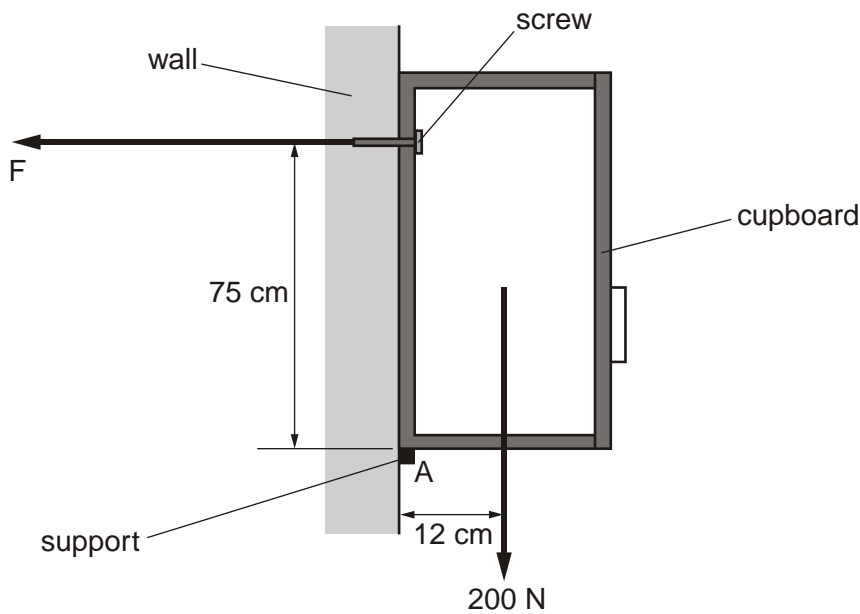


### Questions on Forces

1. The figure below shows a kitchen cupboard securely mounted to a vertical wall. The cupboard rests on a support at **A**.



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

- (i) State the principle of moments.

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

.....  
.....  
.....

[2]

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

$$F = \dots\dots\dots \text{ N}$$

[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.

$$\text{pressure} = \dots\dots\dots \text{ Pa}$$

[2]

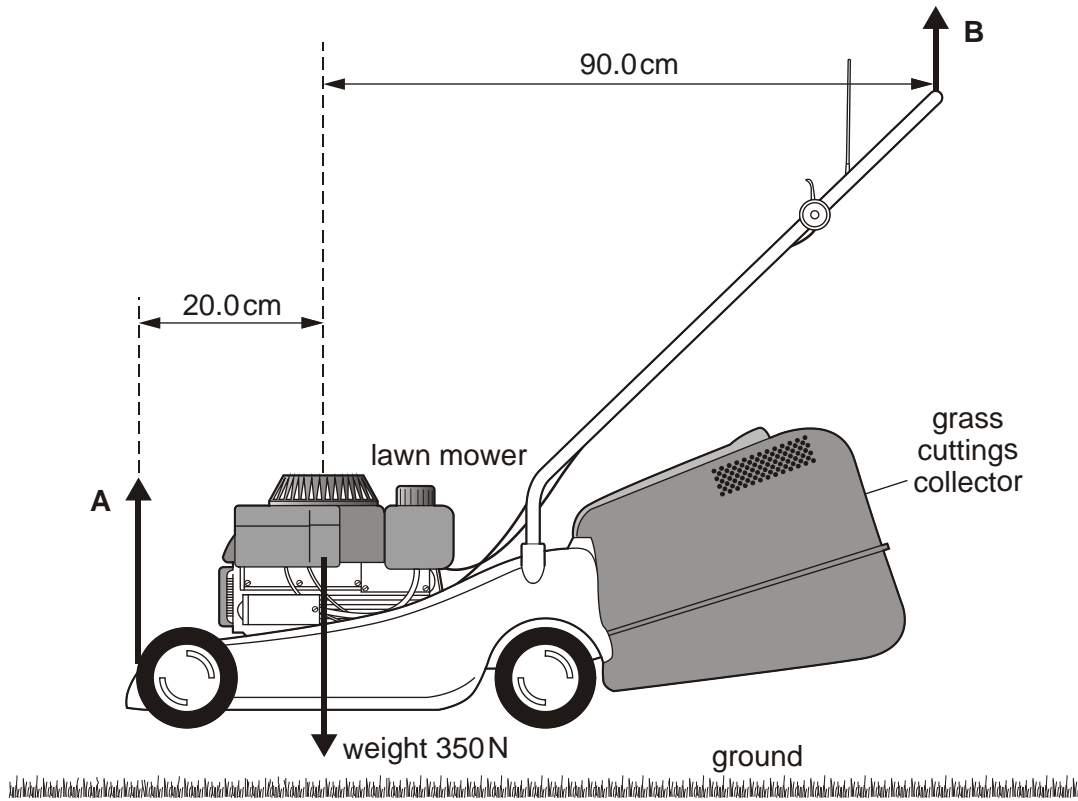
- (iv) State and explain how your answer to (iii) would change, if at all, if the same screw was secured much closer to **A**.

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.....

[2]

[Total 8 marks]

2. The figure below shows a lawn mower which is carried by two people.



(i) The two people apply forces **A** and **B** at each end of the lawn mower. The weight of the lawn mower is 350 N.

1 Explain why the weight of the lawn mower does not act in the middle of the lawn mower, that is 55 cm from each end.

.....  
 .....

[1]

2 Use the principle of moments to show that the force **B** is 64 N.

[2]

3 Determine the force **A**.

**A** = .....N

[1]

- (ii) State and explain what happens to the forces **A** and **B** if the person that applies force **B** moves his hands along the handle towards the middle of the lawn mower.

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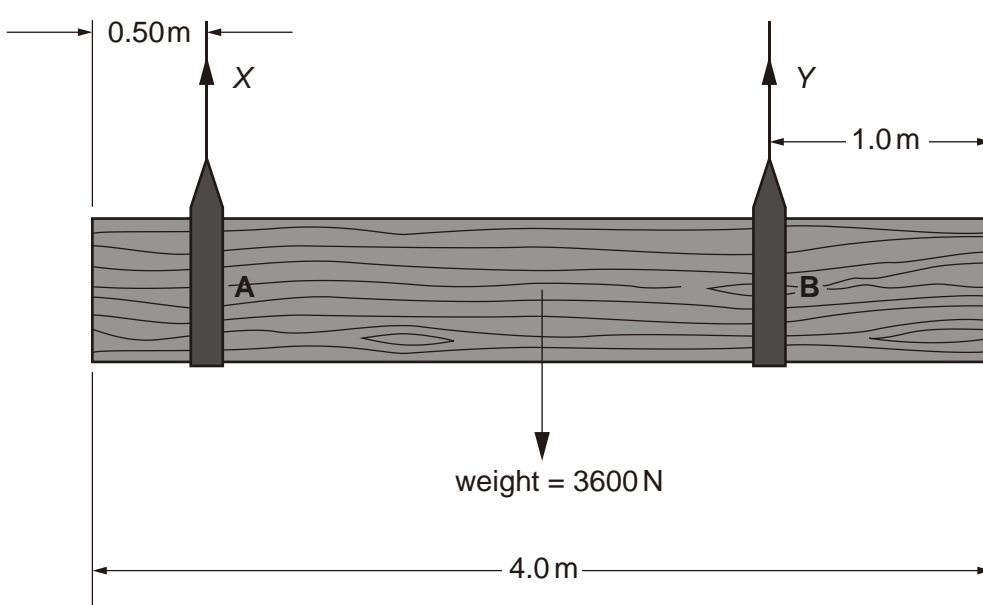
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[2]

[Total 6 marks]

3. The figure below shows a uniform rectangular beam supported by two straps. The beam is in equilibrium.



The weight of the beam is 3600 N and its length is 4.0 m. The strap **A** is positioned 0.50 m from one end of the beam and the strap **B** is positioned 1.0 m from the other end.

- (i) **1** Use the principle of moments to show that the upward force *X* at strap **A** is 1440 N.

[2]

- 2** Hence determine the force *Y* at the strap **B**.

force = ..... N

[2]

- (ii) Discuss whether the forces *X* and *Y* provide a couple.

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.....

.....

.....

[2]

- (iii) The area of strap **A** in contact with the underside of the beam is  $2.3 \times 10^{-2} \text{ m}^2$ . Calculate the average pressure exerted on the beam by strap **A**.

pressure = ..... unit .....

[3]

[Total 9 marks]

4. Define the *newton*.

.....  
.....

[Total 1 mark]

5. A car of mass 1380 kg, travelling at  $31.1 \text{ m s}^{-1}$ , is brought to rest by the brakes in 48.2 m. Calculate

- (i) the initial kinetic energy of the car

kinetic energy = ..... J

[3]

- (ii) the average deceleration of the car

deceleration = .....  $\text{m s}^{-2}$

[2]

(iii) the average braking force.

braking force = ..... N

[2]

[Total 7 marks]

6. Describe in terms of the forces acting on the driver how wearing a seat belt and having an airbag in a car can help to protect the driver from injury in a head on collision.

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[Total 4 marks]

7. State two factors that affect the braking distance of a car. Describe how each factor affects the braking distance.

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.....  
.....  
.....  
.....

[Total 4 marks]

8. Describe how Global Positioning System (GPS) is used to locate the position of a car on the Earth's surface.



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

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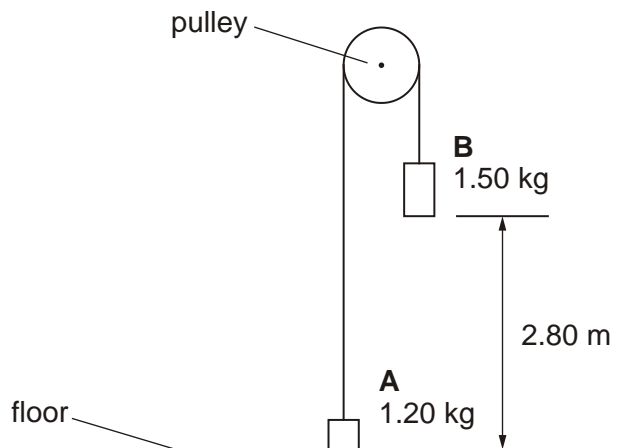
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[Total 4 marks]

9. The figure below shows two masses **A** and **B** tied to the ends of a length of string. The string passes over a pulley. The mass **A** is held at rest on the floor.



The mass **A** is 1.20 kg and the mass **B** is 1.50 kg.



- (a) Calculate the weight of mass **B**.

weight = ..... N

[1]

- (b) Mass **B** is initially at rest at a height of 2.80 m above the floor. Mass **A** is then released. Mass **B** has a constant downward acceleration of  $1.09 \text{ m s}^{-2}$ . Assume that air resistance and the friction between the pulley and the string are negligible.

- (i) In terms of forces, explain why the acceleration of the mass **B** is less than the acceleration of free fall  $g$ .

.....  
.....

[1]

- (ii) Calculate the time taken for the mass **B** to fall 1.40 m.

time = ..... s

[3]

- (iii) Calculate the velocity of mass **B** after falling 1.40 m.

velocity = .....  $\text{m s}^{-1}$

[2]

- (iv) Mass **B** hits the floor at a speed of  $2.47 \text{ m s}^{-1}$ . It **rebounds** with a speed of  $1.50 \text{ m s}^{-1}$ . The time of contact with the floor is  $3.0 \times 10^{-2} \text{ s}$ . Calculate the magnitude of the average acceleration of mass **B** during its impact with the floor.

acceleration = .....  $\text{m s}^{-2}$

[2]

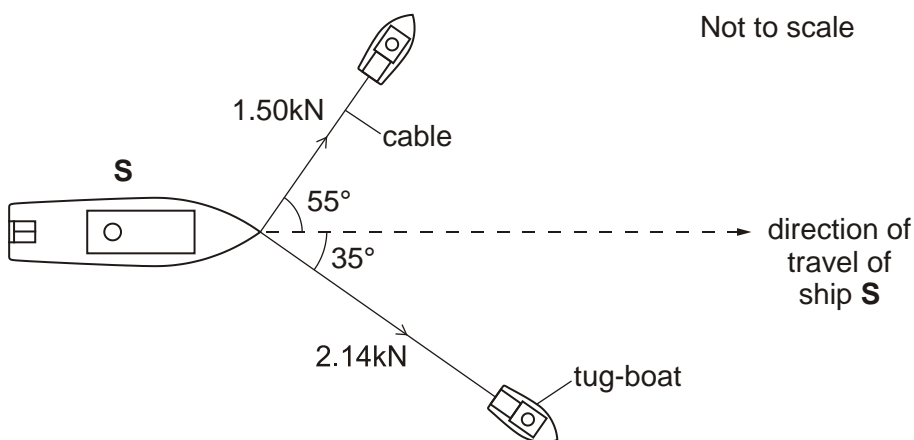
[Total 9 marks]

10. State why the equation ' $F = ma$ ' cannot be applied to particles travelling at speeds very close to the speed of light.

.....  
 .....

[Total 1 mark]

11. The figure below shows a ship **S** being pulled by two tug-boats.



The ship is travelling at a constant velocity. The tensions in the cables and the angles made by these cables to the direction in which the ship travels are shown in the figure above.

- (i) Draw a vector triangle and determine the resultant force provided by the two cables.

resultant force = ..... kN

[3]

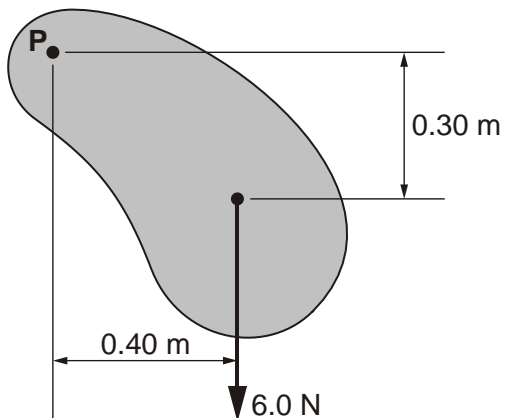
- (ii) State the value of the drag force acting on the ship **S**. Explain your answer.

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 .....  
 .....

[2]

[Total 5 marks]

12. Describe an experiment to determine the centre of gravity of the metal plate shown in the figure below.



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[Total 3 marks]

13. The figure below shows the horizontal forces acting on a car of mass 900 kg when it is travelling at a particular velocity on a level road.



The total forward force between the tyres and the road is 200 N and the air resistance (drag) is 80 N.

- (i) Calculate the acceleration of the car.

acceleration = .....  $\text{m s}^{-2}$

[2]

- (ii) Explain why we cannot use the equation  $v = u + at$  to predict the velocity of the car at a later time even when the forward force is constant.

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[1]

[Total 3 marks]