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Answer ALL the questions.

Write your answers in the spaces provided in this question paper.

1. You are provided with approximately 0.5 g of a solid labelled **J**, and 3 cm³ of an aqueous solution of compound **K**.

Each compound contains one anion and one cation.

Carry out the following tests, recording your observations and answers to the questions in the appropriate boxes.

- (a) Carry out a flame test on a small portion of solid **J**. In the inference box state the identity of the ion in **J** which is identified by this test.

Observation	Inference

(2)

- (b) Dissolve the remainder of **J** in 5 cm³ of distilled water in a test tube. Divide the solution between two test tubes and **keep one for test (f)**.

To the other portion, add 10 drops of dilute hydrochloric acid. Test the gas produced with limewater.

In the inference box, identify the gas.

Observation	Inference

(2)

- (c) Suggest the formula of compound **J**.

(1)



- (d) (i) To 1 cm³ of the solution of **K** in a boiling tube, add 0.5 cm³ of aqueous sodium hydroxide. **Keep the mixture for test (d)(ii).**

Observation

(1)

- (ii) To the mixture from test (d)(i), add a small piece of aluminium foil and warm the mixture gently. Test the gas with damp red litmus paper.

In the inferences box, identify the gas and indicate which ion(s) in **K** could be identified from this test.

Observation	Inferences

(3)

- (e) To 1 cm³ of the solution of **K** in a test tube, add 0.5 cm³ of aqueous sodium chloride, followed by 4 cm³ of aqueous ammonia.

In the inference box, identify the ion in **K** that could be identified by this test.

Observation	Inference

(3)



(f) To 1 cm³ of the solution of **K**, add the portion of solution of **J** prepared in test (b).

Observation

(1)

Q1

(Total 13 marks)

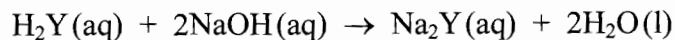
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2. You are provided with:

- Solution **L**, aqueous sodium hydroxide of concentration $0.150 \text{ mol dm}^{-3}$;
- Solution **M**, an aqueous solution of a dibasic acid H_2Y of concentration 6.43 g dm^{-3} ;
- Phenolphthalein indicator

You are required to titrate portions of solution **M** with solution **L**.



(a) **Procedure**

1. Rinse out the burette with a small amount of solution **L** and fill the burette with solution **L**.
2. Rinse out the pipette with a small amount of solution **M**, then use the pipette to transfer 25.0 cm^3 of the solution **M** to a conical flask. Add 4 drops of phenolphthalein indicator to the conical flask.
3. Titrate solution **M** with solution **L** until the end-point is reached.
4. Record your burette readings and titre in **Table 1**.
5. Repeat the procedure until you obtain **two** titres that differ by no more than 0.20 cm^3 . Record all your burette readings and titres in **Table 1**.

Table 1

Titration number	1	2	3	4	5
Burette reading (final)/ cm^3					
Burette reading (initial)/ cm^3					
Titre/ cm^3					

List the numbers of the titrations that you will use to calculate the mean (or average) titre.

Calculate the mean titre.

Write the value of your mean titre in the space below.

..... cm^3 of aqueous sodium hydroxide, solution **L**, reacts with 25.0 cm^3 of solution **M**.

(12)



(b) Calculations

(i) Calculate the amount (moles) of sodium hydroxide in the mean titre.

(1)

(ii) Calculate the amount (moles) of acid H_2Y in 25.0 cm^3 of solution **M**.

(1)

(iii) Calculate the amount (moles) of acid H_2Y in 1 dm^3 of solution **M**.

(1)

(iv) Hence determine the molar mass of the acid H_2Y .

(1)

(v) A student does this exercise but, by mistake, fills the burette with solution **M**. Once it is emptied, the student fails to rinse it with solution **L** before filling it with solution **L**.

State and explain what effect, if any, this would have on the first titre.

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(2)

Q2

(Total 18 marks)



3. You are provided with a specimen tube containing a sample of a Group 1 compound, **E**.
 You are required to find the molar enthalpy change when **E** dissolves in water.

(a) **Procedure**

1. Use the 50 cm³ measuring cylinder to measure 50 cm³ of distilled water into a dry polystyrene cup held securely in a beaker. Place the thermometer in the distilled water.
2. Weigh, to at least two decimal places, the specimen tube containing **E**. Record the mass of the tube and **E** in **Table 2**.
3. Measure the temperature of the water in the cup to an accuracy of at least 0.5 °C. Record this temperature in **Table 3**.
4. Empty the sample of **E** from the specimen tube into the cup, stirring continuously until all of the solid has dissolved. The temperature of the mixture will change and then become steady. Measure this steady temperature of the solution of **E** to an accuracy of at least 0.5 °C. Record this temperature in **Table 3**.
5. Weigh the emptied specimen tube and record its mass in **Table 2**.

Table 2

Mass of specimen tube + E / g	
Mass of emptied specimen tube / g	
Mass of E transferred / g	

(2)

Table 3

Temperature of water before addition of E , T ₁	°C
Steady temperature of the solution of E , T ₂	°C

Calculate the change in temperature by subtracting T₁ from T₂.

$$\Delta T = T_2 - T_1 = \dots\dots\dots \text{°C}$$

(6)



(b) Calculations

- (i) Calculate the molar enthalpy change when **E** dissolves in water using the formula below:

$$\Delta H = \frac{-21.1 \times \Delta T}{\text{Mass of E}} \text{ kJ mol}^{-1}$$

Include a sign with your value of ΔH , which should be given to an appropriate number of significant figures.

(3)

- (ii) If 40 cm³ of water was used instead of 50 cm³, state whether the value of ΔT would be more positive or more negative. Explain how this would affect the accuracy of the value of ΔH .

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(1)

(Total 12 marks)

Q3

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4. A sample of sodium nitrate is believed to be contaminated. The sodium nitrate decomposes when heated strongly to give sodium nitrite and oxygen, but the contaminant remains unchanged.



You are required to plan an experiment the results of which may be used to calculate the percentage by mass of sodium nitrate in the sample.

You are provided with a Bunsen burner and tripod, crucible with tongs, spatula and a laboratory balance.

You may use these pieces of apparatus ONLY, and no other chemicals.

Include in your plan:

- The procedure you would follow
- The measurements you would make (you are **not** expected to invent data)
- An explanation of how you would use your measurements to calculate the percentage by mass of sodium nitrate in the sample.

[molar mass / g mol⁻¹: N = 14, O = 16, Na = 23]

You are not required to carry out your plan.

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Q4

(Total 7 marks)

TOTAL FOR PAPER: 50 MARKS

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