# FORCES

Challenging **MCQ** questions by The Physics Cafe


**Compiled and selected by The Physics Cafe**

1 Fig. 2.1 shows a signboard suspended by two elastic ropes of tension $T_1$ and $T_2$. The tension in $T_1$ is **300 N** and the tension in $T_2$ is **252 N**.

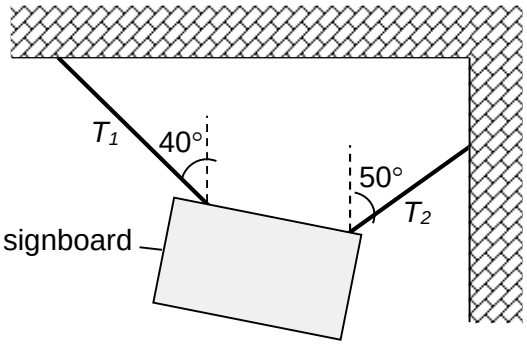



**Fig. 2.1**

**(a) (i)** State the conditions for equilibrium.

……

…… [2]

**(ii)** On Fig. 2.1, mark the centre of gravity of the signboard with a dot and label the point as G. Show clearly your construction to determine the centre of gravity on Fig. 2.1. [1]

**(iii)** Determine the weight of the signboard.

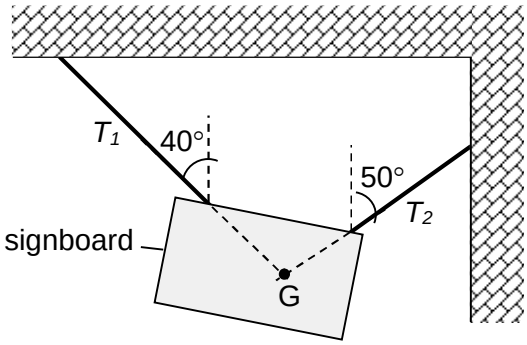
weight = ……N [1]

**(b)** The signboard is pulled vertically downwards with a force of **20 N** so that the ropes are stretched. Determine the acceleration of the signboard immediately after it is released.

acceleration = ……m $s^{-2}$ [2]

Ans **ai** There is <u>zero net force</u> acting on the signboard.
There is <u>zero net torque about any axis</u> acting on the signboard.

**ii**




G is at the intersection of lines of action of $T_1$ and $T_2$

**iii** Weight = $T_1 \cos 40° + T_2 \cos 50°$
$= 300 \cos 40° + 252 \cos 50°$
$= 391.8$
$= 390$ N

**b** Net force acting on the board immediately after released = 20 N

Initial net acceleration = F/m
$= 20/(391.8/9.81) = 0.501 \approx 0.50$ m $s^{-2}$ [allow ecf from (aiii)]

2 **(a)** State the *principle of moments*.

……

……

…… [1]

**(b)** A uniform rigid rod of mass **30 kg** is attached to a vertical wall by a hinge as shown in Fig. 1. The other end of the rod is held to the ceiling by a cable.

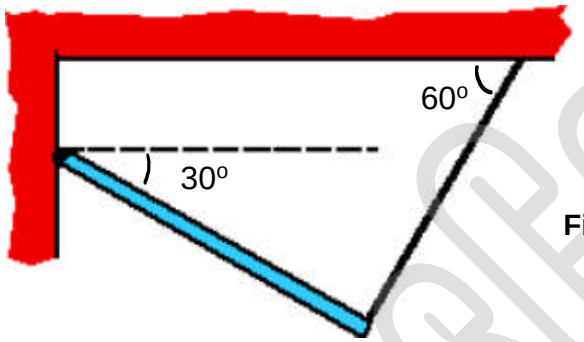



**Fig. 1**

Draw the free body diagram of the forces acting on the rod in Fig. 1. Label and explain all the forces clearly. [2]

**(i)** Show that the tension *T* in the cable is 127 N. [2]

**(ii)** Determine the force acting on the rod by the hinge.

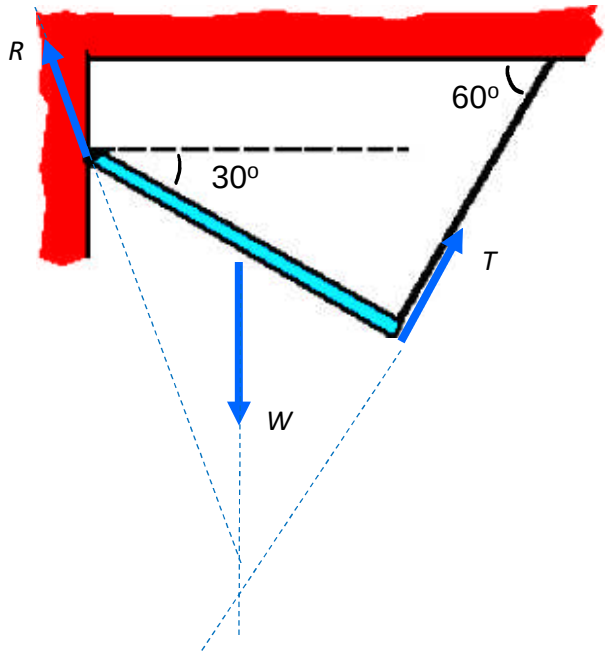
force = …… N

direction = …… [4]

Ans

**(a)** The principle of moments states that for a body to be in rotational equilibrium, sum of clockwise moments about any point equals sum of anticlockwise moments about that same point. B1

**(b)**




- All 3 forces correctly labeled and explained [B1]
- All 3 forces intersect to meet at a common point. [B1]
- Appropriate magnitudes of forces. [B1]

Any missing point deduct 1 mark.

*W* is the weight of the rod, *T* is the tension acting on the rod, *R* is the force acting on the rod by the hinge.

**(i)** Take moments about the hinge, M1

$30 \times 9.81 \times \cos 30^o (\frac{L}{2}) = T \times L$

$T = 127.4 \approx 127\,N$ C1

**(ii)** $(\leftarrow +) \quad R_X = T\sin 30^o = 127.4\sin 30^o = 63.7\,N$ M1

$(\uparrow +) \quad R_Y = 30 \times 9.81 - T\cos 30^o = 184\,N$ M1

$R = \sqrt{R_X^2 + R_Y^2} = \sqrt{63.7^2 + 184^2} = 194.7 \approx 195\,N$ A1

$\tan\theta = \frac{184}{63.7} \Rightarrow \quad \theta = 70.9^o$ above the horizontal as shown in Fig. 1 A1

3 A uniform sheet of steel weighing **800 N** is supported by a bolt at its lower-left hand corner and by a cable tied to a point on its left-edge as shown in Fig. 3.1 below. The pull by the cable on the sheet is *T*.

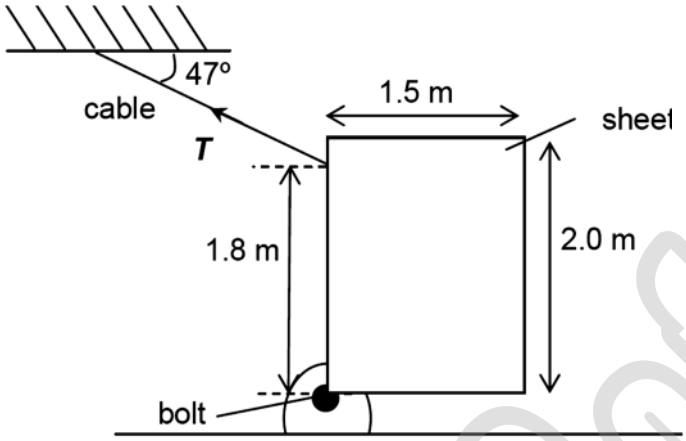



**Fig. 3.1**

**(a)** Show that *T* is 489 N.

[2]

**(b)** Determine the magnitude of force acting on the bolt by the sheet.

magnitude of force = …… N [3]

Ans

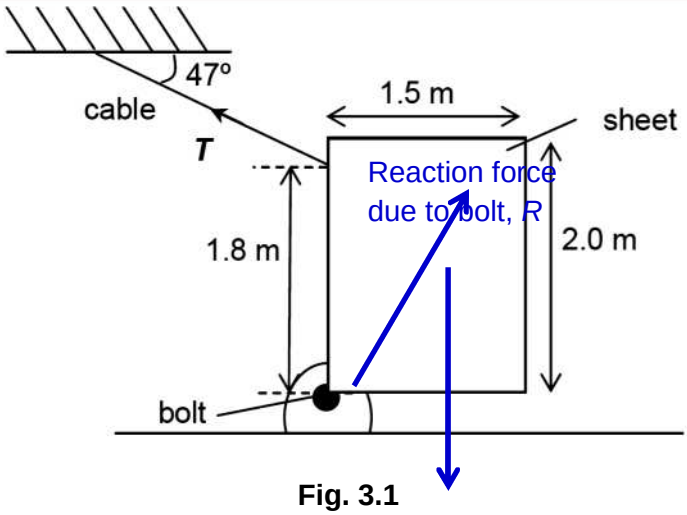



**Fig. 3.1**

(a) Taking moment about the bolt,

$Wd_1 = T_x d_2$

$800(1.5/2) = (T\cos 47)(1.8)$

$T = 489$ N

(b) Using Cosine Rule,

$R = \sqrt{W^2 + T^2 - 2WT\cos\theta}$

$R = \sqrt{800^2 + 489^2 - 2(800)(489)\cos 43}$

Force on sheet by botlt, $R = 554$ N

By Newton's 3rd Law, force on bolt by sheet is equal
in magnitude but opposite in direction to force on sheet by bolt.
Hence, force on bolt by sheet $= 554$ N