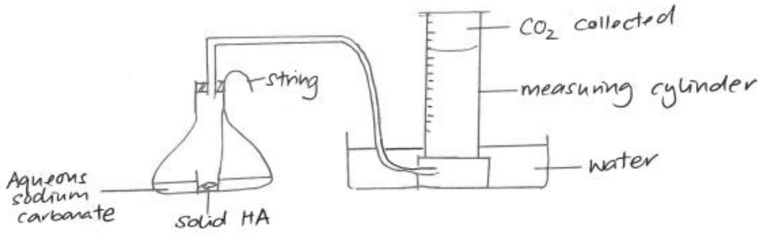
<u>Answer to Sec 4 Prelim Exams 2024</u>

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark</th></tr>
<tr><td>1(a)(i)</td><td>
<table>
<tr><td>Final burette reading /cm^3</td><td>18.70</td><td>28.90</td><td>28.90</td></tr>
<tr><td>Initial burette reading /cm^3</td><td>0.00</td><td>10.00</td><td>10.00</td></tr>
<tr><td>Volume of P used /cm^3</td><td>18.70</td><td>18.90</td><td>18.90</td></tr>
<tr><td>Reading chosen</td><td></td><td>✓</td><td>✓</td></tr>
</table>

A-Accuracy (average titre within 0.20 cm^3 of teacher’s average tire value) [2] (average titre within 0.10 cm^3) [1]
C- Concordance (two accurate titre values are within 0.20cm^3) [1]
T- [2]
✓ The table headings and units has to be correct
✓ All burette readings for all accurate titres in titration table are recorded to nearest 0.05 cm^3
</td><td>[5]</td></tr>
<tr><td>1(a)(ii)</td><td>Average volume of P = (18.90 + 18.90) / 2 = 18.90 cm^3</td><td>[1]</td></tr>
<tr><td>1(b)(i)</td><td>Number of moles of sodium hydroxide = 0.200 x 18.90/1000 = 0.00378 mol
Number of moles of HA = 0.00378 mol</td><td>[1]</td></tr>
<tr><td>1(b)(ii)</td><td>In 25 cm^3, there are 0.00378 moles of HA.
In 1000 cm^3, there are (0.00378/25) x 1000 = 0.1512 mol

Concentration in cleaning product = 0.1512 / 100/1000 = 1.51 mol.dm^3</td><td>Working – [1],

answer – [1]</td></tr>
<tr><td>1(c)(i)</td><td>


1) Measure 25.0 cm^3 of aqueous sodium carbonate using a measuring cylinder and pour the solution into a conical flask.
2) Weigh 1.0 g of solid HA using an electronic balance and place the solid into a small vial. Carefully lower the solid HA into the conical flask, ensuring the chemicals do not mix.
3) Set up the apparatus as shown above.
4) Pull the string to allow the solid HA to react completely with the aqueous sodium carbonate.
5) Assume all the solid HA has reacted with the aqueous sodium carbonate (in excess).
6) Record the total volume of carbon dioxide gas collected in the measuring cylinder when reaction is completed (no more effervescence or more further change in the volume of CO_2) in the conical flask.
7) Calculate the number of moles of CO_2 produced using the formula: volume (in cm^3) / 24 000 cm^3 = x mol
8) Using the mole ratio HA:Na_2CO_3 = 2:1
Number of moles of HA = 2x mol
9) Using the formula, number of moles of HA = mass of HA / Mr of HA
2x = 1/Mr of HA
Mr of HA = 1/2x
</td><td>Apparatus (measuring cylinder, electronic balance) – [1]
Measurement: excess aqueous sodium carbonate – [1]
Measurement: Total volume of carbon dioxide collected – [1]
Calculation for number of moles of HA – [1]
Calculation for Mr– [1]</td></tr>
</table>

<table>
<tr><td>1(c)(ii)</td><td>Since CO_2 is soluble in water, the total volume of CO_2 collected would be lower than actual, which will cause the number of moles of CO_2 as well as number of moles of HA to be lower than expected.
As a result, the Mr of HA will be larger than actual.</td><td>[1]

[1]
[1]</td></tr>
<tr><td>1(c)(iii)</td><td>Change: Collect the volume of CO_2 produced by using a gas syringe instead of displacement of water.

Explanation: Volume of CO_2 will be the true volume as water is absent in the collection of CO_2.</td><td>[1]</td></tr>
<tr><td>2(a)(i)</td><td>
<table>
<tr><td>metal carbonate</td><td>X: carbonate of metal R</td><td>Y: carbonate of metal S</td></tr>
<tr><td>Colour of carbonate before heating</td><td>white</td><td>white</td></tr>
<tr><td>Colour change during heating/cooling</td><td>Yellow when hot
White when cold</td><td>white</td></tr>
<tr><td>Mass of test-tube and contents before heating /g</td><td>16.31</td><td>16.24</td></tr>
<tr><td>Mass of test-tube and contents after heating for 1 min /g</td><td>16.14</td><td>16.24</td></tr>
<tr><td>Mass of test-tube and contents after heating for 2 min /g</td><td>16.09</td><td>16.24</td></tr>
<tr><td>Mass of test-tube and contents after heating for 3 min /g</td><td>16.07</td><td>16.24</td></tr>
<tr><td>Total mass loss after heating /g</td><td>0.24</td><td>0.00</td></tr>
</table>
</td><td>[2]

[2]

[1]</td></tr>
<tr><td>2(a)(ii)</td><td>More reactive metal: S
Less reactive metal: R
Carbonate Y does not decompose at all, showing that it is more thermally stable. Hence, metal S is more reactive.
Carbonate X decomposes over the 3 min of heating, showing that it is less thermally stable. Hence, metal R is less reactive.</td><td>[1]

[1]</td></tr>
<tr><td>2(b)(i)</td><td>Add aqueous ammonia and sodium hydroxide to the solutions.
Observe the colour of ppt, and and their solubility in excess reagents</td><td>[1]
[1]</td></tr>
<tr><td>2(b)(ii)</td><td>
<table>
<tr><td></td><td>Solution with metal ions of R (prepared using carbonate X)</td><td>Solution with metal ions of S (prepared using carbonate Y)</td></tr>
<tr><td>Test</td><td>White ppt, soluble in excess aqueous ammonia, giving colourless solution

White ppt, soluble in excess sodium hydroxide, giving colourless solution</td><td>White ppt, insoluble in excess sodium hydroxide

no ppt with aqueous ammonia</td></tr>
</table>

Metal R: zinc, Metal S: calcium</td><td>[2]

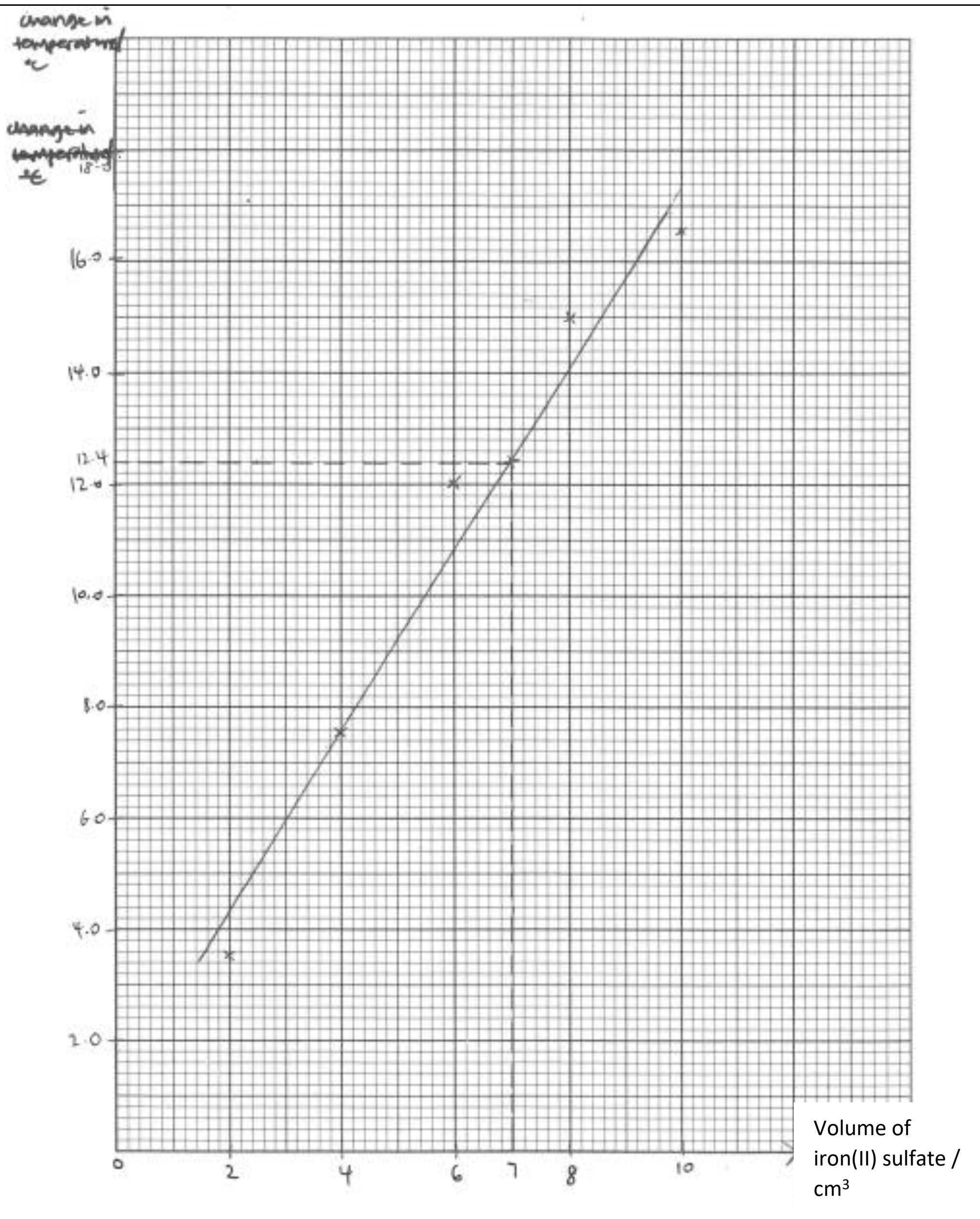
[1]</td></tr>
</table>

3(a)

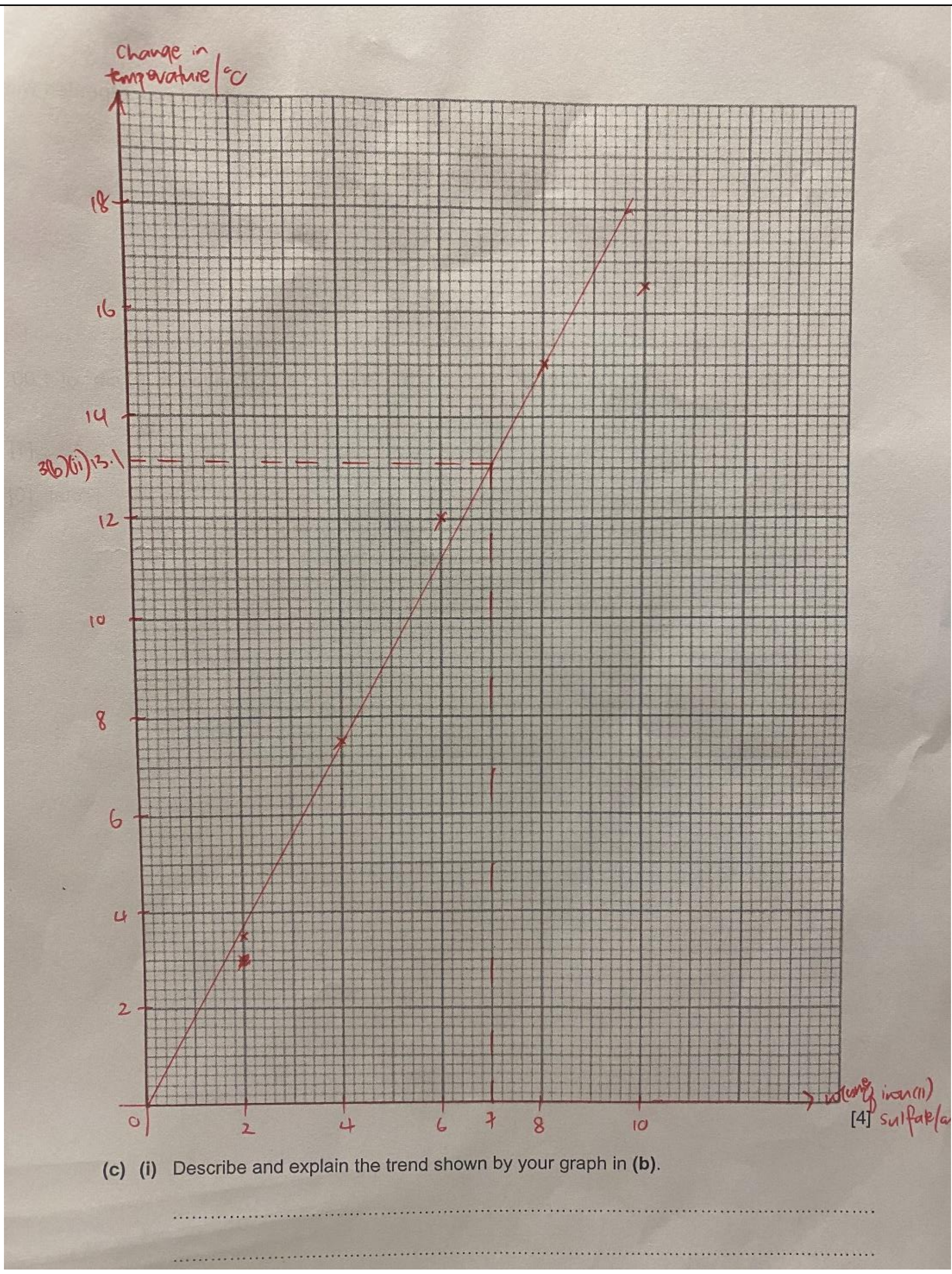
experiment	volume of aqueous iron(II) sulfate /cm^3	volume of distilled water /cm^3	initial temperature /^{O}C	highest temperature /^{O}C	change in temperature /^{O}C
1	10.0	0.0	30.0	46.5	**16.5**
2	8.0	2.0	29.5	44.5	**15.0**
3	6.0	4.0	29.0	41.0	**12.0**
4	4.0	6.0	29.5	37.0	**7.5**
5	2.0	8.0	29.5	33.0	**3.5**

[1]

3(b)



Axis – [1]
Scale – [1]
Points plotted correctly – [1]
Best fit line – [1]

		
3(c)(i)	The larger the volume of iron(II) sulfate used, the greater the change in temperature. The larger the volume of iron(II) sulfate used, the higher the concentration of the iron(II) sulfate solution. This leads to a faster reaction and a large temperature change.	[1] [1]
3(c)(ii)	1000 cm^3 – 0.500 mol ? cm^3 – 0.0035 mol Volume of iron(II) sulfate solution with the same number of moles as 0.0035 / 0.500 x 1000 = 7 cm^3 Expected temperature is 12.4 ^{O}C.	[1] [1]
3(c)(iii)	10 cm^3 of 0.500 mol/dm^3 iron(II) sulfate leads to a change in temperature of 16.5 ^{o}C. 10 cm^3 of 0.1 mol/dm^3 iron(II) sulfate will lead to a change in temperature of 16.5 x 2 = **33.0 ^{o}C.**	 [1]