1. Assuming that the force the car is able to generate is the same in both cases.

Newtons 2nd law states; $F = ma$

So $a = \frac{F}{m}$. For a constant F

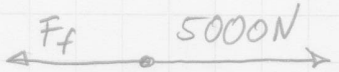
the greater the mass, the smaller the acceleration.

2. 

$m = 1100kg$

a) $F = ma = (1100kg)(3m/s^2)$

$$\boxed{F = 3300N}$$

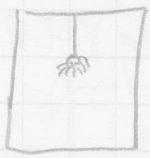
b) 

F_f could be from air, frictions of mechanical parts, etc.

$$\Sigma F = 5000N - F_f = 3300N$$

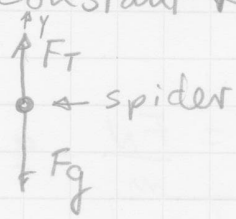
$$F_f = 5000N - 3300N$$

$$\boxed{F_f = 1700N}$$

3. 

$m = 10.2g = 1.02 \times 10^{-2} kg$

a) Constant velocity $\Sigma F = F_T - F_g = 0$



$F_T = F_g = (1.02 \times 10^{-2} kg)(9.8 m/s^2)$

$$\boxed{F_T = 1.00 \times 10^{-1} N}$$
$$\boxed{F_T = 0.10 N}$$

$a = 2.0\ m/s^2$

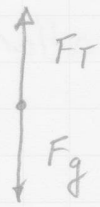
b) 

$$\Sigma F = F_T - F_g = ma$$

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

$$F_T = (1.02 \times 10^{-2}\,kg)(2.0\,m/s^2 + 9.8\,m/s^2)$$

$$\boxed{F_T = 0.12\ N}$$

c) 

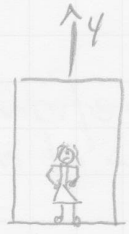
$$\Sigma F = F_T - F_g = ma$$

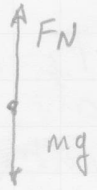
$$F_T = ma + F_g = ma + mg = m(a+g)$$

$a = -2.0\ m/s^2$

$$F_T = (1.02 \times 10^{-2}\,kg)(-2.0\,m/s^2 + 9.8\,m/s^2)$$

$$\boxed{F_T = 0.080\ N}$$

4. 



$$\Sigma F_y = F_N - mg = ma$$

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

$m = 60\ kg$

a) $a = 1\ m/s^2$

$$F_N = 60\,kg(9.8\,m/s^2 + 1.0\,m/s)$$

$$\boxed{\vec{F}_N = 648\ N \text{ upwards}}$$

b) $v = \text{constant}, a = 0\ m/s^2$ $\quad F_N = (60\,kg)(9.8\,m/s^2)$

$$\boxed{\vec{F}_N = 588\ N \text{ upwards}}$$

c) $F_N = 500\ N$ $\quad ma = F_N - mg$

$$a = \frac{F_N - mg}{m} = \frac{F_N}{m} - g = \frac{500N}{60kg} - 9.8\,m/s^2$$

$$\boxed{a = -1.47\ m/s^2}$$

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5. $m = 0.170\,kg$

$F_f = -0.5\,N$

a) $F_f = ma \qquad a = \frac{F_f}{m} = \frac{-0.5\,N}{0.170\,kg} =$

$$\boxed{a = -2.94\,m/s^2}$$

b) $x_i = 0\,m \qquad v_i = 15\,m/s$
$x_f = ? \qquad v_f = 0\,m/s$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$-\frac{v_i^2}{2a} = \Delta x$$

$$\Delta x = -\frac{(15\,m/s)^2}{2(-2.94\,m/s^2)}$$

$$\boxed{\Delta x = 38.3\,m}$$

6. 

$M = 50\,kg + 10\,kg = 60\,kg$

$F = 48\,N$

$v_i = 0\,m/s$
$v_f = 4\,m/s$
$x_i = 0\,m$
$x_f = ?$
$\Delta t = ?$

$F = ma \qquad a = \frac{F}{m}$

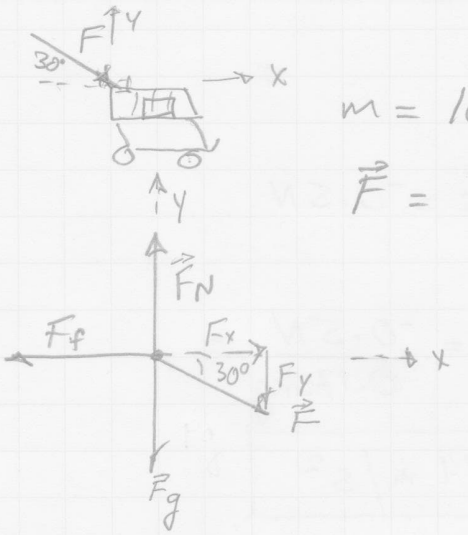
$$a = \frac{48\,N}{60\,kg} = 0.8\,m/s^2$$

$$v_f = v_i + a\Delta t$$

$$\Delta t = \frac{v_f - v_i}{a} = \frac{4\,m/s}{0.8\,m/s^2} = 5.0\,s$$

$$\boxed{\Delta t = 5.0\,s}$$

7.



$m = 10kg + 30kg = 40kg$

$\vec{F} = 50N$ @ $30°$ below horizontal

Constant velocity implies zero net force

$\Sigma F_x = F\cos 30° - F_f = 0$

$\Sigma F_y = F_N - F\sin 30° - F_g = 0$

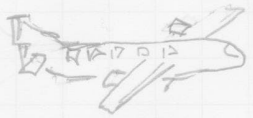
a) $F_f = F\cos 30° = (50N)\cos 30° = 43.3N$

$\boxed{F_f = 43.3N}$

b) $F_N = F\sin 30° + mg = (50N)\sin 30° + (40kg)(9.8m/s^2)$

$\boxed{F_N = 417N}$

8.



$F = 2(60{,}000N) = 1.2\times10^5 N$

$m = 7.5\times10^4 kg$ $\quad \Delta x = ?$

$V_i = 0m/s$

$V_f = 220\,km/h\left(\frac{1h}{3600s}\right)\left(\frac{1000m}{1km}\right)$ $\quad V_f = 61.1 m/s$

$F = ma \quad a = \frac{F}{m} = \frac{1.2\times10^5 N}{7.5\times10^4 kg} = 1.6 m/s^2$

$V_f^2 = V_i^2 + 2a\Delta x$ ($V_i \to 0$)

$\Delta x = \frac{V_f^2}{2a} = \frac{(61.1 m/s)^2}{2(1.6 m/s^2)} =$

$\boxed{\Delta x = 1167m}$

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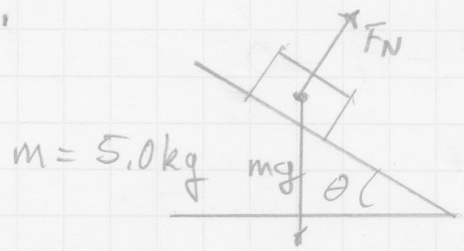
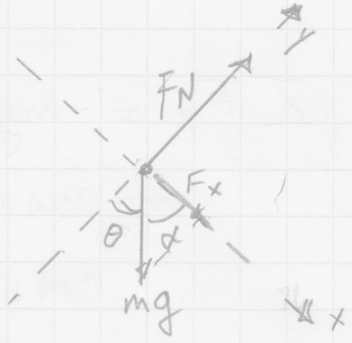
8. (cont'd)

b) The run way must be longer.

The friction & air resistance reduce the magnitude of the net force, the force accelerating the plane. Smaller net force means a smaller net acceleration meaning longer distance to reach air speed.

9.





$\alpha + \theta = 90°$

$a = 3.0 m/s^2$

$$\sum F_x = F_x = mg\cos\alpha = ma$$

$$\cos\alpha = \frac{ma}{mg} = \frac{a}{g}$$

$$\alpha = \cos^{-1}\left(\frac{a}{g}\right) = \cos^{-1}\left(\frac{3.0\ m/s^2}{9.8\ m/s^2}\right)$$

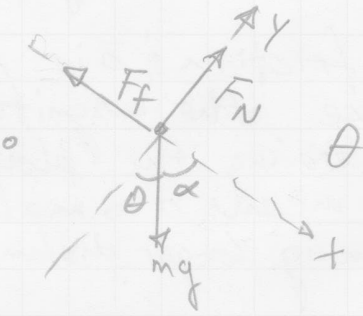
$\alpha = 72.2°$

$\theta = 90° - \alpha$

$= 90° - 72.2°$

$\boxed{\theta = 17.8°}$

10. Use the same drawing as in problem 9.



$\alpha + \theta = 90°$ $\quad \theta = ?$

$m = 5.0\,kg$

$v = \text{constant} \Rightarrow a = 0\,m/s^2$

$F_f = 20\,N$

$$\Sigma F_x = mg\cos\alpha - F_f = 0$$

$$mg\cos\alpha = F_f$$

$$\cos\alpha = \frac{F_f}{mg}$$

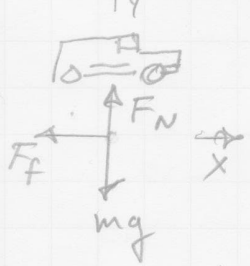
$$\alpha = \cos^{-1}\left(\frac{F_f}{mg}\right) = \cos^{-1}\left(\frac{20\,N}{(5.0\,kg)(9.8\,m/s^2)}\right)$$

$\alpha = 65.9°$ $\quad \theta = 90° - \alpha = 90° - 65.9°$

$$\boxed{\theta = 24.1°}$$

11. $m = 1000\,kg$ $\quad v_i = 100\,km/h\left(\frac{1000\,m}{1\,km}\right)\left(\frac{1\,h}{3600\,s}\right) = 27.8\,\frac{m}{s}$

$F_f = -7000\,N$ $\quad v_f = 0\,m/s$



$F_f = ma$ $\quad a = \frac{F_f}{m} = \frac{-7000\,N}{1000\,kg} = -7.0\,m/s^2$

a) $v_f^2 = v_i^2 + 2a\Delta x$ ($v_f = 0$)

$$\frac{-v_i^2}{2a} = \Delta x \qquad \Delta x = \frac{-(27.8\,m/s)^2}{2(-7.0\,m/s^2)}$$

$$\boxed{\Delta x = 55.2\,m}$$

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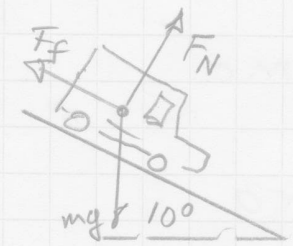
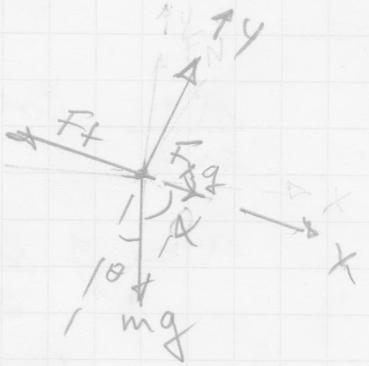
10. b)



What is the new acceleration?



$\theta = 10°$

$\alpha = 90° - \theta$

$\alpha = 80°$

$$F_{xg} = mg\cos\alpha$$

$$\sum F_x = mg\cos\alpha - F_f = ma$$

$$a = \frac{mg\cos\alpha - F_f}{m} = g\cos\alpha - \frac{F_f}{m}$$

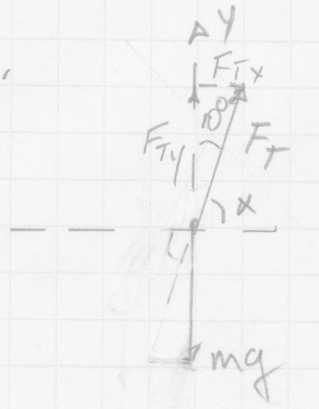
$$a = (9.8\,m/s^2)\cos 80° - \frac{7000\,N}{1000\,kg}$$

$$a = -5.3\,m/s^2$$

$$\Delta x = \frac{-v_i^2}{2a} = \frac{-(27.8\,m/s)^2}{2(-5.3\,m/s^2)}$$

$$\boxed{\Delta x = 72.9\,m}$$

12.



$\theta = 10°$ $\quad \alpha = 80°$

$$\sum F_x = F_{Tx} = F_T\cos\alpha = ma$$

$$\sum F_y = F_{Ty} - F_g = 0\,N$$

$$F_{Ty} = F_g$$

$$F_{Ty} = F_T\sin\alpha = F_g = mg$$

$$F_T = \frac{F_g}{\sin\alpha} = \frac{mg}{\sin\alpha}$$

12. (Cont'd) Now F_x:

$$F_T \cos\alpha = ma$$

$$\frac{mg}{\sin\alpha} \cos\alpha = ma$$

$$a = g\frac{\cos\alpha}{\sin\alpha} = g\cot\alpha$$

$$a = (9.8\,m/s^2)\cot(80^\circ)$$

$$\boxed{a = 1.73\,m/s^2}$$