7 To simulate a bungee jump, a solid cuboid of 600 N weight is attached to one end of a long rubber cord on a high platform, with the other end of the cord secured to the platform. The cube is pushed off in the horizontal direction from the platform, dragging the cord from the platform. The variation of the vertical position of the cuboid below the platform with time is shown in Fig. 7.1.

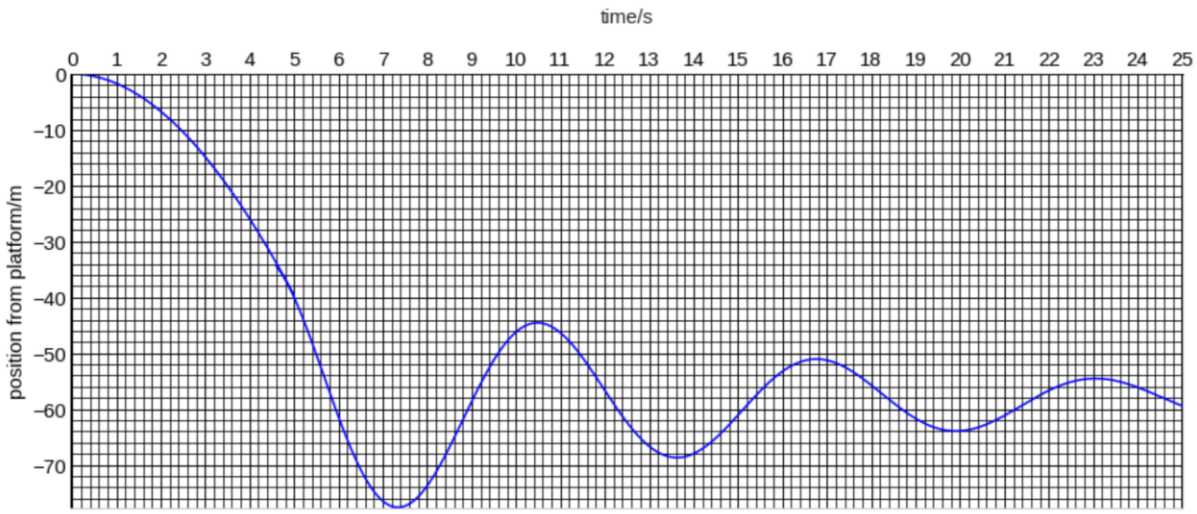
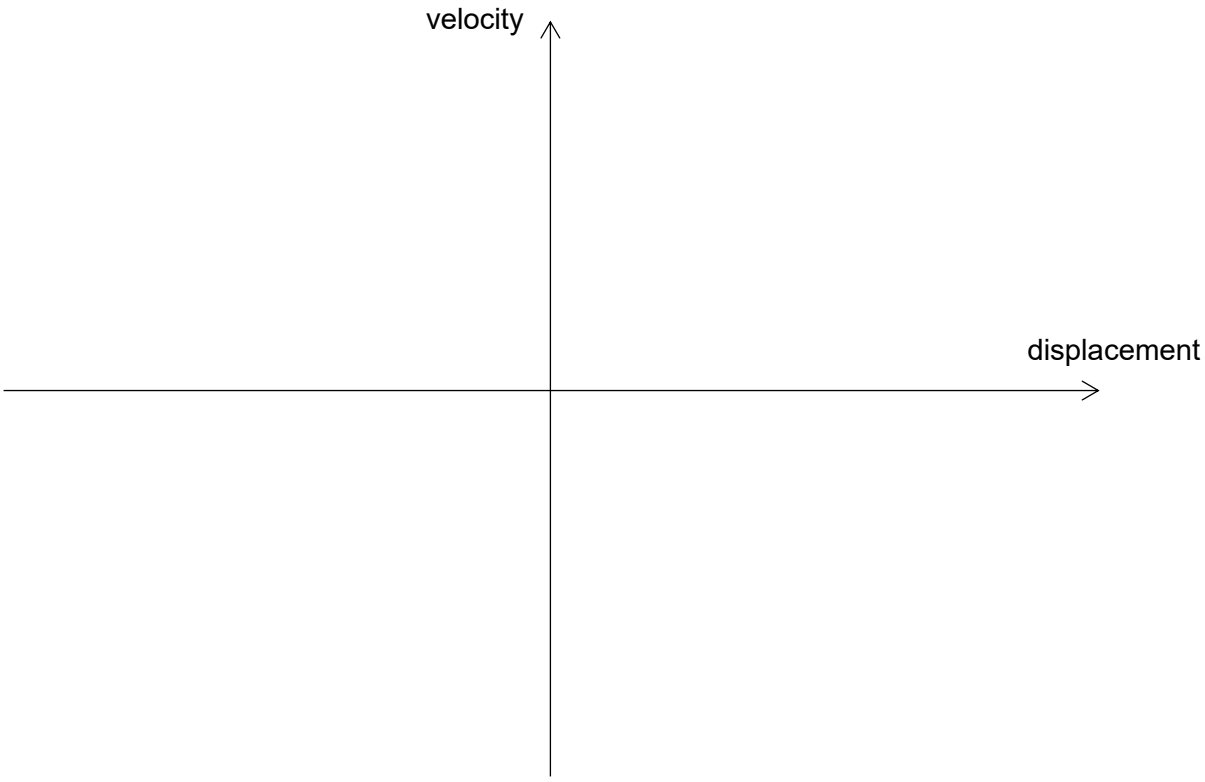


Fig. 7.1

(a) Determine the maximum speed of the cube at 58.0 m below the platform from the graph.

maximum speed = …….. m s^{-1} [2]

(b) Sketch a graph of velocity versus displacement of the mass from the position of the maximum speed mentioned in **(a)** for at least 2 cycles.



[2]

(c) **(i)** The vertical equilibrium position of the cuboid during the oscillation is at 58.0 m below the platform. Explain what is meant by the equilibrium position.

……..

……. [1]

(ii) During the oscillations, the maximum magnitude of displacement from the equilibrium position A, of the oscillating cuboid varies with time t according to this equation,

$$A = A_o e^{-ct}$$

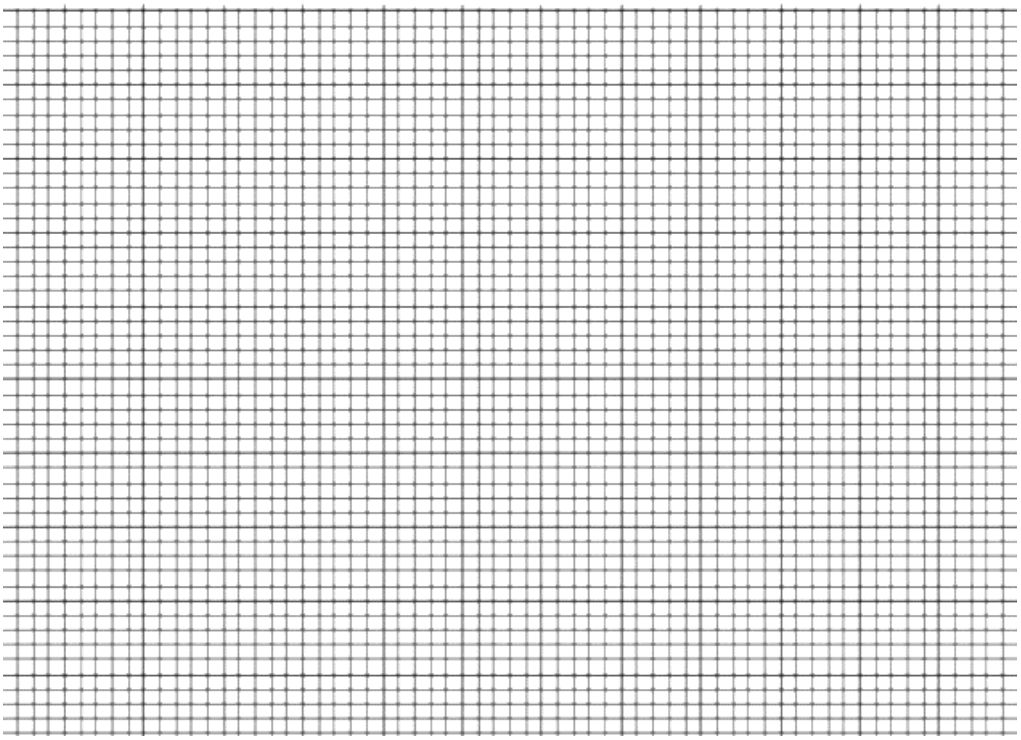
where A_o and c are constants.

Complete the table below, for the maximum magnitude of displacement at various t. Also complete the 4th column of the table in order to plot a suitable graph to determine the values of A_o and c.

t / s	Position / m	Magnitude of displacement, A / m	
7.4	- 78	20	
10.5	- 44	14	
13.6	- 69	11	
16.8	- 51	7	
20.0	- 64		
23.0	- 54		

[2]

(d) Plot a suitable graph and use it to determine the values of c and A_0.



c = …….. s^{-1}

A_0 = ..…… m [5]

(e) Suggest why the data from the graph *just* after t = 0 is not to be included in the analysis in part **(cii)**.

……..

…….. [1]

(f) **(i)** Using Fig. 7.1, determine the period T of the oscillation.

period T = …….. s [1]

(ii) Theory suggests that

$$\frac{4\pi^2}{T^2} = \frac{k}{m} - q,$$

where k is the elastic constant of the cord,

m is the mass of the cuboid, and

$q = 1.00 \times 10^{-2}\ s^{-2}$.

Determine the extension of the cord at equilibrium.

extension = …….. m [2]

(iii) Hence, calculate the loss in total energy when the mass first crosses the equilibrium point.

energy loss = ..…… J [3]

(g) Explain why a thicker cord has to be used for a person with larger mass for a bungee jump.

……..

…… [1]

End of paper