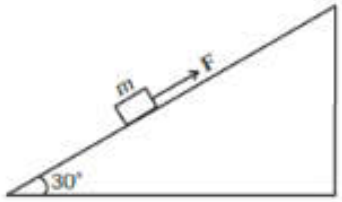
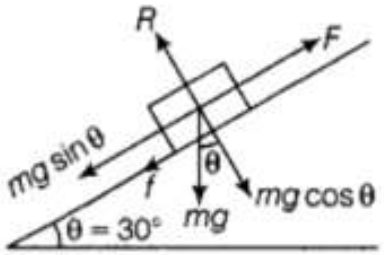
4. A wooden block of mass 1 kg is pushed up a surface inclined to horizontal at an angle of 30° by a force of 10 N parallel to the inclined surface [see figure]. The coefficient of friction between the block and the incline is 0.1. If the block is pushed up by 10 m along the incline. Calculate



i. Work done against gravity.
ii. Work done against the force of frictio
iii. Increase in potential energy
iv. Increase in kinetic energy
v. Work done by the applied force.

Sol.



Mass of the block m = 1 kg
Angle of inclination = 30°
Coefficient of friction = 0.1
Displacement = 10 m

i. Work done against gravity, W_g = mg sin $\theta \times$ d = 1 $\times$ 10 $\times$ sin $30^\circ \times$ 10 = 50J
ii. Work done against friction W_f = $\mu \times$ normal reaction $\times$ displacement
= $\mu \times$ mg cos $\theta \times$ d = 0.1 $\times$ 1 $\times$ 10 $\times$ cos $30^\circ \times$ 10
= 8.7 J
iii. Vertical raise in height h, sin $30^\circ = \frac{h}{10} \Rightarrow$ h = 5 m
$\therefore$ change in P.E.= mgh = 1 $\times$ 10 $\times$ 5 J = 50 J
iv. Applying work energy theorem,
W_{ext} = change in total energy
$\Rightarrow W_{ext}$ = change in potential energy + change in kinetic energy ...(i)
W_{ext} = work done by frictional force = 8.7 J from part (ii)
change in potential energy = 50 J from part (iii)
Putting these in equation (i),
we get.
8.7 = 50 + Δ K.E
$\Rightarrow \Delta$ K.E = 8.7-50 = -41.3 J
There is a decrease in the kinetic energy by 41.3 J
v. Applied force = 10 N
Displacement d = 10
Work done W by the force F is given as
Force F $\times$ Displacement d
= 10 $\times$ 10 Joules
= 100 Joules