

- 2 A student investigates the drag force acting on toy parachutes. She thinks that the magnitude of the drag force depends only on the speed of the parachute.

(a) (i) Explain why the drag force must depend on at least one other quantity.

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

(ii) State a variable, other than speed, which affects the magnitude of the drag force acting on the parachute.

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

- (b) A toy parachute is attached to a load. It is released from a height of approximately 2 m and falls vertically. The student records the fall using a video camera. Then, using processing software, she determines the velocity of the parachute at a number of points in the fall.

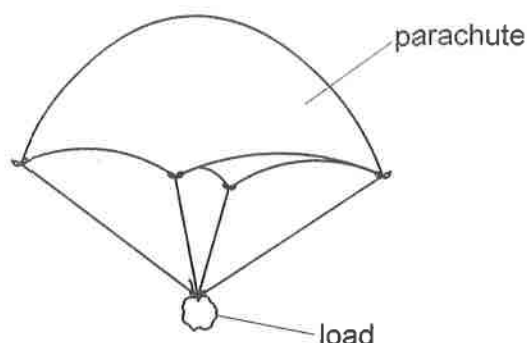


Fig. 2.1

- (i) On Fig. 2.1, draw and label the **two** vertical forces acting on the parachute falling through the air. [1]

- (ii) A short time after release, the parachute reaches a constant speed.

State the relationship between the forces acting on the parachute when the parachute is falling at a constant speed.

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

- (c) The experiment is repeated with different loads attached to the parachute. For each value of the drag force  $F_D$  acting on the parachute, the constant speed  $v$  reached by the falling parachute is determined three times. The average constant speed  $v_{av}$  is calculated. The results are shown in Table 2.1.





Table 2.1

$F_D/\text{N}$	$v_1/\text{ms}^{-1}$	$v_2/\text{ms}^{-1}$	$v_3/\text{ms}^{-1}$	$v_{\text{av}}/\text{ms}^{-1}$	$\lg(F_D/\text{N})$	$\lg(v_{\text{av}}/\text{ms}^{-1})$
0.50	1.05	1.12	1.07	1.08	-0.301	0.033
1.00	1.48	1.59	1.51	1.53	0.000	0.185
1.50	1.90	1.93	1.83	1.89		
2.00	2.14	2.20	2.15	2.16	0.301	0.334
2.50		2.35	2.41	2.41	0.398	0.382

(i) Complete Table 2.1.

[2]

(ii) Some of the data from Table 2.1 is plotted on the graph in Fig. 2.2.

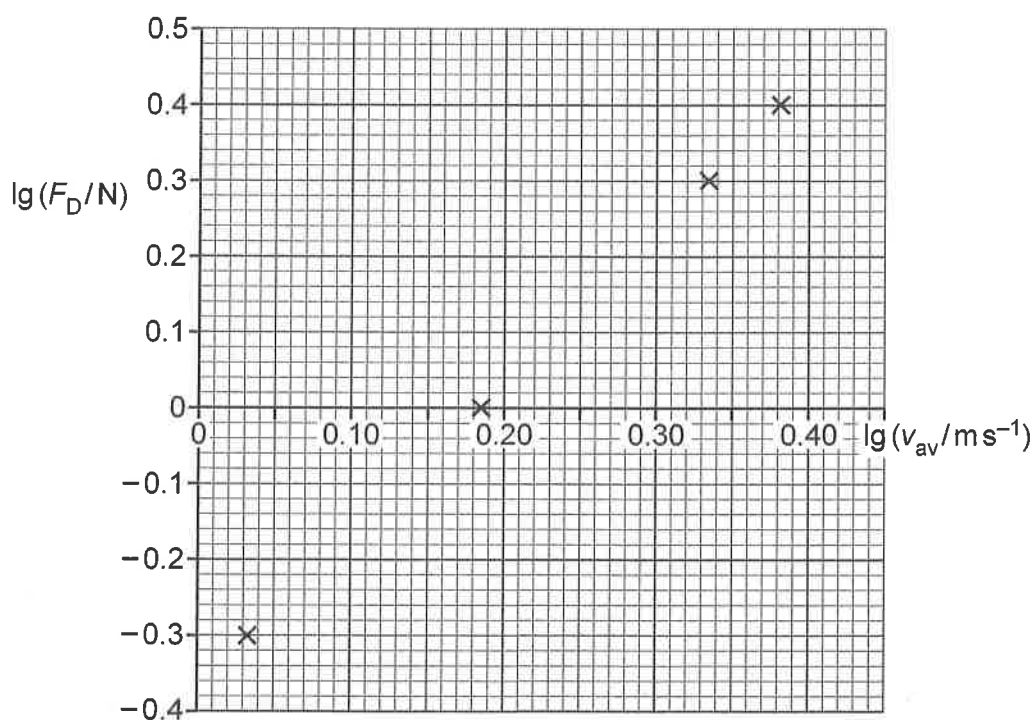


Fig. 2.2

Plot the missing point and draw a line of best fit on the graph in Fig. 2.2.

[2]

(iii) It is suggested that  $F_D$  is directly proportional to  $(v_{\text{av}})^x$ , where  $x$  is a constant. Using the graph in Fig. 2.2, determine the value of  $x$ .

[4]





- (iv) Explain how the constant of proportionality between  $F_D$  and  $(v_{av})^x$  can be determined from Fig. 2.2.

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

- (v) Another student repeats the investigation.  
 The values for  $v_{av}$  are the same for values of  $F_D$  except for  $F_D = 0.50\text{ N}$ , where  $v_{av} = 1.11\text{ ms}^{-1}$ .

Explain the effect on the value of  $x$  calculated using these values of  $F_D$  and  $v_{av}$ .

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 .....  
 ..... [2]

[Total: 15]

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