Energy changes – GCSE Chemistry

1. June/ 2023/Paper_ 8462/1F/No.10

1 0 This question is about temperature changes.

A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.

This is the method used.

1. Measure 200 cm^3 of water into a polystyrene cup.
2. Measure the temperature of the water.
3. Add 4.0 g of ammonium nitrate to the water.
4. Stir the solution until all the ammonium nitrate has dissolved.
5. Measure the lowest temperature reached by the solution.
6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

1 0 . 1 Give the independent variable and the dependent variable in the investigation.

[2 marks]

Independent variable: Mass of ammonium nitrate.

Dependent variable: Change in temperature of the solution.

Table 6 shows the results.

Table 6

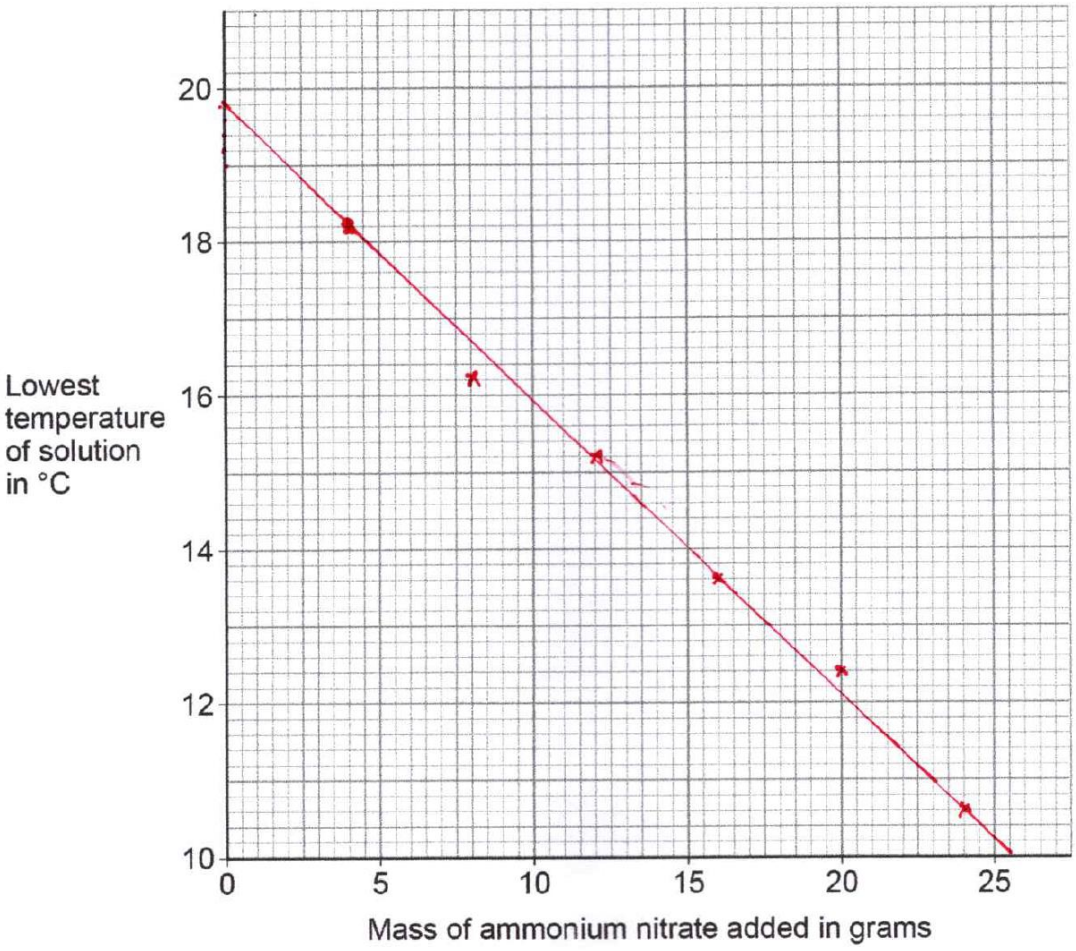
Mass of ammonium nitrate added in grams	Lowest temperature of solution in °C
4.0	18.2
8.0	16.2
12.0	15.2
16.0	13.6
20.0	12.4
24.0	10.6

1 0 . 2 Plot the data from **Table 6** on **Figure 11**.

Draw a line of best fit.

[3 marks]

Figure 11



1 0 . 3 Determine the initial temperature of the water.

You should extend your line of best fit on **Figure 11**.

[2 marks]

Initial temperature of the water = 19.8 °C

1 0 . 4 How do the results show that dissolving ammonium nitrate in water is endothermic?

[1 mark]

Temperature decreases.

The student repeated the experiment three more times.

Table 7 shows the results for 8.0 g of ammonium nitrate.

Table 7

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in °C	16.2	16.6	16.8	16.4	16.5

1 0 . 5 The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 °C.

Explain why the student included ± 0.3 °C after the mean lowest temperature.

[2 marks]

To show the range of uncertainity in the measurement.
Highest value is 16.8°C. and lowest is 16.2.
So. uncertainity = $\frac{(16.8 - 16.2)}{2}$ = 0.3°C.

1 0 . 6 What type of error is shown by the results in **Table 7**?

[1 mark]

Tick (✓) **one** box.

Random error	✓
Systematic error	
Zero error	

Random errors are unpredictable variations in measurements that cause the data points to scatter around the true value. In this case, the smallest variation in the lowest temperature across the four trials are indicative of random error.

2. June/ 2023/Paper_ 8462/1H/No.2

0 2 This question is about temperature changes.

A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.

This is the method used.

1. Measure 200 cm^3 of water into a polystyrene cup.
2. Measure the temperature of the water.
3. Add 4.0 g of ammonium nitrate to the water.
4. Stir the solution until all the ammonium nitrate has dissolved.
5. Measure the lowest temperature reached by the solution.
6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

0 2 . 1 Give the independent variable and the dependent variable in the investigation.

[2 marks]

Independent variable Mass of ammonium nitrate.

Dependent variable Change in temperature of the solution.

Table 2 shows the results.

Table 2

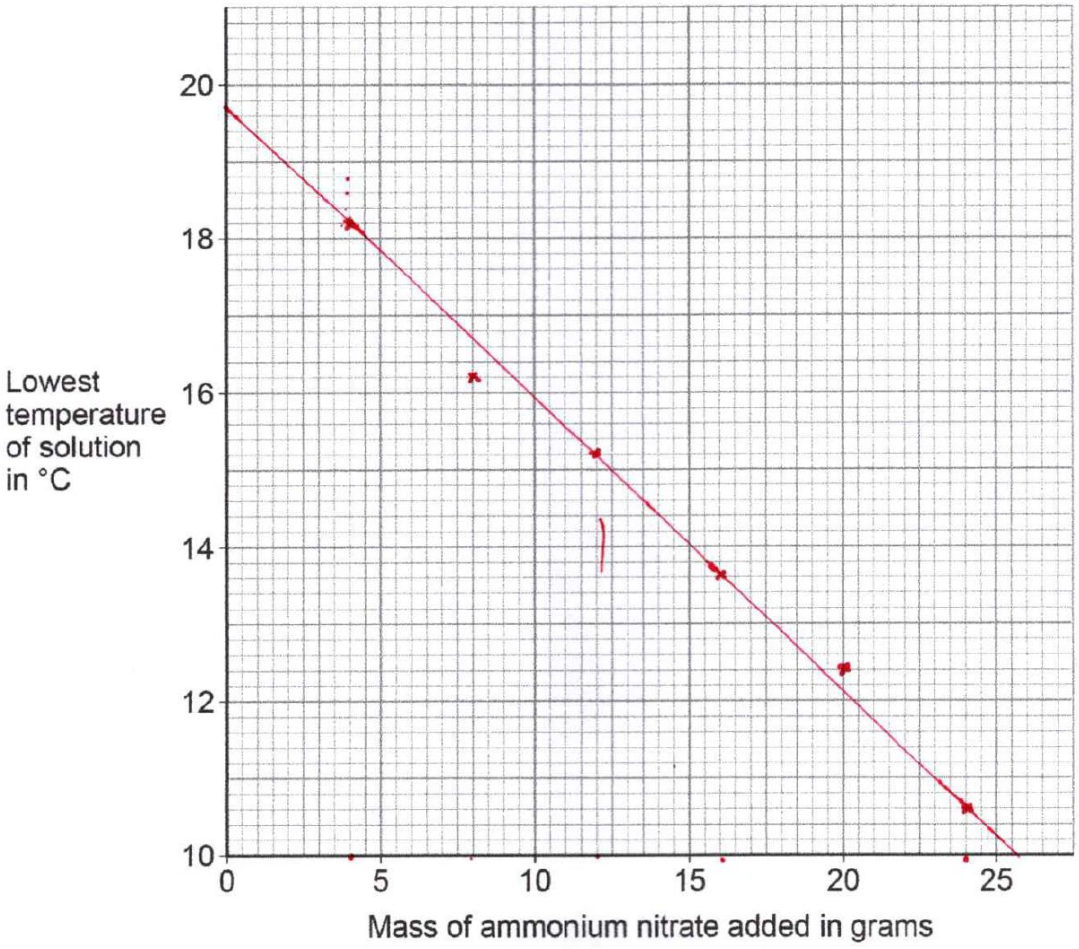
Mass of ammonium nitrate added in grams	Lowest temperature of solution in °C
4.0	18.2
8.0	16.2
12.0	15.2
16.0	13.6
20.0	12.4
24.0	10.6

0 2 . 2 Plot the data from **Table 2** on **Figure 2**.

Draw a line of best fit.

[3 marks]

Figure 2



0 2 . 3 Determine the initial temperature of the water.

You should extend your line of best fit on **Figure 2**.

[2 marks]

Initial temperature of the water = 19.7 °C

0 2 . 4 How do the results show that dissolving ammonium nitrate in water is endothermic?

[1 mark]

Temperature decreased.

The student repeated the experiment three more times.

Table 3 shows the results for 8.0 g of ammonium nitrate.

Table 3

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in °C	16.2	16.6	16.8	16.4	16.5

0 2 . 5 The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 °C.

Explain why the student included ± 0.3 °C after the mean lowest temperature.

[2 marks]

To show the range of uncertainity in the measurement.
Highest value is 16.8°C and lowest is 16.2°C.
So uncertainity = $\frac{(16.8 - 16.2)}{2}$ = 0.3°C.

0 2 . 6 What type of error is shown by the results in **Table 3**?

[1 mark]

Tick (✓) **one** box.

- Random error ✓
- Systematic error
- Zero error

Random errors are unpredictable variations in measurements that cause the data points to scatter around the true value. In this case, smallest variation in the lowest temperature across the four trials are indicative of random error.

3. June/ 2023/Paper_ 8462/1H/No.4

0 4 This question is about hydrogen and compounds of hydrogen.

Figure 3 shows the displayed formulae for the reaction between hydrogen and chlorine.

Figure 3

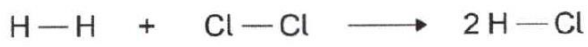


Table 4 shows the bond energies.

Table 4

Bond	H — H	Cl — Cl	H — Cl
Bond energy in kJ/mol	436	346	432

0 4 . 1 Which expression shows how to calculate the overall energy change for the reaction in **Figure 3**?

Use **Table 4**.

[1 mark]

Tick (✓) **one** box.

436 + 346 + 432 kJ/mol ☐

436 + 346 + (2 × 432) kJ/mol ☐

436 + 346 − 432 kJ/mol ☐

436 + 346 − (2 × 432) kJ/mol ☑

The reaction between hydrogen and chlorine is exothermic.

0 4 . 2 Explain why this reaction releases energy to the surroundings.

[2 marks]

Formation of HCl H–Cl bonds releases more energy than is required to break H–H and Cl–Cl bonds, resulting in a net release of energy to surrounding.

0 4 . 3 **Figure 4** shows part of a reaction profile for the reaction between hydrogen and chlorine.

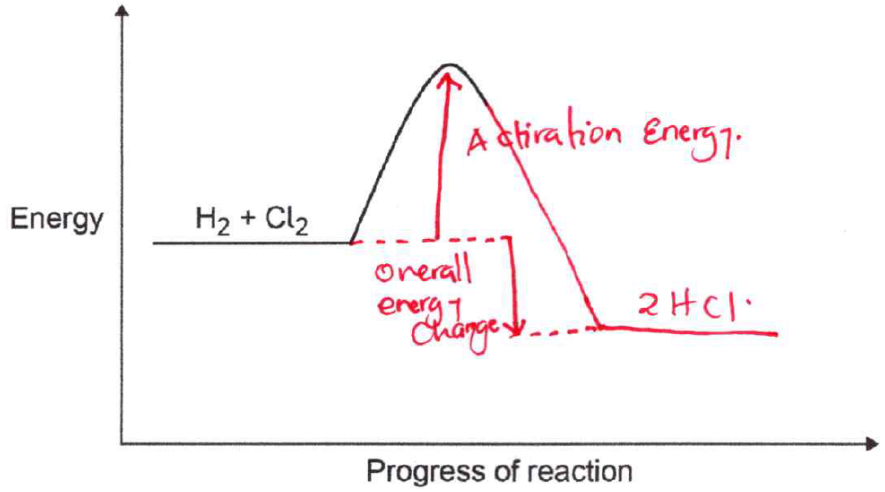
Complete the reaction profile in **Figure 4**.

You should:

- label the activation energy
- label the overall energy change.

[3 marks]

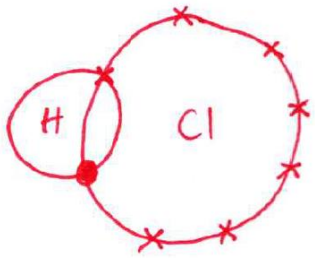
Figure 4



0 4 . 4 Draw a dot and cross diagram for a molecule of hydrogen chloride (HCl).

Show the outer shell electrons only.

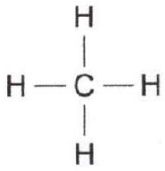
[2 marks]



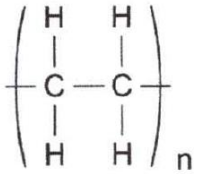
0 4 . 5 **Figure 5** represents molecules of methane and of poly(ethene).

Figure 5

Methane



Poly(ethene)



Methane is a gas at room temperature but poly(ethene) is a solid at room temperature.

Explain why methane and poly(ethene) exist in different states at room temperature.

[4 marks]

Due to molecular size and structure of the substances. Methane's small size result in weak intermolecular forces allowing it to be a gas with lower boiling point while poly(ethene)'s large complex structure leads to stronger intermolecular forces resulting in a solid state with higher boiling point.