Mark Scheme (Results)

October 2020

Pearson International Advanced Level
In Chemistry (WCH16)
Paper 1: Practical Skills in Chemistry II

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. 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 2020
Publications Code WCH16_01_2010_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.

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.

Question Number	Answer	Additional Guidance	Mark
1(a)(i)	• (precipitate **B** is) copper(II) hydroxide / $Cu(OH)_2$ / $Cu(OH)_2(H_2O)_4$ **(1)** • (complex ion **D** is) tetraamminediaquacopper(II) ions / $[Cu(NH_3)_4(H_2O)_2]^{2+}$ **(1)**	In Q1 if name and formula are given both must be correct and ignore state symbols even if incorrect. Penalise omission of copper oxidation state once only In (a)(i) and (a)(ii) Ignore omission of or unnecessary brackets. Ignore copper hydroxide Allow $Cu(NH_3)_4^{2+}$ / tetraamminecopper((II)) ions Do not award $[Cu(NH_3)_6]^{2+}$ Ignore spaces in names of complexes If no other mark is awarded in (a) **D** = $Ni(NH_3)_6^{2+}$ / $Cr(NH_3)_6^{2+}$ scores (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	• (black solid) is copper(II) oxide / CuO	Allow CuO **and** copper oxide	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	• (yellow solution **E** contains) tetrachlorocuprate(II) ions / $[CuCl_4]^{2-}$	Allow tetrachlorocuprate tetrachlorocopper((II)) / $CuCl_4^{2-}$	**(1)**

Question Number	Answer		Additional Guidance	Mark
1(b)(i)			If oxidation numbers are given they must be correct.	**(3)**
	• (yellow colour is) chromate(VI) / CrO_4^{2-}	**(1)**	Allow chromate	
	• (orange colour is) dichromate(VI) / $Cr_2O_7^{2-}$	**(1)**	Allow dichromate	
	• (green colour is) chromium(III) / Cr^{3+} / hexaaquachromium(III) / $[Cr(H_2O)_6]^{3+}$	**(1)**	Ignore hexaaquachromium	

Question Number	Answer	Additional Guidance	Mark
1(b)(ii)	• ethanal / CH_3CHO	Allow ethanoic acid / CH_3COOH Allow displayed / skeletal formulae Do not award CH_3COH If name and formula are given both must be correct	**(1)**

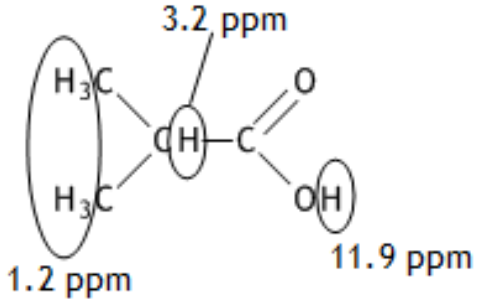
Question Number	Answer	Additional Guidance	Mark
1(c)	• Copper(II) chromate(VI) / copper(II) chromate / $CuCrO_4$	ALLOW copper chromate(VI) / copper chromate	**(1)**

Question Number	Answer	Additional Guidance	Mark
1(d)	An answer that makes reference to the following points: • Copper(II) ions / Cu^{2+} and chromate(VI) ions /CrO_4^{2-} are both coloured and the observed (green) colour is a mixture	If oxidation numbers are given they must be correct. If name and formula are given both must be correct e.g. copper(II) ions are blue, chromate(VI) ions are yellow and the two colours mix to give green Allow omission of oxidation numbers Allow answers that do not refer to specific ions e.g. compound contains blue ions and yellow ions (so seen as green) Ignore just 'mixing blue and yellow forms green' Ignore explanations for the colours of transition metal ions or the observed colour being due to the absorption of the complementary colour Ignore formula errors e.g. CrO_4^-	**(1)**

(Total for Question 1= 10 marks)

Question Number	Answer	Additional Guidance	Mark
2(a)	An answer that makes reference to the following points: • smell (and formula) **(1)** • volatile product identified as ethanol / CH_3CH_2OH or peak at m / z = 46 due to $CH_3CH_2OH^+$ **(1)** • identifies the mass spectrum peak as CH_3CO^+ **(1)** • identifies **P** as $CH_3COOCH_2CH_3$ **(1)**	If names and formulae are give in 2 both must be correct suggest an ester Allow ethanol without stated justification Allow peak at m / z = 46 because ethanol present Any structure, and charge on any part of the structure Allow $C_2H_3O^+$ Do not award $C_3H_7^+$ Do not award if charge omitted Accept displayed or skeletal structure Allow ethyl ethanoate / $CH_3COOC_2H_5$ No TE on incorrect deductions Standalone mark	**(4)**

Question Number	Answer	Additional Guidance	Mark
2(b)(i)	An answer that makes reference to the following points: • meaning of carbon dioxide evolved (and molecular formula) **(1)** • structures of **Q** and **R** **(1)**	e.g. React with $NaHCO_3$ / form CO_2 so Q and R are carboxylic acids / C_3H_7COOH Allow acids for carboxylic acids $(CH_3)_2CHCOOH$ **and** $CH_3CH_2CH_2COOH$ Allow any type of structure Allow names 2-methylpropanoic acid / methylpropanoic acid and butanoic acid	**(2)**

Question Number	Answer	Additional Guidance	Mark
2(b)(ii)	An answer that makes reference to the following points: • three peaks indicates three proton environments **(1)** • peak areas indicate one proton environment with six protons **(1)** • doublet (at 1.2 ppm) indicates (six) protons adjacent to a proton environment with only one proton OR Heptuplet (at 3.2 ppm) indicated a proton adjacent to a proton environment with six protons **(1)** • identification of **Q** as $(CH_3)_2CHCOOH$ **(1)**	Allow three types of proton Allow non-standard terminology e.g. 'two splits' If no other mark is scored correct description of n+1 rule on given structure scores (1) Structure of **Q** with the proton environments labelled and linked to the spectrum scores M1, M2 and M4 e.g.  	**(4)**

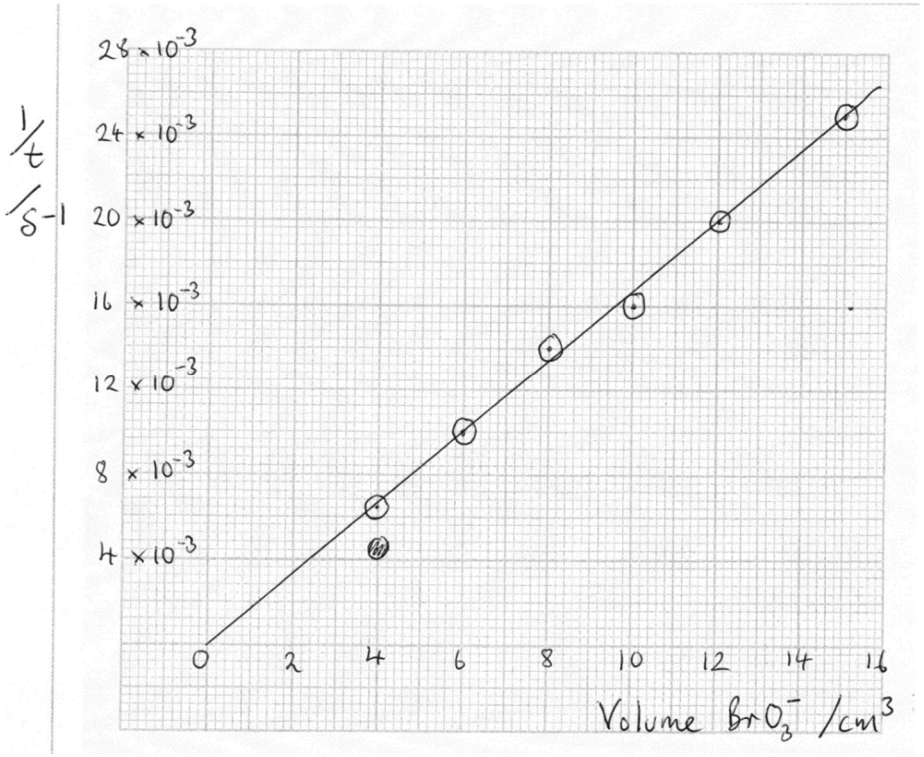
(Total for Question 2 = 10 marks)

Question Number	Answer	Additional Guidance	Mark
3(a)	• phenol is corrosive **and** wearing gloves	Allow caustic Allow phenol is toxic by skin absorption so wear gloves Ignore irritates the skin Ignore use of fume cupboard Do not award toxic so use fume cupboard **and** corrosive so use gloves	**(1)**

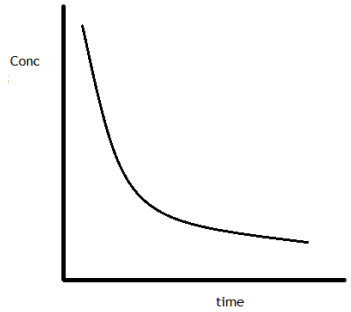
Question Number	Answer	Additional Guidance	Mark
3(b)	An answer that makes reference to the following points: • phenol reacts (rapidly) with the bromine (formed in the reaction) **(1)** • when all the phenol is used up the (excess)bromine bleaches the methyl red indicator (marking a fixed point in the progress of the reaction) **(1)**	Ignore reference to white precipitate (of 2,4,6-tribromophenol) Allow phenol removes the bromine Do not award phenol is a solvent Allow indicator decolourises when all the phenol has reacted / is used up	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(c)	• use a **white** card / **white** background	Allow any position of the white card (etc) Ignore adding more indicator / increased conc Do not award use of a cross (on white card) Do not award use of a colorimeter	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(d)(i)	• so the volume (of $BrO_3^-(aq)$) is proportional to concentration	Allow equal / equivalent to for proportional Ignore fair test	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(d)(ii)	• suitable choice of scale and correct choice of axes **(1)** • axes labelled, with units **(1)** • **all** six points plotted correctly **and** best fit line (through the origin) **(1)** COMMENT Mark the plotting and BFL by impression but points 1,2 5 and 6 should be on the line with 3 slightly above the line and 4 slightly below. If the scale is non-linear only M2 is available	Points plotted **together with** the origin (if included but not required) must cover at least 50% of the graph in both directions 1/t on vertical axis Ignore punctuation errors e.g. (cm^3) instead of / cm^3 	**(3)**

Question Number	Answer	Additional Guidance	Mark
3(d)(iii)	• first order (with respect to bromate(V) ions) **and** because the graph ((of 1/t ∝ rate) v volume of BrO_3^- (∝ concentration)) is a straight line (through the origin)	Allow first order (with respect to bromate(V) ions) **and** because as the concentration / volume (of BrO_3^-) doubles, the rate doubles. Or because as the concentration / volume (of BrO_3^-) doubles, the time halves. Ignore rate increases as concentration of BrO_3^- increases because rate proportional to concentration of BrO_3^-	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(d)(iv)	• the methyl red is decolourised early in the reaction when the concentration of reactant vs time graph is (almost) linear so the gradient of the tangent is the same as the (change in) concentration / time Example of possible graph  	Accept this shown on a sketch graph Allow assumes that the reaction **rate** is constant for a particular run using conc v time graph as shown on left do not award just 'concentration is proportional to time'	**(1)**

Question Number	Answer	Additional Guidance	Mark
3(d)(v)	An explanation that makes reference to the following points: • the portion need not be discarded **and** as the data is plotted on a graph, the actual volume of the BrO_3^- solution is not important (provided the (accurate) volume is known) **(1)** • but the volume of water added must change from 7.0 cm^3 to 6.5 cm^3 **(1)**	Ignore references to experimental uncertainty Allow the portion need not be discarded **and** if the volume is known or the total volume of the solution must still be kept at 40 cm^3 If no other mark is scored, 'portion should be discarded **and** because the total volume will have changed' scores (1)	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(e)(i)	• the burette would transfer the liquid too slowly (so the start time would be inaccurate)	Accept reverse arguments Accept if a burette is used the reaction will start before all the $KBrO_3$ is added. Allow if a burette is used the reaction will start immediately so difficult to measure the time	**(1)**

Question Number	Answer		Additional Guidance	Mark
3(e)(ii)	• 15.0 cm^3 (of the BrO_3^-) is the largest volume so it will have the lowest (percentage) uncertainty • no water is used so this (volume measurement uncertainty) is eliminated	**(1)** **(1)**	Ignore reference to measurement error Allow just 'this is the largest volume' Allow just 'no water added' Allow only 3 volumes measured	**(2)**

Question Number	Answer		Additional Guidance	Mark
3(f)	An answer that makes reference to the following points: • repeat the experiment for (various concentrations of) Br^- ions and (then for) H^+ ions • varying volume of each, (adding the appropriate volume of water and) keeping all other volumes constant	**(1)** **(1)**	Allow H_2SO_4 for H^+ ions Allow concentration for volume If no other mark is scored Repeat experiment varying the volume of Br^- varying the volume of Br^-ion solution and keeping volume of BrO_3^- constant scores (1)	**(2)**

(Total for Question 3 = 17 marks)

Question Number	Answer	Additional Guidance	Mark
4(a)	• when the reagents are mixed an exothermic reaction occurs	Allow just 'exothermic reaction' Ignore violent / vigorous Ignore 'to keep the mixture cool' Ignore 'to prevent evaporation' Ignore 'to slow the reaction' Ignore 'reference to equilibrium' Do not award explosive Do not award to prevent decomposition Do not award to quench the reaction	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(b)	An answer that makes reference to the following points: • concentrated sulfuric acid acting as a catalyst	Allow speeds up the reaction / lowers the activation energy Ignore increases yield of ester / shifts equilibrium to the right / provides H^+ Do not award to initiate the reaction	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(c)	• calculation of mass of 5.0 cm^3 of ethanoic anhydride **(1)** • calculation of amount of ethanoic anhydride **(1)** • calculation of amount of 2.00 g of 2-hydroxybenzoic acid **and** comparison **(1)**	Example of calculation: mass = 5.0 x 1.082 = 5.41 g mol ethanoic anhydride = 5.41/102 = 0.05304 / 5.304 x 10^{-2} (mol) mol 2-hydroxybenzoic acid = 2/138 = 0.01449 / 1.449 x 10^{-2} (mol) and 0.01449 < 0.05304 Ignore SF Penalise incorrect rounding once only TE at each stage Allow alternative methods e.g. mol 2-hydroxybenzoic acid = 2/138 = 0.01449 (mol) (1) mass of min mol ethanoic anhydride = 0.01449 x 102 = 1.4783 g (1) vol of min mol ethanoic anhydride = 1.4783 ÷ 1.082 = 1.3662 cm^3 **and** 5 > 1.3662 (so ethanoic anhydride in excess) (1)	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(d)	An answer that makes reference to the following points: • reflux condenser sealed **(1)** • direction of water flow in condenser is incorrect **(1)** • conical flask should not be used **(1)**	If additional errors are listed, mark these first Allow reflux condenser should be open (at top) Allow water should flow in through the bottom (and out through the top) Allow pear-shaped / round-bottom flask should be used Allow the answers as annotations on the diagram Do not award use of a thermometer	**(3)**

Question Number	Answer	Additional Guidance	Mark
4(e)	• to react with / remove excess ethanoic anhydride	Allow to dissolve excess ethanoic anhydride to dissolve / remove ethanoic acid to precipitate / crystallise the aspirin to improve yield of crystals Do not award quenches / stops the reaction Ignore just ‘to cool the mixture’	**(1)**

Question Number	Answer	Additional Guidance	Mark
4(f)	An answer that makes reference to the following points: • speed of filtration **(1)** • removal of water **(1)**	Example of answers faster drier product Allow dries product Allow removes more filtrate Ignore more efficient Do not award removes more impurity	**(2)**

Question Number	Answer	Additional Guidance	Mark
4(g)	A description that makes reference to the following points • melting temperature determination **(1)** • melting temperature sharp **and** close to book value / 136°C **(1)**	M1 may be inferred from M2 Allow melting point Do not award boiling temperature determination measurement of percentage yield. heat to constant mass Allow melting temperature sharp and compare to literature value Ignore descriptions of experimental method	**(2)**

(Total for Question 4 = 13 marks)
Total for paper = 50 marks

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom