H2 Chemistry Prelim Exam Answers

Paper 4 Answers

1 (a) (i)

Final burette reading / cm ³		
Initial burette reading / cm ³		
Volume of FA 2 added / cm ³	25.40	25.40

(ii) Volume of FA 2 =
$$\frac{25.40 + 25.40}{2}$$

Volume of FA 2 = 2 = 25.40 cm³
(b) (i)
$$25.40$$

$$n_{\text{NaOH}} = 1000 \text{ x } 0.115 = 0.002921 = 0.00292 \text{ mol}$$

(ii) Mass of 1 dm³ of FA $1 = 1.75 \times 1000 = 1750 \text{ g}$

Mass of H₃PO₄ in 1 dm³ of **FA 1** = $\frac{8.40}{100}$ x 1750 = 147 g

Concentration of H_3PO_4 in **FA 1** = 147 g dm⁻³

Concentration of H_3PO_4 in FA 1 = 147 ÷ 98.0 = 1.50 mol dm⁻³

(iii) Concentration of H₃PO₄ in FA 3 = $\frac{10.0}{250}$ x 1.50 = 0.0600 mol dm⁻³

Amount of H₃PO₄ in 25.0 cm³ of **FA 3** = $\frac{25.0}{1000}$ x 0.0600 = 0.00150 mol

(iv) $\frac{n_{NaOH}}{n_{H_3PO_4}} = \frac{0.002921}{0.00150} = 1.947 \approx 2 \text{ (nearest whole number)}$ \Rightarrow Major product is Na₂HPO₄

 $H_3PO_4(aq) + 2NaOH(aq) \rightarrow Na_2HPO_4(aq) + 2H_2O(l)$

(c)

final burette reading	25.60 cm^3
initial burette reading	1.35 cm^3
volume added	24.25 cm ³

• The initial burette reading made by student A was 0.05 cm³ greater than the true value but the volume added was exactly 24.25 cm³.

The final burette reading was also 0.05 cm² greater than the true value.

• The initial burette reading made by student B was 0.05 cm³ less than the true value and the actual volume added was exactly 24.15 cm³.

The final burette reading was 0.05 cm³ greater than the true value.

t / min	T / ⁰C
0.0	32.0
1.0	32.0
2.0	32.0
3.0	32.0
4.0	
5.0	43.0
5.5	42.5
6.0	42.0
6.5	41.5
7.0	41.0
7.5	40.5
8.0	40.0

2	(a)	(i)	The temperature,	T_1	, of the	hot water	t = 4.0	min is	63.0	°C.
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(iii) Minimum temperature, T_2 , at t = 4.0 min is <u>32.0</u> °C.

Maximum temperature, T_3 , at t = 4.0 min is <u>44.0</u> °C.

Temperature rise for 50 cm³ of cold water in beaker A, $(T_3 - T_2)$ is <u>12.0</u> °C.

Temperature fall for 50 cm³ of hot water from the 250 cm³ beaker, $(T_1 - T_3)$ is <u>19.0</u> °C.

(iv) Heat lost by hot water = Heat gained by cold water + Heat gained by beaker A

Heat gained by beaker A = Heat lost by hot water – Heat gained by cold water = $(50.0 \times 4.18 \times 19.0) - (50.0 \times 4.18 \times 12.0)$ = 1463 = 1460 J

(v) Heat absorbed by beaker
$$\mathbf{A} = C_{\text{beaker A}} \times (T_3 - T_2)$$

Heat capacity of beaker $A = \frac{1463}{12.0} = 121.9 = 122 \text{ J} \circ \text{C}^{-1}$

(b) (i)

mass of boiling tube + FA 4 / g	
mass of empty boiling tube / g	
mass of boiling tube + residual FA 4 / g	
mass of FA 4 added / g	9.963
initial temperature of water / °C	
minimum temperature obtained / °C	
temperature fall, $\Delta T / °C$	6.0

(ii)
$$\frac{9.963}{53.5} = 0.1862 = 0.186 \text{ mol}$$

- (iii) Heat absorbed by solution = $100 \times 4.3 \times 6.0 = 2580 \text{ J}$
- (iv) Total change in heat energy $= 2580 + (121.9 \times 6.0) = 3311 \text{ J}$

$$\Delta H_{\text{solution}} = + \frac{3311}{0.1862} \times 10^{-3} = +17.78 = +17.8 \text{ kJ mol}^{-1}$$

(v) The sign is positive since the reaction is endothermic / heat is absorbed in the reaction as the temperature falls during the reaction.

(c)

major source of error	suggested improvement	explanation	
hast loss / gain	lid	prevents convection or evaporation	
neat ioss / gain	insulation	prevents conduction	
	polystyrene cup	provides insulation	

3 (a)

(b)

- 1. Fill a burette with sodium thiosulfate.
- 2. Using separate 100 cm³ measuring cylinders measure 75 cm³ of potassium peroxodisulfate and potassium iodide. Transfer both solutions into a 250 cm³ beaker and start the stopwatch.
- 3. Using a 25 cm³ pipette transfer 25 cm³ of the solution into a clean 250 cm³ conical flask and add about 150 cm³ of deionised water when timing is 2 minutes.
- 4. Titrate the iodine in the conical flask against sodium thiosulfate from the burette
- 5. Add 3–5 drops of starch when the colour of the colour of the solution turns yellow and continue titrating till the blue–black colour decolorised.
- 6. Repeat steps 4 to 7 for another 4 times at 5, 8, 11 and 15 minutes (approximate)
- $n(I^{-})$ present in 150 cm³ reaction mixture = 75/1000 x 0.800 = 0.0600 mol

 $n(I^{-})$ present in 25.0 cm³ pipetted volume = 0.0600 x (25.0 / 150) = 0.0100 mol

max n(I₂) produced in 25 cm³ pipetted volume = $\frac{1}{2}$ x 0.0100 = 0.0050 mol

 $n(S_2O_3^{2-})$ need to react with max I₂ produced = 2 x 0.0050 = 0.0100 mol

 $V(S_2O_3^{2-})$ required for compete reaction = 0.0100 / 0.200 = 0.050 dm³



Since $1^{\text{st t}}/_2 = 2^{\text{nd t}}/_2$, order with respect to iodide ion concentration is first order.

- (d) There is high activation energy between $S_2O_8^{2-}$ and I^- ions as they are both negatively charged hence.
- (e) Adding water to the extracted volumes will decrease the concentration of the reactants, causing the reactant particles to be further apart hence frequency of effective collision and rate of reaction decreases significantly.

4 (a) (i)

Table 4.1

	44	observations	
	test	FA 5	
(i) To 1 cm depth of the FA 5 solution in a test–tube, add aqueous sodium hydroxide, with shaking, until no further change is seen.		White ppt formed is soluble in excess aq NaOH to give a colourless solution.	
(ii) To 1 cm depth of the FA 5 solution in a test–tube, add aqueous ammonia, with shaking, until no further change is seen.		White ppt formed is insoluble in excess aq NH ₃ .	

Identity of cation in FA 5: \underline{Al}^{3+}

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(ii)

	test	observations
(i)	Test for CO_3^{2-} To 1 cm depth of FA 5 solution in a test–tube, add 1 cm depth of HC <i>l</i> (aq).	No effervescence. No observable change.
(ii)	$(H_2SO_4 \text{ and } HNO_3 \text{ accepted})$ Test for halide ions To 1 cm depth of FA 5 solution in a test–tube, add 1 cm depth of HNO ₃ (aq), followed by 1 cm depth of AgNO ₃ (aq).	White ppt formed is soluble in NH ₃ (aq).
	Add excess $NH_3(aq)$ to the resulting solution.	
(iii)	Test for SO ₄ ²⁻	White ppt formed insoluble in excess
	To 1 cm depth of FA 5 solution in a test-tube, add 1 cm depth of BaC $l_2(aq)$ followed excess HC $l(aq)$.	HC <i>l</i> (aq).

Anions present: $\underline{SO_4}^2$ and \underline{Cl}^2

Table 4.2

test		observations
(i)	To 1 cm depth of FA 6 , add 1 cm depth of dilute sulfuric acid followed by 3 drops of aq potassium manganate(VII). Warm the test-tube in a hot water bath.	Purple aq KMnO₄ decolourised.
(ii)	To 1 cm depth of FA 6 , add 5 drops of 2,4–dinitrophenylhydrazine and warm.	No orange ppt formed / Yellow solution remains.
(iii)	To 6 drops of FA 6 , add 1 cm depth of aqueous iodine followed by 1 drop of aqueous sodium hydroxide. Warm the mixture in a water bath for 1 minute. Cool the mixture.	Yellow ppt of CHI ₃ formed.

(ii)

