Suggested Answers for 2024 4Exp Prelim 6092 Chemistry P3

<table>
<tr><th>Q No.</th><th>Answer</th><th>Marks</th></tr>
<tr><td>1ai</td><td>records initial burette reading, final burette reading, volume of P added with correct headings & units in titration table,
all burette readings recorded to nearest 0.05 cm^3,
at least 2 titre values within 0.20 cm^3, (Do not award marks for wrong calculations)*
average titre of consistent readings with 0.20 cm^3 of Supervisor's average value
[Award 1 m if average titre of consistent readings with 0.30 cm^3 of Supervisor's average value] (Do not award marks for accuracy if the concordance is not within 0.20 cm^3)

<table>
<tr><td>Titration No.</td><td>1</td><td>2</td></tr>
<tr><td>Final Burette Reading / cm^3</td><td>22.70</td><td>22.70</td></tr>
<tr><td>Initial Burette Reading / cm^3</td><td>0.00</td><td>0.00</td></tr>
<tr><td>Volume of P Used / cm^3</td><td>22.70</td><td>22.70</td></tr>
<tr><td>Best Results</td><td>√</td><td>√</td></tr>
</table>
Markers' Comment: This standard titration table was surprisingly badly done. .</td><td>1

1
1

2</td></tr>
<tr><td>1aii</td><td>Average volume (based on identified values) correctly calculated to 2 d.p.

[Allow ECF from part 1ai]*</td><td>1</td></tr>
<tr><td>1bi</td><td>No. of moles of thiosulfate ions= 0.120mol/dm^3 x (23.25 /1000) dm^3
= 0.00279 mol (3 s.f)</td><td>1</td></tr>
<tr><td>1bii</td><td>Compare mole ratio $S_2O_3^{2-}$ to Cu^{2+}
No. of moles of $S_2O_3^{2-}$: No. of moles of Cu^{2+}
1:1
No. of moles of Cu^{2+} in 25 cm^3 = 0.00279 mol
No. of moles of Cu^{2+} in 1 dm^3 = 0.00279 x (1000/25) = 0.1116 mol = 0.112 mol (3 s.f)

[Allow ECF]</td><td>2</td></tr>
<tr><td>1biii</td><td>Mass = no of moles of Cu x Ar of Cu = 0.1116 mol x 64 = 7.1424 g = 7.14g

[Allow ECF]</td><td>1</td></tr>
<tr><td>1biv</td><td>%mass of Cu = 7.1424/9.50 x 100%= 75.2% [1M]

[1M–unit (for answers in Q2aii and 2biii)]

[1M–3 sig fig (for answers in Q2bi, ii, iii and iv)]</td><td>3</td></tr>
<tr><td>1c</td><td>If potassium iodide is not in excess, not all Cu^{2+} will be reacted. Less I_2 will be produced. [1M] The volume of $Na_2S_2O_3$ used will be lower which leads to a smaller mass of copper calculated and smaller percentage by mass of copper. [1M]</td><td>2</td></tr>
<tr><td>2a</td><td>
<table>
<tr><th>test</th><th>observations</th></tr>
<tr><td>Test 1
Put about 1 cm depth of hydrogen peroxide in a clean test-tube. Add an equal volume of dilute sulfuric acid. Then add 10 drops of C with shaking.
You do not need to test any gas evolved in Test 1.</td><td>Purple acidified potassium manganate (VII) turns colourless.

Bubbles of gas formed.
[Both observations must be recorded to get 1M]</td></tr>
</table>
</td><td>9</td></tr>
</table>

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	Test 2 Put about 1cm depth of hydrogen peroxide in a clean test-tube. Use a spatula to carefully add a small amount of **D**.	Bubbles of gas formed. Gas relights glowing splint. Gas is oxygen. Test-tube feels warm. **[Any 2 observations must be recorded to get 1M]**	
	Test 3 Put about 1 cm depth of dilute sulfuric acid in a clean test-tube. Add an equal volume of aqueous potassium iodide. Then add 10 drops of **C** with shaking.	Colourless acidified KI solution turns brown. **[1M]** Purple acidified potassium manganate (VII) turns colourless. **[1M]** *Markers' Comment: This is a standard phrasing to be used for testing of reducing/oxidising agents.*	
	Test 4 Put about 2 cm depth of **C** in a clean test-tube. Add an equal volume of aqueous sodium hydroxide. Use a spatula to carefully add a small amount of **D**. Use a glass rod to stir the mixture for about 20 seconds. Filter the mixture and collect the filtrate in a clean test-tube. Then,	A green /dark green solution is obtained as the filtrate. A black solid is obtained as the residue. **[Both observations must be recorded to get 1M]**	
	put about 1 cm depth of the filtrate in a clean test-tube. Add dilute sulfuric acid slowly with shaking until no further change is seen.	Green/dark green solution turns purple/red/dark red/reddish-brown. **[1M]**	
	Test 5 Put about 1 cm depth of **E** in a clean test-tube. Add an equal volume of dilute nitric acid then add about 1 cm depth of aqueous silver nitrate.	White precipitate is formed. **[1M]**	
	Test 6 Put about 1 cm depth of **E** in a clean test-tube. Add aqueous sodium hydroxide slowly with shaking until no further change is seen. Leave to stand for a few minutes.	A beige/light brown/pale orange precipitate is formed insoluble in excess sodium hydroxide. **[1M]** **BOD yellow ppt** Upon standing the precipitate turned from light brown to brown. **[1M]**	
2b	Hydrogen peroxide acts as a reducing agent. From test 1, it changes the colour of the oxidising agent, acidified potassium manganate(VII) from purple to colourless.		1 1

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<table>
<tr><td>2c</td><td>Formula of E: $MnCl_2$
Markers' Comment: Students did not realise that it was mentioned in the front that the compound contains manganese. Examiners do expect students to find clues in the earlier parts of the question.</td><td>1</td></tr>
<tr><td>2d</td><td>Approach
Measure the time taken for the fixed mass of X or Y to turn acidified potassium manganate(VII) colourless.

Procedure
(i) Measure 5 g/ fixed mass of X using an electronic balance and pour it into a test-tube connected to a stopper with a delivery tube.
(ii) Heat the sample strongly and pass the gas produced through a fixed volume of acidified potassium manganate(VII). Start timing with the stopwatch.
(iii) Record the time taken for the acidified potassium manganate(VII) to turn colourless.
(iv) Repeat the step with 5 g/ same mass of Y and same volume of acidified potassium manganate(VII).

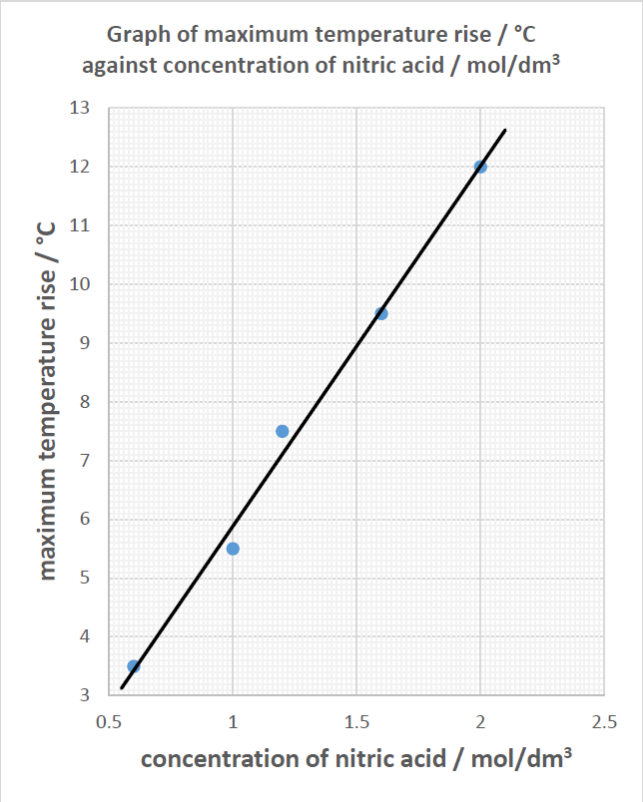
Conclusion
(v) The coal that took a shorter time to turn the acidified potassium manganate(VII) colourless is the one that produces more sulfur dioxide when heated.

1M for correct method
1M for correct setup/apparatus used
1M for correct procedure and key conditions [i.e. fixed mass of X, fixed volume and concentration of acidified potassium manganate(VII)]
1M for correct data collection [i.e. time taken for acidified potassium manganate(VII) to be decolourised]
1M for correct conclusion

Markers' Comment: Students did not realise that a gas syringe set-up should not be used when heating is involved as the build-up of gas pressure in a sealed set-up will cause an explosion!</td><td>5</td></tr>
<tr><td>3a</td><td>
<table>
<tr><th>volume of nitric acid / cm^3</th><th>volume of distilled water/ cm^3</th><th>concentration of nitric acid / mol/dm^3</th><th>initial temperature of nitric acid / ^oC</th><th>highest temperature of mixture / ^oC</th><th>maximum temperature rise / ^oC</th></tr>
<tr><td>15.0</td><td>0.0</td><td>2.00</td><td>28.0</td><td>40.0</td><td>12.0</td></tr>
<tr><td>12.0</td><td>3.0</td><td>1.60</td><td>28.0</td><td>37.5</td><td>9.5</td></tr>
<tr><td>9.0</td><td>6.0</td><td>1.20</td><td>285</td><td>36.0</td><td>7.5</td></tr>
<tr><td>7.5</td><td>7.5</td><td>1.00</td><td>28.0</td><td>33.5</td><td>5.5</td></tr>
<tr><td>4.5</td><td>10.5</td><td>0.60</td><td>28.5</td><td>32.0</td><td>3.5</td></tr>
</table>
(Penalise if the values are not in 1 decimal place)

Markers' Comment: Quite a few students left this in 2.d.p. (wrong as should follow the d.p. of the data), or even made mistakes in this simple calculation.</td><td>1</td></tr>
<tr><td></td><td></td><td></td></tr>
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3b	 1 m – correct labelling of both axes with units 1 m – correct scale (graph occupies at least half the length of both axes and no odd scales. Only accepted scales are 1:2/5/10 or equivalent) + correct plotting of points 1 m – line of best fit (No need to pass through origin)	3
3c	As the concentration of nitric acid increases (decreases), the maximum temperature rise increases (decreases). *Markers' Comment: It is not possible to tell from the graph whether it passes through the origin, hence by right not able to tell whether the relationship is directly proportional. Some students missed out the word "rise".*	1
3d	heat released (in J) = volume of solution (in cm^3) × maximum temperature rise (in °C) × 4.2 = 30 × 12 × 4.2 = 1510 J (3 s.f) *Markers' Comment: Again, most students forgot that the total volume is 30 cm3, not 15. Examiners do expect students to find clues in the earlier parts of the question.*	1
3e	$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$ Comparing Mole Ratio $HNO_3 : H_2O$ 1 : 1 number of moles of water, H_2O, produced = number of moles of HNO_3 = concentration × volume = 2.00 × (15.00 ÷ 1000) = 0.0300 mol (3 s.f)	1
3f	heat released (in kJ/mol) = (1512 ÷ 0.0300) × 1 = 50400J/mol = 50.4 kJ/mol (3 s.f) **[Accept ECF from part 3d and 3e]**	1

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