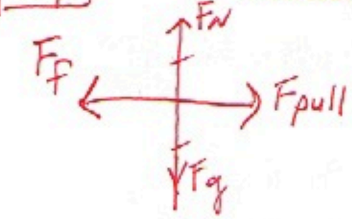
Name______________________________ Date______________ Pd______________

Net Force Particle Model:
Newton's Second Law Review Problems

1. An 80 kg water skier is being pulled by a boat with a force of 220 N causing the skier to accelerate at 1.8 m/s². Find the frictional force on the skier.

Step 1



Step 2

$m = 80\ kg$
$F_{pull} = 220N$
$a = 1.8\ m/s^2$
$F_f = ?$

Step 3

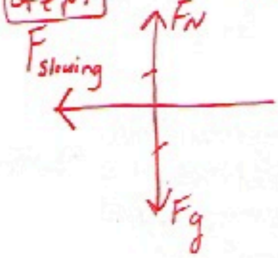
$\Sigma F_{net\,x} = F_f + F_{pull}$
Need F_{net}
$F_{net} = ma$
$F_{net} = 80kg(1.8m/s^2)$
$F_{net} = 144N$

$\Sigma F_x = F_f + F_{pull}$
$144N = F_f + 220N$
$144N - 220N = F_f$
$\boxed{-76N = F_f}$

2. A 2000 kg car is slowed down uniformly from 20 m/s to 5 m/s in 4 seconds. Determine the average net force on the car during this time, and how far the car traveled while slowing down.

Could be friction, brakes, etc

Step 1



Step 2

$m = 2000\ kg$
$a = ?$
$V_f = 5m/s$
$V_i = 20m/s$
$t_i = 0s$
$t_f = 4s$
$x_i = 0m$
$x_f = ?$

Step 3

$F_{net} = ma$
need a
$a = \frac{V_f - V_i}{t_f - t_i}$
$= \frac{5m/s - 20m/s}{4s - 0s}$
$= \frac{-15m/s}{4s}$
$a = -3.75m/s^2$

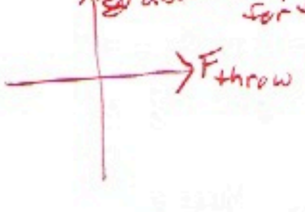
$F_{net} = ma$
$= 2000kg(-3.75m/s^2)$
$\boxed{F_{net} = -7500m/s^2}$

$x_f = \frac{1}{2}a\Delta t^2 + v_i\Delta t + x_i$
$= \frac{1}{2}(-3.75m/s^2)(4s)^2 + 20m/s(4s) + 0m$
$= -1.875m/s^2(16s^2) + 80m$
$= -30m + 80m$
$\boxed{x_f = 50m}$

3. Some baseball pitchers are capable of throwing a fastball at 100 mi/hr. The pitcher achieves this speed by moving his arm through a distance of 1.5 m. Determine the average net force that must be exerted on the 0.15 kg ball during the pitch. (1 mile = 1600 meters)

Step 1

Its tricky with no visible surface and air so Don't think about the y axis for this one



Step 2

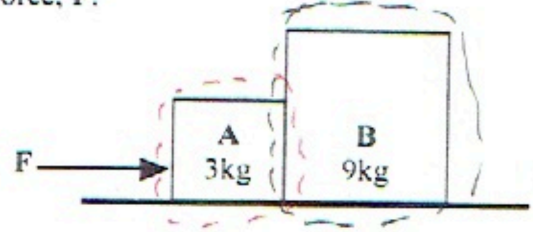
$V_f = 100mi/hr = 44.44m/s$
$V_i = 0$
$x_f = 1.5m$
$x_i = 0$
$m = 0.15kg$
$F_{net} = ?$
change units for V_f
$\frac{100mi}{hr}\left(\frac{1600m}{1mi}\right)\left(\frac{1hr}{3600sec}\right) = 44.44m/s$

Step 3

$F_{net} = ma$ Find a
$V_f^2 = V_i^2 + 2a\Delta x$
$(44.44m/s)^2 = (0m/s)^2 + 2(a)(1.5m)$
$1974.9m^2/s^2 = 3m\,a$
$a = 658\ m/s^2$
$F_{net} = ma$
$= 0.15kg(658m/s^2)$
$\boxed{F_{net} = 98.7}$

4. The blocks below are moving at a constant velocity of 1m/s. If μ_k=.3 between the surface and each block then determine the following:

a. the frictional force on each block
b. the contact forces (F_B on A, F_A on B) on each block
c. the applied force, **F**.



CV = 1 m/s means $\Sigma F_y = 0$

$\mu_k = 0.3$

$Mass_A = 3$ kg

$Mass_B = 9$ kg

(a.)

Box A

$F_N = +29.46N$

B

Fpush

F_F

$F_g = 3(9.82) = -29.46N$

$F_F = \mu F_N$

$= 0.3(29.46)$

$F_{FA} = -8.84N$

Box B

$F_N = +88.38N$

F_F

F_A

$F_g = 9(9.82) = -88.38N$

$F_F = \mu F_N$

$= 0.3(88.38)$

$F_{FB} = -26.5N$

(B) Start with similper force diagram

For Box B

$\Sigma F_x = F_F + F_A$

$0 = -26.5N + F_A$

$F_A = 26.5N$

For Box B

$F_A = -F_B$ so $F_B = -26.5N$

(C) Use Box A

$\Sigma F_x = 0$

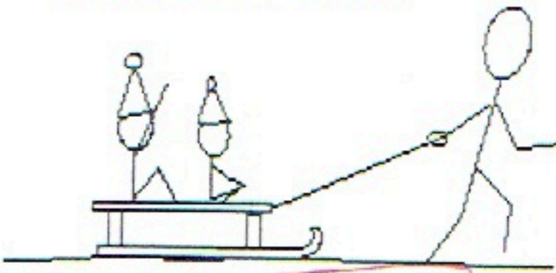
$0 = F_{push} + F_B + F_F$

$0 = F_{push} + -26.5N + -8.84N$

$0 = F_{push} + -35.34N$

$35.34N = F_{push}$

5. In the diagram below, the cord makes a 25° angle with the horizontal, the mass of the sled and occupants is 100 kg. The tension in the cord is 120 N and the friction force is 15 N. Find the acceleration of the sled.



Step 1

+982N F_N

$F_F = 15N$

$F_{pull} = 120N$

25

F_{pully}

F_{pullx}

$F_g = 100kg(9.82N/kg) = -982N$

Step 2

m = 100 kg

$F_g = -982N$

$F_N = 982N$

$F_{pull} = 120N$

$F_{pully} \Rightarrow \sin 25 = \frac{opp}{hyp}$ $\sin 25 = \frac{F_{py}}{120N}$ $F_{py} = .42(120N) = 50.7N$

$F_{pullx} = \cos 25 = \frac{adj}{hyp}$ $\cos 25 = \frac{F_{px}}{120N}$ $F_{px} = 0.9(120N) = 108N$

Step 3 $F_{net} = ma$

need F_{net}

$F_{net_x} = \Sigma F_x$

$\Sigma F_x = F_F + F_{pullx}$

$= -15N + 108N$

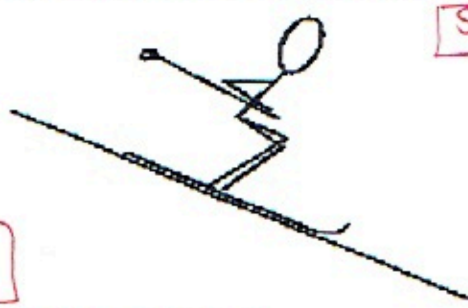
$\Sigma F_x = 93N = F_{net}$

$F_{net} = ma$

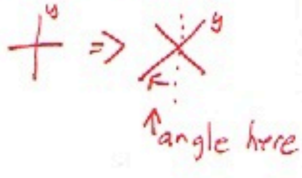
$93N = 100 kg\ a$

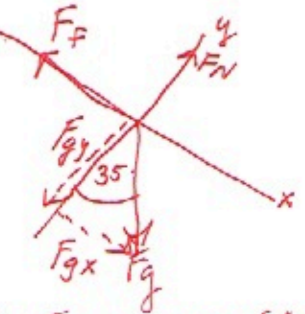
$0.93 m/s^2 = a$

6. The 60 kg skier shown below is skiing down a 35° incline with a coefficient of friction is 0.08. Determine the acceleration of the skier.



Step 1 Surface is tilted so tilt axis





Step 2

$F_g = 60(9.82) = {}^{-}589.2$

$F_{gx} \Rightarrow \sin 35 = \frac{F_{gx}}{589.2}$

$F_{gx} = 0.57(589.2) = {}^{+}338N$

$F_{gy} \Rightarrow \cos 35 = \frac{F_{gy}}{589.2}$

$F_{gy} = 0.82(589.2) = {}^{-}483N$

$m = 60kg$

$\mu = 0.08$

Step 3 $F_{net} = ma$ so need F_{net} $\Sigma F_x = F_{net}$

$F_n = -F_{gy}$ so $F_N = 483N$

$F_f = \mu F_N$

$= (0.08)(483N)$

$F_f = {}^{-}38.64$

$\Sigma F_x = F_f + F_{gx}$

$= -38.64_N + 338N$

$\Sigma F_x = 299.4N$

$F_{net} = ma$

$299.4N = 60kg\,a$

$a = 4.99\,m/s^2$

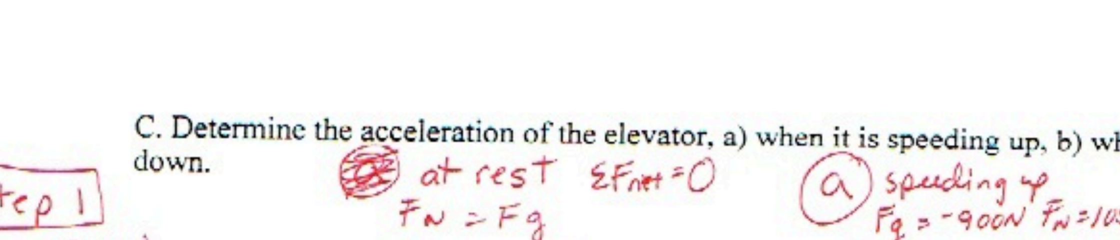
7. A student, standing on a scale in an elevator at rest, sees that his weight is 900 N. As the elevator rises, his weight increases to 1050 N, then returns to normal. When the elevator slows to a stop his weight drops to 700 N, and then returns to normal. Make the positive direction upward.

A. Describe the motion of the elevator in words.

When the student first stands on scale the $F_n = F_g$. As elevator rises and weight increases (as read on scale) so $F_N > F_g$. When it returns to normal its constant velocity so $F_N = F_g$. When it slows weight drops so $F_g > F_N$. Back to normal means at rest or $F_N = F_g$

B. Draw a force diagram for each of the following portions of the trip:

a. At rest
b. Moving from rest to constant speed
c. Slowing from a constant speed to rest



C. Determine the acceleration of the elevator, a) when it is speeding up, b) when it is slowing down.

Step 1

$F_g = {}^{-}900N$

$m = \frac{900N}{9.82} = 91.65kg$

at rest $\Sigma F_{net} = 0$

$F_N = F_g$

$F_{net} = ma$

$0 = 91.65kg\,a$

$a = 0$ at rest

(a) speeding up

$F_g = -900N$ $F_N = 1050N$

$\Sigma F_y = -900N + 1050N = 150N$

$F_{net} = ma$

$150 = 91.65\,a$

$a = 1.64\,m/s^2$

(b) slowing down

$F_g = {}^{-}900N$ $F_N = 700N$

$\Sigma F_y = {}^{-}900N + 700N = -200N$

$F_{net} = ma$

$-200N = 91.65\,kg\,a$

$a = -2.18\,m/s^2$