Mark Scheme (Results)

October 2017

Pearson Edexcel International Advanced Level In Chemistry (WCH02) Paper 01 Application Of Core Principles Of Chemistry

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information, please visit our website at www.edexcel.com.

Our website subject pages hold useful resources, support material and live feeds from our subject advisors giving you access to a portal of information. If you have any subject specific questions about this specification that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

www.edexcel.com/contactus

Pearson: helping people progress, everywhere

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

October 2017
Publications Code WCH02_01_1710_MS

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

Question Number	Correct Answer	Mark
1	**1. The only correct answer is D** ***A*** *is not correct because not Ionic* ***B*** *is not correct because not Ionic* ***C*** *is not correct because smaller cation, larger anion*	**(1)**

Question Number	Correct Answer	Mark
2	**2. The only correct answer is C** ***A*** *is not correct because trigonal planar* ***B*** *is not correct because trigonal planar* ***D*** *is not correct because trigonal planar*	**(1)**

Question Number	Correct Answer	Mark
3	**3. The only correct answer is C** **A** *is not correct because no dative covalent bond* **B** *is not correct because no dative covalent bond* **D** *is not correct because no dative covalent bond*	**(1)**

Question Number	Correct Answer	Mark
4	**4. The only correct answer is D** **A** *is not correct because non-polar molecule* **B** *is not correct because non-polar molecule* **C** *is not correct because non-polar molecule*	**(1)**

Question Number	Correct Answer	Mark
5	**5. The only correct answer is C** ***A*** *is not correct because only London forces* ***B*** *is not correct because only London forces* ***D*** *is not correct because only London forces*	**(1)**

Question Number	Correct Answer	Mark
6	**6. The only correct answer is D** ***A*** *is not correct because only hexagonal rings* ***B*** *is not correct because no pentagonal rings* ***C*** *is not correct because no pentagonal rings*	**(1)**

Question Number	Correct Answer	Mark
7	**7. The only correct answer is D** ***A*** *is not correct because linear* ***B*** *is not correct because tetrahedral* ***C*** *is not correct because tetrahedral*	**(1)**

Question Number	Correct Answer	Mark
8	**8. The only correct answer is B** **A** *is not correct because brick red flame* **C** *is not correct because brick red flame* **D** *is not correct because neutral solution*	**(1)**

Question Number	Correct Answer	Mark
9	**9. The only correct answer is A** **B** *is not correct because it increases* **C** *is not correct because it decreases* **D** *is not correct because it remains the same*	**(1)**

Question Number	Correct Answer	Mark
10	**10. The only correct answer is A** **B** *is not correct because not the most soluble* **C** *is not correct because not the most soluble* **D** *is not correct because* not *the most soluble*	**(1)**

Question Number	Correct Answer	Mark
11	**11. The only correct answer is A** **B** *is not correct because bond energies decrease down the group* **C** *is not correct because bond energies decrease down the group* **D** *is not correct because* b*ond energies decrease down the group*	**(1)**

Question Number	Correct Answer	Mark
12	**12. The only correct answer is B** ***A*** *is not correct because incorrect observation* ***C*** *is not correct because incorrect observation* ***D*** *is not correct because incorrect observation*	**(1)**

Question Number	Correct Answer	Mark
13	**13. The only correct answer is A** **B** *is not correct because should be slower* **C** *is not correct because should be half the volume* **D** *is not correct because should be half the volume*	**(1)**

Question Number	Correct Answer	Mark
14	**14. The only correct answer is B** **A** *is not correct because unchanged* **C** *is not correct because unchanged* **D** *is not correct because unchanged*	**(1)**

Question Number	Correct Answer	Mark
15	**15. The only correct answer is C** **A** *is not correct because it should be constant* **B** *is not correct because it should be constant* **D** *is not correct because it should be decreased*	**(1)**

Question Number	Correct Answer	Mark
16	**16. The only correct answer is A** **B** *is not correct because not necessarily true* **C** *is not correct because untrue* **D** *is not correct because untrue*	**(1)**

Question Number	Correct Answer	Mark
17	**17. The only correct answer is B** **A** *is not correct because change in number of moles* **C** *is not correct because change in number of moles* **D** *is not correct because change in number of moles*	**(1)**

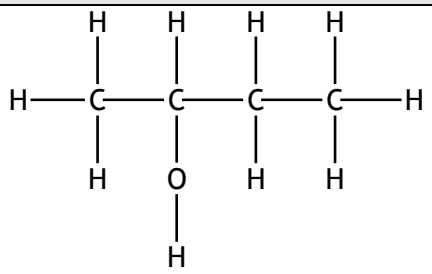
Question Number	Correct Answer	Mark
18	**18. The only correct answer is B** **A** *is not correct because 0.1 is a tenth of 1000* **C** *is not correct because incorrect formula for sulfate* **D** *is not correct because* ratio *wrong way round*	**(1)**

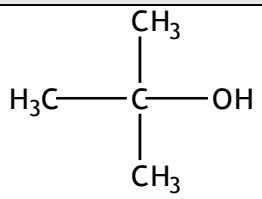
Question Number	Correct Answer	Mark
19	**19. The only correct answer is C** **A** *is not correct because 0.65 x 390; wrong calculation* **B** *is not correct because* 0.65 x 420; wrong calculation **D** *is not correct because 10 x 60 ; wrong calculation*	**(1)**

Question Number	Correct Answer	Mark
20	**20. The only correct answer is C** **A** *is not correct because wrong type of reaction* **B** *is not correct because wrong type of reaction* **D** *is not correct because wrong type of reaction*	**(1)**

(Total for Section A: 20 marks)

Section B

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	 ALLOW −OH IGNORE Point of attachment of bond to OH unless horizontal to −HO	Other types of formulae	**(1)**

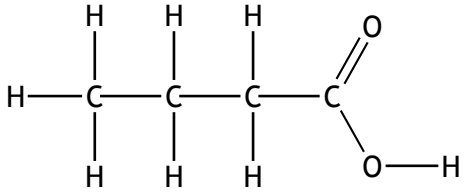
Question Number	Acceptable Answers	Reject	Mark
21(a)(ii)	 / $(CH_3)_3C(OH)$ / other variations eg $(CH_3)_2C(OH)CH_3$ ALLOW Displayed or skeletal IGNORE Point of attachment of bond to OH unless horizontal to −HO	Any incorrect structure in a list.	**(1)**

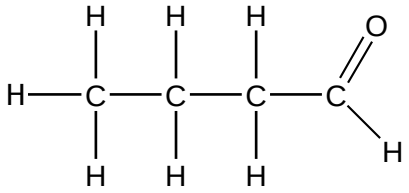
Question Number	Acceptable Answers	Reject	Mark
21(a)(iii)	2-methylpropan-1-ol ALLOW Methylpropan(e)-1-ol / 2-methylpropane-1-ol IGNORE Formulae	2-methylpropanol	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	Circle drawn around the peak furthest to the left on the infrared spectrum OR Appropriate indication such as a circle around the gap at the top of the peak	Any other additional circles or circles including other additional peaks	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	Find the spectrum that matches / is the same as the spectrum shown / the spectrum in a database ALLOW (Compare) fingerprint region		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	Primary / 1° (alcohol)		**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	 ALLOW −OH not displayed IGNORE Name	Other types of formulae	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iii)	 ALLOW Correct formula of butanoic acid if butanal is the answer to (ii) IGNORE Name	Only penalise incorrect side chain once in cii and ciii Only penalise structural or skeletal formulae once in cii and ciii.	**(1)**

Question Number	Acceptable Answers	Reject	Mark
21(c)(iv)	Type of reaction) Oxidation ALLOW Oxidisation IGNORE 'redox'		**(1)**

(Total for Question 21 = 9 marks)

Question Number	Acceptable Answers	Reject	Mark
22(a)(i)	As a (co-) solvent for both (aqueous) silver nitrate and the halogenoalkane OR As a (co-) solvent for polar and non-polar molecules OR To allow the reagents/reactants/halogenoalkane and water to mix/dissolve/become miscible ALLOW Ethanol has both polar and non-polar parts OR **Just** As a co-solvent	Just 'to act as a solvent' Just 'to dissolve the silver nitrate' Just 'to dissolve the halogenoalkane'	**(1)**

Question Number	Acceptable Answers	Reject	Mark
22 (a)(ii)	($CH_3CH_2CH_2CH_2I + H_2O \rightarrow$) $CH_3CH_2CH_2CH_2OH + HI$ / $H^+ + I^-$ IGNORE State symbols, even if incorrect		**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	Butan-1-ol ALLOW 1-butanol Butane-1-ol		**(1)**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iv)	Nucleophilic **(1)** Substitution **(1)** ALLOW 1 mark for just S_N1 and/or S_N2		**(2)**

Question Number	Acceptable Answers	Reject	Mark
22 (a)(v)	**1st mark:** Rates of hydrolysis increases from 1-chlorobutane to 1-iodobutane / down the group **(1)** **2nd mark:** C—X bond (energies) decrease in strength / get weaker from C—Cl to C—I **(1)** **3rd mark:** So bonds break more easily / quickly / with less energy from C—Cl to C—I **(1)** IGNORE Bond length arguments / shielding arguments / size of atoms / electronegativity	Reference to only time taken for hydrolysis Just 'from chlorine to iodine'	**(3)**

Question Number	Acceptable Answers	Reject	Mark
22 (b)(i)	**First mark:** C—F bond is stronger than the C—Cl bond **(1)** **Second mark:** Either C—Cl bond breaks (in stratosphere) forming free radicals (which reacts with ozone) OR Chlorine radicals / Cl• form (which reacts with ozone) **(1)** **IGNORE** There is no chlorine in HFCs Mark each scoring point independently	HFCs are broken down before they reach the ozone layer	**(2)**

Question Number	Acceptable Answers	Reject	Mark
22 (b)(ii)	Some CFCs still being used / CFCs take a (very) long time to reach ozone layer / other chlorine containing compounds / oxides of nitrogen (deplete the ozone layer) / some CFCs remain / some chlorine radicals remain Allow other explanations that are in line with those above.	CO_2 depletes the ozone layer Just 'free radicals are present'	**(1)**

(Total for Question 22 = 11 marks)

Question Number	Acceptable Answers	Reject	Mark
23(a)	Final volume would not be (exactly) 250 cm^3 of solution ALLOW Weighing bottle would not have been washed IGNORE Problems due to reactivity of metal hydroxide and water	Not all of the hydroxide will dissolve	**(1)**

Question Number	Acceptable Answers	Reject	Mark
23 (b)	Pipette ALLOW Recognisable spellings e.g. Pippete	Burette 'burette or pipette'	**(1)**

Question Number	Acceptable Answers	Reject	Mark
23 (c)	**EITHER** (Indicator) Methyl orange **(1)** From yellow **(1)** To orange/ pink / 'peach' (colour) ALLOW red **(1)** **OR** (Indicator) Phenolphthalein **(1)** From (pale) pink **(1)** To colourless **(1)** ALLOW Other indicators IGNORE "Clear" ALLOW 1 out of 2 for the correct colours of either indicator in the reverse order	Phenylphthalein purple / red Litmus / Universal Indicators	**(3)**

APPLY T.E. THROUGHOUT PART (d). IGNORE SF EXCEPT 1SF in (ii)-(v) / incorrect units (eg mol/g not g/mol). IGNORE rounding errors.

Question Number	Acceptable Answers	Reject	Mark
23 (d)(i)	Either Moles HCl (= $\frac{0.730}{36.5}$) = 0.02(00) (mol) **(1)** Conc (= $\frac{0.02(00)}{0.1(00)}$) = 0.2(00) (mol dm^{-3}) **(1)** OR Mass HCl in 1 dm^3 = 0.730 x 10 = 7.30 (g dm^{-3}) **(1)** Conc = $\frac{7.30}{36.5}$ = 0.2(00) (mol dm^{-3}) **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
23(d)(ii)	(Moles HCl = $\frac{0.2(00) \times 23.80}{1000}$) = 0.00476 / 4.76 x 10^{-3} (mol)		**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(d)(iii)	(Moles NaOH) = 0.00476 / 4.76 x 10^{-3} (mol)		**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(d)(iv)	10 x 0.00476 = 0.0476 / 4.76 x 10^{-2} (mol)		**(1)**

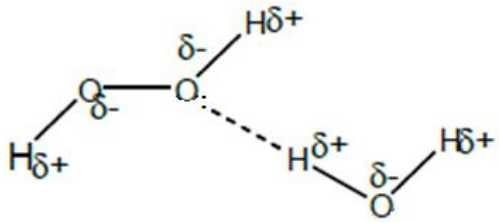
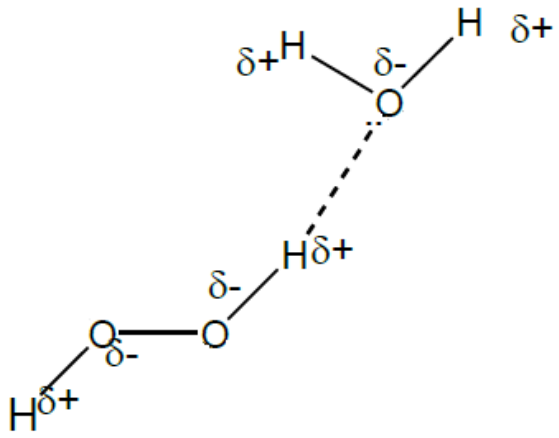
Question Number	Acceptable Answers	Reject	Mark
23(d)(v)	(Molar mass = $\frac{1.14}{0.0476}$) = 23.9496 (g mol^{-1})		**(1)**

Question Number	Acceptable Answers	Reject	Mark
23(d)(vi)	(A_r = 23.9496 — 17.0 = 6.9496) (so) Li / lithium ALLOW Lithium hydroxide Allow TE on other group 1 metals providing a calculation of —17 is shown and allow metal hydroxide in this case		**(1)**

(Total for Question 23 = 12 marks)

Question Number	Acceptable Answers	Reject	Mark
24(a)	104 – 105^{o} ALLOW 94 – 95^{o}		**1**

Question Number	Acceptable Answers	Reject	Mark
24(b)(i)	(Intermolecular) Hydrogen bond(ing) / H bonding / H bond(s)	Additional types of interaction e.g dipole-dipole attractions, London forces	**1**

Question Number	Acceptable Answers	Reject	Mark
24 (b)(ii)	**1st mark:** At least one lone pair of electrons shown on an O atom even if not the one involved in the hydrogen bond in EITHER H_2O OR in H_2O_2 **(1)** **2nd mark:** Hydrogen bond shown between an H atom on one molecule AND an O atom of the other molecule AND O-H-O angle at (about) 180° 180° must be drawn at about 180° not just labelled IGNORE Labelled bond angles even if incorrect. **(1)** **3rd mark:** At least one δ^+ shown on any H atom AND at least one δ^- shown on any O atom **(1)** EITHER  OR  	Any bond angles labelled as 180° must be between the correct bonds Any full charges Any incorrect partial charges	**(3)**

Question Number	Acceptable Answers	Reject	Mark
24 (c)	**First mark:** Electronegativity of S lower than that of O OR Electronegativity difference between H and S is less (than that between H and O) **ALLOW** Reverse argument **(1)** **Second mark:** No hydrogen bonding / (only) London forces etc (and dipole-dipole forces) between H_2S_2 molecules **OR** Hydrogen bonding between H_2O_2 molecules **(1)**	Award **(0) overall** if any clear reference to breaking covalent bonds	**(2)**

(Total for Question 24 = 7 marks)

Question Number	Acceptable Answers	Reject	Mark
25 (a)	Outermost / valence **electron** in a p-orbital / in a p-subshell OR (During the build-up of its atoms) last added **electron** is in a p sub-shell / in a p-orbital ALLOW They have a partially filled p-orbital / p sub-shell The last **occupied** shell / valence shell ends with p-orbital / p sub-shell	'p shell'	**(1)**

Question Number	Acceptable Answers	Reject	Mark
25 (b)	(Bromine) liquid / (l) **(1)** (Iodine) solid / (s) **(1)** IGNORE description, e.g. colour.		**(2)**

Question Number	Acceptable Answers	Reject	Mark
25 (c)(i)	$Cl_2(g)$ / (aq) + $2Br^-(aq) \rightarrow 2Cl^-(aq) + Br_2(aq)$ Species **(1)** Balanced and all state symbols correct **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
25 (c)(ii)	(Colourless solution turns) brown / orange / red-brown ALLOW Yellow Liquid IGNORE pale		**(1)**

Question Number	Acceptable Answers	Reject	Mark
25(c)(iii)	(Chlorine acts as an) oxidising agent / is an oxidant **(1)** (Chlorine) gains electrons / accepts electrons (from the bromide ions) / causes bromide ions to lose electrons **(1)** IGNORE Oxidation numbers throughout		**(2)**

Question Number	Acceptable Answers	Reject	Mark
25(d)	(At high acidity) an increase in the concentration / high concentration of hydrogen ions / H^+ (ions) ALLOW Increase in (amount of) H^+ (ions) **(1)** Shifts the position of equilibrium to the **left** (by application of Le Chatelier's principle) / favours the backward reaction **(1)**		**(2)**

Question Number	Acceptable Answers	Reject	Mark
25(e)(i)	$Br_2 + 2e^{(-)} \rightarrow 2Br^-$ ALLOW Multiples No charge on electrons IGNORE state symbols even if incorrect	$Br_2 \rightarrow 2Br^- - 2e^{(-)}$	**(1)**

Question Number	Acceptable Answers	Reject	Mark
25(e)(ii)	$SO_2 + 2H_2O \rightarrow SO_4^{2-} + 4H^+ + 2e^{(-)}$ ALLOW $SO_2 + 2H_2O - 2e^{(-)} \rightarrow SO_4^{2-} + 4H^+$ Multiples IGNORE state symbols even if incorrect		**(1)**

Question Number	Acceptable Answers	Reject	Mark
25 e)(iii)	$SO_2 + 2H_2O + Br_2 \rightarrow SO_4^{2-} + 4H^+ + 2Br^-$ Species **(1)** Balancing (dependent on M1) **(1)** IGNORE state symbols even if incorrect No TE on incorrect half equations in (i) and (ii) except for formation of sulfate(IV) $SO_2 + H_2O + Br_2 \rightarrow SO_3^{2-} + 2H^+ + 2Br^-$	e^- left in equation (no M1)	**(2)**

Question Number	Acceptable Answers	Reject	Mark
25 (f)(i)	(acidified) silver nitrate / $AgNO_3$ (and nitric acid) If name and formula given they must both be correct Note this mark can only be scored if the answer is in this part of (f)	Silver nitrate and sulfuric acid Use of chlorine Use of concentrated sulfuric acid	**(1)**

Question Number	Acceptable Answers	Reject	Mark
25 (f)(ii)	These marks may be scored here from (f)(iv) providing silver nitrate is given in (f)(iii) (With KBr) cream precipitate / off-white precipitate / **pale yellow** precipitate **(1)** (With KI) yellow precipitate **(1)** ALLOW 'solid' for precipitate in each case	**Just** 'yellow precipitate' Pale yellow precipitate	**(2)**

Question Number	Acceptable Answers	Reject	Mark
25(f)(iii)	**Concentrated (**This can be scored if clear in f(iv)) **(1)** Ammonia (solution) / NH_3((aq)) **(1)** These 2 marks can be scored with concentrated ammonia given in (f)(i) 1 mark can be scored here if ammonia is given in (f)(i)	If given with a substance other than ammonia	**(2)**

Question Number	Acceptable Answers	Reject	Mark
25(f)(iv)	(With AgBr) precipitate dissolves / precipitate disappears **(1)** (With AgI) precipitate remains **(1)** **ALLOW** Bromide/iodide ions and potassium bromide/iodide as indication of which precipitate is being considered IGNORE Colours of any precipitate, even if incorrect, although the colour may be used to identify which precipitate is dissolving if they match the answers in (ii) Note these 2 marks can be scored here if written in (f)(ii) provided in (f)(i) ammonia is mentioned		**(2)**

(Total for Question 25 = 21 marks)

TOTAL FOR PAPER: 80 MARKS