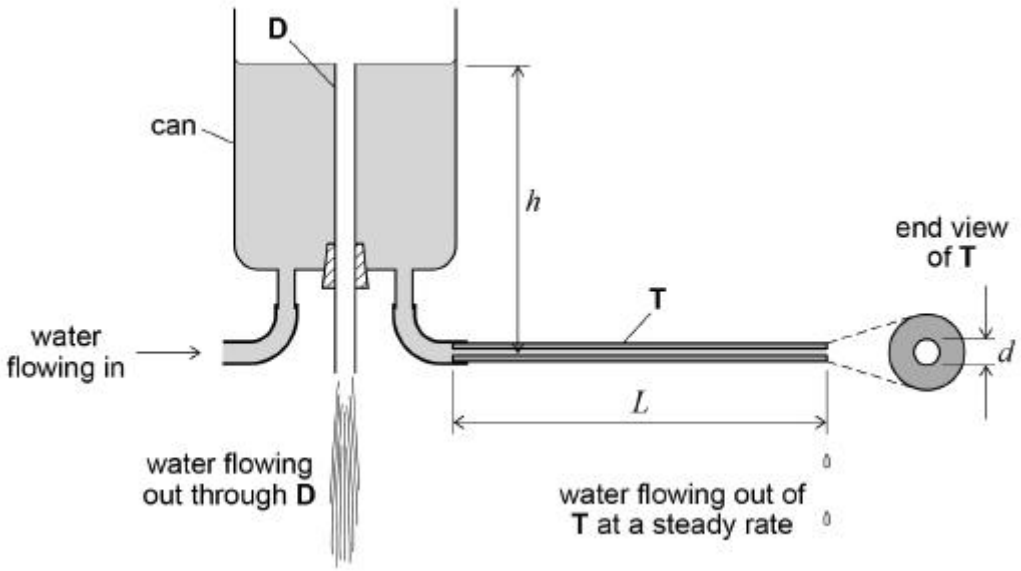
**Name of the Student**:_____
**Max. Marks : 21 Marks** **Time : 21 Minutes**

## Q1.

**Figure 1** shows apparatus used to investigate the rate at which water flows through a horizontal cylindrical tube **T** of internal diameter $d$ and length $L$.

**Figure 1**




The apparatus ensures that the water level in the can is at a constant height $h$ above the centre of **T**.

Water flows out of **T** at a steady rate.

(a) The volume flow rate through **T** is $Q$, where $Q$ is in $m^3\ s^{-1}$.
A student wants to measure $Q$ as water flows through **T**.

Outline a procedure the student should follow to measure $Q$.
Include in your answer

- the measuring instruments used
- how uncertainty in the measurements can be reduced.

_____

_____

_____

_____

_____

Downloaded from www.merit-minds.com

**(4)**

(b) It can be shown that

$$Q = \frac{\pi \rho g h d^4}{128 L \eta}$$

where $\rho$ is the density of water
$g$ is the gravitational field strength
$\eta$ is a property of the water called the coefficient of viscosity.

What is the SI unit for $\eta$?

Tick (✔) **one** box.

N $m^{-1}$ s ☐

N $m^{-2}$ s ☐

N $m^{-1}$ $s^{-1}$ ☐

N $m^{-2}$ $s^{-1}$ ☐

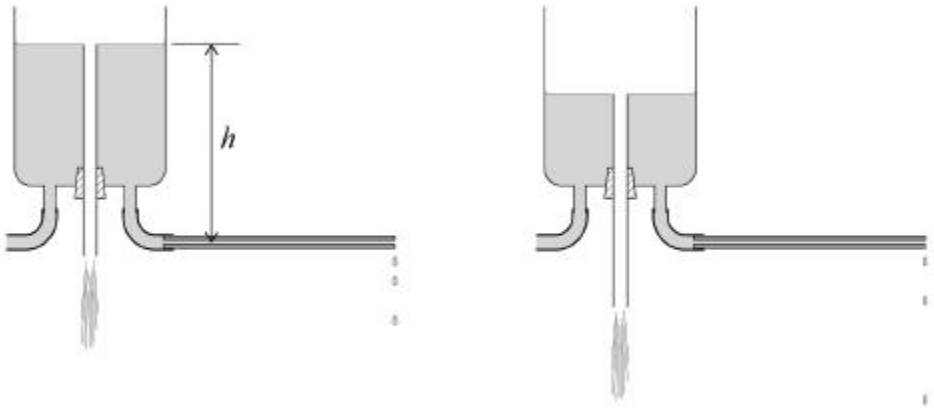
Downloaded from www.merit-minds.com

**(1)**

(c) An experiment is carried out to determine $\eta$ by a graphical method.

The rate at which water flows out of **T** is varied by adjusting the height of the drain tube as shown in **Figure 2**.

**Figure 2**




During the experiment the temperature is kept constant.
$Q$ is found for different values of $h$ and a graph of these data is plotted, with $Q$ on the vertical axis.
The percentage uncertainty in the gradient of the graph is 6.4%.

The dimensions of tube **T** are measured and the uncertainties in these data are calculated.

The percentage uncertainty

- in $d$ is 2.9%
- in $L$ is 1.8%.

The percentage uncertainties in $\rho$ and $g$ are negligible.

Deduce the percentage uncertainty in the result for $\eta$.

percentage uncertainty in $\eta$ = _____

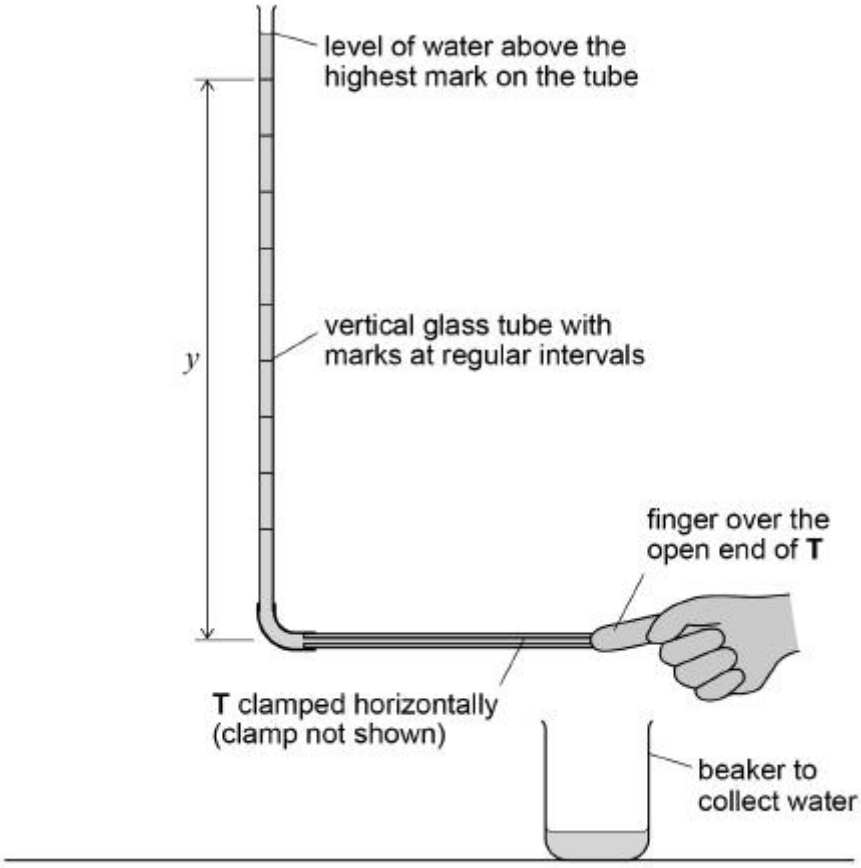
**(2)**

(d) In a different experiment, the horizontal tube **T** is connected to a vertical glass tube.
Marks have been made at regular intervals on the glass tube.
The student measures and records the vertical distance $y$ between each of the marks and the centre of **T**.

She seals the open end of **T** and fills the glass tube with water, as shown in **Figure 3**.

Downloaded from www.merit-minds.com

**Figure 3**




**T** is opened and water flows into a beaker.
When the water level falls to the highest mark on the tube, she starts a stopwatch.
She records the time *t* for the water to reach each of the other marks.

Explain how the student could check that the glass tube was vertical.
You may wish to add detail to **Figure 3** to illustrate your answer.

_____

_____

_____

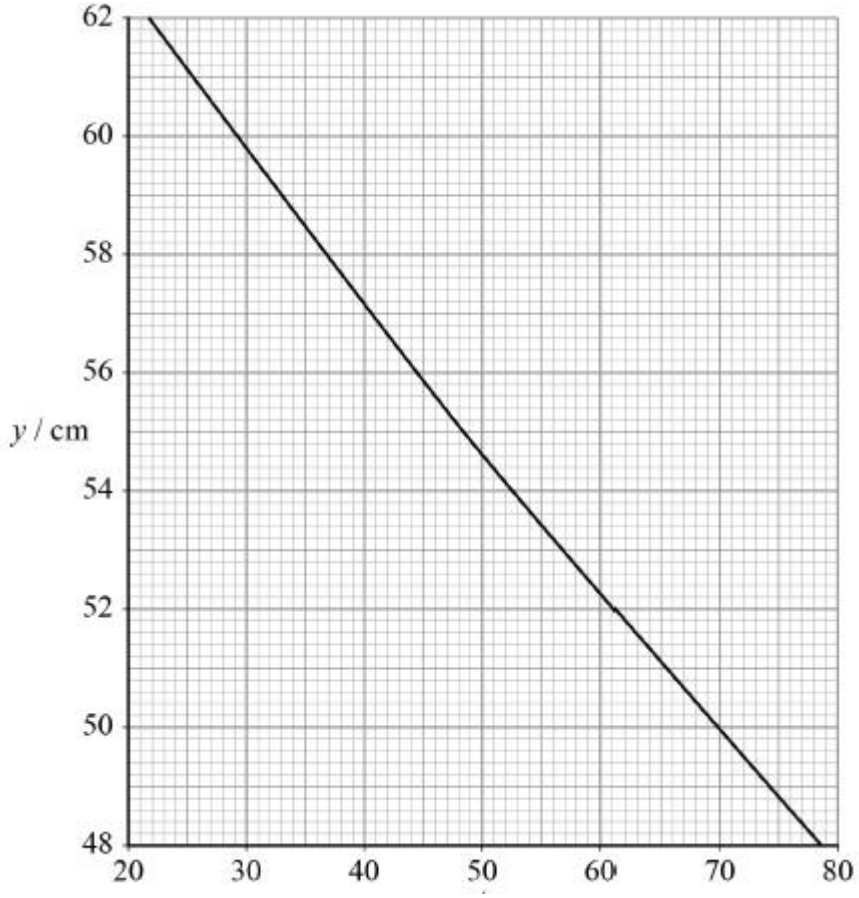
_____

**(1)**

(e) **Figure 4** shows part of the graph drawn from the student's data.

**Figure 4**

Downloaded from www.merit-minds.com




It can be shown that $y$ decreases exponentially with $t$.

Show that λ, the decay constant for this process, is about $4.5 \times 10^{-3}$ $s^{-1}$.

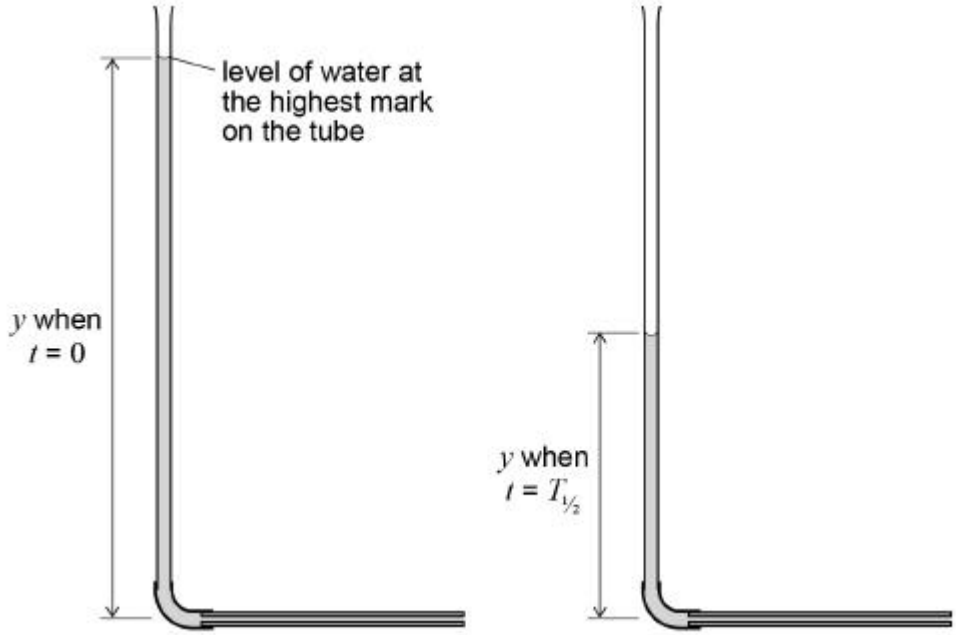
λ = _____ $s^{-1}$

**(2)**

(f) $T_{½}$ is the time for $y$ to decrease by 50%, as shown in **Figure 5**.

**Figure 5**

Downloaded from www.merit-minds.com

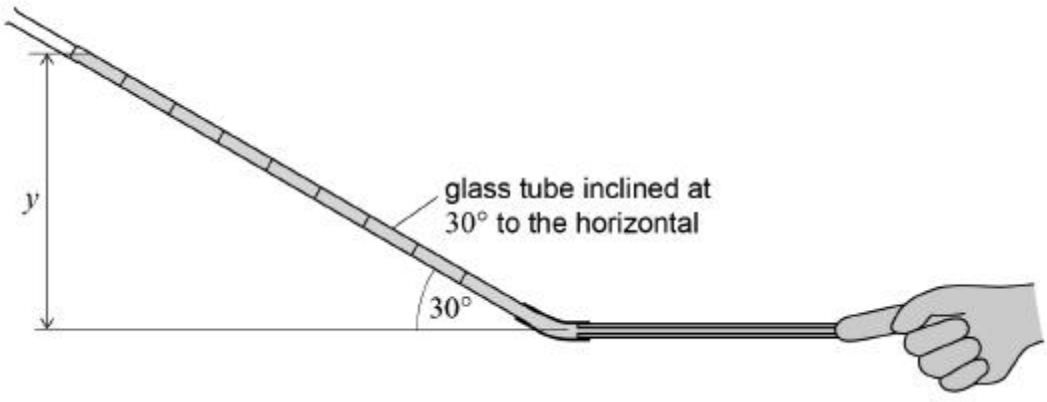



$T_{½}$ = _____ s

**(1)**

(g) The apparatus is adjusted so that the glass tube is inclined at 30° to the horizontal tube **T**, as shown in **Figure 6**.

**Figure 6**

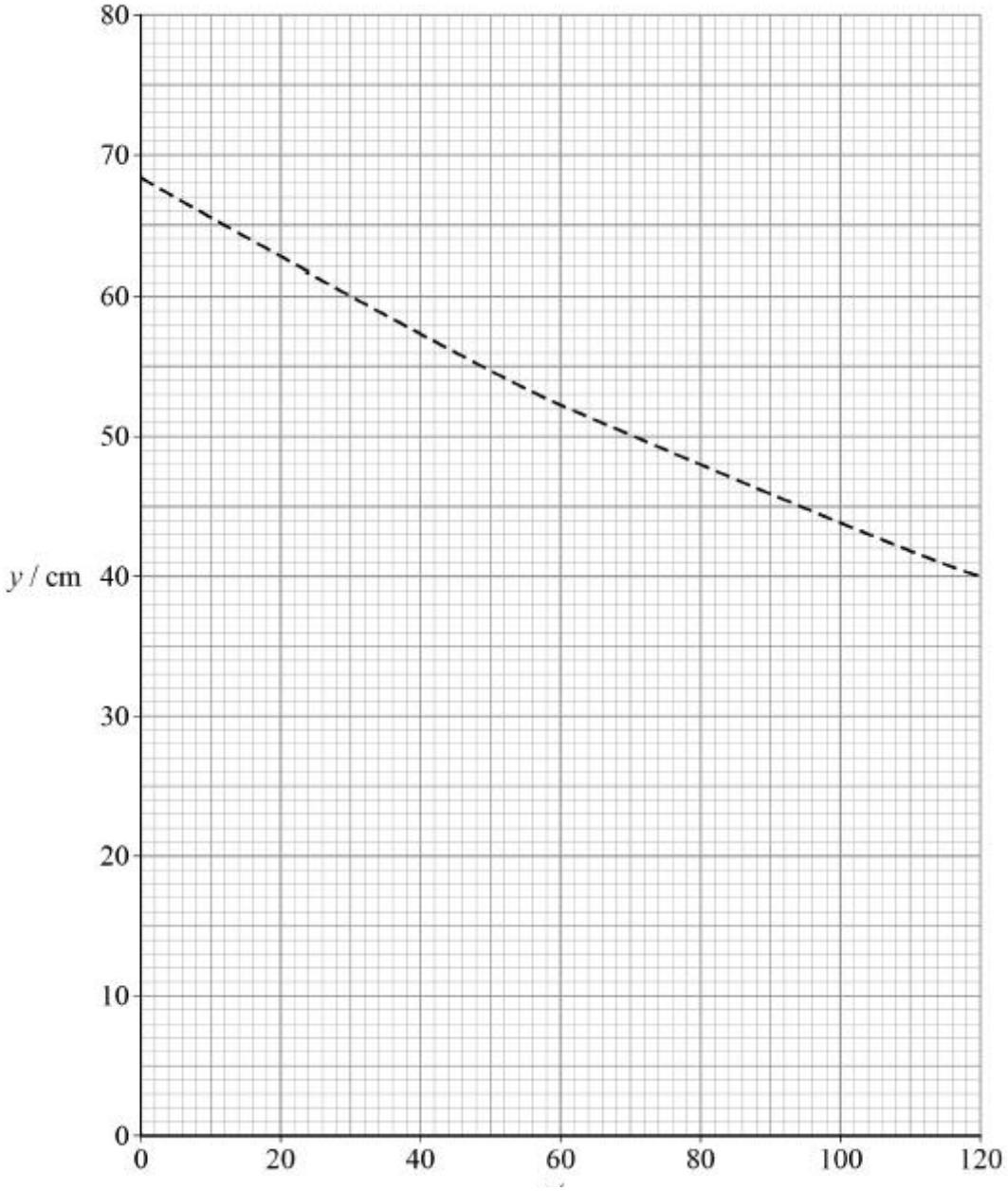



The student measures and records the new values of $y$, the mean vertical distance between each of the marks and the centre of **T**.
She then carries out the experiment as before, recording new values of $t$ corresponding to each new value of $y$.

Draw a line on **Figure 7** to show the graph produced using the modified apparatus.
The dashed line is the original graph when the glass tube was vertical as shown in **Figure 3**.

**Figure 7**

Downloaded from www.merit-minds.com




**(2)**

**(Total 13 marks)**

## Q2.

(a) The lenses used in refracting telescopes can cause chromatic aberration.

Complete the diagram to show how a lens produces chromatic aberration.

Downloaded from www.merit-minds.com




**(1)**

(b) A Cassegrain telescope uses mirrors.

What are the shapes of the primary and secondary mirrors in a Cassegrain telescope?

Tick (✔) **one** box.

| Primary mirror | Secondary mirror | |
|---|---|---|
| concave | concave | |
| concave | convex | |
| convex | concave | |
| convex | convex | |

**(1)**

(c) The table contains information about two telescopes, **A** and **B**. Each telescope is planned to be the biggest of its type in the world.

| **Telescope** | **A** | **B** |
|---|---|---|
| **Type** | Optical reflecting telescope | Radio telescope |
| **Diameter / m** | 39.3 | 110 |
| **Range of wavelengths detected** | 350 nm to 1800 nm | 2.5 mm to 1000 mm |

Discuss the similarities and differences between optical reflecting telescopes and radio telescopes. Your answer should include references to:

- structure
- positioning
- collecting power.

Go on to discuss which telescope, **A** or **B**, will give a more detailed image of an astronomical object that emits both radio waves and visible light.

_____

_____

_____

Downloaded from www.merit-minds.com

_____

_____

_____

_____

_____

_____

_____

_____

_____

**(6)**
**(Total 8 marks)**

Downloaded from www.merit-minds.com