**1** **P** is a solution that contains 0.0164 mol of $KIO_3$, in 1.00 $dm^3$ of water. An acidified solution of $KIO_3$ oxidises potassium iodide to iodine.

$$KIO_3 + 5\ I^- + 6\ H^+ \rightarrow K^+ + 3\ I_2 + 3\ H_2O$$

The iodine produced can be titrated with **Q**, a solution of an organic acid.

1 mole of iodine reacts with 1 mole of the organic acid.

You are going to determine the relative molecular mass of the organic acid by using titration.

**Q** was prepared by dissolving 10.0 g of the solid organic acid, **R**, in 1.00 $dm^3$ of water.

**Read all the instructions carefully before starting the experiments.**

**Instructions**

**(a)** Put **Q** into the burette.

Pipette 25.0 $cm^3$ of **P** into a flask. Add 1 test-tube full of aqueous potassium iodide solution and one test-tube full of dilute sulfuric acid to **P** in the flask. Swirl to mix the solutions well.

Add **Q** from the burette until the red-brown colour fades to pale yellow, then add a few drops of the starch solution. This will give a deep blue, almost black colour with a small quantity of iodine remaining.

Continue adding **Q** slowly from the burette until one drop of **Q** causes the blue colour to disappear, leaving a colourless solution.

Record your titration results in the space provided, repeating the titration as many times as you consider necessary to achieve consistent results.

**Results**

[5]

**(b)** From your titration results, obtain an average volume of **Q** to be used in your calculations. Show clearly how you obtained this volume.

Average volume of **Q**……[1]

**(c)** The equation shows that one mole of $KIO_3$ reacts with 5 moles of potassium iodide to produce 3 moles of iodine.

Calculate the number of moles of iodine produced.

Number of moles of iodine produced …..……[2]

**(d)** From your answer in **(c)**, calculate the number of moles of the organic acid, **R**, in **Q** that reacted with the iodine.

Number of moles of organic acid that reacted with iodine …..……[1]

**(e)** Using relevant information from the question and your answer in **(d)**, determine the relative molecular mass of the organic acid, **R**, in **Q**.

Show all relevant working.

Relative Molecular mass of organic acid, **R** …..……[2]

**[Total: 11]**

**2** Five experiments were conducted by a student to investigate the temperature change when another organic acid, **C**, dissolves in water. The relative molecular mass of **C** is 192.

*Experiment 1*

Measure 200.0 $cm^3$ of deionised water using a measuring cylinder and pour it into a Styrofoam cup, nested in a beaker.

Add 0.04 moles of solid **C** into the deionised water, stir with the thermometer and measure the temperature until no further change. Record the temperature change.

Empty the Styrofoam cup and rinse it with water.

*Experiments 2 to 5*

Repeat Experiment 1 but use different number of moles of solid **C** for each experiment.

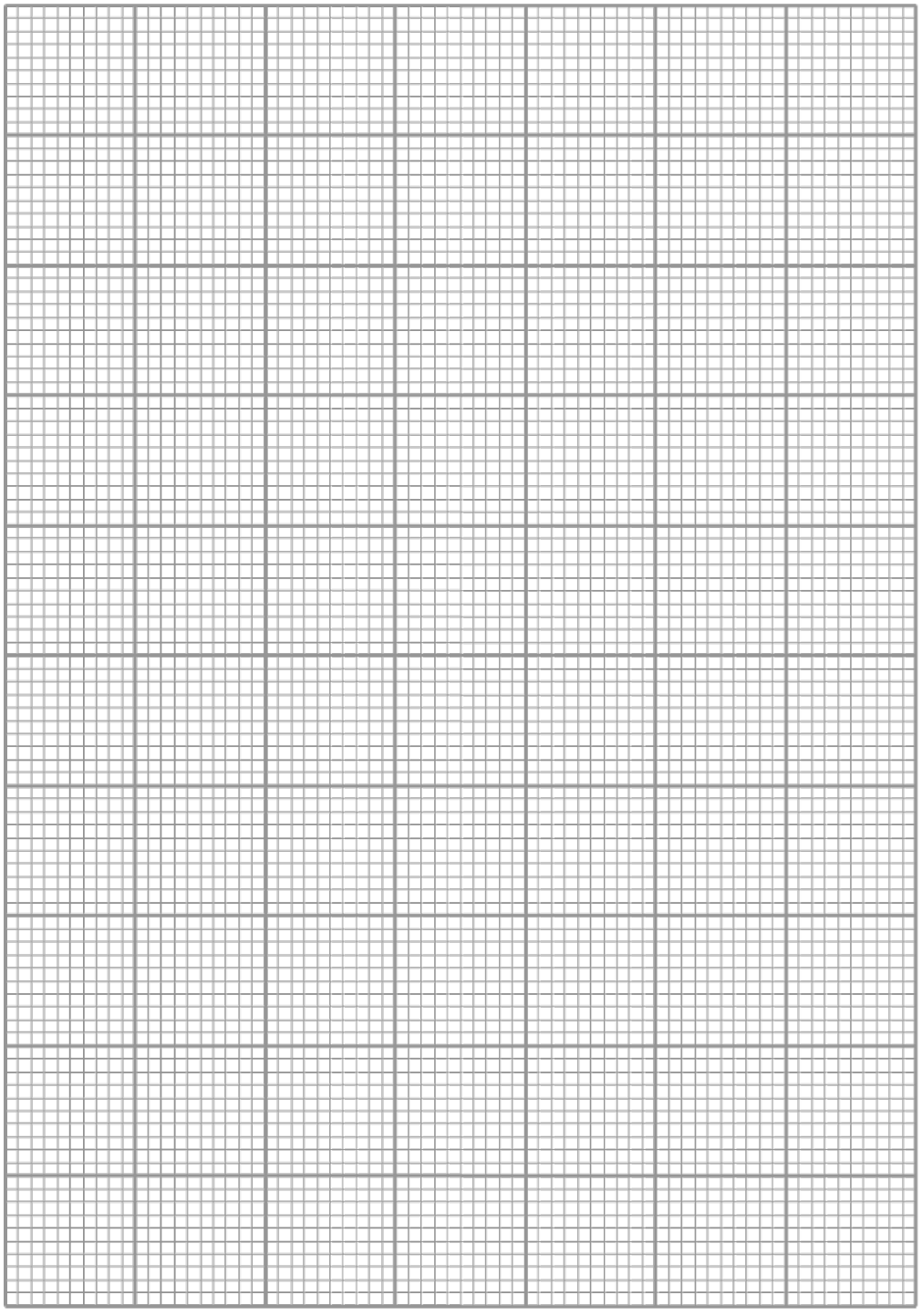
The results from the students' investigation are shown in the table.

**Results**

| experiment | no. of moles of solid **C** | temperature change / °C |
|---|---|---|
| 1 | 0.04 | - 1.0 |
| 2 | 0.08 | - 3.0 |
| 3 | 0.12 | - 5.0 |
| 4 | 0.16 | - 7.0 |
| 5 | 0.2 | - 9.0 |

**(a)** Plot the results on the grid with number of moles of the organic acid, **C**, against temperature change.

Complete the graph by drawing a line of best fit.



[4]

**(b)** Describe the trend shown by your graph in **(a)**.

.....

.....

[1]

.....

**(c)** From the graph, determine the temperature change when 9.60 g of solid **C** is dissolved in 200.0 $cm^3$ of deionised water.

Temperature change is ……[1]

**(d)** You are going to conduct Experiment 6.

Measure 9.60 g of solid **C** and put into a Styrofoam cup, nested in a beaker. Add 200.0 $cm^3$ of deionised water into it. Stir with the thermometer to dissolve solid **C** until no further change in temperature.

Record all necessary data to clearly show all necessary workings on how the temperature change is obtained. ($M_r$ of **C** = 192)

[2]

**(e)** Explain why the temperature change obtained from the graph in **(c)** is more reliable.

.....

.....

[1]

.....

**(f)** In another experiment, the solubility of the organic acid, **C**, in different solvents, water, ethanol and acetone is investigated.

Plan an investigation to find the effect of the nature of solvent on the solubility of the organic acid, **C**.

You may assume the apparatus normally found in the school laboratory is available for the investigation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[5]

**[Total: 14]**