Physics Worksheet

Newton’s Law of Motion (2)

Solutions

1. How long would it take a block (staring from rest) to slide down a 2.40 m long incline ($\theta = 20^\circ$) if the kinetic coefficient between the surfaces of the block and incline equals to 0.32?

   \[ F_u = F_g \sin \theta = mg \sin \theta \]
   \[ F_l = F_g \cos \theta = mg \cos \theta \]
   \[ F_f = \mu_k \cdot F_N = \mu_k \cdot F_l = 0.32 mg \cos \theta \]

   \[ \Sigma F_{net} = ma \]

   \[ F_u - F_f = ma \]

   \[ mg \sin \theta - 0.32 mg \cos \theta = ma \]

   \[ a = g (\sin \theta - 0.32 \cos \theta) = 0.40 \text{ m/s}^2 \]

   Step 2. \[ V_i = 0, \quad d = V_i t + \frac{1}{2} a t^2 \]

   \[ t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(2.40)}{0.40}} = 3.50 \text{ s} \]
2. Given: \( m = 1500 \text{ kg}, \theta = 12^\circ, \mu_k = 0.12, \)

Find the applied force \( F_a \): i) when the object is moving at a constant velocity.

ii) When the object is accelerating at \( 1.5 \text{ m/s}^2 \)

\[
\text{Step 1.}
\]

\[
F_h = mg \sin \theta = (1500)(9.8) \sin 12^\circ = 3056.3 \text{ (N)}
\]

\[
F_f = mg \cos \theta = (1500)(9.8) \cos 12^\circ = 14378.8 \text{ (N)}
\]

\[
F_f = \mu_k F_N = \mu_k F_h = (0.12)(14378.8) = 1725.5 \text{ (N)}
\]

(i) when the object is moving at a constant velocity

\[
\therefore F_a - F_h - F_f = 0
\]

\[
\therefore F_a = F_h + F_f = 3056.3 + 1725.5 = 4781.8 \text{ (N)}
\]

(ii) when the object is accelerating at \( 1.5 \text{ m/s}^2 \)

\[
\Sigma F_{net} = ma \quad \therefore F_a - F_h - F_f = 0
\]

\[
\therefore F_a - F_h - F_f = ma
\]

\[
\therefore F_a = F_h + F_f + ma = 3056.3 + 1725.5 + 1500 \times (1.5)
\]

\[
\therefore F_a = 7031.8 \text{ N}
\]

\[
\therefore \text{ i) } F_a = 4782 \text{ (N)} \quad \text{ ii) } F_a = 7032 \text{ (N)}
\]