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.
- Mark schemes will indicate within the table where, and which strands of Quality of Written Communication, are being assessed. The strands are as follows:
    i. ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
    ii. select and use a form and style of writing appropriate to purpose and to complex subject matter
    iii. organise information clearly and coherently, using specialist vocabulary when appropriate.

Using the Mark Scheme

Examiners should NOT give credit for incorrect or inadequate answers, but allow candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected, it may still be creditworthy.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/	Means that the responses are alternatives and either answer should receive full credit.
()	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.
Bold	Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq	(error carried forward)(transfer error)(consequential) 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.

Candidates must make their meaning clear to the examiner to gain the mark. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions that involve the writing of continuous prose require candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where Quality of Written Communication is likely to be particularly important are indicated (Quality of Written Communication) in the mark scheme, but this does not preclude others.

Section A

Question Number	Answer	Mark
1	C	(1)

Question Number	Answer	Mark
2	D	(1)

Question Number	Answer	Mark
3	A	(1)

Question Number	Answer	Mark
4	C	(1)

Question Number	Answer	Mark
5	C	(1)

Question Number	Answer	Mark
6	C	(1)

Question Number	Answer	Mark
7	A	(1)

Question Number	Answer	Mark
8	D	(1)

Question Number	Answer	Mark
9	D	(1)

Question Number	Answer	Mark
10	D	(1)

Question Number	Answer	Mark
11	A	(1)

Question Number	Answer	Mark
12	B	(1)

Question Number	Answer	Mark
13	B	(1)

Question Number	Answer	Mark
14	D	(1)

Question Number	Answer	Mark
15	B	(1)

Question Number	Answer	Mark
16	B	(1)

Question Number	Answer	Mark
17	B	(1)

Question Number	Answer	Mark
18	A	(1)

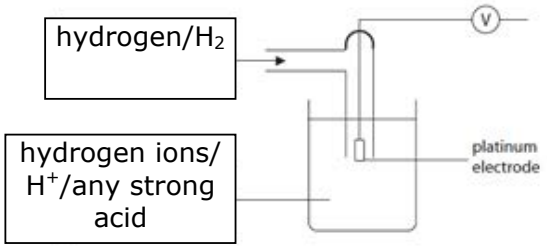
Question Number	Answer	Mark
19	B	(1)

Question Number	Answer	Mark
20	C	(1)

Total for Section A = 20 Marks

Section B

Question Number	Acceptable Answer	Reject	Mark
21(a)	<table><tr><th>Half-equation</th><th>$E^{\ominus}$/V</th></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td>+0.4(0)</td></tr><tr><td></td><td>+1.23</td></tr></table> **One mark** for each correct value. Penalise omission of + once only.	+2.46	**(2)**

Question Number	Acceptable Answer	Reject	Mark
21(b)(i)	 **First mark:** Hydrogen/H_2(g)/H_2 IGNORE Any pressure value quoted **Second mark:** Name or formula of any strong acid (e.g. HCl/H_2SO_4) ALLOW hydrogen ions/H^+(aq)/H^+. IGNORE Any acid concentration value quoted. IGNORE State symbols for ANY formula of hydrogen and/or acid, even if incorrect. IGNORE any references to platinum.	H(g)/H for hydrogen gas 'HCL'/HSO_4 Just 'acidic'	**(2)**

Question Number	Acceptable Answer	Reject	Mark
21(b)(ii)	1 atm/100 kPa/101 kPa/1 bar 1 mol dm^{-3} ($[H^+]$/[HCl]) ALLOW '1 molar'/'1M' 298 K/25°C ALLOW '°K' All **THREE** conditions correct = **2 marks.** Any **TWO** conditions correct = **1 mark.** IGNORE References to 'standard conditions'. References to Pt/catalyst. ALLOW 0.5 mol dm^{-3} H_2SO_4. INSTEAD of the 1 mol dm^{-3} ($[H^+]$/[HCl]).	Wrong pressure units Incorrect concentration units (e.g. '1 mol'/1 mol^{-1} dm^3 for $[H^+]$) 273 K/0°C/'room temperature'	**(2)**

Question Number	Acceptable Answer	Reject	Mark
21(c)	**First mark:** Mentions/some evidence for the use of BOTH equations 1 AND 3 from the table in any way, even if reversed or left unbalanced for example: $O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$ AND $4OH^-(aq) + 2H_2(g) \rightarrow 4H_2O(l) + 4e^-$ **(1)** ALLOW $\rightleftharpoons$ for $\rightarrow$ **Second mark:** (Adds the above half-equations cancelling $4e^-$ to get.) $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$ OR $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ **(1)** ALLOW $\rightleftharpoons$ for $\rightarrow$ but must have H_2 and O_2 on left. Mark the second scoring point independently. Award this mark if the correct equation is seen, no matter how it is derived. ALLOW MULTIPLES OF EQUATIONS IN ALL CASES. IGNORE any state symbols, even if incorrect. ALLOW equilibrium sign $\rightleftharpoons$ used in **ANY** of the above equations instead of the full arrows.	Equations involving H^+ **If** $e^-/OH^-/H^+$/two surplus H_2O molecules remain in this final equation **(0)** for 2nd mark	**(2)**

Question Number	Acceptable Answer	Reject	Mark
21(d)	$E^{\ominus}_{cell}$ = +0.40 - (-0.83) (V) = (+)1.23 (V) + sign NOT required in final answer Correct answer with or without working scores. **(1)** No ECF from any incorrect $E^{\ominus}$ values used.	-1.23 (V)	**(1)**

Question Number	Acceptable Answer	Reject	Mark
21(e)	Reaction/equation is the same OR Reaction/equation for both is $2H_2(g) + O_2(g) \rightarrow 2H_2O(l)$. ALLOW $\rightleftharpoons$ for $\rightarrow$ IGNORE state symbols even if incorrect. ALLOW statements such as 'they both produce water from hydrogen and oxygen'/'reactants and products are the same'. ALLOW multiples of the **equation.**	'Electrode potentials don't change' **Just** same product/water is produced **Just** same reactants are oxidized and reduced Same reaction but in **reverse** scores **(0)**	**(1)**

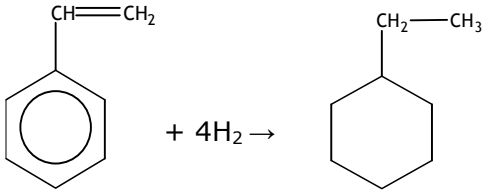
Question Number	Acceptable Answer	Mark
21(f)	To **increase** the **surface area**/to increase the number of active sites.	**(1)**

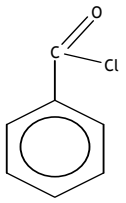
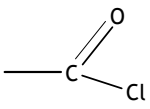
Question Number	Acceptable Answer	Reject	Mark
21(g)	Any one of: Storage (problems) Hydrogen/oxygen/the gases have to be stored under pressure Leakage (of hydrogen/of oxygen/of gas) Transport(ation) problems Hard to carry/lack of portability Hydrogen flammable inflammable Hydrogen explosive (Fuel cell) costly/expensive Needs (regular) re-filling Needs continual replenishment of H_2 and O_2 Lack of availability (of hydrogen/fuel) Hydrogen is made from fossil fuels/hydrogen is made by electrolysis/hydrogen is made from natural gas/hydrogen is made from non-renewable resources. ALLOW water is a greenhouse gas/ fuel cell(s) have short(er) lifespan/ fuel cells have to be (regularly) replaced. IGNORE references to 'danger' or 'safety' or 'hazardous'. Any arguments in terms of **voltage** output. References to hydrogen-oxygen fuel cell cannot be recharged.	'Fuel cell can only be used once' scores **(0)**	**(1)**

Total for Question 21 = 12 Marks

Question Number	Acceptable Answer	Reject	Mark
22(a)(i)	Addition/reduction/free-radical addition. IGNORE references to 'hydrogenation'.	Redox Electrophilic addition Nucleophilic addition	**(1)**

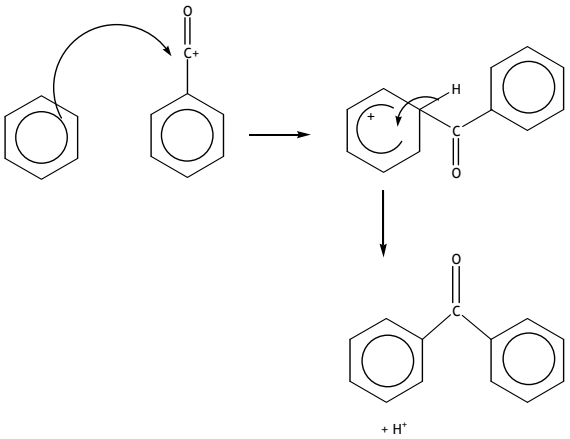
Question Number	Acceptable Answer	Mark
***22(a)(ii) Quality of Written Communication**	**First mark:** **Delocalisation** (of π/p electrons in benzene ring). **(1)** IGNORE reference to 'resonance' **Second mark:** Results in more **energy** needed to **break** the **bonds** in benzene (compared with three separate π bonds). **(1)** ALLOW confers **stability** on the molecule/makes benzene **more stable** (than expected) IGNORE Reference to carbon-carbon bond lengths Values of any enthalpy changes. Mark the two points independently.	**(2)**

Question Number	Acceptable Answer	Mark
22(a) (iii)	 (Δ*H*=) **-328 (**kJ mol^{-1}) **First mark**: For '4' **Second mark**: product as above/correct skeletal formula of product ALLOW Side chain written as $-C_2H_5$. **Third mark**: **-**328 (kJ mol^{-1}) **N.B.** **One** H_2 added showing a consequential correct product with only side chain reduced and consequential Δ*H* = **-**120 (kJ mol^{-1}) scores. **(2)** **Three** H_2 added showing a consequential correct product with only the benzene ring reduced and Δ*H* = **-**208 (kJ mol^{-1}) scores. **(2)** **Five** H_2 added with fully correct product drawn and Δ*H* = **-**448 (kJ mol^{-1}) scores. **(2)** **Three and a half** H_2 added showing a fully correct product and Δ*H* = **-**268/**-**293(.3)(kJ mol^{-1}) scores. **(2)** **N.B.** mark scoring points independently	**(3)**

Question Number	Acceptable Answer	Mark
22(b)(i)	 Mark awarded for displaying 	(1)

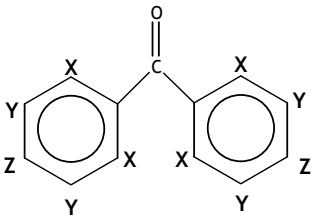
Question Number	Acceptable Answer	Mark
22(b)(ii)	Electrophilic substitution **BOTH** words needed. **IGNORE references to acylation and/or Friedel-Crafts.**	(1)

Question Number	Acceptable Answer	Mark
22(b)(iii)	Friedel **and** Crafts **BOTH** names are needed for this mark **.**	(1)

Question Number	Acceptable Answer	Mark
22(b) (iv)	**First mark:** **C_6H_5COCl** + $AlCl_3$ → **$C_6H_5CO^+$** + $AlCl_4^-$ **+** can be anywhere on the C_6H_5CO in the equation for the first mark.  ($AlCl_4^-$ + H^+ → HCl + $AlCl_3$) **N.B.** If ethanoyl chloride or any other acid chloride or the generic RCOCl is used **instead** of benzoyl chloride, no first mark can be awarded but the 2nd, 3rd and 4th marks can be awarded consequentially. **Second mark**: First curly arrow, as shown, to start from inside the hexagon to the correct C+ carbon (i.e. not to the benzene ring)**.** **N.B.** the + must be on the C of the C=O/CO for this mark **Third mark:** Intermediate correctly drawn. **N.B. +** can be shown anywhere in the ring or at the C atom where electrophile is bonded. The 'horseshoe' in the intermediate to cover at least three carbon atoms. **Fourth mark:** Second curly arrow as shown from C—H bond to reform the ring, not from the H atom in this bond **N.B.** products do not have to be shown nor the equation for regeneration of the catalyst given.	**(4)**

Question Number	Acceptable Answer	Reject	Mark
22(b)(v)	Absorbs/reflects/blocks/protects from/shields against/**uv** (light/radiation) IGNORE 'non-toxic'/references to IR	**Adsorbs** UV light	**(1)**

Question Number	Acceptable Answer	Mark
22(c)(i)	Any **TWO** of the following: One mark for identifying the bond by formula as shown and one mark for wavenumber in each matching pair. **UNITS** are not required. Bond / Wavenumber range/wavenumber (cm^{-1}) C=C / 1600/1580/1500/1450 **All four values needed** C=O / 1700–1680 C-H / 3030 C-H / 750/700 **Both values needed** ALLOW correct wavenumber range, or any number within the correct range, **for C=O.** Mark identification of the bond and the wavenumber independently. (e.g. a correct bond with a wrong wavenumber, or vice versa, scores one of the two marks in each case) IGNORE nmr values/chemical shifts.	**(4)**

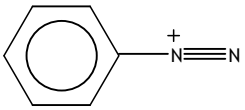
Question Number	Acceptable Answer	Mark
22(c)(ii)	 **First mark:** EITHER Identifies correctly the **three** different proton environments ALLOW If the three different proton environments are shown on only one of the benzene rings. **N.B.** on right-hand ring, clockwise from C=O, positions 2, 3 and 4 And/or 2, 4 and 5 are shown as different environments and/or on left-hand ring, anti-clockwise from C=O, positions 2, 3 and 4 And/or 2, 4 and 5 are shown as different environments. OR Identifies proton Z correctly on both benzene rings. **Second mark:** Fully correct labelling on both rings using the letters **X**, **Y** and **Z.** **N.B. X** and **Y** labels are interchangeable, **Z** is not.	**(2)**

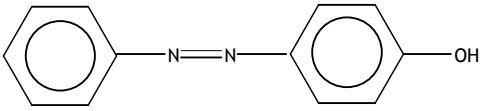
Total for Question 22 = 20 Marks

Question Number	Acceptable Answer	Reject	Mark
23(a)(i)	**Lone pair** (of electrons on the nitrogen atom) ALLOW non-bonded pair (of electrons on the nitrogen atom).	**Lone pairs** **Spare pair**	**(1)**

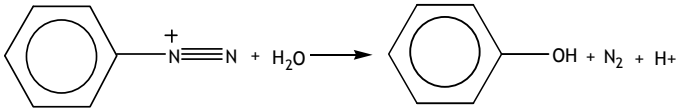
Question Number	Acceptable Answer	Mark
23(a)(ii)	**(with H_2SO_4)** $(C_4H_9NH_3^+)_2SO_4^{2-}$ **(1)** ALLOW $C_4H_9NH_3^+HSO_4^-$ **(with CH_3COOH)** $C_4H_9NH_3^+CH_3COO^-$ **(1)** **CHARGES** not essential. Cation and anion can be in either order. Maximum one mark if formula of the amine is incorrect in either case. ALLOW one mark if only the correct cation is given in each case (i.e. the anion has been omitted in both cases). **N.B.** the correct ions can be shown separately, e.g. $(C_4H_9NH_3^+)_2$ **+** SO_4^{2-} .	**(2)**

Question Number	Acceptable Answer	Reject	Mark
23(b)	Tin/Sn ALLOW Iron/Fe **(1)** (concentrated) **hydrochloric acid** **N.B.** if candidates write 'HCl', there must be some indication of concentrated, e.g. 'conc HCl'/'concentrated HCl'. ALLOW HCl(aq). (Followed by addition of alkali to liberate the free amine) **(1)** Mark the two points independently. **N.B.** do not allow second mark if there is a suggestion that the acid and alkali are added together simultaneously.	$LiAlH_4$ Just 'HCl' 'Dilute' hydrochloric acid/sulfuric acid	**(2)**

Question Number	Acceptable Answer	Reject	Mark
23(c)(i)	 **N.B.** if the above structure is drawn, the + charge must be on the N connected directly to the benzene ring. ALLOW —N=N$^+$ on ring. IGNORE Cl^-.	N_2^+ on ring	**(1)**

Question Number	Acceptable Answer	Mark
23(c)(ii)		**(1)**

Question Number	Acceptable Answer	Mark
23(c)(iii)	**(Conditions)** (Presence of) NaOH/KOH/alkali/OH^- **(1)** ALLOW 'Alkaline (conditions)' or 'base' or 'high pH'. IGNORE Any references to temperature. **(Use)** Dye/pigment/colouring/indicator/in foodstuff/in paint/methyl orange **(1)** IGNORE Any reference to medicines.	**(2)**

Question Number	Acceptable Answer	Mark
23(d)	 ALLOW The + sign to be on either N atom in the benezenediazonium ion. OR $C_6H_5N_2^+ + H_2O \rightarrow C_6H_5OH + N_2 + H^+$ OR $C_6H_5N_2Cl + H_2O \rightarrow C_6H_5OH + N_2 + HCl$ OR $C_6H_5N_2^+ + 2H_2O \rightarrow C_6H_5OH + N_2 + H_3O^+$ OR $C_6H_5N_2^+Cl^- + H_2O \rightarrow C_6H_5OH + N_2 + HCl$ **N.B.** $-C_6H_5$ can be written or drawn **First mark:** for $\mathbf{N_2}$ **(1)** **Second mark:** for rest of the equation correct **(1)** IGNORE State symbols, even if incorrect.	**(2)**

Question Number	Acceptable Answer	Mark
23(e)(i)	(Otherwise) too much (product) remains in solution OR If excess (solvent) is used, crystals might not form ALLOW To avoid losing (too much) product (in the filtrate when crystallization occurs). To maximise the yield. Will crystallize better from a concentrated solution/will recrystallize (better) when cold. IGNORE References to a 'saturated solution' or references to 'dilution' or references to the time taken for crystals to form.	**(1)**

Question Number	Acceptable Answer	Mark
23(e)(ii)	**(Insoluble impurities removed)** By **hot** filtration/During the **first** filtration/During the **second** step in the process. **(1)** **(Soluble impurities removed)** By remaining in solution/Left in filtrate/Removed when washed (with cold solvent). **(1)**	**(2)**

Question Number	Acceptable Answer	Reject	Mark
23(e)(iii)	Measure the melting temperature/melting point **and** compare with data/known value (from a data book/literature/internet/database) (BOTH points needed for the mark). OR The melting point is sharp (just this statement is needed for the mark). ALLOW Any form of chromatography. IGNORE References to any types of spectroscopy.	**(0)** If reference to determination of the boiling point is made	**(1)**

Total for Question 23 = 15 Marks

Total for Section B = 47 Marks

Question Number	Acceptable Answer	Mark
24(a)(i)	$TiCl_4 + 4Na \rightarrow 4NaCl + Ti$ IGNORE State symbols, even if incorrect. ALLOW Multiples. Reversible arrows.	**(1)**

Question Number	Acceptable Answer	Mark
24(a)(ii)	Ti **reduced** as oxidation number decreases from **+4 to 0**/changes from **+4 to 0.** **(1)** Na **oxidized** as oxidation number increases from **0 to +1**/changes from **0 to +1.** **(1)** ALLOW Correct oxidation numbers only for one mark. **N.B.** max (1) if no + sign included. ALLOW **'4+'** and/or **'1+'** given instead of **+4** and **+1.** **N.B.** if any of the oxidation numbers are wrong, award max (1) for the idea that during oxidation the oxidation number increases **AND** during reduction the oxidation number decreases. IGNORE References to loss and /or gain of electrons.	**(2)**

Question Number	Acceptable Answer	Mark
24(b)	(Ti [Ar]) $3d^2$ $4s^2$/$4s^2$ $3d^2$ **(1)** (Ti^{3+} [Ar]) $3d^1$ /$3d^1$ $4s^0$ (Ti^{4+} [Ar]) 'nil'/$3d^0$ $4s^0$ /$3d^0$ space left blank by candidate BOTH Ti^{3+} and Ti^{4+} correct for second mark. **(1)** Mark CQ on Ti electron configuration for the second mark. ALLOW Upper case (e.g. 'D' for 'd' in electronic configurations). Subscripts for numbers of electrons. Full correct electronic configurations $1s^2$ $2s^2$.	**(2)**

Question Number	Acceptable Answer	Reject	Mark
24(c)(i)	**(d-block element)** EITHER Ti has (two) electrons in the 3d subshell/ Ti has a partially filled d-subshell/ Ti has a partially filled d-orbital/ Ti has electrons in d-orbital(s)/ Ti has electrons in d-subshell (During the build up of its atoms) last added/valence electron is in a d-subshell/d-orbital. OR (During the build up of its atoms) last added/valence electron is in a d-subshell/d-orbital.	**Outer/highest energy** electrons are in a d-orbital/**Outer/highest energy** electrons are in a d-subshell Electrons in the 'd-block'/ 'electrons in the d-shell'	**(1)**

Question Number	Acceptable Answer	Mark
24(c)(ii)	(Transition element) Forms one (or more stable) **ions**/forms **Ti^{3+}** (ions) which have. Incomplete d-orbital(s)/an incomplete d-subshell/a partially filled d-subshell/an unpaired d electron IGNORE references to variable oxidation states.	**(1)**

Question Number	Acceptable Answer	Reject	Mark
*24(d)(i) Quality of Written Communication	**First mark:** d-subshell splits/d-orbital**s** split (in energy by ligands)/d energy level(s) split(s) **(1)** **Second mark:** Absorbs light (in visible region) **(1)** **Third mark:** Electron transitions from lower to higher energy/electron(s) jump from lower to higher energy. OR Electron(s) promoted (within d). **(1)** Mark independently **N.B.** maximum of (1) mark (i.e. the first mark only) if refers to electrons falling back down again.	d-**orbital/**d-**shell** splits Absorbs **purple** light	**(3)**

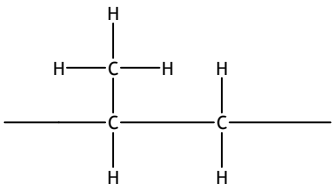
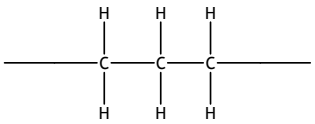
Question Number	Acceptable Answer	Mark
24(d)(ii)	No d-electrons/empty d-subshell	**(1)**

Question Number	Acceptable Answer	Reject	Mark
*24(e)(i) Quality of Written Communication	**TiO_2 'Structure' mark** EITHER Giant (structure) OR Lattice (structure) **(1)** IGNORE Whether stated as ionic or covalent for this mark. **TiO_2 'Bonding' mark** EITHER **Strong** (electrostatic) attraction between ions. ALLOW **Strong** ionic bonds/ionic bonds require a lot of energy to break. OR **Strong** covalent bonds/covalent bonds require a lot of energy to break. **(1)** **$TiCl_4$ 'Structure' mark** (Simple) molecules/(small) molecules /molecular. **(1)** **$TiCl_4$ 'Bonding' mark** **Weak** London/dispersion/van der Waals' forces (between molecules)/ London/dispersion/van der Waals' forces (between molecules) require little energy to break. **(1)**	TiO_2 (small) molecules/simple molecular For TiO_2 mention of any type of intermolecular forces between molecules of TiO_2 $TiCl_4$ giant structure Covalent bonds broken (on melting) in $TiCl_4$ Ionic bonding in $TiCl_4$ Hydrogen bonding **(0)** for this mark	**(4)**

Question Number	Acceptable Answer	Mark
24(e)(i) continued	**N.B.** if candidate assumes TiO_2 and $TiCl_4$ are both simple molecular, can score last mark for saying that the named intermolecular forces in TiO_2 are stronger. IGNORE (Permanent) dipole-dipole forces. Mark the four scoring points independently.	

Question Number	Acceptable Answer	Mark
24(e)(ii)	Amphoteric ALLOW Recognisable spellings.	**(1)**

Question Number	Acceptable Answer	Mark
24(e)(iii)	$TiO_2 + 2H_2O + 2KOH \rightarrow K_2Ti(OH)_6$ OR $TiO_2 + 2H_2O + 2OH^- \rightarrow Ti(OH)_6^{2-}$ IGNORE state symbols even if incorrect.	**(1)**

Question Number	Acceptable Answer	Reject	Mark
24(e)(iv)	 **MUST** have continuation bonds at each end. ALLOW CH_3 IGNORE n and any brackets.	 **Two** (or more) repeat units shown.	**(1)**

Question Number	Acceptable Answer	Mark
24(f)(i)	(H_2O_2 + $2H^+$ +) **$2e^{(-)}$ → $2H_2O$** **BOTH** $2e^{(-)}$ **and 2**H_2O needed for the mark.	**(1)**

Question Number	Acceptable Answer	Mark
***24(f)(ii) Quality of Written Communication**	(Moles H_2O_2 = 0.0200 x 22.50/1000) = 4.5 x 10^{-4} mol H_2O_2 **(1)** (Moles Ti^{3+} reacting in 25.0 cm^3) = 9.0 x 10^{-4} mol Ti^{3+} **(1)** (Moles Ti^{3+} in 250 cm^3) = 9.0 x 10^{-3} mol Ti^{3+} **(1)** (Original concentration of Ti^{3+}= 9.0 x 10^{-3}/0.00500) = 1.8 (mol dm^{-3}) **(1)** 1.8 (mol dm^{-3}) with or without working scores **(3)** **N.B.** if mole ratio H_2O_2 : Ti^{3+} is 1:1 final answer for concentration of Ti^{3+} is 0.9 (mol dm^{-3}) scores. Overall **(2)** If mole ratio H_2O_2 : Ti^{3+} is 2:1 final answer for concentration of Ti^{3+} is 0.45 (mol dm^{-3}) scores. Overall **(2)** If candidate forgets to multiply number. of moles of Ti^{3+} by 10 then answer is 0.18 (moldm^{-3}) this scores. **(2)** If volume of H_2O_2 used is 25.0 no first mark, but can score two marks if final answer CQ is 2(.0) (mol dm^{-3}).	**(3)**

Question Number	Acceptable Answer	Reject	Mark
24(f)(iii)	(It/titanium(III)/Ti^{3+}) **oxidized** (by oxygen in the air) ALLOW 'It is a **strong** reducing agent'	Hydrolysis	**(1)**

Total for Question 24 = 23 marks

Total for Section C = 23 marks

Total for Paper = 90 marks