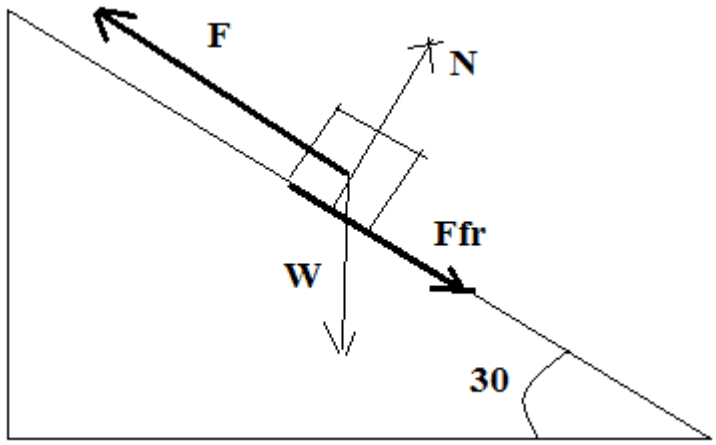
Answer on Question #73034-Physics-Classical Mechanics

A crate of mass 30.0 kg is pulled by a force of 180 N up an inclined plane which makes an angle of 30º with the horizon. The coefficient of kinetic friction between the plane and the crate is mk = 0.225. If the crates starts from rest, calculate its speed after it has been pulled 15.0 m. Draw the free body diagram.

Solution

The free body diagram:



The sum of forces parallel to the incline:

$$ma = F - W\sin 30 - F_{fr}.$$

The sum of forces perpendicular to the incline:

$$0 = N - W\cos 30.$$

$$F_{fr} = \mu_k N = \mu_k W\cos 30$$

Thus,

$$ma = F - W\sin 30 - \mu_k W\cos 30.$$

$$ma = F - mg\sin 30 - \mu_k mg\cos 30.$$

$$a = \frac{F}{m} - g\sin 30 - \mu_k g\cos 30 = \left(\frac{180}{30} - 9.8\sin 30 - (0.225)9.8\cos 30\right) = -0.809.$$

We use kinematic equation:

$$v^2 - 0^2 = 2ad.$$

$$v = \sqrt{2ad}$$

$$v = \sqrt{2d\left(\frac{F}{m} - g\sin 30 - \mu_k g\cos 30\right)}$$

$$v = \sqrt{2(15)\left(\frac{180}{30} - 9.8\sin 30 - (0.225)9.8\cos 30\right)} = 4.93\frac{m}{s}.$$

Answer: $4.93\frac{m}{s}$.