1) 4.10

a)

$\Sigma F = F_g - F_n = 0$

$F_g = F_n$

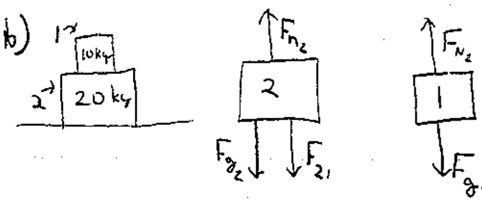
The weight is $F_g = mg$

$= 20 \cdot (9.8)$

$\boxed{F_g = 196\,N}$

so $\boxed{F_n = F_g = 196\,N}$

b)



$F_{N_2} = F_{12}$ but from Newton's 3rd law

$|F_{12}| = |F_{21}|$

$\Sigma F_2 = F_{n_2} - F_{g_2} - F_{21} = 0$

$\Sigma F_1 = F_{12} - F_{g_1} = 0$

$F_{n_2} = F_{g_2} + F_{21}$

$= F_{g_2} + F_{12}$

$= m_2 g + F_{12}$

$= 20 \cdot 9.8 + 98$

$F_{12} = F_{g_1}$

$F_{12} = m_1 g$

$= 10 \cdot 9.8$

$\boxed{F_{12} = 98\,N}$

$F_{n_2} = 196 + 98$

$\boxed{F_{n_2} = 294\,N}$

2) 4.14

a) $x_f = x_0 + v_0 t + \frac{1}{2} a t^2$

$x_0 = 0$
$x_f = 402\,m$
$v_0 = 0$
$t = 6.4\,s$

$x_f = \frac{1}{2} a t^2$

$a = \frac{2 x_f}{t^2}$

$= \frac{2(402)}{(6.4)^2}$

$a = 19.63\,m/s^2 \quad \frac{1g}{9.8\,m/s^2}$

$\boxed{a = 2g\text{'s}}$

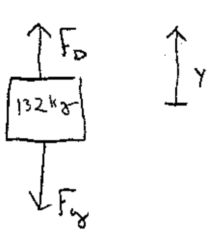
b) $F_n = ma$

$= (535)(19.63)$

$\boxed{F = 10{,}502\,N}$

3) 4.22

a)



$\sum F = F_D - F_g = ma$

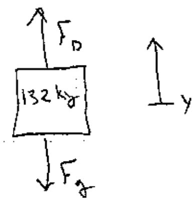
$\frac{1}{4}\cancel{m}g - \cancel{m}g = \cancel{m}a$

$\frac{1}{4}g - g = a$

$-\frac{3}{4}g = a$

$\boxed{a = -7.35 \text{ m/s}^2}$

b)



F_D is the Drag Force

$\sum F = F_D - F_g = 0$

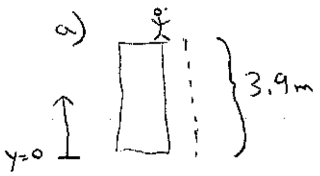
$F_D = F_g$

$F_D = mg$
$= (132)(9.8)$

$\boxed{F_D = 1290 \text{ N}}$

4) 4.26

a)



$v_f^2 = v_0^2 + 2a(\Delta y)$

$v_0 = 0$
$a = -9.8 \text{ m/s}^2$
$\Delta Y = -3.9 \text{ m}$

$v_f^2 = 2(-9.8)(3.9)$

$v_f = \sqrt{2(9.8)(3.9)}$

$\boxed{v_f = 8.7 \text{ m/s}}$ (Downward)

b) Now we need to find his deceleration

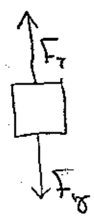
$v_0 = 8.7 \text{ m/s}$
$v_f = 0$
$\Delta y = -.7 \text{ m}$

$v_f^2 = v_0^2 + 2a(\Delta y)$

$2a(\Delta y) = -v_0^2$

$a = \frac{-v_0^2}{2(\Delta y)}$

$a = \frac{-(8.7)^2}{2(-.7)}$



$\underline{a = 54 \text{ m/s}^2}$ (in an upward direction)

so, to find the force exerted on his torso we need Newton's 2nd law

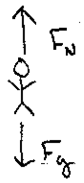
$\sum F = F_T - F_g = ma$

$F_T = F_g + ma$
$= mg + ma$
$= m(g + a)$
$= 42(9.8 + 54)$

$\boxed{F_T = 2667 \text{ N}}$

5) 4.28

a) before he jumps, he has the force of gravity pulling down, and the normal force from the floor pushing up



b) after he jumps, only the force of gravity is acting on him

6) 4.40

to find the velocity at $t = 3s$ we must 1st find the acceleration, which we can find using Newton's 2nd law

$$\Sigma\vec{F} = \vec{F}_1 + \vec{F}_2 = ma$$

$$(16\hat{i} + 12\hat{j}) + (-10\hat{i} + 22\hat{j}) = ma$$
$$(16-10)\hat{i} + (12+22)\hat{j} = ma$$
$$6\hat{i} + 34\hat{j} = 3a$$

$$\underline{\vec{a} = 2\hat{i} + \tfrac{34}{3}\hat{j}}$$

Now we can find the velocity using kinematics equations,

$$\vec{v} = \vec{v}_0 + \vec{a}t \qquad v_0 = 0$$

$$\vec{v} = \left(2\hat{i} + \tfrac{34}{3}\hat{j}\right)(3)$$

$$\boxed{\vec{v} = (6\hat{i} + 34\hat{j})\ m/s}$$

$$|\vec{v}| = \sqrt{v_x^2 + v_y^2} \qquad \tan^{-1}\left(\frac{34}{6}\right) = 80^\circ$$

$$|\vec{v}| = 34.5\ m/s$$

or $\boxed{\vec{v} = 34.5 m/s \ @\ 80^\circ}$

7) 4.44

For each ball, we have the following:

$\Sigma F = F_T - F_g = ma$ where a is the acceleration of the elevator.

we know that F_T has a maximal value of 22.2 N

$F_T = F_g + ma$

$F_T = m(g+a)$ F_T is proportion to m, so the higher m, the higher F_T

the 2.10 kg ball is the lightest ball to fall so we know that the acceleration of the elevator must be somewhere between the acceleration needed to the 2.10 kg ball fall and that needed to make the 2.05 kg ball fall.

solving for a, $F_T = m(g+a)$

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

so we have

$a > \frac{F_T}{2.10} - g$ and $a < \frac{F_T}{2.05} - g$

$a > \frac{22.2}{2.10} - 9.8$ $a < \frac{22.2}{2.05} - g$

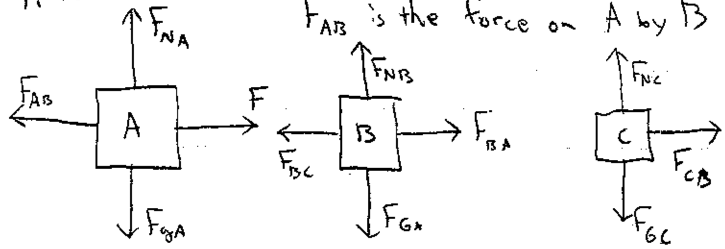
$a > .77\ m/s^2$ $a < 1.03\ m/s^2$

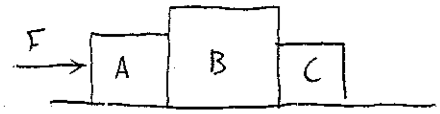
so $\boxed{.77\ m/s^2 < a < 1.03\ m/s^2}$

8) 4.46

F_{AB} is the force on A by B

(a)





and by Newton's 3rd law we have

$$|F_{AB}| = |F_{BA}| \quad \text{and} \quad |F_{CA}| = |F_{AC}|$$

(b) for each block the vertical forces are equal giving $F_{NA} = m_A g$, $F_{NB} = m_B g$ and $F_{NC} = m_C g$

and since the blocks move as a system, we have for the horizontal forces,

$$\sum F = F - \cancel{F_{AB}} + \cancel{F_{BA}} - \cancel{F_{BC}} + \cancel{F_{CB}} = (m_A + m_B + m_C)a$$

$$F = (m_A + m_B + m_C)a$$

$$\boxed{a = \frac{F}{(m_A + m_B + m_C)}}$$

(c) from Newtons second law we know that $\sum F = ma$ for each block, and we know from b, that the acceleration is the same for each block, so we have:

$$\boxed{\begin{aligned} \sum F_A &= \frac{F m_A}{(m_A + m_B + m_C)} \\ \sum F_B &= \frac{F m_B}{(m_A + m_B + m_C)} \\ \sum F_C &= \frac{F m_C}{(m_A + m_B + m_C)} \end{aligned}}$$

(d) For box C, we know $\sum F_C = \boxed{F_{CB} = \frac{F m_C}{(m_A + m_B + m_C)}}$

and we know $F_{CB} = \boxed{F_{BC} = \frac{F m_C}{(m_A + m_B + m_C)}}$ but in the opposite direction

For A, we have $\sum F = F - F_{AB} = \frac{F m_A}{(m_A + m_B + m_C)}$

so $F_{AB} = F - \frac{F m_A}{(m_A + m_B + m_C)}$

$$= F\left(1 - \frac{m_A}{(m_A + m_B + m_C)}\right)$$

$$= F\left(\frac{m_A + m_B + m_C}{m_A + m_B + m_C} - \frac{m_A}{m_A + m_B + m_C}\right)$$

$$\boxed{F_{AB} = F\left(\frac{m_B + m_C}{m_A + m_B + m_C}\right)} \quad \text{and } |F_{AB}| = |F_{BA}|$$

so $\boxed{F_{BA} = F\left(\frac{m_B + m_C}{m_A + m_B + m_C}\right)}$ but again in the opposite direction

(e) plugging in values:

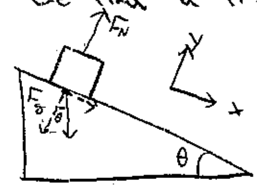
$$\boxed{\begin{aligned} &a = 3.2\,m/s^2 \\ &\sum F_A = \sum F_B = \sum F_C = 32\,N \\ &F_{AB} = F_{BA} = 64\,N \\ &F_{CA} = F_{AC} = 32\,N \end{aligned}}$$

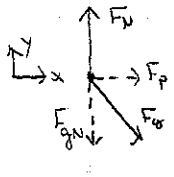
since F pushes all 3 blocks, F_{AB} pushes the second 2 blocks, and F_{BC} pushes only the 3rd block it makes sense that

$F > F_{BA} > F_{CB}$

9) 4.48

a) we find $\vec{a}$ from Newton's second law





F_p is the force of gravity parallel to the plane

$F_p = F_g \sin\theta$

$\theta = 22°$

$\sum F_x = F_p = ma$

$F_g \sin\theta = ma$

$mg\sin\theta = ma$

$a = g\sin\theta$

$\boxed{a = 3.67\ m/s^2}$

(b) to find the final speed we use kinematics.

$v_f^2 = v_0^2 + 2a(\Delta x)$ $\quad v_0 = 0$

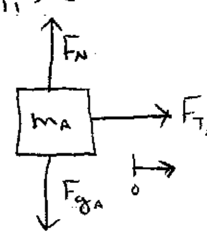
$\Delta x = 12\ m$

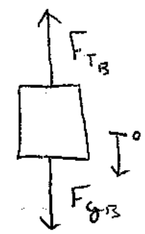
$v_f = \sqrt{2a(\Delta x)}$

$\boxed{v_f = 9.39\ m/s}$

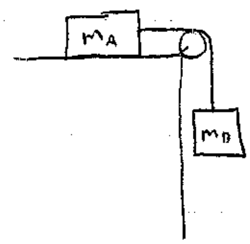
10) 4.52

a)





$|F_{T_A}| = |F_{T_B}|$



$m_A = 13\ kg$

$m_B = 5\ kg$

$\sum F_A = F_{T_A} = m_A a$ $\qquad$ $\sum F_B = F_{g_B} - F_{T_B} = m_B a$ $\qquad$ (they both have the same $\vec{a}$)

since $F_{T_A} = m_A a$

we have $F_{T_B} = m_A a$ $\quad \Rightarrow F_{g_B} - m_A a = m_B a$

$m_B g = a(m_A + m_B)$

$\Rightarrow \boxed{a = \dfrac{m_B g}{m_A + m_B}}$

$\boxed{a = 2.72\ m/s^2}$ (Both Blocks have the same a!)

b) use kinematics

$x_f = x_0 + v_0 t + \frac{1}{2}at^2$

$x_0 = 0$

$x_f = 1.25$

$v_0 = 0$

$1.25 = \frac{1}{2}(2.72)t^2$

$\Rightarrow \boxed{t = .96\ s}$

c) $a = \left(\dfrac{m_B}{m_A + m_B}\right) g = \dfrac{1}{100} g$ $\qquad m_B = 1\ kg$

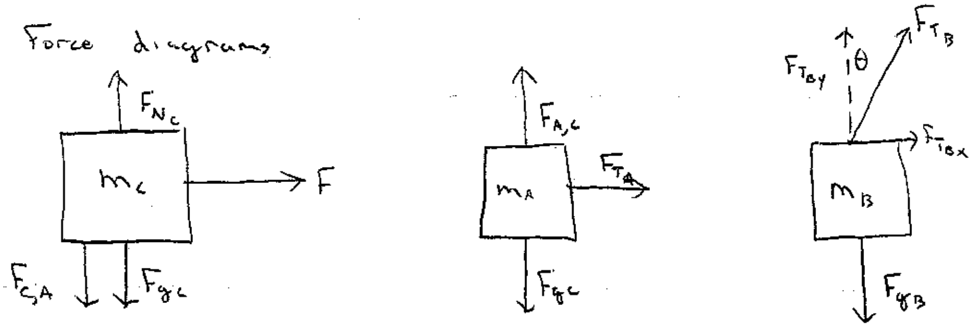
$\dfrac{1}{m_A + 1} = \dfrac{1}{100}$

$\Rightarrow \boxed{m_A = 99\ kg}$

11) 4.59

since m_A & m_C do not move relative to each other, they must have the same horizontal acceleration. Also, m_B must have no acceleration in the y-direction, since it is not pulling m_A forward. In the end we have $\Sigma F = \underline{F = ma}$

Force diagrams



$|F_{T_B}| = |F_{T_A}| = F_T$

$$\Sigma F_{B_x} = F_{T_{Bx}} = m_B a \qquad \Sigma F_{B_y} = F_{T_{By}} - F_{gB} = 0$$

$$= F_T \sin\theta = m_B a \qquad F_T \cos\theta = m_B g$$

square both of these, and add them together

$$(F_T \sin\theta)^2 = (m_B a)^2 \qquad (F_T \cos\theta)^2 = (m_B g)^2$$

$$F_T^2 \sin^2\theta = m_B^2 a^2 \qquad F_T^2 \cos^2\theta = m_B^2 g^2$$

$$F_T^2 \sin^2\theta + F_T^2 \cos^2\theta = m_B^2 a^2 + m_B^2 g^2$$

$$F_T^2(\sin^2\theta + \cos^2\theta) = m_B^2(a^2 + g^2) \qquad \text{but } \sin^2\theta + \cos^2\theta = 1$$

so $\quad F_t^2 = m_B^2(a^2 + g^2)$

Now look at m_A

$$\Sigma F_{A_x} = F_{T_A} = m_A a \qquad \Sigma F_{A_y} = F_{A,C} - m_A g = 0$$

$$F_T = m_A a$$

or $\quad F_T^2 = m_A^2 a^2$

so we have $\quad m_A^2 a^2 = m_B^2(a^2 + g^2) = F_T$

$$m_A^2 a^2 - m_B^2 a^2 = g^2$$

$$a^2(m_A^2 - m_B^2) = g^2 m_B^2$$

$$a = \frac{g m_B}{\sqrt{m_A^2 - m_B^2}}$$

$$F = (m_A + m_B + m_C)a$$

so $\quad \boxed{F = \frac{(m_A + m_B + m_C)}{\sqrt{m_A^2 - m_B^2}} g m_B}$