Newton's Laws of Motion

1. In a tug of war game, the left side with a total mass of 300 kg exerts a tension force of 12400 N while the right side with a total mass of 350 kg exerts a tension force of 11000 N. Mass of the rope is negligible. Air resistance and friction are negligible.
    a. What is the net force?
    b. What is the acceleration?
2. A martial artist strikes his 120 kg opponent in the body with an upward knee with a force of 10000 N. g-force represents the number of $g \approx 9.81 m/s^2$ accelerations. Martial artists of this weight class will get knocked out with 8 g-forces. Air resistance and friction are negligible.
    a. What is the acceleration of his opponent's head directly after the knee strike?
    b. Does the knee strike knock out his opponent?
3. Force is defined by $F(t) = 6t - 9$ represents a 3 kg cart being pushed from rest at position $x = 0$
    a. Find $a(t)$.
    b. What is the acceleration of the cart at $t = 2$?
    c. What is the change in acceleration of the cart during the time interval $2 \leq t \leq 4$?
    d. Find $v(t)$.
    e. What is the velocity of the cart at $t = 2$?
    f. What is the average velocity of the ball during the time interval $1 \leq t \leq 3$?
    g. What is the change in velocity of the cart during the time interval $2 \leq t \leq 4$?
    h. Find $x(t)$.
    i. What is the position of the cart at $t = 2$?
    j. What is the displacement of the cart during the time interval $2 \leq t \leq 4$?
4. A 100 kg powerlifter is attempting a weighted pushup with barbell plates with a total mass of 125 kg on top of him. Unweighted push ups involve pushing 64% of the person's body mass. Air resistance and friction are negligible. What is the minimum force that he needs to exert to perform the weighted push up?
5. Lisa, who is 60 kg, pushes Carl, who is 120 kg. Carl experiences an acceleration of $5\ m/s^2$ directly after her push. What is the acceleration of Lisa immediately after her push?

Free-Body Diagrams

Draw the Free-Body Diagrams for the first mentioned "object".

1. Object is at rest on a flat surface.

2. Object is being pulled by a rope at an angle above the horizontal on a flat surface with friction and no air resistance.

3. Object is pushed by a person with a force parallel to the flat surface with friction and air resistance.

4. Object is at rest on an incline with friction.

5. Object is being pushed up an incline by a person exerting a force parallel to the inclined surface with friction and no air resistance.

6. Object is hung from the ceiling with a spring.

7. Two people are pulling an object with a rope on two different sides with friction and no air resistance. The person on the right exerts more force than the person on the left.

8. Object has another object on top of it.

9. Object is free falling and has reached terminal velocity with air resistance.

10. Object on an incline is being pulled by a rope with a force parallel to the inclined surface with friction, but the object stays at rest.

11. A person holds the object up while the object remains at rest.

Forces

1. A 100 kg block is suspended using a spring that is attached to the ceiling, the spring can exert a maximum pull of 900N on the load before it deforms. Will the spring be deformed by pulling on the block?
2. A 5000 kg jet is sliding (no manual brakes) on a platform with an initial velocity of 150 m/s. The kinetic coefficient of friction between the tire and the platform is 0.4. Air resistance is negligible. What is the displacement of the jet before it comes to a stop?
3. Jade's car ran out of gas, and she had to push it to the gas station from rest. The car has a mass of 2000 kg. The static coefficient of friction between the tire and road is 0.4 while the kinetic coefficient of friction between the tire and road is 0.2. She can exert a maximum force of 7000 N on the car. Is she able to push the car?
4. What is the static coefficient of friction needed to keep a 20kg block at rest on an incline of angle 30° to the horizontal?
5. A 3 kg book on the floor has a large 50 kg box on top of it, which is connected to a wall near it with a massless rope. The static coefficient of friction between the book and the floor is 0.7 while the static friction between the book and the box is 0.4. What is the force needed to pull the book out?
6. A 50 kg cart connected with a massless rope has an initial velocity of 50 m/s in the direction opposite of the rope on a flat surface with friction. The static coefficient of friction between the cart and the flat surface is 0.8 while the kinetic coefficient of friction between the cart and the flat surface is 0.2. Air resistance is negligible. What is the minimum tension force that is needed to be exerted on the object so that it stops before traveling 20 m?
7. Asteroid of mass 100000 kg is attracted to a planet of mass 20000000 kg. At the moment where the distance between the asteroid and planet is 2000 m, what is the force of attraction between them?
8. A 5 kg block with an initial velocity of 20 m/s slides onto a surface with friction. The coefficient of friction between the block and the surface is 0.4. What is the displacement of the block before it comes to a rest?