Experimental Data

Q1

Results

Time	Temperature/ °C
0.0	24.3
1.0	24.3
2.0	24.3
3.0	24.3
3.5	22.4
4.0	21.2
5.0	18.0
6.0	14.5
7.0	15.0
8.0	15.6
9.0	16.1
Weigh the capped bottle containing solid FA 1	25.892g
Weigh the capped bottle after emptying solid FA 1	15.030g
Mass of FA 1	10.862g

Q2

(a)

(i)

final burette reading / cm^3	**25.00**	**25.00**	
initial burette reading / cm^3	**0.00**	**0.00**	
volume of FA 3 added / cm^3	**25.00**	**25.00**	

Q3
(a)

	tests	observations with FA 5	observations with FA 6	observations with FA 7	observations with FA 8
1	Add 1 cm depth of **FA 4** to a clean test-tube. To this test-tube, add 5 drops of **FA 5** followed by 5 drops of **FA 3**. Prepare a hot water bath using the hot water provided. Warm the mixture in the water bath for two minutes. **Repeat using FA 6 and FA 7, in place of FA 5.**	FA 3 solution decolourises [1]	FA 3 solution decolourises [1]	FA 3 solution remain purple and does not decolourise	**FA 3** solution decolourises
2	Add 1 cm depth of deionised water to a clean test-tube. To this test-tube, add 5 drops of **FA 5** followed by 6 drops of aqueous sodium hydroxide. Add iodine solution, dropwise, until a permanent yellow / orange colour is present. Warm the mixture in the water bath for two minutes. **Repeat using FA 6, FA 7 and FA 8, in place of FA 5.**	No ppt is formed	Pale yellow ppt is formed [1]	Pale yellow ppt is formed [1]	No ppt is formed
3	Add 1 cm depth of Fehling's solution A to a clean test-tube. Then add Fehling's solution B, dropwise, until the initial precipitate just dissolves to give a deep blue solution. Add 5 drops of **FA 5**. Warm the mixture in the water bath for five minutes. **Repeat using FA 6, FA 7 and FA 8, in place of FA 5.**	Red brown ppt is formed [1]	No ppt is formed	No ppt is formed	No ppt is formed

[6]

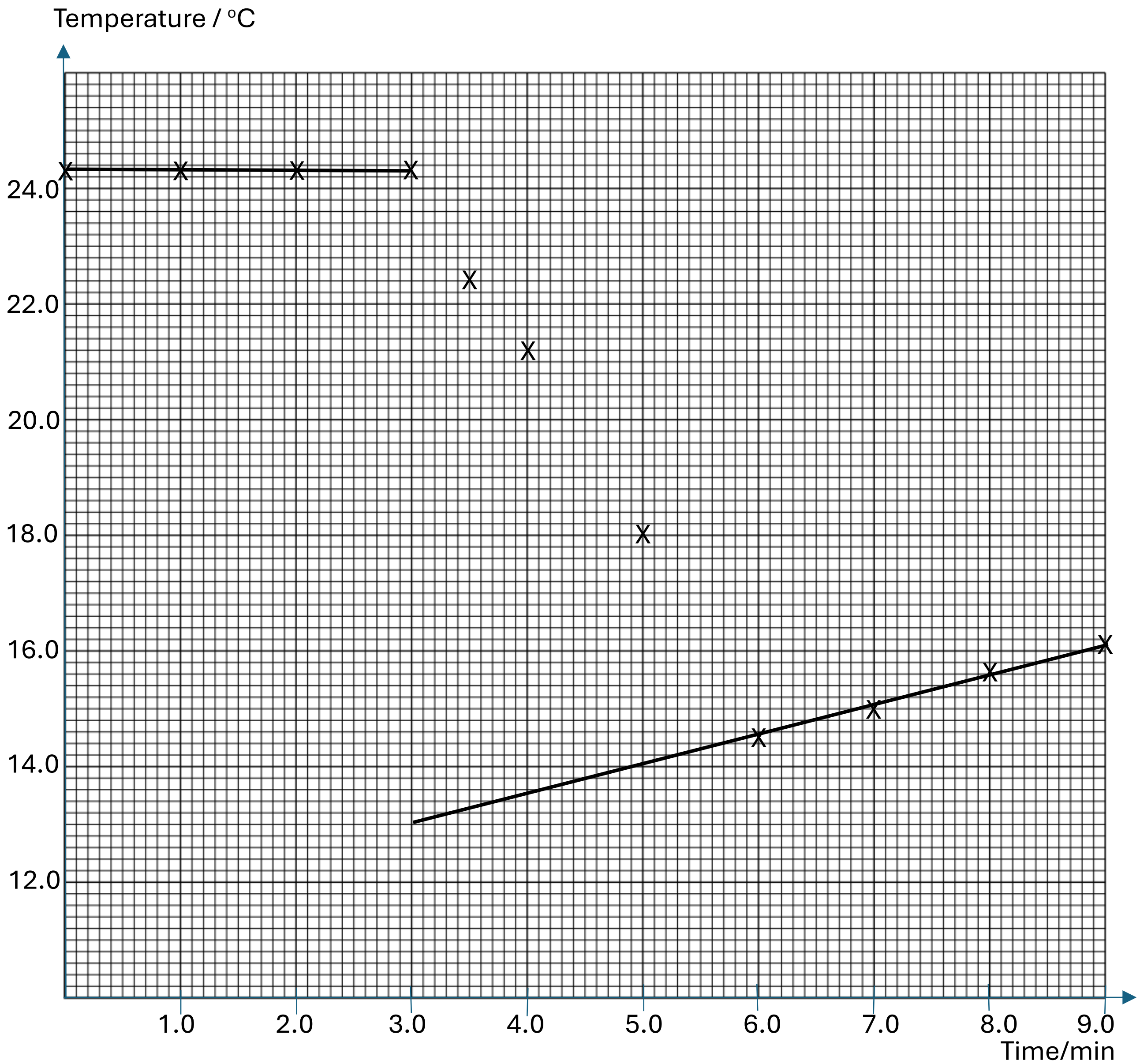
Answers

Q1

Results

Time	Temperature/ °C
0.0	24.3
1.0	24.3
2.0	24.3
3.0	24.3
3.5	22.4
4.0	21.2
5.0	18.0
6.0	14.5
7.0	15.0
8.0	15.6
9.0	16.1
Weigh the capped bottle containing solid FA 1	25.892g
Weigh the capped bottle after emptying solid FA 1	15.030g
Mass of FA 1	10.862g

(b)



(c)

Tmin = 13.0°C

Tmax = 24.3°C

ΔT = 11.3 °C

(d)

$q = mc\Delta T = (50)(4.18)(11.3) = 2361.7 = 2360$ J

(e)

Mr of KCl = 39.1 + 35.5 = 74.6 & no of mol of KCl, N = 10.862÷74.6 mol

$\Delta H_{sol} = q \div N = 16.220 = +16.2$ kJ/mol

(f)

Lower ΔT → Lower temperature decrease

However q is still the same given that m is larger; hence there is no effect on ΔH_{sol}

Q2

(a)

(i)

final burette reading / cm^3	25.00	25.00	
initial burette reading / cm^3	0.00	0.00	
volume of FA 3 added / cm^3	25.00	25.00	

(ii)

volume of FA 3 = 25.00 cm^3

(b)

(i)

No of mol of MnO_4^- = 25.00/1000 x 0.0200 mol dm^{-3} = 5.00 x 10^{-4} mol

In 25.0cm^3 of diluted Q,

No of mol of $C_2O_4^{2-}$ = 5.00 x 10^{-4} mol x $^5/_2$ = 1.25 x 10^{-3} mol

(ii)

In 250cm^3 of diluted Q,

No of mol of $C_2O_4^{2-}$ = 1.25 x 10^{-3} mol x 250/25 = 1.25 x 10^{-2} mol

[$C_2O_4^{2-}$]= 1.25 x 10^{-2} mol ÷ 35.70/1000 = 0.35014 = 0.350 $moldm^{-3}$

(iii)

$$Mr = \frac{64.5\ g}{0.35014} = 184.212$$

(iv)

2 (Ar of X) + 2 x 12.0 + 4 x 16.0 + 18 = 184.212 → Ar of X = 39.106

X is K

(c)

ΔV = 0.4% x 22.40 = 0.0896 = 0.09

V = 22.40 ± 0.09 (range from 22.31-22.49)

Student result is not accurate within the ±0.4% since 22.20 < 22.31

(d)

(i)

Mass of $X_2C_2O_4.H_2O$ = 184.2

Mass of $X_2C_2O_4.H_2O$ = 0.250 x 0.05 x Mr = 2.3025 = 2.30g

(ii)

Expected volume of gas collected [1]	Use 25.0cm^3 of $X_2C_2O_2$ solution to generate CO_2 No of mol of $C_2O_4^{2-}$ = 0.0250 x 0.05 = 1.25 x 10^{-3} mol No of mol of CO_2 = 1.25 x 10^{-3} mol x 2 Vol of CO_2 = 1.25 x 10^{-3} mol x 2 x 24000 = 60 cm^3
the preparation of 250.0 cm^3 of 0.05 mol dm^{-3} $X_2C_2O_2$ solution	Weigh the container with solid $X_2C_2O_4.H_2O$ to ensure it is 2.30g (M2) and use the tare function

[2]	Measure 50cm^3 of deionised water using a measuring cylinder and pour into a 250ml beaker. Add all the solid $X_2C_2O_4.H_2O$ into beaker and stir to dissolve. Pour solution in beaker into volumetric flask and add deionised water till its total volume is 250cm^3
Reaction [1]	Ensure FA 3 is in excess: Measure 50cm^3 of $KMnO_4$ in a measuring cylinder Ensure FA 4 is in excess Measure 10cm^3 of H_2SO_4 in another measuring cylinder Pour both into a conical flask.
Procedure & apparatus [2]	Pipette 25.0cm^3 of aq $X_2C_2O_4$ and add into the same conical flask with FA3 and FA4. Stopper the conical flask with delivery tube to 100ml gas syringe attached to retort stand to collect CO_2. Place the conical flask on a Bunsen burner to gently warm it over a wire gauze to speed up reaction.
Measurement [1]	Measure the volume of CO_2 in gas syringe and when it reaches its maximum value, stop the experiment. Wait for the temperature of the gas to return to room temperature by waiting for at least 30 mins before measuring the Vol of carbon dioxide collected (V) in cm^3
Identify of X [1]	No of mol of CO_2 = V/24000 mol No of mol of $C_2O_4^{2-}$ = V/24000 x ½ mol In 25cm^3, No of mol of $X_2C_2O_4^{2-}.H_2O$ = V/24000 x ½ mol In 250cm^3, No of mol of $X_2C_2O_4^{2-}.H_2O$, N = V/24000 x ½ x 10 mol Mr $X_2C_2O_4^{2-}.H_2O = \frac{2.30g}{N}$ Ar of X can be determined

(iii)

Gas like carbon dioxide can dissolve in water

Q3

(a)

	tests	observations with FA 5	observations with FA 6	observations with FA 7	observations with FA 8
1	Add 1 cm depth of **FA 4** to a clean test-tube. To this test-tube, add 5 drops of **FA 5** followed by 5 drops of **FA 3**. Prepare a hot water bath using the hot water provided. Warm the mixture in the water bath for two minutes. **Repeat using FA 6 and FA 7, in place of FA 5.**	FA 3 solution decolourises [1]	FA 3 solution decolourises [1]	FA 3 solution remain purple and does not decolourise	**FA 3** solution decolourises
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[6]

(b)

	Identity	Evidence
FA5	**CH_3CH_2CHO**	**Test 3 is a confirmation test for aldehyde / tested +ve with Fehling's solution**
FA6	**$CH_3CH(OH)CH_3$**	**Test 1 confirms the absence of 1°/2° alcohol group** **Test 2 is a confirmation test for $CH_3CH(OH)$- / tested +ve with iodoform reagent**
FA7	**CH_3 CO CH_3**	**Test 1 confirms the absence of 1°/2° alcohol group & 3C is unable to form tertiary alcohol** **Test 3 is a confirmation test for CH_3CO / tested +ve with iodoform reagent**
FA8	**$CH_3CH_2CH_2OH$**	**Test 1 confirms the absence of 1°/2° alcohol group**

		Given that FA6 is secondary alcohol, the only other possible structure for 3C alcohol is secondary alcohol

(c) CH_3CH_2COOH (Mr = 29+45)