

PAPER 2022 PP3

5.5.3 Chemistry Paper 3 (233/3)

1 (a)

Table 1

Solution	Colour
Solution B + indicator solution A	Yellow (¹ / ₂)
Solution C1 + indicator solution A	Pink (¹ / ₂)

(1 mark)

The colour change at the end point is from yellow/orange (¹/₂) to pink/red (¹/₂).

(1 mark)

Table 2

	I	II	III
Final Burette Reading	14.85	28.50	26.75
Initial burette eading	1.05	14.85	13.20
Volume of solution (C2 used, cm ³)	13.80	13.65	13.55

(4 marks)

- A) Complete table.....(1 mark)
- B) Use of decimals (1or 2 decimal places consistently used).....(1 mark)
- C) Accuracy (compare the candidate's correct value with the school value (S.V).....(1 mark)
- D) Principles of averaging (average values within $\pm 0.2\text{cm}^3$ of each other.....(in (i) below)
- E) Final accuracy compared to the school value tied to the correct average titre) (S.V).....(1 mark)

(i) Average volume of solution C2 used =

$$= \frac{13.65 + 13.55}{2} \text{ cm}^3 (\frac{1}{2})$$

$$= 13.60 \text{ cm}^3 (\frac{1}{2})$$

(1 mark)

(ii) Number of moles of compound B used.

$$= \frac{25.0 \times 0.05}{1000} \text{ OR } \frac{0.05}{40} \text{ OR } 0.05 \times 0.025^{(1/2)}$$

(1 mark)

$$= 0.00125 = (1.25 \times 10^{-3}) \text{ moles }^{(1/2)}$$

(iii) Moles of hydrochloric acid (C2) used = Answer in (ii) above $\times 2$

$$= 0.00125 \times 2^{(1/2)}$$

$$= 0.0025^{(1/2)}$$

(1 mark)

(iv) Concentration of hydrochloric acid in solution C2 = $\frac{\text{No. of moles in (iii)} \times 1000}{\text{Volume in (i)}}$

$$= \frac{0.0025 \times 1000}{13.60}^{(1/2)}$$

$$= 0.18 \text{ mol l}^{-1}^{(1/2)}$$

(1 mark)

(v) Concentration of hydrochloric acid in solution C1 = $\frac{\text{Answer in (iv)} \times 250}{25}$

$$\text{OR } \frac{250 \times \text{Ans}(iii)}{\text{Average titre}} \quad \text{OR } \frac{250 \times \text{Ans}(iii) \times 1000}{\text{Average titre} \times 25}$$

$$= \frac{0.18 \times 250}{25} \text{ mol l}^{-1}^{(1/2)}$$

$$= 1.8 \text{ mol l}^{-1}^{(1/2)}$$

(1 mark)

(b)

Table 3

Final temperature of the solution, °C	20.0 ^(1/2)
Initial temperature of water, °C	23.5 ^(1/2)
Temperature change, °C	-3.5 ^(1/2)

(1½ marks)

(A) Complete table..... (½ mark)

(B) Use of decimals (tied to the 1st and 2nd columns only) (½ mark)

(C) Accuracy (compare candidate's initial temperature reading to the initial temperature of the S.V) if within ± 2 units..... (½ mark)

(i) Heat change of the solution = $4.2 \times 30 \times \Delta T$

$$= -(4.2 \times 30 \times (-3.5)) \text{ Joules } (^{1/2})$$

$$= +441 \text{ J } (^{1/2})$$

(1 mark)**OR**

$$= \frac{30}{1000} \times 4.2 \times \Delta T$$

$$= \text{Answer in KJ}$$

(ii) Moles of sodium hydrogen carbonate

$$= \frac{2.5}{84} (^{1/2})$$

$$= 0.02976$$

$$\approx 0.03 (^{1/2})$$

(1 mark)

(iii) Heat change, $\Delta H_1 = + \frac{441}{0.03} \times \frac{1}{1000} \text{ kJ mol}^{-1} (^{1/2})$

$$= +14.7 \text{ kJ mol}^{-1} (^{1/2})$$

(1 mark)**OR**

$$= \frac{\text{answer in b(i) in kJ}}{\text{Answer in b(ii)}}$$

$$= \text{Correct answer}$$

Table 4

Final temperature of solution, °C	18.0 (¹ / ₂)
Initial temperature of solution C1, °C	24.0 (¹ / ₂)
Temperature change, °C	-6.0 (¹ / ₂)

(1½ marks)

- (A) Complete table..... (¹/₂mark)
 (B) Use of decimals (tied to the 1st and 2nd columns only)(¹/₂ mark)
 (C) Accuracy (compare candidate's initial temperature reading to the initial temperature of the S.V) if within ±2 units.....(¹/₂ mark)

(i) Heat change of the solution = $4.2 \times 30 \times \Delta T$
 $= -(4.2 \times 30 \times (-6.0)) \text{ Joules } (^{1/2})$
 $= -(-756) \text{ Joules}$
 $= +756 \text{ J } (^{1/2})$

(1 mark)

OR

$$= \frac{30}{1000} \times 4.2 \times \Delta T$$

$$= \text{Answer in KJ}$$

(ii) Heat change, $\Delta H_2 = + \frac{756 \times 1}{0.03 \times 1000} \text{ kJ mol}^{-1} (^{1/2})$
 $= +25.2 \text{ kJ mol}^{-1} (^{1/2})$

(iii) $\Delta H_3 = \Delta H_2 - \Delta H_1$
 $= (+25.2) - (+14.7) \text{ kJ mol}^{-1} (^{1/2})$
 $= +10.5 \text{ kJ mol}^{-1} (^{1/2})$

(1 mark)

OR

(1 mark)

$$\Delta H_3 = \Delta H_2 - \Delta H_1$$

$$= \text{Answer in IIb(ii)} - \text{Answer in Ib(iii)}$$

$$= \text{Correct answer}$$

20 Marks

2. (a)	<p style="text-align: center;">Observations</p>	<p style="text-align: center;">Inferences</p>	(2 Marks)
<p>- Solid burns with a smoky, yellow/ luminous/sooty flame (1)</p>	<p>-Long chain hydrocarbon/ unsaturated compound (1)</p> <p style="text-align: center;">OR</p> <p style="text-align: center;"> $\begin{array}{c} \diagup \quad \diagdown \\ \text{C} = \text{C} \\ \diagdown \quad \diagup \end{array} / -\text{C} \equiv \text{C}- \text{absent}$ </p>		
(b) (i)	<p style="text-align: center;">Observations</p>	<p style="text-align: center;">Inferences</p>	(2 Marks)
<p>-Orange colour of $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$ persists/ does not change to green (1)</p>	<p>Alkanol/ alcohol absent/ R-OH absent (1)</p>		
(ii)	<p style="text-align: center;">Observations</p> <p>- Brown/ yellow colour of bromine is retained/persists/does not change /remains the same (1)</p> <p style="text-align: center;">OR</p> <p>- Bromine water is not decolourised</p>	<p style="text-align: center;">Inferences</p> <p>- Alkene/ alkyne absent (1)</p> <p style="text-align: center;"> $\begin{array}{c} \diagup \quad \diagdown \\ \text{C} = \text{C} \\ \diagdown \quad \diagup \end{array} \text{ OR } -\text{C} \equiv \text{C}- \text{absent}$ </p> <p style="text-align: center;">(Award 1 mark for any one correct)</p>	(2 marks)
(iii)	<p style="text-align: center;">Observations</p> <p>Effervescence/bubbling/fizzing, colourless gas evolved, ($1/2$) extinguishes burning splint ($1/2$)</p>	<p style="text-align: center;">Inferences</p> <p>Alkanoic/ carboxylic acid present H^+, $-\text{COOH}$, present (1)</p> <p style="text-align: center;">OR</p> <p style="text-align: center;">R-COOH (Tied to effervescence/bubbling/fizzing)</p>	(2 marks)

	NB: For tests (a), b(i), b(ii) and b(iii), penalize fully for the inferences of any contradictory functional groups		08 marks
3. (a)	Observations	Inferences	(2 marks)
	White precipitate ($1/2$) insoluble in excess ($1/2$)	Ca^{2+} or Mg^{2+} or Ba^{2+} present (1) (Penalize $1/2$ mark for any contradictory ion to a maximum of 1 mark)	
(b)	Observations	Inferences	(2 marks)
	White precipitate ($1/2$) insoluble in excess ($1/2$)	Mg^{2+} present (1) (Penalize fully for any contradictory ion to a maximum of 1 mark)	
(Penalize $1/2$ mark for any contradictory ions)			
(c)	Observations	Inferences	(3 marks)
	White precipitate/solid/suspension (1) No effervescence/ insoluble in nitric (v) acid (1)	SO_4^{2-} present / SO_3^{2-} or CO_3^{2-} absent (1) (Award 1 mark for any of the options) NB: Both must be mentioned in the absence of SO_4^{2-} present	
(d) (i)	Observations	Inferences	(2 marks)
	Red litmus paper remains red/ red litmus paper does not change/ red litmus does not turn blue (1)	NH_4^+ absent (1)	

(ii)	Observations	Inferences	(3 marks)
	Effervescence/bubbles of a colourless gas ($1/2$), red litmus turns blue ($1/2$)	NO ₃ ⁻ present/ NH ₃ evolved (1) (Tied to red litmus paper turning blue)	
	<p>Cation: Magnesium ions/ Mg²⁺ ($1/2$)</p> <p>Anions: SO₄²⁻ (sulphate), NO₃⁻ (nitrate) ($1/2$)</p>		
			12 marks