Forces in action

Question Paper 3

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Forces and Motion
Sub-Topic	Forces in action
Booklet	Question Paper 3

Time Allowed: **62 minutes**

Score: **/ 51**

Percentage: **/100**

Grade Boundaries:

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

1 Fig. 5.1 shows the vertical forces acting on a helium-filled weather balloon just before lift off.

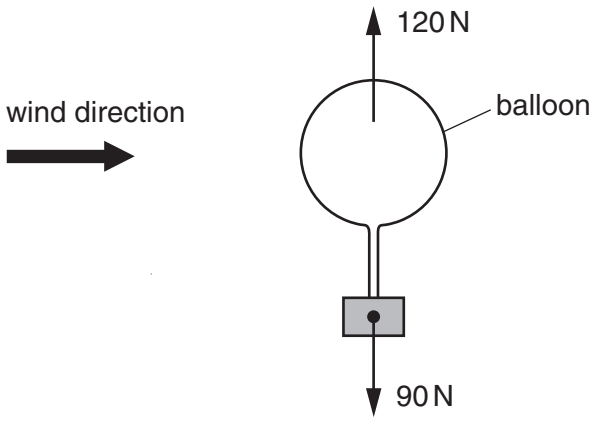

Fig. 5.1

The balloon experiences an upward vertical force (upthrust) equal to 120 N. The weight of the balloon and its contents is 90 N. The magnitude of the horizontal force provided by the wind is 18 N.

(a) Determine the magnitude of the resultant force acting on the balloon and the angle this resultant force makes with the horizontal.

net force = ... N

angle = ... °

[4]

(b) As the balloon rises through the air, it experiences a drag force. State two factors that affect the magnitude of the drag force on this balloon.

1. .....

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

[Total: 6]

2 **(a)** Define *density*.

.....

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

(b) Fig. 2.1 shows the variation of density of the Earth with **depth** from the surface.

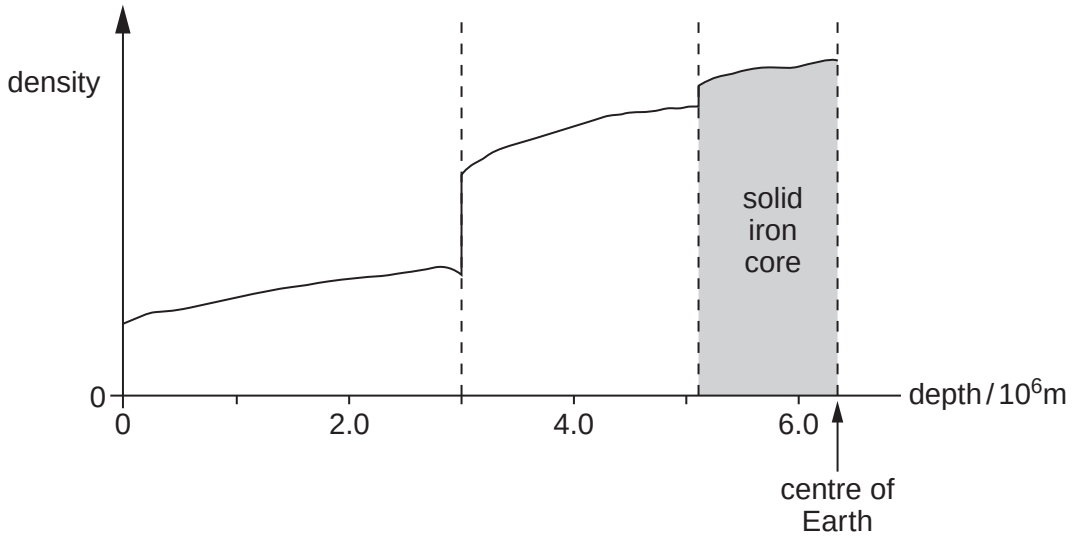

Fig. 2.1

(i) Suggest how Fig. 2.1 shows that the Earth consists of a number of distinct layers.

.....

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

(ii) Geophysicists believe that the central core of the Earth is solid iron. This central core is surrounded by a layer of molten metal. The central core starts at a **depth** of 5.1×10^6 m. The solid iron core accounts for 18% of the mass of the Earth. The mass of the Earth is 6.0×10^{24} kg and its radius is 6.4×10^6 m. Calculate the mean density of the central core of the Earth.

volume of a sphere = $\frac{4}{3}\pi r^3$

density = ... $kg\,m^{-3}$ **[3]**

[Total: 5]

3 **(a)** State two factors that affect the magnitude of the drag force acting on an object falling through air.

1. .....

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

(b) Fig. 4.1 shows a skydiver of total mass 75 kg falling vertically towards the ground.

Fig. 4.1

The air resistance, or drag force, D in newtons (N) acting on the skydiver falling through the air is given by the equation

$$D = 0.3v^2$$

where v is the speed in $m\,s^{-1}$ of the skydiver.

(i) On Fig. 4.1, draw arrows to represent the weight (labelled W) and drag force (labelled D). **[1]**

(ii) Calculate the weight of the skydiver.

weight = ... N **[1]**

(iii) At a particular instant, the speed of the skydiver is $20\,m\,s^{-1}$. Calculate the instantaneous acceleration of the skydiver.

acceleration = ... $m\,s^{-2}$ **[3]**

(iv) State the relationship between the forces *W* and *D* when the skydiver reaches terminal velocity.

.....

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

(v) Determine the terminal velocity of the skydiver.

terminal velocity = ... $m\,s^{-1}$ **[2]**

[Total: 10]

4 **(a)** Define the *newton*.

.....

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

(b) Fig. 3.1 shows a spaceship on the surface of the Earth.

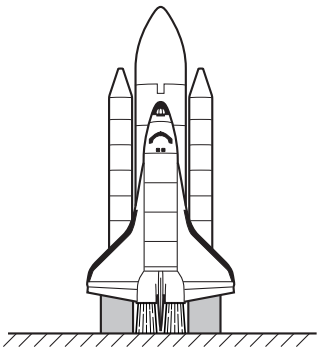

Fig. 3.1

The mass of the spaceship is 1.9×10^6 kg. During lift off, the spaceship rockets produce a vertical upward force of 3.1×10^7 N.

(i) Calculate the weight of the spaceship.

weight = ... N **[1]**

(ii) Calculate the initial vertical acceleration as the spaceship lifts off.

acceleration = ... $m\,s^{-2}$ **[2]**

(iii) The vertical upward force on the spaceship stays constant. Explain why the acceleration of the spaceship increases after lift off.

.....

.....

.....

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

[Total: 5]

5 **(a)** Define *braking distance* of a car.

.....

.....

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

(b) Other than the speed of the car, state two factors that affect the braking distance of a car. Describe how the braking distance is affected by each factor.

1. .....

.....

.....

.....

2. .....

.....

.....

..... **[4]**

(c) Describe and explain how seat belts in cars reduce impact forces on the driver in an accident.

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..... **[3]**

(d) Fig. 5.1 shows the variation of braking distance with speed *v* of a car.

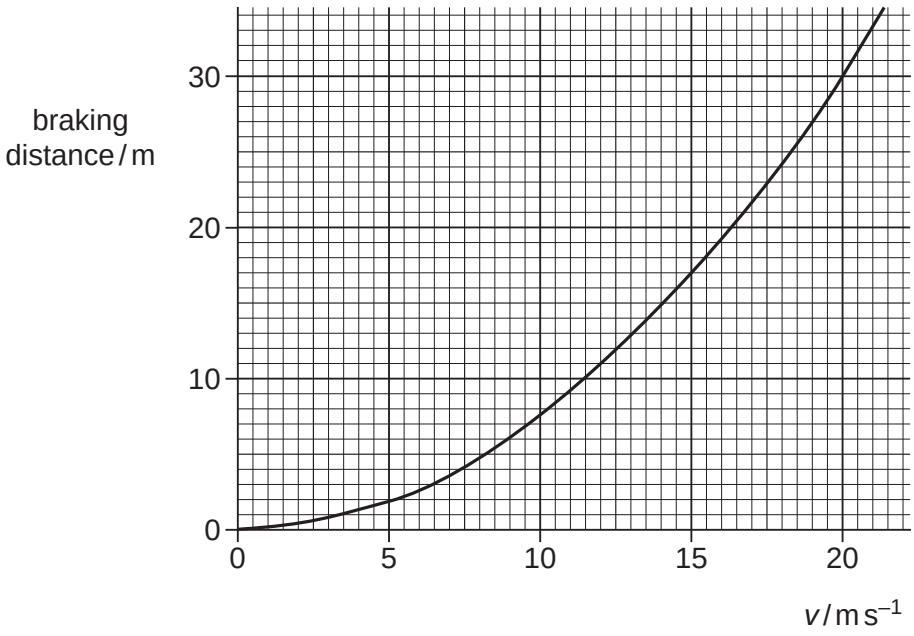

Fig. 5.1

(i) The car is travelling on a level straight road at a speed of 20 m s^{-1}. The reaction time of the driver is 0.50 s.

1 Calculate the thinking distance.

thinking distance = ... m

2 Hence, determine the stopping distance of the car.

stopping distance = ... m

[3]

(ii) In Fig. 5.1, the braking distance is directly proportional to the square of the speed. Determine the braking distance of the car when travelling at a speed of 32 m s^{-1}.

braking distance = ... m **[2]**

[Total: 13]

6 **(a)** Fig. 6.1 shows two equal but opposite forces acting on an object.

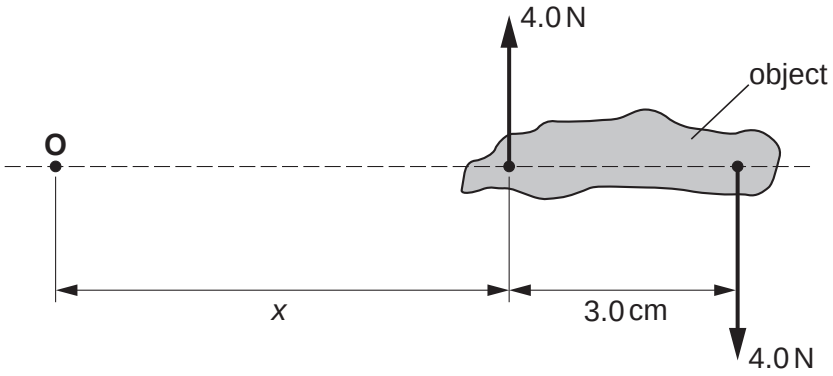

Fig. 6.1

The point **O** is at a distance *x* from the nearer of the two forces.

(i) The separation between the two parallel forces is 3.0 cm. Determine the torque of the couple exerted on the object.

torque = ... N m **[2]**

(ii) Calculate the total moment of the forces about the point **O** and state the significance of this value.

.....

..... **[3]**

(b) State two conditions necessary for an object to be in equilibrium.

.....

.....

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

(c) A concrete paving slab has mass 45 kg and dimensions 0.600 m × 0.600 m × 0.050 m.

(i) Calculate the density of the concrete.

density = ... kg m^{-3} **[2]**

(ii) Fig. 6.2 shows the concrete paving slab in equilibrium.

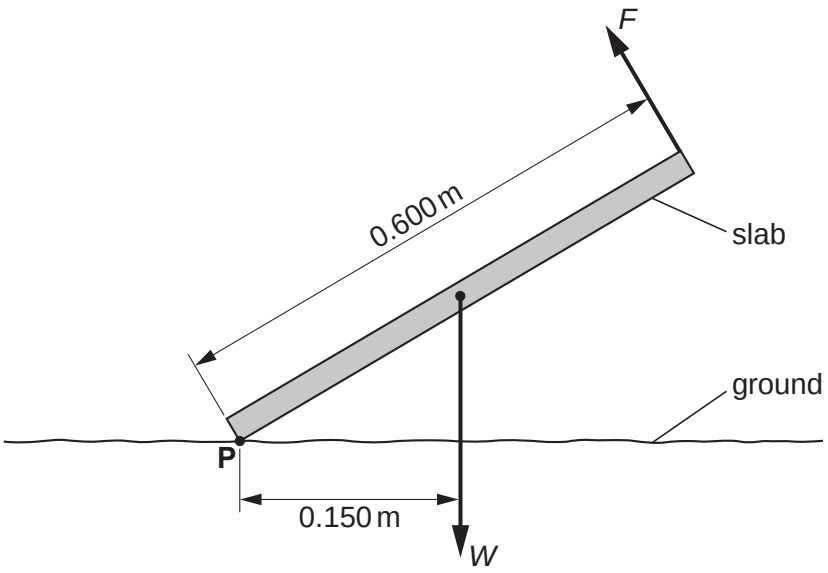

Fig. 6.2

Two forces acting on the slab are shown. The weight of the slab is *W*. The force *F* is applied at right angles to the end of the slab. By taking moments about **P**, determine the size of the force *F*.

F = ... N **[3]**

[Total: 12]