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** = $\dfrac{25.40 + 25.40}{2}$ = 25.40 cm^3

(b) (i) $n_{NaOH} = \dfrac{25.40}{1000} \times 0.115 = 0.002921 = 0.00292$ mol

(ii) Mass of 1 dm^3 of **FA 1** = 1.75 x 1000 = 1750 g

Mass of H_3PO_4 in 1 dm^3 of **FA 1** = $\dfrac{8.40}{100} \times 1750 = 147$ 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 H_3PO_4 in **FA 3** = $\dfrac{10.0}{250} \times 1.50 = 0.0600$ mol dm^{-3}

Amount of H_3PO_4 in 25.0 cm^3 of **FA 3** = $\dfrac{25.0}{1000} \times 0.0600 = 0.00150$ mol

(iv) $\dfrac{n_{NaOH}}{n_{H_3PO_4}} = \dfrac{0.002921}{0.00150} = 1.947 \approx 2$ (nearest whole number)

$\Rightarrow$ Major product is Na_2HPO_4

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

(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 cm^3 greater than the true value but the volume added was exactly 24.25 cm^3.

  The final burette reading was also 0.05 cm^3 greater than the true value.

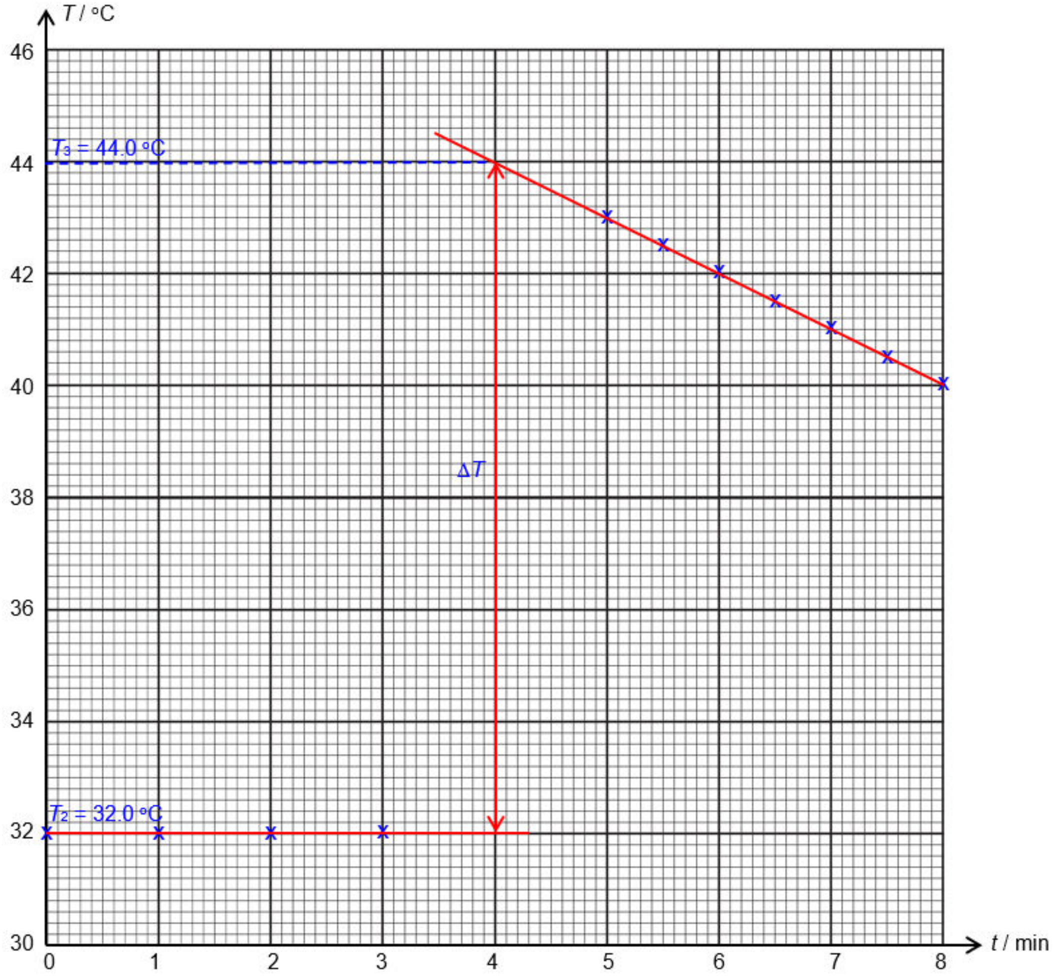
- The initial burette reading made by student B was 0.05 cm^3 less than the true value and the actual volume added was exactly 24.15 cm^3.

  The final burette reading was 0.05 cm^3 greater than the true value.

2 **(a)** **(i)** The temperature, T_1, of the hot water at t = 4.0 min is 63.0 °C.

t / min	T / °C
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

(ii)



(iii) Minimum temperature, T_2, at t = 4.0 min is 32.0 °C.

Maximum temperature, T_3, at t = 4.0 min is 44.0 °C.

Temperature rise for 50 cm^3 of cold water in beaker **A**, $(T_3 - T_2)$ is 12.0 °C.

Temperature fall for 50 cm^3 of hot water from the 250 cm^3 beaker, $(T_1 - T_3)$ is 19.0 °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 x 4.18 x 19.0) – (50.0 x 4.18 x 12.0)
= 1463
= 1460 J

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

Heat capacity of beaker **A** = $\frac{1463}{12.0}$ = 121.9 = 122 J °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, ΔT / °C	6.0

(ii) Mass of NH_4Cl = $\frac{9.963}{53.5}$ = 0.1862 = 0.186 mol

(iii) Heat absorbed by solution = 100 x 4.3 x 6.0 = 2580 J

(iv) Total change in heat energy = 2580 + (121.9 x 6.0) = 3311 J

$\Delta H_{\text{solution}} = +\frac{3311}{0.1862} \times 10^{-3}$ = +17.78 = +17.8 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
heat loss / gain	lid	prevents convection or evaporation
	insulation	prevents conduction
	polystyrene cup	provides insulation

3 **(a)**

1. Fill a burette with sodium thiosulfate.
2. Using separate 100 cm^3 measuring cylinders measure 75 cm^3 of potassium peroxodisulfate and potassium iodide. Transfer both solutions into a 250 cm^3 beaker and start the stopwatch.
3. Using a 25 cm^3 pipette transfer 25 cm^3 of the solution into a clean 250 cm^3 conical flask and add about 150 cm^3 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)

(b) n(I^-) present in 150 cm^3 reaction mixture = 75/1000 x 0.800 = 0.0600 mol

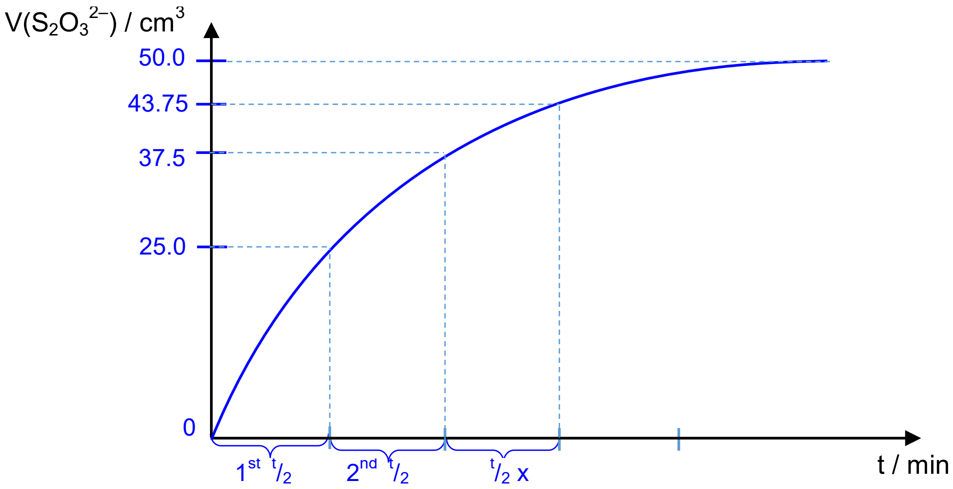
n(I^-) present in 25.0 cm^3 pipetted volume = 0.0600 x (25.0 / 150) = 0.0100 mol

max n(I_2) produced in 25 cm^3 pipetted volume = ½ x 0.0100 = 0.0050 mol

n($S_2O_3^{2-}$) need to react with max I_2 produced = 2 x 0.0050 = 0.0100 mol

V($S_2O_3^{2-}$) required for compete reaction = 0.0100 / 0.200 = 0.050 dm^3

(c)



Since 1st $^t/_2$ = 2nd $^t/_2$, 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

test		observations
		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**: $\underline{Al^{3+}}$

(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*l*(aq). (H_2SO_4 and HNO_3 accepted)	No effervescence. No observable change.
(ii)	**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). Add excess NH_3(aq) to the resulting solution.	White ppt formed is soluble in NH_3(aq).
(iii)	**Test for SO_4^{2-}** 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).	White ppt formed insoluble in excess HC*l*(aq).

Anions present: SO_4^{2-} and C*l*$^-$

(b) (i) **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 $KMnO_4$ 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)