edexcel

Mark Scheme (Results)

January 2016

Pearson Edexcel International Advanced Level in Chemistry (WCH05) Paper 01 - General Principles of Chemistry II (including synoptic assessment)

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

January 2016
Publications Code IA043134*

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	Reject	Mark
1	**B**		1

Question Number	Correct Answer	Reject	Mark
2(a)	**D**		1

Question Number	Correct Answer	Reject	Mark
2(b)	**D**		1

Question Number	Correct Answer	Reject	Mark
3	**C**		1

Question Number	Correct Answer	Reject	Mark
4	**A**		1

Question Number	Correct Answer	Reject	Mark
5	**C**		1

Question Number	Correct Answer	Reject	Mark
6	**D**		1

Question Number	Correct Answer	Reject	Mark
7	**C**		1

Question Number	Correct Answer	Reject	Mark
8	**D**		1

Question Number	Correct Answer	Reject	Mark
9	**D**		1

Question Number	Correct Answer	Reject	Mark
10	**A**		1

Question Number	Correct Answer	Reject	Mark
11	**B**		1

Question Number	Correct Answer	Reject	Mark
12	**A**		1

Question Number	Correct Answer	Reject	Mark
13	**A**		1

Question Number	Correct Answer	Reject	Mark
14	**B**		1

Question Number	Correct Answer	Reject	Mark
15(a)	**B**		1

Question Number	Correct Answer	Reject	Mark
15(b)	**D**		1

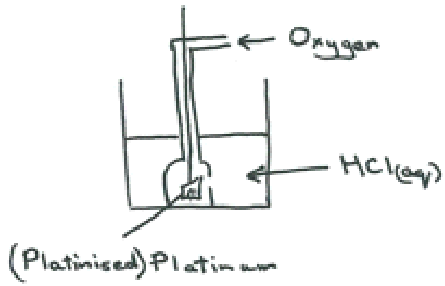
Question Number	Correct Answer	Reject	Mark
16	**C**		1

Question Number	Correct Answer	Reject	Mark
17	**C**		1

Question Number	Correct Answer	Reject	Mark
18	**B**		1

TOTAL FOR SECTION A = 20 Marks

Section B

Question Number	Correct Answer	Reject	Mark
19(a)	Mark independently  Glassware with oxygen **and** 1 atm pressure Tube carrying oxygen must be open at the bottom **but** not after the feed at the top **(1)** (Platinised) platinum/Pt (electrode) **and** 298 K/ 25°C **(1)** Hydrochloric acid/HCl(aq), **covering** some of the electrode **and** 1 mol dm^{-3} OR 1 mol dm^{-3} H^+ covering electrode **(1)** A fully correct hydrogen electrode **2max**	 Sulfuric acid	3

Question Number	Correct Answer	Reject	Mark
19(b)	$CH_3OH + 1½O_2 \rightarrow CO_2 + 2H_2O$ OR multiples	Uncancelled electrons, H^+ ions and $\mathbf{H_2O}$	1

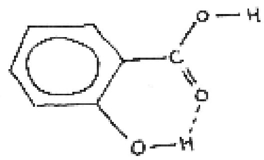
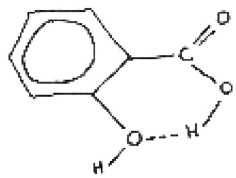
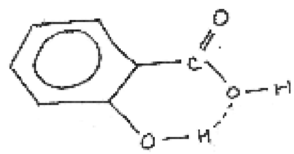
Question Number	Correct Answer	Reject	Mark
19(c)	$E^{\ominus}_{cell}$ = +1.23 – 0.02 = (+) 1.21 (V)	- 1.21 (V)	1

Question Number	Correct Answer	Reject	Mark
19(d)	**Additional Comment** Note that the words advantage and disadvantage are not required **(Advantages)** Any one from: Easier to store/transport than hydrogen (as a liquid rather than a gas) OR Methanol can be produced from waste / methanol is renewable OR Energy per volume is greater **(1)** IGNORE Hydrogen is flammable/ explosive **(Disadvantages)** Any one from: Produces CO_2 OR Low efficiency OR Limited power/energy **(1)** OR Lower emf/E value IGNORE Land used up in producing methanol instead for crops		2

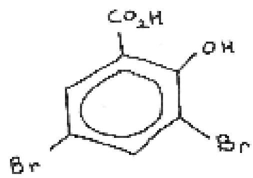
(Total for Question 19 = 7 marks)

Question Number	Correct Answer	Reject	Mark
20(a)	$C_7H_6O_3$ IGNORE Any other formulae eg $C_6H_4OHCOOH$		1

Question Number	Correct Answer	Reject	Mark
20(b)	$NaCO_3$ scores 0 $2C_6H_4OHCOOH + Na_2CO_3 \rightarrow$ $2C_6H_4OHCOO^{(-)}Na^{(+)} + CO_2 + H_2O$ Entities **(1)** Balancing correct entities/H_2CO_3/$C_7H_6O_3$ ALLOW Incorrect hydrogens in organic formula on both sides **(1)** ALLOW other correct formulae for 2-hydroxybenzoic acid Fully correct ionic equation (2) IGNORE State symbols even if incorrect	H_2CO_3/ $C_7H_6O_3$	2

Question Number	Correct Answer	Reject	Mark
20(c)(i)	 OR  OR  Ignore bond angles around H ALLOW Two hydrogen bonds within one molecule between **phenol** and **carboxylate** groups		1

Question Number	Correct Answer	Reject	Mark
20(c)(ii)	**First mark** 4-hydroxybenzoic acid has a higher melting temperature with some attempt at justification which may not be correct **(1)** **Second mark** EITHER There are (more) hydrogen bonds between molecules OR chains of molecules held together by hydrogen bonds OR So more hydrogen bonds have to be broken OR More energy is needed to break the extra hydrogen bonds OR The intramolecular hydrogen bonds in 2-hydroxybenzoic acid do not need to be broken **(1)** Or reverse argument	Lower/same melting temperature loses first mark	2

Question Number	Correct Answer	Reject	Mark
20(d)	**Scroll down answer to check name first**  OR COOH for carboxylic acid group **(1)** 3,5-dibromo-2-hydroxybenzoic acid ALLOW 2-hydroxy-3,5-dibromobenzoic acid **(1)** TE for name on their incorrect mono/di/tri/tetra substituted product for **1** max	Look out for substitution of the **phenol group or the carboxylic acid group 0 out of 2**	2

Question Number	Correct Answer	Reject	Mark
20(e)(i)	Methanol **(1)** (Concentrated) sulfuric acid ALLOW (concentrated) hydrochloric acid IGNORE Acidic conditions **And** Heat/reflux/warm/any temperature above 25^{o}C Second mark dependent on an alcohol in MP1 **(1)**	Nitric acid	2

Question Number	Correct Answer	Reject	Mark
20 (e)(ii)	Methyl 2-hydroxybenzoate molecules are held together by (strong) London/ dispersion forces IGNORE Dipole forces and hydrogen bonds **(1)** Less / limited hydrogen bond **between** water and methyl 2-hydroxybenzoate (so sparingly soluble) **(1)** The hydrogen bonding between water molecules is (very) strong **(1)** Insufficient energy released to break hydrogen bonds in water/ London forces in methyl 2-hydroxybenzoate **(1)** (Some of the) hydrogen bonds are internal in methyl 2-hydroxybenzoate **(1)** The oxygens in methyl 2-hydroxybenzoate can form hydrogen bonds to the hydrogens of water molecules OR The hydrogen on the oxygen in methyl 2-hydroxybenzoate can form hydrogen bonds to the oxygens of water molecules **(1)**		3

Question Number	Correct Answer	Reject	Mark
20 (e)(iii)	ALLOW Correct formulae for names **First mark** Sodium hydrogencarbonate (solution) ALLOW Sodium carbonate (solution) IGNORE water **(1)** **Second mark** to neutralise/ remove remaining acids **(1)** IGNORE references to saturated sodium chloride solution to reduce solubility of ester **Third mark** (Dried with) (anhydrous) sodium sulfate OR magnesium sulfate OR calcium sulfate OR calcium chloride **(1)**	Anything else	3

Question Number	Correct Answer	Reject	Mark
20 (e)(iv)	Distillation OR Distil off the ethyl ethanoate ALLOW Fractional distillation/redistillation	Steam distillation Solvent extraction	1

Question Number	Correct Answer	Reject	Mark
20(e)(v)	**First marking point** A is methyl 2-hydroxybenzoate OR B is 2-hydroxybenzoic acid **and** a bond / wavenumber considered (eg O-H, C-O, C=O, C-H in CH_3) **(1)** **Second marking point** This is independent of the first mark Any one bond with wavenumber from: In spectrum B the carboxylic acid OH between 3300 and 2500 (cm^{-1}) In spectrum A no broad peak between 3300 and 2500 (cm^{-1}) In spectrum A, C-O (benzoate) between 1150-1100 (cm^{-1}) and/or 1310-1250 (cm^{-1}) In spectrum A alkyl C-H between 2962 – 2853 (cm^{-1}) **(1)** IGNORE In spectrum A phenol/OH peak between 3300 and 3100 (cm^{-1}) OR C-H arene	C=O in acid/ ester	2

Question Number	Correct Answer	Reject	Mark
20(e)(vi)	moles of 2-hydroxybenzoic acid = $\frac{9.00}{138}$ = 0.0652 **and** moles of methyl 2-hydroxybenzoate = 0.6 x 0.0652 = 0.0391 **(1)** Mass of methyl 2-hydroxybenzoate = 0.0391 x 152 = 5.948 (g) **(1)** Volume of methyl 2-hydroxybenzoate = 5.948/1.174 = 5.066 = 5.07 cm^3 Correct volume with no working 3 marks **(1)** ALLOW Internal TE s eg For 100% gives 9.91(3) g and 8.44(4) cm^3 **(2)** IGNORE SF		3

(Total for Question 20 = 22 marks)

Question Number	Correct Answer	Reject	Mark
21(a)(i)	$3d^5\ 4s^1$ $/4s^1\ 3d^5$ ALLOW Complete configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ ALLOW Capitals and subscripts		1

Question Number	Correct Answer	Reject	Mark
21 (a)(ii)	It is $4s^1$ rather than $4s^2$ because with two of the reasons below $3d^5$/ half-filled 3d sub shell is particularly stable **(1)** The paired electrons repel **(1)** All six electrons are in separate orbitals (minimizing repulsion) **(1)** ALLOW The energy required to promote/ transfer 4s to 3d is small OR The energy difference between 4s and 3d is small **(1)**		2

Question Number	Correct Answer	Reject	Mark
21(b)(i)	($E^\ominus$ $Zn^{2+}(aq)$| $Zn(s)$ = -0.76 V $E^\ominus$ $Cr^{3+}(aq)$, $Cr^{2+}(aq)$|Pt = -0.41 V $E^\ominus$ [$Cr_2O_7^{2-}(aq)$ + $7H^+(aq)$], [$2Cr^{3+}(aq)$ + $7H_2O(l)$]|Pt = +1.33 V) If no other mark is scored, data scores (1) however shown Calculation of $E^\ominus_{cell}$ values: $E^\ominus_{cell}$ for first step = 1.33 – -0.76 = (+)2.09 (V) **(1)** $E^\ominus_{cell}$ for second step = -0.41 – -0.76 = (+)0.35 (V) **(1)** As (both) values are positive, (both) reactions are spontaneous/feasible **(1)** Third mark is independent		3

Question Number	Correct Answer	Reject	Mark
21(b)(ii)	**Orange** to **green** to **blue** IGNORE qualifying words eg pale blue		1

Question Number	Correct Answer	Reject	Mark
21 (b)(iii)	The small amount of hydrogen produced (does not present a serious risk) ALLOW “Less” for small amount Indication of ventilation		1

Question Number	Correct Answer	Reject	Mark
21(c)(i)	It is bridging/ bidentate ligand	Polydentate	1

Question Number	Correct Answer	Reject	Mark
21(c)(ii)	Dative (covalent) (bonds)/ co-ordinate (bonds)		1

Question Number	Correct Answer	Reject	Mark
21 (c)(iii)	**Any two from:** Chromium atoms/ ions are covalently bonded/bonded to each other OR Two (chromium) ions/ chromium atoms in the complex **(1)** Each ethanoate ligand forms bonds to two different atoms/ ions **(1)** Ethanoate ions are not normally bidentate ligands **(1)** ALLOW Contains both monodentate and bidentate ligands **(1)** Allow six ligands **and** complex not octahedral **(1)**	Just "two different ligands"	2

Question Number	Correct Answer	Reject	Mark
21 (c)(iv)	The energies of the d electron levels are split to different extents (by different ligands) ALLOW d-d (orbitals) splitting is different OR d-d transitions are different **(1)** So different energy/ frequency/ wavelength light absorbed **(1)**	… (just) transmitted	2

Question Number	Correct Answer	Reject	Mark
21(c)(v)	There are two peaks as two different hydrogen environments **(1)** EITHER The areas due to hydrogen in water molecules compared to hydrogen in ethanoate ions is in the ratio 1 to 3/ 4 to 12 OR As there are 4 hydrogen atoms in water and 12 hydrogen atoms in ethanoate ions **(1)**		2

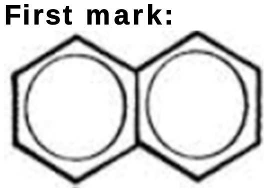
Question Number	Correct Answer	Reject	Mark
21(d)	**First mark** Dilution factor: moles of chromium(II) ethanoate in 25.0 cm^3 $= \frac{2.66 \times 10^{-3}}{10} = 2.66 \times 10^{-4}$ **(1)** **Second mark** Ratio of manganate(VII) to chromium 4 mol manganate(VII) react with 5 mol of chromium (II) OR 8 mol mangante(VII) react with 5 mol of chromium(II) ethanoate **(1)** **Third mark** moles of manganate(VII) ion $= \frac{4 \times 5.32 \times 10^{-4}}{5}$ OR $\frac{8 \times 2.66 \times 10^{-4}}{5}$ $= 4.256 \times 10^{-4}$ **(1)** **Fourth mark** Volume of manganate(VII) solution $= \frac{4.256 \times 10^{-4}}{0.00750} \times 1000$ $= 56.75$ cm^3 **(1)** Correct answer no working (4) 28.375 cm^3 gets (3) **Fifth mark** This is unsuitable/ inaccurate because it requires refilling the burette hence increasing burette error OR Better to use more concentrated potassium manganate(VII) OR less chromium ethanoate **(1)**		5

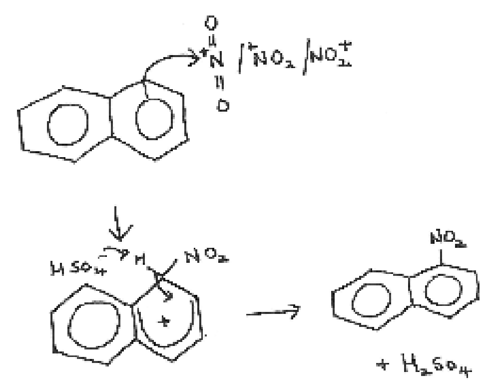
(Total for Question 21 = 21 marks)

TOTAL FOR SECTION B = 50 Marks

Section C

Question Number	Correct Answer	Reject	Mark
22(a)	X-ray diffraction/crystallography	X-rays alone X radiation IR/UV/nmr	1

Question Number	Correct Answer	Reject	Mark
22(b)	Mark independently **First mark:**  ALLOW Single ring and two double bonds Single ring around all atoms **(1)** **Second mark:** EITHER electrons delocalised (around the ring(s)) OR pi system around all (10) carbon atoms **(1)** **Third mark:** EITHER overlap of p-orbitals OR p/ pi-/π/ 10 (ALLOW pie) electrons **(1)** ALLOW six electrons if single ring and two double bonds shown Phthalic anhydride structure **2 max**	Single ring and three double bonds delocalised orbitals	3

Question Number	Correct Answer	Reject	Mark
22(c)	**First mark** Formation of nitronium ion (may combine equations) **(1)** $2H_2SO4 + HNO_3 \rightarrow$ $^{+}NO_2/NO_2^{+} + H_3O^{+} + 2HSO_4^{-}$ OR $H_2SO4 + HNO_3 \rightarrow$ $^{+}NO_2/NO_2^{+} + H_2O + HSO4^{-}$ OR $H2SO4 + HNO3 \rightarrow H_2NO_3^{+} + HSO_4^{-}$ **And** $H2NO_3^{+} \rightarrow NO_2^{+} + H_2O$ **Charges are needed for first mark**  TE on incorrect electrophile If benzene used instead of naphthalene **3 max** Do not penalise the use of Phthalic anhydride Correct Kekulé structures score full marks ALLOW multiple nitrations		4

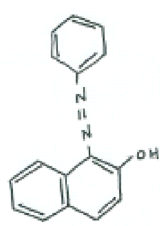
	Second mark Curly arrow from on or within the circle to (positive) N ALLOW Curly arrow from anywhere within the hexagon Arrow to **any** part of the electrophile including to the + charge (which can be anywhere on electrophile), OR Arrow to a point at least half the distance between ring and electrophile **(1)** **Third mark** Intermediate structure 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. ALLOW dotted horseshoe **(1)** IGNORE displayed nitro group even if incorrect A single lapse of omitting internal circle or double bonds in 3rd or 4th mark **Fourth mark** If final product not 1, 4, 5 or 8 MP4 cannot be scored Curly arrow from C—H bond to anywhere in the ring reforming delocalised structure of a correct stable molecule. **(1)** IGNORE Absence of HSO_4^-/H_2SO_4/H^+	Curly arrow on or outside the hexagon Partial bonds to H or Subs group H_2 / H product	

Question Number	Correct Answer	Reject	Mark
22(d)	$C_{10}H_8$ This mark can be awarded if the molar mass of naphthalene has been used as 128 even if the skeletal formula in the equation has been used **(1)** $C_{10}H_8 + 12O_2 \rightarrow 10CO_2 + 4H_2O$ **(1)** ALLOW The balanced equation with skeletal formula of naphthalene scores both marks Ignore state symbols even if incorrect Number of moles of naphthalene $= \frac{1.28}{128} = 0.01(00)$ Volume of gas = 10 x 0.01 x 24.0 = 2.4(0) dm^3 /2400 cm^3 **(1)** ALLOW TE on incorrect formula of naphthalene for max 2		3

Question Number	Correct Answer	Reject	Mark
22(e)	Hydrogen /H_2 **(1)** **Second mark is consequential on Hydrogen** Heat/any specified temperature above 100°C **And** nickel/ Ni /platinum/ Pt/ palladium / Pd catalyst **(1)**	H alone loses first mark but not second	2

Question Number	Correct Answer	Reject	Mark
22(f)(i)	Water/H_2O		1

Question Number	Correct Answer	Reject	Mark
22(f)(ii)	(In strong acid) an oxygen (in the C−O/C=O/O−H bond) will protonate/gain H/H^+ **(1)** (In alkali) a proton is lost from each/both phenol group(s) ALLOW (In alkali) a proton/hydrogen/ H/H^+ is lost from phenol group(s) **(1)**		2

Question Number	Correct Answer	Reject	Mark
22(g)	Phenylamine is added to a mixture of sodium nitrite/ sodium nitrate(III)/ $NaNO_2$ **and** (dilute) hydrochloric acid/ HCl/ sulfuric acid/ H_2SO_4 ALLOW nitrous acid/ HNO_2 **(1)** at 5°C/between 0 and 10°C/ at 10°C/ or less than 10 °C ALLOW ice bath ALLOW any temperature or range of temperatures within that range **(1)** (A mixture of 2-naphthol and) aqueous sodium hydroxide/alkali is added to produce a dye **(1)**  OR rings in hexagons ALLOW $C_6H_5N_2$ group at any carbon except fused carbons **(1)**	Just sodium nitrate	4

(Total for Question 22 = 20 marks)

TOTAL FOR PAPER = 90 Marks