Pearson Edexcel

Mark Scheme (Results)

June 2024

Pearson Edexcel International Advanced Level in Chemistry (WCH15) Paper 01
Transition Metals and Organic Nitrogen Chemistry

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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.

Section A (Multiple Choice)

Question number	Answer	Mark
1	**The only correct answer is B** (green) ***A*** *is incorrect because this is the colour of vanadium(IV)* ***C*** *is incorrect because this is the colour of vanadium(II)* ***D*** *is incorrect because this is the colour of vanadium(V)*	**(1)**

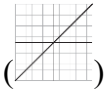
Question number	Answer	Mark
2	**The only correct answer is C** ($SO_2 \rightarrow SO_3$, $+5 \rightarrow +4 \rightarrow +5$) ***A*** *is incorrect because this is not the step catalysed* ***B*** *is incorrect because the vanadium is reduced* ***D*** *is incorrect because this is not the step catalysed and the vanadium is reduced*	**(1)**

Question number	Answer	Mark
3(a)	**The only correct answer is A** (II → III, VII → II) ***B*** *is incorrect because the final oxidation number for manganese is incorrect* ***C*** *is incorrect because the iron is oxidised and the manganese is reduced* ***D*** *is incorrect because the iron is oxidised and the initial and final oxidation numbers of manganese are incorrect*	**(1)**

Question number	Answer	Mark
3(b)	**The only correct answer is C** ($0.450\ mol\ dm^{-3}$) ***A*** *is incorrect because this is the number of moles of* $FeSO_4$ *in 25* cm^3 ***B*** *is incorrect because this is the concentration of manganate(VII) ions* ***D*** *is incorrect because this is the ratio of the two volumes*	**(1)**

Question number	Answer	Mark
4	**The only correct answer is B** (2.72 V) ***A*** *is incorrect because this is 0.5% lower than the cell potential* *C* *is incorrect because this is 1% higher than the cell potential* ***D*** *is incorrect because this 5% higher than the cell potential*	**(1)**

Question number	Answer	Mark
5	**The only correct answer is A** ($Zn(s) \mid Zn^{2+}(aq) \parallel Ni^{2+}(aq) \mid Ni(s)$) ***B*** *is incorrect because the solid electrodes must be on the ends of the diagram* ***C*** *is incorrect because oxidation should be on the left* ***D*** *is incorrect because the solid electrodes must be on the ends of the diagram and oxidation should be on the left*	**(1)**

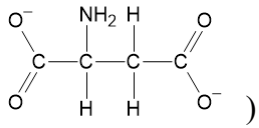
Question number	Answer	Mark
6	**The only correct answer is A** () ***B*** *is incorrect as this shows a negatively proportional relationship* ***C*** *is incorrect as this shows a curve* ***D*** *is incorrect as this line is not directly proportional*	**(1)**

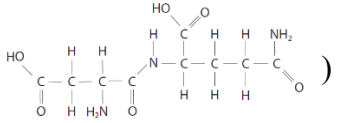
Question number	Answer	Mark
7	**The only correct answer is B** (mass spectrometry) ***A*** *is incorrect as infrared data provide evidence for benzene's structure* ***C*** *is incorrect as thermochemical data provide evidence for benzene's structure and stability* ***D*** *is incorrect as X-ray diffraction data provide evidence for benzene's structure*	**(1)**

Question number	Answer	Mark
8	**The only correct answer is B** ($HNO_3 + 2H_2SO_4 \rightarrow NO_2^+ + 2HSO_4^- + H_3O^+$) ***A*** *is incorrect because the reaction system is too acidic for the sulfate ion to be formed* ***C*** *is incorrect because no NO_3^+ ion is formed* ***D*** *is incorrect because hydroxide ion cannot exist in a strongly acidic solution*	**(1)**

Question number	Answer	Mark
9(a)	**The only correct answer is B** (57.7%) ***A*** *is incorrect because this is the percentage atom economy of HBr* ***C*** *is incorrect because this is the percentage of the mass of 2,4,6-tribromophenol compared to 3 bromine molecules* ***D*** *is incorrect because the HBr is included as a useful product*	**(1)**

Question number	Answer	Mark
9(b)	**The only correct answer is B** (13.5 g) ***A*** *is incorrect because this is 76.8% of 5.00 g* ***C*** *is incorrect because this is the value for a 100% yield* ***D*** *is incorrect because the value has been divided by 76.8 instead of multiplying*	**(1)**

Question number	Answer	Mark
10(a)	**The only correct answer is C (**  **)** ***A*** *is incorrect because this is the zwitterion* ***B*** *is incorrect because only one acid group has dissociated* ***D*** *is incorrect because the amino acid is fully protonated*	**(1)**

Question number	Answer	Mark
10(b)(i)	**The only correct answer is D (**  **)** ***A*** *is incorrect because the peptide link is not on either α-carbon atom* ***B*** *is incorrect because there is no aspartic acid monomer* ***C*** *is incorrect because the peptide link is not on the glutamine α-carbon*	**(1)**

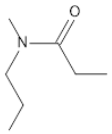
Question number	Answer	Mark
10(b)(ii)	**The only correct answer is C** (2) ***A*** *is incorrect because there are two chiral centres on each* ***B*** *is incorrect because there are two chiral centres on each* ***D*** *is incorrect because there are two chiral centres on each*	**(1)**

Question number	Answer	Mark
11(a)	**The only correct answer is D** (mineral oil) ***A*** *is incorrect because the boiling temperature of water is below the melting temperature of aspirin* ***B*** *is incorrect because the boiling temperature of ethanol is below the melting temperature of aspirin* ***C*** *is incorrect because the boiling temperature of hexane is below the melting temperature of aspirin*	**(1)**

Question number	Answer	Mark
11(b)	**The only correct answer is D** (2-hydroxybenzoic acid) ***A*** *is incorrect because ethanoic acid is soluble in water and won't crystallise* ***B*** *is incorrect because ethanoic anhydride is hydrolysed by water and won't crystallise* ***C*** *is incorrect because ethanol is soluble in water and won't crystallise*	**(1)**

Question number	Answer	Mark
12(a)	**The only correct answer is C** (magnesium) ***A*** *is incorrect because the metal used is magnesium* ***B*** *is incorrect because the metal used is magnesium* ***D*** *is incorrect because the metal used is magnesium*	**(1)**

Question number	Answer	Mark
12(b)	***The only correct answer is C*** *(*nucleophile*)* ***A*** *is incorrect because it is not a redox reaction* ***B*** *is incorrect because it is not a redox reaction* ***D*** *is incorrect because the reagent acts as a nucleophile*	**(1)**

Question number	Answer	Mark
13(a)	 ***The only correct answer is D*** ( ) ***A*** *is incorrect because the methyl group is in the wrong location on the amine* ***B*** *is incorrect because the acyl chloride is not propanoyl chloride and the methyl group is in the wrong location on the amine* ***C*** *is incorrect because this would be formed with ethanoyl chloride and the amine has an extra methyl group*	**(1)**

Question number	Answer	Mark
13(b)	***The only correct answer is A*** *(*12.0 dm^3*)* ***B*** *is incorrect because the value of the M_r is calculated incorrectly (127)* ***C*** *is incorrect because the value of 2 moles of HCl are produced* ***D*** *is incorrect because this value is 10 times too large*	**(1)**

Total for Section A = 20 marks

Section B

Question number	Answer	Additional guidance	Mark
14(a)(i)	• reduction	Ignore redox / equilibrium Ignore standard electrode potential Ignore gain/loss of electrons	1

Question number	Answer	Additional guidance	Mark
14(a)(ii)	• electrochemical (series)	Allow reduction potential (series) Allow standard electrode potential (series) Ignore galvanic Ignore reactivity	1

Question number	Answer	Additional guidance	Mark
14(b)(i)	• platinum / Pt (1) • 1 mol dm^{-3} Cr^{2+} **and** 1 mol dm^{-3} Cr^{3+} (1)	Accept platinised platinum / platinum black Allow 1 mol dm^{-3} named soluble chromium(II) salts Allow named soluble chromium(III) salts giving 1 mol dm^{-3} Cr^{3+} solution Allow 1 mol dm^{-3} Cr^{2+} and Cr^{3+} Ignore equimolar	2

Question number	Answer	Additional guidance	Mark
14(b)(ii)	An answer that makes reference to two from the following: • the Cr(II) is (rapidly) oxidised (by oxygen in the air) (1) • the temperature may not be standard (298K) (1)	Allow the resistance in the circuit/voltmeter/wires may be too low Allow there may be oxidation products on the electrodes Allow the salt bridge may not be fully saturated Ignore takes time for equilibrium to be established Ignore impurities If no other mark is awarded allow other examples of non-standard conditions for 1 mark only	**2**

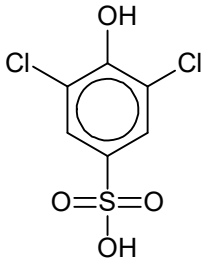
Question number	Answer	Additional guidance	Mark
14(b)(iii)	An explanation that makes reference to the following points: • the (concentration of) Cr^{2+} decreases / Cr^{3+} increases (1) • because E_{cell} is positive / +0.41 V (1)	Allow the blue-green colour becomes green(er) Allow correct half equation of oxidation Allow Cr^{2+} oxidises/changes to Cr^{3+} Ignore colours if concentration is discussed Ignore equilibrium shifts to the left alone Ignore comments relating to salt bridge	**2**

Question number	Answer	Additional guidance	Mark
14(c)(i)	Answer that includes the following: (5, 8, 21, 28) • zinc converts dichromate(VI) ions to chromium(III) ions with an $E^{\ominus}_{cell}$ value of +2.09 V (1) • and then to chromium(II) ions with an $E^{\ominus}_{cell}$ value of +0.35 V (1) • iron(II) converts dichromate(VI) ions to chromium(III) ions with an $E^{\ominus}_{cell}$ value of +0.56 V (1) • but not to chromium(II) ions as $E^{\ominus}_{cell}$ value is −1.18 V which is negative (1)	If no other mark is awarded allow one mark for the four numbers in any order 5, 8, 21, 28 or values −0.76 V, −0.41V, +0.77 V and +1.33 V Accept equations in place of descriptions Allow positive numbers without + sign No TE on incorrect equations being used	**4**

Question number	Answer	Additional guidance	Mark
14(c)(ii)	Answer that includes the following: • acidified solution	Allow acid / H^+ / H_3O^+ / named acid Allow acid catalyst Ignore standard conditions Ignore cell components e.g. salt bridge Ignore equations without ions highlighted	**1**

(Total for Question 14 = 13 marks)

Question number	Answer	Additional guidance	Mark
15(a)(i)	Answer that makes reference to the following point: • (concentrated) sulfuric acid / H_2SO_4	Accept fuming sulfuric acid / sulfuric acid and SO_3 Allow oleum / $H_2S_2O_7$ Ignore HSO_3 / H_2SO_3 Ignore SO_2 Ignore conditions Do not award dilute sulfuric acid /H_2SO_4(aq) Do not award nitric acid / HNO_3 Do not award hydrochloric acid / HCl	**1**

Question number	Answer	Additional guidance	Mark
15(a)(ii)	Answer that makes reference to the following point: • correct structure	 Allow SO_3H (any order) attached to the ring via sulfur atom Ignore connectivity of phenol OH	**1**

Question number	Answer	Additional guidance	Mark
15(a)(iii)	An explanation that makes reference to the following points: • **lone pair** of electrons on the oxygen (1) • overlap/interact with the (π) electrons on the ring **and** increasing its electron density (1) • so (phenol) is more susceptible to **electrophilic** attack (1)	 Allow lone pair of electrons on the OH Allow plurals Allow lone pair on O^- Allow (lone pair) donated to the (π) electrons of the ring Allow are incorporated into the ring Do not award charge density Allow ring becomes more electron rich Allow "phenol is more attractive to electrophiles" Ignore increasing the reactivity of the ring Ignore reference to phenol being a nucleophile	**3**

Question number	Answer	Additional guidance	Mark
15(b)	• ester	Accept ester bond / ester linkage /ester group	**1**

Question number	Answer	Additional guidance	Mark
15(c)	An answer that makes reference to three of the following points: • number of steps in each reaction sequence • purification required (after each step) • availability/cost of reagents/catalysts • toxicity of reagents/intermediates/by-products • atom economy (of the product) • (%) yield of each step • side reactions • carbon dioxide emissions • consideration of reaction conditions	Allow separation of mixtures Allow hazardous reagents/intermediates/by-products Accept yield of (final) product Allow formation of byproducts Allow emissions of greenhouse gases Allow (total) energy required Allow cost of (reaction) conditions Allow high pressures/temperatures Ignore unjustified costs/pollution/safety/yield/efficiency Ignore rates of reaction/time	**3**

Question number	Answer	Additional guidance	Mark
15(d)(i)	An explanation that makes reference to the following points: • (the molecule contains two atoms of chlorine so) a 9:6:1 ratio is seen (1) • because peak at 162 contains two ^{35}Cl isotopes, peak at 164 contains one ^{35}Cl and one ^{37}Cl, and peak at 166 contains two ^{37}Cl isotopes (1)	Allow ^{35}Cl: ^{37}Cl ratio is 3:1 Allow Cl^{35} is more abundant than Cl^{37} Allow three isotope combinations without m/z values	**2**

Question number	Answer	Additional guidance	Mark
15(d)(ii)	An answer that makes reference to the following point: • (the presence of 1 atom of a) carbon-13 isotope	Allow the presence of (1 atom of) a hydrogen-2 isotope / deuterium Ignore M+1 / n+1 peaks	**1**

(Total for Question 15 = 12 marks)

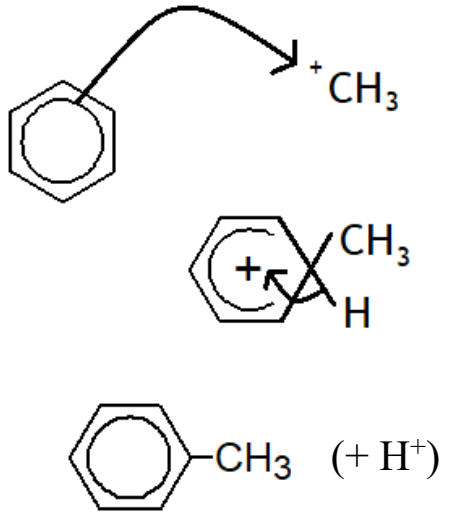
Question number	Answer	Additional guidance	Mark
16(a)	An answer that makes reference to the following points: • correct species (1) • balanced **and** state symbols (1)	An example of an equation $[Fe(H_2O)_6]^{3+}(aq) + 3OH^-(aq) \rightarrow [Fe(OH)_3(H_2O)_3](s) + 3H_2O(l)$ Allow $Fe(OH)_3(s) + 6H_2O(l)$ Allow sodium carbonate $2[Fe(H_2O)_6]^{3+}(aq) + 3CO_3^{2-}(aq) \rightarrow Fe_2(CO_3)_3(s) + 12H_2O(l)$ Allow ammonia $[Fe(H_2O)_6]^{3+}(aq) + 3NH_3(aq) \rightarrow [Fe(OH)_3(H_2O)_3](s) + 3NH_4^+(aq)$ Allow uncancelled cations Allow NaOH on LHS with Na^+ on RHS Square brackets are not required on the RHS	**2**

Question number	Answer	Additional guidance	Mark
16(b)(i)	An answer that makes reference to the following points: • 2+ / +2 (1) • bidentate (1) • 6 **and** octahedral (1)	Ignore 2 Do not award didentate Ignore multidentate	**3**

Question number	Answer	Additional guidance	Mark
16(b)(ii)	An explanation that makes reference to: • equation (1) • ΔS_{system} increases as there are more particles (4 to 7) (1)	$[Ni(H_2O)_6]^{2+} + 3(CH_3)_2NCS_2^- \rightarrow [Ni((CH_3)_2NCS_2)_3]^- + 6H_2O$ Allow Na^+ as a spectator ion in a balanced equation Ignore state symbols even if is incorrect Ignore extra charges on ligands in the complex Allow S/entropy increases as there are more moles Ignore "more products than reactants" Do not award more molecules TE on incorrect numbers in equation with entropy increasing Marks are independent	2

Question number	Answer	Additional guidance	Mark
16(b)(iii)	An answer that includes: • calculation of relative formula mass of precipitate (1) • calculation of mass in grams in 1 dm^3 (1) • calculation of concentration (1)	<u>Example of a calculation</u>: $58.7 + 3(120.2) + 1 = 420.3$ $245 \div 1000 \div 5 = 0.049$ / 4.9×10^{-2} (g dm^{-3}) $0.049 \div 420.3 = 0.000117$ / 1.17×10^{-4} (mol dm^{-3}) TE throughout Alternative M2 and M3: $245 \div 1000 \div 420.3 = 0.000583$ / 5.83×10^{-4} (mol) $5.83 \times 10^{-4} \div 5 = 0.000117$ / 1.17×10^{-4} (mol dm^{-3}) Ignore SF except 1SF Correct answer with some working scores 3	**3**

(Total for Question 16 = 10 marks)

Question number	Answer	Additional guidance	Mark
17(a)	An answer that makes reference to the following points:	An example of a mechanism:  	**3**
	• curly arrow from, on or within circle to C of CH_3^+ (1)	Allow from within the hexagon Allow halogen carrier with $CH_3^{\delta+}$	
	• structure of intermediate ion including charge with horseshoe covering at least 3 carbon atoms **and** facing the tetrahedral carbon **and** with some part of the positive charge within the horseshoe (1)	TE from M1 on incorrect electrophile	
	• curly arrow from C–H bond to anywhere in the ring reforming the delocalised structure **and** correct organic product (1)	Accept skeletal structure	

Question number	Answer	Additional guidance	Mark
17(b)	An explanation that makes reference to the following points: • this reaction produces (a pair of) enantiomers / a racemic mixture / racemate (1) • the molecule is planar around the C=N bond (1) • the CN^-/nucleophile can attack from either side / both sides / above or below (the double bond) (1)	Allow optical(ly active) isomers Allow "molecules that are (non-superimposable) mirror images" Do not award optically active solution Ignore "different" isomers Ignore chiral carbon Allow planar around reaction site Allow (trigonal) planar around the $^{\delta+}C$ Do not award "planar carbocation" Ignore left and right Marks are independent	**3**

Question number	Answer	Additional guidance	Mark
17(c)	An answer that makes reference to the following points: • hydrolysis (1) • aqueous acid solution / $H^+(aq)$ (1) • reflux (1)	Ignore modifiers Allow specific aqueous named strong acids or formulae Allow aqueous alkali solution followed by neutralisation with acid Do not award concentrated acid Further reagents negate M2 Allow heat M3 dependent on M1 or M2	**3**

(Total for Question 17 = 9 marks)

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr>
<td>*18</td>
<td>This question assesses the student's ability to show a coherent and logically structured answer with linkages and fully sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.

The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning
<table>
<tr><th></th><th>Number of marks awarded for structure of answer and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent logical structure with linkages and fully sustained lines of reasoning demonstrated throughout</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured</td><td>0</td></tr>
</table>
</td>
<td>Guidance on how the mark scheme should be applied.

The mark for indicative content should be added to the mark for lines of reasoning. For example, a response with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there were no linkages between the points, then the same indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.

If there is any incorrect chemistry for example electrons moving through the cell, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).

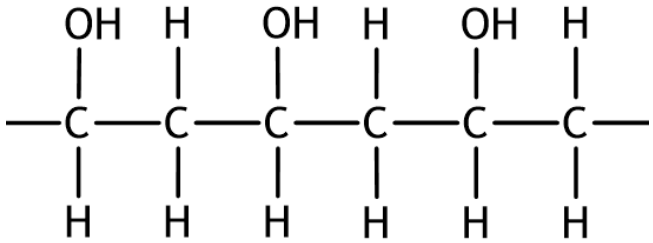
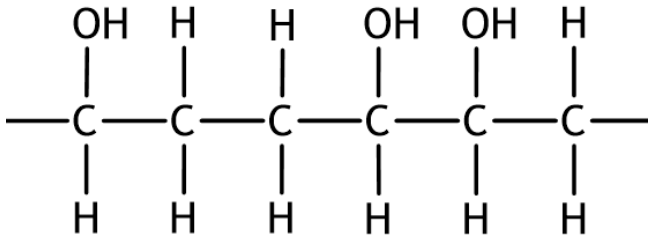
Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning</td>
<td>6</td>
</tr>
</table>

	Indicative content IP1 Fuel cells use the energy released on the reaction of a fuel /hydrogen with oxygen to generate a voltage IP2 (In an acid-based cell the hydrogen fuel loses electrons at the) anode / negative electrode **and** $H_2(g) \rightleftharpoons 2H^+(aq) + 2e^-$ IP3 (hydrogen ions move through the electrolyte where they combine with oxygen at the) cathode / positive electrode **and** $O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l/g)$ IP4 only water produced whereas CO_2 is produced in an internal combustion engine (advantage of fuel cells) IP5 production/transport/storage of hydrogen is difficult (disadvantage of fuel cells) IP6 Example of another fuel e.g. methanol (as it is hydrogen rich)	Allow "reaction releases energy as a flow of electrons" Allow "make electricity from a redox reaction" Allow generate an EMF due to potential difference in electrodes Accept multiples Allow non-reversible equations Ignore omission of state symbols Accept multiples Allow non-reversible equations Ignore omission of state symbols Allow IP3 if two correct equations without anode or cathode or electrodes the wrong way around. Allow water is not a pollutant Allow no CO_2 / greenhouse gases produced Allow more efficient (than combustion of fuels) Allow hydrogen is a renewable fuel Ignore "no pollution" alone Accept hydrogen explosive Accept fuels need to be in constant supply Allow most hydrogen produced from methane/ requires burning fossil fuels Allow limited infrastructure/filling stations Ignore expensive Allow methane/ethanol/methanol	

(Total for Question 18 = 6 marks)
Total for Section B = 50 marks

Section C

Question number	Answer	Additional guidance	Mark
19(a)	• one correct tick	Example of a correct answer:  Allow harmful/irritant or any other indication in the second box only	**1**

Question number	Answer	Additional guidance	Mark
19(b)(i)	An answer that makes reference to the following points: • six C in chain and correct side chains (1) • extension / trailing bonds (M2 dependent on M1 or a near-miss) (1)	Examples of a correct answer:   Accept OHs shown on either side of the carbon chain Allow skeletal structures only when drawn with brackets Ignore brackets in displayed structures Ignore subscripts after brackets Ignore connectivity Ignore structure of ethenol as working	**2**

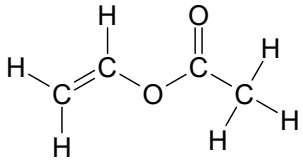
Question number	Answer	Additional guidance	Mark
19(b)(ii)	An answer that makes reference to the following points: • mass of OH groups **and** mass of whole polymer section (1) • percentage calculation (1)	Example of a correct answer: 51 and 132 Allow 17 and 44 38.6% / 39% TE on 19bi Ignore SF except 1 SF Correct answer with some working scores (2)	**2**

Question number	Answer	Additional guidance	Mark
19(b)(iii)	An explanation that makes reference to the following points: • (the OH groups in poly(ethenol)) can form hydrogen bonds with water (1) • poly(ethenol) has high percentage of OH groups so soluble (1)	Ignore references to how hydrogen bond form Allow hydroxyl / alcohol Allow a large number of OH group Allow (over) a third of the mass is OH groups Ignore “it has 3 OH groups” alone Ignore quoted % from (b)(ii) alone Do not award OH molecules	**2**

Question number	Answer	Additional guidance	Mark
19(c)(i)	• propane−1,2,3−triol	Allow propan−1,2,3−triol Allow 1,2,3-propan(e)triol Ignore errors in commas and dashes Do not award 1,2,3-trihydroxypropane	1

Question number	Answer	Additional guidance	Mark
19(c)(ii)	An answer that suggests: • improves (the polymer's) flexibility/fluidity/durability/plasticity	Allow increases strength/elasticity Ignore references to time Do not award increases solubility	1

Question number	Answer	Additional guidance	Mark
19(c)(iii)	• volume of polymer (1) • 0.11% of polymer (1) • mass of glycerol (1) • moles of glycerol (1)	<u>Example of a calculation:</u> 1 000 000 ÷ 1.19 = 840 340 (cm^3) / 8.4034 × 10^5 (cm^3) (0.11 ÷ 100) × 840 336.134 = 924.37 (cm^3) 924.369 × 1.26 = 1 164.7 (g) 1 164.7 ÷ 92 = 12.660 / 12.66 / 12.7 / 13.0 (mol) Ignore SF except 1SF Marks can be awarded in any order, TE throughout Correct answer scores 4	**4**

Question number	Answer	Additional guidance	Mark
19(d)	An answer that makes reference to the following points:	Example of calculation:	**5**
	• calculation of atoms of carbon per molecule (1)	95.6 ÷ 24 = 3.98 so **4** moles CO_2 (per mole of molecules) / **4** carbon atoms per molecule	
	• calculation of atoms of hydrogen (1)	54.1 ÷ 18 = 3.005 moles of water so (×2) = **6** hydrogen atoms per molecule	
	• identification of C=O bond peak with range/value **or** identification of a functional group with its range (1)	(Peak P (1735 cm^{-1})) Allow any number(s) in the range 1760 – 1700 cm^{-1}, functional groups can be ignored (aldehyde) 1740 – 1720 cm^{-1}, (ester) 1750 – 1735 cm^{-1}, (ketones) 1720 – 1700 cm^{-1} Accept absorbances labelled on spectrum	
	• identification of C=C bond peak with its range/value **or** alkene with its range (1)	Peak Q (1645 cm^{-1}) is in the range 1669 – 1645 Accept absorbances labelled on spectrum Allow numbers outside the range if identified as alkyl C=C If no correct ranges or wavelengths are given then 1 mark can be scored for the identification of both bonds.	
	• correct displayed structure (1)	 Allow any compound with 4 carbons and 6 hydrogens and at least one C=O. This does not have to match previous conclusions except: If C=O is not identified then butadiene could score M5 as a TE Do not award acid structures Do not award structures that omit a C=C bond Ignore names even if incorrect	

Question number	Answer	Additional guidance	Mark
19(e)	An answer that makes reference to the following points: • no risk of cross-contamination (1) • no need to wash (and dry) bags (1)	Allow laundry does not need to be handled Allow more hygienic Allow bags will not need to be disinfected Allow comment on conserved energy as bags are not washed (and dried) Ignore biodegradable Ignore references to time Ignore comments on disposal, cost and speed of manufacture	**2**

(Total for Question 19 = 20 marks)

Total for Section C = 20 marks
TOTAL FOR PAPER = 90 MARKS

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