All questions are for both separate science and combined science students

Q1.

A student investigated the energy change of the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm³ of copper sulfate solution into a polystyrene cup.

2. Measure the temperature of the copper sulfate solution.

3. Add 0.20 g of zinc powder to the copper sulfate solution.

4. Stir the reaction mixture.

5. Record the highest temperature reached.

6. Repeat steps 1 to 5 with different masses of zinc powder.

The figure below shows the results.
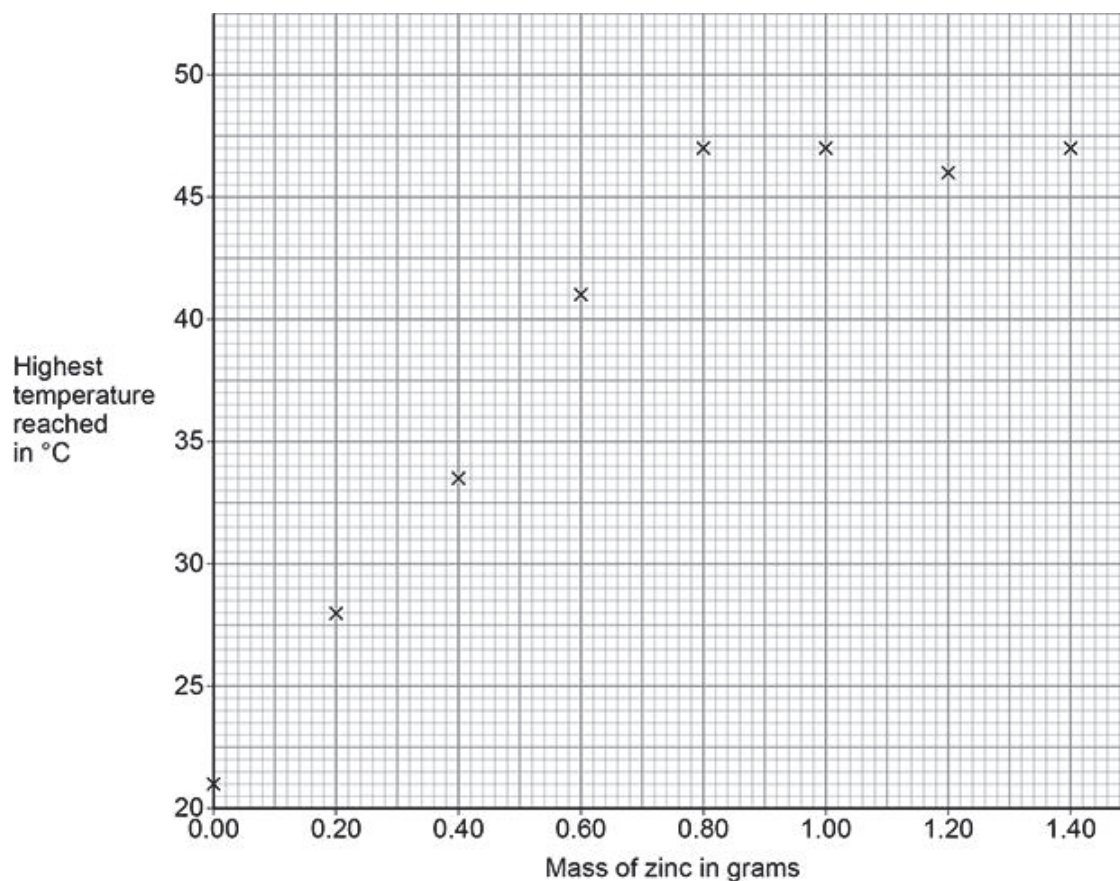
(a)   Draw **two** lines of best fit on the figure above.

The lines should cross.

(2)

(b)   Explain the results shown in above figure.

Do **not** refer to anomalous points.

Use data from the figure above.

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(4)

(c)   Explain why using a polystyrene cup gives more accurate results than using a glass beaker.

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(2)

(d)   Complete the ionic equation for the reaction between zinc and copper sulfate solution.

Include state symbols. **(HT only)**

$Zn(s) + Cu^{2+}(aq) \rightarrow$ _____(_____) + _____(_____)

(2)

A different student repeated steps 1 to 5 of the method four times using 0.50 g of zinc powder.

The table below shows the results.

	Trial 1	Trial 2	Trial 3	Trial 4
Highest temperature reached in °C	37.6	37.2	37.8	37.4

(e) Calculate the mean highest temperature reached.

Include the uncertainty in your answer.

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Mean highest temperature reached = _____ ± _____ °C

(3)

(f) The results show random errors.

The student did not make any measuring errors.

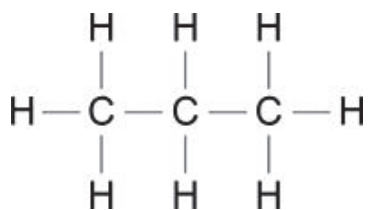Suggest **one** reason for the random errors in this experiment.

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(1)

(Total 14 marks)

Q2.

This question is about propane (C_3H_8).

Figure 1 shows the displayed structural formula of propane.

Figure 1

(a)   Explain why propane has a low boiling point.
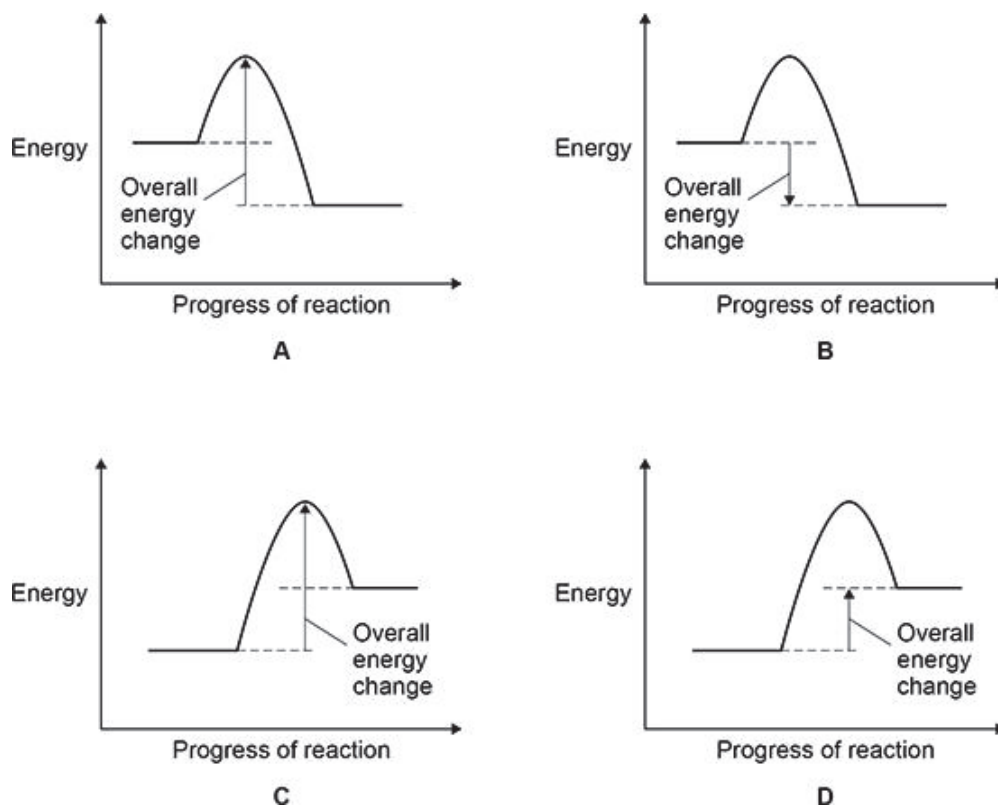
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(3)

Propane reacts with oxygen to produce carbon dioxide and water.

The reaction is exothermic.

(b)   **Figure 2** shows four reaction profiles.

Figure 2

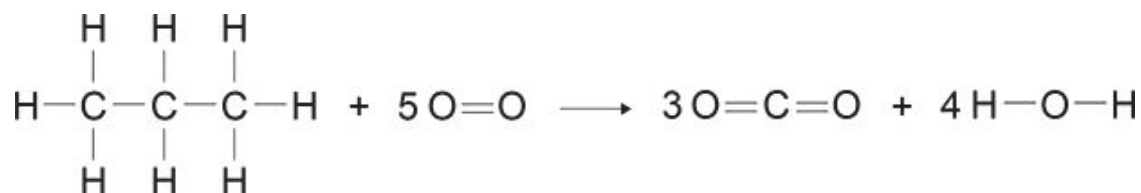Which is the correct reaction profile and labels for the reaction between propane and oxygen?

Tick (✓) **one** box.

A ☐   B ☐   C ☐   D ☐

(1)

(c) **Figure 3** shows the displayed formula equation for the reaction between propane and oxygen.

Figure 3

The overall energy change of this exothermic reaction is 2219 kJ/mol.

The table below shows the bond energies of the bonds in the reaction.

	C — C	C — H	O = O	C = O	O — H
Energy in kJ/mol	347	X	498	805	464

Calculate the bond energy of the C — H bond (**X**). **(HT only)**

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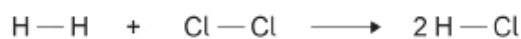Bond energy of the C — H bond (**X**) = _____ kJ/mol

(5)

(Total 9 marks)

Q3.

This question is about hydrogen and compounds of hydrogen.

Figure 1 shows the displayed formulae for the reaction between hydrogen and chlorine.

Figure 1

$$H—H \quad + \quad Cl—Cl \quad \longrightarrow \quad 2\,H—Cl$$

The table below shows the bond energies.

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

(a)   Which expression shows how to calculate the overall energy change for the reaction in **Figure 1**? **(HT only)**

Use the table above.

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 ☐

(1)

The reaction between hydrogen and chlorine is exothermic.

(b)   Explain why this reaction releases energy to the surroundings. **(HT only)**
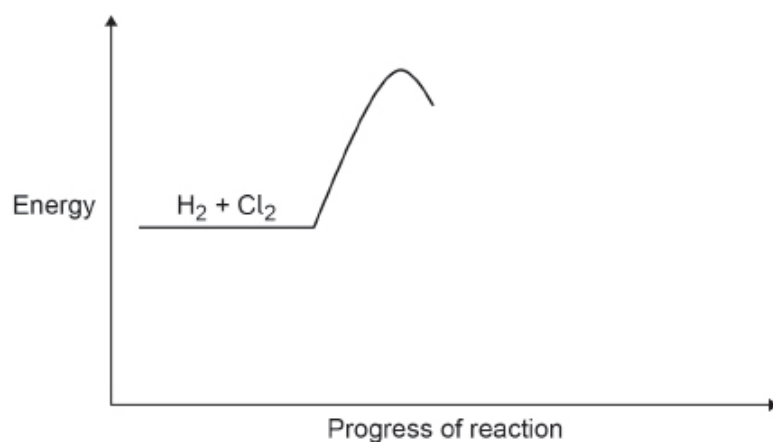
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(2)

(c)   **Figure 2** shows part of a reaction profile for the reaction between hydrogen and chlorine.

Complete the reaction profile in **Figure 2**.

You should:
- label the activation energy
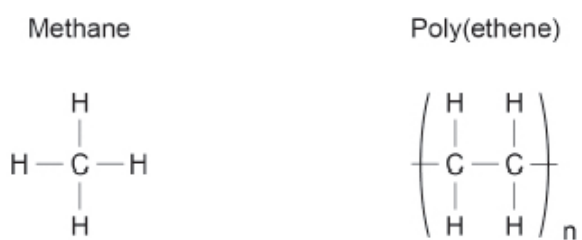- label the overall energy change.

Figure 2

(3)

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

Show the outer shell electrons only.

(2)

(e) **Figure 3** represents molecules of methane and of poly(ethene).

Figure 3

Methane   Poly(ethene)

$$H-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-H \qquad\qquad \left(\!\!-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\!\!\right)_{n}$$

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.

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(4)
(Total 12 marks)