

Name of the Student: _____

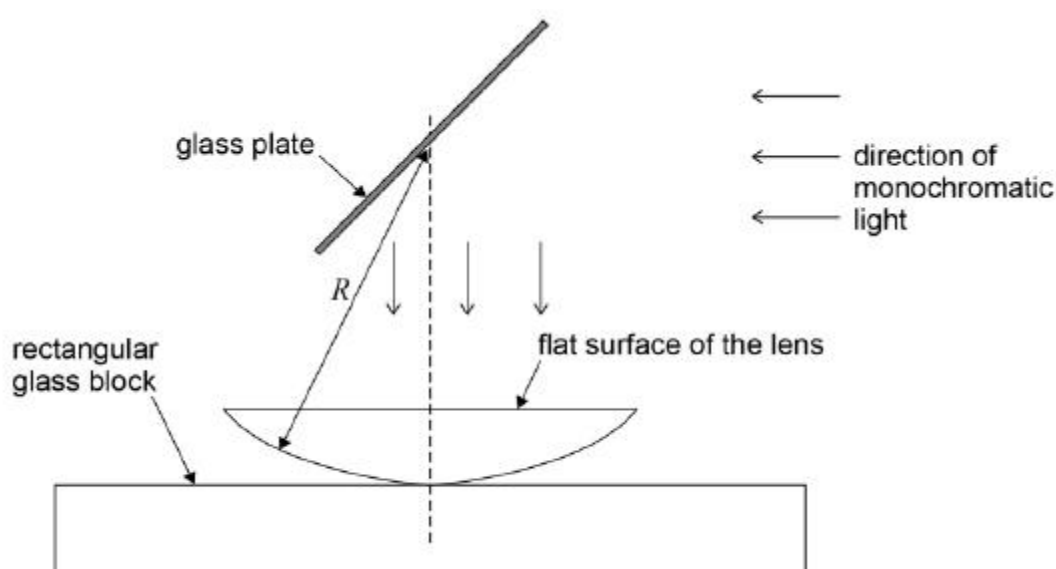
Max. Marks : 21 Marks

Time : 21 Minutes

Q1.

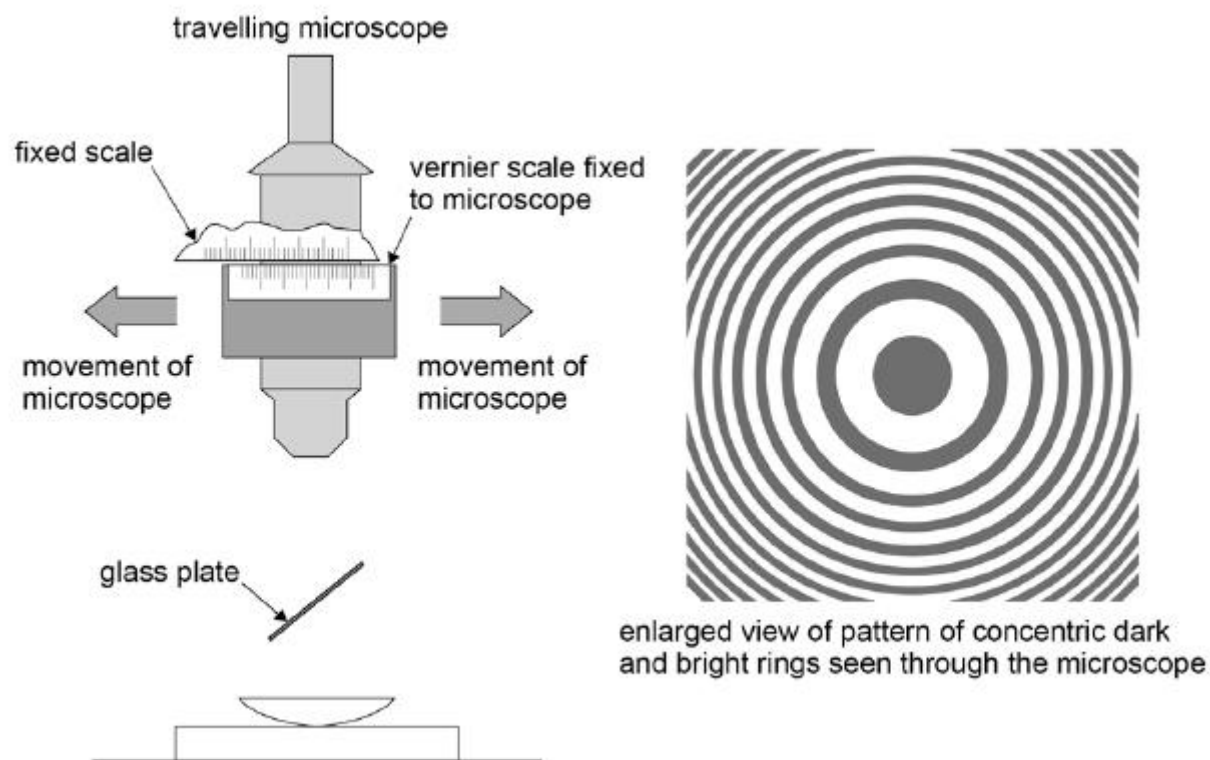
A lens has a flat surface and a curved surface. An experiment is carried out to determine the radius R of the curved surface of the lens. The lens is placed on a rectangular glass block with its flat surface upwards. The lens is illuminated with monochromatic light reflected from a glass plate as shown in **Figure 1**.

Figure 1



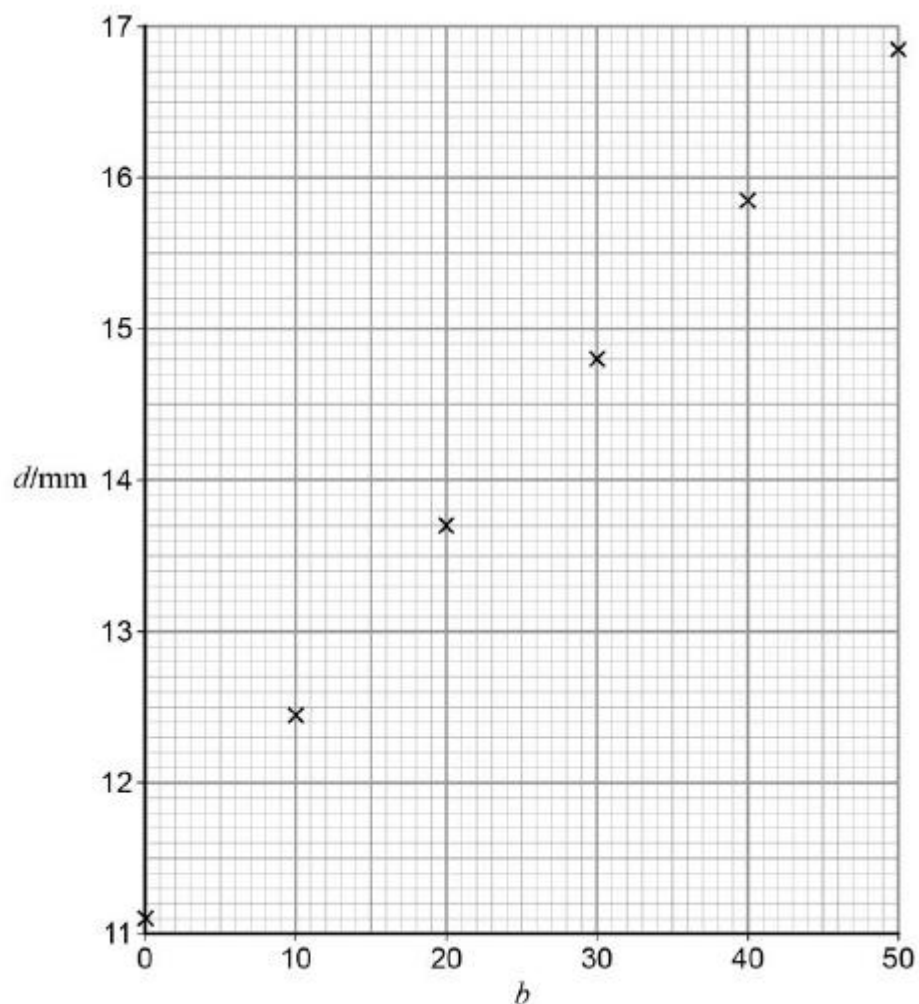
When the apparatus is viewed from above an interference pattern consisting of concentric dark and bright rings is seen. A travelling microscope positioned as shown in **Figure 2** is used to measure the diameter of the **bright** rings.

Figure 2



- (a) A student chose a particular bright ring (not at the centre of the pattern) and measured its diameter. He called this ring number 0. Counting outwards from the centre, he measured the diameter of every tenth ring.

Below is a graph of ring number b against ring diameter d .



Draw a line of best fit on the graph above.

(1)

- (b) Determine the gradient G corresponding to $b = 25$.

$$G = \underline{\hspace{2cm}}$$

(3)

- (c) The radius of curvature R of the lens can be calculated using any point on the graph together with the formula

$$R = \frac{Gd}{2\lambda}$$

where $\lambda = 589.3 \text{ nm}$.

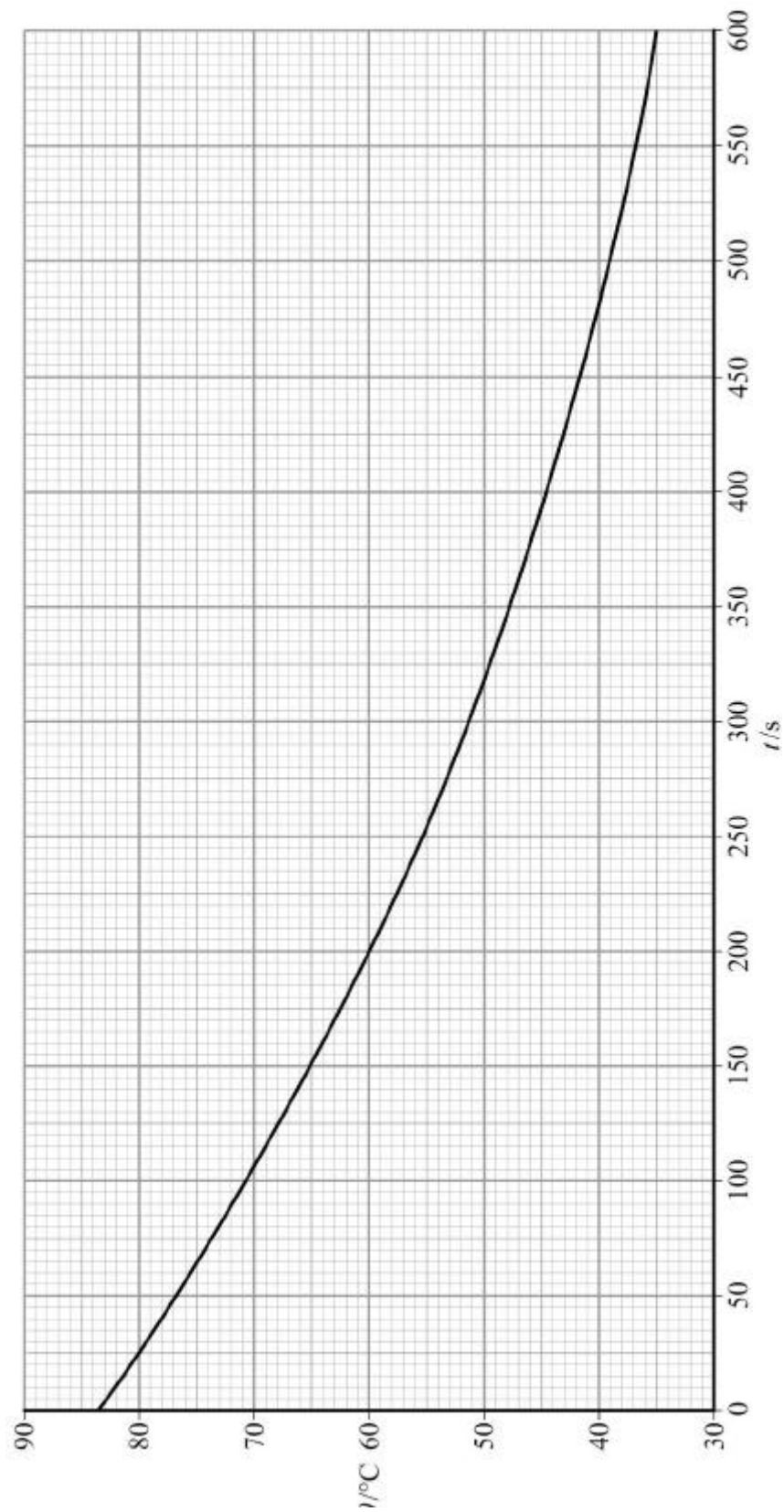
Determine R .

$R = \underline{\hspace{2cm}} \text{ m}$
(3)
(Total 7 marks)

Q2.

A temperature sensor is connected to a data logger to monitor how the temperature θ of a fixed mass of recently-boiled water varies with time t , over an interval of 600 s. These data are processed to produce the graph shown in **Figure 1**.

Figure 1



- (a) Determine the temperature θ_1 of the water when t is 190 s.

$$\theta_1 = \underline{\hspace{2cm}} \text{ } ^\circ\text{C} \quad (1)$$

- (b) Determine the gradient G_1 of the graph at t is 190 s.

$$G_1 \underline{\hspace{2cm}} \quad (3)$$

- (c) When $t = 370$ s the temperature $\theta_2 = 46.6$ $^\circ\text{C}$ and the gradient $G_2 = -0.0645$.

$$\text{The room temperature } \theta_R \text{ is given by } \frac{G_1\theta_2 - G_2\theta_1}{G_1 - G_2}$$

Evaluate θ_R .

$$\theta_R = \underline{\hspace{2cm}} \text{ } ^\circ\text{C} \quad (1)$$

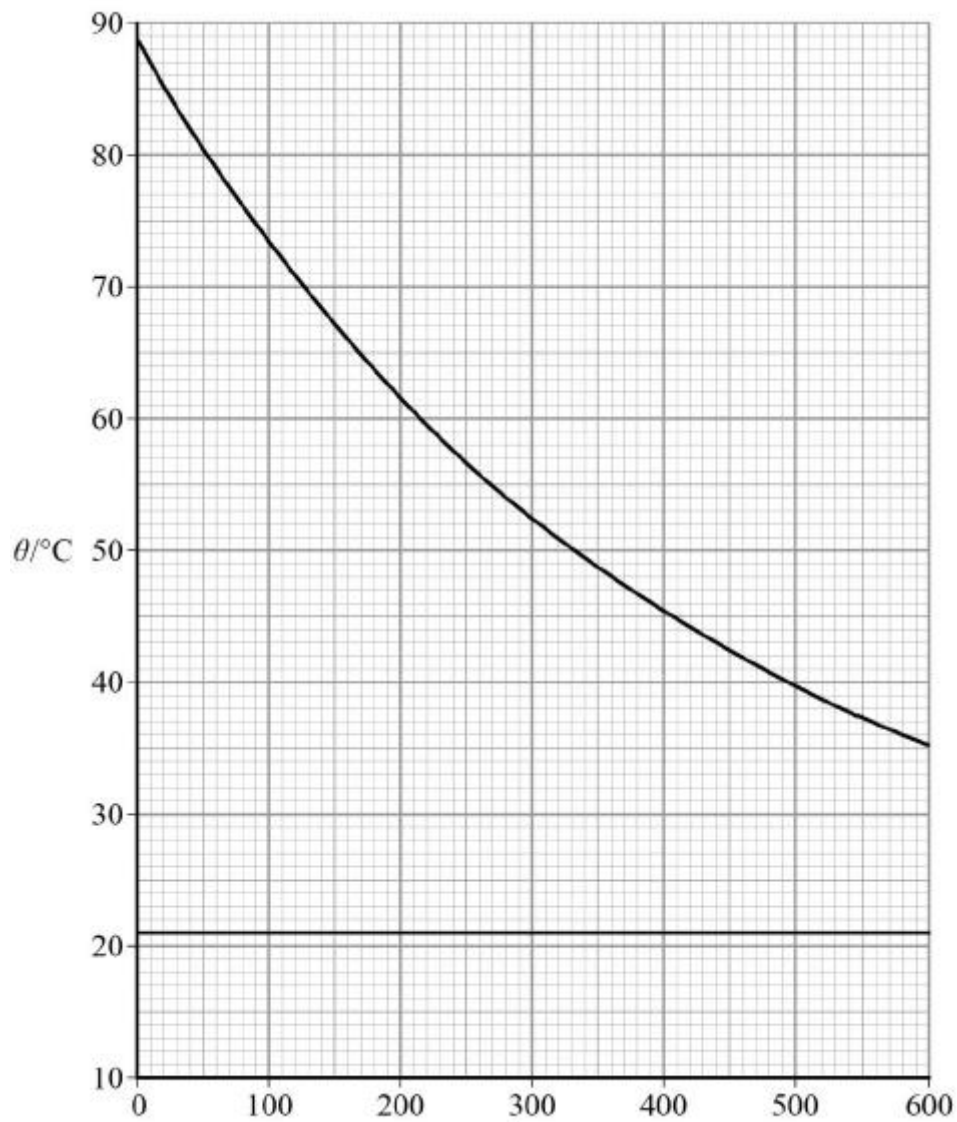
- (d) It can be shown that when a hot object at a temperature θ is allowed to cool in a draught, the rate at which the temperature decreases is directly proportional to the temperature difference $(\theta - \theta_R)$ between the object and the surroundings.

A student realises that $(\theta - \theta_R)$ will decrease exponentially with time and designs an experiment in which two temperature sensors are connected to a data logger.

- Sensor 1 is placed in a beaker of recently-boiled water.
- Sensor 2 measures the air temperature in the room.
- The data logger is programmed to record the output from the sensors as the water cools for 600 s.

The output data from the sensors are processed to produce the graph shown in **Figure 2**.

Figure 2



$(\theta - \theta_R)$ will decrease exponentially in the same way that the potential difference (pd) across a discharging capacitor decreases with time.

When a capacitor discharges, the pd across the capacitor falls to $\frac{1}{e}$ of an initial value in a time called the **time constant**. Electronic engineers assume that a capacitor becomes fully discharged in a time equal to **5 time constants**.

Estimate the time taken for the water to cool down to room temperature.

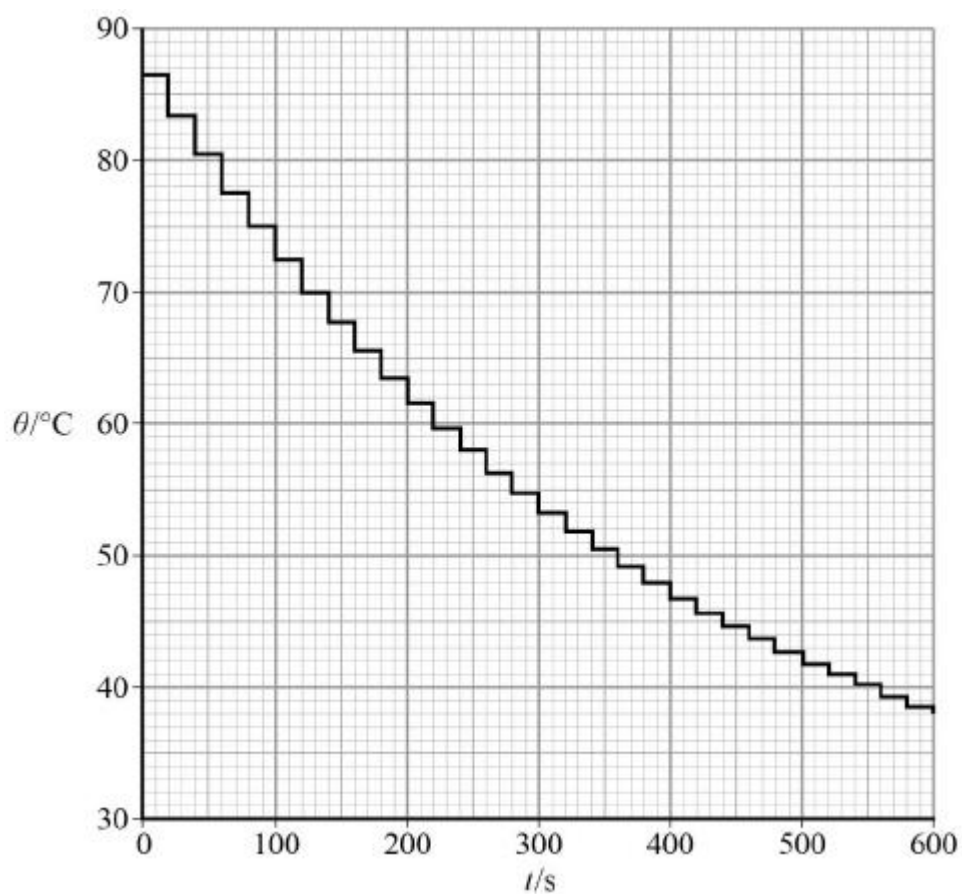
time taken = _____ s

(4)

- (e) Another student carries out the experiment using the same mass of recently-boiled water and beaker as before.

The output data for sensor 1 from this student's experiment are shown in **Figure 3**.

Figure 3



Account for the differences between these results and the way they are displayed, with those shown in **Figure 2**.

You should include appropriate quantitative detail in your answer.

(5)
(Total 14 marks)