P.321 Ch 14 Dr. Bob

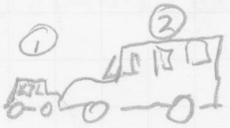
1. a) First Law

   b) Third Law - Ball exerts force on foot.

   Second Law - Force results in deceleration.

   c) Third Law - Car pushes you back.

   d) Second Law

2. 

The small car experences a greater acceleration.

The forces are equal & opposite

$F_1 = -F_2$

$m_1 a_1 = m_2 a_2$ $\quad\quad m_2 > m_1$

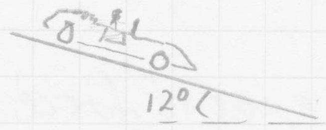
$a_1 = \frac{m_2}{m_1} a_2 > a_2$

3. If the car stops suddenly, the object will 'fly forward' in the car, because the car stops & the object keeps moving.

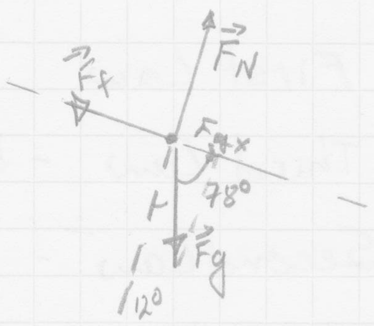
4.

The satellite 'pulls' the earth toward with a force of 1000N

5.



m = 1200kg



$$\sum F_x = F_g \cos 78^\circ - F_f = 0$$ Not accelerating

$$F_f = mg\cos 78^\circ = (1200\,kg)(9.8\,m/s^2)\cos 78^\circ$$

$$\boxed{F_f = 2445\,N}$$

$$\sum F_y = F_N - F_g \sin 78^\circ$$

$$F_N = mg\sin 78^\circ = (1200\,kg)(9.8\,m/s^2)\sin 78^\circ$$

$$\boxed{F_N = 11{,}500\,N}$$

6. $m = 2.92 \times 10^6\,kg$ $\quad F_T = 3.34 \times 10^7 N$

a) $F_g = mg = (2.92 \times 10^6\,kg)(9.8\,m/s^2)$

$$F_g = 2.86 \times 10^7\,N$$

b)

$$\sum F = F_T - F_g = F_R$$ Resultant

$$F_R = 3.34 \times 10^7 N - 2.86 \times 10^7 N$$

$$\boxed{F_R = 4.78 \times 10^6 N}$$

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6. (cont'd)

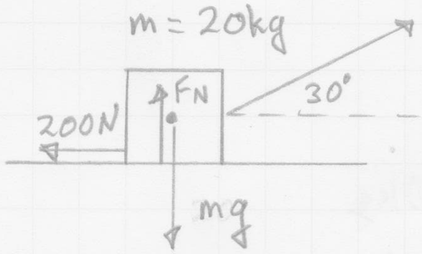
c) $F_R = ma$ $\quad a = \frac{F_R}{m} = \frac{4.78 \times 10^6\ N}{2.92 \times 10^6\ kg}$

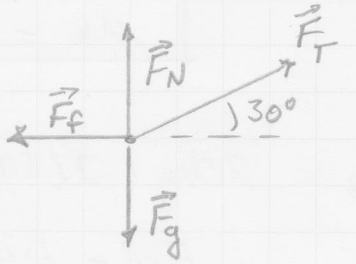
$$\boxed{a = 1.64\ m/s^2}$$

d) The rocket fuel is being thrust out the back of the vehicle.

e) The acceleration increases. In the equation, $a = F_R/m$, as m gets smaller 'a' get's bigger.

7. No. There is no air in space for the wings, ailerons, and rudders to interact with. The space craft will go in the direction that the thrusters push. To turn a thruster would have to push in the direction of the turn

8. 



$m = 20kg$
$g = 9.8\ m/s^2$
$F_f = 200N$

To put the crate in motion the horizonta component of the tension must equal the friction force.

$$\sum F_x = F_T \cos 30° - F_f = 0$$

$$F_T = \frac{F_f}{\cos 30°} = \frac{200N}{\cos 30°} = 231N$$

8(cont'd)

$$\boxed{F_T = 231\,N}$$

Now the forces in the y-direction must sum to 0.

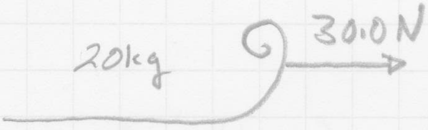
$$\sum F_y = F_T \sin 30° + F_N - F_g = 0$$

$$F_N = F_g - F_T \sin 30° = mg - F_T \sin 30°$$

$$= (20kg)(9.8m/s^2) - (231N)\sin 30°$$

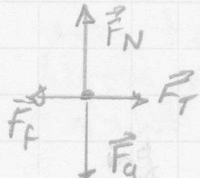
$$\boxed{F_N = 80.5\,N}$$

9.



Constant motion means, $a=0$, means net force $= 0$,

$m = 20kg$ $\qquad F_T = 30.0N$



a) $\sum y = F_N - F_g = 0$

$$F_N = F_g = mg = (20kg)(9.8m/s^2)$$

$$F_N = 196N$$

$F_f = \mu_k F_N$ $\qquad \mu_k = \frac{F_f}{F_N} = \frac{30.0N}{196N}$

$$\boxed{\mu_k = 0.153}$$

b) $m_{tot} = 20kg + 2(60kg) = 140kg$

$$F_N = (140kg)(9.8m/s^2) = 1372N$$

$\sum F_x = F_T - F_f = 0$ $\qquad F_T = F_f = \mu_k F_N = (0.153)(1372N)$

$$\boxed{F_T = 210\,N}$$

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10.

$$V_i = 90.0\frac{km}{h}\left(\frac{1000m}{1km}\right)\left(\frac{1h}{3600s}\right) = 25m/s$$

$F_f = 5000N$ $\qquad m = 1500kg$

$F = ma \qquad a = \frac{F}{m} = \frac{-5000N}{1500kg} = -3.33m/s$

a) $V_i = 25m/s \qquad x_i = 0m$

$V_f = 0m/s \qquad x_f = ?$

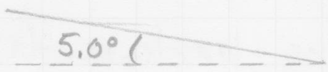
$$\cancel{V_f^2}^{\,0} = V_i^2 + 2a\Delta x$$

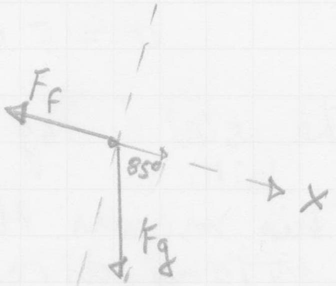
$$-V_i^2 = 2a\Delta x$$

$$\Delta x = \frac{-V_i^2}{2a} = \frac{-(25m/s)^2}{2(-3.33m/s^2)}$$

$$\boxed{\Delta x = 93.8m}$$

b)





$$\Sigma F_x = F_g\cos 85° - F_f = ma$$

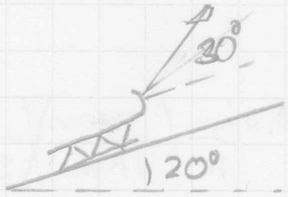
$$a = \frac{F_g\cos 85° - F_f}{m} = \frac{\cancel{m}g\cos 85° - F_f}{\cancel{m}} = g\cos 85° - \frac{F_f}{m}$$

$$a = (9.8m/s^2)\cos 85° - \frac{5000N}{1500kg}$$

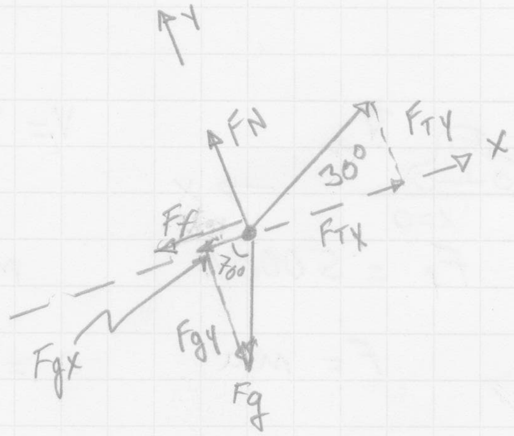
$$a = -2.48m/s^2$$

$$\Delta x = \frac{-(25m/s)^2}{2(-2.48m/s^2)} \qquad \boxed{\Delta x = 126m}$$

11.



$m = 50kg$



$F_T = 200N$ $\quad F_f = 50N$ $\quad F_g = mg$

X-direction (up the hill) the sum of the forces equals the net force.

$$\sum F_x = F_T \cos 30° - F_f - F_g \cos 70° = ma$$

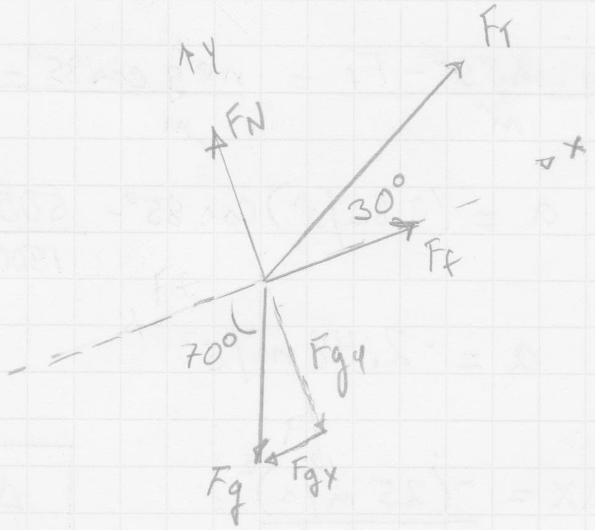
$$a = \frac{F_T \cos 30° - F_f - mg\cos 70°}{}$$

$$a = \frac{(200N)\cos 30° - 50N - (50kg)(9.8m/s^2)\cos 70°}{50kg}$$

$$a = -0.888 m/s$$

The sled & dog are sliding backwards down the hill.

This means the friction force is drawn in the wrong direction.



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11(cont'd)

$$\Sigma F_x = F_T \cos 30° + F_f - F_g \cos 70° = ma$$

$$a = \frac{F_T \cos 30° + F_f - mg \cos 70°}{m}$$

$$a = \frac{(200N)\cos 30° + 50N - (50kg)(9.8 m/s^2)\cos 70°}{50kg}$$

$a = 1.11\ m/s^2$ uphill Can't be

This is also wrong. The friction force always opposes the motion, but using this friction force the sled moves in the same direction as the friction. This is unphysical.

There's a problem with the statement of the problem. We can increase the force of the dog on the sled to make it work.

Assume $F_T = 300N$ instead

Now $a = \frac{(300N)\cos 30° - 50N - (50kg)(9.8 m/s^2)\cos 70°}{50kg}$

$$\boxed{a = 0.84 m/s^2 \quad \text{uphill}}$$