1.) *Multiple Choice* *(18 pts.)*

For each statement below, circle the correct answer (TRUE or FALSE, no reasoning required).

(a) In projectile motion, the acceleration at the highest point of the motion is equal to $\vec{g}$.
TRUE FALSE

(b) The magnitude of the sum of two vectors, $\vec{C} = \vec{A} + \vec{B}$, cannot be larger than the sum of the magnitudes of $\vec{A}$ and $\vec{B}$.
TRUE FALSE

(c) In uniform circular motion, the centripetal acceleration is directed radially outward.
TRUE FALSE

(d) If you are sitting in your car and accelerate, there is a force on you that pushes you back into the seat.
TRUE FALSE

(e) If an accelerator is moving downward at constant velocity, your apparent weight in the elevator is smaller than your true weight.
TRUE FALSE

(f) When a car starts from rest at constant acceleration, its distance covered after 10 seconds is 2 times as large as the distance covered after the initial 5 seconds.
TRUE FALSE

No.	Points
1	CH
2	SC
3	LS
4	RL
5	RR
Sum	

2.) *Projectile Motion* (10+4+6 pts.)

A student hits a tennis ball toward a practice wall. The ball is launched one meter above the horizontal ground at an angle of 35° above the horizontal. The ball strikes the wall, which is 12 m away, 4 m (3) above the ground.

(a) Calculate the initial speed of the tennis ball.

(b) How long is the ball in the air (between launch and impact)?

(c) Find the x and y components of the velocity just before the ball hits the wall.

(a) $\Delta x = V_{ox} t \rightarrow t = \frac{\Delta x}{V_{ox}} = \frac{\Delta x}{V_o \cos\theta}$ insert below

$\Delta y = V_{oy} t - \frac{1}{2} g t^2$

$= V_o \sin\theta \left(\frac{\Delta x}{V_o \cos\theta}\right) - \frac{1}{2} g \left(\frac{\Delta x}{V_o \cos\theta}\right)^2$

$= \tan\theta \, \Delta x - \frac{1}{2} g \frac{\Delta x^2}{V_o^2 \cos^2\theta}$ solve for V_o

$\Delta y - \Delta x \tan\theta = -\frac{1}{2} g \frac{\Delta x^2}{V_o^2 \cos^2\theta}$

$\Rightarrow \boxed{V_o = \frac{\Delta x}{\cos\theta} \left(\frac{(-g)}{2(\Delta y - \Delta x \tan\theta)}\right)^{1/2}} = \boxed{13.95 \frac{m}{s}}$

$\left(12.82 \frac{m}{s}\right)$

(b) $\boxed{t = \frac{\Delta x}{V_o \cos\theta}} = \boxed{1.05 \text{ s}}$ (1.14s)

(c) $\boxed{V_{fx}} = V_{ox} = V_o \cos\theta = \boxed{11.4 \text{ m/s}}$ (10.5 m/s)

$\boxed{V_{fy}} = V_{oy} - gt = \boxed{-2.3 \text{ m/s}}$ (-3.8 m/s)

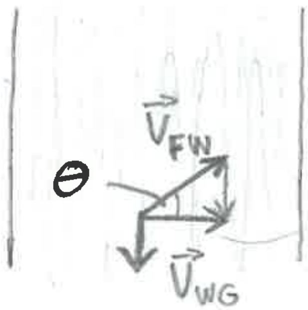
3.) *Relative Velocity* (20 pts.)

A river (230 m wide) is flowing due south with a current of 5 mph. A ferry, which has a still water speed of 12 mph, needs to cross the river due east. (7)

(a) At what angle relative to due east should the captain aim his ferry?

(b) How long does it take the ferry to cross the river?

(a)



$$\vec{V}_{FG} = \vec{V}_{FW} + \vec{V}_{WG}$$

$$\sin\theta = \frac{V_{WG}}{V_{FW}} \Rightarrow \boxed{\theta = \sin^{-1}\left(\frac{5}{12}\right) = 24.6^\circ}$$

(35.7°)

(b) $V_{FG}^2 = V_{FW}^2 - V_{WG}^2 \Rightarrow V_{FG} = 10.9\ mph = 4.85\ \frac{m}{s}$

(4.33)

$$d = V_{FG}\, t \Rightarrow \boxed{t = \frac{d}{V_{FG}} = \frac{230}{4.85} = 47.4\ s}$$

(53.1 s)

4.) *Normal Force in Elevator* (4 + 8 + 8 *pts.*)

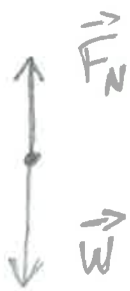
An elevator cabin has a scales implemented into its floor. A person steps into the elevator and reads off his weight of 800 N (400). Then the elevator starts to move at a constant acceleration, and the scales is showing a reading of 720 N.

(a) Draw a free-body diagram of the person.

(b) How large is the initial acceleration of the elevator, and what is its direction (up or down)?

(c) Now the elevator is slowing down at a deceleration of $2m/s$. What is the scales reading?

(a)



(b) $ma = \sum_i F = F_N - W$

$a = \frac{F_N - W}{m} = -0.98 \frac{m}{s^2}$ down $\left(-1.96 \frac{m}{s^2}\right)$

$m = W/g = 81.6 kg$

(c) $ma = F_N - W \Rightarrow F_N = W + ma = 963 N$ (1084 N)

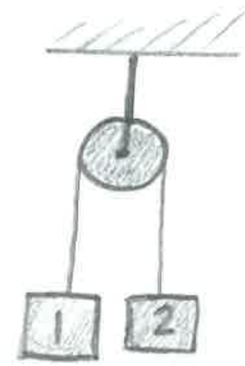
5.) *Tension Force in Atwood's Machine* (8+10+4 *pts.*)

Two weights (m_1=5 kg, m_2=4 kg) are attached to an ideal rope which passes over an ideal pulley (massless, no friction). (3)

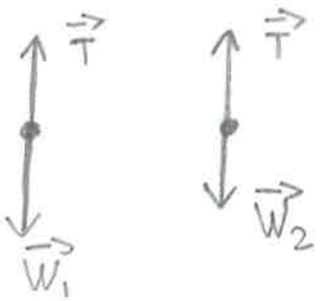
(a) Draw the free-body diagram of each box.

(b) Find the acceleration of the boxes.

(c) Find the tension force in the rope.



(a)



(b)

$$\sum_i F_{1i} = m_1 a_1 = T - m_1 g$$

$$\sum_i F_{2i} = m_2 a_2 = T - m_2 g$$

$$a_1 = -a_2$$

$$\Rightarrow \quad \left.\begin{aligned} m_1 a_1 &= T - m_1 g \\ -m_2 a_1 &= T - m_2 g \end{aligned}\right\} \quad \text{subtract}$$

$$(m_1 + m_2)\, a_1 = (m_2 - m_1)\, g$$

$$\Rightarrow \quad \boxed{a_1 = \frac{(m_2 - m_1)}{(m_1 + m_2)}\, g = -\frac{1}{9} g = -1.09 \frac{m}{s^2}} \quad \left(-2.45 \frac{m}{s^2}\right)$$

$$\boxed{a_2 = +1.09\ m/s^2} \quad (+2.45\ m/s^2)$$

(c) $\boxed{T = m_1 g + m_1 a_1 = m_1 (g + a_1) = 43.6\,N}$ (36.75 N)