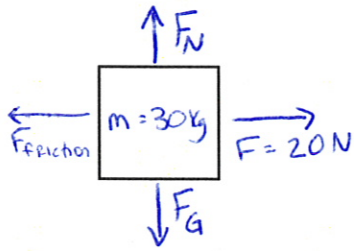
Newton's Laws: Simple Practice Problems

Directions: Solve the following problems using Newton's Laws of Motion. Construct a Free Body Diagram using the square next to each problem and show all of your work. If you need more space, continue on the back of the paper.

1. A loveseat with m=30kg is sitting in the living room. You exert a force of 20N to begin to slide the loveseat closer to the TV, and it accelerates at a rate of 0.5m/s^2. Calculate the force of friction opposing the motion of the loveseat.



$$F_y = F_N + F_G = m \cdot a_y = 0$$

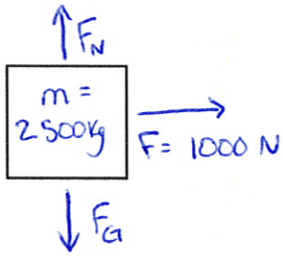
$$F_{net} = 20N + F_{friction} = m \cdot a$$

$$20N - m \cdot a = -F_{friction}$$

$$20N - (30kg)(0.5 m/s^2) = 5N = -F_{friction}$$

The force of friction is 5N in the negative x-direction.

2. Your car battery died, and you need to push your car out of its parking spot in order to jump it. Your car has m=2500kg and, with the help of some friends, you exert a force of 1000N on the car. Neglecting friction, at what rate will the car accelerate?



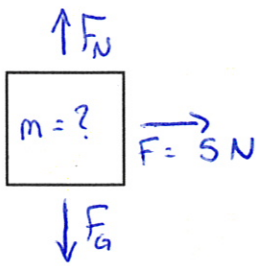
$$F_y = F_N + F_G = m \cdot a_y = 0$$

$$F_{net} = 1000N = m \cdot a$$

$$a = \frac{F}{m} = \frac{1000N}{2500kg} = 0.4 m/s^2$$

The car will accelerate at a rate of $0.4 m/s^2$

3. You are coaching tee ball and you place a ball on a tee. A preschooler hits the ball horizontally with a force of 5N, and it accelerates at a rate of 33m/s^2 while the force is applied. Ignore friction between the ball and the tee. What is the mass of the ball?



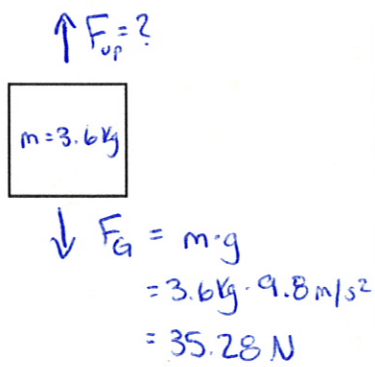
$F_y = F_N + F_G = m \cdot a_y = 0$

$F_{net} = 5N = m \cdot a$

$m = \frac{F}{a} = \frac{5N}{33 m/s^2} = 0.15 kg$

The ball has a mass of 0.15 kg.

4. You are putting away groceries and you lift a gallon of milk (m=3.6kg). It accelerates upwards at a rate of 2.5 m/s^2. How much upward force are you exerting on the milk? (F_G = m*g, where g is the acceleration due to gravity, 9.8 m/s^2 downward)



$F_{net} = F_{up} + F_G = m \cdot a$

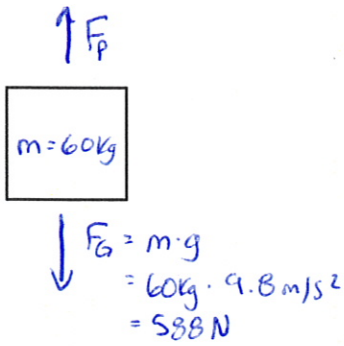
$F_{up} = m \cdot a - F_G$

$= (3.6kg)(2.5 m/s^2) - (-35.28 N)$

$= 44.28 N$

You are exerting an upward force of about 44N on the milk.

5. A man (m=80kg) is doing a pushup. We can model this as an object with 75% of his mass being pushed straight up. If he wants to accelerate his upper body at a rate of 0.5m/s^2, how much force must he exert with his arms? (Remember: $F_G = m*g$)



$m = 80kg \cdot 75\% = 60kg$

$F_{net} = F_p + F_G = m \cdot a$

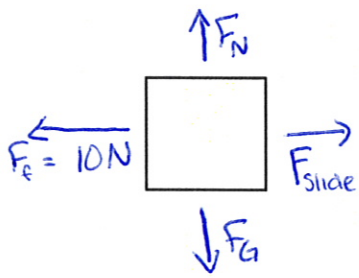
$F_p = m \cdot a - F_G$

$= (60kg)(0.5m/s^2) - (-588N)$

$= 618N$

The man must exert an upward force of 618N.

6. You are sliding a heavy box along a carpeted floor with a constant velocity of 1m/s. Friction is opposing your movement with a force of 10N. How much force are you exerting on the box?



$F_y = F_N + F_G = m \cdot a_y = 0$

$F_{net} = F_{Slide} + F_f = m \cdot a$ $\quad a=0$ because velocity is constant.

$F_{Slide} + F_f = 0$

$F_{Slide} = -F_f = -(-10N) = 10N$

You are exerting a force of 10N on the box.