Question Number	Acceptable Answers	Reject	Mark
1(a)(i)	$CuO(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + H_2O(l)$ Left hand side **(1)** right hand side **(1)** If SO_4^{2-} are on both sides max one mark ALLOW correct entities and balancing with no or incorrect state symbols for one mark. ALLOW multiples It is sometimes difficult to be sure of the '2' on the Cu^{2+}. Give BOD provided $2H^+$ on the left of the equation	Charges within water molecule	**2**

Question Number	Acceptable Answers	Reject	Mark
1(a)(ii)	1.749/1.75/1.7 with or without working scores 2 If answer incorrect look for Mass = 79.5 x 0.02 OR =1.59 (1) OR TE from incorrect mass for one mark Their mass x 1.1= their correct answer to 2/3/4SF (g) (1) Accept crossed 7's ALLOW both ways of writing 4 and be generous if 4 looks like 9	1.74 1.8	**2**

Question Number	Acceptable Answers	Reject	Mark
1(b)(i)	Add in small portions / use a spatula / use a **small** spoon / slowly / gradually **(1)** To prevent (mixture / acid) boiling over / frothing / spilling / splashing / splash back **(1)** Mark independently Bubbles are neutral IGNORE add carefully / cautiously alone	Spitting / violent reaction / fizzing Because reaction is exothermic alone Bubbles of carbon dioxide	**2**

Question Number	Acceptable Answers	Reject	Mark
1(b)(ii)	Dip in glass rod. Remove and allow to cool. See if crystals form ALLOW any workable suggestion Examples: See crystals / salt forming around edge of beaker Depth of colour of solution increases Solution / colour becomes darker Solution / colour becomes deeper blue Dark blue solution Reduce volume by at least half / until crystals form	Solution thickens Precipitate forming	**1**

Question Number	Acceptable Answers	Reject	Mark
1(b)(iii)	Blue	mention of green or other colour	**1**

Question Number	Acceptable Answers	Reject	Mark
1(b)(iv)	(The ions are arranged in a) regular (way) / lattice OR The ions are arranged in the same way / have same arrangement / have uniform arrangement The term structure is neutral and should be ignored IGNORE statements about ions attracting or repelling	The ions are arranged in a similar / fixed way	**1**

Question Number	Acceptable Answers	Reject	Mark
1(c)(i)	249.6 g mol^{-1} ALLOW 249.5 g mol^{-1} ALLOW 250 g mol^{-1} value **(1)** units **(1)** Common wrong values are 159.5 / 6, 185.5 / 6, 249 ALLOW unit mark with any or no value. ALLOW g / mol for unit	g/mol^{-1}	**2**

Question Number	Acceptable Answers	Reject	Mark
1(c)(ii)	Max yield = 249.6 x 0.02 = 4.992(g) **(1)** Percentage yield = $\frac{2.7 \times 100}{4.992}$ = (54.0865) = 54% **(1)** If 249.5 is used = (54.1082) = 54% OR 2.7 / 249.6 = 0.01082 **(1)** Percentage yield = 0.01082 x 100/0.02 = 54% **(1)** ALLOW TE from any value in (i), and note 159.6 gives 84.6% 185.6 gives 72.7% IGNORE SF except one SF Correct answer, no working scores (2)		**2**

Question Number	Acceptable Answers	Reject	Mark
1(c)(iii)	(Copper(II) sulfate is soluble) so some remains in solution / some remains on the **filter paper** IGNORE other transfer errors Incomplete crystallization / not all the crystals are formed	Experimental error/ incomplete reaction Filtering alone Efflorescence	**1**

Question Number	Acceptable Answers	Reject	Mark
1(d)	This is a (chemical) test for (the presence of) water Invisible ink Moisture / humidity test Test to see if solutions are aqueous	Check to see if substance is hydrated Drying agent Quantitative measurements of water content.	**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(i)	**In (a) any units given must be correct. Penalise once only.** **IGNORE SF except 1SF. Penalise once only.** **TE throughout** ((0.1x11.6)/(1000) = 1.16 x 10^{-3}/ 0.00116/ 0.0012/1.2 x 10^{-3}(mol)		**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(ii)	(1.16 x 10^{-3} / 2) = 5.8x10^{-4} / 0.00058 (mol I_2 react with thiosulfate) 6.0x 10^{-4} if 1.2 x 10^{-3} used	6 x 10^{-4}	**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(iii)	((50x0.25)/1000) = 1.25x10^{-2} / 12.5x10^{-3} / 0.0125 (mol)	0.012	**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(iv)	= Answer to (a)(iii)- answer to a(ii) (1.25 x 10^{-2} **-** 5.8x10^{-4}) = 1.192 x10^{-2}/0.01192 (mol reacted with tin) 1.19 x10^{-2} /0.0119 (mol) if 6.0x 10^{-4} used ALLOW		**1**

Question Number	Acceptable Answers	Reject	Mark
2(a)(v)	Mass of tin = answer to (a)(iv) x118.7/ = 1.414904/ 1.415 g **(1)** % tin = $\frac{1.415 \times 100}{10.25}$ = 13.803941 = 13.8 % **(1)** TE from mass if only 1 error in its calculation 13.83/ 13.8% if 1.194 x10^{-2} used If answer to(a)(iv) = 5.8x10^{-4} mol I_2 this gives 0.068846 g Sn and 0.67167 % Sn scores (2) Correct answer without working scores (2) ALLOW (1) for 17.5% of SnO_2		**2**

Question Number	Acceptable Answers	Reject	Mark
2(b)(i)	Divide solution into separate portions for titration	Just 'repeat the titration' Use starch	**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)(ii)	$\frac{0.05 \times 2 \times 100}{11.6}$ = (±) 0.86% ALLOW 0.9%	 0.90%	**1**

Question Number	Acceptable Answers	Reject	Mark
2(b)(iii)	Use more dilute thiosulfate (to make titration reading bigger) / Use a larger volume or moles of excess iodine	 Use more rock	**1**

Question Number	Acceptable Answers	Reject	Mark
2(c)	(Pale) yellow / straw-coloured to colourless	Clear for colourless Blue / black to colourless Orange / grey / brown	**1**

Question Number	Acceptable Answers	Reject	Mark
3 **(a) (i**	**In (a) any units given must be correct. Penalise once only** **IGNORE SF except 1SF. Penalise once only** **If rounding is done then must be correct, penalise once only** **TE throughout** n = (0.100 x 0.0141) = 1.41 x 10^{-3} / 0.00141 (mol)	 1 x 10^{-3}	**1**

Question Number	Acceptable Answers	Reject	Mark
3 **(a) (ii**	7.05 x 10^{-4} / 0.000705 (mol) ALLOW TE = ans to (i) ÷ 2 1.4 x 10^{-3} gives 7.0 x 10^{-4} 0.0014 gives 0.00070	7.10 x 10^{-4} / 0.000710	**1**

Question Number	Acceptable Answers	Reject	Mark
3 **(a) (i**	c = (7.05 x 10^{-4} ÷ 0.05) = 1.41 x 10^{-2} / 0.0141 (mol dm^{-3}) ALLOW TE = ans to (ii) ÷ 0.05 OR ALLOW TE = ans to (ii) x 20		**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a) (iv	$Ca(OH)_2$ M_r = 74.1 **(1)** ALLOW 74 m = (1.41 x 10^{-2} x 74.1) = 1.04481 = 1.045 = 1.04 (g dm^{-3}) **(1)** If M_r = 74 then m= 1.0434 = 1.04 (g dm^{-3}) ALLOW TE = ans to (iii) x 74.1 ALLOW TE for second mark if ans to (iii) x incorrect Mr value OR 7.05 x 10^{-4} x 74.1 = 0.0522405 = 0.0522 (g) **(1)** (0.0522 ÷ 0.05) = 1.044 (g dm^{-3}) **(1)**	1.05	**2**

Question Number	Acceptable Answers	Reject	Mark
3 (a) **(v)**	It's only a rangefinder / It's a rough OR approximate titration / It's an estimation / More than 0.2 cm^3 from other titres / Overshot on first titration / Not concordant ALLOW It is anomalous / It is out of range It differs / is not consistent with titrations 1 and 2 Titrations 1 and 2 are more consistent If a list of suggestions is given, a wrong cancels a right	Not titrated accurately It is not precise Control Just 'it's a trial'	**1**

Question Number	Acceptable Answers	Reject	Mark
3 (a) (vi	**Pipette** 50.0 cm^3 (of distilled water) into weighed beaker and find the mass ALLOW "fill the **pipette**" (with water) and transfer into weighed beaker and find the mass / measure the mass of the **pipetted** distilled water **(1)** ALLOW alternative containers to beaker. Use the density of water to determine the exact volume / density of water is 1(.00)g cm^{-3} /check it weighs 50(.0) g **(1)** Stand-alone marks	"Transfer 50cm^3 water into a beaker" without reference to pipette. Approx. 50g Use of lime water Use of solution	2

Question Number	Acceptable Answers	Reject	Mark
3 (b)	A – (Strong) heat / high temperature **(1)** B – $CaCl_2 + H_2O$ (Both needed) **(1)** C – $Ca(OH)_2$ **(1)** D – Ca **(1)** IGNORE state symbols even if wrong IGNORE any number in front of species, e.g.$\frac{1}{2}O_2$ or 2Ca given in D	Warm / Gentle heat Reflux Combustion / burnt Answers suggesting reaction with air or oxygen CaCl CaOH Ca_2	**4**

Question Number	Acceptable Answers	Reject	Mark
3 (c)	Bubble(s) / Fizz(ing) / Effervescence IGNORE references to colourless solution, solid disappearing and energy / temperature changes and further tests eg effect on limewater	Coloured or colourless fumes Cloudy solution Just 'CO_2 forming' Just '(colourless) gas forming' Bubbles of any gas except CO_2	**1**

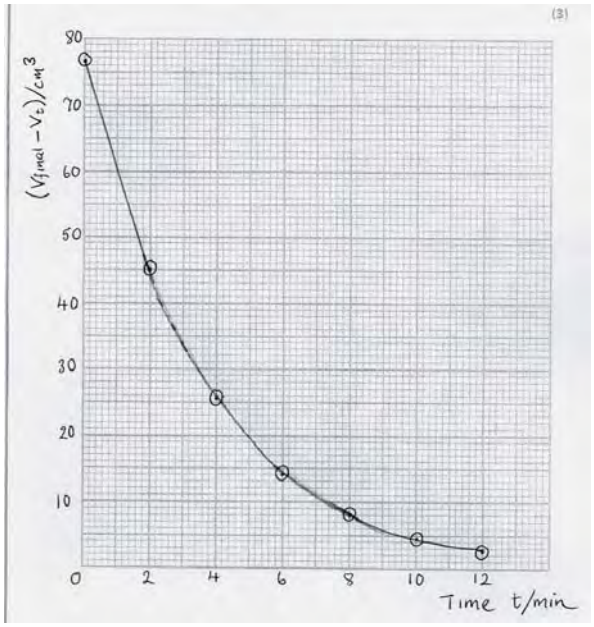
Question Number	Acceptable Answers	Reject	Mark
3 (d)	**Method 1:** Calcium is larger **ion** / calcium has a bigger **ionic** radius / or reverse argument for magnesium **ion** Use of the reverse argument applies throughout **(1)** (Distance between centres of ions increases so) weaker attraction/weaker bond between (calcium and carbonate) ions OR Shielding is greater in the calcium ion so weaker attraction (of calcium nucleus for carbonate ion) **(1)** **Method 2:** Calcium **ion** has a lower charge density **(1)** weaker attraction (between ions) **(1)** IGNORE references to polarization and the breaking of the covalent bonds in the carbonate ion	Calcium is bigger Any reference to atoms/molecules scores 0 Reference to ionization energy/weaker attraction for own electrons	2

Question Number	Acceptable Answers	Reject	Mark
3 (e)	Calcium's flame is yellow-red /orange-red / red / brick red Magnesium has no colour (Both needed for first mark) **(1)** Electrons excited / promoted (by heat energy) **(1)** (Colour produced from) energy / light emitted as electron returns (to ground state) **(1)**	Crimson Magnesium is white / bright Just "Mg / Ca decomposes" Electrons escape the orbitals	**3**

Question Number	Acceptable Answers	Reject	Mark
4(a)(i)	Mass of bromobutane = 0.6 x 1.276 (=0.7656 (g)) **(1)** Amount of bromobutane = $\frac{0.6 \times 1.276}{137.0}$ = 5.5883×10^{-3} = 5.59×10^{-3} / 0.00559 (mol) OR Amount of bromobutane = $\frac{0.6 \times 1.276}{136.9}$ = 5.5924×10^{-3} = 5.59×10^{-3} / 0.00559 (mol) TE on incorrect mass ALLOW 6×10^{-3} (mol) **(1)** Correct answer with no working scores 2 marks		**2**

Question Number	Acceptable Answers	Reject	Mark
4(a)(ii)	$5.5883 \times 10^{-3} \times 24\,000$ = 134.12 (134.22 from 136.9)=134 cm^3 **(1)** ALLOW answer from (i) x 24000 IGNORE SF except 1 Any two from: Formation of butan-1-ol / other / side reactions Incomplete reaction Some but-1-ene may remain in solution **(2)** IGNORE Reaches equilibrium / reaction reversible But-1-ene reacts with ethanol/ solvent	Transfer losses Gas escapes Gas reacts with water But-1-ene condenses	**3**

Question Number	Acceptable Answers	Reject	Mark
4(b)(i)	So $[OH^-]$ remains (effectively) constant OR [1-bromobutane] is the only variable IGNORE So $[OH^-]$ is not the limiting factor	Ensure that all C_4H_9Br reacts $[OH^-]$ is in excess $[OH^-]$ does not affect the rate Just 'Only [1-bromobutane] affects the rate'	**1**

Question Number	Acceptable Answer	Reject	Mark
4 (b)(ii)	 Axes correct with sensible scales to use at least half of graph paper on both axes **(1)** Labels ((V_{final} - V_t) and t) fully correct with units **(1)** All 7 points correctly plotted and smooth curve drawn **(1)**	Axes plotted wrong way round 'Volume'	**3**

Question Number	Acceptable Answers	Reject	Mark
4(b)(iii)	(V_{final} - V_t) is proportional to the concentration of 1-bromobutane		**1**

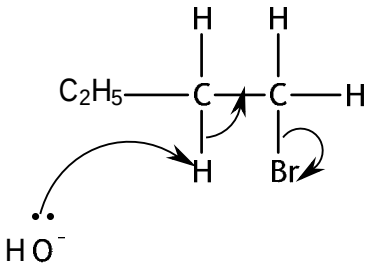
Question Number	Acceptable Answers	Reject	Mark
4(b)(iv)	Two values 2.5 ± 0.3 (min) (each scores one mark) **(2)**		**2**

Question Number	Acceptable Answers	Reject	Mark
4(b)(v)	Answer must be consistent with values in (iv) Because half lives are constant / similar **(1)** The reaction is first order... **(1)** If values in (iv) are 2.5 and 5, then: Reaction is 2nd order because half lives are increasing scores both marks. Reaction is 1st order because half lives are constant scores 1 mark		**2**

Question Number	Acceptable Answers	Reject	Mark
4(c)(i)	Order one **(1)** Any one of: (Exp 1 and 2) $[OH^-]$ halves and rate halves. (Exp 1 and 3) $[OH^-]$ 1/5 and rate 1/5 (Exp 2 and 3) $[OH^-]$ 2/5 and rate 2/5 ALLOW reverse logic **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
4(c)(ii)	Rate = $k[C_4H_9Br][OH^-]$ IGNORE case of K/k TE on b(v) and c(i)		**1**

Question Number	Acceptable Answers	Reject	Mark
4(c)(iii)	$dm^3\ mol^{-1}\ min^{-1}$ ALLOW $dm^3\ mol^{-1}\ s^{-1}$ any sequence of units TE on (ii)		**1**

Question Number	Acceptable Answers	Reject	Mark
4(c)*(iv)	 Arrows from OH-to H and from C-H bond to make additional bond between carbons **(1)** Third arrow from bond between carbon and bromine to bromine **(1)** (Because) both 1–bromobutane and hydroxide ion appear in the RDS ALLOW Attack of OH- on H is slow, therefore this is the RDS (Because) both 1–bromobutane and hydroxide ion appear in the slow step **(1)** IGNORE mention of rate equation	Both are involved in the reaction Mechanism described as S_N2	**3**