



Pearson

# Mark Scheme (Results)

Summer 2017

Pearson Edexcel GCE  
in Chemistry (6CH05) Paper 01  
General Principles of Chemistry II – Transition  
Metals and Organic Nitrogen Chemistry

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# General marking guidance

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- 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 QWC, 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

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Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing 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 be worthy of credit.

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.

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) 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. Make sure that the answer makes sense. 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 which involve the writing of continuous prose will expect 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 QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

### Section A (multiple choice)

Question Number	Correct Answer	Mark
<b>1</b>	<b>1. The only correct answer is C</b> <i>A is not correct because neither Al nor H has oxidation number +5</i> <i>B is not correct because neither K nor Mn has oxidation number +5</i> <i>D is not correct because neither Fe, C nor N has oxidation number +5</i>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>2</b>	<b>2. The only correct answer is A</b> <i>B is not correct because I disproportionates from 0 to +5 and -1</i> <i>C is not correct because O disproportionates from -1 to -2 and 0</i> <i>D is not correct because Cu disproportionates from +1 to +2 and 0</i>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>3</b>	<b>3. The only correct answer is C</b> <i>A is not correct because zinc atoms would be oxidised by hydrogen ions</i> <i>B is not correct because zinc is the negative electrode so does not gain electrons</i> <i>D is not correct because zinc atoms lose electrons to hydrogen ions</i>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>4</b>	<p><b>4. The only correct answer is C</b></p> <p><i>A is not correct because the electrode potential of the cell containing iron(II) ions is less positive than the one containing Vanadium (III) ions</i></p> <p><i>B is not correct because iron is a reducing agent</i></p> <p><i>D is not correct because silver is a reducing agent</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>5</b>	<p><b>5. The only correct answer is A</b></p> <p><i>B is not correct because there is no hydrogen gas present</i></p> <p><i>C is not correct because the reaction must supply electrons</i></p> <p><i>D is not correct because the reaction must supply electrons</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>6</b>	<p><b>6. The only correct answer is B</b></p> <p><i>A is not correct because nickel(II) ions form a soluble complex with ammonia</i></p> <p><i>C is not correct because nickel(II) ions form a soluble complex with ammonia</i></p> <p><i>D is not correct because nickel(II) hydroxide is not soluble in excess NaOH</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>7</b>	<p><b>7. The only correct answer is D</b></p> <p><i>A is not correct because the product is not <math>S_4O_6^{2-}</math> ions</i></p> <p><i>B is not correct because the product is not <math>S_4O_6^{2-}</math> ions</i></p> <p><i>C is not correct because the charges are not balanced</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>8</b>	<p><b>8. The only correct answer is D</b></p> <p><i>A is not correct because the end point could still be seen</i></p> <p><i>B is not correct because the starch is not decomposed</i></p> <p><i>C is not correct because the blue-black colour would be seen</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>9</b>	<p><b>9. The only correct answer is A</b></p> <p><i>B is not correct because infrared spectroscopy does not measure bond length</i></p> <p><i>C is not correct because the enthalpy changes do not measure bond length</i></p> <p><i>D is not correct because the rates of reaction do not measure bond length</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>10</b>	<p><b>10. The only correct answer is B</b></p> <p><i>A is not correct because SO<sub>3</sub>H is substituted</i></p> <p><i>C is not correct because SO<sub>3</sub>H is substituted</i></p> <p><i>D is not correct because SO<sub>3</sub>H is substituted</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>11</b>	<p><b>11. The only correct answer is B</b></p> <p><i>A is not correct because the electrophile which forms is CH<sub>3</sub>CO<sup>+</sup></i></p> <p><i>C is not correct because the electrophile which forms is CH<sub>3</sub>CO<sup>+</sup></i></p> <p><i>D is not correct because the electrophile which forms is CH<sub>3</sub>CO<sup>+</sup></i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>12</b>	<p><b>12. The only correct answer is C</b></p> <p><i>A is not correct because there is no doublet in the spectrum</i></p> <p><i>B is not correct because there is no sextet on the spectrum</i></p> <p><i>D is not correct because there is no doublet in the spectrum</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>13</b>	<p><b>13. The only correct answer is B</b></p> <p><i>A is not correct because the bonds are too similar to be distinguished by infrared</i></p> <p><i>C is not correct because the splitting patterns will be the same</i></p> <p><i>D is not correct because the number of peaks in the low resolution spectra</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>14</b>	<p><b>14. The only correct answer is D</b></p> <p><i>A is not correct because there is no alcohol or phenol to give the peak at above <math>3300\text{cm}^{-1}</math></i></p> <p><i>B is not correct because there is no alcohol or phenol to give the peak at above <math>3300\text{cm}^{-1}</math></i></p> <p><i>C is not correct because there is no alcohol or phenol to give the peak at above <math>3300\text{cm}^{-1}</math></i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>15</b>	<p><b>15. The only correct answer is A</b></p> <p><i>B is not correct because it does not form an alkaline solution</i></p> <p><i>C is not correct because it is not very soluble in water</i></p> <p><i>D is not correct because it does not form an alkaline solution</i></p>	<b>(1)</b>



Question Number	Correct Answer	Mark
<b>16</b>	<p><b>16. The only correct answer is B</b></p> <p><i>A is not correct because the property which is essential is that the capsule is water soluble to release the detergent</i></p> <p><i>C is not correct because the property which is essential is that the capsule is water soluble to release the detergent</i></p> <p><i>D is not correct because the property which is essential is that the capsule is water soluble to release the detergent</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>17</b>	<p><b>17. The only correct answer is A</b></p> <p><i>B is not correct because the OH and CONH<sub>2</sub> groups will not react to form a polymer</i></p> <p><i>C is not correct because the number of (CH<sub>2</sub>) groups in the polymer is incorrect</i></p> <p><i>D is not correct because the OH and NH<sub>2</sub> groups will not react to form a polymer</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>18</b>	<p><b>18. The only correct answer is C</b></p> <p><i>A is not correct because 1 mol alcohol gives 4 mol CO<sub>2</sub> so 4C are present</i></p> <p><i>B is not correct because 1 mol alcohol gives 4 mol CO<sub>2</sub> so 4C are present</i></p> <p><i>D is not correct because 1 mol alcohol gives 4 mol CO<sub>2</sub> so 4C are present</i></p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>19(a)</b>	<p><b>19(a). The only correct answer is C</b></p> <p><b>A</b> is not correct because theoretical yield =  <math>(2 \times 181/136) = 2.66\text{g}</math>  so % yield = <math>(1.5/2.66) \times 100</math></p> <p><b>B</b> is not correct for the same reason</p> <p><b>D</b> is not correct for the same reason</p>	<b>(1)</b>

Question Number	Correct Answer	Mark
<b>19(b)</b>	<p><b>19(b). The only correct answer is D</b></p> <p><b>A</b> is not correct because some product would remain dissolved in excess ethanol</p> <p><b>B</b> is not correct because the ethanol should be warmed until all the crude solid dissolves, which is not related to its boiling point</p> <p><b>C</b> is not correct because slow filtration could cause crystallisation in the filter funnel</p>	<b>(1)</b>

**Total for Section A = 20 MARKS**

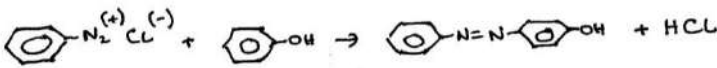
## Section B

Question Number	Acceptable Answers	Reject	Mark
<b>20(a)(i)</b>	<p>Concentrated nitric acid/ HNO<sub>3</sub> <b>and</b> concentrated sulfuric acid/H<sub>2</sub>SO<sub>4</sub></p> <p>ALLOW Concentrated nitric and sulfuric acid(s)</p> <p>IGNORE References to temperature</p>	<p>Nitric acid and concentrated sulfuric acid</p> <p>Nitrous acid HNO<sub>2</sub></p>	<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>20(a)(ii)</b>	<p>H<sub>2</sub>SO<sub>4</sub> + HNO<sub>3</sub> → NO<sub>2</sub><sup>+</sup> + H<sub>2</sub>O + HSO<sub>4</sub><sup>-</sup></p> <p>OR</p> <p>H<sub>2</sub>SO<sub>4</sub> + HNO<sub>3</sub> → H<sub>2</sub>NO<sub>3</sub><sup>+</sup> + HSO<sub>4</sub><sup>-</sup> <b>and</b></p> <p>H<sub>2</sub>NO<sub>3</sub><sup>+</sup> → NO<sub>2</sub><sup>+</sup> + H<sub>2</sub>O</p> <p>OR</p> <p>2H<sub>2</sub>SO<sub>4</sub> + HNO<sub>3</sub> → NO<sub>2</sub><sup>+</sup> + H<sub>3</sub>O<sup>+</sup> + 2HSO<sub>4</sub><sup>-</sup></p> <p>IGNORE</p> <p>state symbols even if incorrect <b>(1)</b></p> <p>Curly arrows from on or within the circle to N of NO<sub>2</sub><sup>+</sup></p> <p>ALLOW</p> <p>Curly arrow from anywhere within the hexagon</p> <p>curly arrow to any part of the NO<sub>2</sub><sup>+</sup> including the + charge <b>(1)</b></p> <p>Intermediate structure including charge with horseshoe covering at least 3 C atoms <b>and</b> facing the tetrahedral carbon <b>and</b> some part of the + charge must be within the horseshoe <b>(1)</b></p> <p>Curly arrow <b>from C-H bond</b> to anywhere in the hexagon reforming the delocalised structure <b>(1)</b></p> <p>Correct Kekule structures score full marks</p> <p>IGNORE</p> <p>Any involvement of HSO<sub>4</sub><sup>-</sup> in the final step</p>	<p>Curly arrow on or outside the hexagon</p> <p>Dotted bonds to H and NO<sub>2</sub> unless clearly part of a 3D structure</p>	<b>(4)</b>

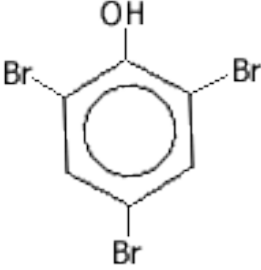
Question Number	Acceptable Answers	Reject	Mark
<b>20(a)(iii)</b>	<p><b>X</b> = C<sub>6</sub>H<sub>5</sub>NH<sub>2</sub> /phenylamine / aniline/ aminobenzene/ C<sub>6</sub>H<sub>5</sub>NH<sub>3</sub><sup>+</sup> Cl<sup>-</sup> /phenylammonium chloride/ aniline hydrochloride <b>(1)</b></p> <p>Reagents: Sn/ tin <b>and</b> (concentrated) hydrochloric acid/ HCl (followed by NaOH)</p> <p>ALLOW Iron/Fe for Sn <b>(1)</b></p> <p>IGNORE Mention of catalyst</p> <p>Second mark is <b>independent</b> of first</p>	Dilute HCl	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>20(a)(iv)</b>	<p>Reagents: Sodium nitrite/ potassium nitrite/ NaNO<sub>2</sub>/ KNO<sub>2</sub> <b>and</b> hydrochloric acid/ HCl</p> <p>ALLOW Nitrous acid / HNO<sub>2</sub> <b>and</b> hydrochloric acid /HCl <b>(1)</b></p> <p>IGNORE concentration of acid</p> <p>Condition: temperature between 0(°C) and 10(°C )/ less than 10(°C ) <b>(1)</b></p>	Just H <sup>+</sup> for an acid	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>20(b)</b>	<p>Equation using phenol, phenylamine or other compound with <b>activated</b> benzene ring and HCl as one product</p> <p>e.g.</p>  <p>Structure of dye including azo link / -N=N- <b>(1)</b></p> <p>Rest of equation</p> <p>ALLOW TE on incorrect reagent provided -N=N- linking two benzene rings Use of NaOH ( as solvent for phenol) giving NaCl</p> <p>Any position of substitution on ring <b>(1)</b></p>	<p>Use of chloro-benzene/ nitro-benzene</p>	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>20(c)</b>	<p>Hydrochloric acid / HCl / any strong acid/ H<sup>+</sup>(aq)</p> <p>OR NaOH <b>followed by</b> hydrochloric acid / HCl</p> <p>IGNORE concentration , addition of water</p>	<p>HCN</p> <p>"NaOH <b>with</b> HCl"</p>	<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>20(d)(i)</b>	<p>C<sub>6</sub>H<sub>5</sub>N<sub>2</sub>Cl + H<sub>2</sub>O → N<sub>2</sub> + HCl + C<sub>6</sub>H<sub>5</sub>OH</p> <p>N<sub>2</sub> as a product <b>(1)</b></p> <p>Rest of the equation <b>(1)</b> IGNORE state symbols even if incorrect.</p>	<p>O<sub>2</sub> as a reagent</p>	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>20(d)(ii)</b>	 <p data-bbox="432 573 539 607">ALLOW</p> <p data-bbox="432 645 1158 678">Kekule / C<sub>6</sub>H<sub>2</sub>(OH)Br<sub>3</sub> / C<sub>6</sub>H<sub>2</sub>OHBr<sub>3</sub> <b>(1)</b></p>	monobromophenol	<b>(1)</b>

**(Total for Question 20 = 15 marks)**

Question Number	Acceptable Answers	Reject	Mark
<b>21(a)(i)</b>	<p>Electrons are removed from 4s (orbital) in each element <b>(1)</b></p> <p>Shielding (by 3d electrons) is the same in each element OR Increase in nuclear charge/ proton number is balanced by increase in number of shielding/3d electrons <b>(1)</b></p>		<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>*21(a)(ii)</b>	<p><b>MP1</b> In Cr<sup>+</sup> the (second) electron is lost from the 3d subshell <b>and</b> in V<sup>+</sup> and Mn<sup>+</sup> it is lost from the 4s subshell <b>(1)</b></p> <p><b>MP2 and MP3</b></p> <p>Any <b>TWO</b> of</p> <p>3d is closer to nucleus than 4s, harder to remove <b>(1)</b> OR 3d is not as well shielded as 4s, harder to remove <b>(1)</b> OR 3d is half full so relatively stable, harder to remove <b>(1)</b></p>		<b>(3)</b>

Question Number	Acceptable Answers			Reject	Mark
<b>21(b)(i)</b>	Ion	Oxidation number of chromium	Colour in aqueous solution	purple	<b>(3)</b>
	$\text{Cr}(\text{H}_2\text{O})_6^{2+}$	+2	Blue		
	$\text{Cr}(\text{H}_2\text{O})_6^{3+}$	+3	Green ALLOW violet		
	$\text{CrO}_4^{2-}$	+6	Yellow		
	$\text{Cr}_2\text{O}_7^{2-}$	+6	Orange		
	Oxidation number and colour for $\text{Cr}(\text{H}_2\text{O})_6^{3+}$ <b>(1)</b>				
	Oxidation number and colour for $\text{CrO}_4^{2-}$ <b>(1)</b>				
Oxidation number and colour for $\text{Cr}_2\text{O}_7^{2-}$ <b>(1)</b>					
ALLOW 1 mark for any two correct responses 2 marks for any four correct responses 2+ for +2 etc. Dark/ light along with colour					



Question Number	Acceptable Answers	Reject	Mark
<b>*21(b)(ii)</b>	<p><b>MP1</b> (3)d orbitals are split/ (3)d subshells are split (by the attached ligands) <b>(1)</b></p> <p><b>MP2</b> Electrons are promoted (from lower to higher energy d orbital(s)/ levels OR Electrons are moved from lower to higher energy (d (orbital(s) / levels)</p> <p>ALLOW d-d transitions occur/ electrons are excited <b>(1)</b></p> <p><b>MP3</b> absorbing energy/ photons of a certain frequency (in the visible region)</p> <p>ALLOW Absorbing light <b>(1)</b></p> <p><b>MP4</b> Transmitted/ remaining/ reflected light is coloured/ is in the visible region</p> <p>ALLOW Complementary colour seen (The frequency of) transmitted/ remaining /reflected light/ is seen <b>(1)</b></p> <p>Penalise omission of (3)d once only. Ignore reference to electrons relaxing/dropping to the ground state</p>	Emitted light	<b>(4)</b>

Question Number	Acceptable Answers	Reject	Mark
21(b)(iii)	<div data-bbox="432 264 1166 548" data-label="Diagram"> </div> <p data-bbox="432 645 1158 757"><b>MP1</b> Beaker with Zn electrode in <math>Zn^{2+}(aq)</math> <b>and</b> salt bridge <b>and</b> voltmeter <b>(1)</b></p> <p data-bbox="432 790 1158 902"><b>MP2</b> beaker with Pt electrode in mixture of <math>Cr^{2+}</math>, <math>Cr^{3+}</math> <b>(1)</b></p> <p data-bbox="432 936 1158 1216"><b>MP3</b> All solutions <math>1 \text{ mol dm}^{-3}</math> (with respect to the ions) <b>and</b> <math>T = 298 \text{ K}</math></p> <p data-bbox="432 1115 1158 1216">ALLOW Concentrations given for one beaker only <math>1 \text{ M}</math> for <math>1 \text{ mol dm}^{-3}</math> <b>(1)</b></p> <p data-bbox="432 1256 1158 1323">ALLOW diagram with Zn electrode on right.</p> <p data-bbox="432 1361 1158 1424">IGNORE References to pressure</p>	<p data-bbox="1190 663 1310 869">Salt bridge not dipping into solution</p> <p data-bbox="1190 981 1278 1014">1 mol</p>	<b>(3)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>21(b)(iv)</b>	$\text{Zn}^{2+}(\text{aq}) \text{Zn}(\text{s}) \quad E^\ominus = -0.76 \text{ (V)}$ <p><b>and</b></p> $\text{Cr}^{3+}(\text{aq}) \text{Cr}^{2+}(\text{aq}) \quad E^\ominus = -0.41 \text{ (V)}$ <p style="text-align: right;"><b>(1)</b></p> $E^\ominus_{\text{cell}} = (-0.41 - (-0.76))$ $= (+)0.35 \text{ (V)} \quad \textbf{(1)}$ <p>Correct answer including sign +0.35 with no working scores two</p> <p>Value of 0.35 with no sign and no working scores 1</p> <p>No TE on incorrect data</p>		<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>21(c)(i)</b>	$\text{Cr}^{3+}(\text{aq}) + 8\text{OH}^- \rightarrow \text{CrO}_4^{2-} + 4\text{H}_2\text{O} + 3\text{e}^-$ <p>IGNORE</p> <p>State symbols</p>	$\text{Cr}^{3+}(\text{aq}) + 4\text{OH}^- \rightarrow \text{CrO}_4^{2-} + 4\text{H}^+ + 3\text{e}^-$	<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>21(c)(ii)</b>	$2\text{Cr}^{3+}(\text{aq}) + 10\text{OH}^- + 3\text{H}_2\text{O}_2 \rightarrow 2\text{CrO}_4^{2-} + 8\text{H}_2\text{O}$ <p>ALLOW</p> <p>TE on equation in (c)(i) using <math>4\text{OH}^-</math> :</p> $2\text{Cr}^{3+}(\text{aq}) + 2\text{OH}^- + 3\text{H}_2\text{O}_2 \rightarrow 2\text{CrO}_4^{2-} + 8\text{H}^+$		<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>21(d)</b>	$2\text{CrO}_4^{2-} + 2\text{H}^+ \rightarrow \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O}$		<b>(1)</b>

**(Total for Question 21 = 20 marks)**

Question Number	Acceptable Answers	Reject	Mark
<b>22(a)</b>	Both a negative and a positive charge are present (in a neutral molecule)  OR Both COO <sup>-</sup> and NH <sub>3</sub> <sup>+</sup> are present  ALLOW "Ion with extra H <sup>+</sup> on amine group and one less H <sup>+</sup> on carboxyl O"  Formula showing the correct charges	Just "pole" or "region" for charge  Just an ion that acts as an acid or a base	<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(b)</b>	$\begin{array}{c} \text{NH}_3^+ \\   \\ \text{H} - \text{C} - \text{COOH} \\   \\ \text{CH}_2\text{OH} \end{array}$ <p style="text-align: center;">pH 1.0</p> <p>Ion at pH 1.0: with NH<sub>3</sub><sup>+</sup> <b>(1)</b></p> $\begin{array}{c} \text{NH}_2 \\   \\ \text{H} - \text{C} - \text{COO}^- \\   \\ \text{CH}_2\text{OH} \end{array}$ <p style="text-align: center;">pH 10.0</p> <p>Ion at pH 10.0 with COO<sup>-</sup> <b>(1)</b></p>	Charge on -CH <sub>2</sub> OH group	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(c)</b>	$\begin{array}{ccccccc} & \text{H} & & \text{H} & & \text{O} & & & \text{H} & & \text{O} \\ &   & &   & &    & & &   & &    \\ \text{---} & \text{N} & \text{---} & \text{C} & \text{---} & \text{C} & \text{---} & \text{N} & \text{---} & \text{C} & \text{---} & \text{C} & \text{---} \\ & & &   & & & &   & &   & & & \\ & & & \text{CH}_3 & & & & \text{H} & & \text{CH}_3 & & & \end{array}$ <p>CONH displayed <b>(1)</b></p> <p>Rest of molecule with extension bonds from C and N</p> <p>ALLOW 3 complete units Brackets round units and n following <b>(1)</b></p>	Ester link       partial repeat units	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(d)(i)</b>	They rotate (the plane of polarization) of (plane-)polarised light OR They are optically active OR they have a chiral centre/ they are chiral/they have a chiral carbon/ they have optical isomers / they form enantiomers		<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(d)(ii)</b>	Esterification <b>(1)</b> IGNORE condensation  Neutralization/ salt formation /acid-base / protonation <b>(1)</b>	Trans-esterification	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(d)(iii)</b>	Ethanol/ C <sub>2</sub> H <sub>5</sub> OH  If name <b>and</b> formula are given <b>both</b> must be correct		<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(d)(iv)</b>	Hydrolysis Acid hydrolysis	Extra answers	<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>22(d)(v)</b>	Carbon dioxide/ CO <sub>2</sub>  ALLOW H <sub>2</sub> CO <sub>3</sub> <b>(1)</b>  ammonium chloride/ NH <sub>4</sub> Cl  ALLOW Ammonia/ NH <sub>3</sub> <b>(1)</b>  ALLOW Aminomethanoic acid / H <sub>2</sub> NCOOH (max 1)		<b>(2)</b>

**(Total for Question 22 = 12 marks)**

Question Number	Acceptable Answers	Reject	Mark
<b>*23(a)</b>	<p>Transition metals have empty /partially filled d-orbitals (of suitable energy level) OR Group 1 metals such as Na do not have empty / partially filled d-orbitals (of suitable energy level) <b>(1)</b></p> <p>Which can accept pairs of electrons (from ligands) OR Ligands can form dative covalent bonds into these (d) orbitals (into these empty orbitals) <b>(1)</b></p>		<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(b)(i)</b>	<p>Ionic <b>and</b> dative covalent / co-ordinate</p> <p>ALLOW Ionic and dative</p>	London forces	<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(b)(ii)</b>	<p>Geometric ALLOW cis-trans (isomers) / E-Z (isomers) <b>(1)</b></p> <p>The 2 Cl ligands may be beside each other or opposite each other / The Cl-Co-Cl bond angle may be 90 or 180°.</p> <p>ALLOW diagrams <b>(1)</b></p> <div style="text-align: center;"> </div> <p>IGNORE Lack of charge</p> <p>Second mark is independent of first</p>	Diagrams not looking at all 3D	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(c)</b>	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow \text{CuCl}_4^{2-} + 6\text{H}_2\text{O}$ <b>(1)</b>  Ignore state symbols even if incorrect.  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ Octahedral  ALLOW Bi-pyramidal if accompanied by a diagram <b>(1)</b>  $\text{CuCl}_4^{2-}$ Tetrahedral  ALLOW Square planar <b>(1)</b>	planar	<b>(3)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(d)(i)</b>	Monodentate ligands use one lone pair in bonding OR Donate one pair of electrons (to the central ion) OR Form one dative covalent bond <b>(1)</b>  Hexadentate ligands donate six lone pairs of electrons from (six different atoms in) the same molecule/ ion/ (to the central ion) OR Donate six pairs of electrons (to the central ion) OR Form six dative covalent bonds <b>(1)</b>	Just "have" one lone pair	<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>*23(d)(ii)</b>	<p>2 moles of reactants go to 7 moles of products/ there is a <b>large</b> increase in the number of particles (going from left to right) <b>(1)</b></p> <p>This means <math>\Delta S_{(\text{system})}</math> is <b>larger/more</b> positive / <b>higher</b> (so reaction more likely to have a positive <math>\Delta S_{\text{total}}</math> and larger <math>K_c</math> ) <b>(1)</b></p>		<b>(2)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(e)(i)</b>	<p><math>(0.22 \times 100 / 2.00) = \mathbf{11(\%)}</math></p> <p>IGNORE sf except 1sf</p>		<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(e)(ii)</b>	<p>Mol <math>\text{MnO}_4^- = (36.60 \times 0.0100 / 1000)</math> <math>= \mathbf{3.66 \times 10^{-4}}</math> <b>(1)</b></p> <p>Mol ethanedioate reacting = <math>(3.66 \times 10^{-4} \times 5 / 2)</math> <math>= \mathbf{9.15 \times 10^{-4}}</math> <b>(1)</b></p> <p>Mass ethanedioate = <math>(9.15 \times 10^{-4} \times 88)</math> <math>= \mathbf{0.0805 \text{ g}}</math> <b>(1)</b></p> <p>% ethanedioate = <math>(0.0805 / 0.150 \times 100)</math> <math>= \mathbf{53.68}</math> <b>(1)</b></p> <p>IGNORE sf except 1sf</p>		<b>(4)</b>

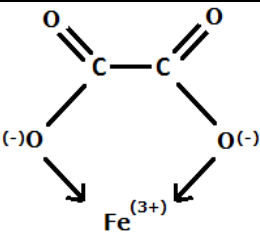
Question Number	Acceptable Answers	Reject	Mark
<b>23(e)(iii)</b>	Because ethanedioate reacts with manganate(VII) ions		<b>(1)</b>



Question Number	Acceptable Answers	Reject	Mark										
<b>23(e)(iv)</b>	<table border="1"> <thead> <tr> <th>species</th> <th>Percentage by mass</th> </tr> </thead> <tbody> <tr> <td>water</td> <td>11</td> </tr> <tr> <td>ethanedioate</td> <td>53.68</td> </tr> <tr> <td>iron</td> <td>11.4</td> </tr> <tr> <td>potassium</td> <td><b>23.92</b></td> </tr> </tbody> </table> <p>TE on % for water and ethanedioate as long as some attempt made in (e)(ii)</p> <p>Ignore sf except 1 sf</p>	species	Percentage by mass	water	11	ethanedioate	53.68	iron	11.4	potassium	<b>23.92</b>		<b>(1)</b>
species	Percentage by mass												
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Question Number	Acceptable Answers	Reject	Mark															
<b>23(e)(v)</b>	<table border="1"> <thead> <tr> <th>Species</th> <th>Number of moles in 100 g</th> <th>Mole ratio</th> </tr> </thead> <tbody> <tr> <td>water</td> <td>0.611</td> <td>3</td> </tr> <tr> <td>ethanedioate ions</td> <td>0.61</td> <td>3</td> </tr> <tr> <td>iron</td> <td>0.204</td> <td>1</td> </tr> <tr> <td>potassium</td> <td>0.61</td> <td>3</td> </tr> </tbody> </table> <p>Number of moles and ratio for water and iron <b>(1)</b></p> <p>Number of moles and ratio for ethanedioate and potassium <b>(1)</b></p> <p>TE on (e)(iv)  Ethanedioate = (e)(iv) value /88  Potassium = (e)(iv) value /39</p>	Species	Number of moles in 100 g	Mole ratio	water	0.611	3	ethanedioate ions	0.61	3	iron	0.204	1	potassium	0.61	3		<b>(2)</b>
Species	Number of moles in 100 g	Mole ratio																
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Question Number	Acceptable Answers	Reject	Mark
<b>23(e)(vi)</b>	$[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$ ALLOW $[\text{Fe}(\text{C}_2\text{O}_4)_3(\text{H}_2\text{O})_3]^{3-}$		<b>(1)</b>

Question Number	Acceptable Answers	Reject	Mark
<b>23(e)(vii)</b>	 <p data-bbox="432 539 1027 573">Two bonds shown, one from each COO<sup>-</sup></p> <p data-bbox="432 611 544 645">ALLOW</p> <p data-bbox="432 683 1027 819">Lines instead of dative covalent arrows OR Delocalised structure shown with bonds from O at each end of the ion.</p>		<b>(1)</b>

**(Total for Question 23 = 23 marks)**  
**Total for Section C = 70 MARKS**

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**TOTAL FOR PAPER = 90 MARKS**

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