

## Experimental Skills: Drag Force

- (a) An experiment to investigate the drag force acting on an object at different speeds is carried out in a wind tunnel. The results are shown in the table below:

Speed $v$ ( $\text{m s}^{-1}$ )	Drag force $D$ (N)	Speed squared $v^2$ ( $\text{m}^2 \text{s}^{-2}$ )
4.04	169	
6.12	340	
7.99	512	
10.1	820	
11.9	1080	

- (i) Complete the table above by calculating each of the values of speed squared  $v^2$  to the appropriate number of significant figures. (3 marks)
- (ii) On the page opposite, plot (*in pencil*) a graph of drag force  $D$  against speed squared  $v^2$  and draw a line of best fit. (4 marks)
- (iii) State and explain whether your graph is consistent with the hypothesis that the drag force is directly proportional to the speed squared ( $D \propto v^2$ ).

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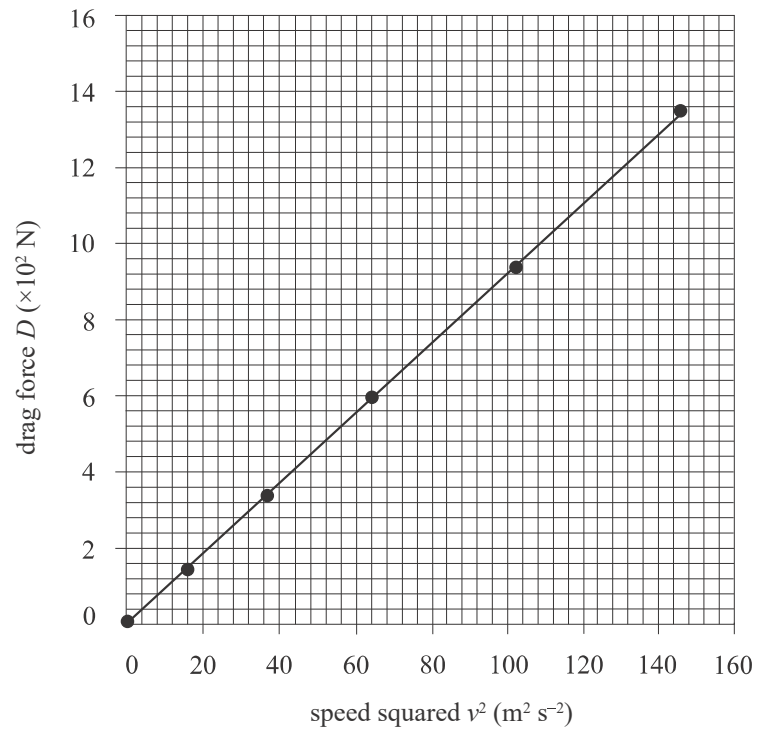
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(3 marks)

- (b) The experiment is repeated, using a different-shaped object. The graph obtained from the results of this second experiment is shown below:



- (i) Using the graph above, determine the drag force that would be produced if  $v^2 = 155 \text{ m}^2 \text{ s}^{-2}$ . Clearly indicate on your graph how you arrived at your answer.

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(2 marks)

- (ii) Calculate the gradient of the line of best fit for this graph, clearly labelling on the graph the points you have used. State the units of the gradient.

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(3 marks)

(iii) The relationship between the drag force and the speed of the object is given by

$$D = \frac{1}{2} \rho v^2 A C$$

where  $\rho$  is the density of the surrounding fluid,  $A$  is the cross-sectional area of the object, and  $C$  is the drag coefficient of the object (it has no units).

Using this relationship and the gradient you calculated in part (b)(ii), find the value of the drag coefficient  $C$  for this experiment if  $\rho = 1.23 \text{ kg m}^{-3}$  and  $A = 0.25 \text{ m}^2$ .

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(3 marks)

(c) State and explain the type of error in your graph in part (a), given the relationship described in part (b)(iii).

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(2 marks)

(d) Identify *two* factors that should be held constant during an experiment to investigate the drag force acting on an object at different speeds.

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(2 marks)