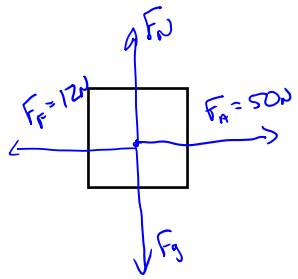
Newton's Laws – Sample Problems

- A 25 kg box is sitting on a table. A 50 N force is applied to the box while a frictional force of 12 N is acting on it.
  - Draw a FBD for the box



  - Write the equation for the net force in the <u>vertical</u> direction on the box:
    - $F_{net(y)} = F_N - F_g$
  - What is the gravitational force (weight) of the box?

$F_g = mg = (25\,kg)(9.8) = 245\,N$

  - Is there a net force acting on the box in the <u>vertical</u> direction? How do you know?

$F_{NET_y} = 0 \Rightarrow$ Not Acceleration in vertical direction

  - Use the equation you wrote above to find the normal force (F_n) acting on the box

$0 = F_N - F_g \Rightarrow 0 = F_N - 245\,N \quad F_N = 245\,N$

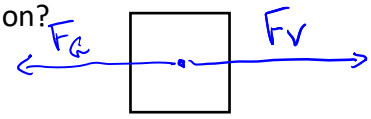
  - Write the equation for the net force in the <u>horizontal</u> direction on the box:
    - $F_{net(x)} = F_A - F_F$
  - What is the net force acting on the box in the <u>horizontal</u> direction?

$F_{NET_x} = 50 - 12 = 38N$

  - What is the acceleration of the box? $F = MA \quad 38\,N = 25A \quad A = 1.52\,m/s^2$

- Victoria and George are fighting to get the last Playstation 5 (mass = 1.2 kg) on Black Friday. Victoria pulls with a force of 14 N that causes the Playstation to accelerate toward her at a rate of 2.3 m/s^2.
  - Draw a FBD for Playstation
  - What is the net force acting on the Playstation in the <u>horizontal</u> direction?

$F_{NET} = MA = 1.2(2.3) = 2.76\,N$

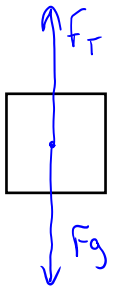


  - Write the equation for the net force in the <u>horizontal</u> direction on the Playstation:
    - $F_{net(x)} = F_V - F_G$
  - What is the George's applied force?

$2.76 = 14 - F_G$

$F_G = 11.24\,N$

- An 1500 kg elevator moved upward by its motor. The acceleration of the elevator is 1.7 m/s^2.
  - Draw a FBD for elevator



  - What is the net force acting on the elevator in the horizontal direction?

$F_{NET_x} = 0$

  - What is the gravitational force (weight) on the elevator?

$F_g = mg = 1500(9.8) = 14{,}700\,N$

  - What is the net force acting on the elevator in the vertical direction?

$F_{NET} = MA = 1500(1.7) = 2550\,N$

  - Write the equation for the net force in the vertical direction on the elevator:
    - $F_{net(y)} = F_T - F_g$
  - What is the tension in the cable pulling the elevator upward?

$2550 = F_T - 14{,}700\,N$

$F_T = 2550 + 14{,}700$

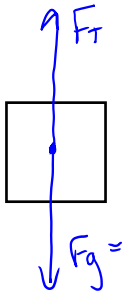
$F_T = 17{,}250\,N$

- A crane is lowering a 1200 kg air conditioning unit from the top of the school. The unit is accelerating at a rate of 0.45 m/s^2.
  - Draw a FBD for air conditioning unit

$F_{NET} = MA$

$= 1200(-.45)$

$= -540$



  - What is the tension in the crane's cable?

$F_g =$

$F_{NET} = F_T - F_g$

$-540 = F_T - 11{,}760$ $F_T = 11{,}220\,N$

- A 1 N force pushes a 1 kg mass. What is the acceleration of the mass?

$F = MA \Rightarrow 1\,N = 1kg(A)$

$1\,m/s^2 = A$

  - What would happen to the acceleration if you tripled the force?

$3 = 1A$ $A =$ 3x LARGER

  - What would happen to the acceleration if you doubled the the mass?

$1 = 2A$ $A =$ 1/2 AS LARGE

  - What would happen to the acceleration if you doubled the force and doubled the mass?

$2 = 2A$ $A =$ 1 x LARGER $\Rightarrow$ SAME SIZE