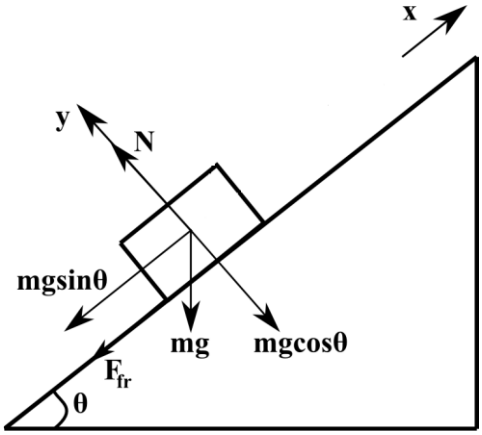
Answer on Question #52867-Physics-Mechanics-Kinematics-Dynamics

1) A $1kg$ box starts up a 2 degrees incline with a speed of 5 m/s. How far will the box slide up the incline if the coefficient of kinetic friction between the box and incline is 0.4?

Solution



Let us first find the acceleration of the box. Let's write all forces that acts on the box:

$$m\vec{g} + \vec{N} + \overrightarrow{F_{fr}} = m\vec{a}$$

Then projected the forces on axis x and y:

$$-mgsin\theta - F_{fr} = ma, N - mgcos\theta = 0.$$

By the definition, the friction force is $F_{fr} = \mu_k N = \mu_k mgcos\theta$, and we can find the acceleration of the box from the first equation:

$$-mgsin\theta - \mu_k mgcos\theta = ma,$$

$$a = -g(sin\theta + \mu_k cos\theta).$$

Obviously, the box will slide up the incline before the velocity of the box becomes zero and it will stop. Then, we can find the distance s that the box slides up the incline before it stop from the kinematic equation:

$$v^2 = v_0^2 + 2as.$$

Because $v = 0$ we get:

$$s = -\frac{v_0^2}{2a} = \frac{v_0^2}{2g(sin\theta + \mu_k cos\theta)} = \frac{\left(5\frac{\mathrm{m}}{\mathrm{s}}\right)^2}{2 \cdot 9.8\frac{m}{s^2} \cdot (sin2° + 0.4 \cdot cos2°)} = 2.93\ m.$$

Answer: 2.93 m.

2) A disc starting from rest rotates about its central axis with constant angular acceleration. In $3s$, it rotates $27rad$. During that time, determine

a) the angular acceleration

b) the instantaneous angular velocity of the disk at the end of the $3s$.

Solution

a) By the definition, $\theta = \frac{1}{2}\alpha t^2 + \omega_i t$, where θ is the angular displacement, α is the angular acceleration, t is the time and ω_i is the initial angular velocity. Since, ω_i=0 (disc starting rotates from rest) we get:

$$\theta = \frac{1}{2}\alpha t^2.$$

From this formula we can find the angular acceleration:

$$\alpha = \frac{2\theta}{t^2} = \frac{2 \cdot 27\ rad}{(3s)^2} = 6\frac{rad}{s^2}.$$

b) In order to find the instantaneous angular velocity we use the formula:

$$\omega = \alpha t = 6\frac{rad}{s^2} \cdot 3s = 18\frac{rad}{s}.$$

Answer: $6\frac{rad}{s^2}$; $18\frac{rad}{s}$.