

Forces in action

Question Paper 4

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Forces and Motion
Sub-Topic	Forces in action
Booklet	Question Paper 4

Time Allowed: 60 minutes

Score: / 50

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A skydiver jumps from a stationary hot-air balloon several kilometres above the ground.

(a) In terms of acceleration and forces, explain the motion of the skydiver

immediately after jumping

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at a time **before** terminal velocity is reached

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at terminal velocity.

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[6]

- (b) In the final stage of the fall, the skydiver is falling through air at a constant speed. The skydiver's kinetic energy does not change even though there is a decrease in the gravitational potential energy. State what happens to this loss of gravitational potential energy.

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

- (c) Fig. 3.1 shows a sketch graph of the variation of the velocity v of the skydiver with time t .

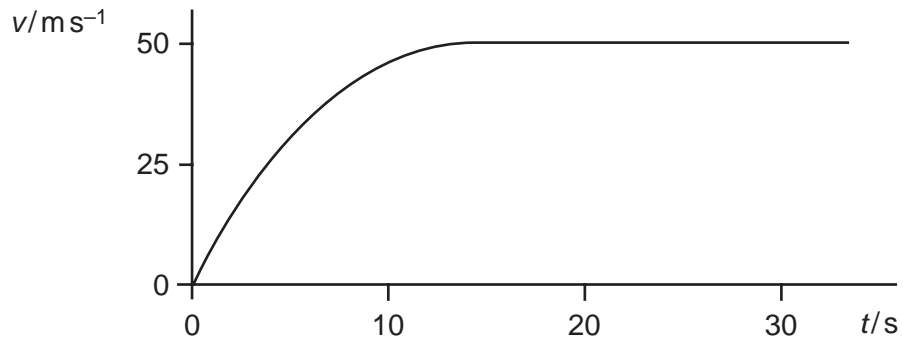


Fig. 3.1

Suggest the changes to the graph of Fig. 3.1, if any, for a more massive (heavier) skydiver of the same shape.

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..... [2]

[Total: 9]

- 2 (a) Fig. 5.1 shows a wooden block motionless on an inclined ramp.

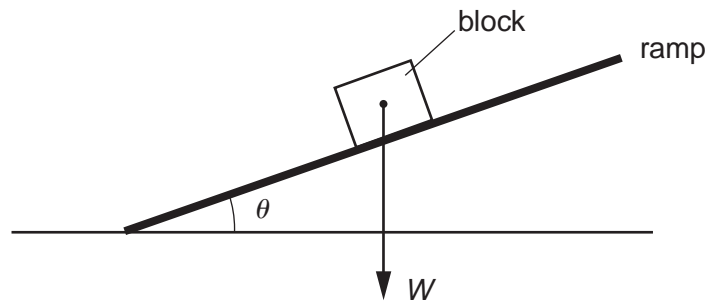


Fig. 5.1

The angle between the ramp and the horizontal is θ .

- (i) The weight W of the block is already shown on Fig. 5.1. Complete the diagram by showing the normal contact (reaction) force N and the frictional force F acting on the block. [2]
- (ii) Write an equation to show how F is related to W and θ .

.....
 [1]

- (b) Fig. 5.2 shows a kitchen cupboard securely mounted to a vertical wall. The cupboard rests on a support at A.

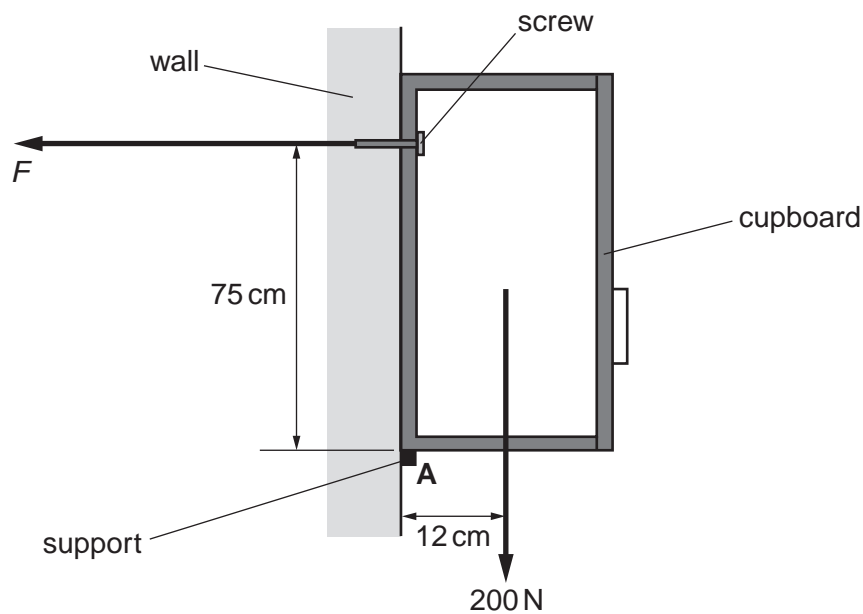


Fig. 5.2

The total weight of the cupboard and its contents is 200 N. The line of action of its weight is at a distance of 12 cm from A. The screw securing the cupboard to the wall is at a vertical distance of 75 cm from A.

- (i) State the principle of moments.



In your answer, you should use appropriate technical terms, spelled correctly.

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..... [2]

- (ii) The direction of the force F provided by the screw on the cupboard is horizontal as shown in Fig. 5.2. Take moments about **A**. Determine the value of F .

$F = \dots\dots\dots$ N [2]

- (iii) The cross-sectional area under the head of the screw in contact with the cupboard is $6.0 \times 10^{-5} \text{ m}^2$. Calculate the pressure on the cupboard under the screw head.

pressure = $\dots\dots\dots$ Pa [2]

- (iv) State and explain how your answer to (iii) would change, if at all, if the same screw was secured much closer to **A**.

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..... [2]

[Total: 11]

- 3 In February 1999 NASA launched its Stardust spacecraft on a mission to collect dust particles from the comet Tempel 1. After a journey of 5.0×10^{12} m that took 6.9 years, Stardust returned to Earth with samples of the dust particles embedded in a special low-density gel. When a dust particle hits the gel, it buries itself in the gel creating a cone-shaped track as shown in Fig. 6.1. The length of the track is typically 200 times the diameter of the dust particle.

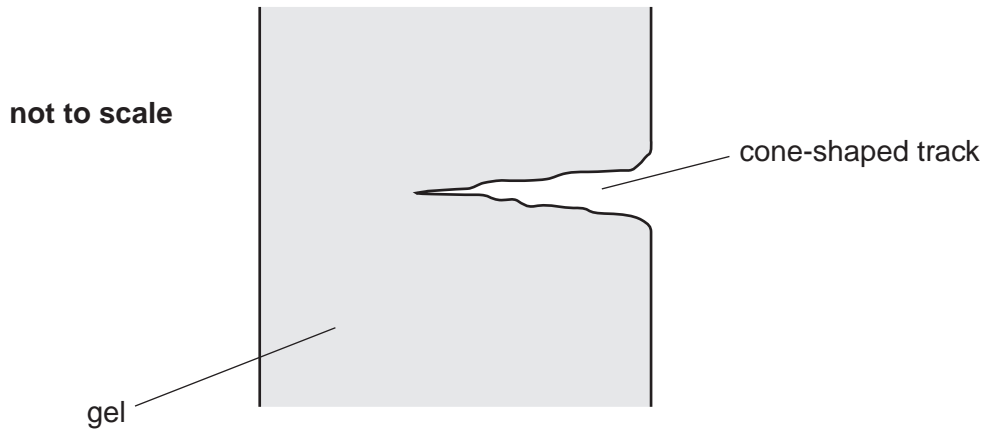


Fig. 6.1

- (a) Calculate the average speed in m s^{-1} of Stardust during its voyage.

speed = m s^{-1} [2]

- (b) Calculate the average stopping force produced by the gel for a dust particle of diameter 0.70 mm and mass 4.0×10^{-6} kg travelling at a velocity of $6.1 \times 10^3 \text{ m s}^{-1}$ relative to Stardust.

force = N [3]

[Total: 5]

(c) A skydiver is falling towards the ground at a terminal velocity of 50 m s^{-1} .

(i) State the **two** main forces acting on the skydiver and how they are related at terminal velocity.

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..... [1]

(ii) The skydiver opens her parachute. After some time, the skydiver reaches a lower terminal velocity of 4.0 m s^{-1} . Describe and explain how the magnitude of the deceleration of the skydiver changes as her velocity reduces from 50 m s^{-1} to 4.0 m s^{-1} .

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..... [4]

[Total: 9]

- 5 (a) Fig. 7.1 shows several forces acting on an object that is free to move.

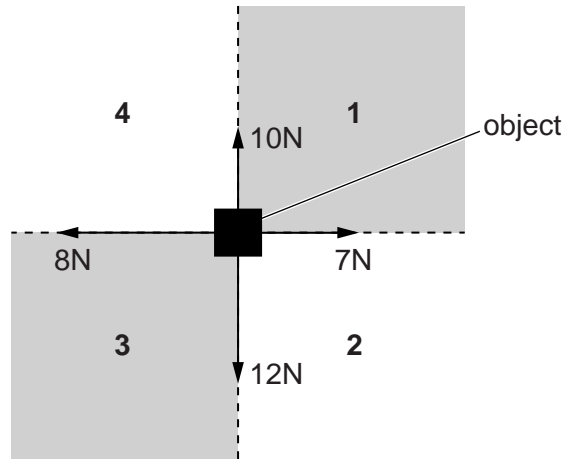


Fig. 7.1

Using simple calculations, deduce whether the object will move into region 1, 2, 3 or 4. Briefly explain your reasoning.

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..... [2]

- (b) State the *principle of moments*.

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..... [1]

(c) Fig. 7.2 shows the forces acting on a suitcase with wheels as it is held stationary.

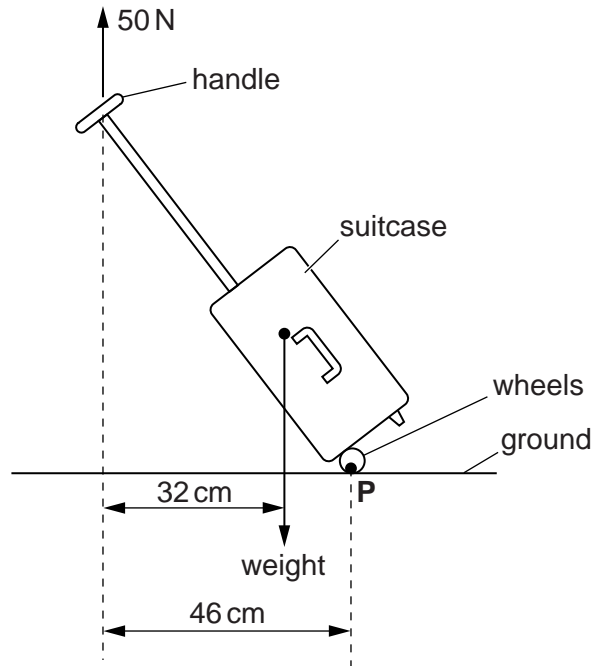


Fig. 7.2

A vertical force of 50 N is applied to the top of the handle in order to keep the suitcase stationary in the position shown in Fig. 7.2. The line of action of this force acts at a perpendicular distance of 46 cm from P, the point of contact with the ground. The line of action of the weight of the suitcase acts at a perpendicular distance of 32 cm from the top of the handle.

By taking moments about P, calculate the mass m of the suitcase.

$m = \dots\dots\dots$ kg [3]

[Total: 6]

