Answer</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>1.(a)</td><td>
Table 1
Check subtractions and averaging arithmetic, correcting if necessary.
All volumes recorded to 0.05 cm^3 (1)
ALLOW one slip but withhold this mark if any readings are in the wrong boxes.
ALLOW 0 as initial volume NOT 50 as initial volume
All subtractions correct (1)

[✓✓top RHS of Table 1]

Mean titre
For correct averaging of chosen values / choosing identical values and for recording the average correct to 2 or 3 dps or to nearest 0.05 cm^3 (1)
Do not penalise missing 2/3rd dp if already penalised in Table 1.

[✓by the mean in space <u>or</u> near the dotted line in paragraph below]

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

Examiner to write "SR = titre value" on each script

Award marks for accuracy as follows.

<table>
<tr><td>Difference (d) =</td><td>±0.20</td><td>±0.30</td><td>±0.40</td><td>±0.50</td></tr>
<tr><td>Mark</td><td>4</td><td>3</td><td>2</td><td>1</td></tr>
</table>
</td><td></td><td></td><td>10</td></tr>
</table>

	Range Award a mark on the range of titres used by the candidate to calculate the mean. The range(r) is the difference between the outermost titres used to calculate the mean. If the examiner has corrected titres because of incorrect subtraction then award the range mark on the corrected titres used by the examiner to re-calculate the mean Range(r) of titres/cm^3 ± 0.20 ± 0.30 ± 0.50 Mark **3** **2** **1** Examiner to show the mark awarded for accuracy and range as d= value ✓ 4 max r = value ✓ 3 max Then the mark out of 10 written in margin.			

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(i)	Moles MnO_4^- in mean titre = mean titre x 0.020 / 1000 (1) moles Fe^{2+} in $25cm^3$ = moles MnO_4^- in mean titre x 5 (1) concentration Fe^{2+} = moles Fe^{2+} in 25 cm^3 / 0.0250 (dm^3) to 3sf(1) Ignore units. Do not penalise loss of trailing zeros.	Correct answer from any method for **(3)** Ignore sf except on final conc^n.	Final conc^n if not to 3 sf. ∴ max (2)	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1.(b)(ii)	Either mass Fe^{2+} in 1 dm^3 = conc^n Fe^{2+}(from (i)) x 56.0 (1) % = mass x 100 / 38.0 = 14.1% (1) OR Mass of Fe^{2+} = moles of Fe^{2+} in 25 cm^3 x 56.0 (1) % = mass x 100 / 38.0 ÷ 40 = 14.1 % (1)			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(a)	**Observations** White precipitate (1) Dissolves / disappears (in excess NaOH) / colourless solution (1) **Inference** Zinc / Zn^{2+}, aluminium / Al^{3+}, lead(II) / Pb^{2+} any two (1) Ignore Cd^{2+} / Sn^{2+} / Sn^{4+} / Sb^{3+}	Soluble in excess/ goes clear	Symbols Zn, Al, Pb.	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(b)	**Observations** White precipitate (1) Dissolves / disappears (in excess NH_3) / colourless solution (1) **Inferences** Zinc (ions) / Zn^{2+} (1) $Zn(OH)_2$ / $[Zn(H_2O)_4(OH)_2]$ (1) $[Zn(NH_3)_4]^{2+}$ (1)	Soluble in excess/ goes clear Allow equivalent Cd species if Cd given in (a) $[Zn(NH_3)_4(H_2O)_2]^{2+}$		5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(c)	Observation White precipitate (1) Inference Sulphate / SO_4^{2-} (1)	hydrogensulphate/ HSO_4^-	Barium sulphate	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(d)	$ZnSO_4$			1

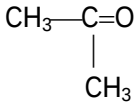
Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(e)	**Observations** (any) blue precipitate (1) Dissolves/ disappears in excess (1) Deep(er) blue solution (1) **Inferences** $Cu(OH)_2$ / $[Cu(H_2O)_4(OH)_2]$ (1) $[Cu(H_2O)_2(NH_3)_4]^{2+}$ (1)	Soluble in excess/ goes clear $[Cu(NH_3)_4]^{2+}$	$[Cu(NH_3)_6]^{2+}$	5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2.(f)	$CuSO_4$			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(a)	**Observation** Yellow / orange precipitate (1) **Inference** Carbonyl / C=O/>C=O/ both of aldehyde or ketone (1)	Yellow-orange		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(b)	**Observation** Stays orange / no change (1) **Inferences** Ketone / not aldehyde if follows A or K in (a) (1) Not oxidised / no redox / does not reduce $Cr_2O_7^{2-}$ (1)	No reaction	Just "nothing" Tertiary alcohol Reject cq on wrong colour	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(c)	**Observation** (pale) Yellow precipitate (1) **Inferences** Triiodomethane / Iodoform / CHI_3 (1) Methyl ketone / CH_3CO (1)	Cream ppte	CH_3I Methyl secondary alcohol / ethanol / ethanal	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(i)	*m/e* 58 (1) Structure  (1) Ignore positive charge		CH_3COCH_3 Species with negative charge	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3.(d)(ii)	CH_3^+		Formula with no positive charge	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ Add NaCl to all five; the one that gives white ppte is $AgNO_3$. **2** ✔ Add $AgNO_3$ to remaining four. **3** ✔ Solution that gives yellow ppte is KI. **4** ✔ Solutions that give white ppts are KCl and $BaCl_2$. **5** ✔ No ppte with Na_2SO_4. **6** ✔ Add Na_2SO_4 to remaining solutions of KCl and $BaCl_2$. **7** ✔ Solution that gives white ppte is $BaCl_2$.			7

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4.	**1** ✔ Add NaCl to all five; the one that gives white ppte is $AgNO_3$. **2** ✔ Add $AgNO_3$ to remaining four. **3** ✔ Solution that gives yellow ppte is KI. **4** ✔ Solutions that give white ppts are KCl, $BaCl_2$ and Na_2SO_4. **5** ✔ Distinguish Ag_2SO_4 ppte by appearance so identify Na_2SO_4. **6** ✔ Add Na_2SO_4 to KCl and $BaCl_2$. **7** ✔ Solution that gives white ppte is $BaCl_2$.			7

6246/01C - Materials

Apparatus and Materials

Apparatus

Each candidate will require:

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

Materials

Each candidate will require:

(a) 200 cm^3 of aqueous potassium manganate(VII) of concentration between 0.019 and 0.021 mol dm^{-3} labelled **Solution P**. Candidates will be told that this solution has a concentration of 0.0200 mol dm^{-3};

(b) 200 cm^3 of aqueous ammonium iron(II) sulphate, $(NH_4)_2SO_4.FeSO_4.6H_2O$, of concentration 38.0 g dm^{-3}, made up by dissolving the solid in about 500 cm^3 of 1.0 mol dm^{-3} aqueous sulphuric acid then making up to exactly 1.00 dm^3 with distilled water labelled **Solution Q**. The identity of this solution is **not** to be disclosed to candidates;

(c) 100 cm^3 of dilute sulphuric acid of concentration approximately 1.0 mol dm^{-3}, labelled **Dilute sulphuric acid**;

(d) 10 cm^3 of approximately 0.25 mol dm^{-3} aqueous zinc sulphate in a stoppered container labelled **Solution of R**. The identity of this solution is **not** to be disclosed to candidates;

(e) 10 cm^3 of approximately 0.25 mol dm^{-3} aqueous copper(II) sulphate in a stoppered container labelled **Solution of S**. The identity of this solution is **not** to be disclosed to candidates;

(f) 5 cm^3 of propanone in a stoppered container labelled **T**. The identity of this compound is **not** to be disclosed to candidates;

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

(h) 15 cm^3 of dilute aqueous ammonia; concentration approximately 2.0 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 2,4-dinitrophenylhydrazine solution. This may be made by adding 0.1 g of the solid reagent to 45 cm^3 of water and 5 cm^3 of concentrated hydrochloric acid, stirring and filtering if necessary. Alternatively centres may prepare this reagent using their own procedure providing the reagent gives a positive test with propanone;

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

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

(n) 10 cm^3 of aqueous sodium hydroxide; concentration approximately 0.50 mol dm^{-3}. Label this solution **0.50 mol dm^{-3} sodium hydroxide for Q3(c)**;

(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) a supply of distilled water.

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (a)	Heat/enthalpy/energy change (for a reaction) is independent of the path/route taken (depending only on the initial and final states) OR Heat/enthalpy/energy change (for a reaction) depends only on the initial and final states.	Enthalpy change for a direct path is the same as that of an indirect path.	enthalpy change for the reaction is the same as the sum of the values for each step.	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (b)	heat change (= $mC\Delta\theta$) = 30g x 4.18 J $^{o}C^{-1}g^{-1}$ x(30.1–23.7) ^{o}C for this expression **or** the answer = (+)803 (J). **(1)** Units do not have to be in the calculation. If candidate believes that 803 or - 803 is the value of ΔH next two marks are lost. ΔH_1 = – 803 J ÷ 0.0187 mol = — 43 for sign and value (rounded or unrounded) **(1)** **to 2sf only** and kJ mol^{-1} **(1)** if value and units do not agree loses both second and third marks Correct answer plus some working **(3)**	(+) 802.56 or – 803 or – 802.56 - 802.56 ÷ 0.0187 —43000 J mol^{-1} **(2)**		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(i)	Multiplies the $KHCO_3$ equation by 2 **(1)** and subtracts the K_2CO_3 equation from it **(1)** This can come from a cycle. $\Delta H = 2\Delta H_2 - \Delta H_1$ scores these first two marks if $\Delta H = \Delta H_1 - 2\Delta H_2$ loses second and third marks if $\Delta H = \Delta H_1 + 2\Delta H_2$ loses second and third marks $\Delta H = 2\Delta H_2 - \Delta H_1$ = (+ 29.3 x 2) – (– 43) kJ mol $^{-1}$ = (+)101.6 (kJ mol $^{-1}$) **(1)** IGNORE SF Correct answer plus some working **(3)** Failing to multiply by 2 loses first mark above, but can then score max 2 as follows: $\Delta H = \Delta H_2 - \Delta H_1$ **(1)** = +29.3 – (- 43) kJ mol $^{-1}$ = (+)72.3 kJ mol $^{-1}$ **(1).** Third mark is consequential on candidate answer in 1(b), e.g. if 1(b) equals + 43 kJ mol $^{-1}$ the answer will be (+)15.6/15.7 kJ mol $^{-1}$	(+)101.5 if candidates uses – 42.9 from (b).		3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (c)(ii) QWC	reaction in solution produces $H_2O(l)$ whereas thermal decomposition produces $H_2O(g)$ OR water produced in the decomposition is gaseous which is not the standard state OR **energy** is required to vapourise (liquid) water		heat required to vapourise water must be taken into account	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
1 (d)	**First mark:** K_c is smaller **as forward reaction is endothermic (1)** **Second mark:** The second mark can only be awarded if the amount of reactant/product changes **because** of a change in K_c. Increases the amount of $KHCO_3$ /reactants OR decreases amount K_2CO_3 /products **(1).** If K_c is said to be larger, then the second mark can be awarded consequentially for saying that the amount of $KHCO_3$ decreases, etc.	equilibrium shifts to the left	Equilibrium moves to left **and so K falls** scores (0) more $KHCO_3$ than K_2CO_3	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(i)	Ignore any conditions (other than the need for aqueous acid) and ignore mechanisms whether correct or not. $CH_2=CH_2 + HBr \rightarrow CH_3CH_2Br$ **(1)** mark being for whole equation; OR $H_2C=CH_2 + H_2 \rightarrow CH_3CH_3$ *and* $CH_3CH_3 + Cl_2 \rightarrow CH_3CH_2Cl$ (+ HCl) **(1)** Then Mg **(1)** $CH_3CH_2Br \rightarrow CH_3CH_2MgBr$ **(1)** mark for the Grignard structure. Halogen must agree with the halogenoalkane used. $(CH_3CH_2MgBr) + CO_2$ **(1)** **followed by** $H^+(aq)$ **(1)** Any acid acceptable but it must be clear that it is dilute or aqueous. **Note:** $CO_2 + H^+(aq)$ scores **(1)** only. An equivalent answer in words can score full marks but the halogenoalkane must be identified and the **formula** of the Grignard reagent must be included OR for the last two marks: Grignard + HCHO **and** hydrolysis (to give propan-1-ol) **(1)** followed by oxidation of product with dichromate(VI) + acid *or* manganate(VII) + acid **(1)** This last mark can be awarded however the propan-1-ol is obtained.	HCl or HI in place of HBr to give the appropriate product C_2H_5 instead of CH_3CH_2 + Br_2 to give bromoethane C_2H_5 instead of CH_3CH_2 dry ice for CO_2 hydrochloric acid dichromate or permanganate	+ I_2 CH_3CH_2BrMg e.g. HCl, conc HCl HCl with MnO_4^-	5

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (a)(ii)	Nucleophile/nucleophilic reagent **(1)** attack by $CH_3CH_2^{\delta-}$ of the Grignard on $C^{\delta+}$ (of C=O) **(1)**	 $CH_3CH_2^-$ C_2H_5 for CH_3CH_2		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(i)	$CH_3CH_2COCl + CH_3CH_2OH \rightarrow CH_3CH_2COOCH_2CH_3 + HCl$ **(1)** $CH_3CH_2COOH + CH_3CH_2OH \rightleftharpoons CH_3CH_2COOCH_2CH_3 + H_2O$ **(1)** Allow $CH_3CH_2OCOCH_2CH_3$ or $CH_3CH_2OC(O)CH_2CH_3$ for the ester since it is symmetrical.	C_2H_5 instead of CH_3CH_2 $-CO_2-$ instead of $-COO-$ $\rightarrow$ instead of $\rightleftharpoons$ or vice versa		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (b)(ii)	Reaction with the acid chloride since it is not an equilibrium/not reversible/goes to completion (so the yield is higher) There must be a reason as to **why** the acid chloride reaction is better for the mark.	loss of HCl **as a gas** pulls equilibrium to the r.h.s.	Reaction faster HCl is a gas **alone** Just 'HCl pulls eqm to the right'	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(i)	Solution maintaining an almost constant pH **(1)** for a **small** addition of acid or alkali/base **(1)** Ignore any reference to the composition of the buffer, whether correct or not. Ignore references to 'contaminated with' acid or alkali.	resists change in pH withstands changes in pH maintains pH	resists small changes in pH	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(ii)	Correct answer with unit and some working scores **(4)**. Correct answer with unit but no working scores **(3)**. $[H^+] = 10^{-5.06} = 8.71 \times 10^{-6}$ mol dm^{-3} **(1)** [HA] = 0.10 mol dm^{-3}, so $[A^-] = \frac{1.3 \times 10^{-5} \times 0.10}{8.71 \times 10^{-6}}$ **(1)** (= 0.149 mol dm^{-3}) amount of A^- = 0.149 x 0.125 (= 0.0187 mol) **(1)** mass NaA = 0.0187 mol x 96 g mol^{-1} = **1.79 g (1)** MUST INCLUDE UNIT BUT IGNORE SF UNLESS ROUNDED TO 1 SF IN WORKING OR ANSWER. OR pH - pK_a = log([A^-] ÷ [HA]) = 5.06 – 4.886 = 0.174 **(1)** ([A^-] ÷ [HA]) = 1.49 so [A^-] = 0.149 x 0.0125 = 0.0187 mol **(1)** mass NaA =0.0187 mol x 96 g mol^{-1} = **1.79 g (1)** MUST INCLUDE UNIT BUT IGNORE SF OR Candidates who round the value of pK_a will get: pH = pK_a + log([A^-] ÷ [HA]) **(1)** pH - pK_a = log([A^-] ÷ [HA]) = 5.06 – 4.89 = 0.17 **(1)** ([A^-] ÷ [HA]) = 1.48 so [A^-] = 0.148 x 0.0125 = 0.0185 mol **(1)** mass NaA =0.0185 mol x 96 g mol^{-1} = **1.77/1.78 g (1)** MUST INCLUDE UNIT BUT IGNORE SF	1.8**g** 1.8**g** 1.8**g**	2g 2g 2g	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iii)	($[OH^-] = K_w / [H^+]$) (=) 1.0×10^{-14} mol^2 $dm^{-6} \div 8.71 \times 10^{-6}$ $mol\ dm^{-3}$ **(1)** no need for units in calculation = 1.15×10^{-9} (mol dm^{-3}) **(1)** Ignore units even if wrong The answer is consequential on their value of $[H^+]$ in (ii) **provided that** the final answer is smaller than 10^{-7} mol dm^{-3}, i.e. the solution must be acidic. OR pOH = 14 – pH = 8.94 **(1)** $[OH^-]$ = 1.15×10^{-9} (mol dm^{-3}) **(1)** Ignore units even if wrong	1.148×10^{-9}	1.14×10^{-9}	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
2 (c)(iv) QWC	H^+ and OH^- can be removed by reaction with HA or with A^- **(1)** but since $[A^-]$ is small the ratio $[A^-] \div [HA]$ changes significantly and so does the pH **(1)** OR $[A^-] \div [HA]$ must remain nearly constant on addition of H^+ or OH^- **(1)** but this is possibly only if large reserves of both are present **(1)** For **(1)** only: If H^+ is added no/very little A^- available to react **so the pH will alter (1)**			2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(i)	V-shape drawn **(1)** Ignore the bond angle (except for linear) and ignore the number of lone pairs. (justified on the basis of) **2 bond pairs and 2 lone pairs** repelling as far apart as possible/to minimum repulsion/to maximum separation **(1)** **Note:** The numbers of electron pairs can come from the diagram, the drawing of the bond being equivalent to the bond pair. If the diagram shows one lone pair but two are mentioned here ignore the diagram.		linear structure any double bonds O-H-O any argument based on three pairs of electrons maximum repulsion lp-lp>bp-bp **alone**	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (a)(ii)	For the first two marks: **H**$^{\delta+}$ attracted to **lone pair** on (small) **O** on **different molecule (1)** but S atom is too large/not sufficiently electronegative for H-bonding **(1)** stand alone For third mark: boiling temperature of H_2O higher than that of H_2S **or** melting temperature of H_2O higher than that of H_2S **or** heat capacity of H_2O higher than that of H_2S **or** density of ice less than that of liquid water but solid H_2S denser than liquid H_2S (must give the states) **or** water is a liquid but H_2S a gas (at room temperature) **(1)**			3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(i)	Ligand (water) lost from the copper(II) ions **or** no ligands in the product **(1)** so no splitting of *d*-subshell/*d*-orbitals **or** all *d*-orbitals are degenerate **(1)** so no electron **transitions**/*d*-*d* **transitions** (and so no colour) **(1)** Any mention of emission loses this mark. Any suggestion that copper has full *d*-subshell or changes its oxidation state after heating loses the last two marks.	no electrons promoted	no light absorbed **alone**	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (b)(ii)	Bonds formed between ligand/water and the copper(II) ion/copper/copper sulphate **(1)** There is no need to mention the nature of this bond. and bond **formation** is exothermic/gives out heat/gives out energy **(1)**		**reaction** is exothermic	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (c) QWC	Solubility increases from Be to Ba because: hydration enthalpy (of the cation) becomes less exothermic (from Be^{2+} to Ba^{2+}) **(1)** lattice energy becomes less exothermic (from $Be(OH)_2$ to $Ba(OH)_2$) **(1)** but the change in lattice energy is dominant so the enthalpy of solution is more exothermic (and the compound is more soluble) **(1)** OR Hydration enthalpy (of cation) and lattice energy both exothermic **(1)** both decrease but lattice energy decreases more **(1)** enthalpy of solution is more exothermic (so compound is more soluble) **(1)** OR lattice energy and the hydration enthalpy (of the cation) both decrease/fall **(1)** but lattice energy decreases/falls more (than hydration enthalpy) **(1)** enthalpy of solution is more exothermic (so compound is more soluble) **(1)**	lattice enthalpy for lattice energy	'more endothermic' for 'less exothermic' atom or molecule for cation loses first mark only	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(i) QWC	silicon has (energetically available) **3***d*-orbitals **(1)** for the **lone pair** on water to attack **(1)** whereas carbon has no energetically accessible/available *d*-orbitals **or** has no 2*d* orbitals **(1)** so a strong C-Cl bond would need to break first/ the small C atom is obstructed by the large Cl atoms so the water cannot get close enough to form a bond **(1)** **OR** (small) C atom surrounded by large Cl atoms **(1)** leads to obstruction/steric hindrance **(1)** so the water cannot get close enough to form a bond via its lone pairs **(1)** whereas the larger silicon atom will allow attack since the chlorine atoms are further apart **(1)** The marks are for four ideas that are relevant to the steric hindrance argument, the *d*-orbital argument, or a mixture of these.	converse for CCl_4 converse for $SiCl_4$	no *d*-orbitals/CCl_4 has no *d*-orbitals anything based on C-Cl bond being stronger than Si-Cl Cl^- ions for Cl atoms Cl^- ions for Cl atoms	4

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
3 (d)(ii)	**First mark:** NaCl dissolves to give ions which do not react further with water/are only solvated OR $NaCl(s) + aq \rightarrow Na^+(aq) + Cl^-(aq)$ **(1)** **Second mark:** $CH_3CH_2COO^- + H_2O \rightarrow CH_3CH_2COOH + OH^-$ OR $CH_3CH_2COONa + H_2O \rightarrow CH_3CH_2COOH + NaOH$ **(1)** OR propanoate ions react with water to give propanoic acid and hydroxide ions OR sodium propanoate reacts with water to give propanoic acid and sodium hydroxide **(1)** **Third mark:** (stand-alone) so $[H_3O^+] < [OH^-]$ as a result of reaction (and the solution is alkaline) OR hydroxide **ions** are formed/produced in the reaction which makes the solution alkaline **(1)**		Any reaction to give equal amounts of HCl and NaOH	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(i)	The activation energy for the reaction is high **or** to ensure that more molecules have $E \geq E_a$.	$E > E_a$	to overcome E_a **alone** reactants kinetically stable; reactants thermodynamically stable	1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(ii)	protonates the alcohol **(1)** providing H_2O as the leaving group which is more easily displaced by the bromide ion/is a better leaving group than hydroxide **(1)** OR reacts with NaBr **(1)** to give HBr (which is the attacking reagent) **(1)**		'as a catalyst' alone	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iii)	H-bonding between water and the alcohol not strong enough to overcome hydrophobic interactions /effect of alkyl group **(1)** acid and alcohol form ionic species/$C_4H_9OH_2^+$ which is more soluble **(1)**	butyl group		2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(iv)	Removes acid	neutralises HCl /HBr neutralises acid		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(v)	Removes water	Absorbs water Dries the product		1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (a)(vi)	Electric heating mantle **or** sand bath **or** oil bath**(1)** because the alcohol/reaction mixture/bromobutane is flammable **or** because the heating is uniform and less likely to crack the flask **(1)** This mark is conditional on the first being scored.	Water bath	heat under reflux no naked flame fume cupboard 'volatile' for 'flammable'	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (b) QWC	**EITHER** Intermediate (ion) in S_N1 is planar **(1)** equal attack (by hydroxide ions) from either side **(1)** produces a racemic mixture **(1)** **Note:** Statement that the S_N2 mechanism is consistent with the information cannot score any marks. **OR** S_N2 involves attack from one side **(1)** so configuration of the product would be inverted **(1)** leading to retention of optical activity **so must be S_N1 (1)** Statement that the reaction is S_N1 alone scores zero.	Intermediate carbocation is a planar molecule forms one optical isomer only	intermediate **molecule alone** loses this mark attack by bromide ions	3

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(i)	Orange $\rightarrow$ green			1

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(ii)	$Cr_2O_7^{2-} + 6e^- + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$ **(1)** $\underline{(3CH_3CH(OH)CH_2CH_3 \rightarrow 3CH_3COCH_2CH_3 + 6H^+ + 6e^-)}$ $Cr_2O_7^{2-} + 3CH_3CH(OH)CH_2CH_3 + 8H^+ \rightarrow 2Cr^{3+} + 7H_2O + 3CH_3COCH_2CH_3$ **(1)** No consequential marking on incorrect equations.	C_4H_9OH and C_4H_8O equation having non-cancelled H^+ ions	equation having non-cancelled electrons	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (c)(iii)	The broad peak/absorption/trough around 3400 cm^{-1} due to –OH **(1)** has disappeared in the product to be replaced by C=O at 1700 cm^{-1} **(1)** If no reference to both groups responsible for the peaks then max **(1)** OR If no reference to both wavenumbers responsible for the peaks then max **(1)**	3230 – 3550 1680 - 1750	broad transmission	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(i)	Addition of barium ions pulls equilibrium to r.h.s. **(1)** increases $[H^+]$ **and** so lower pH/the pH falls **(1)** stand-alone mark		‘..so gets more acidic’	2

Question Number	Correct Answer	Acceptable Answers	Reject	Mark
4 (d)(ii)	lower pH/pH falls		‘mixture is more acidic’ for ‘lower pH’	1

Further copies of this publication are available from
Edexcel Publications, Adamsway, Mansfield, Notts, NG18 4FN

Telephone 01623 467467
Fax 01623 450481

Email publications@linneydirect.com

Order Code UA 020042 Summer 2008

For more information on Edexcel qualifications, please visit www.edexcel.org.uk/qualifications

Edexcel Limited. Registered in England and Wales no.4496750
Registered Office: One90 High Holborn, London, WC1V 7BH