## Question 1a

A student is investigating the rate of cooling of water under different conditions. A greater rate of cooling occurs if there is a greater change in the temperature during the same period of time.

Fig. 3.1 shows some of the apparatus.

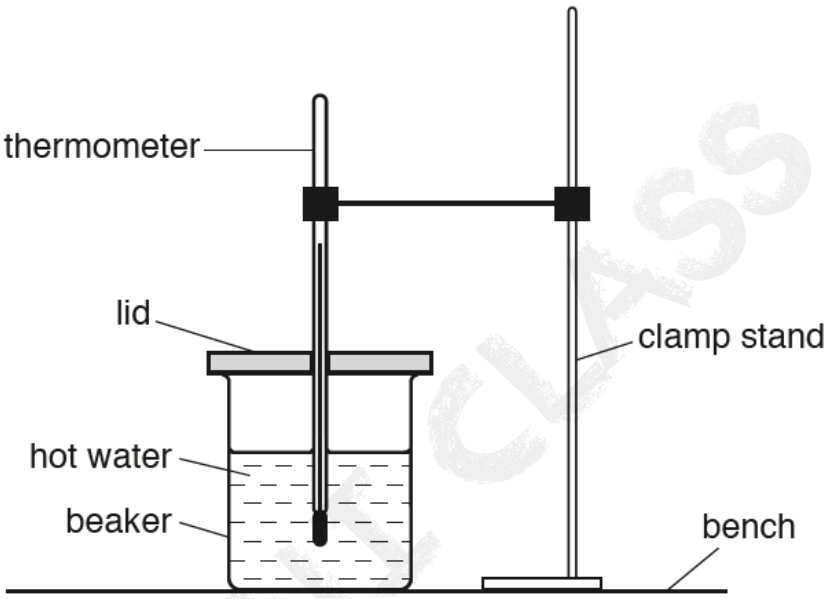



**Fig. 3.1**

The thermometer in Fig.3.2 shows the room temperature $\theta_R$ at the beginning of the experiment. Record $\theta_R$.

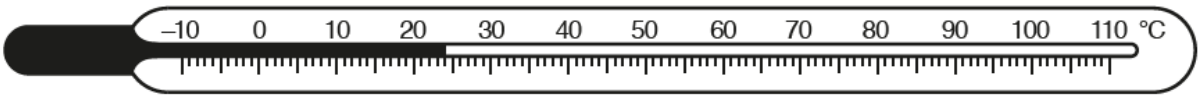



**Fig. 3.2**

$\theta_R$ = .....

**[1 mark]**

## Question 1b

The student pours 200 $cm^3$ of hot water into the beaker.

She records the temperature $\theta$ of the hot water at time $t = 0$. She immediately starts a stopclock.

She continues recording the time and the temperature readings every 30 s. The readings are shown in Table 3.1.

The student repeats the procedure using a metal can, painted matt black, in place of the beaker.

**Table 3.1**

The readings are shown in Table 3.2.

Beaker

| $t$ / | $\theta$ / |
|---|---|
| 0 | 94 |
| 30 | 93 |
| 60 | 92 |
| 90 | 91 |
| 120 | 90 |
| 150 | 89 |

**Table 3.2**

Can

| t / | θ / |
|---|---|
| 0 | 93 |
| 30 | 91 |
| 60 | 90 |
| 90 | 89 |
| 120 | 88 |
| 150 | 87 |

(i) Complete the column headings in Table 3.1 and in Table 3.2.

[1]

(ii) Look carefully at the readings in Table 3.1 and in Table 3.2.

Tick the box to show your conclusion from the readings.

- ☐ The water in the beaker has a greater rate of cooling than the water in the can.
- ☐ The water in the beaker has a smaller rate of cooling than the water in the can.
- ☐ There is no significant difference between the rates of cooling of the water in the beaker and the can.

[1]

(iii) Justify your conclusion by reference to the readings.

[2]

**[4 marks]**

## Question 1c

A student in another school carries out the experiment and reports that the rate of cooling of the water in the can is different from the rate of cooling of the water in the beaker. He plans a change to the experiment to find out whether this difference in the rates of cooling is caused by

- the matt black surface of the can being a better radiator of thermal energy than the shiny surface of the beaker
- the metal of the can being a better conductor of thermal energy than the material of the beaker.

(i) Suggest two suitable changes to the apparatus that the student could make.

[2]

(ii) Suggest two variables that should be controlled in order to make the experiment a fair test.

[2]

**[4 marks]**



## Question 1d

State **one** precaution that you would take in order to record accurate temperature readings.

**[1 mark]**

## Question 2a

A student is determining the focal length *f* of a lens.

Fig. 3.1 shows the apparatus.

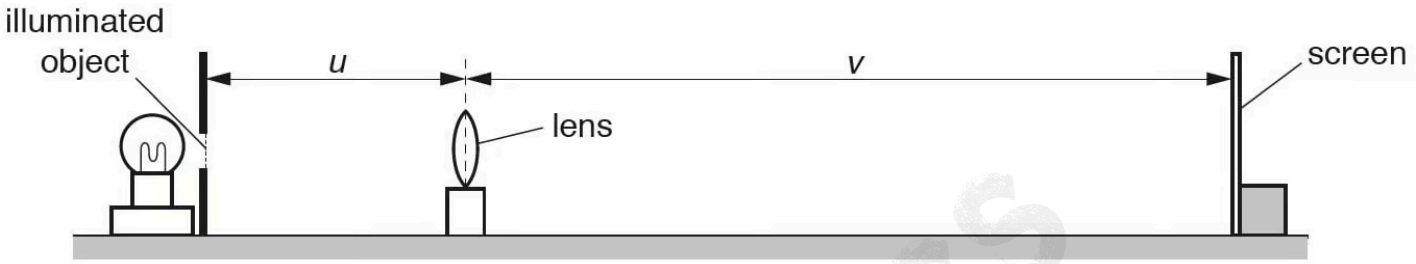



**Fig. 3.1**

The student places the screen a distance *D* = 70.0 cm from the illuminated object.

He places the lens close to the screen and moves the lens slowly away from the screen until a clearly focused image is formed on the screen.

He measures the distance *u* between the centre of the lens and the illuminated object.

He measures the distance *v* between the centre of the lens and the screen.

He repeats the procedure using values for *D* of 75.0 cm, 80.0 cm, 85.0 cm and 90.0 cm.

The readings are shown in Table 3.1.

Formulate a hypothesis regarding the relationship between the focal length of the lens and the distances (u and v) between the lens and the object and screen respectively. **[3 marks]**

## Question 2b

Calculate, and record in Table 3.1, $uv$ for each value of $D$.

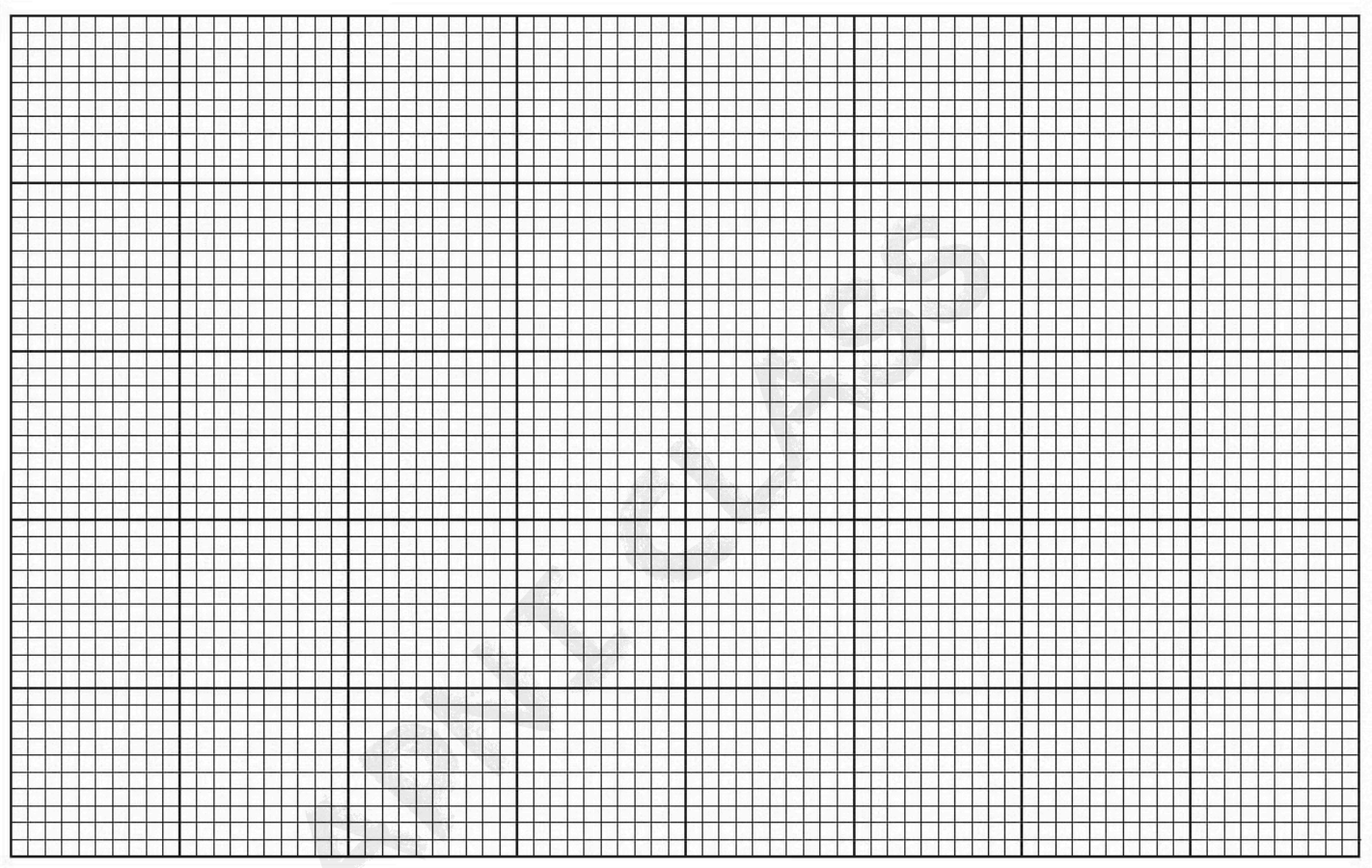
**Table 3.1**

| $D$/cm | $u$/cm | $v$/cm | $uv$/cm$^2$ |
|---|---|---|---|
| 70.0 | 22.0 | 48.4 | |
| 75.0 | 20.7 | 54.5 | |
| 80.0 | 20.0 | 60.0 | |
| 85.0 | 19.5 | 65.8 | |
| 90.0 | 19.0 | 71.2 | |

**[3 marks]**

**Question** 2c

Plot a graph of $uv/\text{cm}^2$ (y-axis) against $D/\text{cm}$ (x-axis). You do not need to start your axes at the origin (0,0).



**[4 marks]**

**Question** 2d

Determine the gradient *G* of the line. Show clearly on the graph how you obtained the necessary information.

*G* = .....

**[2 marks]**

**Question** 2e

The focal length *f* of the lens is numerically equal to the gradient *G* of the graph. Write down a value for the focal length *f* of the lens. Give your answer to a suitable number of significant figures for this experiment.

*f* = .....

**[2 marks]**

**Question** 2f

Suggest **two** difficulties in this experiment when trying to obtain accurate readings.

**[2 marks]**