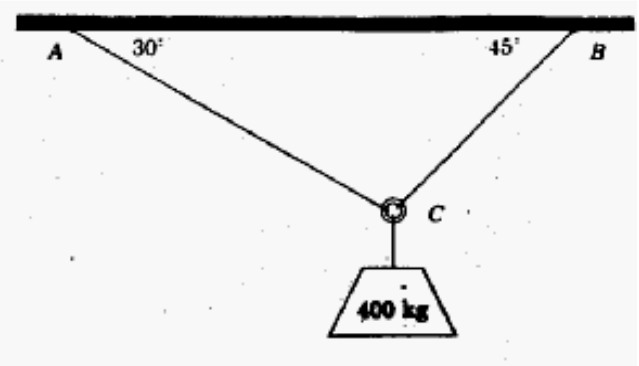
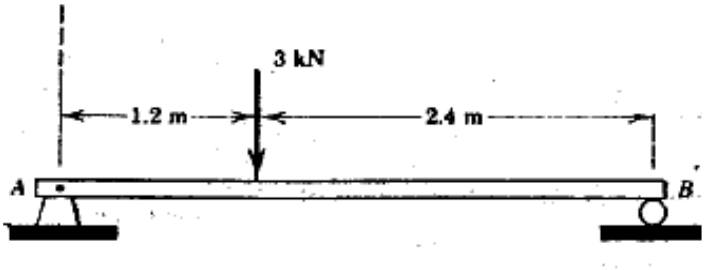
# New Problem Sheet No. 1
## Equilibrium

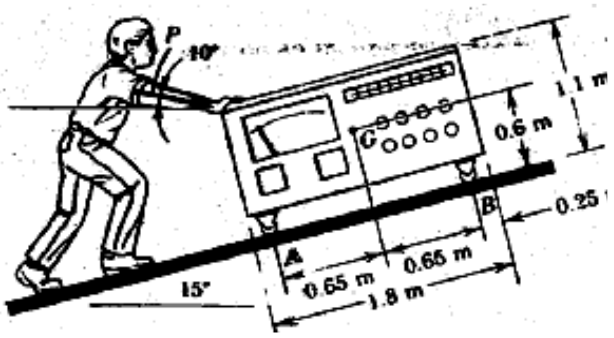
1. Determine the tension in cables CA and CB.
   Ans. $T_{CA}$ = 2870 N, $T_{CB}$ = 3520 N.



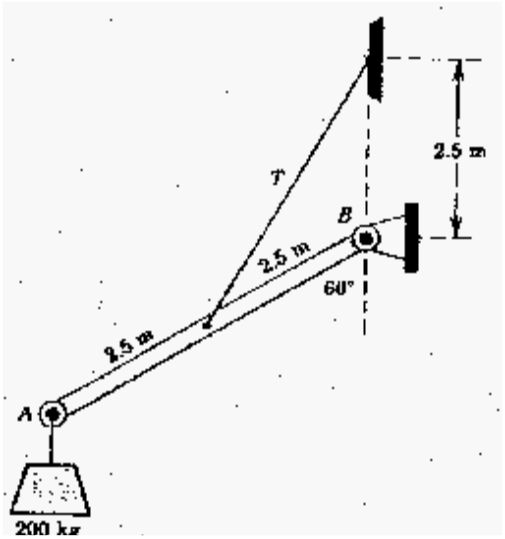

2. The uniform bar has a mass per unit length of 60 kg/m. Determine the reactions at the supports.
   Ans. $A_y$ = 3060 N, $B_y$ = 2060 N.



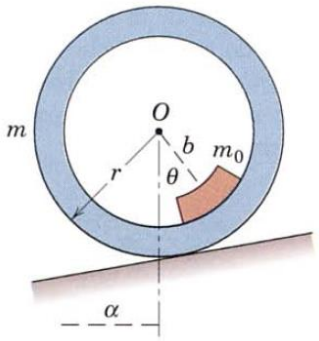

3. A man pushes the 40 kg machine with mass centre at G up an incline at a steady speed. Determine the required force magnitude P and the normal reaction forces at A and B. Neglect the small effects of friction.
   Ans. P = 112.1 N, $N_B$ = 219 N, $N_A$ = 207 N.




4. The uniform bar AB has a mass of 50 kg and supports the 200-kg load at A. Calculate the tension in the supporting cable and the magnitude $F_B$ of the force supported by the pin at B.
   Ans. T = 7650 N, $F_B$ = 5660 N



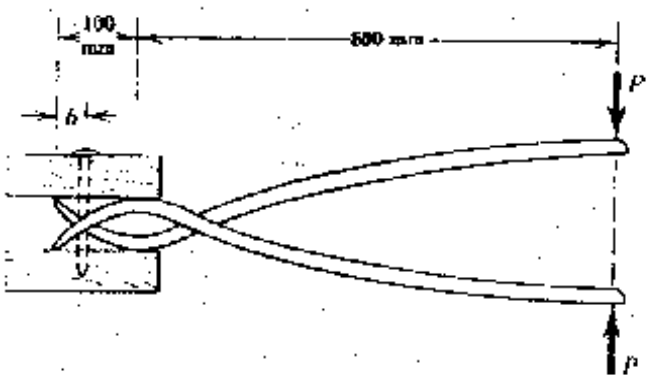
5. A uniform ring of mass m and radius r carries an eccentric mass $m_0$ at a radius b and is in an equilibrium position on the incline, which makes an angle α with the horizontal. If the contacting surfaces are rough enough to prevent slipping, write the expression for the angle θ which defines the equilibrium position.




$$Ans.\theta = \sin^{-1}\left[\frac{r}{b}\left(1+\frac{m}{m_0}\right)\sin\alpha\right]$$

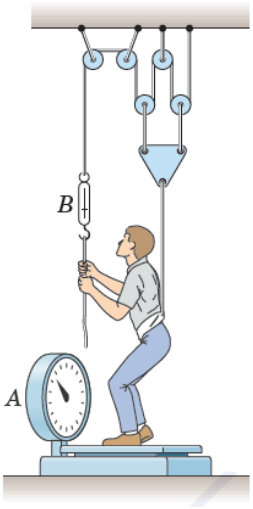
6. The two planks are connected by a large spike. If a force P = 120 N is required on the handle of each crowbar to loosen the spike, calculate the corresponding tension T in the spike. Also find the value of b which will eliminate any tendency to bend the spike. State any assumptions which you make.

Ans. T = 1560 N, b = 53.8 mm



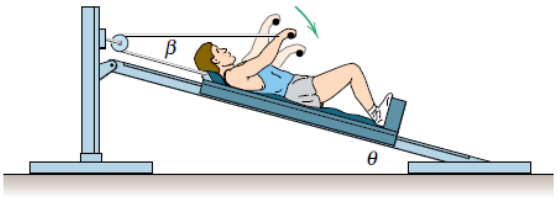

7. A former student of mechanics wishes to weigh himself but has access only to a scale A with capacity limited to 400 N and a small 80-N spring dynamometer B. With the rig shown he discovers that when he exerts a pull on the rope so that B registers 76 N, the scale A reads 268 N. What are his correct weight and mass m?

Ans. W= 648 N, m= 66.1 kG

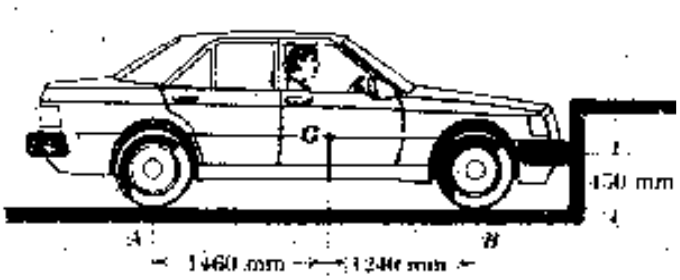



8. The exercise machine consists of a lightweight cart which is mounted on small rollers so that it is free to move along the inclined ramp. Two cables are attached to the cart – one for each hand. If the hands are together so that the cables are parallel and if each cable lies essentially in a vertical plane, determine the force P which each hand must exert on its cable in order to maintain an equilibrium position. The mass of the person is 70 kg, the ramp angle is $15^0$ and the angle β is $18^0$. In addition, calculate the force R which the ramp exerts on the cart.

Ans. P = 45.5 N, R = 691 N

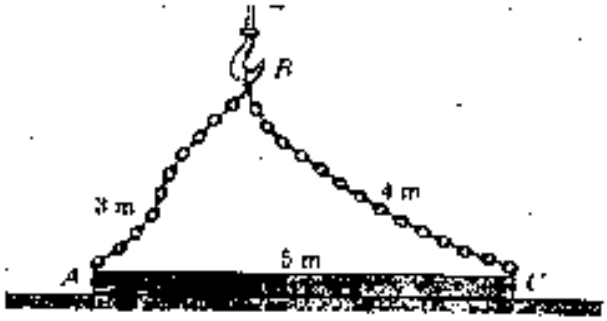


9. The rear-wheel-drive car has a mass of 1400 kg with mass center at G. First calculate the normal forces under the front and rear wheel pairs when the car is at normal test. Then repeat your calculations for the case shown where the front bumper is tested by causing the car to push, via its rear wheels, against the fixed barrier with a 2500-N force. Neglect friction at the bumper-barrier interface, but not at the tire-ground interface.



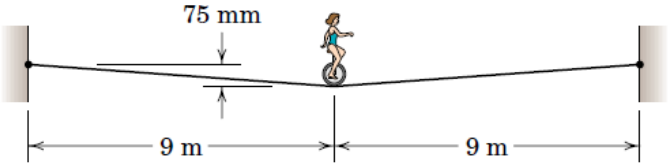

Ans. Normally, $N_A = 6310$ N, $N_B = 7430$ N
Under test, $N_A = 6720$ N, $N_B = 7010$ N

10. The 5-m uniform steel beam has a mass of 600 kg and is to be lifted from the ring at B with the two chains, AB of length 3 ,m, and CB of length 4 m. Determine the tension in chain AB when the beam is clear of the platform.



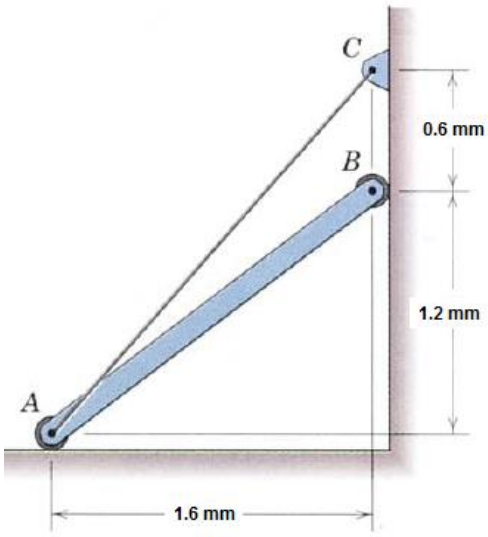

Ans. T = 3.53 kN

11. A 50-kg acrobat pedals her unicycle across the taut but slightly elastic cable. If the deflection at the center of the 18-m span is 75 mm, determine the tension in the cable. Neglect the effects of the weights of the cable and unicycle.




Ans. T = 29.4 kN

12. The uniform 30-kg bar with end rollers is supported by the horizontal and vertical surfaces and by the wire AC. Calculate the tension T in the wire and the reactions against the rollers at A and at B.




Ans. 73.6 N, B = 196.2 N, T = 295 N