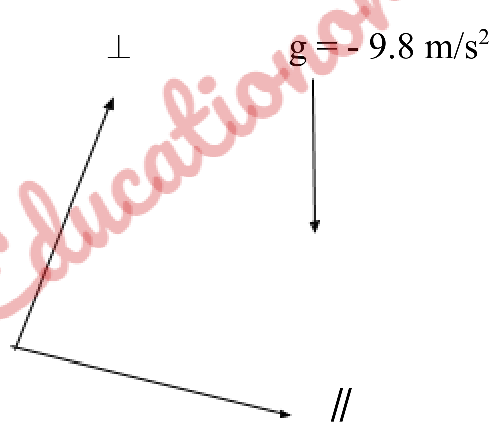
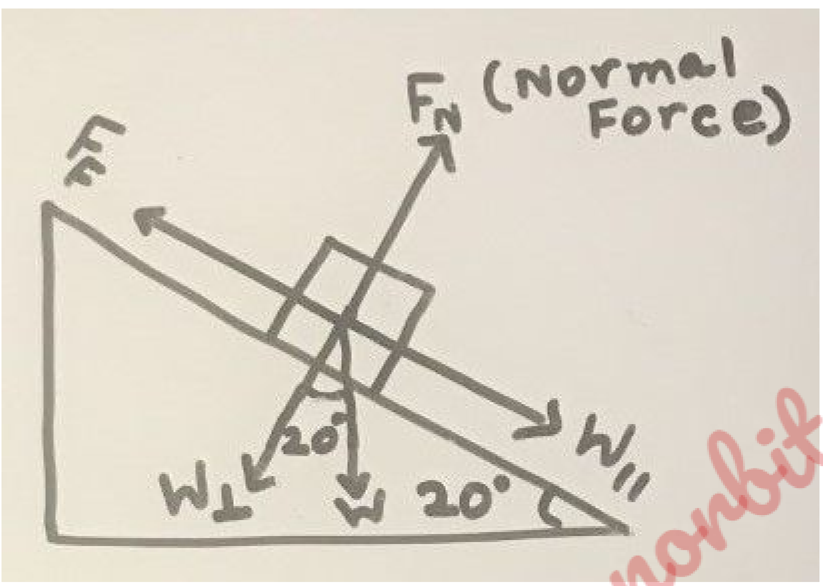
A box slides down a surface at 20° inclination to the horizontal. If the co-efficient of kinetic friction between the box and the surface is 0.25, calculate the acceleration on the box.





Given:

Angle of inclination of the surface: $\theta = 20^o$

Co-efficient of kinetic energy : $\mu_k = 0.25$

Determine: acceleration of box: "a"

Forces acting on the box:

Normal force acting on the box perpendicular to the surface: F_N

Gravitational force or Weight of the box acting vertically downwards: $W = mg$

Y component of $W = mg$ provides the force $W_\perp = mg \times (\cos\theta)$ that balances out the normal force F_N.

Resultant force normal to the surface :

$$F_\perp = F_N - W_\perp = 0$$
$$F_N - mg \times (\cos\theta) = 0$$
$$F_N = mg \times (\cos\theta) \text{ ---------------------(1)}$$

|| component of W= mg provides the force $W_{||} = mg \times (\sin\theta)$ that aids the box to slide down the ramp.

Frictional force acting parallel to the surface opposite to the direction of motion of the box: F_F

Resultant force acting on the box downwards along the ramp:

$$F_{||} = ma = W_{||} - F_F$$
$$F_{||} = ma = [mg \times (\sin\theta)] - F_F \text{ ----------------(2)}$$

But

$F_F = \mu_k F_N$

Then (2) becomes:

$$ma = [\, mg \times (\sin \theta)] - \mu_k F_N \text{ ------------------(2)}$$

Replacing F_N in (2) from (1):

$$ma = [\, mg \times (\sin \theta)] - [\, \mu_k \times mg| \times (\cos \theta) \,]$$

Dividing by “m” on both sides, the above equation becomes:

$$a = [\, g \times (\sin \theta)] - [\, \mu_k \times g \times (\cos \theta) \,]$$

Substituting for g, θ, and μ_k:

$$\mathbf{a = [\,|\,-9.8\,|\, \times (\sin 20^{0})] - [\, 0.25 \times |\,-9.8\,|\, \times (\cos 20^{0}) \,] = 1.05\ m/s^2}$$

N is Newtons, the unit of force.
1 N = 1 kg m / s^2.