

## Static and Kinetic Friction

Friction is the force that opposes the motion of one surface sliding over another. This force is dependent on the types of surfaces and the strength of the contact force between the surfaces.

**Normal Force-** The normal force is the contact force between two objects. It is called normal because it is always perpendicular to the surface. This is not a new force. If a box is sitting on the ground, the normal force would be the force of the ground on the box. This is the contact force that is used to determine friction forces.

**Static Friction-** When the surfaces do not move with respect to each other, there is static friction. Static friction can go up to a value. If the pull exceeds that value, the objects will slide and there will not be static friction.

$$F_{Static} \leq \mu_s N$$

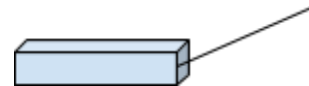
**Kinetic Friction-** When one surface slides over the other, there is kinetic friction. Kinetic friction has a single value.

$$F_{Kinetic} = \mu_k N$$

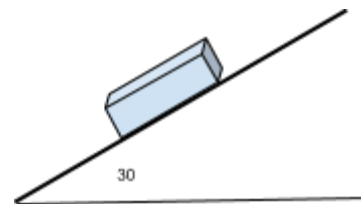
Draw the free body diagram for each situation below. Find the value for the normal force, the maximum static friction and the kinetic friction.

1. A 5.0 kg block is pulled with a horizontal pull along a level table with  $\mu_s = 0.7$  and  $\mu_k = 0.3$ .

2. A 5.0 kg block is pulled along a level table with  $\mu_s = 0.7$  and  $\mu_k = 0.3$ . The pull has a vertical component of 10 N.



3. A 5.0 kg block is sitting on a ramp with an incline of 30 degrees and  $\mu_s = 0.7$  and  $\mu_k = 0.4$ .



4. A 60 kg runner is wearing shoes with  $\mu_s = 0.35$  and  $\mu_k = 0.25$  for running on the road.