Friction Practice Problems  SOLUTIONS

Calculating normal force and weight:

1. A 30 kg brick is laying on a table, not moving. What is the normal force.

\[ F_n = mg \]
\[ F_n = 30\text{kg} \cdot 9.8\text{m/s}^2 \]
\[ F_n = 294\text{N} \]

2. What is the weight of a 36 kg person on earth?

\[ W = mg \]
\[ W = 36\text{kg} \cdot 9.8\text{m/s}^2 \]
\[ W = 352.8\text{N} \]

3. What is the weight of a 12 kg dog on the moon? (acceleration of gravity is \(1.63 \text{ m/s}^2\))

\[ W = mg \]
\[ W = 12\text{kg} \cdot 1.63\text{m/s}^2 \]
\[ W = 19.6\text{N} \]

Friction Problems

For the following problems, calculate the force of friction acting on the object.

1. A 10 kg rubber block sliding on a concrete floor (\(\mu = 0.65\))

\[ f_k = \mu_k F_n \]
\[ f_k = 0.65 \cdot \left( 10\text{kg} \cdot 9.8 \text{m/s}^2 \right) \]
\[ f_k = 637\text{N} \]

2. A 8 kg wooden box sliding on a leather covered desk. (\(\mu = 0.40\))

\[ f_k = \mu_k F_n \]
\[ f_k = 0.40 \cdot \left( 8\text{kg} \cdot 9.8 \text{m/s}^2 \right) \]
\[ f_k = 31.4\text{N} \]

3. A 37 kg wooden crate sliding across a wood floor. (\(\mu = 0.20\))

\[ f_k = \mu_k F_n \]
\[ f_k = 0.20 \cdot \left( 37\text{kg} \cdot 9.8 \text{m/s}^2 \right) \]
\[ f_k = 72.5\text{N} \]

4. The coefficient of static friction between the surface and a wooden box is \(\mu = 0.55\). What is the minimum force to start the block moving?
Combining Kinetics, Newton’s Laws & Friction

1. A 248 kg object moving at 19 m/s comes to stop over a distance of 38 m. What is the coefficient of kinetic friction between the surfaces?

Solve for \( a \) using K3: \( \frac{v^2}{2} = v_0^2 + 2ad \)

\[
19^2 = 0^2 + 2a \times 38
\]

\[
a_x = -4.75 \, \text{m/s}^2
\]

\[
F_{\text{net}} = -f_k = ma_x, \text{ and}
\]

\(-f_k = \mu_k F_n = \mu_k mg, \text{ so we can say}
\]

\(-ma_x = \mu_k \cdot mg
\]

\[
\mu_k = \frac{ma_x}{mg} = \frac{-a_x}{g}
\]

\[
\mu_k = \frac{-(-4.75) \, \text{m/s}^2}{9.8 \, \text{m/s}^2} = 0.48
\]

2. A hockey puck is hit on a frozen lake and starts moving with a velocity of 13.0 m/s. It travels across the ice and 6.0s later, the velocity is 7 m/s. What is the coefficient of friction between the puck and the ice?

Solve for \( a \) using K1: \( v = v_0 + at \)

\[
7 \, \text{m/s} = 13 \, \text{m/s} + a \cdot 6.0s
\]

\[
a = -1.0 \, \text{m/s}^2
\]

Because the net force acting on the ice is from kinetic friction, we can use the same solution from problem 1, so

\[
\mu_k = \frac{ma_x}{mg} = \frac{-a_x}{g}
\]

\[
\mu_k = \frac{-a_x}{g} = 0.10
\]
3. A force of 36.0N accelerates a 6.0kg block at 7.0m/s² along a horizontal surface. How large is the friction force? What is the coefficient of kinetic friction?

\[ F_{\text{net}} = 36\text{N} - f_k \quad F_{\text{net}} = ma \]

\[ 36\text{N} - f_k = ma \]

\[ 36\text{N} - f_k = 6.0\text{kg} \cdot 7.0\text{ m/s}^2 \]

\[ 36\text{N} - f_k = 42\text{N} \]

\[-f_k = 6\text{N}\]

\[ f_k = \mu_k F_n \]

\[ \mu_k = \frac{6\text{N}}{58.8\text{N}} = 0.10 \]