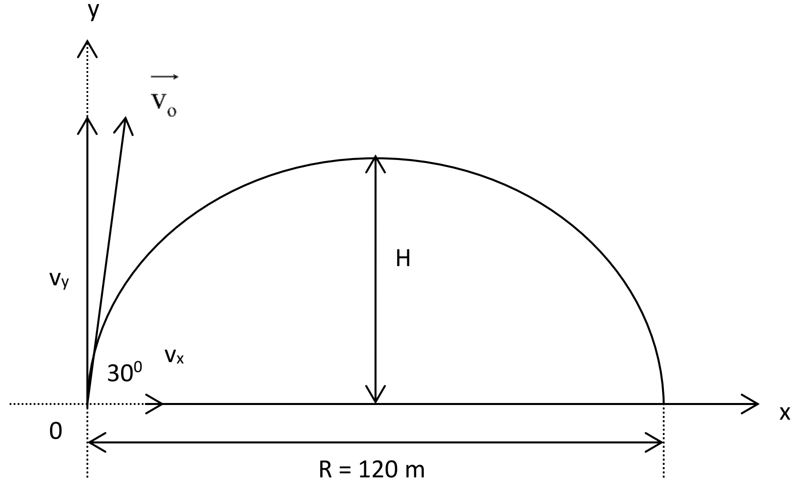
Solution:



a)

$$R = v_x t = (v_o \cos\theta)t$$

$$120 = (v_o \cos 30^0)t$$

$$t = \frac{120}{v_o \cos 30^0}$$

$$y = (v_o \sin\theta)t - \tfrac{1}{2}gt^2$$

$$0 = (v_o \sin 30^0)t - (\tfrac{1}{2})(9.8)(t)^2$$

$$0 = (v_o \sin 30^0)\left(\frac{120}{v_o \cos 30^0}\right) - (4.9)\left(\frac{120}{v_o \cos 30^0}\right)^2$$

$$\frac{120 \sin 30^0}{\cos 30^0} = \frac{(4.9)(120)^2}{v_o^2 \cos^2 30^0}$$

$$v_o^2 = \frac{(4.9)(120)^2}{\sin 30^0 \cos 30^0} = 1357.93$$

$$= 36.85\, m/s \quad \rightarrow \quad \text{initial velocity of the ball}$$

b)

$$H = \frac{v_o^2 \sin^2\theta}{2g} = \frac{(36.85)^2 \sin^2 30^0}{2 \bullet 9.8} = 17.3$$

$H = 17.3m$ $\rightarrow$ maximum height reached by the ball

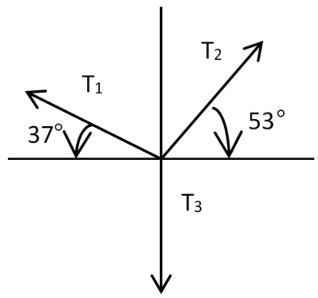
c)

$$t = \frac{2v_o \sin\theta}{g} = \frac{(2)(36.85)(\sin 30^0)}{9.8} = 3.76$$

t = 3.76*s* $\rightarrow$ total time of flight of the ball

$$\sum Fy = 0$$

$$T_1 \sin 37^0 + T_2 \sin 53^0 - T_3 = 0 \quad \rightarrow \text{ eqn (1)}$$



$$\sum Fx = 0$$

$$T_2 \cos 53^0 - T_1 \cos 37^0 = 0$$

$$T_2 \cos 53^0 = T_1 \cos 37^0$$

$$T_2 = \left(\frac{\cos 37^0}{\cos 53^0} \right) T_1$$

$$= 1.33\,T_1 \quad \rightarrow \text{ eqn (2)}$$

Substitute equation 1 to equation 2

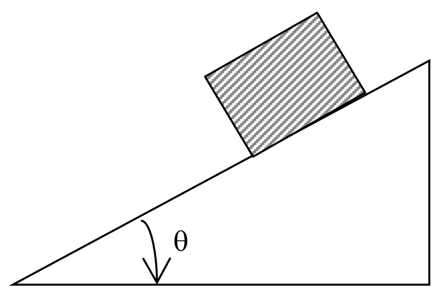
$$T_1 \sin 37^0 + (1.33T_1) \sin 53^0 - 100N = 0$$

$$T_1 = 60N$$

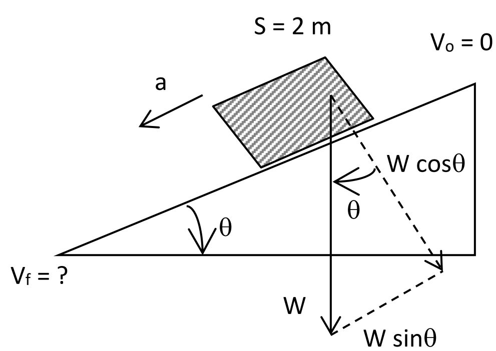
$$T_2 = 1.33T_1 = 79.8N$$

8. A block slides down a smooth plane having an inclination of θ = 15°, as shown in the figure. If the block starts from rest at the top and the length of the incline is 2 m, find

a) the acceleration of the block, and
b) its speed when it reaches the bottom of the inclined plane



Solution:



a) What are the coefficients of static and kinetic friction?

b) If the force is not applied horizontally but in a direction 30^0 above the horizontal, find the coefficients of static and kinetic friction.

Solution:

a) $f_s \le \mu_s N, \quad f_s = F_1 = 25N$

$$F_1 = \mu_s N \quad \Rightarrow \quad \mu_s = \frac{F_1}{N}$$

$$N - W = 0 \quad \Rightarrow \quad N = W$$

$$\mu_s = \frac{F_1}{W} = \frac{25N}{100N} = 0.25$$

$$f_k = \mu_k N, \quad f_s = F_2 = 20N \quad \Rightarrow \quad F_2 = \mu_k N \quad \Rightarrow \quad \mu_k = \frac{F_2}{N}$$

$$\mu_k = \frac{F_2}{W} = \frac{20N}{100N} = 0.20$$

b) x – axis: $F\cos 30^0 - f = 0$

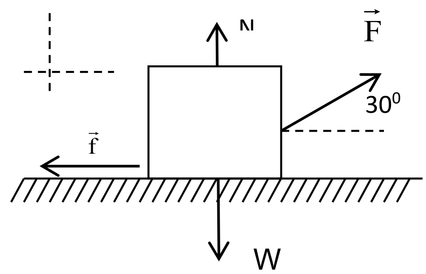
$F\cos 30^0 = f = \mu N$

y-axis: $F\sin 30^0 + N - W = 0$

$N = W - F\sin 30^0$

$\Rightarrow F\cos 30^0 = \mu N = \mu\,(W - F\sin 30^0)$

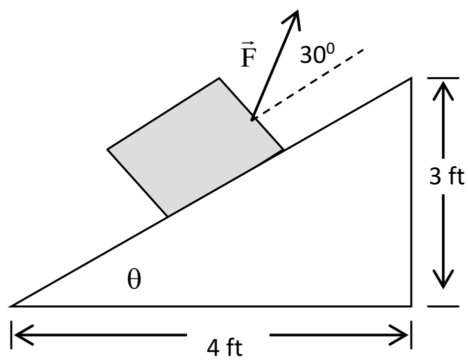
$$\Rightarrow \quad \mu = \frac{F\cos 30^0}{W - F\sin 30^0}$$



$$\mu_s = \frac{F_2\cos 30^0}{W - F_1\sin 30^0} = \frac{25N\cos 30}{100N - 25N\sin 30^0} = 0.247$$

$$\mu_k = \frac{F\cos 30^0}{W - F_2\sin 30^0} = \frac{20N\cos 30^0}{100N - 20N\sin 30^0} = 0.19$$

2. A 50 N body on an inclined plane, 4 ft wide at the base and 3 ft high, is pulled upward by a force 30° above the plane as shown, making the body move upward uniformly. Determine the magnitude of the applied force if the coefficient of kinetic friction between the surfaces in contact is 0.25.



Solution:

$$\theta = \arctan\frac{3}{4} = 37^0$$

The forces acting on the block are as shown:

$$\sum Fx = 0$$

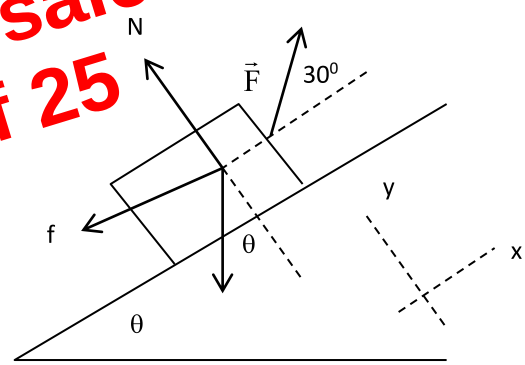
x-axis: $F\cos 30^0 - f - W\sin 37^0 = 0$

$f = \mu_k N$

$F\cos 30^0 - \mu_k N - W\sin 37^0 = 0$

y-axis: $F\sin 30^0 + N - W\cos 37^0 = 0$

$N = W\cos 37^0 - F\sin 30^0$



$$F\cos 30^0 - \mu_k W\cos 37^0 - F\sin 30^0 - W\sin 37^0 = 0$$

$$F\cos 30^0 + \mu_k F\sin 30^0 = W\sin 37^0 + \mu_k W\cos 37^0$$

$$F = \frac{W\left(\sin 37^0 + \mu_k \cos 37^0\right)}{\cos 30^0 + \mu_k \sin 30^0}$$

$$= \frac{50Ns\left[\sin 37^0 + (0.25)\left(\cos 37^0\right)\right]}{\cos 30^0 + 0.25\sin 30^0}$$

$$= 40.4N$$