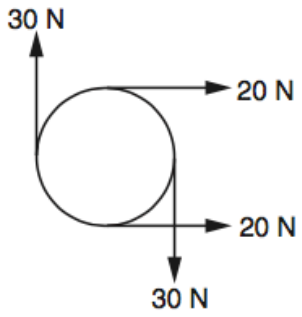
1)

The diagram shows four forces applied to a circular object.

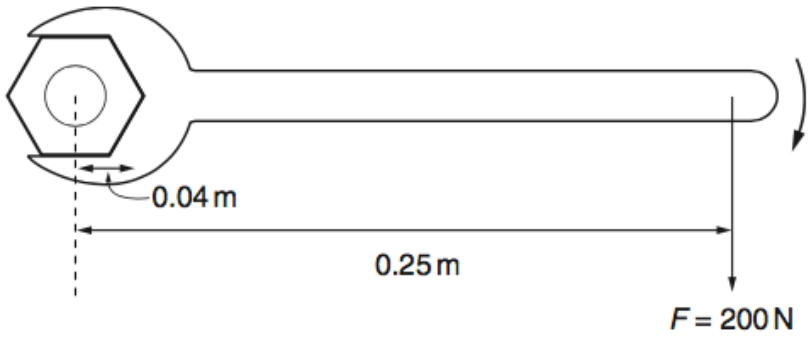


Which of the following describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

2)

A spanner is used to tighten a nut as shown.



A force *F* is applied at right-angles to the spanner at a distance of 0.25 m from the centre of the nut. When the nut is fully tightened, the applied force is 200 N.

What is the resistive torque, in an anticlockwise direction, preventing further tightening?

A 8 N m

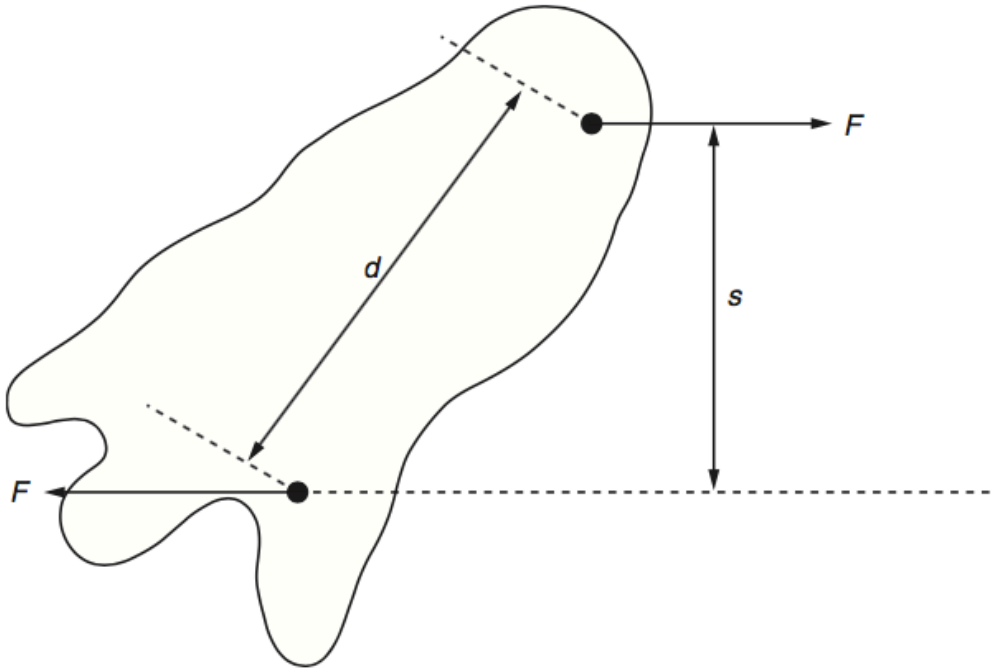
B 25 N m

C 50 N m

D 800 N m

3)

Two parallel forces, each of magnitude *F*, act on a body as shown.

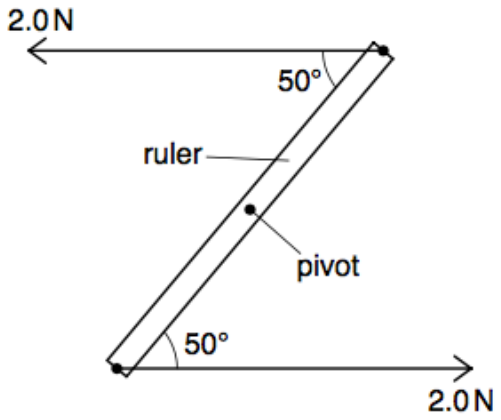


What is the magnitude of the torque on the body produced by these forces?

A *Fd* **B** *Fs* **C** 2*Fd* **D** 2*Fs*

4)

A ruler of length 0.30 m is pivoted at its centre. Equal and opposite forces of magnitude 2.0 N are applied to the ends of the ruler, creating a couple as shown.



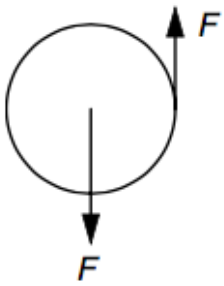
What is the magnitude of the torque of the couple on the ruler when it is in the position shown?

A 0.23 Nm **B** 0.39 Nm **C** 0.46 Nm **D** 0.60 Nm

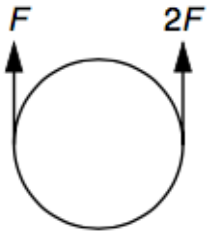
5)

Which of the following pairs of forces, acting on a circular object, constitutes a couple?

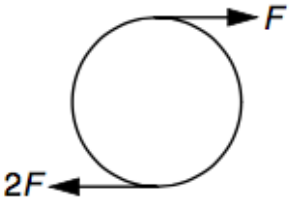
A



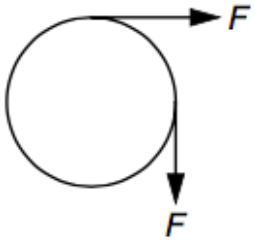
B



C

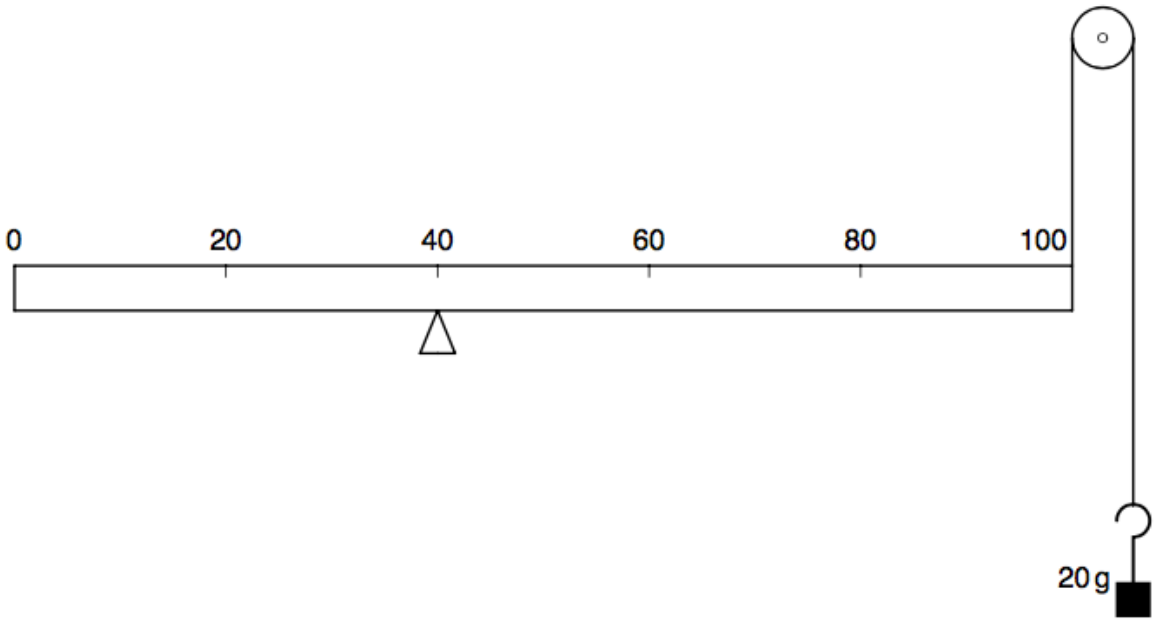


D



6)

A uniform metre rule of mass 100 g is supported by a knife-edge at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.



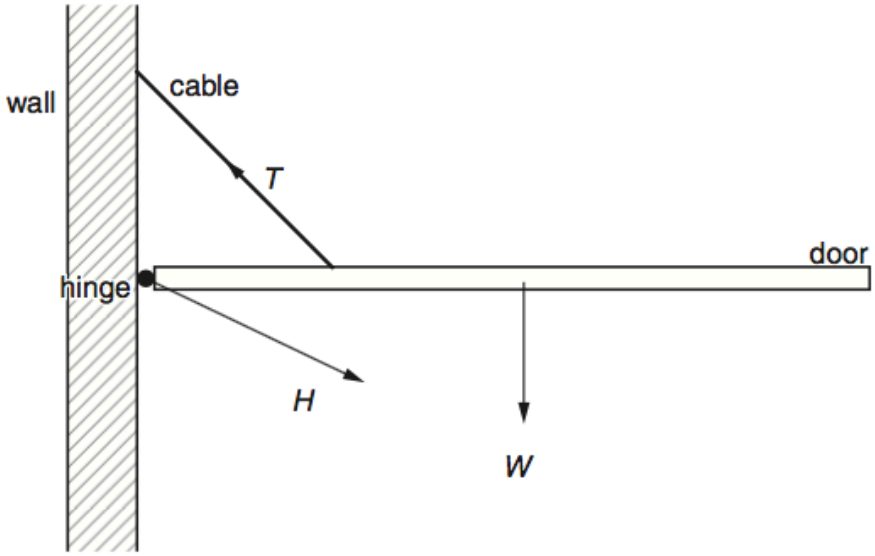
At which mark on the rule must a 50 g mass be suspended so that the rule balances?

A 4 cm **B** 36 cm **C** 44 cm **D** 96 cm

7)

A hinged door is held closed in the horizontal position by a cable.

Three forces act on the door: the weight *W* of the door, the tension *T* in the cable, and the force *H* at the hinge.

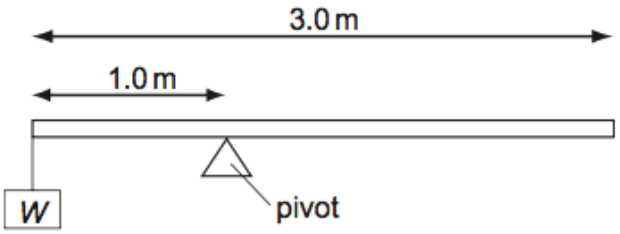


Which list gives the three forces in **increasing** order of magnitude?

A *H,T,W* **B** *T,H,W* **C** *W,H,T* **D** *W,T,H*

8)

A uniform beam of weight 50 N is 3.0 m long and is supported on a pivot situated 1.0 m from one end. When a load of weight *W* is hung from that end, the beam is in equilibrium, as shown in the diagram.

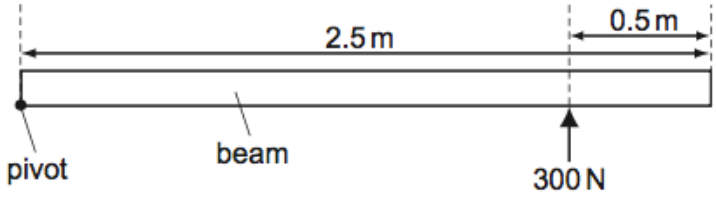


What is the value of *W*?

A 25 N **B** 50 N **C** 75 N **D** 100 N

9)

A long uniform beam is pivoted at one end. A force of 300 N is applied to hold the beam horizontally.

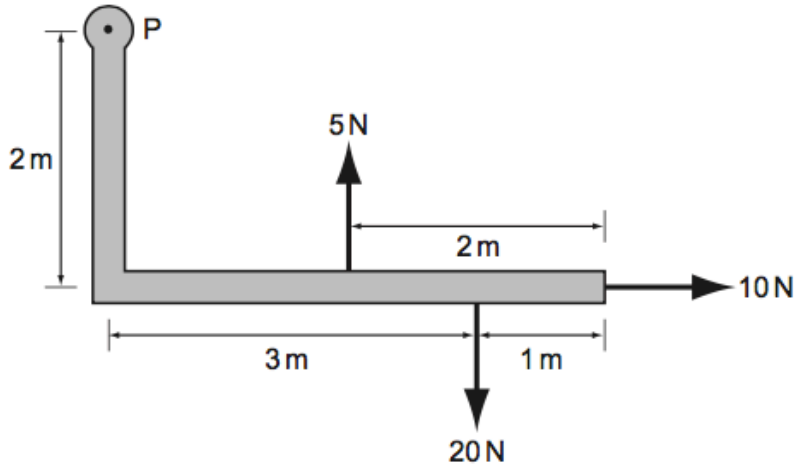


What is the weight of the beam?

A 300 N **B** 480 N **C** 600 N **D** 960 N

10)

An L-shaped rigid lever arm is pivoted at point P.



Three forces act on the lever arm, as shown in the diagram.

What is the magnitude of the resultant moment of these forces about point P?

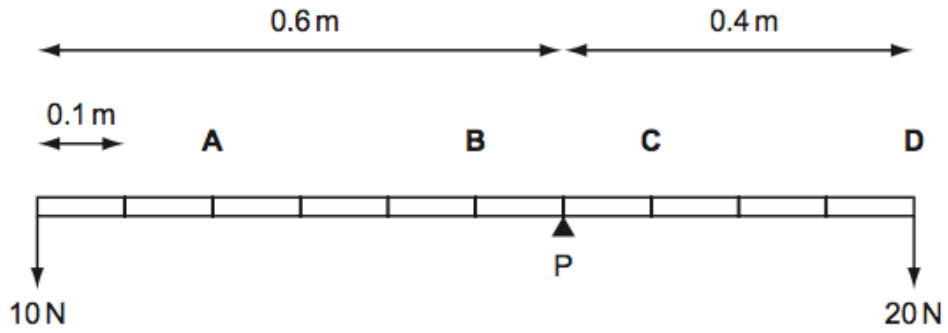
A 30 N m **B** 35 N m **C** 50 N m **D** 90 N m

11)

A uniform beam of weight 100 N is pivoted at P as shown. Weights of 10 N and 20 N are attached to its ends.

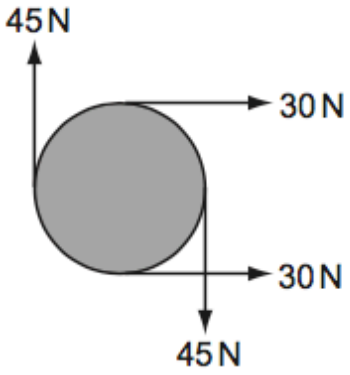
The length of the beam is marked off at 0.1 m intervals.

At which point should a further weight of 20 N be attached to achieve equilibrium?



12)

The diagram shows four forces applied to a circular object.



Which of the following describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	non-zero	non-zero
B	non-zero	zero
C	zero	non-zero
D	zero	zero

13)

(a) Define the *moment* of a force.

.....

..... [2]

(b) State the two conditions necessary for a body to be in equilibrium.

1. .....

.....

2. .....

..... [2]

(c) Two parallel strings S_1 and S_2 are attached to a disc of diameter 12 cm, as shown in Fig. 3.1.

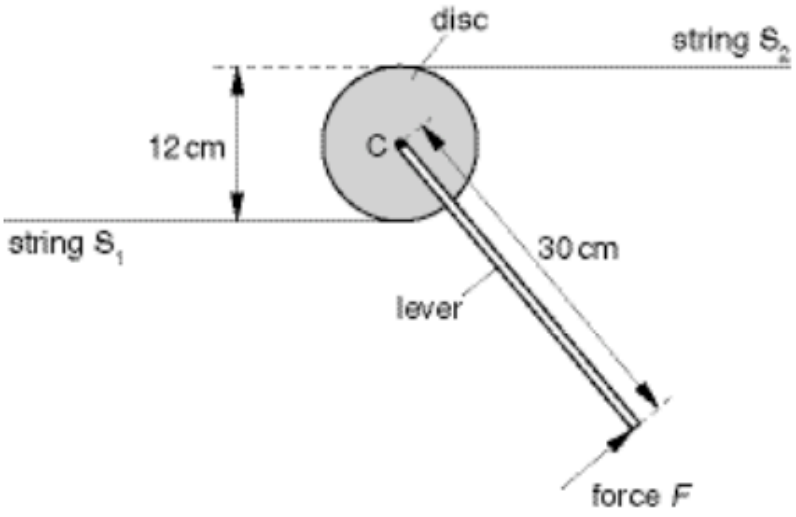


Fig. 3.1

The disc is free to rotate about an axis normal to its plane. The axis passes through the centre C of the disc.

A lever of length 30 cm is attached to the disc. When a force *F* is applied at right angles to the lever at its end, equal forces are produced in S_1 and S_2. The disc remains in equilibrium.

(i) On Fig. 3.1, show the direction of the force in each string that acts on the disc. [1]

(ii) For a force *F* of magnitude 150 N, determine

1. the moment of force *F* about the centre of the disc,

moment = ... N m

2. the torque of the couple produced by the forces in the strings,

torque = ... N m

3. the force in S_1.

force = ... N

[4]

14)

A rod AB is hinged to a wall at A. The rod is held horizontally by means of a cord BD, attached to the rod at end B and to the wall at D, as shown in Fig. 2.1.

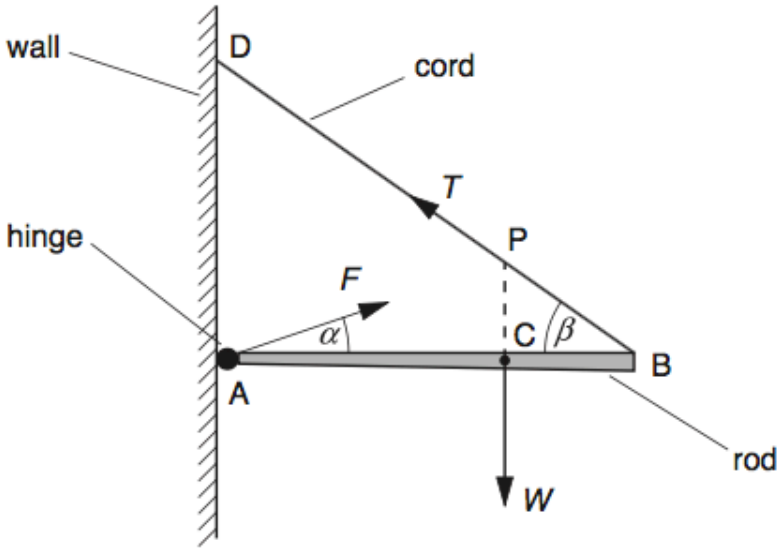


Fig. 2.1

The rod has weight *W* and the centre of gravity of the rod is at C. The rod is held in equilibrium by a force *T* in the cord and a force *F* produced at the hinge.

(a) Explain what is meant by

(i) the *centre of gravity* of a body,

.....

.....

..... [2]

(ii) the *equilibrium* of a body.

.....

.....

.....

..... [2]

(b) The line of action of the weight W of the rod passes through the cord at point P.

Explain why, for the rod to be in equilibrium, the force F produced at the hinge must also pass through point P.

.....

.....

.....

..... [2]

(c) The forces F and T make angles α and β respectively with the rod and AC = $\frac{2}{3}$AB, as shown in Fig. 2.1.

Write down equations, in terms of F, W, T, α and β, to represent

(i) the resolution of forces horizontally,

..... [1]

(ii) the resolution of forces vertically,

..... [1]

(iii) the taking of moments about A.

..... [1]

15)

(a) **(i)** Define potential energy.

.....

..... [1]

(ii) Distinguish between *gravitational* potential energy and *elastic* potential energy.

gravitational potential energy .....

.....

elastic potential energy .....

..... [2]

(b) A small sphere of mass 51 g is suspended by a light inextensible string from a fixed point P.
The centre of the sphere is 61 cm vertically below point P, as shown in Fig. 3.1.

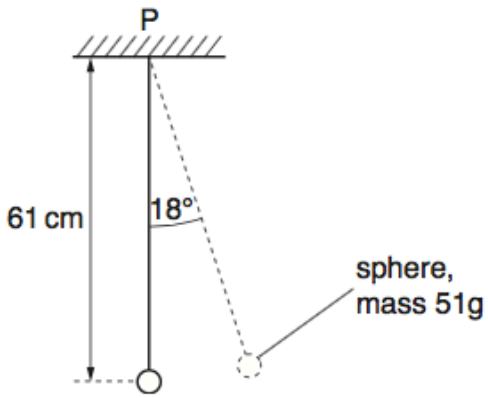


Fig. 3.1

The sphere is moved to one side, keeping the string taut, so that the string makes an angle of 18° with the vertical. Calculate

(i) the gain in gravitational potential energy of the sphere,

gain = ... J [2]

(ii) the moment of the weight of the sphere about point P.

moment = ... N m [2]

16)

(a) Distinguish between the moment of a force and the torque of a couple.

moment of a force .....

.....

.....

torque of a couple .....

.....

.....

[4]

(b) One type of weighing machine, known as a steelyard, is illustrated in Fig. 3.1.

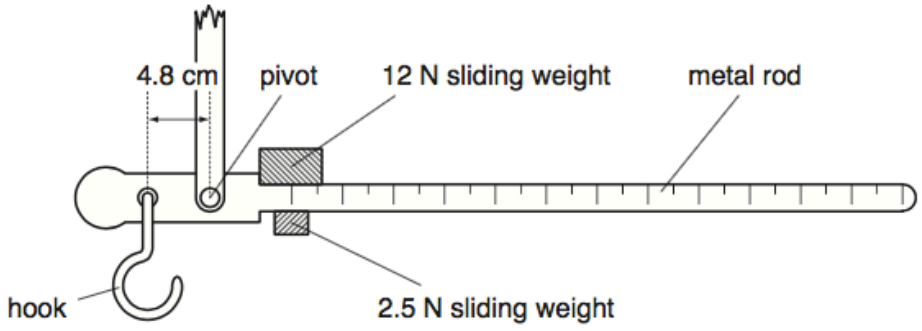


Fig. 3.1

The two sliding weights can be moved independently along the rod.

With no load on the hook and the sliding weights at the zero mark on the metal rod, the metal rod is horizontal. The hook is 4.8 cm from the pivot.

A sack of flour is suspended from the hook. In order to return the metal rod to the horizontal position, the 12 N sliding weight is moved 84 cm along the rod and the 2.5 N weight is moved 72 cm.

(i) Calculate the weight of the sack of flour.

weight = ...N [2]

(ii) Suggest why this steelyard would be imprecise when weighing objects with a weight of about 25 N.

.....

.....[1]

17)

State the two conditions necessary for the equilibrium of a body which is acted upon by a number of forces.

1. .....

.....

2. .....

.....[2]

18)

(a) Define the *torque* of a couple.

.....

.....

..... [2]

(b) A torque wrench is a type of spanner for tightening a nut and bolt to a particular torque, as illustrated in Fig. 3.1.

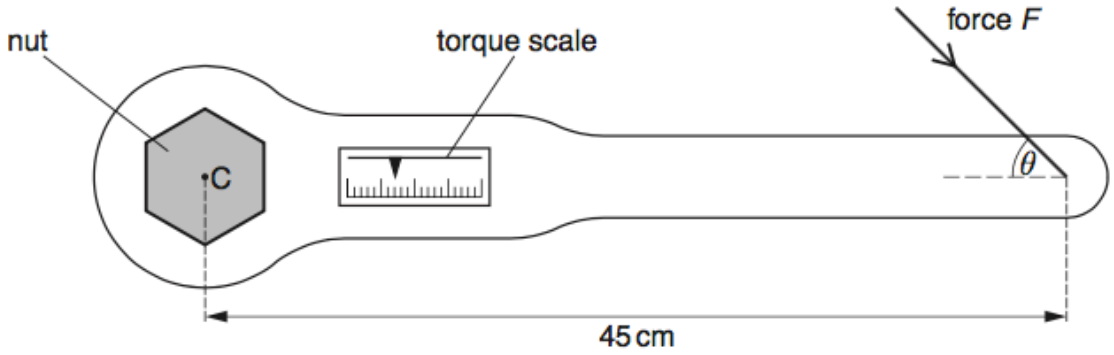


Fig. 3.1

The wrench is put on the nut and a force is applied to the handle. A scale indicates the torque applied.

The wheel nuts on a particular car must be tightened to a torque of 130 N m. This is achieved by applying a force F to the wrench at a distance of 45 cm from its centre of rotation C. This force F may be applied at any angle θ to the axis of the handle, as shown in Fig. 3.1.

For the minimum value of F to achieve this torque,

(i) state the magnitude of the angle θ that should be used,

θ = ... ° [1]

(ii) calculate the magnitude of F.

F = ... N [2]