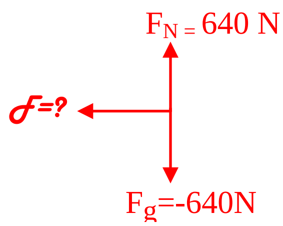
Physics 10
More Practice Problems—Newton's Laws

1. A 640 N person in stocking feet runs on a carpet until he reaches 6 m/s and then skids on a hardwood floor. After skidding for 1.5 seconds, the person comes to a stop. For this problem, only consider the time spent on the hardwood floor.
   a. Draw a FBD of the person as they skid.



   b. What is the acceleration of the person?

      t=1.5 s   **Vi=6m/s**   **Vf=0m/s**   **a=(Vf-Vi)/t**   **<u>a= - 4.0 m/s^2</u>**

   c. How far does the person skid on the wood floor before coming to a rest?

      <u>ΔX = 4.5 m</u>

   d. What is the frictional force between the person's socks and wood floor?

      ΣF = (64 kg)(-4.0 m/s^2) = -256 N   **ΣF = f**   **<u>f = -256 N</u>**

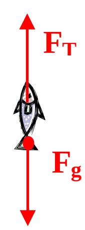
   e. What kind of friction is this?

      <u>Kinetic Friction</u>

   f. If the person wanted to skid across the floor at constant speed, how much force would a friend (wearing sneakers) need to provide?

      <u>256 N</u>

2. A 5.00 kg fish is hanging from a spring scale that records the tension supporting the fish, in Newtons.
   a. Draw a FBD for this scenario.



   b. What does the scale read when the fish is hanging at rest?

      $\Sigma F = F_g + F_T$ **$\Sigma F = 0$**   **F_g = -50 N**   **<u>F_T = 50 N</u>**

c. What does the scale read when the fish is being accelerated upwards at a rate of 3.0 m/s^2

$\Sigma F = (5\text{ kg})\ (3.0\text{ m/s}^2)$ **$\Sigma F = +15\text{ N}$** **$\Sigma F = F_g + F_T$**

$F_g = -50\text{ N}$ **$\underline{F_T = 65\text{ N}}$**

d. What does the scale read when the fish is travelling upwards at a constant speed of 2.0 m/s?

$\Sigma F = (5\text{ kg})\ (0\text{ m/s}^2)$ **$\Sigma F = 0\text{ N}$** **$\Sigma F = F_g + F_T$**

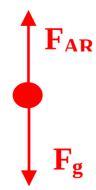
$F_g = -50\text{ N}$ **$\underline{F_T = 50\text{ N}}$**

3. A “typical raindrop” (mass = 13 g) has a terminal velocity of 15 mph.

a. What is the terminal velocity in m/s? (1 mile = 1607 m)

$\underline{V_{terminal} = 6.7\text{ m/s}}$

b. Draw a FBD corresponding to this raindrop.



c. What is the magnitude of the force of air resistance on the raindrop when it is traveling at terminal velocity?

$\Sigma F = 0$ **$\Sigma F = F_{AR} + F_g$`** **$F_g = -0.13\text{ N}$** **$\underline{F_{AR} = 0.13\text{ N}}$**

4. Consider a 440 kg football blocking sled. The coefficient of static friction between the sled and the grass is 0.88 and the coefficient of kinetic friction between the sled and the grass is 0.84.

a. What is the weight of the sled in Newtons?

$W = Fg = (m)(g) = (440\text{ kg})(-10\text{ m/s}^2)\ \underline{= -4400\text{ N}}$

b. What is the normal force pushing up on the sled as it sits at rest on the grass?

$\Sigma F = 0$ **$\Sigma F = F_N + F_g$** **$\underline{F_N = 4400\text{ N}}$**

c. What is the maximum force of static friction between the sled and the grass?

$f_S = (\mu_S)(N)$ **$f_S = (0.88)(4400\text{N}) = \underline{3872\text{ N}}$**

d. Lethargic Larry, the large lineman attempts to push the sled with 3052 N of force. Does the sled move?

Fap < f_S so the <u>sled does NOT move</u>

e. The coach gets in Larry's grill and motivates him to push harder. Suppose Larry now pushes with 4026 N, will the sled move?

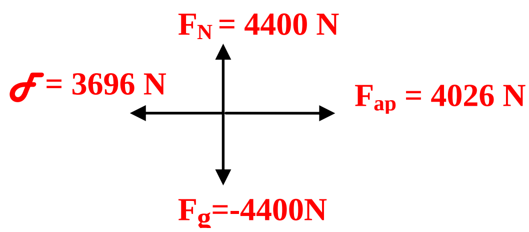
Fap > f_S so the <u>sled does NOT move</u>

f. What is the force of kinetic friction acting on the sled as it slides?

$f_k = (\mu_k)(N)$ **$f_S = (0.84)(4400N) =$ <u>3696 N</u>**

g. Suppose Larry maintains the constant force of 4026 N.

i. Draw the FBD for the sled



ii. Starting from rest, how much time will it take for the sled to cover a distance of 6.0 meters?

$\Sigma F = f + F_{ap}$	**$\Sigma F = 4026 + (-3696)$**	**$\Sigma F = +330$ N**
$\Sigma F = (m)(a)$	**$+330N = (440\ kg)(a)$**	**$a = +0.75\ m/s^2$**

$\Delta X = \frac{1}{2}(a)(t^2) + Vi(t)$ **$Vi = 0$** **$a = +0.75\ m/s^2$** **$\Delta X = +6.0$ m**

<u>t = 4.0 s</u>