Newton's laws Revisited

1. State Newton's first Law.
An object in a constant state of motion stays in its constant state unless acted upon by a Net Force

2. What is an external net force?
unbalanced Forces on an object

3. What is inertia and how is it measured?
Resistance to acceleration (mass)

4. State Newton's second Law. $F=ma$
acceleration of an object is directly Proportional To the Net force acting on it and Inversly to its mass

5. If the is no net force acting on an object what are its two possible states of motion?
const Velocity @ Rest

6. Describe the motion of an object that has a non-zero net force acting on it.
accelerating

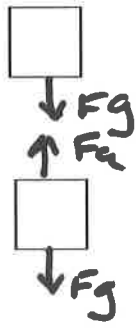
7. For the following scenarios, draw the free body diagrams and write the net force equations:

a) An acorn falling from an oak tree ignoring air resistance.

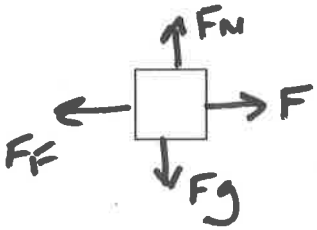
$F_g = ma$

b) A leaf falling from an oak tree at terminal velocity.

$F_a - F_g = 0$



c) A 0.75 kg book being pushed across a desk and accelerated to the right against a force of friction equal to 2.5 N.



"y" $F_N - F_g = 0$

"x" $F - F_F = ma$

8. The force of gravity acting on an object can also be called the objects WEIGHT

9. What is the force of gravity of an object with a mass of 10.0 kg?

$F_g = mg = 10(9.8) = 98N$

10. a) What is the mass of an object weighing 490 N?

$F_g = mg \qquad 490 = m(9.8) \qquad m = \frac{490}{9.8} = 50kg$

b) What would the weight of the object be if it were placed on the moon where the acceleration due to gravity is only 1/6 that of the earth?

$F_g = mg = 50\left(\frac{9.8}{6}\right) = 81.7\ N$

c) What is the mass of the object if it were placed on the moon?

50 kg

11. A 0.75 kg book is pushed across a desk to the right against a force of friction equal to 2.5 N.

a) What force is required to keep the book moving at a constant velocity?

$F_{Net} = 0 \qquad F - 2.5 = 0$

$F - F_F = 0 \qquad F = 2.5\ N$

b) What force is required to cause the book to accelerate at a rate of 1.5 m/s^2.

$F_{Net} = ma \qquad F - 2.5 = 0.75(1.5) = 3.625N$

$F - F_F = ma$

Review Problems – show all work

1. A 40 kg person sits in an elevator accelerating upward at 2.0 m/s^2. The elevator has a mass of 500 kg;

a) What is the tension in the elevator cable? _____

$T - F_g = ma$

$T = ma + F_g = 540(2) + 540(9.8) = 6372\ N$

b) If the person is standing on a scale that measures force, what will it read? _____

$T = ma + F_g = 40(2) + 40(9.8) = 472\ N$

2. A 40 kg person sits in an elevator accelerating downward at 2.0 m/s^2. The elevator has a mass of 500 kg, What is the tension in the elevator cable?

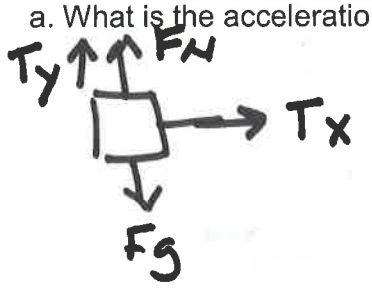
$T - F_g = m(-a) \qquad T = m(9.8) - m(2)$

$T = F_g - ma \qquad = 540(9.8) - 540(2) = 4212\ N$

_____

3. A 20 kg box is pulled across the ice with a rope. A force of 100 N is applied at an angle of 20° to the horizontal. The coefficient of friction with the ice is μ=0.10

a. What is the acceleration of the box.



$F_{Net} = ma$

$Tx = ma$

$100\cos(20) = 20a$

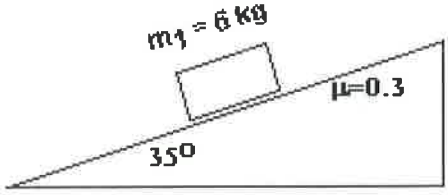
$a = 4.7\ m/s^2$

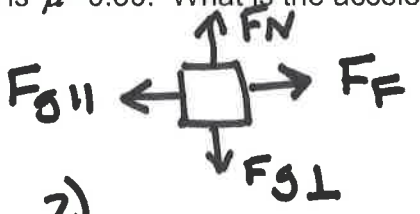
b. If you push the box at a 20° downward will the acceleration be the same, more or less? Explain why or show your work!

Without Friction it would Be the same since Tx is the only F_x.

If there were friction "a" would be less since $F_F \uparrow$ due to $F_N \uparrow$

4. A 6 Kg crate is placed on an inclined plane that makes an angle of 35° with the horizontal. The coefficient of friction with the plane is μ=0.30. What is the acceleration of the crate as it slides down the plane? *3.21 m/s²*





1) $F_N = F_{G\perp}$

$F_N = mg\cos\theta$

$F_N = 6(9.8)\cos(35)$

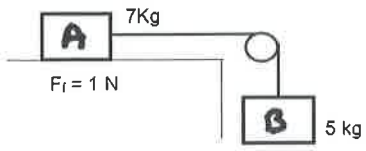
$F_N = 48.2N$

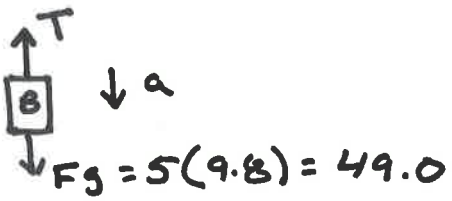
2) $F_{G||} = mg\sin\theta$

$F_{G||} = 6(9.8)\sin 35 = 33.7N$

$a = \frac{F_{Net}}{M} = \frac{F_{G||} - F_F}{M} = \frac{33.7 - .3(48.2)}{6} = 3.21\ m/s^2$ ($F_F = \mu F_N$)

5. Find acceleration and tension of this two body system. *4m/s² – 29N*





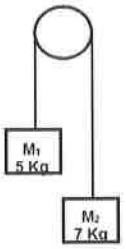
$a = \frac{F_{Net}}{M} = \frac{49 - 1}{7+5} = 4\ m/s^2$

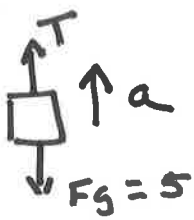
using diagram A $\Rightarrow T - F_F = ma$ $\quad T - 1 = 7(4)$

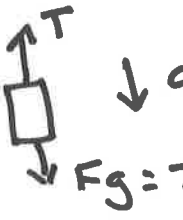
$T - 1 = 28$

$T = 29\ N$

6. Find acceleration of the blocks and tension in the cord of this two body system. *1.63 m/s² – 57.17 N*







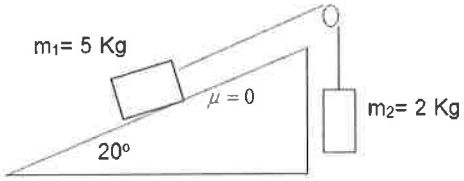
$a = \frac{F_{NET}}{m} = \frac{68.6 - 49}{7+5} = 1.63\ m/s^2$

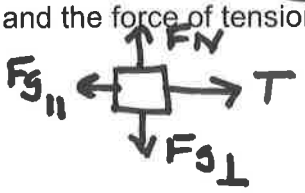
For "T" use 5 kg Block

$T - F_g = ma$

$T - 49 = 5(1.63) \Rightarrow T = 57.17$

7. No friction, find the acceleration and the force of tension on the cord. *0.4m/s² – 18.8 N*





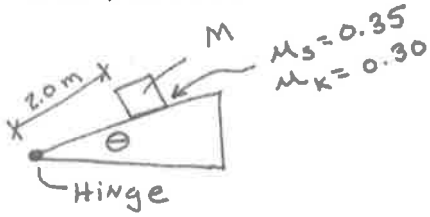
$F_{g\parallel} = mg\sin\theta = 5(9.8)\sin 20 = 16.7\ N$

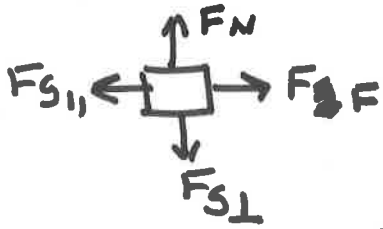
$a = \frac{F_{Net}}{m} = \frac{19.6 - 16.7}{5+2} = 0.406\ m/s^2$

$T - F_{g\parallel} = ma$

$T - 16.7 = 5(.406) \Rightarrow T = 16.7 + 2.1 = 18.8\ N$

8. The block shown in the diagram below is on a ramp where the angle can be varied from Θ=0° - 90°. The block is placed 2.0m from the left end while the ramp is in a horizontal position Θ=0°. The right end is slowly raised increasing the angle. At what angle does the block begin to move? What is the velocity of the block at the bottom of the ramp? *19.29°, 1.36 m/s.*





1) The Block will MOVE when $F_F = F_{g\parallel}$

2) $F_F = \mu_s F_N$

$F_N = F_{g\perp} = mg\cos\theta$

$F_F = \mu_s mg\cos\theta$

3) $F_{g\parallel} = mg\sin\theta$

$F_{g\parallel} = F_F$

$mg\sin\theta = \mu_s mg\cos\theta \Rightarrow \sin\theta = \mu_s\cos\theta$

$\tan\theta = \mu_s \Rightarrow \theta_s = \tan^{-1}(.35)$

4) $a = \frac{F_{Net}}{M} = \frac{F_{g\parallel} - F_F}{M}$

$a = \frac{mg\sin\theta - \mu_k mg\cos\theta}{M}$

$a = g(\sin\theta - \mu_k\cos\theta)$

USE $V_i V_f dt$ to Find V_f