Physics A - PHY 2048C

Mass & Weight, Normal Force, and Friction

09/25/2019

My Office Hours:
Thursday 2:00 - 3:00 PM

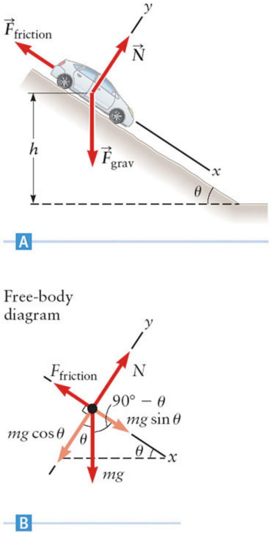
212 Keen Building

Outline

Normal Force and Friction

Choose a coordinate system.

Best choice: axes perpendicular and parallel to the incline.



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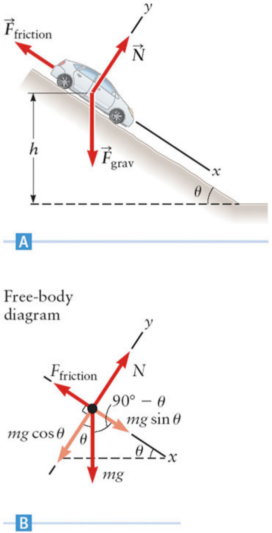
$$\Sigma F_{\parallel} = F_{\text{grav}} \sin\theta - F_{\text{friction}} = 0$$

$$mg \sin\theta - F_{\text{friction}} = 0$$



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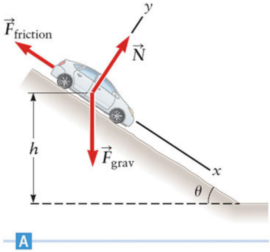
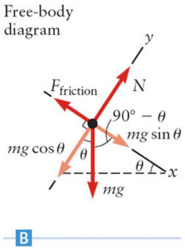
$$\Sigma F_{\perp} = N - F_{\text{grav}} \cos\theta = 0$$

$$N - mg\cos\theta = 0$$

Minimum frictional force to keep the object from slipping is:

$$mg\sin\theta = N\mu_s = mg\cos\theta\,\mu_s$$





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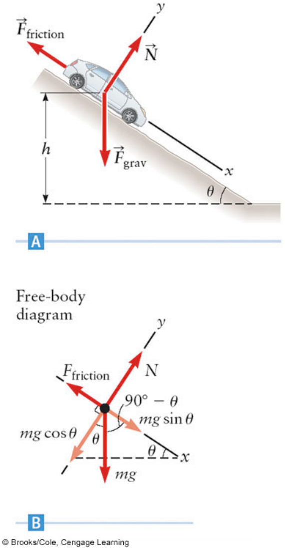
Minimum angle to keep object from slipping is:

$$\tan\theta = \mu_s$$



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Friction

Aristotle's idea was that rest was the natural state of terrestrial objects.

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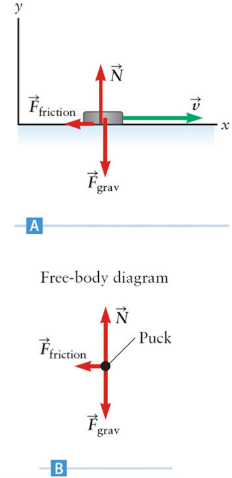
The force of friction opposes the motion. The magnitude of the frictional force is related to the magnitude of the normal force:

$$F_{\text{friction}} = \mu_k N$$

μ_k is called coefficient of kinetic friction. It has no units.



Kinetic Friction

Without an external force:

$$\Sigma F = F_{\text{friction}} = -\mu_k N = m a$$

From the y-direction:

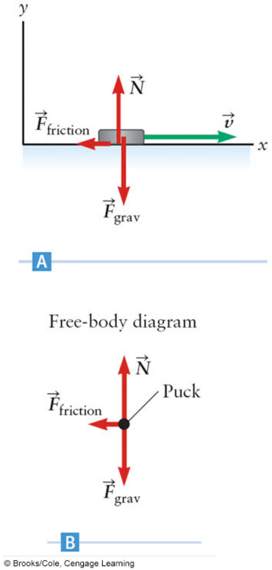
$$F_{\text{grav}} = N = m g$$

Therefore:

$$-\mu_k m g = m a$$

$$-\mu_k g = a$$

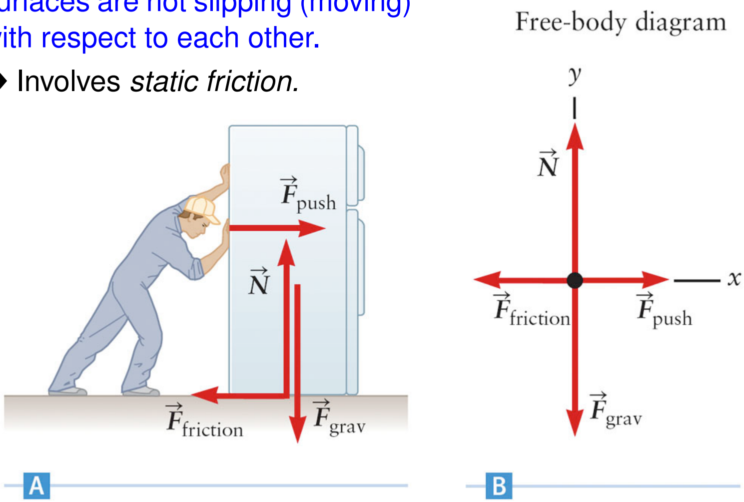
Once you have found the acceleration, other quantities involved with motion can also be found.



Static Friction

In many situations, the relevant surfaces are not slipping (moving) with respect to each other.

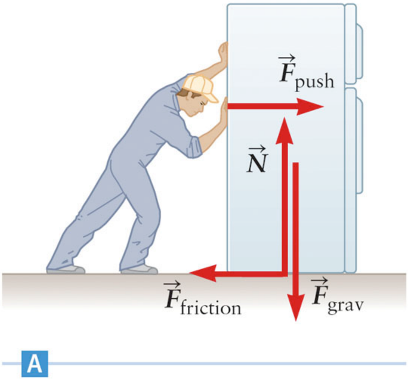
➜ Involves *static friction.*

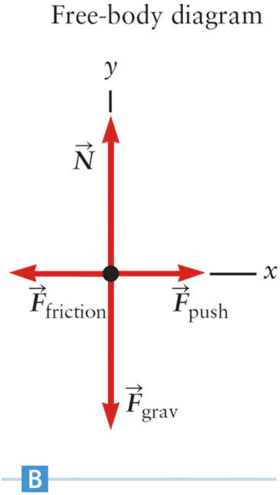


Static Friction

Static indicates that the two surfaces are not moving relative to each other:

$$|F_{\text{friction}}| \leq \mu_s N$$





Friction

For a given combination of surfaces, generally $\mu_s > \mu_k$. With:

- $F_{\text{friction}} = \mu_k N$ (kinetic friction)
- $|F_{\text{friction}}| \leq \mu_s N$ (static friction)

usually static friction > kinetic friction.

It is more difficult to start something moving than it is to keep it moving once started.

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Examples:

- Friction and Walking
- Friction and Rolling