Slide 1

Friction

A true Slow Force

Slide 2

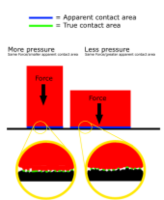
Friction opposing Motion

- Friction is generated by macro and microscopic irregularities in the surfaces of two objects in contact.

Slide 3

Friction

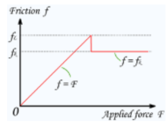
- Dependent on
  - the surfaces in contact
  - Additional applied forces
- Not dependent on:
  - Surface area
  - Mass of the object
- Defined by the coefficient of friction, µ



Slide 4

Frictional Force

- Two basic types of Friction
  - Static
  - Kinetic
- In general it takes more force to get an object to move than to keep it moving.
- This means that the coefficient of static friction, μ_s, is larger than the coefficient of kinetic friction, μ_k, for most surfaces.



Slide 5

Frictional Force

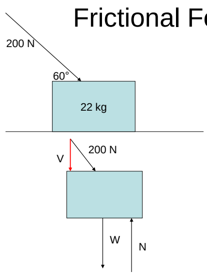
- Equation:

$$F_f = \mu F_N$$

- Normal force is found by finding the net vertical force.

Slide 6

Frictional Force



If the coefficient of static friction is 0.4, what is the frictional force on the box?

$\Sigma F_y=0$

$F_{go}-F_{slow} = 0$

N – (W+V) = 0

N = W + V

N = mg + 200 sin 60

N = 22 (9.8) + 200 (.866)

N = 215.6 + 173.2 = 388.8 N

$F_f = \mu F_N$

F_f = 0.4 (388.8) = 155.52 N

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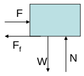
Friction Problem

- A 36 kg box is pushed by an outside force. There is a coefficient of static friction, μs, of 0.3 between the box and the floor and a coefficient of kinetic friction, μk, of 0.25. What is the minimum force required to get the box to begin moving and to keep it moving at a constant speed?



$\Sigma F_y=0$

$F_{go}-F_{slow} = 0$

$N - W = 0$

$N = W$

$N = mg$

$N = 36(9.8) = 352.8$

$\Sigma F_x=0$

$F_{go}-F_{slow} = 0$

$F - F_f = 0$

$F = F_f = \mu N$

$F_s = 0.3 (352.8) = 106$ N

$F_k = 0.25 (352.8) = 88$ N

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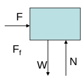
Friction Problem

- A force of 300 N causes a 50 kg box to start to move, but a 250 N force keeps the box moving at a constant speed. What is the coefficients of static and kinetic friction between the box and the floor?



$\Sigma F_y=0$

$F_{go}-F_{slow} = 0$

$N - W = 0$

$N = W$

$N = mg$

$N = 50(9.8) = 490$

$\Sigma F_x=0$

$F_{go}-F_{slow} = 0$

$F - F_f = 0$

$F = F_f = \mu N$

$300 = \mu_s(490)$

$\mu_s = 300/490 = 0.61$

$250 = \mu_s(490)$

$\mu_s = 250/490 = 0.51$

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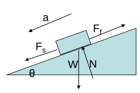
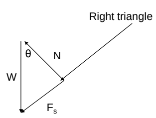
Coefficient of Friction

- Calculated by:





$\Sigma F_{incline} = 0$

$F_{go}-F_{slow} = 0$

$F_s - F_f = 0$

$F_s = F_f$

$mg\sin\theta = \mu\, mg \cos\theta$

$\sin\theta = \mu \cos\theta$

$\mu = \sin\theta/\cos\theta = \tan\theta$

$N = W \cos\theta = mg \cos\theta$

$F_s = W \sin\theta = mg \sin\theta$

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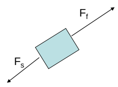
Friction on an Incline

- A 45 kg box is sitting on a 30 degree incline. What is the coefficient of static friction between the box and the incline? If the coefficient of kinetic friction is 80% of the coefficient of static friction, how much mass must be removed from the box in order to begin sliding down the ramp at a constant speed? With what acceleration would the box slide down the ramp?



$\Sigma F_{incline} = 0$

$F_{go} - F_{slow} = 0$

$F_s – F_f = 0$

$F_s = F_f$

$mg\sin\theta = \mu\, mg \cos \theta$

$\sin\theta = \mu \cos\theta$

$\mu = \sin\theta/\cos\theta$

$\mu_s = \tan 30 = 0.58$

$\mu_k = 0.8\ (0.58) = 0.46$

$\Sigma F_{incline} = ma$

$F_{go} - F_{slow} = ma$

$F_s – F_f = ma$

$mg\sin\theta - \mu\, mg \cos \theta = ma$

$g\sin 30 - \mu\, g \cos 30 = a$

$9.8\ (.5) - .46(9.8)(.866) = a$

$4.9 - 3.92 = a$

$0.98\ m/s^2 = a$