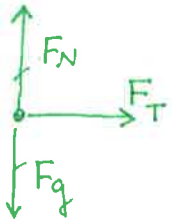
PRACTICE WITH NEWTON'S 1ST AND 2ND LAWS ANSWER KEY

***Instructions**: Answer the following questions in your journal. Make sure to draw a FBD for each situation and show all of your work completely.*

1. How much tension force must a rope withstand if it is used to accelerate a 1050 kg car horizontally at 1.2 $^{m}/_{s^2}$? (Ignore friction)

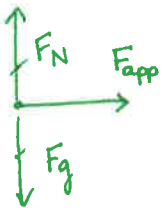


$F_{NET} = F_T = ma$

$= (1050\ kg)(1.2\ m/s^2)$

$\boxed{F_T = 1260\ N}$

2. The net horizontal thrust of a jet-powered supersonic land vehicle, which accelerates at 7 *g*'s, is 40,000 N. (1 g would be an acceleration of 9.8 $^{m}/_{s^2}$)
   a. What is the vehicle's mass?
   b. If the vehicle above starts at rest, and accelerates as described for 3.0 s, how fast will it be going at the end of the 3.0 seconds?
   c. How far will the vehicle have traveled at the end of the 3.0 seconds?



a. $a = 7 \cdot (9.80\ m/s^2) = 68.6\ m/s^2$

$F_{NET} = ma \Rightarrow m = \frac{F_{NET}}{a} = \frac{40{,}000\ N}{68.6\ m/s^2}$

$\boxed{m = 583\ kg}$

b. $V_1 = 0$

$a = 68.6\ m/s^2$

$t = 3\ s$

$V_2 = ?$

$V_2 = \cancel{V_1}^{0} + at$

$= 0 + (68.6\ m/s^2)(3\ s)$

$\boxed{V_2 = 206\ m/s}$

c. $d = ?$

$d = \cancel{V_1 t}^{0} + \frac{1}{2}at^2$

$= 0 + \frac{1}{2}(68.6\ m/s^2)(3s)^2$

$\boxed{d = 309\ m}$

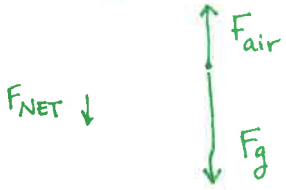
3. A pinecone with a mass of 10.0 grams falls off a tree (yes, there is some biology...)
   a. At one instant during its fall it has an acceleration of 6.0 $^{m}/_{s^2}$. What is the force of air drag on the pinecone at that instant?
   b. What is the force of air drag when the pinecone reaches terminal velocity?

a. $-F_{NET} = F_{air} - F_g \Rightarrow F_{air} = -F_{NET} + F_g$

$= -ma + mg = m(g-a)$

$F_{air} = 0.01\,kg\,(9.80\,m/s^2 - 6.0\,m/s^2)$

$\boxed{F_{air} = 0.038\,N}$



b. $F_{NET} = 0 = F_{air} - F_g$

$F_{air} = mg = (0.01\,kg)(9.80\,m/s^2)$

$\boxed{F_{air} = 0.098\,N}$

4. A horse pulls a 105 kg cart with a net force of 300. N for 5.00 seconds.
   a. What is the acceleration of the cart?
   b. What was the average speed of the cart during the 5.00 seconds?
   c. How far did it travel during that time?

a. $F_{NET} = ma \Rightarrow a = \frac{F_{NET}}{m} = \frac{300\,N}{105\,kg}$

$\boxed{a = 2.86\,m/s^2}$

b. $\bar{v} = ?$

$d = v_i t + \frac{1}{2}at^2$ ($v_i = 0$)

$= \frac{1}{2}(2.86\,m/s^2)(5.00\,s)^2$

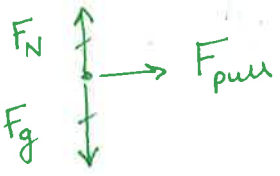
$\boxed{d = 35.7\,m}$

$\bar{v} = \frac{d}{t}$

$= \frac{35.7\,m}{5.00\,s}$

$\boxed{\bar{v} = 7.14\,m/s}$

c.



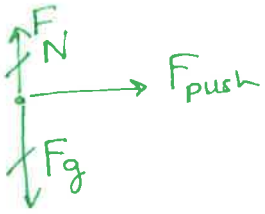
5. A wheelbarrow racer pushed his wheelbarrow so it accelerated at 3.00 $^{m}/_{s^2}$ until it reached a distance of 100. m.
   a. How much time was required to travel the 100. m?
   b. If he pushed it with 120. N of net force, what was the mass of the wheelbarrow?
   c. How fast was it going at the end of the 100. m?

a. $d = \cancel{v_1 t}^{0} + \frac{1}{2}at^2 \Rightarrow t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(100m)}{3.00\,m/s^2}}$

$t = 8.16s$

b. $F_{NET} = ma \Rightarrow m = \frac{F_{NET}}{a} = \frac{120N}{3.00\,m/s^2}$

$m = 40.0\,kg$



c. $v_2 = \cancel{v_1}^{0} + at = (3.00\,m/s^2)(8.16s)$

$v_2 = 24.5\,m/s$

6. A race car initially going 100 $^{m}/_{s}$ suddenly revs up so that a constant 1,600 N of net force is applied to the car. It speeds up to 175 $^{m}/_{s}$ in 4.0 seconds.
   a. What is the car's acceleration?
   b. What is the car's mass?
   c. How far did it travel during the 4.0 second period?

a. $a = \frac{v_2 - v_1}{t} = \frac{175\,m/s - 100\,m/s}{4.0s}$

$a = 18.8\,m/s^2$

b. $F_{NET} = ma \Rightarrow m = \frac{F_{NET}}{a} = \frac{1600N}{18.8\,m/s^2}$

$m = 85.3\,kg$

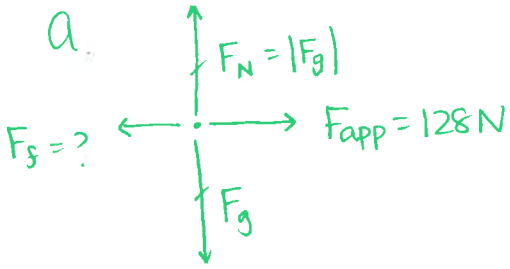
c. $d = v_1 t + \frac{1}{2}at^2$

$= (100\,m/s)(4.0s) + \frac{1}{2}(18.8\,m/s^2)(4.0s)^2$

$d = 550\,m$

7. Max is trying to push a heavy 21 kg box across the floor. He manages to push the box at an acceleration of 1.3 $^{m}/_{s^2}$ using a force of 128 Netwons.
   a. What is the force of friction felt by the box?
   b. What is the coefficient of friction (μ) between the box and the floor?

a.



$F_{NET(y)} = 0$

$F_{NET(x)} = F_{app} + (-F_f) = m \cdot a$

$F_f = F_{app} - (ma)$

$= 128\,N - (21\,kg)(1.3\,m/s^2)$

$27\,N$

$\boxed{F_f = 101\,N}$

b. $F_f = \mu \cdot F_N \Rightarrow \mu = \frac{F_f}{F_N}$ $\qquad F_N = |F_g| = m \cdot g$

$\mu = \frac{F_f}{m \cdot g} = \frac{101\,N}{(21\,kg)(9.80\,m/s^2)}$

$\boxed{\mu = 0.49}$