Unit 5: Forces

Force of Friction

Friction is created whenever two surfaces move past one another. On the microscopic level, irregularities in the two surfaces catch on each other.

Friction is given by the equation:

\[ F_f = \mu F_N \]

Where:

- \( F_N \) = Normal force
- \( \mu \) = always perpendicular to surface
- \( \mu \) = coefficient of friction, nonunits
- \( \mu \) = greek letter “mu”
- \( \mu \) = depends on both surfaces

### Static Friction
- friction on a stationary object

### Kinetic Friction
- friction on a moving object

\( \mu_{\text{static}} > \mu_{\text{kinetic}} \)

**Ex 1:** A 3.75 kg block is pushed along a tabletop with a force of 45.0 N. The coefficient of friction is 0.65.

a) Find the force of friction.

b) Find the acceleration.

\[ F_f = \mu F_N = \mu F_g = \mu mg \]
\[ \mu = \frac{0.65}{3.75} = 0.173 \]
\[ F_N = F_g = mg = (3.75 \text{ kg})(9.8 \text{ m/s}^2) = 36.7 \text{ N} \]
\[ F_f = \mu F_N = \mu mg = 0.173 \times 36.7 \text{ N} = 6.3 \text{ N} \]
\[ a = \frac{F_{\text{net}}}{m} = \frac{45 - 36.7}{3.75} = 2.2 \text{ m/s}^2 \]

**Ex 2:** A 0.200 kg puck is pushed along a sheet of ice with a force of 0.240 N. If it moves at a constant velocity, find the coefficient of friction.

\[ F_f = \mu F_N = \mu mg \]
\[ F_N = F_g = mg = (0.200 \text{ kg})(9.8 \text{ m/s}^2) = 1.96 \text{ N} \]
\[ F_f = \mu F_N = \mu mg = 0.240 \text{ N} \]
\[ \mu = \frac{F_f}{F_N} = \frac{0.240}{1.96} = 0.122 \]

**Ex 3:** A 1.1 kg textbook is held against a vertical wall with a force of 45 N. What is the coefficient of friction between the book and the wall?

\[ F_f = \mu F_N \]
\[ F_N = F_g = mg = (1.1 \text{ kg})(9.8 \text{ m/s}^2) = 10.78 \text{ N} \]
\[ F_f = \mu F_N = \mu mg = ? \]
\[ \mu = \frac{F_f}{F_N} = \frac{10.78}{45} = 0.24 \]