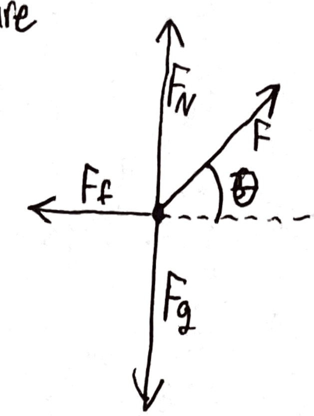
$\theta = 35^0$
$m = 3kg$
$a = 1 m/s^2$

1. Draw Picture



2. Write equations

$$F_{net} = ma$$

$$F_{netx} = ma_x \qquad F_{nety} = ma_y$$

$F_g = mg$
$F_f = \mu_k F_N$
$a_y = 0,\ a_x = 1 m/s^2$

$$F\cos\theta - F_f = ma_x \qquad F_N + F\sin\theta - F_g = ma_y$$

3. Solve

$$F\cos\theta - \mu_k F_N = ma_x \qquad F_N + F\sin\theta - mg = 0$$

$$F_N = mg - F\sin\theta$$

$$F\cos\theta - \mu_k(mg - F\sin\theta) = ma_x$$

$$F\cos\theta - \mu_k mg + \mu_k F\sin\theta = ma_x$$

$$F\cos\theta + F\mu_k\sin\theta = ma_x + \mu_k mg$$

$$F(\cos\theta + \mu_k\sin\theta) = ma_x + \mu_k mg$$

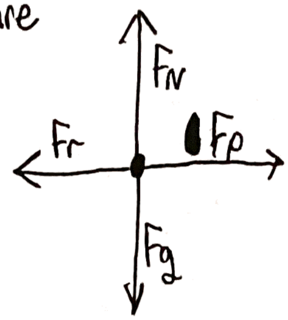
$$F = \frac{ma_x + \mu_k mg}{\cos\theta + \mu_k\sin\theta} = \frac{(3)(1) + (.4)(3)(9.8)}{\cos(35) + (.4)\sin(35)} = 14.076 \approx \boxed{14.1N}$$

2. $m = 100kg$

$F_p = 600N$

$F_r = 200N$

1. Draw Picture



2. Write equations

$F_{net} = ma$

$F_{net\,x} = ma_x$

$F_p - F_r = ma_x$

$F_p - F_r = ma_x$

$F_{net\,y} = ma_y$

$F_N - F_g = ma_y$

$F_N - mg = 0$

$a_y = 0$

$F_g = mg$

3. Solve

$\frac{F_p - F_r}{m} = a_x$

$a_x = \frac{(600) - (200)}{(100)} = 4 m/s^2$

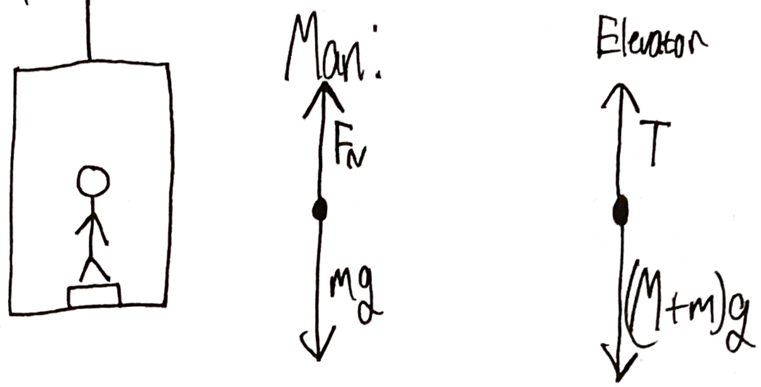
3. $W = 1029N$

$W = mg \rightarrow \frac{W}{g} = \frac{1029}{9.8} = 105kg = m$

$F_N = 1134N$

$M = 1200kg$

1. Draw Picture



2. Write equations

$F = ma$

Man:

$F_N - mg = ma$

3. Solve

$\frac{F_N}{m} - g = a$

$\frac{1134}{105} - 9.8 = 1m/s^2 = a$

Elevator

$T - (M+m)g = (M+m)a$

$T = (M+m)g + (M+m)a$

$T = (1200+105)(9.8) + (1200+105)(1)$

$= 14094N$

4. $m = 2kg$

$T = 14.12N$

1. Draw Picture

2. Write equations

$F_{net} = ma$

$F_{net\,x} = ma_x$ $F_{net\,y} = ma_y$

$-T\sin\theta + T\sin\theta = ma_x$

$0 = 0$

$T\cos\theta + T\cos\theta - mg = ma_y$

$2T\cos\theta - mg = 0$

$a_x = 0$

$a_y = 0$

3. Solve

$2T\cos\theta = mg$

$\cos\theta = \frac{mg}{2T}$

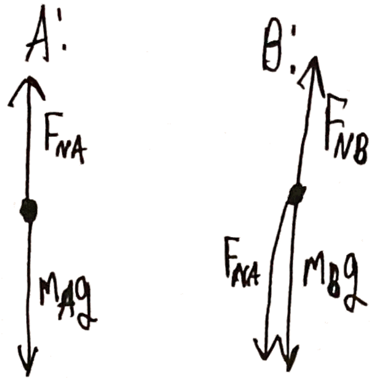
$\theta = \arccos\left(\frac{mg}{2T}\right)$

$\theta = \arccos\left(\frac{(2)(9.8)}{2(14.12)}\right) = 46^\circ$

5. $M_A = 1 kg$

$F_{NB} = 29.4 N$

1. Draw Picture



2. Write equations

A:

$F_{net} = M_A a_A$

$F_{NA} - M_A g = M_A a_A$

$F_{NA} - M_A g = 0$

B:

$F_{net} = M_B a_B$

$-F_{NA} + F_{NB} - M_B g = M_B a_B$

$F_{NB} - F_{NA} - M_B g = 0$

$a_A = 0$

$m_b = 0$

3. Solve

$F_{NA} = M_A g$

$F_{NB} - F_{NA} = M_B g$

$F_{NB} - M_A g = M_B g$

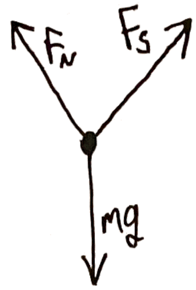
$\frac{F_{NB}}{g} - M_A = M_B$

$\frac{29.4}{9.8} - 1 = M_B$

$M_B = 2$

6. $m = 5kg$
$k = 300 N/m$
$d = 8cm = .08m$

1. Draw Picture



2. Write equations

$F_{net} = ma$

$F_{netx} = ma_x$

$F_s - mg\sin\theta = ma_x$

• $k\Delta x - mg\sin\theta = 0$

$F_{nety} = ma_y$

$F_N - mg\cos\theta = ma_y$

$F_N - mg\cos\theta = 0$

$a_x = 0$
$a_y = 0$
$F_s = k\Delta x$

3. Solve

• $k\Delta x = mg\sin\theta$

$\frac{k\Delta x}{mg} = \sin\theta$

$\theta = \arcsin\left(\frac{k\Delta x}{mg}\right) = \arcsin\left(\frac{(300)(.08)}{(5)(9.8)}\right) \approx 29.327$

≈ 29

7. $\theta = 25^\circ$

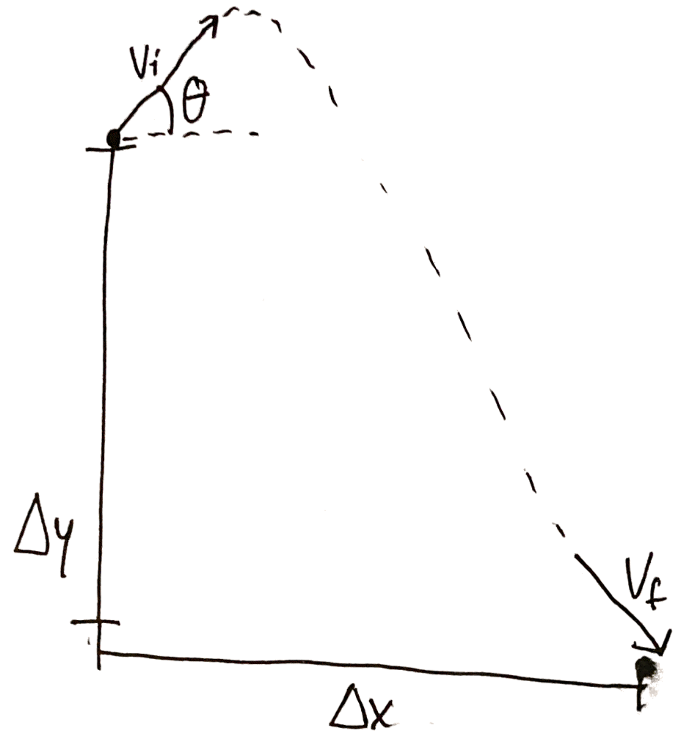
$t = 4.2s$

$\Delta x = 105m$

$a_y = -9.8m/s^2$

$a_x = 0$

1. Draw Picture



2. Write equations

$\Delta x = V_{ix}t + \frac{1}{2}a_x t^2$

$\Delta x = V_i \cos\theta t$

$V_{fx} = V_{ix} + a_x t$

$V_{fx} = V_{ix}$

$V_{fx} = V_i \cos\theta$

$V_{fy} = V_{iy} + a_y t$

$a_x = 0$

$a_y = -9.8m/s^2 = -g$

$V_{fy} = V_i \sin\theta - gt$

3. Solve

$\frac{\Delta x}{t\cos\theta} = V_i$

$\frac{(105)}{(4.2)\cos 25} = 27.58m/s = V_i$

$V_{fx} = (27.58)\cos 25$

$V_{fx} = 25m/s$

$V_{fy} = (27.58)\sin 25 - (9.8)(4.2)$

$V_{fy} = -29.5m/s$

$V_f = \sqrt{V_{fx}^2 + V_{fy}^2}$

$V_f = \sqrt{(25)^2 + (-29.5)^2}$

$= 38.67m/s \approx 38.1m/s$

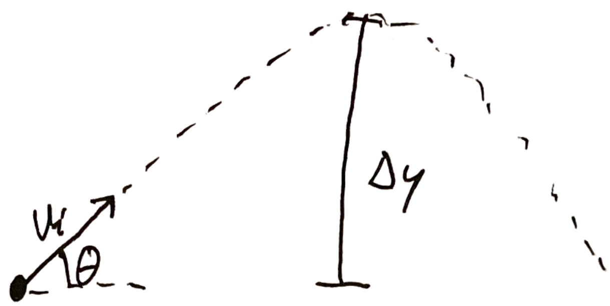
8. $v_i = 38 \text{ m/s}$

$\Delta y = 19.5 \text{ m}$

$a_y = -9.8 \text{ m/s}^2$

$a_x = 0$

1. Draw Picture



2. Write equations

$$V_{fy}^2 = V_{iy}^2 + 2a_y \Delta y$$

$$0 = V_{iy}^2 - 2g\Delta y$$

$$0 = (V_i \sin\theta)^2 - 2g\Delta y$$

$a_y = -9.8 \text{ m/s}^2 = -g$

$V_{fy} = 0$

3. Solve

$$2g\Delta y = (V_i \sin\theta)^2$$

$$\sqrt{2g\Delta y} = V_i \sin\theta$$

$$\frac{\sqrt{2g\Delta y}}{V_i} = \sin\theta$$

$$\theta = \arcsin\left(\frac{\sqrt{2g\Delta y}}{V_i}\right) = \arcsin\left(\frac{\sqrt{2(9.8)(19.5)}}{38}\right)$$

$$= 30.96^\circ$$

9. $\Delta y = -37m$
$t = 3.7s$
$a_y = -9.8 m/s^2$

1. Draw Picture

2. Write equations

$\Delta y = V_{iy}t + \frac{1}{2}a_y t^2$ $\qquad a_y = -9.8 m/s^2 = -g$

$\Delta y = V_{iy}t - \frac{g}{2}t^2$

3. Solve

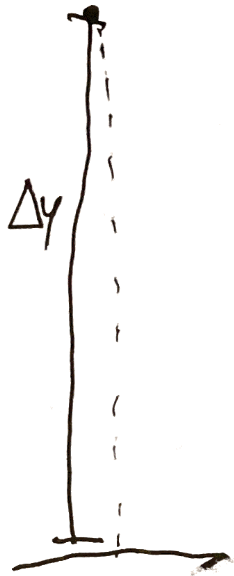
$\Delta y + \frac{g}{2}t^2 = V_{iy}t$

$\frac{\Delta y + \frac{g}{2}t^2}{t} = V_{iy}$

$V_{iy} = \frac{(-37) + \frac{(9.8)}{2}(3.7)^2}{3.7} = \boxed{8.13 m/s}$

10. $\Delta y = -150.2m$
$a_y = -9.8 m/s^2$
$V_i = 0$

1. Draw Picture



2. Write equations

$\Delta y = V_{iy}t + \frac{1}{2}a_y t^2$

$V_{iy} = 0$
$a_y = -g$

$\Delta y = -\frac{g}{2}t^2$

3. Solve

$-\frac{2\Delta y}{g} = t^2$

$\sqrt{\frac{-2\Delta y}{g}} = t$

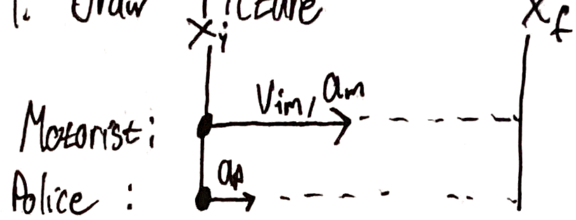
$t = \sqrt{\frac{-2(-150.2)}{9.8}} = \boxed{5.54s}$

11. $a_p = a$

$a_m = \frac{a}{3}$

$V_{im} = 80 \, m/s$

1. Draw Picture



2. Write equations

Motorist:

$\Delta X_m = V_{im}t + \frac{1}{2}a_m t^2$

Police:

$\Delta X_p = V_{ip}t + \frac{1}{2}a_p t^2$

$V_{fp} = V_{ip} + a_p t$

$V_{fp} = at$

$\Delta X = V_{im}t + \frac{1}{6}at^2$

$\Delta X = \frac{1}{2}at^2$

$V_{ip} = 0$

$a_p = a$

$a_m = \frac{1}{3}a$

$\Delta X_m = \Delta X_p = \Delta X$

3. Solve

$\frac{1}{2}at^2 = V_{im}t + \frac{1}{6}at^2$

$-\frac{1}{3}at^2 + V_{im}t = 0$

$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$b = V_{im} = 80$

$a = -\frac{1}{3}a$

$c = 0$

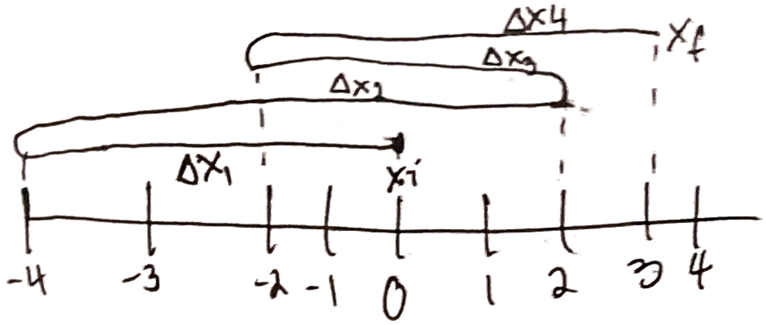
$\frac{-80 \pm \sqrt{80^2 - 0}}{2(-\frac{1}{3}a)} = \frac{-80 \pm 80}{-\frac{2}{3}a} = \frac{-160}{-\frac{2}{3}a} = \frac{240}{a} = t$

$V_{fp} = at$

$= a\left(\frac{240}{a}\right) = \boxed{240 \, m/s}$

2.

1. Draw Picture



2. Write equations

Distance: $|\Delta x_1|+|\Delta x_2|+|\Delta x_3|+|\Delta x_4|$

Displacement: $\Delta x = x_f - x_i$

$= 3 - 0$

$= 3$

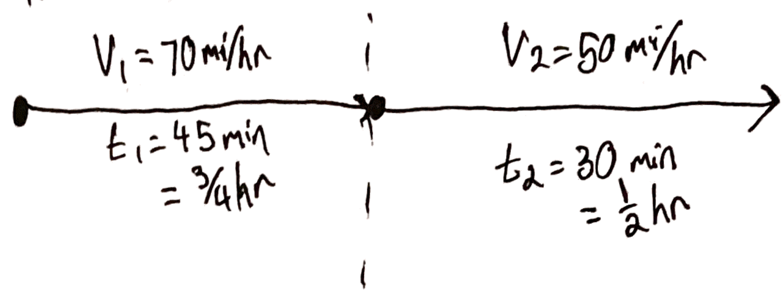
3. Solve →

Distance $= 4 + 6 + 4 + 5$

$= 19.$

13.

1. Draw Picture



2. Write equations

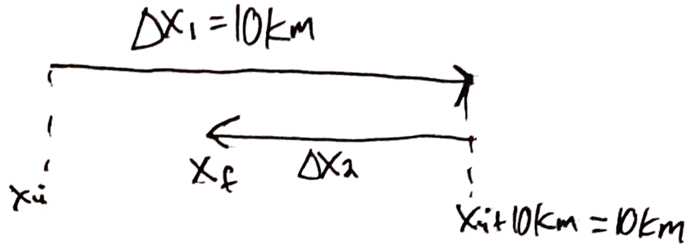
$$V_{avg} = \frac{\Delta x}{\Delta t} = \frac{\Delta x_1 + \Delta x_2}{\Delta t_1 + \Delta t_2} = \frac{V_1 t_1 + V_2 t_2}{t_1 + t_2}$$

3. Solve

$$V_{avg} = \frac{(70)(\frac{3}{4}) + (50)(\frac{1}{2})}{\frac{3}{4} + \frac{1}{2}} = \boxed{62 \text{ mi/hr}}$$

14.

1. Draw Picture



2. Write equations

$$V_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$$

$$S_{avg} = \frac{\text{Distance}}{\Delta t} = \frac{|\Delta x_1| + |\Delta x_2|}{\Delta t}$$

$$15 = \frac{10 + |x_f - 10|}{\Delta t}$$

$$15\Delta t = 10 + |x_f - 10|$$

$$15\Delta t = 10 - (x_f - 10)$$

$$15\Delta t = 20 - x_f$$

$$\Delta t = \frac{4}{3} - \frac{x_f}{15}$$

3. Solve

$$-10 = \frac{x_f - x_i}{\Delta t} \quad x_i = 0$$

$$-10\Delta t = x_f$$

$$\Delta t = \frac{x_f}{-10}$$

$$\frac{-x_f}{10} = \frac{4}{3} - \frac{x_f}{15}$$

$$\frac{-x_f}{30} = \frac{4}{3}$$

$$x_f = -40 \text{ km}$$

$$\Delta x_2 = |x_f - 10|$$

$$= |-40 - 10|$$

$$= |-50|$$

$$= 50 \text{ km}$$

~~Distance = $|\Delta x_1| + |\Delta x_2|$ = $10 + |x_f - 10|$ = $10 + |-40 - 10|$~~

15. F_{push}

F_{net}

m

d

1. Draw Picture

Before:

$F_{net} = F_{push} - F_f$

2. Write equations

$F_{total} = ma$

$F_{net} = F_{push} - F_f$

$F_f = -ma$

$V_f^2 = V_i^2 + 2a\Delta x$

$0 = v_i^2 + 2ad$

$V_f = 0$

$\Delta x = d$

3. Solve

$F_{push} - F_{net} = F_f$

$a = \frac{-F_f}{m}$

$-2ad = v_i^2$

$-2\left(\frac{-F_f}{m}\right)d = v_i^2$

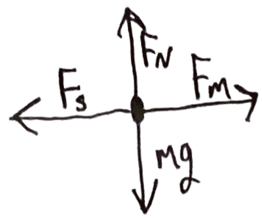
$+2\left(\frac{(F_{push} - F_{net})}{m}\right)d = v_i^2$

$$\sqrt{\frac{2(F_{push} - F_{net})d}{m}} = v_i$$

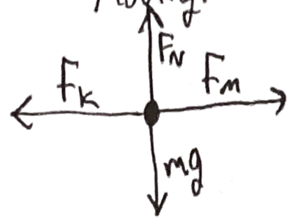
16. m
μ_k
F_m

1. Draw Picture

Minimum force (not moving):



Moving:



2. Write equations

F_x: $F_m - F_s = ma_x$ $\quad a_x = 0$

$F_m - \mu_s F_N = 0$ $\quad a_y = 0$

$F_s = \mu_s F_N$

F_y: $F_N - mg = 0$

x:

$F_m - F_k = ma_x$

$F_m - \mu_k F_N = ma$

y:

$F_N - mg = ma_y$

$a_y = 0$

$F_k = \mu_k F_N$

$F_N - mg = 0$

$F_N = mg$

3. Solve

$F_N = mg$ $\quad F_m - \mu_s(mg) = 0$

$\frac{F_m}{mg} = \mu_s$

$\frac{(ma + \mu_k mg)}{mg} = \mu_s$

$= \frac{ma}{mg} + \frac{\mu_k mg}{mg}$

$= \frac{a}{g} + \mu_k = \mu_s$

$F_m - \mu_k(mg) = ma$

$F_m = ma + \mu_k mg$