2020 PU3 H2 MI Prelim P4 Mark Scheme

1(a)	**M1**	Construct a table for 5 results and Correct headings and units for volumes of FA1, distilled water and time.
	M2	All times recorded to the nearest second and Volumes of FA1 and distilled water to nearest 0.05 cm^3
	M3	Three further experiments chosen with intervals not less than 1 cm^3 and no volume less than 6 cm^3.
	M4	Water added to make total volume of FA 1 and water constant in each experiment and no other changes in volume.
	M5	Time increases with decrease in volume FA 1.
1(b)(i)	**M6**	Amount of $S_2O_3^{2-}$ = $\frac{20}{1000}$ x 0.010 = 0.000200 mol
1(b)(ii)	**M7**	Amount of H_2O_2 = 0.000100 mol
1(b)(iii)	**M8**	Change in concentration of H_2O_2 = $\frac{0.000100}{\frac{65}{1000}}$ = 0.00154 mol dm^{-3}
1(b)(iv)	**M9**	Rates correctly calculated using $\frac{0.00154}{reaction\ time} \times 10^5$ Values in 3 sig fig Units for rate in mol dm^{-3} s^{-1}
1(c)	**M10**	Axes labelled – rate/ mol dm^{-3} s^{-1} on *y*-axis and volume of FA 1 / cm^3 on *x*-axis. Scales to use at least half of each axis
	M11	Correct plotting – **all** points recorded plotted and within half a small square and within correct small square.
	M12	Draws a line of best fit (can be straight line or curve). Straight lines must be straight (single line with no kinks, drawn using a ruler) or a smooth curve (gradual change in gradient).
1(d)	**M13**	Analyse the order based on the shape of graph. Straight line: 1st order
1(e)	**M14**	To ensure an equal amount of iodine (or H_2O_2) has reacted for each experiment before the solution turns dark blue in each experiment.
1(f)	**M15**	States that excess I_2 left in the flask will react with the $S_2O_3^{2-}$ in the new experiment. As there is lesser $S_2O_3^{2-}$ for the new experiment, less I_2 is reacted, the time taken to produce the I_2 will be shorter in the second experiment and hence observe the blue colour faster.

1(g)(i)

Preparation of the 100 cm^3 of 1.00 mol dm^{-3} aqueous iodine standard solution

Amount of I_2 needed = (100/1000) x 1 = 0.100
Mass of I_2 needed = 0.100 x (126.9 x 2) = 25.38 g

1. Weigh accurately about **25.38 g** of I_2 using a clean, dry weighing bottle using a mass balance by recording the mass of the I_2 and weighing bottle as shown in the table below.

Mass reading table

Mass of weighing bottle with I_2 / g	***x***
Mass of weighing bottle with residual mass / g	***y***
Mass of I_2 added/ g	***x - y***

2. Transfer the weighed solid into a 100 cm^3 beaker and dissolve it using distilled water and stir.

3. Transfer the solution and washings into a **100 cm^3 volumetric flask**.

4. Reweigh the empty weighing bottle and record its mass.

5. Top up to the mark with distilled water. Stopper, invert and shake well to obtain a homogeneous solution.

M16 Determination of the correct mass of I_2

M17 Correct procedure for weighing

M18 Correct procedure of preparation of standard solution

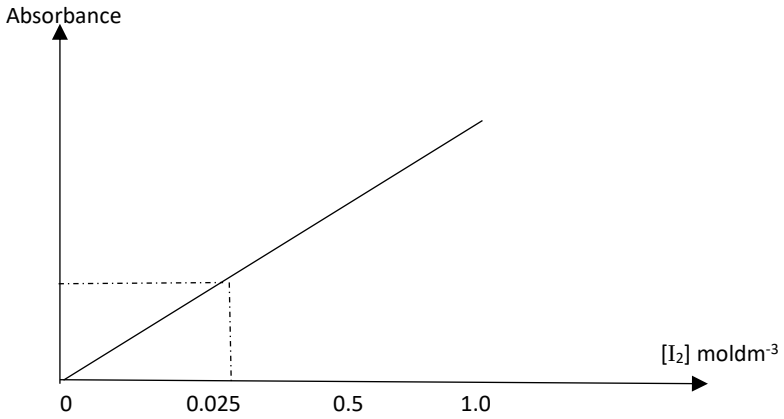
1(g)(ii)

5 different solutions with different concentrations of I_2 (aq) were prepared, as shown in the following table:

Solution	**Volume of 1.0 moldm^{-3} of I_2 (aq) / cm^3**	**Volume of deionized water / cm^3**	**Total volume / cm^3**	**[I_2] / mol dm^{-3}**	Absorbance value
1	20.00	0.00	20.00	1.000	
2	10.00	10.00	20.00	0.500	
3	5.00	15.00	20.00	0.250	
4	2.50	17.50	20.00	0.125	
5	1.00	19.00	20.00	0.050	

1. Fill the 50cm^3 burette with 1.00 mol dm^{-3} I_2 standard solution.
2. To prepare 0.500 mol dm^{-3} of I_2 (aq), add 10.00 cm^3 of 1.00 mol dm^{-3} I_2 standard solution into a 50 cm^3 beaker.

3. Using a separate burette, add 10.00 cm^3 of deionised water into the beaker and stir using a glass rod to obtain a homogenous solution.

	M19 **M20**	4. Repeat the above steps to obtain diluted solutions of different concentrations using the volumes in the table. Prepare at least 3 other solutions of different concentrations with correct calculations Correct procedure with appropriate apparatus
1(g)(iii)		**Table of results** **Using the spectrometer** 1. Add solution 1 into the 1 cm wide glass cuvette and run the spectrometer to record the absorbance value. Repeat for solutions 2-5. 2. Plot a graph of absorbance value versus $[I_2]$. 3. Draw the best-fit straight line passing through the origin. This is the calibration line.  **Analysing solution FA5** 1. Add **FA 5** into the 1 cm wide glass cuvette and run the spectrometer. Record the absorbance value, A_x.

Solution	**$[I_2]$ / mol dm^{-3}**	**Absorbance value**
1	1.000	1.96×10^4
2	0.500	9.80×10^3
3	0.250	4.90×10^3
4	0.125	2.45×10^3
5	0.05	9.80×10^2

		2. Using the graph drawn earlier, draw a horizontal line at value A_x to intersect the calibration line. By drawing a vertical line down from the intersection point, $[I_2]$ in **FA 5** can be determined.
	M21 **M22** **M23** **M24**	Correct calculation of the absorbance value Correct sketch of calibration line Outline of how to obtain the calibration line Appropriate procedure to determine the unknown concentration of the aqueous iodine solution
1(h)	**M25**	$3000 = (1.96 \times 10^4)(c)(1)$ $c =$ **$\underline{0.153 \text{ mol dm}^{-3}}$**
1(i)	**M26** **M27**	Toxic vapour since iodine sublimes easily Carry out in fumehood or keep away from high temperature
2(a)	**M28**	Tabulates initial and final burette readings and volume of **FA 7** used. Table has correct headers and units. All accurate burette readings rounded to the nearest 0.05 cm^3.
	M29	Has at least two uncorrected titres within 0.10 cm^3. (i.e. consistent) Titres labelled "rough" may be included.
	M30	Check all subtractions in (a). Use the titres, corrected where necessary, to select the "best average" titre to be used as an accuracy standard using the following hierarchy. • value of 2 identical titres • average of titres within 0.05 cm^3 • average of titres within 0.10 cm^3, etc. Do not round calculated averages to nearest 0.05 cm^3. Compare the calculated average to the supervisor's value (22.05 cm^3). If the difference is < 0.40 cm^3, award this mark.
(b)	**M31**	Select and calculate correct "average" **from titre values within 0.10 cm^3**.
(c)(i)	**M32**	Correctly identifying the types of reaction as acid-base neutralization and nucleophilic substitution.
(c)(ii)	**M33**	Correctly calculates amount of HCl = $\frac{\text{vol of } \mathbf{FA\ 7} \text{ from (b)} \times 0.100}{1000}$ **And** Amount of KOH is the same.
(c)(iii)	**M34**	Correctly calculates amount of KOH added to **P** = 0.40 × 0.250 = 0.10

(c)(iv)	**M35**	Correctly calculates amount of KOH remaining = answer in **(c)(ii)** × 10
(c)(v)	**M36**	Correctly calculates amount of KOH reacted with **P** = answer in **(c)(iii)** – answer in **(c)(iv)** **And** Amount of **P** = answer ÷ 2
(c)(vi)	**M37**	Correctly calculates M_r of **P** = 4.50 ÷ second answer to **(c)(v)**
(c)(vii)	**M38**	Expression to show 59 + A_r of X = answer in **(c)(vi)**
	M39	Identification of X as halogen with nearest A_r calculated.
(d)	**M40**	Explain that Y has **p-orbital overlap with the π-electron cloud** of the benzene ring, causing the C-Y bond to be stronger hence unable to react with hot aqueous KOH.
3(a)(i)	**M41**	+Na_2CO_3 : effervescence (of a gas that forms white ppt with limewater)
	M42	+$KMnO_4$: purple to colourless
	M43	+ $AgNO_3$: no ppt
	M44	+ Tollens' : silver mirror / grey ppt
(a)(ii)	**M45**	Correctly identify functional groups as carboxylic acid **And either one of** Alkene / aromatic alkyl side-chain / 1°/2° alcohol / aldehyde
(b)(i)	**M46**	Describe the test: add aq NH_3 dropwise until in excess
	M47	Describe the observation: White ppt formed dissolves in excess NH_3(aq)
	M48	Correctly identify the cation in **FA 9** as Zn^{2+} (ECF from M47)
(b) (ii)	**M49**	**FA 9** : purple solution remains **FA 10** : purple solution turns colourless
	M50	**FA 9** : no ppt formed **FA 10** : white ppt formed
	M51	**FA 9** : white ppt formed (soluble in NaOH(aq)) **FA 10** : no white ppt formed
	M52	**FA 9** : gas evolved turned moist red litmus paper blue. **FA 10** : gas evolved, moist red litmus paper remains red
(b)(iii)	**M53**	Correctly identify anion in **FA 9** as nitrate
	M54	Correctly identify anion in **FA 10** as sulfite
(b)(iv)	**M55**	$2MnO_4^-(aq) + 6H^+(aq) + 5SO_3^{2-}(aq) \rightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 3H_2O(l)$ Or $Ba^{2+}(aq) + SO_3^{2-}(aq) \rightarrow BaSO_3(s)$ Or $3NO_3^-(aq) + 8Al(s) + 5OH^-(aq) \rightarrow 3NH_3 + 8[Al(OH)_4]^-$ OR $3Zn^{2+}(aq) + 2Al(s) \rightarrow 3Zn(s) + 2Al^{3+}$