Dynamics Notes

Friction

More about....Friction!

Friction is created whenever... two objects move, or attempt to move, past one another

On the microscopic level... irregularities in the two surfaces catch on each other

There are 2 types of friction:

Static Friction: F_s, friction on a stationary object

$F_s = \mu_s \cdot F_N$

Kinetic Friction: F_k, friction an object in motion

$F_k = \mu_k \cdot F_N$

where $F_N = mg$ if on a level surface

Note that the irregularities in a static object will tend to "dig in" more and generally:

$$\text{Friction}_{static} > \text{Friction}_{kinetic}$$

$$\mu_s > \mu_k$$

Ex: The driver of a 2.0×10^3 kg car in motion applies the brakes on a dry concrete roadway.

(a) Calculate the force of friction between the tires and the road surface. You will need to obtain the coefficient of friction from a table.

$\Sigma F_x = ma$ but no way to find a

$F_K = \mu_K F_N$

$= \mu mg$

$= (0.8)(2000\text{kg})(9.8\text{m/s}^2)$

$= 15680\text{ N} = \boxed{1.6 \times 10^4\text{ N}}$

(b) Would the amount of friction be the same if the car was not in motion?

$F_S = \mu_S F_N$

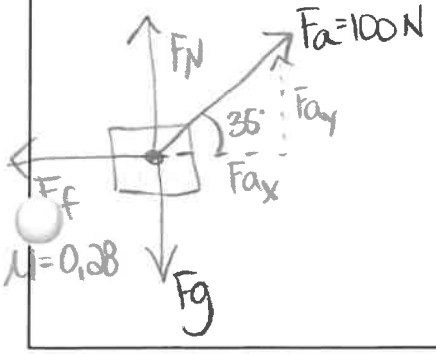
$= (1.0)(2000\text{kg})(9.8\text{m/s}^2)$

$= 19600\text{ N} = \boxed{2.0 \times 10^4\text{ N}}$

$\boxed{F_S > F_K}$

Don't forget that F_N doesn't always equal mg! For example: on an incline, when Fa is at an θ

Ex: An object with mass of 7.0 kg is pulled along a horizontal surface by a rope that makes an angle of 24° with the horizon. If the coefficient of friction is 0.52 and the tension in the rope is 45 N, what is the acceleration of the object?



$\Sigma F_x = ma$

$F_{ax} - F_f = ma$

$a = \frac{F_{ax} - F_f}{m} = \frac{F_a \cos\theta - \mu F_N}{m}$

$= \frac{45\cos 24 - 0.52(50.3)}{7.0\text{ kg}}$

$F_N \neq mg$

$\Sigma F_y = ma = 0$

$F_N + F_{ay} - F_g = 0$

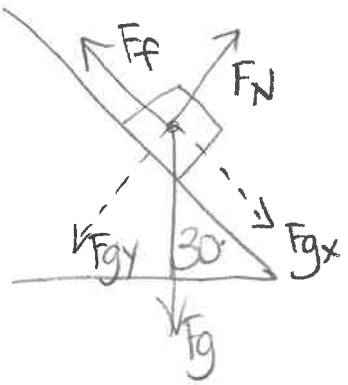
$F_N = F_g - F_{ay}$

$= mg - F_a \sin\theta$

$= 50.3\text{ N}$

$\boxed{\vec{a} = 2.1\text{ m/s}^2\text{ [fwd]}}$

Ex: A 15 kg block has an acceleration of 2.2 m/s^2 down a 30° incline. What is the magnitude of the friction force and what is the coefficient of friction for the surface?



$$\Sigma F_x = ma$$

$$F_{gx} - F_K = ma$$

$$-F_K = ma - F_{gx}$$

$$F_K = F_{gx} - ma$$

$$= mg\sin\theta - ma$$

$$= 15\,kg\left(\frac{9.8\,m}{s^2}\right)\sin 30 - 15\,kg\left(\frac{2.2\,m}{s^2}\right)$$

$$= 40.5\,N = \boxed{41\,N}$$

$$F_K = \mu_K F_N$$

$$\mu_K = \frac{F_K}{F_N} = \frac{41\,N}{mg\cos\theta} = \frac{41\,N}{15 \cdot 9.8 \cos 30} = \boxed{0.32}$$