Mark Scheme

Q1.

Question Number	Correct Answer	Reject	Mark
(a)	Reduction (1) Has gained 1 electron / oxidation number has decreased (from (+)2 to (+)1) (1) Oxidation = 0		2

Question Number	Correct Answer	Reject	Mark
(b)(i)	Starch (1) Blue-black / Blue / black to colourless (1)	 Purple, clear	2

Question Number	Correct Answer	Reject	Mark
(b)(ii)	Moles of thiosulfate = (12.75/1000 x 0.2) = 0.00255 mol (1) Moles of iodine = (0.00255 /2) = 0.001275 / 1.275×10^{-3} / 0.00128 / 1.28×10^{-3} (1) Allow TE for correct use of ratio for 2nd mark Correct answer alone = 2 marks		2

Question Number	Correct Answer	Reject	Mark
(b)(iii) QWC	Moles of Cu^{2+} = 0.00255 (1) Allow TE from b (ii) $[Cu^{2+}]$ = 0.255 mol dm^{-3} (1) Allow TE for scaling up correctly Correct answer alone = 2 marks 3SF is the least accurate level of the measurements used in the calculation/experiment (1) OWTTE		3

Question Number	Correct Answer	Reject	Mark
(b)(iv)	They are not reliable as the experiment was only carried out once so there is no evidence that the result is repeatable OWTTE		1

Q2.

Question Number	Acceptable Answers	Reject	Mark
(a)(i)	Amount Na = 1.73 (g) ÷ 23 (g mol^{-1}) = 0.075(22) (mol) Amount O = 1.20 (g) ÷ 16 (g mol^{-1}) = 0.075 (mol) **(1)** IGNORE sf, even if 1 sf NaO **(1)** Correct answer no working **(2)** NOTE: Correct answer can be obtained via incorrect working and all responses should be read carefully e.g. Amount Na = 23 ÷ 1.73 = 13.3 Amount O = 16 ÷ 1.20 = 13.3 scores second mark only for NaO if obtained by incorrect working OR e.g. Use of atomic numbers gives the Na : O ratio as 0.157 : 0.150 and an empirical formula of NaO. This scores (1) overall (i.e. the 2nd mark). OR e.g Use of atomic number ONLY for Na (i.e. Na = 11) gives the Na : O ratio as 0.157 : 0.075 and an empirical formula of Na_2O. This scores (1) overall (i.e. the 2nd mark). NOTE: Use of **O** = 32 gives Na_2O and scores second mark	Na_2O_2	**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(ii)	(NaO = 39 hence molar mass twice that of NaO ∴) so **Na_2O_2**	'2NaO'	**1**

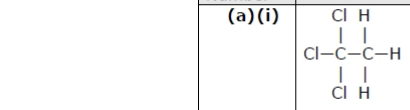
Question Number	Acceptable Answers	Reject	Mark
(a)(iii)	$2Na(s) + O_2(g) \rightarrow Na_2O_2(s)$ All species correct **(1)** State symbols and balancing **(1)** NOTE: 2nd mark is conditional on correct species. NOTE: $2Na(s) + O_2(g) \rightarrow 2NaO(s)$ scores **(1)** $Na(s) + O_2(g) \rightarrow NaO_2(s)$ scores **(1)** $4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$ scores **(2)**		**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(iv)	Moles of O_2 = 0.075 ÷ 2 = 0.0375 OR 1.2 ÷ 32 = 0.0375 (mol) **(1)** 0.0375 mol x 24 dm^3 mol^{-1} = 0.9(0) (dm^3) **(1)** ALLOW 900 **cm^3 (units must be present here)** Correct answer no working **(2)** OR Moles of Na = 1.73 ÷ 23 = 0.075217 = moles of O Moles of O_2 = 0.075217 ÷ 2 = 0.0376085 0.0376085 x 24 = 0.903 (dm^3) or 903 **cm^3** IGNORE s.f., including ONE s.f. NOTE: If number of moles x 24 (dm^3 mol^{-1}) is clearly evident and correctly calculated in stated units, award second mark		**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(v)	0.0375 x 6.02 x 10^{23} (= 2.2575 x 10^{22} (molecules)) = 2.26 x 10^{22} (molecules) IGNORE s.f. unless 1 s.f.		**1**

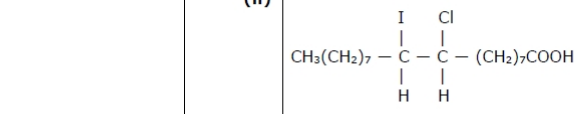
Question Number	Acceptable Answers	Reject	Mark
(b)	Sodium might react with nitrogen in the air/sodium forms a nitride/ nitrogen (gas) is present in the air (which reacts with the sodium) OR sodium might form a different oxide (e.g. Na_2O or allow NaO_2) NOTE: If nitrogen / N_2 is mentioned as part of a 'list' of substances that can be present in air, award the mark	**Just** 'very reactive' OR 'very explosive' sodium forms Na_2O_2 alone References to hydrogen in the air **Just** 'reacts with other substances in the air' (as nitrogen not identified Sodium nitrate formation **Just** sodium hydroxide formation	**1**

Q3.

Question Number	Correct Answer	Reject	Mark
(a)(i)		Skeletal / structural formulae	**(1)**

Question Number	Correct Answer	Reject	Mark
(iii)	Because they damage the ozone layer OR (Halothane products like) 1,1,1-trichloroethane are narcotic inhalants / poisonous / toxic **IGNORE** References to just: • formation of chlorine radicals • formation of Cl• • carcinogen	Any statement that this compound is a CFC / forms Cl_2 (on breaking down)	**(1)**

Question Number	Correct Answer	Reject	Mark
(b)(i)	ICl is a **stronger** electrophile / **better** electrophile Allow a correct description of an electrophile even if the term is not used. e.g. ICl has a vacancy for a bonding pair of electrons OR the ICl (bond) is polar **NOTE:** ALLOW the ICl (bond) is more polar OR Mention of presence of the $I^{\delta+}$ (in ICl) ALLOW 'It' for ICl	Any references to Cl attacking the C=C	**(1)**

Question Number	Correct Answer	Reject	Mark
(ii)	 I and Cl can be interchanged and on either side Look out for only I or Cl added without hydrogen, also 2I and 2Cl added.	I and Cl on the same carbon	**(1)**

Question Number	Correct Answer	Reject	Mark
(iii)	To prevent formation of free radicals OR To prevent (free radical) substitution OR To prevent (I-Cl) bonds breaking homolytically **ALLOW** **UV** causes it to react / to decompose **IGNORE** light causes it to react / to decompose	Causes oxidation **C-Cl** breaks	**(1)**

Question Number	Correct Answer	Reject	Mark
(iv)	ALL THREE oxidation numbers must be correct: (Iodine monochloride) +1 ALLOW 1+ (Iodide ion) -1 ALLOW 1- (Iodine) 0 **(1)** (Ionic equation) $ICl + I^- \rightarrow I_2 + Cl^-$ Ignore state symbols even if incorrect Both partial and full charges on ICl are acceptable, provided they are the right way around **(1)**		**(2)**

Question Number	Correct Answer	Reject	Mark
(c)	(Indicator) Starch (solution) **(1)** (Colour change from) Blue-black to colourless **ALLOW** Blue to colourless OR Black to colourless **IGNORE** References to 'clear' **(1)** **Mark independently**	No M2 if states "From **purple** to ..."	**(2)**

In (d) penalise incorrect units once **only**

Question Number	Correct Answer	Reject	Mark
(d)(i)	Number of moles of thiosulfate = $\frac{20.0 \times 0.100}{1000} = 2(.00) \times 10^{-3} / 0.002(00)$		**(1)**

Question Number	Correct Answer	Reject	Mark
(ii)	$(2S_2O_3^{2-}(aq) + I_2(aq) \rightarrow) \ S_4O_6^{2-} + 2I^-$ IGNORE state symbols even if incorrect		**(1)**

Question Number	Correct Answer	Reject	Mark
(iii)	Number of moles of iodine = 0.002(00)÷2 = $1(.00) \times 10^{-3} / 0.001(00)$ (mol)		**(1)**

Question Number	Correct Answer	Reject	Mark
(iv)	$1(.00) \times 10^{-3} / 0.001(00)$ (mol)		**(1)**

Question Number	Correct Answer	Reject	Mark
(v)	(0.001(00) - 0.000365) = $6.35 \times 10^{-4} / 0.000635$ (mol)		**(1)**

Question Number	Correct Answer	Reject	Mark
(vi)	$\frac{0.000635 \times 100}{0.2(00)}$ **OR** 0.000635×500 = 0.3175 (mol)		**(1)**

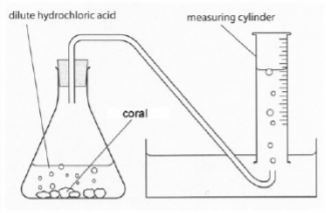
Question Number	Correct Answer	Reject	Mark
(vii)	$0.3175 \times 2 \times 126.9 = 80.5815$ (g) If student uses A_r for I = 127, final answer equals 80.645 (g)		**(1)**

Question Number	Correct Answer	Reject	Mark
(e)	(Sample titre) Higher **and** (Iodine value) Lower		**1**

Q4.

Question Number	Acceptable Answers	Reject	Mark
(a) (i)	$H_2O + CO_2 \rightarrow H_2CO_3$ (Allow atoms in H_2CO_3 in any order) Or $H_2O + CO_2 \rightarrow H^+ + HCO_3^-$ Or $H_2O + CO_2 \rightarrow 2H^+ + CO_3^{2-}$ Or H_3O^+ in place of H^+ *IGNORE STATE SYMBOLS EVEN IF INCORRECT*		1

Question Number	Acceptable Answers	Reject	Mark
(a) (ii)	$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2$ LHS (1) RHS (1) **OR** $2H_3O^+ + CO_3^{2-} \rightarrow 3H_2O + CO_2$ LHS (1) RHS (1) *IGNORE STATE SYMBOLS, EVEN IF INCORRECT* *IGNORE* = arrows	H_2CO_3 as a product $H^+ + CO_3^{2-} \rightarrow HCO_3^-$ Any other ions including spectator ions (e.g. Ca^{2+}, Cl^-) in the equation scores zero	2

Question Number	Acceptable Answers	Reject	Mark
(b) (i)	 Conical flask and a delivery tube leaving the conical flask (1) *IGNORE* "heat" beneath conical flask Inverted measuring cylinder with collection over water shown and cylinder above mouth of delivery tube (1) *ALLOW* collection over water to be shown/implied in the diagram without labels or other annotation	If collection over water is not somehow evident	2

Question Number	Acceptable Answers	Reject	Mark
(b) (ii)	Any method which is likely to bring the reactants into contact after the apparatus is sealed	Method suggesting mixing the reactants and then putting bung in flask very quickly	1

Question Number	Acceptable Answers	Reject	Mark
(b) (iii)	(224 ÷ 24000 =) $0.009333 / 9.333 \times 10^{-3}$ (mol) **Ignore SF except 1 SF** **Ignore any incorrect units**	"0.009" as answer	1

Question Number	Acceptable Answers	Reject	Mark
(b) (iv)	$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g/aq)$ **ALL FOUR** state symbols must be correct for this mark		1

Question Number	Acceptable Answers	Reject	Mark
(b) (v)	(Mass of 1 mol $CaCO_3$ = 40 + 12 + 3 x 16) = **100** g *ALLOW* just "100" *ALLOW* any incorrect units *ALLOW* "100.1 g" *OR* just "100.1" (Reason: this uses the Periodic Table value of A_r = 40.1 for Ca)		1

Question Number	Acceptable Answers	Reject	Mark
(b) (vi)	(Mass of $CaCO_3$ = 100 x 0.009333) = 0.9333 (g) (1) *IGNORE* sig figs including 1 sf here **NOTE:** Moles of $CaCO_3$ consequential on answers to (b)(iii) and (b)(v) [**NOTE:** if A_r = 40.1 used for Ca, then the answer = 0.9339 (g)] Percentage of $CaCO_3$ in the coral = 100 x 0.9333 /1.13 = 82.6% (1) **NOTE:** If mass $CaCO_3$ used is 0.93, final answer is 82.3% [**NOTE:** if A_r = 40.1 used for Ca, then the answers = 0.9339 (g) and 82.7%]	Final % answer is not given to 3 sf	2

Question Number	Acceptable Answers	Reject	Mark
(b) (vii)	(Different samples of) coral have different amounts of $CaCO_3$ /different proportions of $CaCO_3$ / different "levels" of $CaCO_3$ *ALLOW* "calcium carbonate" for $CaCO_3$ OR Only one sample of coral (was) used	Answers that do not include any mention of $CaCO_3$ References to solubility of CO_2 in water References to repeating the experiment at a different temperature	1

Q5
Steps:

- How many moles of HCl were used in the titration?
  0.02245*0.2 = **$4.49x10^{-3}$**
- How many moles of NaOH were used in the titration?
  HCl + NaOH ⟶ NaCl + H_2O, so same as moles HCl, = **$4.49x10^{-3}$**
- How many moles of NaOH were in the 250cm^3?
  We tested 25cm^3, so in 250 there must be x10 as much = **$4.49x10^{-2}$**
- How many moles of NaOH were added in the first place?
  Moles = conc x vol = 5 x 0.01 = **0.05**
- How many moles of NaOH reacted with the ethanoic acid?
  Difference between moles added and mole reacted with HCl = 0.05 - 0.0449 = **0.0051**
- How many moles of ethanoic acid were there in 50cm^3?
  CH_3COOH + NaOH ⟶ CH_3COONa + H_2O so same as moles NaOH = **0.0051**
- What is the concentration of the ethanoic acid?
  Conc =mol/vol = 0.0051/0.05 = **$0.102moldm^{-3}$**

(if you have got this you are officially awesome, particularly if you didn't use the steps hint!!)