Pearson Edexcel

Mark Scheme (Unused)

January 2022

Pearson Edexcel International Advanced Level
In Chemistry (WCH16)
Paper 01: Practical Skills in Chemistry II

Question number	Answer	Additional guidance	Mark
1(a)	• **X** contains a transition metal ion	Accept **X** contains iron(II) / Fe^{2+} / nickel(II) / Ni^{2+} / chromium(III) / Cr^{3+} Allow **X** is a transition metal compound Ignore references to the d block Ignore does not contain Fe^{3+}	**1**

Question Number	Answer	Additional guidance	Mark
1(b)	• (cation is) ammonium (ion) / NH_4^+	Ignore references to the **gas** being ammonia / NH_3	**1**

Question number	Answer	Additional guidance	Mark
1(c)(i)	• observation (1) inferences • carbonate / CO_3^{2-}(1) • sulfite / sulfate(IV) / SO_3^{2-}(1)	White **and** precipitate Allow ppt / ppte / solid / crystals for precipitate Allow any two of hydrogencarbonate / HCO_3^- hydrogensulfite / hydrogensulfate(IV) / HSO_3^- hydrogensulfate / HSO_4^- ethanedioate /oxalate / $C_2O_4^{2-}$ If name and formula are given both must be correct	**3**

Question number	Answer	Additional guidance	Mark
1(c)(ii)	• no change	Accept precipitate remains / does not dissolve Allow no reaction / no effervescence / no fizzing / no bubbling	**1**

Question number	Answer	Additional guidance	Mark
1(c)(iii)	An answer that makes reference to the following point: • identification of one suitable cation	chromium(III) / Cr^{3+} / $Cr(H_2O)_6^{3+}$ / $Cr^{3+}(aq)$ Or nickel(II) / Ni^{2+} / $Ni(H_2O)_6^{2+}$ / $Ni^{2+}(aq)$ Do not award if oxidation state / charge omitted or incorrect Do not award iron(II) / Fe^{2+} if name and formula are given both must be correct	**1**

Question number	Answer	Additional guidance	Mark
1(c)(iv)	An answer that makes reference to the following point: • $Cr(OH)_6^{3-}$	Ignore name even if incorrect Do not award a nickel complex	**1**

Question number	Answer	Additional guidance	Mark
1(c)(v)	An answer that makes reference to the following point: • identification of the ion by name or formula	 chromate((VI)) / CrO_4^{2-} if name and formula are given both must be correct If oxidation state is given it must be correct	**1**

Question number	Answer	Additional guidance	Mark
1(c)(vi)	• identification of the ion by name or formula	dichromate((VI)) / $Cr_2O_7^2$ if name and formula are given both must be correct If oxidation state is given it must be correct	**1**

Question number	Answer	Additional guidance	Mark
1(d)	• identification of the eliminated ion by name or formula (1) • justification (1)	iron(II) / Fe^{2+} cannot be the cation Or iron(II) hydroxide / $Fe(OH)_2$ cannot be the precipitate because precipitate would turn brown / reddish-brown Allow iron(III) hydroxide / $Fe(OH)_3$would be formed (on standing) Ignore just ‘precipitate will be oxidised’	**2**

Question number	Answer	Additional guidance	Mark
1(e)	• balanced-charge formula of suitable compound	$CrNH_4(SO_4)_2$ / $Cr_2(NH_4)_2(SO_4)_4$ / $Cr_2(SO_4)_3 \cdot (NH_4)_2SO_4$ Allow ions in any order If ion charges are given they must be correct Do not award unless no overall charge Ignore water of crystallisation Allow balanced-charge formula with Fe or Ni instead of Cr as TE on 1(c)(iii)	**1**

(Total for Question 1= 13 marks)

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional guidance</th><th>Mark</th></tr>
<tr>
<td>2(a)</td>
<td>
Route 1
• calculation of moles of carbon, hydrogen and oxygen (1)

• division by lowest number of moles (1)

• simplest whole number ratio of C:H:O
and
empirical formula (1)

• use of M_r to deduce molecular formula (1)

Route 2
• use of molecular ion peak to deduce M_r (1)

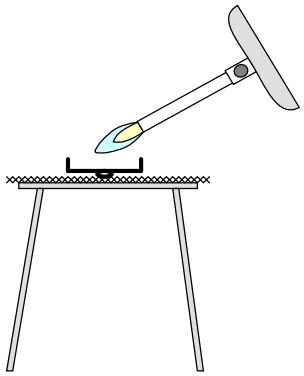
• calculation of mass of each element in 1 mol of P (1)

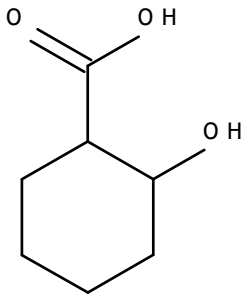
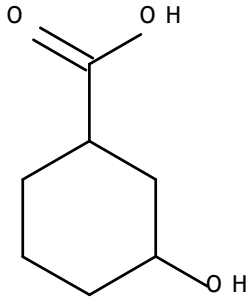
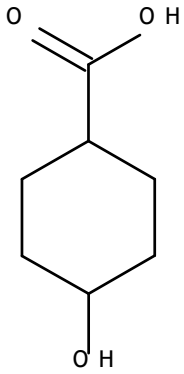
• calculation of moles of each element in 1 mol of P (1)

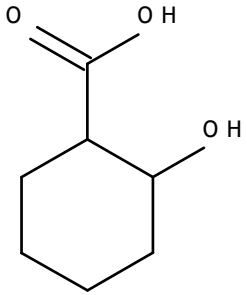
• statement of molecular formula of P (1)
</td>
<td>
Example of calculation
<table>
<tr><td></td><td>Carbon</td><td>Hydrogen</td><td>Oxygen</td></tr>
<tr><td>%</td><td>60.87</td><td>4.35</td><td>34.78</td></tr>
<tr><td>mol</td><td>60.87/12
= 5.0725</td><td>4.35/1
= 4.35</td><td>34.78/16
= 2.1738</td></tr>
<tr><td>÷2.1738</td><td>2.3335</td><td>2.0011</td><td>1</td></tr>
<tr><td>Ratio</td><td>7</td><td>6</td><td>3</td></tr>
</table>
and
(Empirical formula) = $C_7H_6O_3$

Molecular ion peak = Empirical formula mass =138
and
molecular formula = $C_7H_6O_3$ or P is $C_7H_6O_3$
Or
Molecular ion peak = 138 = M_r
<table>
<tr><td></td><td>Carbon</td><td>Hydrogen</td><td>Oxygen</td></tr>
<tr><td>%</td><td>60.87</td><td>4.35</td><td>34.78</td></tr>
<tr><td>mass /g+</td><td>0.6087
x 138
= 84.0</td><td>0.0435
x 138
= 6.003</td><td>0.3478
x 138
= 48.00</td></tr>
<tr><td>mol</td><td>84/12
7</td><td>6.003/1
= 6</td><td>48/16
= 3</td></tr>
</table>
molecular formula = $C_7H_6O_3$ or P is $C_7H_6O_3$
Correct answer with no working scores M4 only
</td>
<td>4</td>
</tr>
</table>

Question number	Answer	Additional guidance	Mark
2(b)(i)	An answer that explains the significance of • effervescence with sodium hydrogencarbonate (1) • no reaction with cold dilute solution of potassium manganate(VII) (1) • reaction with bromine water (1) • smoky flame (1)	Carboxylic acid group / COOH Allow just 'acid' No C=C / alkene group Ignore reference to oxidation not occurring Do not award other functional groups phenol group Do not award alkene aromatic compound / arene / aryl group Allow benzene ring present Ignore **P** is unsaturated / has high carbon to hydrogen ratio	**4**

Question number	Answer	Additional guidance	Mark
2(b)(ii)	An answer that makes reference to • the use of a crucible lid (1) • on a tripod and gauze / pipe-clay triangle **and** ignition from above (1) • use of a Bunsen burner (1)	Allow other ceramic apparatus e.g. evaporating basin / crucible Do not award use of glassware Allow place on a heat-proof mat Example of diagram which scores 3 marks  Allow for 3 marks Combustion / deflagrating spoon (1) Bunsen burner (1) Non-luminous flame / air-hole open (1) Do not award M2 and M3 for use of lighted splint	**3**

Question number	Answer	Additional guidance	Mark
2(c)	  	Three structures correct scores (2) Two structures correct scores (1) Allow any structure that shows the different substituent positions including Kekulé structures and. COOH / CO_2H Penalise the omission of the delocalised / Kekulé ring once only	2

Question number	Answer	Additional guidance	Mark
2(d)	An answer that makes reference to • the wavenumber of the circled peak **and** appreciation that this shows that **P** has 4 adjacent C-H groups (1) • only possible if OH and COOH are on adjacent carbon atoms (1)	750—760 cm^{-1} Allow M2 for correct structure selected  or 2-hydroxybenzoic acid TE on incorrect wavenumber reading for M2	**2**

(Total for Question 2= 15 marks)

Question number	Answer	Additional guidance	Mark
3(a)(i)	An answer that makes reference to • transfer of the (100 cm^3) solution to a (250 cm^3) volumetric flask (1) • addition of washings / rinsings (1) • making up the solution to the mark (with distilled water / dilute sulfuric acid) **and** mixing (1)	Allow graduated / standard /measuring flask Allow 'to the line' / 'to 250 cm^3' / to **bottom** of meniscus Allow any indication of mixing e.g. inverting / shaking / swirling	**3**

Question number	Answer	Additional guidance	Mark
3(a)(ii)	• (pale) pink	Ignore reference to solution turning yellow Do not award purple / mauve	**1**

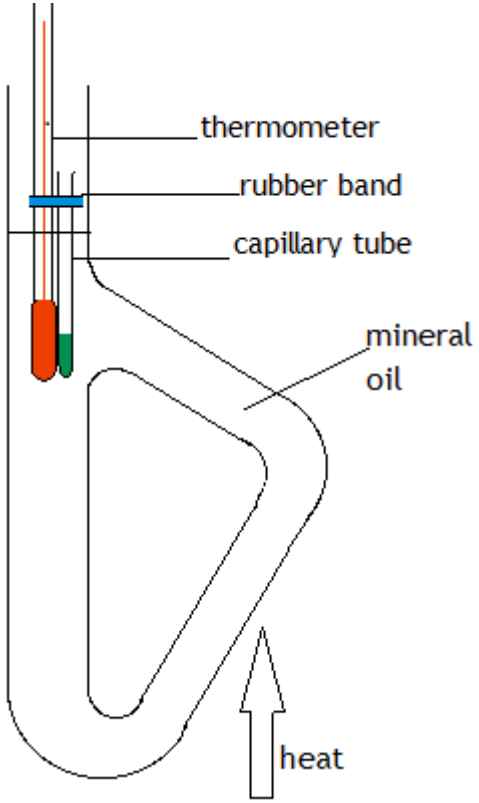
Question number	Answer	Additional guidance	Mark
3(a)(iii)	• calculation of amount of MnO_4^- in the mean titre (1) • calculation of amount of FeC_2O_4 in 25 cm^3 (x 5/3) (1) • calculation mass of 1 mol of $FeC_2O_4.xH_2O$ (1) • calculation of M_r of FeC_2O_4 **and** subtraction from mass of 1 mol of $FeC_2O_4.xH_2O$ (1) • calculation of moles of water (÷18) **and** rounding to integer value (1)	Example of calculation 34.25 x 0.0195 / 1000 = 6.67875 x 10^{-4} / 0.000667875 (mol) 6.67875 x 10^{-4} x 5/3 = 1.11313 x 10^{-3} / 0.00111313 (mol) 2.02 ÷ (1.11313 x 10^{-3} x 10)= 181.471 (g) M_r (FeC_2O_4) (=(55.8 + 12x2 + 16x4) = 143.8 mass of water = 181.471 − 143.8 = 37.671 (g) 37.671 ÷ 18 = 2.0928 **and** x = 2 Accept alternative routes e.g. mass of FeC_2O_4 = 0.00111313 x 10 x 143.8 = 1.60067 mass of water = 0.419326 g then calculation of moles and ratio Do not award correct answer with no working TE at each stage Final answer must be an integer	**5**

Question number	Answer	Additional guidance	Mark
3(b)(i)	An answer that makes reference to • identification of a suitable method (1) • identification of the measurements required (1) • identification of a means of converting the experimental measurements into concentrations of manganate(VII) ions (1)	Example of method Use of a colorimeter / spectrophotometer Measurement of transmittance / absorbance values at various times Use of a calibration curve to obtain concentrations ALLOW Use of a gas syringe / gas collection over water Measurement of gas volumes at various times Use of molar volume and equation to convert volume of CO_2 into amount of manganate(VII) Or Use of mass balance Measurement of mass loss at various times Use of M_r and equation to convert mass of CO_2 into amount of manganate(VII) Do not award sampling methods	**3**

Question number	Answer	Additional guidance	Mark
3(b)(ii)	An answer that makes reference to • rate at point **A** = 1 x 10^{-6} mol dm^{-3} s^{-1} (1) • rate at point **B** = 5.5 x 10^{-6} mol dm^{-3} s^{-1} (1)	Allow 9 x 10^{-7} — 1.1 x 10^{-6} mol dm^{-3} s^{-1} Allow 4.5 — 6.5 x 10^{-6} mol dm^{-3} s^{-1} Ignore signs If both values given but outside the specified ranges, units score 1 mark or two **tangents** and gradient calculations score 1 mark Penalise omission of units once only	**2**

Question number	Answer	Additional guidance	Mark
3(b)(iii)	An answer that makes reference to • rate at B is faster than rate at A **and** appreciation that rate usually slows as the reaction proceeds (1) • reaction is auto-catalysed / catalysed by product / Mn^{2+} (which is produced in the reaction) (1)		**2**

(Total for Question 3= 16 marks)

Question number	Answer	Additional guidance	Mark
4(a)	An answer that makes reference to **M1** • sealing the capillary tube (with a Bunsen flame) **and followed by** inserting the solid into the capillary tube (by pushing the tube into the solid and then tapping the tube gently on the bench / rubbing with a milled coin) (1) **M2** • filling the Thiele tube (just higher than the upper arm) with the clear mineral oil (1) **M3** • use the rubber band to attach the capillary tube to the thermometer **and** so that the bottom of the tube is near the bulb of the thermometer **and** place them into the Thiele tube near upper part of arm (1) **M4** • heat the Thiele tube (anywhere) on the **side-arm (**with the Bunsen burner) (1) **M5** • note the temperature when the solid just changes into a liquid (1)	**M1** to **M4** may be scored with a labelled diagram.  Ignore just 'note melting temperature ' If the mineral oil is used in the beaker only **M1**, **M3** and **M5** may be scored.	**5**

Question number	Answer	Additional guidance	Mark
4(b)	An answer that makes reference to • the impure solid would have a lower melting temperature	Allow The impure solid would melt gradually / over a (wide) range (whereas the pure solid would melt sharply)	**1**

(Total for Question 4= 6 marks)
Total for Question paper = 50 marks