

**Autumn 2018** 

Past Paper (Mark Scheme)

# Mark Scheme (Results)

# October 2018

Pearson Edexcel International Advanced Level In Chemistry (WCH05) Paper 01 Transition of Metals and Organic Nitrogen

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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.

#### 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 <u>meaning</u> 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 (a)	The only correct answer is A	(1)
	<b>B</b> is not correct because Fe(III) acts as an oxidising agent	
	<i>C</i> is not correct because Cr(II) loses electrons so is oxidised	
	<b>D</b> is not correct because Cr(II) loses electrons so is oxidised	

Question Number	Correct Answer	Mark
1 (b)	The only correct answer is B	(1)
	<b>A</b> is not correct because they should both be positive	
	<i>C</i> is not correct because they should both be positive	
	<b>D</b> is not correct because they should both be positive	

Question Number	Correct Answer	Mark
1 (c)	The only correct answer is D	(1)
	A is not correct because carbonate ions might react	
	<b>B</b> is not correct because hydroxide ions might react	
	<i>C</i> is not correct because iodide ions might react	

Question	Correct Answer	Mark
Number		
1 (d)	The only correct answer is A	(1)
	<i>B</i> is not correct because dividing by 10 for 100 cm <sup>3</sup> but not dividing by 2 for $Fe_{2(}SO_{4})_{3}$	
	<i>C is not correct because dividing by 10 for 100 cm<sup>3</sup> but multiplying by 2 and not dividing by 2</i>	
	<i>D</i> is not correct because dividing by 2 for $Fe_{2}(SO_4)_3$ but not dividing by 10	

Question Number	Correct Answer	Mark
2	The only correct answer is C	(1)
	A is not correct because Fe has an oxidation state of +6 B is not correct because Cr has an oxidation state of +6	
	D is not correct because W has an oxidation state of +6	

Question Number	Correct Answer	Mark
3	The only correct answer is A	(1)
	<b>B</b> is not correct because it is oxidised at the negative electrode	
	<i>C</i> is not correct because it is oxidised not reduced	
	<b>D</b> is not correct because it is oxidised not reduced at the negative electrode	

Question Number	Correct Answer	Mark
4 (a)	The only correct answer is C	(1)
	<b>A</b> is not correct because this is the second step	
	<b>B</b> is not correct because this is the second step with an incorrect product	
	<b>D</b> is not correct because this is the first step	

Question Number	Correct Answer	Mark
4 (b)	The only correct answer is C	(1)
	<b>A</b> is not correct because the 3d subshell does split	
	<b>B</b> is not correct because the 3d subshell is full	
	<b>D</b> is not correct because there is no movement of electrons in the 3d subshell	

Question Number	Correct Answer	Mark
5	The only correct answer is B	(1)
	<b>A</b> is not correct because orbitals are occupied singly before pairing	
	<b>C</b> is not correct because the 4s electrons are lost first to form an ion	
	<b>D</b> is not correct because the 4s electrons are lost first to form an ion	

Question Number	Correct Answer	Mark
6	The only correct answer is A	1
	<b>B</b> is not correct because X ray diffraction provides no evidence for this	
	<b>C</b> is not correct because X ray diffraction provides no evidence for this	
	<b>D</b> is not correct because it is not a true statement	

Question Number	Correct Answer	Mark
7	The only correct answer is B <i>A</i> is not correct because this is the reverse order <i>C</i> is not correct because phenylamine has a lower pH than ammonia <i>D</i> is not correct because diethylamine has a higher pH than ethylamine	(1)

Question Number	Correct Answer	Mark
8 (a)	The only correct answer is D	(1)
	<b>A</b> is not correct because this is not a reducing agent	
	<b>B</b> is not correct because this does not produce the amine	
	<i>C</i> is not correct because this is an oxidising agent	

Question Number	Correct Answer	Mark
8 (b)	The only correct answer is D	(1)
	<b>A</b> is not correct because this is not used to separate phenylamine	
	<b>B</b> is not correct because this is not used to separate phenylamine	
	<b>C</b> is not correct because this is not used to separate phenylamine	

Question Number	Correct Answer	Mark
8 (c)	<ul> <li>8 (c) The only correct answer is C</li> <li>A is not correct because this has an extra amine group</li> </ul>	
	<b>B</b> is not correct because use of phenol would leave an - OH in the molecule	
	<b>D</b> is not correct because this is a product of the reaction of 1,4-diaminobenzene with nitrous acid in hydrochloric acid	

Question Number	Correct Answer	Mark
9	The only correct answer is D A is not correct because this is the mass of the intermediate	(1)
	<i>B</i> is not correct because this is the overall percentage <i>C</i> is not correct because this is the overall percentage	

Question Number	Correct Answer	Mark
10	The only correct answer is A B is not correct because this is not the correct momomer	(1)
	<b>C</b> is not correct because this is not the correct momomer	
	<b>D</b> is not correct because this is not the correct momomer	

Question Number	Correct Answer	Mark
11 (a)	The only correct answer is A <i>B</i> is not correct because 2,4-dinitrophenylhydrazine	(1)
	does react with X <b>C</b> is not correct because 2,4-dinitrophenylhydrazine does react with Y	
	<b>D</b> is not correct because 2,4-dinitrophenylhydrazine does react with Z	

Question Number	Correct Answer	Mark
11 (b)	The only correct answer is D	(1)
	<ul> <li>A is not correct because W does not react with either</li> <li>B is not correct because X reacts with acidified potassium dichromate(VI) but not Tollens' reagent</li> <li>C is not correct because Y does not react with either</li> </ul>	

Question Number	Correct Answer	Mark
11 (c)	The only correct answer is D	(1)
	A is not correct only W does not react	
	<b>B</b> is not correct only W does not react	
	<i>C</i> is not correct only <i>W</i> does not react	

Question Number	Correct Answer	Mark
12	The only correct answer is B	(1)
	A is not correct has a chiral carbon	
	<b>C</b> is not correct has a chiral carbon	
	<b>D</b> is not correct has a chiral carbon	

(Total for Section A = 20 marks)

#### Section B

Question	Acceptable Answers			Reject	Mark
Number					
13(a)					1
		E/V			
	$Fe^{3+}(aq) + e^{(-)} \rightleftharpoons Fe^{2+}(aq)$	(+0.77 )		Incorrect	
				symbols	
	$(CL(2a) + 2a^{-} \rightarrow 2CL(2a))$	⊥1 36		-,	
		+1.50		1.36	
	ALLOW			without +	
	Single arrow instead of revers	sible arro	ws	(+)0.68 / (+)2.72	
	IGNORE				
	Missing state symbols				

Question Number	Acceptable Answers	Reject	Mark
13(b)(i)	Zn / Zinc / Zn(s) / Zinc(s)	Zn <sup>2+</sup> / Zinc(II)	1

Question Number	Acceptable Answers	Reject	Mark
13(b)(ii)	$SO_3^{2-}(aq) / sulfate(IV) (ions) / sulfite(ions)ALLOWSO_3^{2-}(aq) + H_2O(I)IGNOREH+missing state symbols$	SO <sub>4</sub> <sup>2-</sup> (aq) / Sulfate(VI) /sulfate	1

		- · ·	
Question	Acceptable Answers	Reject	Mark
Number		0 / 77 /	_
13(c)(i)	+2/2+	2/11/	2
		V(II)	
	This can be scored if there is no answer in		
	the space and $V^{2+}$ is shown as the product		
	in the equation, even if the equation is		
	incorrect		
	ALLOW		
	$V^{2+}/+II/II+$ (1)		
	$VO_2^+ + 4H^+ + 3e^- \rightarrow V^{2+} + 2H_2O$		
	Must be a half-equation not a full		
	equation with zinc		
	ALLOW		
	Multiples (1)		
	IGNORE		
	State symbols even if incorrect		
	No TE for equations on incorrect values of		
	oxidation state.		

Question Number	Acceptable Answers	Reject	Mark
13(c)(ii)	M1 (Recognition of oxidation by air)		4
	(Vanadium(II) / $V^{2+}$ / Vanadium(III) / $V^{3+}$ / solution) is oxidised by / reacts with oxygen (in the air)		
	This can be scored if an equation is given showing reaction of $V^{2+}$ or $V^{3+}$ with $O_2$ (1)		
	M2 (Formation of V(III) from V(II))	V(III) from	
	$4V^{2+} + O_2 + 4H^+ \rightarrow 4V^{3+} + 2H_2O$	VO <sup>2+</sup>	
	ALLOW		
	$V^{2+} \rightarrow V^{3+} + e^- / V^{3+} + e^- \rightleftharpoons V^{2+}$		
	$V^{2+}$ becomes $V^{3+}$ which is green (1)		
	M3 (Formation of V(IV))		
	$4V^{3+} + O_2 + 2H_2O \rightarrow 4VO^{2+} + 4H^+ $ (1)		
	IGNORE		
	State symbols even if incorrect		
	ALLOW		
	$2V^{2+} + O_2 \rightarrow 2VO^{2+}$ Scores 1 (of M2 and M3)		
	M4 (Calculation of E wyaluos)		
	Wi4 (Calculation of E <sub>cell</sub> values)		
	$E_{cell}$ for M2 equation = (+)1.49 (V)		
	and		
	$E_{\text{cell}}$ for M3 equation = (+)0.89 (V) (1)		

Question Number	Acceptable Answers	Reject	Mark
13(c)(iii)	$E_{cell}$ is (+)0.23 (V) so the oxidation of VO <sup>2+</sup> to VO <sub>2</sub> <sup>+</sup> is feasible		2
	ALLOW		
	E <sub>cell</sub> is (slightly) positive (1)		
	EITHER		
	the activation energy is too large / kinetically inert	Rate is slow	
	OR		
	concentration of oxygen is too low (1)		
	IGNORE		
	Non-standard conditions		
	Mark each as stand alone		

(Total for Question 13 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
14(a)			2
	Downward pointing condenser with a collection vessel (and correct water orientation)		
	OR		
	Delivery tube to container in ice bath (1)	Closed	
	Labels Water on the left	system	
	AND		
	Mixture for distillation / tarragon leaves / Estragole (1)	Anethole	
	ALLOW		
	Description of tarragon leaves as a solution in water or an organic solvent		

Question Number	Acceptable Answers	Reject	Mark
14(b)(i)	$C_{10}H_{12}O$	$C_{10}H_{11}OH$	1
	Ignore names e.g. Anethole		

Question Number	Acceptable Answers	Reject	Mark
14(b)(ii)	Restricted rotation around a carbon- carbon double bond ALLOW		2
	No rotation around a carbon-carbon double bond (1)		
	carbon (1)		
	Mark independently		

Question Number	Acceptable Answers	Reject	Mark
14(c)(i)	Propanoyl chloride Ignore formulae as working	Propanyl chloride	1
	ALLOW 1-propanoyl chloride	Propyl chloride	

Question Number	Acceptable Answers	Reject	Mark
14(c)(ii)	First mark		4
	$RCOCI + AICI_3 \longrightarrow RCO^+ + AICI_4$		
	OR		
	$CH_3CH_2COCI + AICI_3 \longrightarrow CH_3CH_2CO^+ + AICI_4^-$		
	ALLOW any acyl chloride or halogenoalkane from (c)(i) (1)		
	$H_{3}CO \xrightarrow{\bigcirc} H_{2}CH_{2}CH_{3} \xrightarrow{\bigcirc} H_{3}CO \xrightarrow{\bigcirc} CCH_{2}CH_{3} \xrightarrow{\bigcirc} H_{3}CO \xrightarrow{\bigcirc} CCH_{2}CH_{3} \xrightarrow{\bigcirc} H_{3}CO \xrightarrow{O} H_{3}CO$		
	H <sub>3</sub> CO <sup>-</sup> VI		
	Second mark Curly arrow from on or within the circle towards the C of $CH_3CH_2CO^+$ / RCO <sup>+</sup> ALLOW curly arrow from anywhere within the hexagon ALLOW curly arrow to any part of the $CH_3CH_2CO^+$ including to the + charge ALLOW TE for any R group attached to $CO^+$ (1)	Curly arrow on or outside the hexagon	
	Third markIntermediate structure including charge with horseshoecovering at least 3 carbon atomsandfacing the tetrahedral carbonandsome part of the positive charge must be within thehorseshoeALLOW dotted horseshoe(1)	Dotted bonds to H and RCO unless part of a 3-D shape	
	IGNORE Incorrect orientation of product at this marking point		
	Fourth mark Curly arrow from C—H bond to anywhere in the hexagon, reforming the correct delocalised structure (and $H^+$ ) (1)	Curly arrow from H	
	IGNORE any involvement of $AlCl_4^-$ in the final step		
	Correct Kekulé / skeletal structures score full marks		

Question Number	Acceptable Answers	Reject	Mark
14(c)(iii)	Lone pair (of electrons) on the oxygen (of the methoxy- group)		2
	AND		
	Overlaps with the п / delocalised electrons in the benzene ring / delocalised system		
	OR		
	Feeds into / donates to / interacts with the delocalised electrons / delocalised system / п system of the benzene ring		
	ALLOW		
	Increases the electron density of the benzene ring (1)		
	Making it more susceptible to electrophilic attack / attack by propanoyl cation / RCO <sup>+</sup>		
	ALLOW		
	Making it a better nucleophile (1)		
	Mark each point independently		

Question Number	Acceptable Answers	Reject	Mark
14(d)	A is $\begin{bmatrix} & & \\ H_3CO \end{bmatrix}^+$	Penalise structures without positive charge once only	2
	OR		
	$[CH_3OC_6H_4]^+$ (1)		
	B is		
	OR		
	$[CH_3OC_6H_4CO]^+ $ (1)		
	ALLOW		
	Kekulé structures		
	ALLOW		
	Reversed answers scores 1		
	If the reversed answers are given and some indication (e.g. masses of the ions) are given in the boxes allow both marks		
	IGNORE		
	Absence of brackets / position of +		
	Note Allow skeletal / displayed formulae for both A and B		

Question Number	Acceptable Answers	Reject	Mark
14(e)(i)	$H_{E} \xrightarrow{H_{C}} O \xrightarrow{H} H_{C} H$	Any other hydrogens labelled	1
	Three hydrogens with E		
	ALLOW		
	Any other unambiguous identification of the <b>three</b> hydrogens		

Question	Acceptable Answers	Reject	Mark
Number			
Number 14(e)(ii)	M1 Two peaks, one centred between $\delta 0.1$ to $\delta 1.9$ and one between $\delta 1.75$ and $\delta 3.0$ (1) Triplet centred between $\delta 0.1$ to $\delta 1.9$ AND Quartet in the region $\delta 1.75$ to $\delta 3.0$ (1) Peak between $\delta 0.1$ to $\delta 1.9$ shown with peak area of 3 and at $\delta 1.75$ to $\delta 3.0$ with peak area of 2. This could be anywhere on the page. (1)		3
	Relative peak height and relative size/height of parts of multiplet		

Question Number	Acceptable Answers	Reject	Mark
14(f)	(Reduction using) Lithium tetrahydridoaluminate((III)) / Lithium aluminium hydride / Lithal / LiAlH <sub>4</sub> in (dry) ether	Hydrogen and nickel	5
	ALLOW		
	Sodium tetrahydridoborate((III)) / Sodium borohydride / NaBH <sub>4</sub> (1)		
	IGNORE		
	Heat / reflux / distillation		
	H <sub>3</sub> CO		
	ALLOW		
	Skeletal formula (1)		
	(Substitution using) PCI₅ OR		
	NaCl / KCl and concentrated / conc. $H_2SO_4$		
	ALLOW	Just acid	
	$PCl_3 / SOCl_2 / concentrated hydrochloric acid$		
	(Substitution using) $PBr_3 / P$ and $Br_2$ (giving bromoalkane)	Just HCI	
	(Substitution using) $PI_3$ / (red) P and $I_2$ (giving iodoalkane) (1)		



(Total for Question 14 = 22 marks)

Question Number	Acceptable Answers	Reject	Mark
15(a)(i)	Moles of thiosulfate		2
	$= 21.60 \times 10^{-3} \times 3 \times 10^{-3}$		
	= 6.48 x 10 <sup>-5</sup> / 0.0000648 (mol) (1)		
	Moles of $Cu^{2+}$ in 100 cm <sup>3</sup> = moles of thiosulfate x 10		
	$= 6.48 \times 10^{-4} / 0.000648 \text{ (mol)} (1)$		
	If M1 is scored, then there is no further attempt, the second mark can be scored in (a)(ii)		
	Ignore SF except 1 SF		
	Correct answer with no working scores 2		

Question Number	Acceptable Answers	Reject	Mark
15(a)(ii)	Mass of Cu = $6.48 \times 10^{-4} \times 63.5$		1
	= 0.041148 / 4.1148 x 10 <sup>-2</sup> (g)		
	$= 0.041 / 4.1 \times 10^{-2} (g)$		
	Answer must be to 2 SF		
	TE on (a)(i) x $63.5$ and answer to 2 SF		

Question Number	Acceptable Answers	Reject	Mark
15(b)	First two marks are stand alone		5
	In 0.500g		
	Mass of water = $0.07(0)$		
	AND		
	Moles of water = $\frac{0.07(0)}{18}$		
	$= 0.0038889 \text{ (mol)} / 3.8889 \text{ x } 10^{-3} \text{ (mol)} $ (1)		
	n = $\frac{\text{moles of water}}{\text{moles of Cu}^{2+}}$		
	$= \frac{0.0038889}{6.48 \times 10^{-4}} = 6(.0014) $ (1)		
	Method 1		
	moles of sulfate = $2 \times \text{moles of } \text{Cu}^{2+}$		
	= 0.001296 / 1.296 x 10 <sup>-3</sup> (mol)		
	Mass of sulfate = moles of sulfate $x$ 96.1		
	= 0.12455 (g) (1)		
	Mass of $M = 0.500 - mass$ of copper - mass of sulfate - mass of water		
	= 0.500 - 0.12455 - 0.070 - 0.041148		
	= 0.26430 (g) (1)		
	Atomic mass of $M = \frac{mass of M}{moles of M}$		
	$= \frac{0.264}{2 \times 6.48 \times 10^{-4}} = 203.94$		
	So compound is $Tl_2Cu(SO_4)_2.6H_2O$ (1)		
	Method 2		

mol compound =	= mol Cu = 6.48 x 10 <sup>-4</sup>		
AND			
<i>M</i> <sub>r</sub> of compound	= 0.5 ÷ 6.48 x 10 <sup>-4</sup> = 771.6 (g mol <sup>-1</sup> )		
<i>M</i> <sub>r</sub> anhydrous	= 771.6 - (6 x 18) = 663.6 (g mol <sup>-1</sup> )	(1)	
<i>M</i> r Cu(SO₄)₂	= 63.5 + 96.1 x 2 = 255.7 (g mol <sup>-1</sup> )	(1)	
2 x Ar(M) = 66 Ar(M) = 203.95	3.6 - 255.7 = 407.9 (g mol <sup>-1</sup> )		
Therefore			
$TI_2Cu(SO_4)_2.6H_2C$	0	(1)	
Method 3			
mol compound =	= mol Cu = 6.48 x 10 <sup>-4</sup>	(mol)	
AND			
Mass of anhydro	us compound = 0.500 = 0.43 (	– 0.70 g)	
<i>M</i> <sub>r</sub> of anhyd. con	$pound = 0.43 \div 6.48 \\= 663.6 (g mol)$	x 10 <sup>-4</sup> <sup>1</sup> ) (1)	
<i>M</i> r Cu(SO₄)₂	= 63.5 + 96.1 x 2 = 255.7	(1)	
2 x Ar(M) = 66 Ar(M) = 203.95	3.6 - 255.7 = 407.9		
Therefore			
$TI_2Cu(SO_4)_2.6H_2C$	0	(1)	
Other methods r	nay be possible.		
ALLOW TE on 15 copper where ap	(a)(ii) for mass and mo propriate.	oles of	
Correct answer v scores 5.	with some correct work	ing	

(Total for Question 15 = 8 marks)

Question Number	Acceptable Answers	Reject	Mark
16(a)(i)	(2-)aminobutan(e)dioic acid (2-)aminobutan(e)-1,4-dioic acid	Answers with dibutan(e) in the name e.g.	1
(2-)aminebutan(e)dioic acid acid	acid		
	(2-)aminebutan(e)-1,4-dioic acid		
	IGNORE Punctuation marks (e.g. hyphens, commas, full stops etc) in either version of the answer so for example 2 aminobutandioic acid would score.		

Question Number	Acceptable Answers	Reject	Mark
16(a)(ii)		Neutral structure Single negative ion	1
	ALLOW		
	Structural formulae / displayed formulae e.g.		
	<sup>-</sup> OOCCH <sub>2</sub> CHNH <sub>2</sub> COO <sup>-</sup>		

		Reject	Mark
Number			
Number 16(a)(iii)	Diagram (1) $\downarrow \downarrow $		2
	Phenylalanine molecules are held to each other by ionic bonds / strong electrostatic attractions between oppositely charged ions (so high melting temperature) / held in (giant) ionic lattice (1) IGNORE Strong electrostatic attractions between molecules without mention of ionic bonds or between oppositely charged ions Reference to hydrogen bonds	Internal ionic bonds specifically mentioned but assume intermolecular if not specific.	
-			

Question	Acceptable Answers	Reject	Mark
Number			
16(b)(i)	Methanol / CH <sub>3</sub> OH		1

Question	Acceptable Answers	Reject	Mark
<u>Number</u> 16(b)(ii)	Put spots of the amino acid mixture /         hydrolysis products (and known amino         acids)         AND         on a tlc plate / filter paper /         chromatography paper         AND         in a (suitable) solvent / run with a (suitable)         solvent         ALLOW         Labelled diagram         visible)         ALLOW         Iodine vapour in place of ninhydrin         ALLOW         Iodine vapour in place of ninhydrin	Just already separated amino acids Amino acids dissolved in mobile phase solvent just 'paper' Ni as an abbreviation	3
	Compare distance travelled of mixture components with known amino acids OR Compare R <sub>f</sub> / formula of R <sub>f</sub> / description of	Just 'compare with data book values' Just 'Calculate R <sub>f</sub>	
	$R_f$ with data book values (1)	values'	

Question Number	Acceptable Answers	Reject	Mark
16(b)(iii)	Heat causes hydrolysis OR	Just `cooking' without `heat'	1
	Amino acids are not sweet ALLOW Decomposition / breakdown / unstable on		
	heating IGNORE Methanol is toxic Changes to flavour without mention of	Decomposition / breakdown / unstable without heat	
	sweetness		

(Total for Question 16 = 10 marks) (Total for Section B = 50 marks)

#### Section C

Question Number	Acceptable Answers	Reject	Mark
17(a)	Two calculations which must be accompanied by a correct statement about toxicity. Several approaches are possible. e.g.		2
	Mass of CO released = $0.35 \times 28 = 9.8$ (g) (1)		
	Mass per $m^3 = \frac{9.8}{200} = 0.049 (g) / 49 (mg)$		
	Which is greater than the toxicity limit (1)		
	OR		
	Max. mass = $43.2 \times 200 = 8640(mg)$ (1)		
	Maximum moles allowed = $\frac{8640}{1000 \times 28}$		
	= 0.30857143		
	Which is less than was released (so not within the limits) (1)		
	OR		
	Max. moles per m <sup>3</sup> = $\frac{43.2 \times 10^{-3}}{28}$		
	$= 0.0015429 / 1.5429 \times 10^{-3} \text{ (mol)} / 1.5429 \text{ (mmol)} $ (1)		
	Moles per m <sup>3</sup> released = $\frac{0.35}{200}$ = 0.00175 (mol)		
	Which is more that the toxicity limit (1)		
	OR		
	Moles per m <sup>3</sup> released = $\frac{0.35}{200}$ = 0.00175 (mol) (1)		
	Mass per $m^3$ released = 0.00175 x 28 = 0.049 (g) / 4.9 x $10^{-2}$ (g) / 49 (mg)		
	Which is more than the toxicity limit (1)		
	ALLOW TE only on a suitable attempt at a calculation of mass or moles in M1		
	Other approaches may be possible		

Question	Acceptable Answers	Reject	Mark
17(b)(i)	If the name of a shape is given award M1 for the name if correct. Do not negate with and incorrect diagram.		2
	Trigonal bipyramid(al)	Square based	
	ALLOW	pyramius	
	Pyramidal / bipyramidal if a correct diagram is given	Just `pyramidal' or `bipyramidal'	
	ALLOW		
	If no name is given, a three dimensional diagram showing three bonds in plane (straight lines) and two bonds out of plane, either a wedge and dots (which may also be wedged, but ignore the direction of this wedge) or two oppositely directed wedges (one fat at Fe and another fat at CO) (1)		
	OC Fe CO CO CO CO CO CO CO CO CO CO	Any additional angles which are labelled incorrectly but not the correct 180°	
	ALLOW	angle	
	If no other mark has been scored, a diagram with no dots and wedges which has at least one correct 90° and one correct 120° angle scores (1)		
	IGNORE		
	Point of attachment of CO to Fe		

Question Number	Acceptable Answers	Reject	Mark
17(b)(ii)	Fe C X O X		2
	Dative covalent bond from C to Fe AND lone pair on O (1)		
	Triple bond between C and O with one dative covalent bond. (1)		
	ALLOW		
	Crosses for carbon and dots for oxygen		
	Dative covalent bond to Fe, double bond between C and O and two lone pairs on O scores (1)		
	IGNORE		
	Circles for electron shells / lines as well as dots and crosses to show bonds / lone pairs on the Fe		

Question Number	Acceptable Answers	Reject	Mark
17(c)(i)	Moles of CO = $\frac{4.8}{24}$ = 0.2 moles (1)		3
	Mass of CO = $0.2 \times 28 = 5.6 \text{ g}$		
	AND		
	Mass of $Mn = 7.8 - 5.6 g = 2.2$ (1)		
	Moles of Mn = $\frac{2.2}{54.9}$ = 0.04007286		
	Ratio is $0.04 : 0.2$ 1 : 5 (So Mn(CO) <sub>5</sub> ) (1)		
	If Ar Mg used instead (24 / 24.3) final answer		
	0.091667 : 0.2 / 0.090535 : 0.2		
	or 1:2 can score M1 and M2.		
	ALLOW		
	TE for incorrect mass of manganese in M2 for ratio M3.		

Question Number	Acceptable Answers	Reject	Mark
17(c)(ii)	Empirical formula mass = 194.9		2
	$390 = 2 \times 194.9$ so molecular formula = Mn <sub>2</sub> (CO) <sub>10</sub>		
	ALLOW		
	Just $Mn_2(CO)_{10}$ without working or a structure with 2Mn and 10CO (1)		
	$OC \longrightarrow Mn \longrightarrow CO$		
	ALLOW		
	Any sensible structure of two Mn and ten CO covalently bonded at any angle to each other		
	IGNORE		
	Connectivity of the CO group		
	Use of M / Mg as a slip if structure is correct		

Question Number	Acceptable Answers		Reject	Mark
17(d)(i)	Sulfuric acid is a catalyst (	(1)		2
	IGNORE			
	Sulfuric acid / $H^+$ is an electrophile			
	<b>Hydrogen ion</b> (reacts with 2- methylpropene and) is regenerated at the end / in the last step of the reaction / takes part in the reaction but is still present at the end (	he:	Just 'sulfuric acid is chemically unchanged after the reaction' 'Not participating in the overall reaction'	
	M2 dependent on M1.			

Question Number	Acceptable Answers	Reject	Mark
17d(ii)	H <sub>3</sub> C H <sub>3</sub> C CH <sub>3</sub> Lone pair of electrons on C (1) Arrow from a lone pair on the C of CO to C or to + on C of correct organic cation	CO.	2
	Arrow from the C of CO to C or the + on C of correct organic cation if the first mark has not been scored Arrow from a lone pair on O of CO to C or the + on C of correct organic cation if the first mark has not been scored (1) IGNORE Number bonds between C and O in carbon monoxide. Product, even if incorrect Mark independently	From CO <sup>-</sup>	

Question Number	Acceptable Answers	Reject	Mark
17(d)(iii)	Sulfuric acid is corrosive	Just cost	1
	OR		
	Difficult to recover the sulfuric acid		
	IGNORE		
	Irritant Burns skin / toxic / discussion of yield		

Question Number	Acceptable Answers	Reject	Mark
17(e)	The (two) reactants are / carbon monoxide is adsorbed onto the surface / active sites of the catalyst (1) The activation energy for the reaction is lowered / bonds are weakened in the reactant molecules (1) The products are desorbed from / diffuse from / leave the catalyst (1)	absorbed	3

(Total for Question 17 = 20 marks) (Total for Section C = 20 marks) Total for Paper = 90 marks

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