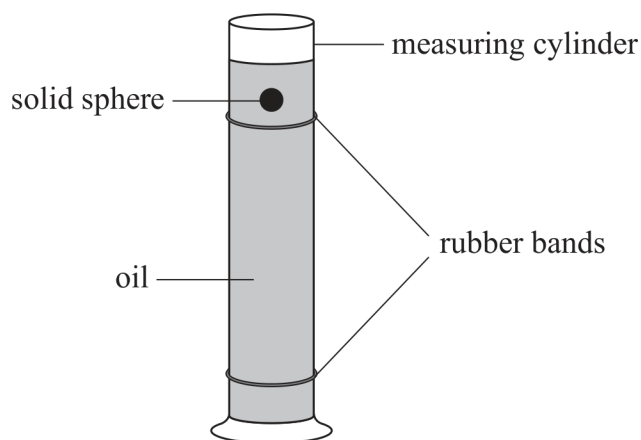


- 15 A student carried out an experiment to determine the viscosity of a sample of oil contained in a large measuring cylinder.

A small solid sphere was released just above the surface of the oil and the terminal velocity of the sphere was determined.



- (a) Two rubber bands were placed around the cylinder as shown. When the sphere passed the top band a timer was started. The timer was stopped when the sphere passed the bottom band.
- (i) Explain why the top rubber band should be placed a short distance below the surface of the oil.

(2)

- (ii) Another student suggested using an additional rubber band halfway between the top and bottom rubber bands.

Discuss the benefit of adding the third rubber band.

(2)



(b) The student used the following equation to determine the viscosity  $\eta$  of the oil.

$$\frac{4}{3} \pi r^3 \rho_s g = \frac{4}{3} \pi r^3 \rho_o g + 6 \pi r \eta v$$

Where

$\rho_s$  = density of the solid sphere

$\rho_o$  = density of the oil

$r$  = radius of the sphere

$v$  = terminal velocity of the sphere

(i) Which quantity is represented by  $\frac{4}{3} \pi r^3 \rho_s g$ ? (1)

(ii) Which quantity is represented by  $\frac{4}{3} \pi r^3 \rho_o g$ ? (1)

(iii) Which quantity is represented by  $6 \pi r \eta v$ ? (1)

(iv) The accepted value for the viscosity of the oil used in this experiment is 41 mPa s at 24 °C.

The student obtained a value of 36 mPa s.

Suggest a possible reason for the student obtaining a lower value for the viscosity than the accepted value.

(1)