Q1.

Draw the Maxwell–Boltzmann distribution curves for a fixed mass of a gas at two different temperatures.
This gas decomposes when heated.

By reference to these distribution curves, explain why the rate of decomposition of this gas increases at higher temperatures.

(Total 6 marks)

Q2.

This question is about rates of reaction.

Potassium manganate(VII), $KMnO_4$, reacts with sodium ethanedioate, $Na_2C_2O_4$, in the presence of dilute sulfuric acid.

$$2\ MnO_4^-(aq) + 16\ H^+(aq) + 5\ C_2O_4^{2-}(aq) \rightarrow 2\ Mn^{2+}(aq) + 8\ H_2O(l) + 10\ CO_2(g)$$

The reaction mixture is purple at the start and goes colourless when all the $MnO_4^-(aq)$ ions have reacted.

The rate of reaction can be measured as $\frac{1000}{t}$ where t = the time taken for the mixture to go colourless.

A student investigated how long it takes for this reaction mixture to go colourless at different temperatures. The same concentrations and volumes of each reagent were used in an experiment at each temperature. The table below shows the results.

Temperature / °C	32	38	44	54	67
Time *t* / s	155	85	50	22	9
$\frac{1000}{t}$	6.45	11.8	20.0	45.5	

(a) Complete the table above.

(1)

(b) State the independent variable in this investigation.

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(1)

(c) The student noticed that the temperature of each reaction mixture decreased during each experiment.

Suggest how the student calculated the temperature values in the table above.

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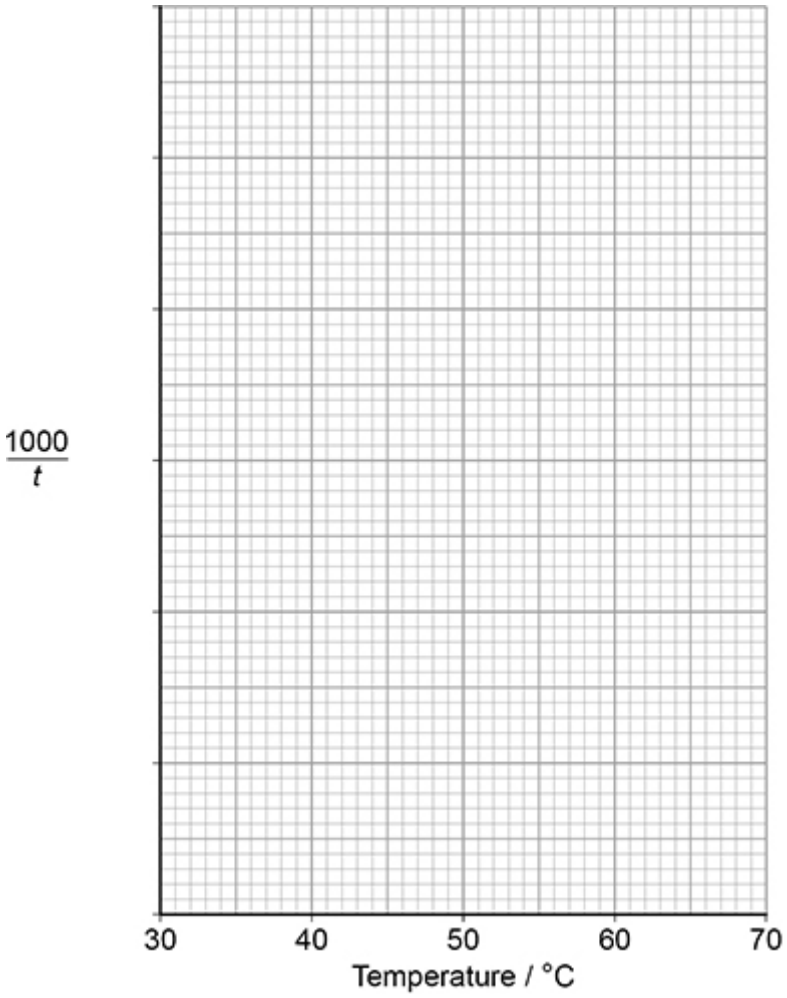
(1)

(d) Use the data in the table to plot a graph of $\frac{1000}{t}$ against temperature.



(3)

(e) Use your graph in part (d) to find the time taken for the mixture to go colourless at 60 °C
Show your working.

Time *t* _____ s

(1)

(f) The investigation shows that increasing the temperature causes the rate of reaction to increase.

Explain why a small increase in temperature causes a large increase in the rate of reaction.

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(2)

(Total 9 marks)