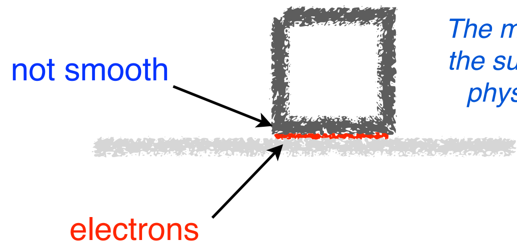
FREEBODY DIAGRAMS

FRICTION

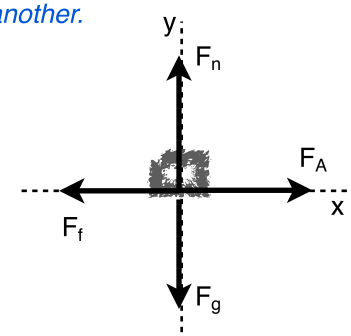
*The relationship between the **normal force** and the **friction force** are a good approximation for the friction between two dry surfaces.*

Friction is both a surface and an electromagnetic phenomenon.



The microscopic 'hills and valleys' on the surfaces cause the objects to get physically caught on one another.

The picoscopic electromagnetic interaction between the electrons in both objects act like of 'hills and valleys'.



coefficient of static friction

$$\mu_s = \frac{\text{Friction Force}}{\text{Normal Force}} = \frac{F_f}{F_n}$$

Friction Equation

$$F_f = \mu F_n$$

Newton's 3rd Law

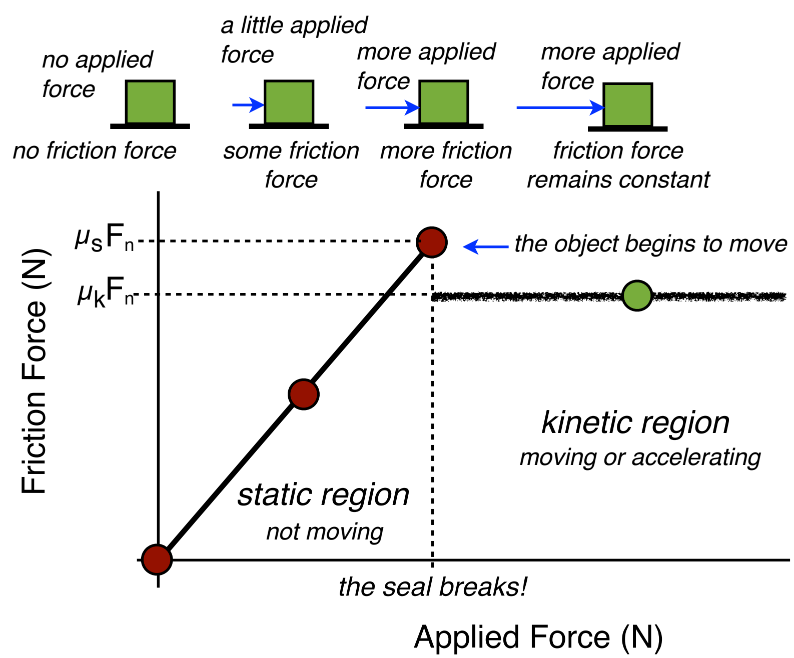
$$F_n = -F_g = mg$$

***static friction:** The **reactive force** that keeps an object from sliding on a surface when given a push.*

***kinetic friction:** a **retarding force** between two surfaces moving relative to one another.*

*The **Friction Equation** is an empirical formula. A formula derived from experiment not theory.*

*It takes more force (**coefficient of static friction**) to get an object to move than to keep it moving (**coefficient of kinetic friction**).*



Physics Lab

Period _____

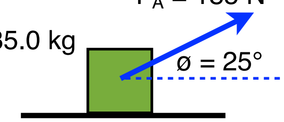
Name ____________________________

Date ________

FREEBODY DIAGRAMS

#1 pg 141

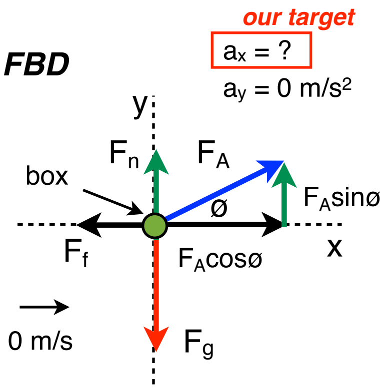
1 *Picture/Diagram*



μ_k = 0.27

coefficient of kinetic friction

2 *FBD*



draw all the forces on the object

3 *Sum of the Forces (F = ma)*

1. $\Sigma F_x = F_A \cos\theta - F_f = ma_x$
2. $\Sigma F_y = F_A \sin\theta + F_n - F_g = ma_y = 0$

4 *Solve the Problem*

What is the acceleration of the box?

solve Eq. 1 for a_x

$$a_x = \frac{F_A \cos\theta - F_f}{m}$$

Friction Equation

$$F_f = \mu_k F_n$$

$$a_x = \frac{F_A \cos\theta - \mu_k F_n}{m}$$

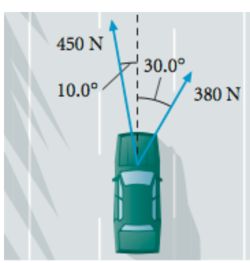
solve Eq. 2 for F_n

$$F_n = F_g - F_A \sin\theta$$

$$a_x = \frac{F_A \cos\theta - \mu_k (F_g - F_A \sin\theta)}{m} = 2.7 \tfrac{m}{s^2}\ \hat{\mathbf{x}}$$

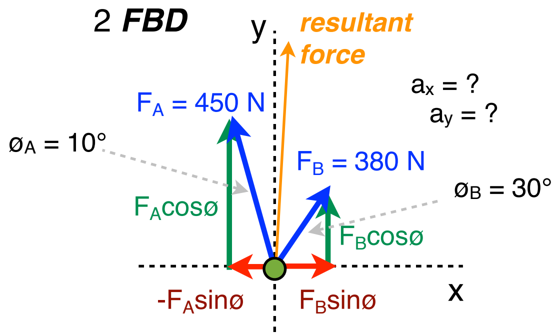
#22 a. What is the resultant force on the car?

1 *Picture/Diagram*



m_{car} = 3200 kg

2 *FBD*



3 Adding two vectors *(old way)*

F_A = -$F_A$sinø x + $F_A$cosø y

F_B = $F_B$sinø x + $F_B$cosø y

$F_A + F_B$ = 111.86 x + 772.25 y

$$mag\ F_A + F_B = \sqrt{(111.86\ N)^2 + (772.25\ N)^2}$$

$$mag\ F_A + F_B = 780\ N$$

$$dir\ \theta = \tan^{-1}\frac{772\ N}{112\ N}$$

$$dir\ \theta = 8.3°\ East\ of\ North$$

b. What is the acceleration of the car?

acceleration vector

$$a = \frac{\Sigma F}{m} = \frac{780 N}{3200\ kg} = 0.243 \tfrac{m}{s^2}$$

method 1

3 *Sum of the Forces (F = ma)*

b. What is the acceleration of the car?

1. $\Sigma F_x = F_B \sin\theta - F_A \sin\theta = ma_x$
2. $\Sigma F_y = F_B \cos\theta + F_A \cos\theta = ma_y$

solve Eq. 1 for a_x

$$a_x = \frac{F_B \sin\theta - F_A \sin\theta}{m} = 0.035 \tfrac{m}{s^2}$$

solve Eq. 2 for a_y

$$a_y = \frac{F_B \cos\theta + F_A \cos\theta}{m} = 0.241 \tfrac{m}{s^2}$$

acceleration vector

$$mag\ a_x + a_y = \sqrt{(0.035 \tfrac{m}{s^2})^2 + (0.241 \tfrac{m}{s^2})^2}$$

$$mag\ a_x + a_y = 0.243 \tfrac{m}{s^2}$$

$$dir\ \theta = \tan^{-1}\frac{.243 \frac{m}{s^2}}{.035 \frac{m}{s^2}}$$

$$dir\ \theta = 8.3°\ East\ of\ North$$

method 2