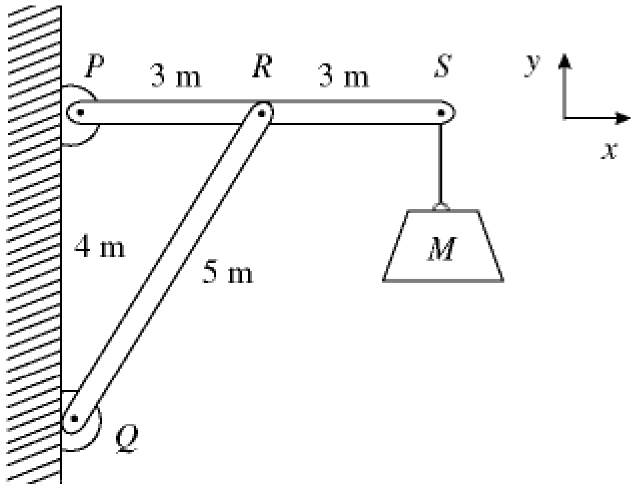
Name_PROFESSOR S.K. SINHA________________________________

g = 9.8 m/s2

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Figure 11.1



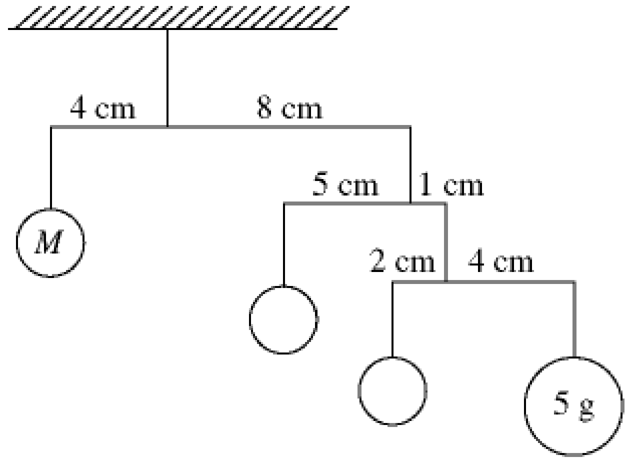
1) A uniform 300-kg beam, 6 m long, is freely pivoted at P. The beam is supported in a horizontal position by a light strut, 5 m long, which is freely pivoted at Q and is loosely pinned to the beam at R. A load of mass is suspended from the end of the beam at S. A maximum compression of 23,000 N in the strut is permitted, due to safety. In Fig. 11.1, the maximum mass M of the load is closest to:

A) 1088 kg B) 554 kg C) 1023 kg D) 788 kg E) 1323 kg

2) Suppose that a heavy person and a light person are balanced on a teeter-totter made of a plank of wood. Each person now moves in toward the fulcrum a distance of 25 cm. What effect will this have on the balance of the teeter-totter?

A) The heavy person's end will go down.
B) The teeter-totter will remain in balance.
C) The light person's end will go down.
D) One cannot tell whether either end will rise or fall without knowing the relative mass of the plank.
E) Only if the plank has significant mass will the light person's end go down.

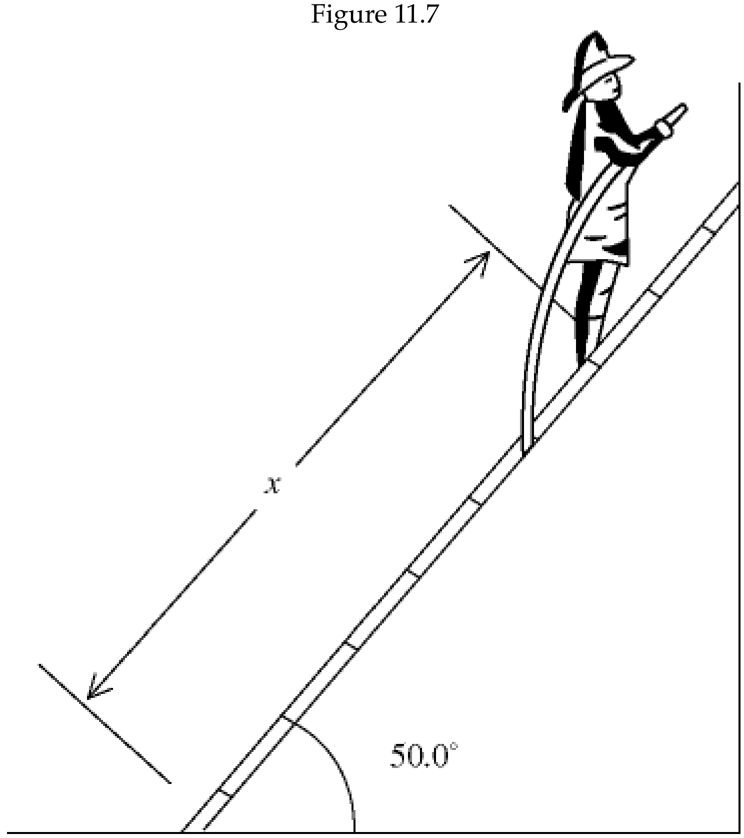
Figure 11.4



3) In Fig. 11.4, all the masses are balanced about their points of suspension. You are given only that the mass on the right is 5 g, and the distances from the points of suspension are as shown. What mass M is required to balance the mobile?

A) 18 g B) 60 g C) 36 g D) 30 g E) 90 g

Figure 11.7



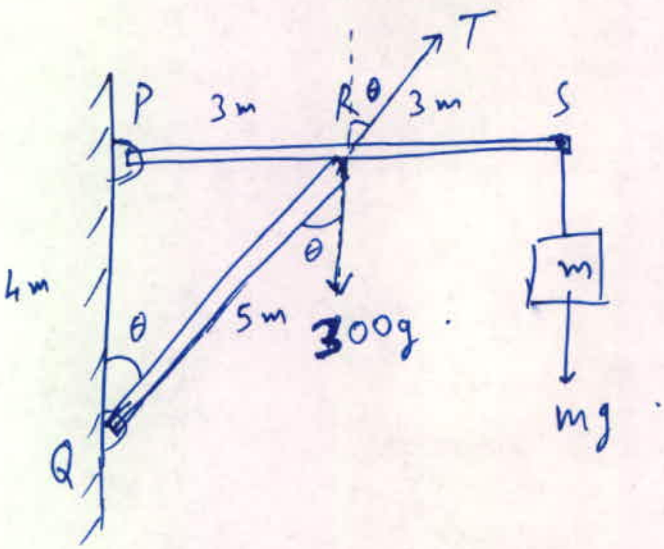
4) In Figure 11.7, a ladder of weight 200 N and length 10 meters leans against a smooth wall (no friction on wall). A firefighter of weight 600 N climbs a distance x up the ladder. The coefficient of friction between the ladder and the floor is 0.5. What is the maximum value of x if the ladder is not to slip?

A) 5.00 m B) 8.44 m C) 6.28 m D) 6.04 m E) 3.93 m

QUIZ 8

PHYS 4A
WINTER '15

1.)



Balancing Torque about Point P for the Beam,

$$\tau_{\text{due to } T} = \underbrace{\tau_{\text{due to } mg}}_{\text{Load}} + \underbrace{\tau_{\text{due to } (300g)}}_{\text{Weight of Beam}}$$

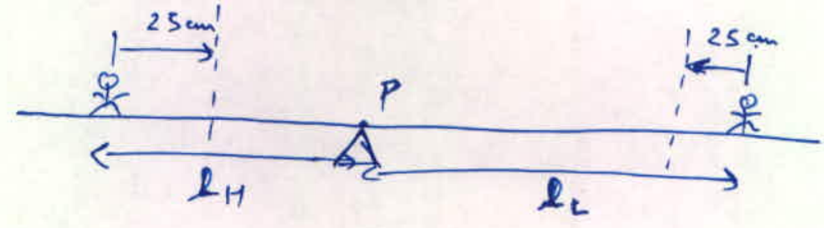
$$\Rightarrow T\cos\theta \times 3 = (mg \times 6) + (300g \times 3)$$

where $\cos\theta = 4/5$

$$\therefore \quad m = 23{,}000 \times \frac{4}{5} \times \frac{3}{6} \times \frac{1}{9.8} - \frac{300 \times 3}{6}$$

$$\Rightarrow m \simeq 788 \text{ kg}$$

2.)



Initially, Torque is balanced about Point P.

$$\therefore \quad \tau_H = \tau_L$$

{ H ⇒ Heavy Person
L ⇒ Light Person }

$$\Rightarrow m_H l_H = m_L l_L \quad -(1)$$

After, they move 25 cm towards P,

$$\tau'_H = m_H(l_H - 25)$$
$$= m_H l_H - 25 m_H$$

$$\tau'_L = m_L(l_L - 25)$$
$$= m_L l_L - m_L 25$$

Now, Consider

$$\Delta\tau = \tau'_H - \tau'_L$$
$$= (m_H l_H - 25 m_H) - (m_L l_L - m_L 25)$$
$$= 25 \underbrace{(m_L - m_H)}_{\text{Negative}}$$

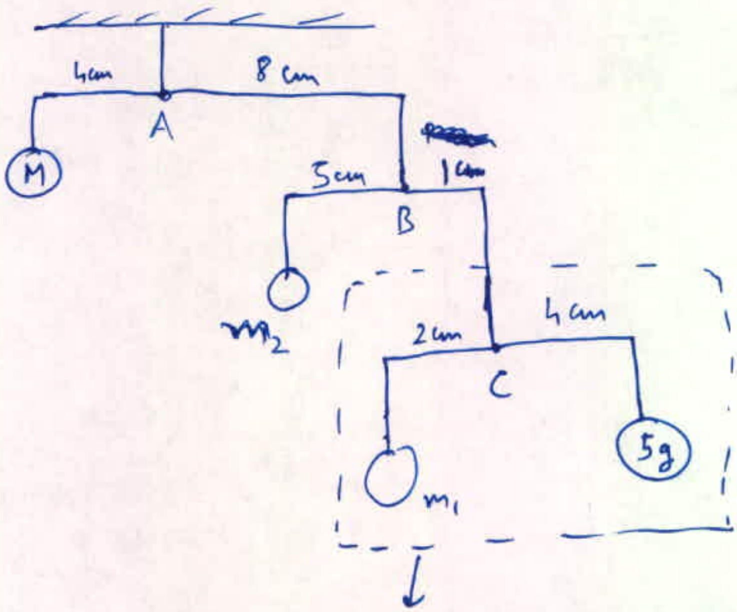
{ as $m_H l_H = m_L l_L$ from eqn (1) }

$$\therefore \quad \Delta\tau < 0$$
$$\Rightarrow \tau'_H - \tau'_L < 0$$

$\Rightarrow \tau_L' > \tau_H'$

$\therefore$ The lighter person's end will go down.

3.)



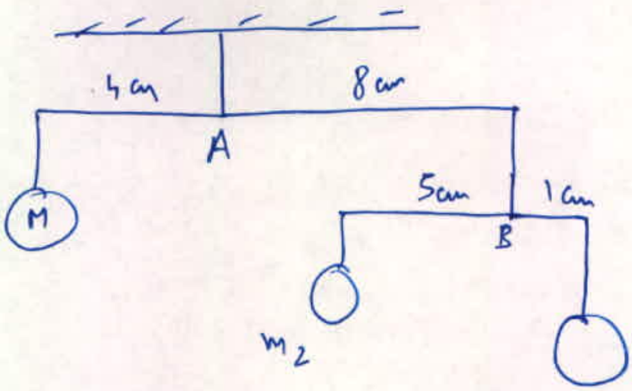
Taking this as our system, and Balancing Torque about point C.

$$\tau_{m_1} = \tau_{5g}$$

$$\Rightarrow m_1 g \times 2 = 5g \times g \times 4$$

$$\Rightarrow m_1 = 10g.$$

$\therefore$ We can re-draw an equivalent figure,



$\{10g + 5g\}$

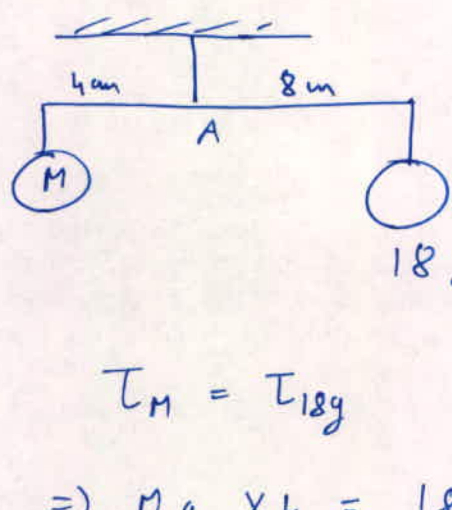
Similarly, Balancing Torque about Point B,

$$\tau_{m_2} = \tau_{15g}$$

$$\Rightarrow m_2 g \times 5 = 15g \times g \times 1$$

$$\Rightarrow m_2 = 3g$$

$\therefore$



$\{15g + 3g\}$

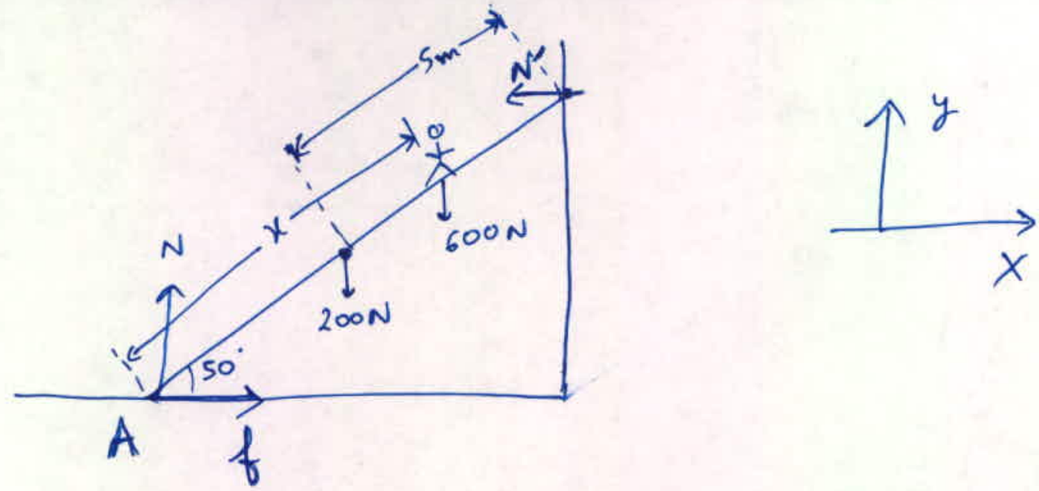
Now,

$$\tau_M = \tau_{18g} \quad \text{(Torque about Point A)}$$

$$\Rightarrow Mg \times 4 = 18g \times g \times 8$$

$$\Rightarrow M = 36g$$

4.)



Balancing forces in x-direction,

$$N' = f = \mu N$$

y-direction,

$$N = (200 + 600)\,N$$
$$= 800\,N$$

$$\therefore N' = \mu N = 0.5 \times 800$$
$$= 400\,N$$

Balancing Torque about point A,

$$\vec{\tau}_N + \vec{\tau}_f + \vec{\tau}_{200} + \vec{\tau}_{600} + \vec{\tau}_{N'} = 0$$

$$\Rightarrow 0 + 0 - (200\cos 50^\circ)\times 5 - (600\cos 50^\circ)\,x + (N'\sin 50^\circ)\,10 = 0$$

$$\Rightarrow x = \frac{(400\sin 50^\circ)\times 10 - (200\cos 50^\circ)\times 5}{(600\cos 50^\circ)}$$

$$\Rightarrow x = 6.28\ \text{m}$$