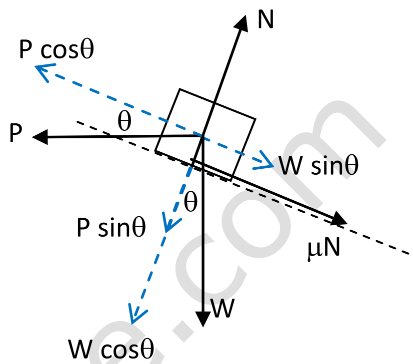
Q- A block of mass 40 kg is place on an incline surface making angle 30^0 with horizontal. If the coefficient of friction between the block and the surface is 0.2, find the minimum horizontal force P required to push the block up the incline.

The forces acting on the block are

(1) Its weight W = mg vertically down
(2) The normal force of the surface N
(3) The friction force F which is along the inclined surface. As with the minimum force P the body will just at the verge of moving up the incline, the friction will be down the incline and its magnitude will be μN.
(4) The force applied P.



The free body diagram for the body is shown.

Resolving the weight W and the force applied P along the incline and normal to incline the components are shown in the free body diagram and in place of these two forces we will now consider their components.

As the body is in equilibrium, the forces along and normal to the incline are balanced separately.

Considering forces along the incline we get the relation

$$Wsin\theta + \mu N - Pcos\theta = 0 \qquad \text{--------------------- (1)}$$

And for the forces normal to the incline we get

$$N - Wcos\theta - psin\theta = 0$$

Or $$N = psin\theta + Wcos\theta$$

Substituting this value of N in equation (1) we get

$$Wsin\theta + \mu(psin\theta + Wcos\theta) - Pcos\theta = 0$$

Or $$Wsin\theta + \mu * psin\theta + \mu * Wcos\theta - Pcos\theta = 0$$

Or $$P(cos\theta - \mu sin\theta) = W(sin\theta + \mu cos\theta)$$

Or $$P = \frac{W(sin\theta+\mu cos\theta)}{(cos\theta-\mu sin\theta)}$$

Substituting the values given in the question

$$P = \frac{40*9.8*(sin30^0+0.2\,cos30^0)}{(cos30^0-0.2\,sin30^0)} = \frac{80(0.500+0.173)}{(0.866-0.1)} = 344.5\ N$$