7.2 Frictional Forces

ANNOUNCEMENTS

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November 27, 2018

LEARNING TARGETS

I can define, analyze, and solve dynamic problems involving friction forces.

Friction Example

You need to move a 105-kg sofa to a different location in the room. When you first push on the sofa, it does not move because of friction.

1. What characteristics about the sofa affect the amount of friction?
   - Shape of legs
   - Surface Area
   - Mass
   - Floor Material
   - Leg Material
   - Shape of couch
   - Weight

2. When you push with 102 N of force the sofa begins to move. Draw a free-body diagram for the sofa right before it moves.

Friction Example

[Diagram showing forces acting on the sofa]

2 Important Friction Ideas

The friction force always acts in a direction opposite to the motion.

The magnitude of the friction force depends on the magnitude of the normal force between the two surfaces.
7.2 Frictional Forces

2 Types Friction

- **Static Friction** ($f_s$) is the force exerted on one surface by another when there is no motion between the two surfaces.

- **Kinetic Friction** ($f_k$) is the force exerted on one surface by another when the two surfaces rub against each other because one or both of them are moving.

**Coefficient Of Friction**

$$\mu$$

The coefficient of friction, $\mu$, is the ratio of the frictional force to the normal force.

**Friction: General Formula**

$$f = \mu N$$

- **Kinetic Friction Force**
  $$f_k = \mu_k N$$

- **Static Friction Force**
  $$f_s \leq \mu_s N$$

**Typical Coefficients of Friction**

<table>
<thead>
<tr>
<th>Materials</th>
<th>Kinetic, $\mu_k$</th>
<th>Static, $\mu_s$</th>
</tr>
</thead>
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<tr>
<td>Rubber on concrete (dry)</td>
<td>0.65</td>
<td>0.80</td>
</tr>
<tr>
<td>Steel on steel</td>
<td>0.57</td>
<td>0.74</td>
</tr>
<tr>
<td>Glass on glass</td>
<td>0.40</td>
<td>0.94</td>
</tr>
<tr>
<td>Wood on leather</td>
<td>0.40</td>
<td>0.50</td>
</tr>
<tr>
<td>Copper on steel</td>
<td>0.36</td>
<td>0.53</td>
</tr>
<tr>
<td>Rubber on concrete (wet)</td>
<td>0.25</td>
<td>0.30</td>
</tr>
<tr>
<td>Steel on ice</td>
<td>0.06</td>
<td>0.10</td>
</tr>
<tr>
<td>Waxed ski on snow</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>Teflon on Teflon</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Synovial joints in humans</td>
<td>0.003</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Friction Example**

How much force do you have to apply to get a 25.0-kg wood box moving on a wood floor.

$$F_p = \mu N$$

$$F_B = \mu N$$

$$F_{f,B} = mg$$

$$N = mg$$

$$F_p \geq 122\text{ N}$$
Friction Example

Now you push the box across the floor at a constant speed of 1.0 m/s. How much force do you exert on the box now?

\[
F_{\text{FBD}} = \mu_k mg = 49 \text{N}
\]

Stopping Force

3. A Mini and a Hummer have the exact same initial velocity, the exact same braking system, and the exact same kind of tires. Both vehicles slam on the brakes on the same road. Which will stop first?

\[
\frac{H}{m} \leq \frac{S}{3} \leq \frac{9}{3}
\]

PRACTICE

UNIT 7 PROBLEMS (4-6)