2026 Sec 4 Prelim Chemistry P3 Mark Scheme

Question	Indicative material	Mark	Total
1(ai)	*Results table:* records initial burette readings, final burette readings and volume added with correct headings and units in a titration Reject: initial volume all burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm^3 *Titration Results:* accuracy for the average titre (of consistent readings) within 0.20 cm^3 of Supervisor's average value score 2 marks for the average titre (of consistent readings) within 0.30 cm^3 of Supervisor's average value score 1 mark concordance at least two titre values are within 0.20 cm^3 (using uncorrected titres) Supervisor's average value: **25.40 cm^3**	 1 1 2 1	**[5]**
1(aii)	appropriate average volume of **Q** in 2 d.p. from closest titre values (titres should be identified either in the table by a tick, or in a calculation)	1	**[1]**
1(bi)	amount of sodium thiosulfate = 0.10 x 0.0254 = 0.00254 mol	1	**[1]**
1(bii)	amount of iodine = 0.00254 ÷ 2 = 0.00127 mol (allow ecf from bi)	1	**[1]**
1(biii)	amount of $KMnO_4$ = 0.00127 ÷ 5 x 2 = 0.000508 mol (allow ecf from bii)	1	**[1]**
1(biv)	Concentration of $KMnO_4$ = 0.000508 ÷ 0.025 = 0.0203 mol/dm^3 (allow ecf from biii) Appropriate significant figures in final answers in **(bi)**, **(bii)**, **(biii)** and **(biv)**.	1 1	**[2]**
1(c)	If insufficient KI is added, not all the $KMnO_4$ reacts and less iodine is produced. Therefore, a smaller volume of sodium thiosulfate (Q) is required, resulting in a lower calculated concentration of $KMnO_4$ than the actual concentration.	1 1	**[2]**

1(d)	1. Measure 20 cm^3 of solution P using a measuring cylinder and place it in a beaker. 2. Measure 20 cm^3 of aqueous iron(II) sulfate using a measuring cylinder. (assume iron(II) sulfate is in excess) 3. Add the aqueous iron(II) sulfate into the beaker containing solution P and start the stopwatch immediately. 4. Swirl the beaker gently. 5. Stop the stopwatch when the purple colour of solution P just disappears. Record the time taken. 6. Prepare a lower concentration by measuring 10 cm^3 of solution P and 10 cm^3 of distilled water into a beaker. 7. Repeat steps 2 to 5. 8. Compare the time taken for each concentration. The solution that takes less time to become colourless has the faster rate of reaction. <u>Marking points (1 mark each)</u> • Apparatus: measuring cylinder, beaker/conical flask + appropriate volume, stopwatch • Method for obtaining lower concentration of solution P by varying volume of P and distilled water • Variable to be kept constant: volume of iron(II) sulfate and total volume of mixture • Describes the experimental procedure correctly, e.g. mix the solutions and <u>start the stopwatch immediately</u> (or equivalent). • Measures time taken for purple to disappear • Describes how results are used to determine the effect of concentration on rate of reaction	6	**[6]**
2(a)	Test 1: white ppt (in blue solution)	1	**[8]**
	Test 2: green ppt dark blue solution obtained (green ppt turns brown)	2	
	Test 3: no observable change	1	
	Test 4: Blue solution turns colourless or decolourises / turns pale or light green / turns pale or light yellow Effervescence Glowing splint glows brighter / oxygen gas	3	
	Test 5: Brown ppt in dark blue solution Allow red-brown ppt	1	
2(bi)	Anion: sulfate Explanation: white ppt obtained in test 1	1	**[1]**

<table>
<tr><td>2(bii)</td><td>Cation: copper(II) ion
Explanation: dark blue solution obtained when aqueous ammonia is added in excess (test 2 or 5)
Or
Cation: iron(II) ion
Explanation: green ppt obtained in test 2</td><td>1</td><td>[1]</td></tr>
<tr><td>2(c)</td><td>It is an oxidising agent.
Brown ppt obtained in test 5 shows that iron(II) ion in R is oxidised to iron(III) ion when hydrogen peroxide is added.</td><td>1
1</td><td>[2]</td></tr>
<tr><td>3(a)</td><td><table>
<tr><th>mass of magnesium / g</th><th>initial temperature of aqueous copper(II) sulfate / °C</th><th>highest temperature of mixture / °C</th><th>Temperature rise / °C</th></tr>
<tr><td>0.20</td><td>30.0</td><td>32.5</td><td>2.5</td></tr>
<tr><td>0.40</td><td>30.0</td><td>35.5</td><td>5.5</td></tr>
<tr><td>0.60</td><td>30.0</td><td>37.0</td><td>7.0</td></tr>
<tr><td>0.80</td><td>30.0</td><td>37.5</td><td>7.5</td></tr>
<tr><td>1.00</td><td>30.0</td><td>37.5</td><td>7.5</td></tr>
</table>
Calculate accurately + 1dp</td><td>1</td><td>[1]</td></tr>
<tr><td>3(b)</td><td>Plotting of Graph:
Plot a graph of rise in temperature (y-axis) against mass of magnesium (x-axis) +
Axes labelled with correct units, appropriate scale

All points plotted correctly.

Draw two best fit straight line with 1 line passing through origin.</td><td>1

1

1</td><td>[3]</td></tr>
<tr><td>3(ci)</td><td>Records to 0.1 °C (30 + value from graph)</td><td>1</td><td>[1]</td></tr>
<tr><td>3(cii)</td><td>Records to 0.01 g</td><td>1</td><td>[1]</td></tr>
<tr><td>3(ciii)</td><td>No. of moles of Mg = 0.59 ÷ 24
= 0.0246 mol

No. of mole of Cu^{2+} = no. of mole of Mg = 0.0246 mol

Concentration of Cu^{2+} = 0.0246 ÷ 0.03
= 0.492 mol/dm^3</td><td>1

1</td><td>[2]</td></tr>
<tr><td>3(d)</td><td>Use smaller intervals of magnesium mass.</td><td></td><td>[1]</td></tr>
</table>

	Allow: **Repeat the experiment and calculate average**. **Reason**: averaging reduces random error **Reducing heat loss** • Use a polystyrene cup. • Add a lid. • Wrap the container with insulating material. **Reason:** If heat loss is constant, it will not affect the point where the two lines intersect. However, these do improve the accuracy of the temperature rise, which genuinely improves the graph from which the mass is estimated. Reject: **Changes to graph presentation** • Use a larger graph scale. • Use graph paper with smaller squares. • Plot the graph on a computer. **Reason:** These do not generate additional data or reduce uncertainty in the mass at which the graph levels off. **Improvements to temperature measurement** • Use a digital thermometer. • Use a temperature probe/data logger. **Reason:** These improve the accuracy of temperature readings but not the precision with which the Mg mass at the plateau is determined.		