

2 In this experiment, you will investigate the rolling of a plastic bottle.

- (a) (i) You are provided with a plastic bottle with a cap, as shown in Fig. 2.1.

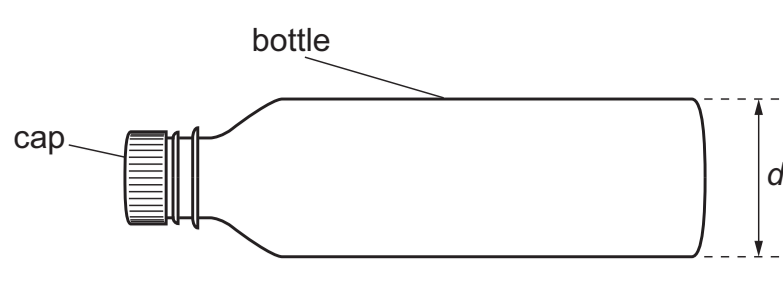


Fig. 2.1

The diameter of the base of the bottle is  $d$ .

Measure and record  $d$ .

$d = \dots\dots\dots$  [1]

- (ii) Estimate the percentage uncertainty in your value of  $d$ . Show your working.

percentage uncertainty =  $\dots\dots\dots$  % [1]

- (b) • Set up the apparatus as shown in Fig. 2.2.

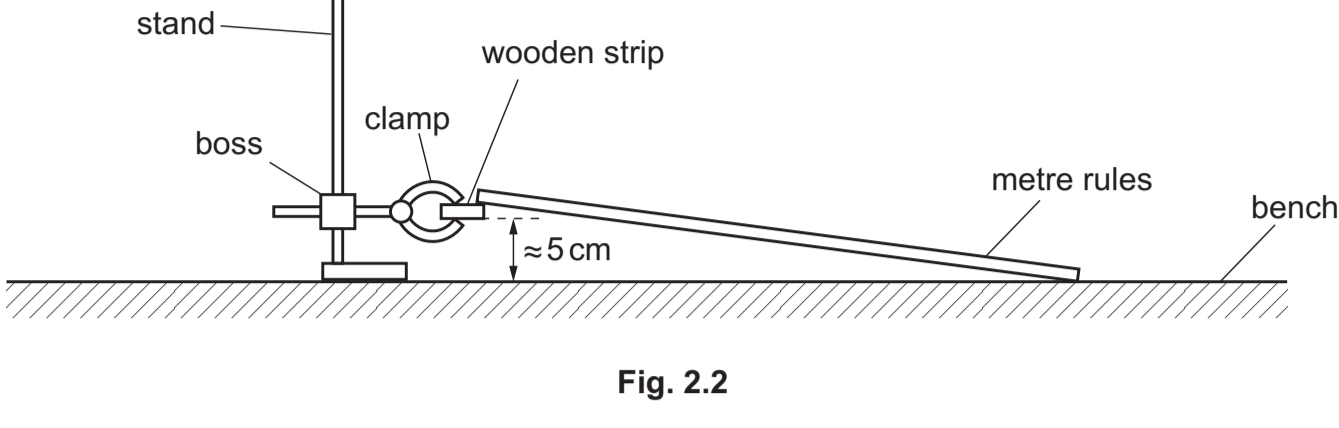


Fig. 2.2

- Adjust the two metre rules so that the rules are approximately parallel to each other, as shown in Fig. 2.3.

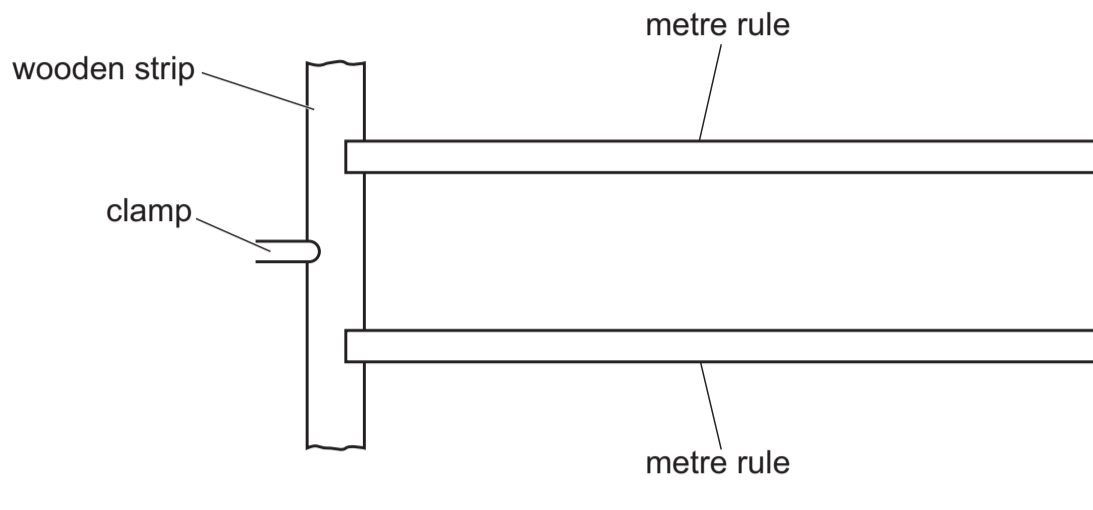


Fig. 2.3

- Pour all the water from the beaker into the bottle.  
• Place the bottle on the two rules as shown in Fig. 2.4.

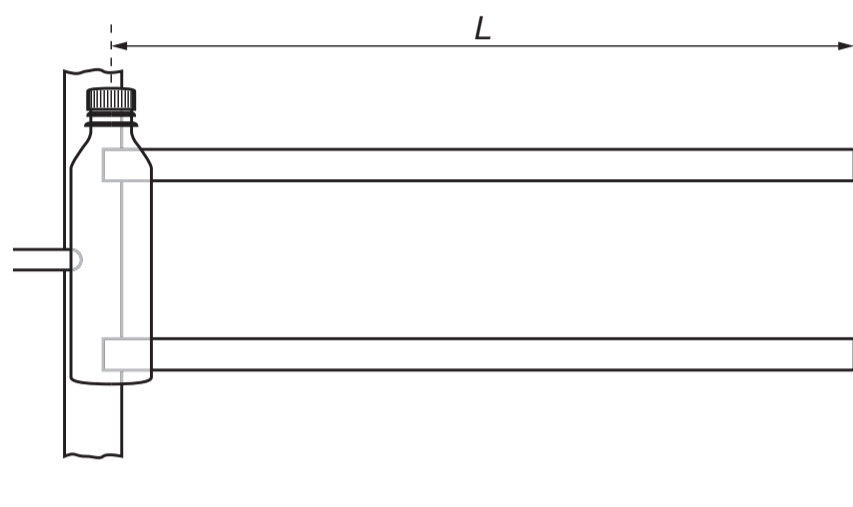


Fig. 2.4 (not to scale)

- Release the bottle. Adjust the rules so that the bottle rolls to the end of the rules.  
• The distance that the bottle rolls on the rules is  $L$ , as shown in Fig. 2.4.

Measure and record  $L$ .

$L = \dots\dots\dots$  [1]

- (c) (i) • Stand the bottle upright on the bench.  
• The height of the water in the bottle is  $h$ , as shown in Fig. 2.5.

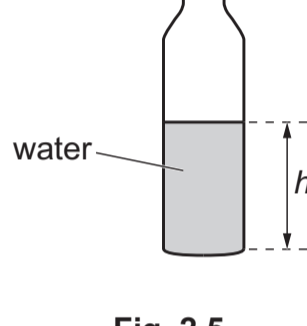


Fig. 2.5

Measure and record  $h$ .

$h = \dots\dots\dots$

- The time for the bottle to roll distance  $L$  on the rules is  $t$ .  
Take measurements to determine  $t$ .

$t = \dots\dots\dots$  [3]

- (ii) A value for the acceleration  $a$  of the bottle is given by

$$a = \frac{2L}{t^2}$$

Calculate  $a$ .

$a = \dots\dots\dots$  [1]

- (iii) Justify the number of significant figures that you have given for your value of  $a$ .

.....  
..... [1]

- (d) • Pour approximately half the water from the bottle into the beaker.

- Repeat (c)(i) and (c)(ii).

$h = \dots\dots\dots$

$t = \dots\dots\dots$

$a = \dots\dots\dots$  [2]

- (e) It is suggested that the relationship between  $a$  and  $h$  is

$$a = \frac{kd\sqrt{\pi h}}{2}$$

where  $k$  is a constant.

Using your data, calculate **two** values of  $k$ .

first value of  $k = \dots\dots\dots$

second value of  $k = \dots\dots\dots$  [1]

- (f) It is suggested that the percentage uncertainty in the values of  $k$  is 15%.

Using this uncertainty, explain whether your results support the relationship in (e).

.....  
..... [1]

- (g) (i) Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

- 1 .....
- 2 .....
- 3 .....
- 4 .....

[4]

- (ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

- 1 .....
- 2 .....
- 3 .....
- 4 .....

[4]