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 cm^3 of copper sulfate solution into a polystyrene cup.

2. Measure the temperature of the copper sulfate solution.

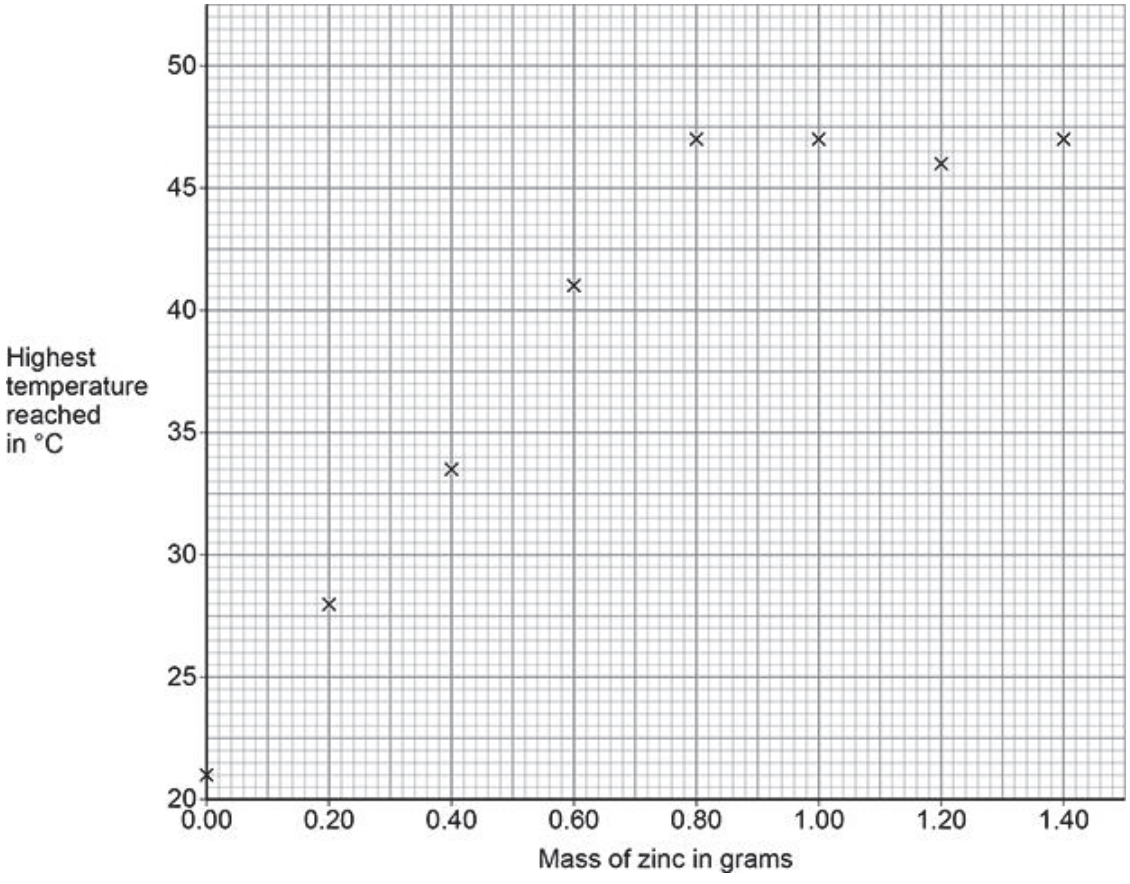
3. Add 0.20 g of zinc powder to the copper sulfate solution.

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.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

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

_____

_____

_____

_____

(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.

_____

_____

_____

_____

_____

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.

_____

_____

(1)

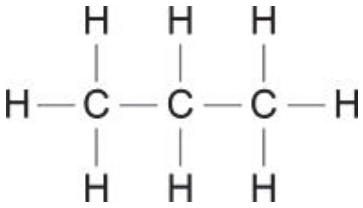
(Total 14 marks)

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.

_____

_____

_____

_____

_____

_____

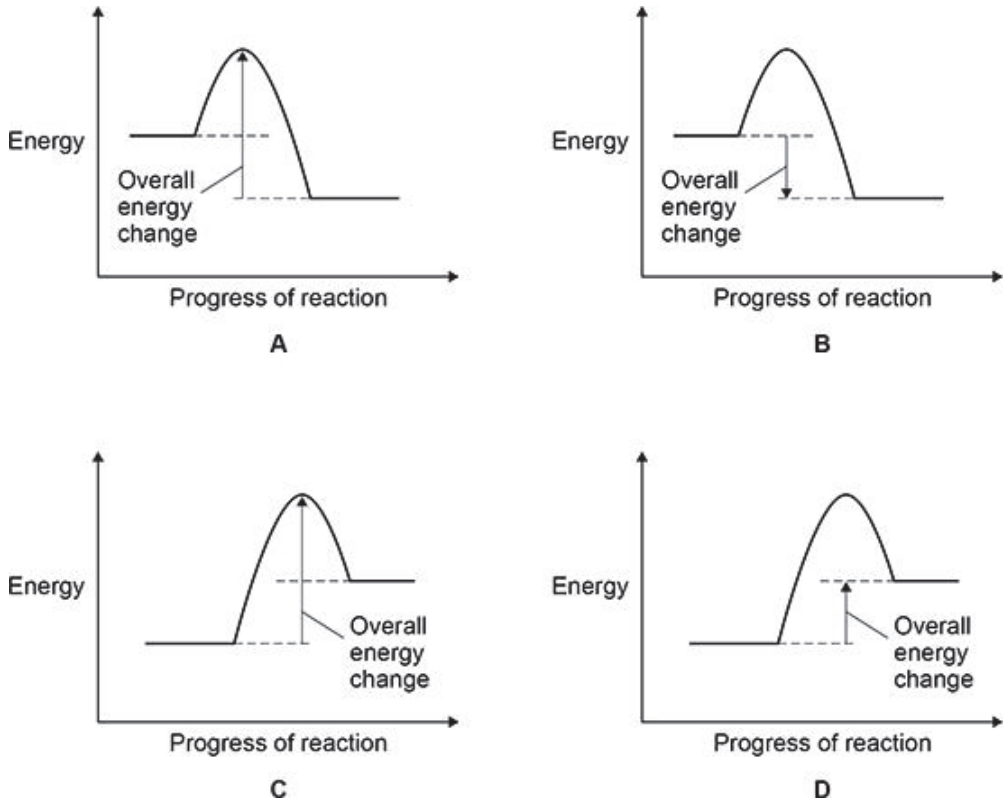
(3)

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?

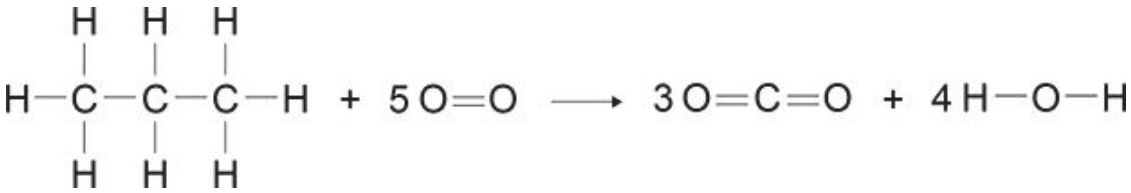
Tick (✓) **one** box.

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)**

_____

_____

_____

_____

_____

_____

_____

_____

_____

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

(5)

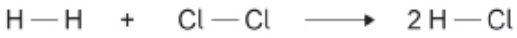
(Total 9 marks)

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



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)**

_____

_____

_____

_____

(2)

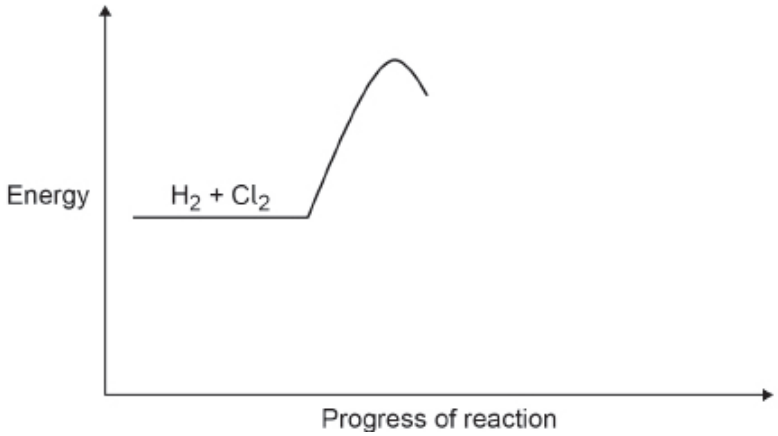
(c) **Figure 2** shows part of a reaction profile for the reaction between hydrogen and chlorine.

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).

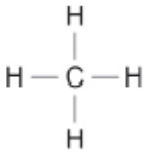
Show the outer shell electrons only.

(2)

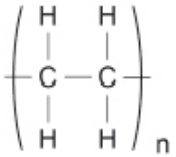
(e) **Figure 3** represents molecules of methane and of poly(ethene).

Figure 3

Methane



Poly(ethene)



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)

(Total 12 marks)