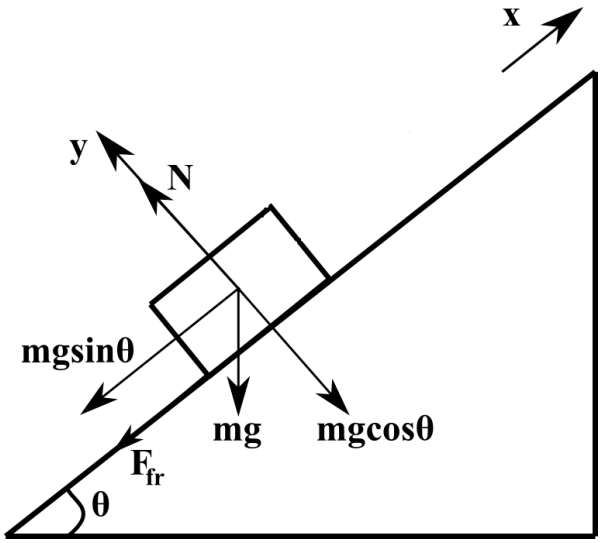
Answer on Question 52812, Physics, Other

Question:

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:

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

Answer:

$s = 2.93m.$

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, $\omega_i = 0$ (disc starting rotates from rest) we get:

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

From this formula we can find the angular acceleration:

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

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

$$\omega = \frac{d\theta}{dt} = \frac{d}{dt}\left(\frac{1}{2}\alpha t^2\right) = \alpha t.$$

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

Answer:

a) $\alpha = 6\frac{rad}{s^2}$.

b) $\omega(3) = 18\frac{rad}{s}$.