Mark Scheme (Results)

January 2017

Pearson Edexcel
International Advanced Subsidiary Level
in Chemistry (WCH05)
Paper 01 General Principles of Chemistry II –
Transition Metals
and Organic Nitrogen Chemistry
(including synoptic assessment)

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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 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

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
1	D	1
	Incorrect answers A - gradual increase in ionisation energies B - gradual increase in ionisation energies C - gradual increase in ionisation energies	

Question Number	Correct Answer	Mark
2	A	1
	Incorrect answers B - ionic is incorrect C - dative covalent is missing D - covalent is missing	

Question Number	Correct Answer	Mark
3	D	1
	Incorrect answers A - precipitate is soluble in excess sodium hydroxide B - gives a blue precipitate C - precipitate does not dissolve in excess aqueous ammonia	

Question Number	Correct Answer	Mark
4	D	1
	Incorrect answers A - incorrect type of reaction B - incorrect type of reaction C - incorrect type of reaction	

Question Number	Correct Answer	Mark
5	B	1
	Incorrect answers A - basic is missing C - acidic is missing D - these are not redox reactions	

Question Number	Correct Answer	Mark
6	B	1
	Incorrect answers A - incorrect number of hydrogen atoms C - incorrect number of hydrogen atoms D - incorrect number of hydrogen atoms	

Question Number	Correct Answer	Mark
7	A	1
	Incorrect answers B - substitution is incorrect C - electrophilic is incorrect D - electrophilic and substitution are both incorrect	

Question Number	Correct Answer	Mark
8	B	1
	Incorrect answers A - does not use the concentration C - solution is not alkaline D - solution is not alkaline	

Question Number	Correct Answer	Mark
9	B	1
	Incorrect answers A - does not use the concentration C - does not use the concentration and no square root D - no square root	

Question Number	Correct Answer	Mark
10	C	1
	Incorrect answers A - no benzene ring B - no benzene ring and no amine D - no amine	

Question Number	Correct Answer	Mark
11	D	1
	Incorrect answers A - can form an amine B - can form an amine C - can form an amine	

Question Number	Correct Answer	Mark
12	B	1
	Incorrect answers A - incorrect volume of oxygen C - incorrect volume of oxygen D - incorrect volume of oxygen	

Question Number	Correct Answer	Mark
13	C	1
	Incorrect answers A - not used mole ratio B - incorrect mole ratio D - incorrect mole ratio	

Question Number	Correct Answer	Mark
14	A	1
	Incorrect answers B - incorrect statement C - incorrect statement D - incorrect statement	

Question Number	Correct Answer	Mark
15	C	1
	Incorrect answers A - refluxing is incorrect B - washing is incorrect D - steam distillation is missing	

Question Number	Correct Answer	Mark
16	A	1
	Incorrect answers B - incorrect electrode C - incorrect process D - incorrect electrode and process	

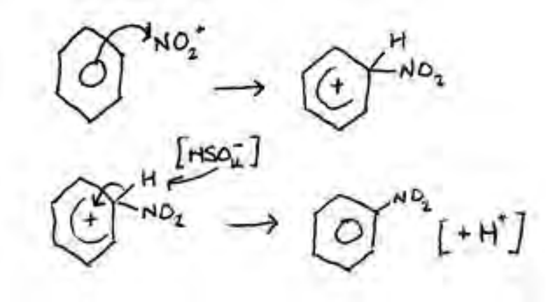
Question Number	Correct Answer	Mark
17	A	1
	Incorrect answers B - incorrect value C - incorrect sign D - incorrect value and sign	

Question Number	Correct Answer	Mark
18	B	1
	Incorrect answers A - Q is not feasible C - Q and R are not feasible D - Q is not feasible	

Question Number	Correct Answer	Mark
19	C	1
	Incorrect answers A - burette error not multiplied by 2 B - burette error not multiplied by 2 and pipette error should not be multiplied by 2 D - pipette error should not be multiplied by 2	

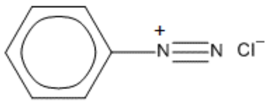
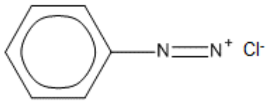
Question Number	Correct Answer	Mark
20	D	1
	Incorrect answers A - incorrect value (2 mol HCl and 1 mol H_2SO_4 formed so 4 mol NaOH needed) B - incorrect value C - incorrect value	

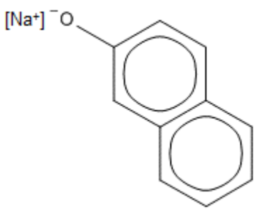
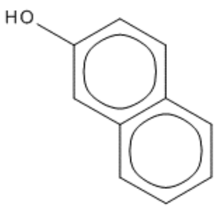
Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	First mark $H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_2O + HSO_4^-$ OR $H_2SO_4 + HNO_3 \rightarrow H_2NO_3^+ + HSO_4^-$ **and** $H_2NO_3^+ \rightarrow NO_2^+ + H_2O$ OR $2H_2SO_4 + HNO_3 \rightarrow NO_2^+ + H_3O^+ + 2HSO_4^-$ IGNORE state symbols, even if incorrect IGNORE $\rightleftharpoons$ **(1)**  Second mark Curly arrow from on or within the circle towards N of NO_2^+ ALLOW curly arrow from anywhere within the hexagon ALLOW curly arrow to any part of the NO_2^+, including to the + charge ALLOW NO_2 with no charge if M1 not awarded, but no other electrophile (1) Third mark - stand alone Intermediate structure including charge with horseshoe covering at least 3 carbon atoms and facing the tetrahedral carbon and some part of the positive charge must be within the horseshoe ALLOW dashed line for horseshoe (1) Fourth mark - stand alone Curly arrow from C-H bond to anywhere in the hexagon reforming the delocalised structure (1) Correct Kekulé structures score full marks IGNORE any involvement of HSO_4^- in the final step	Curly arrow on or outside the hexagon Dotted bonds to H and NO_2 unless clearly part of a 3D structure	4

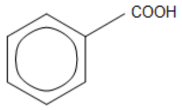
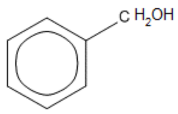
Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	Tin/Sn and (concentrated) hydrochloric acid /(concentrated) HCl((aq)) ALLOW Iron/Fe and (concentrated) hydrochloric acid /(concentrated) HCl((aq)) ALLOW then sodium hydroxide /NaOH /alkali IGNORE mention of catalyst	Dilute / Sulfuric acid / Zinc $LiAlH_4$	1

Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	Benzenediazonium chloride / product / nitrous acid / HNO_2 decomposes ALLOW unstable for decomposes OR Phenol would form ALLOW benzenediazonium chloride undergoes hydrolysis IGNORE just forms another product / further substitution / compound is volatile	Nitrobenzene / phenylamine decomposes	1

Question Number	Acceptable Answers	Reject	Mark
21(a)(iv)	 OR  Must show + charge, this can be on either nitrogen, between the nitrogens or outside of brackets around the cation and bonds around N and separate Cl^- ion IGNORE bond angles Correct Kekulé structure scores the mark	Bond between N and Cl	1

Question Number	Acceptable Answers	Reject	Mark
21(a)(v)	 OR  ALLOW NaO−, provided there is no bond between Na and O IGNORE connectivity of OH if the bond is vertical Correct Kekulé structure scores the mark	OH−C ONa−C	1

Question Number	Acceptable Answers	Reject	Mark
21(b)	Stand alone marks If name and formula are given, both must be correct CH_3Cl / chloromethane OR CH_3Br / bromomethane OR CH_3I / iodomethane (1) (Dry) aluminium chloride / $AlCl_3$ / iron(III) chloride / $FeCl_3$ OR (Dry) aluminium bromide / $AlBr_3$ / iron(III) bromide / $FeBr_3$ OR (Dry) aluminium iodide / AlI_3 / iron(III) iodide / FeI_3 (1) IGNORE heat / reflux /other conditions	Addition of acid / alkali / water	2

Question Number	Acceptable Answers	Reject	Mark
*21(c)	IGNORE unbalanced equations / additional incorrect species in equations throughout the answer Oxidation Potassium dichromate((VI)) / $K_2Cr_2O_7$ / $Cr_2O_7^{2-}$ and (dilute) sulfuric acid / H^+ / acidified(aq) (heat /reflux) ALLOW other oxidizing agents eg $KMnO_4/H^+$(aq) / Fehling's / Benedict's / Tollens' IGNORE concentration of acid (1) Intermediate - stand alone  ALLOW -CO_2H and displayed/ skeletal formula (1) Reduction - of benzaldehyde or benzoic acid Lithium tetrahydridoaluminate((III)) / lithium aluminium hydride /$LiAlH_4$ and (dry) ether / ethoxyethane / $(C_2H_5)_2O$ ALLOW sodium tetrahydridoborate(III) / sodium borohydride / $NaBH_4$ and water / aq (1) Intermediate - stand alone  ALLOW displayed/ skeletal formula IGNORE name, even if incorrect (1) Esterification EITHER React benzoic acid and phenylmethanol and (concentrated) strong acid / hydrochloric acid / HCl / sulfuric acid / H_2SO_4 (and heat / reflux) OR react benzoic acid with PCl_5 / phosphorus(V) chloride and react benzoyl chloride and phenylmethanol together (at room temperature) (1) IGNORE heat	HCl(aq) PCl_5(aq)	5

(Total for Question 21 = 15 marks)

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>22(a)(i)</td><td>
<table>
<tr><td>Sc [Ar]</td><td>↑</td><td></td><td></td><td></td><td></td><td></td><td>↑↓</td></tr>
<tr><td>Mn^{3+} [Ar]</td><td>↑</td><td>↑</td><td>↑</td><td>↑</td><td></td><td></td><td></td></tr>
<tr><td>Fe^{2+} [Ar]</td><td>↑↓</td><td>↑</td><td>↑</td><td>↑</td><td>↑</td><td></td><td></td></tr>
</table>

OR half-headed arrows

Any one row correct scores (1)
All 3 rows correct scores (2)</td><td>Vertical lines with no arrow heads once only</td><td>2</td></tr>
</table>

<table>
<tr><th>Question Number</th><th>Acceptable Answers</th><th>Reject</th><th>Mark</th></tr>
<tr><td>22(a)(ii)</td><td>d-block element:
(When the electronic structure is built up according to the aufbau rules) the last electron goes into the d-subshell / (one) of the d orbitals / a d orbital
(1)

transition element:
Forms / has at least one ion with a partially filled / incomplete d-subshell / incomplete d orbital(s)

ALLOW
Forms / has at least one ion with an unpaired d-electron / incomplete d orbital(s)

ALLOW reference to one ion or more than one ion
(1)

IGNORE additional properties such as variable oxidation state / forms coloured ions / forms complex ions</td><td>Just ‘electrons present in d-subshell

Outer(most) / valence electrons are in d-subshell

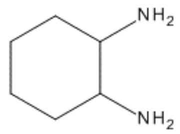
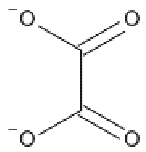
Penalise shell for subshell once only</td><td>2</td></tr>
</table>

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	EITHER The paired electron / an electron in the full orbital in (3d in) Fe^{2+} is easily removed due to repulsion ALLOW The paired electron in Fe^{2+} requires less energy (to remove) due to repulsion (1) But the (3)d^5 arrangement / half-filled (3)d-subshell / half-filled (3)d orbitals in Mn^{2+} is stable (so an electron is not easily lost) (1) OR Fe^{3+} and Mn^{2+} both have (3)d^5 arrangement / half-filled (3)d sub-shell / half-filled (3)d orbitals (1) Stand alone mark The half-filled (3)d-subshell / (3)d orbitals is / are (more) stable (than $3d^6$ in Fe^{2+} and $3d^4$ in Mn^{3+}) (1)	If 'd orbitals' has not been mentioned somewhere in the answer penalise 'half-filled d orbital' in EITHER or OR answers	2

Question Number	Acceptable Answers	Reject	Mark
22(a)(iv)	The energy difference between the (sets / splitting of) (3)d orbitals is different (when water ligands are present) ALLOW The splitting of the (3)d orbitals / sub-shell is different (1) IGNORE just 'they have different energy levels' So they absorb different frequencies / wavelengths (of visible light) (1) IGNORE they have different numbers of d electrons (for d-d transitions) IGNORE just 'they absorb different colours / energy'	(3)d orbital, if not penalised in (a)(iii) Energy released	2

Question Number	Acceptable Answers	Reject	Mark
22(b)	First mark - comment about As 5 mol As_2O_3 (oxidised) so the change / increase in oxidation number is 20 / total $20e^-$ lost / $5As_2O_3 + 10H_2O \rightarrow 5As_2O_5 + 20H^+ + 20e^-$ / 1 mol As_2O_3 loses $4e^-$ / $As_2O_3 + 2H_2O \rightarrow As_2O_5 + 4H^+ + 4e^-$ (1) Second mark - comment about Mn 4 mol MnO_4^- (reduced and) change decrease in oxidation number is 20 / total $20e^-$ gained / change in oxidation number of each Mn is 5 / each Mn(VII) gains $5e^-$ (1) Third mark - final oxidation number (final oxidation number is) +2 / Mn^{2+} / Mn(II) conditional on some working / equation to show this (1)		3

Question Number	Acceptable Answers	Reject	Mark
22(c)(i)	Ligand has 2 atoms that can form (co-ordinate / dative covalent) bonds (to the metal ion) ALLOW Has 2 lone pairs that form (co-ordinate / dative covalent) bonds ALLOW Has 2 lone pairs that it donates (to the metal ion) ALLOW Forms 2 (co-ordinate / dative covalent) bonds (to the metal ion) IGNORE mention of nucleophile	2 ligands attached to the ion Ionic bond Just ‘has 2 lone pairs’	1

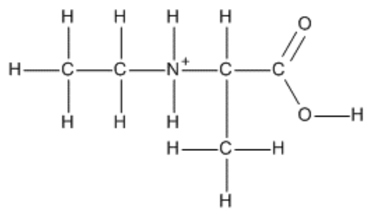
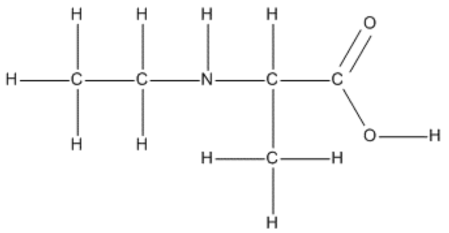
Question Number	Acceptable Answers	Reject	Mark
22(c)(ii)	ALLOW skeletal / displayed / structural formulae or any combination of these  (1)  ALLOW delocalised COO^- groups (1) IGNORE lone pairs		2

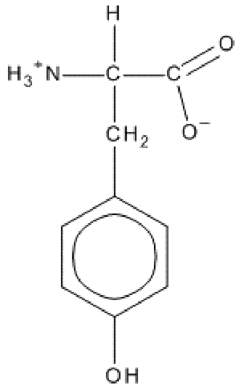
Question Number	Acceptable Answers	Reject	Mark
22(c)(iii)	(+)2 / II /2+		1

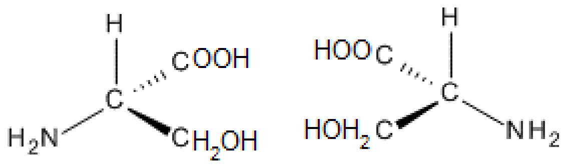
(Total for Question 22 = 15 marks)

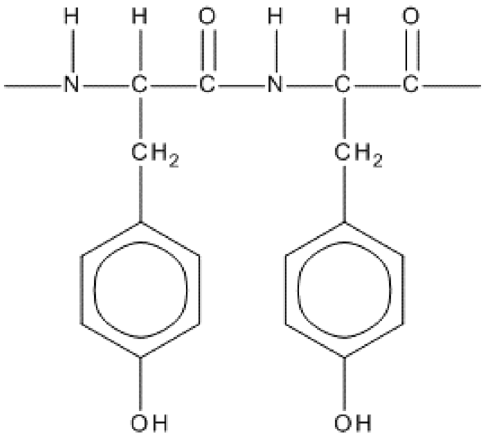
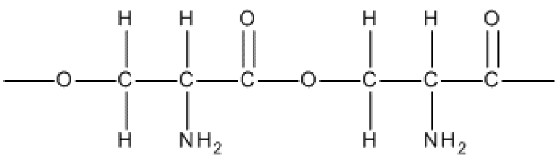
Question Number	Acceptable Answers	Reject	Mark
23(a)(i)	Hydrogen cyanide / HCN (and potassium cyanide / KCN) OR Potassium cyanide / KCN / sodium cyanide / NaCN and pH = 8 / H_2SO_4 / HCl IGNORE concentrations of acids alkali	Just CN^-	1

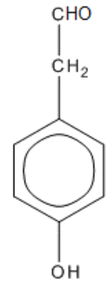
Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	any named strong acid / HCl / H_2SO_4 / H^+ OR any named strong alkali / NaOH / KOH /OH^- followed by an acid IGNORE water / concentrations of solutions	Just 'acid' alkali and acid added at the same time	1

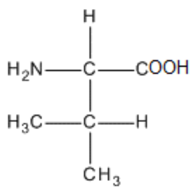
Question Number	Acceptable Answers	Reject	Mark
23(a)(iii)	 (Cl^-) OR  OR formation of tertiary or quaternary amines ALLOW CH_3 / C_2H_5 ALLOW OH ALLOW zwitterions for secondary / tertiary amines		1

Question Number	Acceptable Answers	Reject	Mark
23(b)(i)	 ALLOW positive charge anywhere on NH_3 ALLOW delocalised COO^- group ALLOW structural / displayed / skeletal formulae or any combination of these IGNORE connectivity of OH group / NH_3^+	Negative charge on O of phenol	1

Question Number	Acceptable Answers	Reject	Mark
23(b)(ii)	 1 structure with 4 atoms / groups in any order (1) Structure on right is mirror image of structure on left (1) ALLOW zwitterions		2

Question Number	Acceptable Answers	Mark
23(b)(iii)	ALLOW displayed / skeletal / structural formulae or any combination of these apart from the linkages which must be displayed IGNORE brackets and n / bond angles Polyamide  1 correct displayed amide group in any polyamide (1) rest of structure correct conditional on an amide group - allow this even if amide group is not displayed ALLOW -CO-NH- at start / -CO-NH- at end, but do not allow NH at both ends (1) Polyester  1 correct displayed ester group in any polyester (1) rest of structure correct conditional on an ester group - allow this even if ester group is not displayed ALLOW -O-CO- at start / -CO-O- at end, but do not allow the single bond Os at both ends (1)	4

Question Number	Acceptable Answers	Reject	Mark
23(c)(i)	ALLOW displayed / skeletal / structural formulae or any combination of these  IGNORE connectivity of OH		1

Question Number	Acceptable Answers	Reject	Mark
23(c)(ii)	ALLOW displayed / skeletal / structural formulae or any combination of these e.g $(CH_3)_2CHCH(NH_2)COOH$ /  ALLOW zwitterion		1

Question Number	Acceptable Answers	Reject	Mark
23(d)	Yes, because EITHER the C-H stretching is different in alkanes and arenes / benzene OR tyrosine has an absorption at 3030 (cm^{-1}) and serine does not OR No, because the broad OH absorption from COOH / (the carboxylic) acid would overlap / mask the different C-H absorptions IGNORE mention of absorptions below 2000 (cm^{-1})		1

Question Number	Acceptable Answers	Reject	Mark
23(e)(i)	5 / five (environments)		1

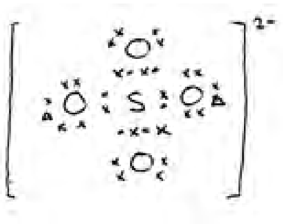
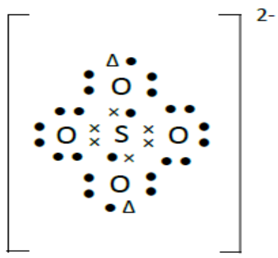
Question Number	Acceptable Answers	Mark
23(e)(ii)	**For 'chemical shift' column, allow any range or any single** value within range and allow range in the opposite order e.g 3.5 - 2.3	3

Protons in valine	Chemical shift / ppm for TMS	Splitting pattern
CH_3	0.1-1.9	doublet / (splits into) 2 (1)
CH	0.1-1.9	octet / octuplet/ (splits into) 8 (1)
OH	10(.0)-12(.0) (1)	singlet

IGNORE multiplet

(Total for Question 23 = 17 marks)

Section C

Question Number	Acceptable Answers	Reject	Mark
24(a)(i)	ALLOW any combination of dots and crosses and just dots or just crosses ALLOW any other symbol for extra electrons eg * ALLOW overlapping circles with electrons in correct places IGNORE missing brackets and charge  2 double bonds and 2 single bonds (1) Rest of diagram correct Conditional on M1 (1) IGNORE other diagrams, such as displayed formula IGNORE shape ALLOW 4 single bonds between S and O (1)  Rest of diagram correct Conditional on M1 (1)	4 double bonds	2

Question Number	Acceptable Answers	Reject	Mark
24(a)(ii)	Tetrahedral ALLOW triangular based pyramidal IGNORE pyramidal		1

Question Number	Acceptable Answers	Reject	Mark
24(a)(iii)	Correct answer with no working scores (2) marks EITHER mass of $PbSO_4$ dissolved in 250.0 cm^3 $= 1.26 \times 10^{-4} \times 303.3 \times \frac{250.0}{1000}$ $= 9.55395 \times 10^{-3}$ (g) (1) mass undissolved $PbSO_4$ $= 0.0500 - 9.55395 \times 10^{-3}$ = 0.040446 / 0.04045/ 0.0404 / 0.04(0) (g) (1) TE on mass dissolved in 250.0 cm^3 OR mol $PbSO_4$ added $= \frac{0.0500}{303.3} = 1.6485 \times 10^{-4}$ and mol $PbSO_4$ dissolved in 250 cm^3 $= 1.26 \times 10^{-4} \times \frac{250.0}{1000}$ $= 3.15 \times 10^{-5}$ (1) mol undissolved $PbSO_4$ $= 1.6485 \times 10^{-4} - 3.15 \times 10^{-5}$ $= 1.3335 \times 10^{-4}$ and mass undissolved $PbSO_4$ $= 1.3335 \times 10^{-4} \times 303.3$ = 0.040446 / 0.04045 / 0.0404 / 0.04(0) (g) (1) TE on mol dissolved in 250 cm^3		2

Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	$Na_2S_2O_7 \rightarrow Na_2SO_4 + SO_3$ ALLOW multiples IGNORE state symbols, even if incorrect		1

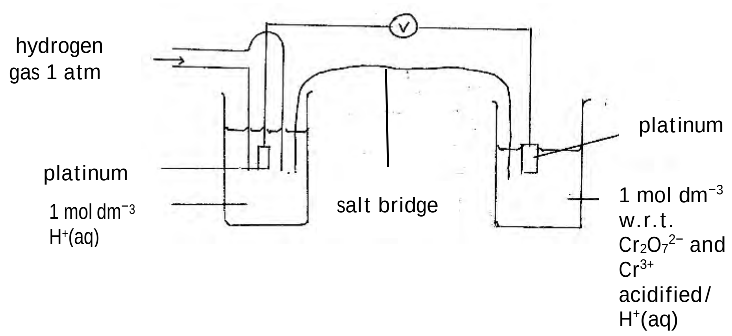
Question Number	Acceptable Answers	Reject	Mark
24(b)(ii)	$(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2O$ ALLOW multiples IGNORE state symbols, even if incorrect		1

Question Number	Acceptable Answers	Reject	Mark
24(c)(i)	$CrO_4^{2-}(aq) + 4H_2O(l) + 3e^{(-)} \rightleftharpoons Cr(OH)_3(s) + 5OH^-(aq)$ and −0.13 (V) ALLOW → IGNORE missing state symbols IGNORE square brackets around $Cr(OH)_3$	Half-cell	1

Question Number	Acceptable Answers	Reject	Mark
24(c)(ii)	$FeO_4^{2-}(aq)$ / FeO_4^{2-}	Additional species	1

Question Number	Acceptable Answers	Reject	Mark
24(c)(iii)	$3MnO_4^{2-}(aq) + 2H_2O(l) \rightarrow 2MnO_4^-(aq) + MnO_2(s) + 4OH^-(aq)$ State symbols are required		1

Question Number	Acceptable Answers	Reject	Mark
24(c)(iv)	(+)0.83 (V) / .83 (V)	−0.83 (V)	1

Question Number	Acceptable Answers	Mark
24(c)(v)	 ALLOW half-cells reversed Hydrogen half-cell: Solution 1 mol dm^{-3} $H^+(aq)$ and platinum (black) electrode ALLOW 1 mol dm^{-3} hydrochloric acid / HCl / nitric acid / HNO_3 ALLOW 0.5 mol dm^{-3} sulfuric acid (1) Hydrogen gas at 1 atm / 1.01 x 10^5 Pa / 100 kPa pressure / 1 bar (1) Chromium half-cell: Solution 1 mol dm^{-3} / equimolar with respect to dichromate / $Cr_2O_7^{2-}$ ions and chromium(III) / Cr^{3+} ions (in the same beaker) (1) Acidified / $H^+(aq)$ / HCl IGNORE concentration of acid and platinum electrode (1) Connections: Salt bridge dipping into both solutions and voltmeter to measure Standard Electrode Potential and complete circuit ALLOW a salt bridge drawn and just labelled with the electrolyte Do not award this mark if the circuit is incorrect, e.g a cell is included. Ignore ammeter. (1)	5

Question Number	Acceptable Answers	Reject	Mark
24(d)(i)	6 : 1 OR $\frac{6}{1}$ ALLOW $Cr_2O_7^{2-}$: $S_2O_3^{2-}$ = 1 : 6 / $\frac{1}{6}$ IGNORE all working		1

Question Number	Acceptable Answers	Reject	Mark
*24(d)(ii)	Correct answer with no working scores (6) M1 mol $S_2O_3^{2-}$ = 0.030 x 9.20/1000 = 2.76×10^{-4} (1) M2 mol $Cr_2O_7^{2-}$ left = $2.76 \times 10^{-4}/6 = 4.60 \times 10^{-5}$ OR mol I_2 = $2.76 \times 10^{-4}/2 = 1.38 \times 10^{-4}$ and mol $Cr_2O_7^{2-}$ left = $1.38 \times 10^{-4}/3 = 4.60 \times 10^{-5}$ TE on mol ratio in (i) (1) M3 original mol $Cr_2O_7^{2-}$ = 0.015 x 10.0/1000 = 1.50×10^{-4} (1) M4 mol $Cr_2O_7^{2-}$ reacted with C_2H_5OH = $1.50 \times 10^{-4} - 4.60 \times 10^{-5}$ = 1.04×10^{-4} and mol C_2H_5OH in 1.00 cm^3 diluted wine = $1.04 \times 10^{-4} \times 3/2$ = 1.56×10^{-4} TE on original mol $Cr_2O_7^{2-}$ and mol $Cr_2O_7^{2-}$ reacted with C_2H_5OH (1) M5 mol C_2H_5OH in 100 cm^3 diluted wine / 5.00 cm^3 original wine = $1.56 \times 10^{-4} \times 100 = 1.56 \times 10^{-2}$ TE on mol C_2H_5OH in 1.00 cm^3 diluted wine (1) M6 mass C_2H_5OH in 5.00 cm^3 original wine = $1.56 \times 10^{-2} \times 46$ = 0.7176 / 0.718 / 0.72 (g) TE on mol C_2H_5OH in 100 cm^3 diluted wine/5.00 cm^3 original wine (1) IGNORE SF except 1 SF		6

(Total for Question 24 = 23 marks)