

Name: _____

Period: _____

Normal Force and Friction

Normal force (F_N) - The supporting force of a surface on an object. Without a normal force the object would break thru the surface.

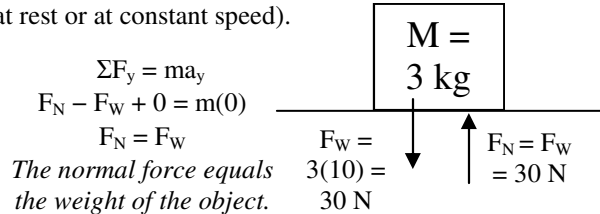
Calculating Normal Force

$$\Sigma F_y = F_N - F_W + F_y = ma_y$$

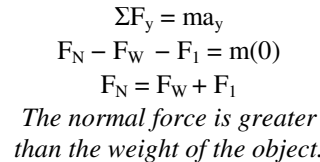
↑
Any additional vertical force (+ or -)

Remember that the x and y directions are independent: an object can be moving left or right and still be not accelerating vertically.

Situation 1 - no additional y forces other than F_W and F_N and $a = 0 \text{ m/s}^2$ (at rest or at constant speed).



Situation 2 - an additional force (+ or -) on the object and $a = 0 \text{ m/s}^2$.



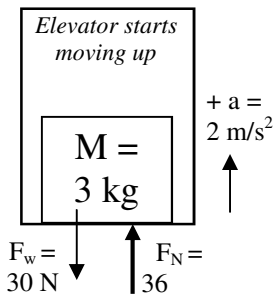
Situation 3 - object is accelerating up or down (like in an elevator).

$$\Sigma F_y = ma_y$$

$$F_N - F_W = m(a)$$

$$F_N = F_W + ma$$

F_N is greater than F_W and you feel heavier than normal.



Situation 4 - An additional force pulls at an angle.

$$\Sigma F_y = ma_y$$

$$F_N - F_W + F_1 \sin \theta = m(0)$$

$$F_N$$

F_{1y}

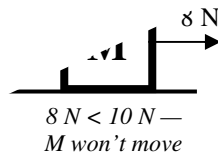
What we perceive as weight is really normal force (pressure on our feet).

Sample

Fri

$F_s = \mu_s F_N$ and F_k

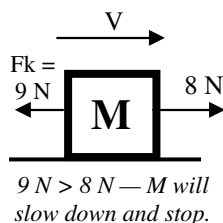
Coefficient of friction (no units)



Static Friction (F_s)

Remember: Friction never causes an object to start sliding!

Kinetic Friction (F_k)—sliding friction; F_k tries to stop an object from sliding. You must use F_k to find acceleration, since an object must be moving to be accelerating.



*If $F > F_k$ it keeps moving.
If $F < F_k$ it will eventually stop.*

Example: Calculate static and kinetic friction for a 4 kg mass where $\mu_s = 0.45$ and $\mu_k = 0.25$.

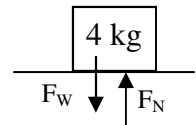
Solution:

1) Calculate Normal Force (F_N) in the y-direction.

$$\Sigma F_y = ma_y \text{ (see top of page)}$$

$$F_N - F_W = m(0)$$

$$F_N = F_W = 4(10) = 40 \text{ N}$$



2) Calculate Friction

$$F_s = \mu_s F_N$$

$$F_s = 0.45(40)$$

$$F_s = 18 \text{ N}$$

It will take 18 N to start M sliding.

$$F_k = \mu_k F_N$$

$$F_k = 0.25(40)$$

$$F_k = 10 \text{ N}$$

It will take 10 N to keep M sliding.

