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

.....

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

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

.....

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

(c) Fig. 3.1 shows the horizontal forces acting on a car of mass 900 kg when it is travelling at a particular velocity on a level-road.

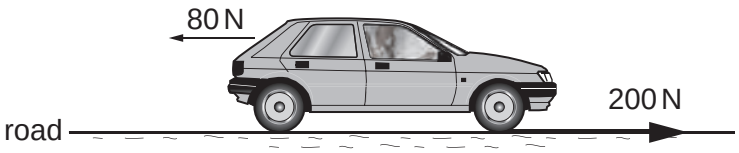


Fig. 3.1

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]**

(d) Fig. 3.2 shows a person being lifted vertically upwards by a rope.

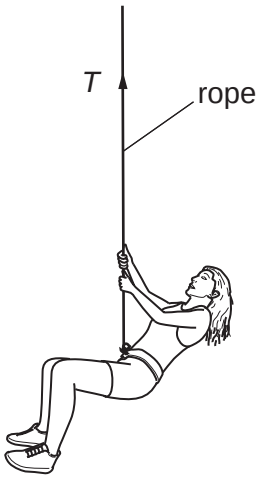


Fig. 3.2

The mass of the person is 72 kg. The upward vertical acceleration of the person is 1.4 m s^{-2}. Calculate the tension T in the rope.

T = ... N **[3]**

[Total: 8]

2 **(a)** Define *torque of a couple*2

.....

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

(b) Explain why *moment of a force* and *torque of a couple* have the same unit N m.

.....

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

(c) Fig. 4.1 shows an irregular shaped metal plate of constant thickness that can swing freely about point **P**.

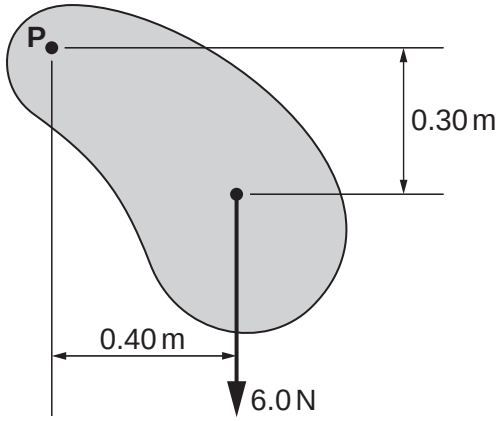


Fig. 4.1

(i) The weight of the plate is 6.0 N. With the plate in the position as shown in Fig. 4.1, calculate the clockwise moment of the weight of the plate about an axis through point **P**.

moment = ... N m **[1]**

(ii) Explain why the moment of the weight reduces to zero when the plate reaches the bottom of the swing.

.....

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

(d) Describe an experiment to determine the centre of gravity of the metal plate shown in Fig. 4.1.

.....

.....

.....

.....

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

(e) Fig. 4.2 shows a section of the human forearm in equilibrium.

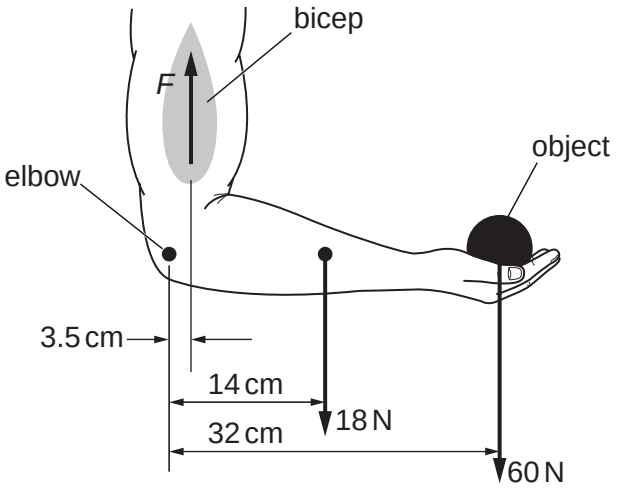


Fig. 4.2

The weight of the object in the hand is 60 N. The centre of gravity of this object is 32 cm from the elbow. The bicep provides an upward force of magnitude *F*. The distance between the line of action of this force and the elbow is 3.5 cm. The weight of the forearm is 18 N. The distance between the centre of gravity of the forearm and the elbow is 14 cm.

By taking moments about the elbow, determine the magnitude of the force *F* provided by the bicep.

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

3 **(a)** Fig. 5.1 shows a 20 N force acting at an angle of 38° to the horizontal.

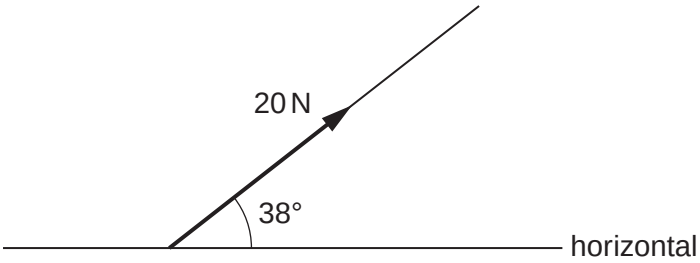


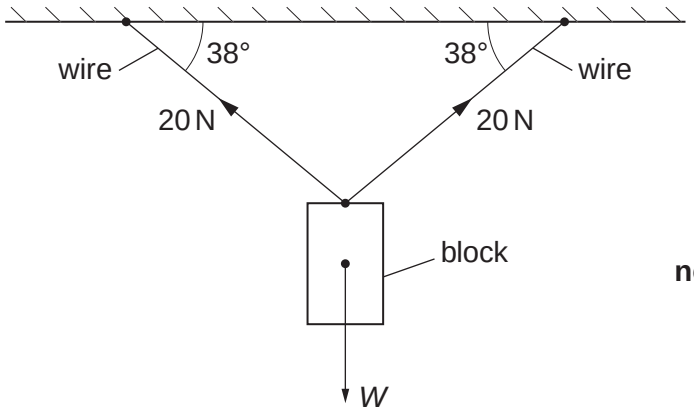
Fig. 5.1

Determine the horizontal and vertical components of this force.

horizontal component = ... N **[1]**

vertical component = ... N **[1]**

(b) Fig. 5.2 shows a metal block held in equilibrium by two wires.



not to scale

Fig. 5.2

The tension in each wire is 20 N.

(i) Show that the weight *W* of the metal block is about 25 N.

(ii) The metal block has a volume of $2.9 \times 10^{-4}\,m^3$. Calculate the density of the metal.

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

[Total: 7]

4 **(a)** Define *stopping distance* of a car4

.....

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

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

.....

.....

.....

.....

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

(c) 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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..... **[4]**

[Total: 9]

5 **(a)** A student conducts an experiment to estimate the acceleration g of free fall by dropping a heavy metal ball from a high wall into a sandpit below. Describe how this student can estimate the acceleration g of free fall. Your description should include:

- the measurements taken
- the instruments used to take the measurements
- how the measurements are used to estimate g
- an explanation of why the value for g is only an estimate

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

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..... **[7]**

(b) The global positioning system (GPS) is used to locate accurately the position of cars on the Earth's surface.

(i) Name the electromagnetic waves used by GPS.

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

(ii) Explain how GPS determines the distance between the car and satellite.

.....

.....

.....

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

(iii) Briefly describe how the distances from two or more satellites are used to locate the position of a car.

.....

.....

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

[Total: 12]

6 **(a)** State what is meant by the *centre of gravity* of an object.

.....

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

(b) Define *moment of a force*.

.....

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

(c) Fig. 5.1 shows a baby's mobile toy.

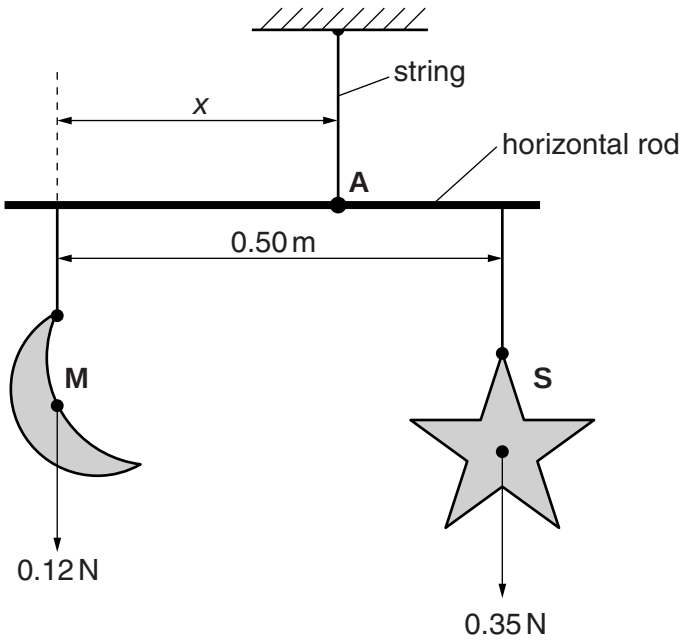

Fig. 5.1

The toy consists of a horizontal rod from which two objects shaped as a crescent moon **M** and a star **S** are suspended from lengths of string. The weight of the rod is negligible and it is pivoted about an axis passing through point **A** perpendicular to the plane of the diagram. The weights of **M** and **S** and the separation between the strings are shown in Fig. 5.1. The distance between the string on the left and point **A** is *x*. The arrangement shown in Fig. 5.1 is in equilibrium.

(i) State **two** conditions necessary for the rod to be in equilibrium.

.....

.....

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

(ii) By taking moments about **A** determine the distance x.

x = ... m **[3]**

(iii) Determine the magnitude of the tension in the string attached to **A**.

tension = ... N **[1]**

[Total: 8]