# Shortcut information

## *Drag-speed*

Use this information to answer (b)(iii):

$D = 10v^2$

## *Pressure-volume*

Use this information to answer (d)(iv):

$$P = 2\frac{1}{V}$$

## *Pivot-mass*

Use this information to answer (f):

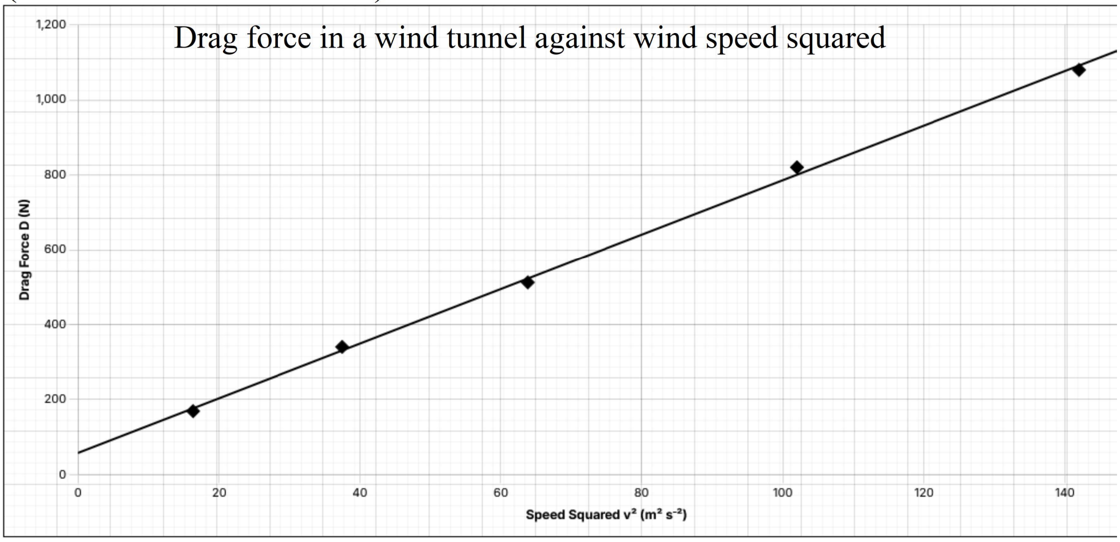
$r_3 = 0.1\ m_2 + 30$

$r_2 = 30.0$

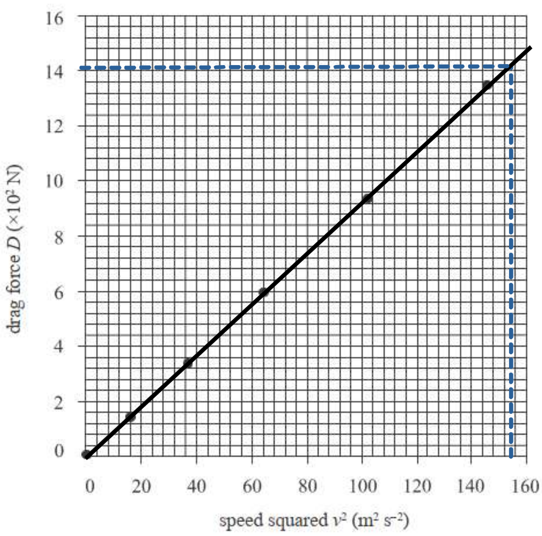
Note: the above use mass in grams and distance in cm.

## *Drag-speed*

(a) (i) 16.3
37.5
63.8
102
142 (all values should be to **3 s.f.**)
(ii)




(iii) The graph is not consistent with the hypothesis that drag force is proportional to speed squared. Proportionality requires both a straight line and a zero intercept, but here the y-intercept is 50 N.
(b) (i)




$D = 14\times10^2$ N

(ii) Using points (0,0) and (155,14.1) gives rise/run = 14.1/155 = ~ 0.1 $\times10^2$ N/($m^2s^{-2}$) (~ 10)
(iii):

$$D = \tfrac{1}{2}\rho v^2 AC$$

$$\therefore D = \tfrac{1}{2}\rho AC\ v^2$$

$$\therefore \tfrac{1}{2}\rho AC = \text{gradient}$$

$$\therefore \tfrac{1}{2}\rho AC = 10$$

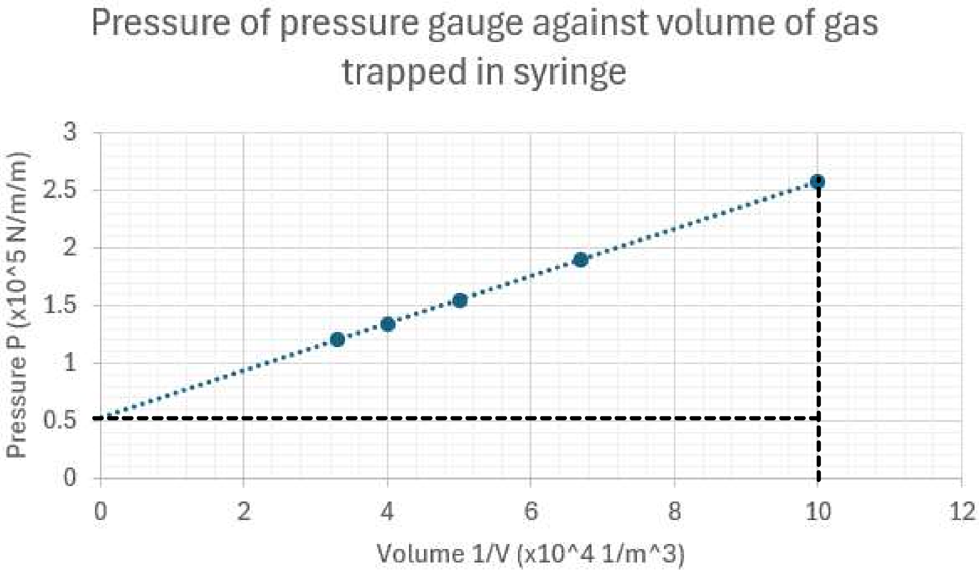
$$\therefore C = \frac{10}{\tfrac{1}{2}\rho A} = \frac{10}{\tfrac{1}{2}\times1.23\times0.25} = 65$$

(c) Systematic, since the values are consistently shifted (inaccurate)
(d) Density of the fluid, Cross-sectional area of the object, Drag coefficient of the object (any two)

## *Pressure-volume*

(a) $1.0\times10^{-5}$
$6.7\times10^{-4}$
$5.0\times10^{-4}$
$4.0\times10^{-4}$
$3.3\times10^{-4}$
(all **2 s.f.**)

(b) (i) volume of gas trapped in the syringe
(ii) it is being deliberately changed



(c)

(d) (i) The formula indicates a proportionality between P and 1/V when b and T are constant. The graph, however, shows a straight line through a y-intercept of approximately 0.5, not zero. This indicates that the data has been shifted consistently from its true value (measurements inaccurate).

(ii) gradient = rise/run = $(2.6\times10^5 - 0.5\times10^5)$ / ( $10\times10^{-4} - 0$ ) = ~2 $Nm^{-2}$ / ($1/m^3$)

(iii) $P = 2\frac{1}{V}$

(iv)

$$P = \frac{bT}{V}$$

$$\therefore P = bT\frac{1}{V}$$

$$\therefore bT = \text{gradient}$$

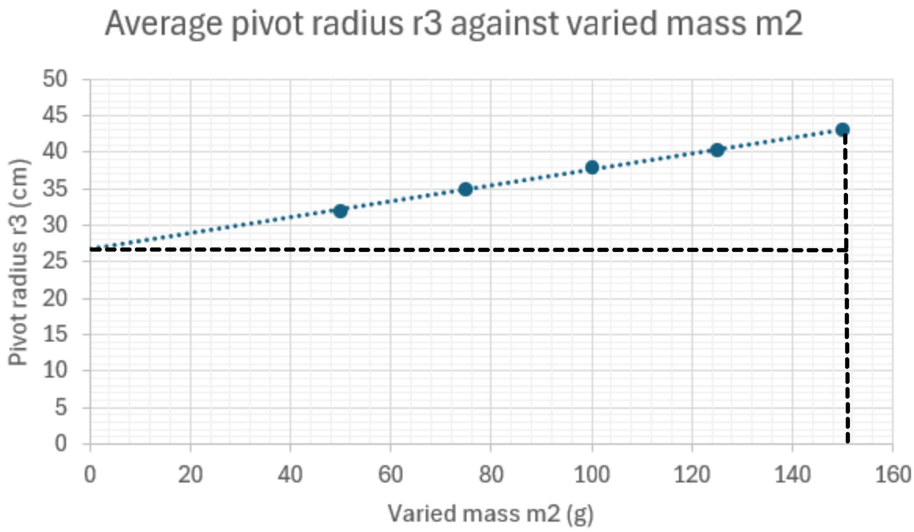
$$\therefore bT = 2$$

$$\therefore T = \frac{2}{b} = \frac{2}{6.71\times10^{-3}} = 300 \text{ K (1 s.f.)}$$

## *Pivot-mass*

(a) 32.0
35.0
38.0
40.3
43.0
(all 3 **s.f.**)

(b)




(c) (i) Random

(ii) They have been reduced, since there is large scatter between values in the table (such as 33.0 to 37.5 for 75 g) but the points on the graph are very close to the line of best fit.

(d) slope = rise / run = ( 43 – 27 ) / ( 150 – 0 ) = ~ 0.1 cm / g

(e) 0.1 $m_2$ + 27

(f) (Using 30 instead of 27 but the working is the same)

$$m_3 r_3 = m_2 r_2 + m_1 r_1$$

$$\therefore r_3 = \frac{m_2 r_2}{m_3} + \frac{m_1 r_1}{m_3}$$

$$\therefore r_3 = \frac{r_2}{m_3} m_2 + \frac{m_1 r_1}{m_3}$$

$$\therefore \frac{r_2}{m_3} = \text{gradient}$$

$$\therefore \frac{r_2}{m_3} = 0.1$$

$$\therefore r_2 = 0.1 \times m_3$$

$$\therefore m_3 = \frac{r_2}{0.1} = \frac{30.0}{0.1} = 300 \text{ g (1 s.f.)}$$