

3 A student investigates the cooling of water.  
The student sets up the apparatus shown in Fig. 3.1.

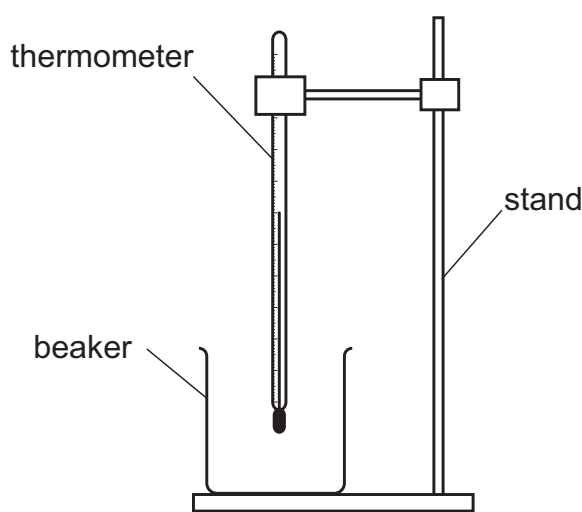


Fig. 3.1

(a) The student records the room temperature  $\theta_R$ .

$$\theta_R = 21.5^\circ\text{C}$$

The student:

- pours  $60\text{ cm}^3$  of hot water into the beaker
- waits for 30s
- measures, and records in Table 3.1 at time  $t = 0$ , the temperature  $\theta$  of the water
- immediately starts a stop-watch and measures the temperature of the water at one-minute intervals for 5 minutes.

The reading on the thermometer for time  $t = 0$  is shown in Fig. 3.2.

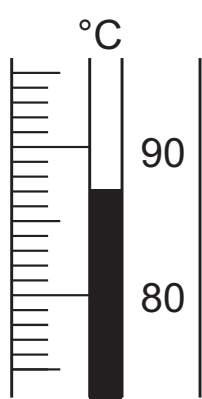


Fig. 3.2

- (i) Record the temperature in Table 3.1 to the nearest  $0.5^\circ\text{C}$ . [1]
- (ii) Complete the time  $t$  column. [1]

Table 3.1

time $t$ / .....	temperature $\theta / ^\circ\text{C}$
0	
	80.5
	75.5
	71.0
	67.5
	64.0

(b) (i) Suggest why the student waits for 30s before measuring the initial temperature of the hot water.  
..... [1]

(ii) State how the student ensures that the temperature readings are as accurate as possible.  
..... [1]

(c) (i) Calculate the decrease in temperature  $\Delta\theta$  of the hot water during the **first two** minutes of cooling.

$$\Delta\theta = \dots\dots\dots^\circ\text{C} \quad [1]$$

(ii) Calculate the average rate of cooling  $R_1$  of the hot water during the **first two** minutes of cooling.

Use the equation:

$$R_1 = \frac{\text{decrease in temperature}}{\text{time}}$$

Include the unit in your answer.

$$R_1 = \dots\dots\dots \text{unit} = \dots\dots\dots [2]$$

(iii) Calculate the average rate of cooling  $R_2$  of the hot water during the **final two** minutes of cooling.

$$R_2 = \dots\dots\dots [1]$$

(d) Use your answers in (c)(ii) and (c)(iii) to write a conclusion about the way in which hot water in a beaker cools.

..... [1]

(e) The water in the beaker is left to continue cooling.

(i) Estimate the temperature of the water  $\theta_5$  after a further 5 minutes of cooling.

$$\theta_5 = \dots\dots\dots^\circ\text{C} \quad [1]$$

(ii) Estimate the temperature of the water  $\theta_{50}$  after a further 50 minutes of cooling.

$$\theta_{50} = \dots\dots\dots^\circ\text{C} \quad [1]$$