8 A student investigated the rate at which a hot liquid transfers thermal energy to the surroundings. He placed hot water in a Pyrex beaker and measured the temperature of the water using a liquid-in-glass thermometer.

He obtained the following data for the temperature θ of the water at times t. He measured t using a stopwatch.

t / s	θ / °C		
0	95		
120	87		
240	81		
360	76		
480	71		

temperature of surroundings = 23 °C

Theory suggests that a liquid transfers internal energy to the surroundings at a rate proportional to the temperature difference $\Delta\theta$ between the liquid and the surroundings.

This leads to the expression

$$\Delta\theta = \Delta\theta_0 e^{-bt}$$

where b is a constant and $\Delta\theta_0$ is the initial temperature difference.

(a) Explain why a graph of ln $\Delta\theta$ against t should be a straight line.

(2)

....

....

....

....

(b) (i) Plot a graph of ln $\Delta\theta$ against t on the grid opposite.
Use the columns provided in the table to show any processed data.

(5)

(ii) Determine the value of b.

(3)

....

....

....

....

....

b = ...

(c) The student suggested that the experiment would have been more accurate if a temperature sensor and data logger had been used to collect the data.

Assess the validity of the student's suggestion.

(4)

....

....

....

....

....

....

....

....

(Total for Question 8 = 14 marks)