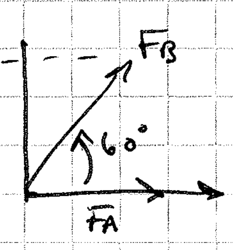
CH4 Excercises:

#1. (4.1)



$F_{A_x} = +270\text{ N}, \; F_{A_y} = 0$

$F_{B_x} = F_B \cos 60° = (300\text{ N})\cos(60°) = +150\text{ N}$

$F_{B_y} = F_B \sin 60° = (300\text{ N})\sin(60°) = +260\text{ N}$

$\vec{R} = \vec{F_A} + \vec{F_B}$

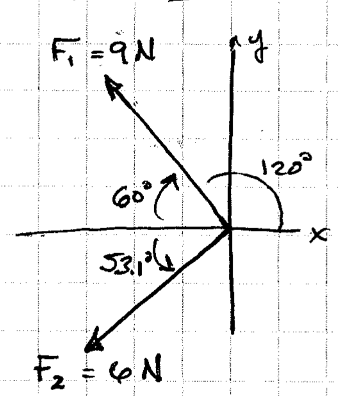
$R = \sqrt{R_x^2 + R_y^2} = \boxed{494\text{ N}}$

$R_x = 270\text{ N} + 150\text{ N} = 420\text{ N}$

$R_y = 0 + 260\text{ N} = 260\text{ N}$

$\theta = \tan^{-1}\left(\frac{R_y}{R_x}\right) = \boxed{31.8°}$

#2 (4.5) Given:



Noted: $53.1° + 180° = 233.1°$

Set-up: $F_x = F\cos\theta$
$F_y = F\sin\theta$

(a) $F_{1x} + F_{2x} = 9\cos(120°) + 6\cos(233.1°) = \boxed{-8.1\text{ N}}$

$F_{1y} + F_{2y} = 9\sin(120°) + 6\sin(233.1°) = \boxed{+3.0\text{ N}}$

(b) $R = \sqrt{R_x^2 + R_y^2} = \boxed{8.6\text{ N}}$

#3. (4.7) Given: $m = 68.5\text{ kg}$ and $v_0 = 2.4\text{ m/s}$, $t = 3.52\text{ s}$

- Solve for force of friction when $v_x = 0$.

Use: $v_x = v_{0x} + a_x t \Rightarrow a_x = \frac{\cancel{v_x} - v_0}{t} = \frac{-2.4\text{ m/s}}{3.52\text{ s}} = \underline{-0.68\text{ m/s}^2}$

Apply $\sum \vec{F} = m\vec{a}$ to skater...

$\Rightarrow f_x = m a_x = (68.5\text{ kg})(-0.68\text{ m/s}^2) = \boxed{-46.6\text{ N}}$

that is, the force is directed in the opposite direction with respect to the motion of the skater

#4 (4.15) Given $m = 8\ \text{kg}$ and $g = 9.8\ \text{m/s}^2$

$$F = A + Bt^2$$

(a) at $t=0$: $F = 100\text{N} = A + B(0) \Rightarrow A = \boxed{100\text{N}}$

at $t = 2\text{s}$: $F = 150\text{N} = A + B(2)^2 \Rightarrow B = \dfrac{150\text{N} - 100\text{N}}{4\text{s}^2} = \boxed{12.5 \dfrac{\text{N}}{\text{s}^2}}$

(b) $F_{grav} = mg = (8\ \text{kg})(9.8\ \text{m/s}^2) = 78.4\ \text{N}$

(i) at $t=0$: $\sum F_y = F - F_{grav} = (100 - 78.4)\text{N} = \boxed{21.6\text{N}}$

(ii) at $t=3\text{s}$: $\sum F_y = F - F_{grav} = \left[100 + 12.5(3)^2\right] - 78.4\ \text{N}$

$= (100 + 112.5) - 78.4\ \text{N} = \boxed{134.1\text{N}}$

$F = ma \Rightarrow a = F/m = (21.6\text{N})/8\text{kg} = \boxed{2.7\ \text{m/s}^2}$

$F = ma \Rightarrow a = (134.1\text{N})/(8\text{kg}) = \boxed{16.8\ \text{m/s}^2}$

(c) $F_{grav} = 0$,

at $t = 3\text{s}$: $F = 212.5\text{N} = ma$

$$\Rightarrow a = \frac{F}{m} = \frac{212.5\text{N}}{8\text{kg}} = \boxed{26.6\ \text{m/s}^2}$$

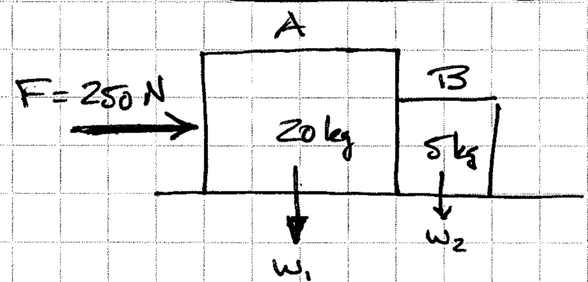
#5 (4.19) $w = mg$ where $g = 9.8\ m/s^2$, and $w = 44\ N$

(a) Solve for mass: $m = \frac{w}{g} = \frac{44\ N}{9.8\ m/s^2} = \boxed{4.5\ kg}$

(b) Given $g = 1.81\ m/s^2$, what is $w = ?$

$$w = (4.5\ kg)(1.81\ m/s^2) = \boxed{8.15\ N}$$

#6. (4.23)



$\sum F = ma$

- Solve for system acceleration: $250\ N = (20\ kg + 5\ kg)\ a_x$

$$\Rightarrow a_x = 250\ N / 25\ kg = \underline{10\ m/s^2}$$

- The force that box A then exerts on B...

$$F_A = m_B \cdot a_x = (5\ kg)(10\ m/s^2) = \boxed{50\ N}$$

Noted: the force acting on box "B" $<$ force on "A"

#7 (4.28) Given: $v_0 = 350\ m/s$, $v_x = 0$ and $\Delta x = 0.13\ m$, what is t?

(a) use: $\Delta x = (x - x_0) = \frac{1}{2}(v_0 + \cancel{v_x})t$

$$\Rightarrow t = \frac{2 \cdot \Delta x}{v_0} = \frac{2(0.13\ m)}{350\ m/s} = 7.43 \cdot 10^{-4}\ s$$

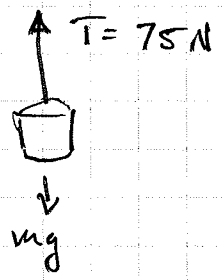
(b) What force does tree exert to stop bullet? $\sum F_x = ma_x$

Use: $v_x^2 = v_0^2 + 2a_x(x - x_0)$

$$\Rightarrow a_x = \frac{\cancel{v_x^2}^{\,0} - v_0^2}{2 \cdot \Delta x} = \frac{-(350\ m/s)^2}{2(0.13\ m)} = 4.71 \cdot 10^5\ m/s^2$$

$$F = ma_x = (1.8 \cdot 10^{-3}\ kg)(4.71 \cdot 10^5\ m/s^2) = \boxed{848\ N}$$

#8 (4.31) <u>Given:</u> $m = 5.6\,kg$, $T = 75N$



$\sum F_y = 0 \Rightarrow T - mg = ma$

For max acceleration, Tension is greatest... solve for a

$$\Rightarrow a_y = \frac{T - mg}{m} = \frac{75N - (5.6\,kg)(9.8\,m/s^2)}{5.6\,kg}$$

$$= \underline{3.59\ m/s^2}$$

Solve for time using:

$\Delta y = v_0 y + \frac{1}{2} a_y t^2$ where $v_0 = 0$ (at rest), $\Delta y = 12m$

$$\Rightarrow t = \sqrt{\frac{2 \cdot \Delta y}{a_y}} = \sqrt{\frac{2(12m)}{3.59\,m/s^2}} = \sqrt{6.69\,s^2} = \boxed{2.58\,s}$$

#9 (4.35) <u>Given</u> $\Delta y = 1.2m$, $g = 9.8\,m/s^2$ and $F_y = 890\,N$...

(a) what is v_0? when $v_x = 0$ (max height $= 1.2m$)

<u>Use</u>: $v_x^2 = V_0^2 + 2a_y(\Delta y)$ $\Rightarrow -v_0^2 = 2a_y(\Delta y)$ $a_y = -9.8\,m/s^2$

$$v_0 = \sqrt{2(9.8\,m/s^2)(1.2m)} = \boxed{4.85\ m/s}$$

(b) <u>Given:</u> $t = 0.3s$ and $v_0 = 4.85\,m/s$

acceleration $\Rightarrow a_y = \frac{v_0}{t} = (4.85\,m/s)/(0.3s) = \underline{16.17\ m/s^2}$

mass of Daniel $w = mg \Rightarrow m = \frac{890N}{(9.8\,m/s^2)} = \underline{90.8\ kg}$

Force required to elevate 1.2m:

$$F = m a_y = (90.8\,kg)(16.17\,m/s^2) = \underline{1468.5\ N}$$

<u>Total Force:</u> $\sum F_y = (1468.5 + 890)N = \underline{2358.5\ N}$

$$\therefore a_{ave} = \frac{\sum F_y}{m} = \frac{(2358.5N)}{90.8\,kg} = \boxed{25.97\ m/s^2}$$

#10 (4.37) Given $v_0 = 46\ m/s$, $\Delta x = 1\ m$ ...

(b) what force did pitcher exert on ball ($= 0.145\ kg$)?

$\sum' F_x = ma_x$ ... Solve for a_x ...

USE: $\{v_x^2 = v_0^2 + 2a_x(\Delta x)\}$ where $v_x = 0$

$$\Rightarrow a_x = \frac{v_0^2}{2(\Delta x)} = \frac{(46\ m/s)^2}{2(1m)} = \underline{\underline{1058\ m/s^2}}$$

$$\therefore F_x = (0.145\ kg)(1058\ m/s^2) = \boxed{153\ N}$$

#11 (4.45) Given: $\sum F_y = mg = 683\ N \Rightarrow m = F/g = 69.7\ kg$

(a) $n = 725\ N$

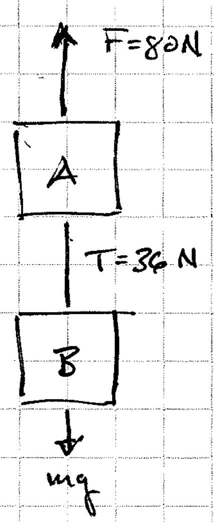
$$\sum' F_y = n - mg = ma_y \Rightarrow a_y = \frac{n - mg}{m}$$

$$\Rightarrow a_y = \frac{725\ N - 683\ N}{(69.7\ kg)} = \boxed{+0.603\ m/s^2 \text{ upwards}}$$

(b) $n = 595\ N$

$$\sum F_y \Rightarrow a_y = \frac{595N - 683N}{(69.7\ kg)} = \boxed{-1.26\ m/s^2 \text{ downwards}}$$

#12 (4.49) USE: $\{\Delta y = v_0 t + \frac{1}{2} a_y t^2\}$ where $\Delta y = 12m$, $t = 4s$, $v_0 = 0$



Solve for system acceleration: $a_y = \dfrac{2\Delta y}{t^2} = \dfrac{2(12m)}{(4s)^2} = \underline{1.5\ m/s^2}$

For box "B": $\sum F_y = mg - T = ma$

$$\Rightarrow m = \frac{T}{g - a} = \frac{36\ N}{(9.8 - 1.5)\ m/s^2} = \boxed{4.34\ kg}$$

For box "A": $\sum F_y = (T + mg) - F = ma$

$$\Rightarrow m = \frac{F - T}{g - a} = \frac{(80 - 36)N}{8.3\ m/s^2} = \boxed{5.30\ kg}$$

#13 (4.41) <u>Given:</u> $x(t) = (9\cdot10^3\ m/s^2)t^2 - (8\cdot10^4\ m/s^3)\cdot t^3$

(a) Object leaves barrel of gun at $t = 0.025$ s ... how long is gun?

$$x(0.025) = (9\cdot10^3)(0.025)^2 - (8\cdot10^4)(0.25)^3 = \boxed{4.4 m}$$

(b) what is speed of object when it leaves barrel?

$$v_x(t) = \frac{dx}{dt} = 2(9\cdot10^3\ m/s^2)\cdot t - 3(8\cdot10^4\ m/s^3)\cdot t^2$$

$$v(0.025) = (18\cdot10^3\ m/s^2)(0.025) - (24\cdot10^4\ m/s^3)(0.025)^2 = \boxed{300\ m/s}$$

(c) $\sum_i F_x = ma_x$ ... Solve for a_x

$$a_x(t) = \frac{dv}{dt} = 18\cdot10^3\ m/s^2 - 6(8\cdot10^4\ m/s^3)t$$

(i) <u>at $t=0$:</u> $a_x(t) = 18\cdot10^3\ m/s^2$

$$F = m a_x = (1.5\ kg)(18\cdot10^3\ m/s^2) = \boxed{2.7\cdot10^4\ N}$$

(ii) <u>at $t = 0.025$ s:</u> $a(0.025) = 18\cdot10^3 - (4.8\cdot10^5\ m/s^3)(0.025) = \underline{6\cdot10^3\ m/s^2}$

$$F = m a_x = (1.5\ kg)(6\cdot10^3\ m/s^2) = \boxed{9\cdot10^3\ N}$$

#14 (4.51) <u>Given:</u> $F(t) = (16.8\ N/s)\cdot t$ and $m = 45$ kg ...

$$F = ma \Rightarrow a(t) = F(t)/m = (0.373\ m/s^3)\cdot t = \alpha t$$

<u>Now:</u> $v(t) = v_0 + \int_0^t a(t)\,dt = \frac{1}{2}\alpha t^2$

$$x(t) = x_0 + \int_0^t v(t)\,dt = \frac{1}{3}\left(\frac{1}{2}\alpha\right)t^3 = \frac{1}{6}\alpha t^3$$

<u>@ $t = 5$ s:</u> $x(5s) = \frac{1}{6}(0.373\ m/s^3)(5)^3 = (0.062\ m/s^3)(125\ s^3)$

$$= \boxed{7.75 m}$$