Mark Scheme (Results)

January 2017

Pearson Edexcel
International Advanced Subsidiary Level
in Chemistry (WCH02)
Paper 01 Application of Core Principles of
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.
- 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 <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

Question Number	Correct Answer	Mark
1	A – This is a displacement reaction and not a disproportionation reaction B – This is a redox reaction but not a disproportionation reaction C –This is a redox reaction but not a disproportionation reaction **D – This is the correct answer**	1

Question Number	Correct Answer	Mark
2	A – Both species have the same bond angles as they are both v-shaped B – Both species have the same bond angles as both are tetrahedral **C – This is the correct answer** D – Both species have the same bond angles as both are linear	1

Question Number	Correct Answer	Mark
3	A - Infrared radiation does not break bonds **B – This is the correct answer** C - Ultraviolet radiation does break bonds but this is not responsible for global warming D - Ultraviolet radiation does not cause bond vibration but this is also not responsible for global warming	1

Question Number	Correct Answer	Mark
4(a)	A - This is a termination reaction **B – This is the correct answer** C - This is a propagation reaction D - This is a propagation reaction	1

Question Number	Correct Answer	Mark
4(b)	**A - This is the correct answer** B - Chlorine is catalysing and not inhibiting C - The 'best' description is catalyst rather than initiator because the chlorine is regenerated and is a product of the initiation reaction. D - Chlorine is not in any termination reaction	1

Question Number	Correct Answer	Mark
4(c)	A - This is a propagation reaction and not a termination reaction B - This is a propagation reaction and not a termination reaction **C – This is the correct answer** D - This is a propagation reaction and not a termination reaction	1

Question Number	Correct Answer	Mark
5	A – Bromine does not have permanent dipoles B – This is a statement and not an explanation C – This question is about intermolecular forces and not the strength of covalent bonds **D – This is the correct answer**	1

Question Number	Correct Answer	Mark
6	A – This molecule only has a chain length of 4 carbons and so has less London forces resulting in a lower boiling temperature B – Branching reduces the boiling temperature C - Branching reduces the boiling temperature **D – This is the correct answer**	1

Question Number	Correct Answer	Mark
7	A – Bond length is from nuclei to nuclei and not to outermost electrons **B – This is the correct answer** C - Bond length is from nuclei to nuclei and not to outermost electrons D - Bond length is from nuclei to nuclei and not to outermost electrons	1

Question Number	Correct Answer	Mark
8	A – Catalysts do increase reaction rate B – Increased concentration does increase reaction rate **C – This is the correct answer** D - Increased temperature does increase reaction rate	1

Question Number	Correct Answer	Mark
9	A – Increasing the pressure does not increase molecular energies B – A correct statement but does not refer to reaction rate **C – This is the correct answer** D - Increased pressure does not decrease activation energy	1

Question Number	Correct Answer	Mark
10	A – This is not the radiation that the specification states the pharmaceutical industry uses **B – This is the correct answer** C – This is not the radiation that the specification states the pharmaceutical industry uses D - This is not the radiation that the specification states the pharmaceutical industry uses	1

Question Number	Correct Answer	Mark
11	**A – This is the correct answer** B – KCl and KBr do not produce hydrogen sulfide with concentrated sulfuric acid C – KCl does not produce sulfur dioxide with concentrated sulfuric acid D - KCl and KBr do not produce sulfur with concentrated sulfuric acid	1

Question Number	Correct Answer	Mark
12	A – This is not the correct ionic equation because both species are spectator ions B – This is not the correct ionic equation because the potassium is a spectator ion should not be present **C – This is the correct answer** D - This is the full equation and not the ionic equation	1

Question Number	Correct Answer	Mark
13	**A – This is the correct answer** B – The enthalpy change is not measured from the initial transition state C – The enthalpy change is not measured from the intermediate to the reactant enthalpy D - The enthalpy change is not measured from the intermediate	1

Question Number	Correct Answer	Mark
14	**A – This is the correct answer** B – The line does not start from the origin C – The line should not touch the x axis D - The line should not go up on the right	1

Question Number	Correct Answer	Mark
15(a)	A – The polarity of 1.4 is less than 2.0 **B – This is the correct answer** C - This a an ionic and not a covalent compound D - This a an ionic and not a covalent compound	1

Question Number	Correct Answer	Mark
15(b)	A – The electronegative difference is 2.5 which is less than 3.1 B – The electronegative difference is 2.3 which is less than 3.1 C – The electronegative difference is 2.5 which is less than 3.1 **D – This is the correct answer**	1

Question Number	Correct Answer	Mark
16	A – The mass of CO_2 from Biodiesel is 7.6 which is more than that from LPG **B – This is the correct answer** C – The mass of CO_2 from Petrol is 7.2 which is more than that from LPG D - The mass of CO_2 from Wood is 9 which is more than that from LPG	1

Question Number	Correct Answer	Mark
17	A – The moles of gas goes down from 3 to 2 B – The moles of gas goes down from 1 to 0 **C – This is the correct answer** D - The moles of gas goes down from 1½ to 1	1

(TOTAL FOR SECTION A = 20 MARKS)

Section B

Question Number	Acceptable Answers	Reject	Mark
18(a)(i)	(Iodine n=0.00100 x 0.01560 =) 1.56×10^{-5} /0.0000156 (mol)		1

Question Number	Acceptable Answers	Reject	Mark
18(a)(ii)	(1:1 ratio so 'Free' SO_2 n=) 1.56×10^{-5} /0.0000156 (mol)	1.6×10^{-5} /0.000016	1

Question Number	Acceptable Answers	Reject	Mark
18(a)(iii)	**If final answer 20.0 (ppm) then with or without working award (2)** There are 3 operations in the calculation: • ÷ 0.050 or ÷(50 ÷1000) or x 20 • x 64.1/64 • x1000 One correct operation scores 1 mark. Two acceptable routes EITHER (c=1.56×10^{-5} ÷ 0.050=)3.12×10^{-4}/0.000312 (mol dm^{-3}) (1) ('Free' SO_2 ppm = 3.12×10^{-4} x 64.1 x 1000 = 19.999) = 20.0 (ppm or mg dm^{-3}) (1) OR m =(1.56×10^{-5} x 64.1=)9.996×10^{-4}/0.0009996 (1) c =((9.996×10^{-4} ÷ 0.05) x 1000=19.9992=) = 20.0 (ppm or mg dm^{-3}) (1) TE ans to (a)(ii) ÷ 0.050 x 64.1 x 1000 Answer to **3 s.f.** without working scores (2) ALLOW Use of 64, in place of 64.1		2

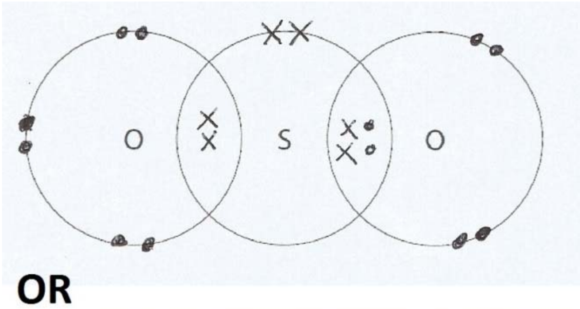
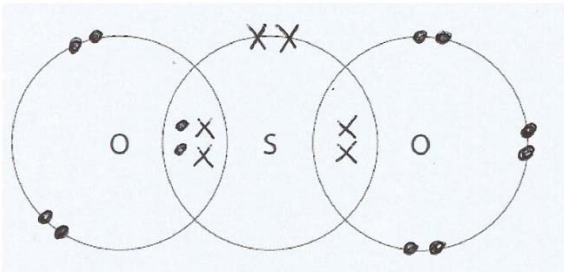
Question Number	Acceptable Answers	Reject	Mark
18(a)(iv)	**If final answer 30.0 (ppm) then with or without working award (1)** EITHER Total SO_2 ppm $(= \frac{23.4}{15.6} \times 20 =)$ **30** (ppm or mg dm^{-3}) OR (Iodine n and total SO_2 = 0.00100 x 0.0234) 2.34×10^{-5} /0.0000234 (mol) c=$2.34 \times 10^{-5} \div 0.050$ = 4.68×10^{-4} /0.000468 (mol dm^{-3}) Total SO_2 ppm = (4.68×10^{-4} x 64.1 x 1000 =) = **29.9988 / 30.0** (ppm or mg dm^{-3}) IGNORE SF TE ans to (a)(iii) x (23.4 ÷15.6)		1

Question Number	Acceptable Answers	Reject	Mark
18(a)(v)	One correct answer scores 1 Three correct answer scores 2 Uncertainty of burette titre for free SO_2 result = ((2 x 0.05) ÷ 15.60) x 100=) 0.64 (%) (1) OR Uncertainty of burette titre for Total SO_2 result = ((2 x 0.05) ÷ 23.40) x 100=) 0.43/0.427(%) (1) OR Pipette uncertainty = ((0.10 ÷ 50) x 100=) 0.20 (%) (1) Ignore SF		2

Question Number	Acceptable Answers	Reject	Mark
18(a)(vi)	Greater confidence in the **free** SO_2 result because of the repeat OR Greater confidence in the **total** SO_2 result because of the lower uncertainty (of the burette reading)	 Bound SO_2	1

Question Number	Acceptable Answers	Reject	Mark
18(b)	(less than 20 ppm) the level of SO_2 is too low to inhibit microbial growth/oxidation (1) (more than 200 ppm) the taste of the wine is affected/taste becomes acidic/ at this level the SO_2 is toxic/poisonous/harmful (1)	 Just 'acidic/low pH'	2

Question Number	Acceptable Answers	Reject	Mark
18(c)	(Red colour from the wine likely to make) the dark blue colour/colour change/end-point/titre difficult to judge ALLOW Colour will make it hard to see (the colour of) the indicator. Compounds in the red wine may interact with the iodine/SO_2/starch (to give an incorrect result) IGNORE References to alcohol content	colour in burette Iodine/brown colour makes it difficult to see colour change	1

Question Number	Acceptable Answers	Reject	Mark
18(d)(i)	Either of the following diagrams  **OR**  Allow electron pairs to be on the same horizontal line Lone pairs of electrons do not have to be 'paired'		1

Question Number	Acceptable Answers	Reject	Mark
18(d)(ii)	Sulfur has (3)**d** orbital(s) (that can be occupied)/ Oxygen is in Period 2 and has no (available) **d** orbitals ALLOW Sulfur has (3) **d** subshell that can be occupied Oxygen is in period 2 and has not available d subshell	2d/4d Promotion to s/p orbitals d shell	1

Question Number	Acceptable Answers	Reject	Mark
18(d)(iii)	Bent / V-shaped / ALLOW non-linear/angular Shown on a suitable diagram (1) 120° ±2.5 (1)		2

TOTAL FOR QUESTION 18 = 15 MARKS

Question Number	Acceptable Answers	Reject	Mark
19(a)	Magnesium hydroxide/$Mg(OH)_2$ **and** magnesium oxide formed/MgO (1) Hydrogen gas/H_2 (is also produced) (1) Standalone marks If name and formula given then both must be correct	 H Any other product(s)	2

Question Number	Acceptable Answers	Reject	Mark
19(b)	(Reaction 1) $Ca(s) + Cl_2(g) \rightarrow CaCl_2(s)$ (Reaction 2) $Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$ These reactions can be given in either order One mark for each balanced equation (2 x 1) One mark for **all** correct state symbols in both equations. Dependent on correct species. (1)	Any other reactions scores 0	3

Question Number	Acceptable Answers	Reject	Mark
19(c)(i)	To prevent 'suck-back' (of water into the hot boiling tube)/ description of suck back/ crack the tube		1

Question Number	Acceptable Answers	Reject	Mark
19(c)(ii)	$Ca(OH)_2$ Ignore names		1

Question Number	Acceptable Answers	Reject	Mark
19(c)(iii)	Calcium carbonate/$CaCO_3$ If name and formula given then both must be correct		1

Question Number	Acceptable Answers	Reject	Mark
19(c)(iv)	**Marking point 1**(trend in time taken for decomposition of Group 2 carbonates) take longer/ increases (1) (Explanation - As group is descended) **Marking point 2** (metal ion size) (Metal) ion radius increases/has more electron shells ALLOW Atom for ion for this mark only OR Charge density of metal ion decreases (1) **Marking point 3** (comparison of polarising species) Polarising power of **metal ion/cation** decreases (1) **Marking point 4** (what is polarised) Polarisation/distortion of the electron cloud of the **carbonate ion/anion** decreases OR Weakening of the C-O bond in the **carbonate ion** decreases (1) Allow reverse argument/ As the group is ascended IGNORE Group II carbonates are less polarised as group is descended If the trend is incorrect **only** M2 can be awarded	Just 'stability increases' Molecule Electron density Atom/anion	4

Question Number	Acceptable Answers	Reject	Mark
19(d)	Magnesium hydroxide is less soluble (than barium hydroxide)/ barium hydroxide is more soluble (than magnesium hydroxide) OR Solubility of hydroxides increases as the group is descended Ignore has a higher concentration of aqueous hydroxide/OH^- ions		1

Question Number	Acceptable Answers	Reject	Mark
19*(e)	Read the whole answer before awarding marks If there is no mention of electrons, then only M3 may be awarded. If there is any reference to molecule then M1 not awarded. **Marking point 1** Electrons excited/promoted (to a higher energy level/shell by thermal energy/heat from the flame) (1) **Marking point 2** electron returns to its ground state/drops back (1) **Marking point 3** Emitting energy/photon (in the visible region) ALLOW 'light'/ 'radiation in the visible region' for 'energy' (1) **Marking point 4** (The different metal ions have) different sized gaps between the **energy levels** (and so give different colours/wavelengths/frequency of light) (1)	Just 'Radiation'	4

(TOTAL FOR QUESTION 19 = 17 MARKS)

For parts a and b the observation mark is dependent on the first correct equilibrium mark. There is no TE from an incorrect equilibrium shift.

Question Number	Acceptable Answers	Reject	Mark
20(a)	(The increase in chlorine gas) shifts the equilibrium position to the right (which results in the formation of more ICl_3) (1) More yellow (solid formed) /brown liquid disappears/lighter brown (1)	Less pale green Just 'turns yellow'	2

Question Number	Acceptable Answers	Reject	Mark
20(b)	(Heating) shifts the equilibrium in the endothermic direction (which shifts the equilibrium to the left resulting in the formation of more ICl) OR shifts the equilibrium to the left because the forward reaction is exothermic (1) More brown (liquid formed) /less yellow (solid)/turns darker brown ALLOW More (pale)green gas formed (1)	Just 'turns brown'	2

Question Number	Acceptable Answers	Reject	Mark
20(c)	Chlorine is oxidised from −1 to 0 (1) Manganese is reduced from +7 to +2 ALLOW Mn is reduced from VII to II (1) If oxidation number changes of further elements are given penalise each one.		2

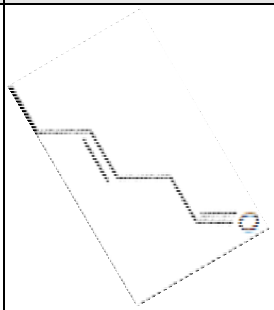
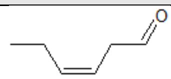
Question Number	Acceptable Answers	Reject	Mark
20(d)	To react with/absorb/remove/ excess chlorine (gas) ALLOW To prevent it entering the lab		1

(TOTAL FOR QUESTION 20 = 7 MARKS)

(TOTAL FOR SECTION B = 39 MARKS)

Section C

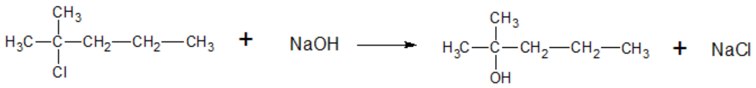
Question Number	Acceptable Answers	Reject	Mark
21(a)	$C_6H_{10}O$ Allow symbols in any order		1

Question Number	Acceptable Answers	Reject	Mark
21(b)	 Ignore any displayed formulae Ignore orientation of other bonds		1

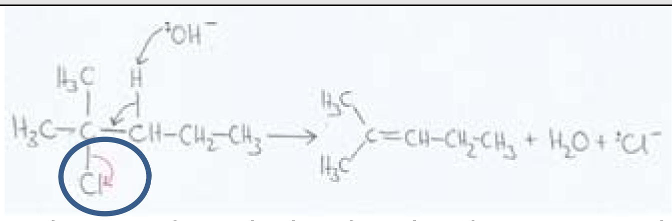
Question Number	Acceptable Answers	Reject	Mark
21(c)	Number of moles in 30 cm^3 $\left(\frac{30}{1000} \times \frac{1.0 \times 10^{-9}}{98} =\right)$ 3.06122×10^{-13}.. (mol) (1) Number of molecules (3.06122×10^{-13}..x 6.02×10^{23} =) 1.8429×10^{11} / 1.84×10^{11} / 1.8×10^{11} (1) Ignore SF Correct answer without working scores (2)	0.03÷24 scores (0)	2

Question Number	Acceptable Answers	Reject	Mark
21(d)	(see table below)	$C_5H_{11}CH_2OH$ Just 'Hexanol' $-COH_2-$	4

Classification of alcohol	Structural formula	Name
Primary	$CH_3CH_2CH_2CH_2CH_2CH_2OH$/ $CH_3(CH_2)_4CH_2OH$ / $CH_3(CH_2)_5OH$ (1)	Hexan-1-ol (1)
Secondary	$CH_3CH_2CH_2CH_2CH(OH)CH_3$/ $CH_3(CH_2)_3CH(OH)CH_3$ OR $CH_3CH_2CH(OH)CH_2CH_2CH_3$ (1)	Hexan-2-ol OR Hexan-3-ol (1)

Question Number	Acceptable Answers	Reject	Mark
21(e)(i)	EITHER  OR 		1

Question Number	Acceptable Answers	Reject	Mark
21(e)(ii)	Nucleophile/Nucleophilic		1

Question Number	Acceptable Answers	Reject	Mark
21(e)(iii)	 Curly arrow from the bond to the Cl atom or just beyond (1) Alkene product (1) Water and chloride ion products (1) (Condition for reaction) Alcoholic solvent (1) ALLOW Any displayed/structural formula for the alkene product	C+ C_6H_{12}	4

Question Number	Acceptable Answers	Reject	Mark
21(f)(i)	Any 2 from: CH_2OH^+ / CH_3O^+ **and** (*m* / e =) 31 (1) CH_3^+ **and** (*m* / e =) 15 (1) COH^+ **and** (*m* / e =) 29 (1) CO^+ **and** (*m* / e =) 28 (1) $CHOH^+$ / CH_2O^+ **and** (*m* / e =) 30 (1) Penalise missing charge once only for both (i) and (ii) Award max (1) for two correct formulae or two correct m/ e values		2

Question Number	Acceptable Answers	Reject	Mark
21(f)(ii)	$C_2H_5O^+$ / $CH_3CH_2O^+$ / $C_2H_5^+$/ $CH_3CH_2^+$/CH_3CHOH^+	$C_2H_5OH^+$	1

Question Number	Acceptable Answers	Reject	Mark
21(g)	Read the whole answer before awarding marks **Marking point 1:** Mention of the presence of two types of intermolecular force: London forces/ van der Waals' forces/dispersion forces **and** hydrogen bonds (1) **Marking point 2:** Z-hex-3-en-1-ol is mostly non-polar/ Z-hex-3-en-1-ol has a long/large non polar chain IGNORE Z-hex-3-en-1-ol is not polar (1) **Marking point 3:** Z-hex-3-en-1-ol forms (strong) London forces/ van der Waals /dispersion forces (and hydrogen bonds)with ethanol (so dissolves) (1) **Marking point 4:** London/dispersion /van der Waals' forces of Z-hex-3-en-1-ol **with water** are weak(er) (so it doesn't dissolve) OR hydrogen bonding in water is stronger than the hydrogen bonding in the other two molecules OR water forms two hydrogen bonds per molecule (the other molecules only form one) (1)		4

(TOTAL FOR SECTION C (QUESTION 21) = 21 MARKS)

TOTAL FOR PAPER = 80 MARKS

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