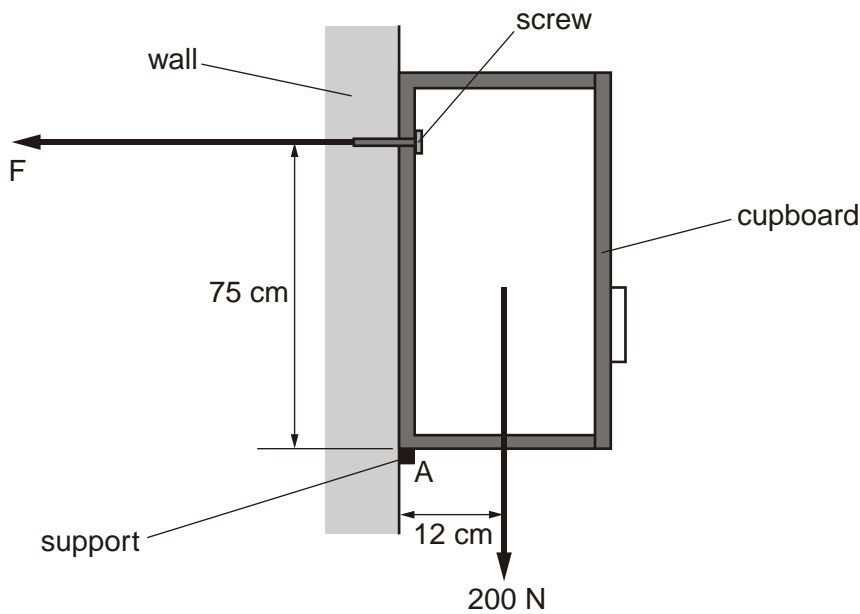**Questions on Forces**

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 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.

....

....

....

[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 = ... N

[2]

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

pressure = ...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**.

....

....

....

[2]

[Total 8 marks]

2. The figure below shows a lawn mower which is carried by two people.
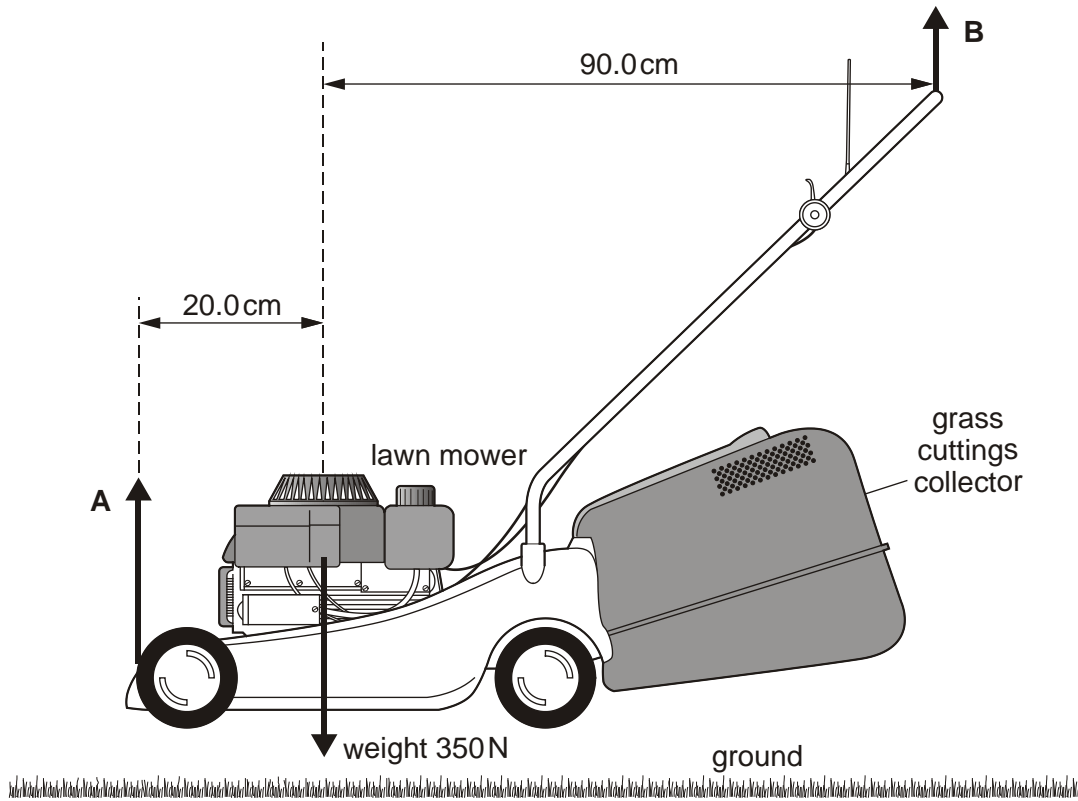
(i) The two people apply forces **A** and **B** at each end of the lawn mower. The weight of the lawn mower is 350 N.

   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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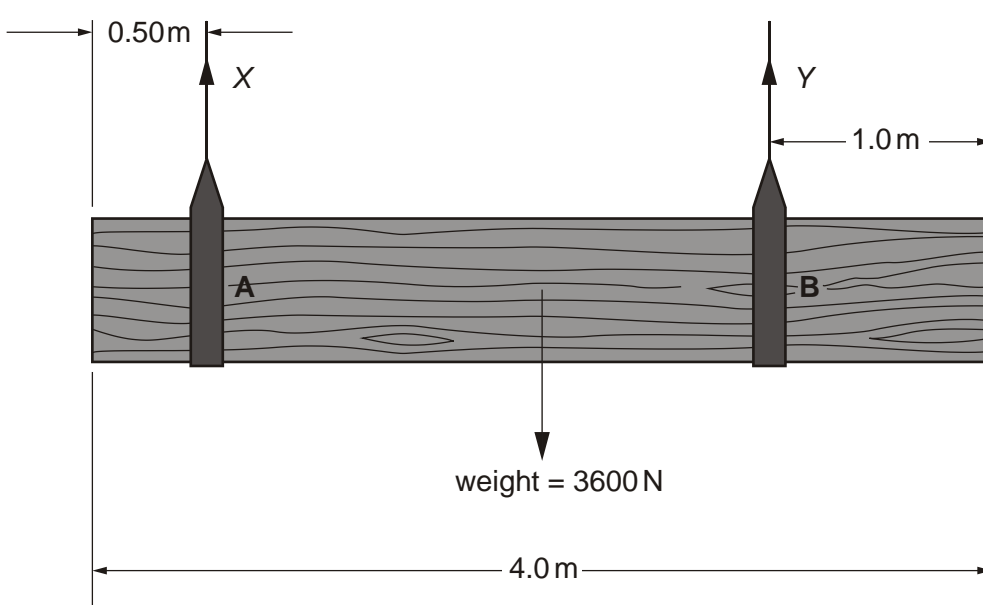
[2]

[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.

....

....

....

....

[2]

(iii)   The area of strap **A** in contact with the underside of the beam is 2.3×10^{-2} m². 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 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 = ... 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.

....

....

....

....

....

[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.
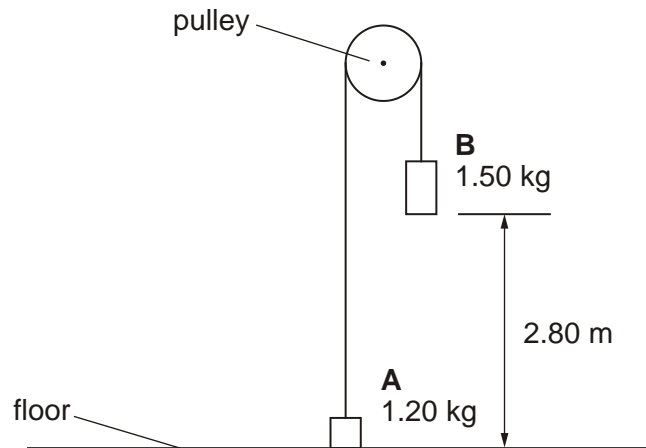
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....

[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.

pulley

B
1.50 kg

2.80 m

A
1.20 kg

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 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 = ... m s^{-1}

[2]

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

acceleration = ... m s^{-2}
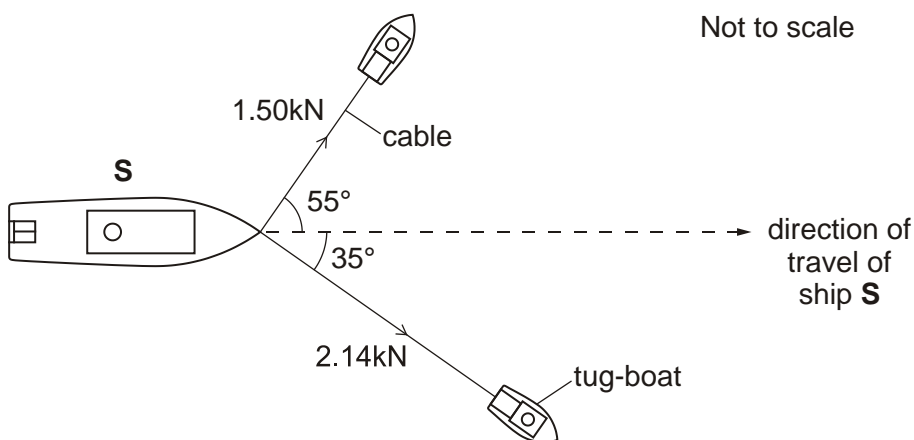
[2]

[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.

Not to scale

1.50kN

cable

S

55°

35°

direction of travel of ship **S**

2.14kN

tug-boat

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.
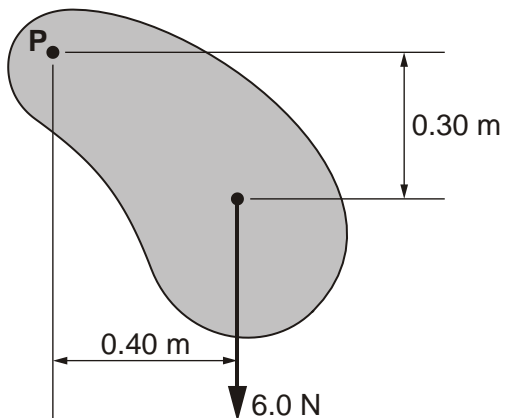
resultant force = ... kN

[3]

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

....

....

....

[2]

[Total 5 marks]

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

....

....

....

....

....

[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 = ... 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.

....

....

[1]

[Total 3 marks]