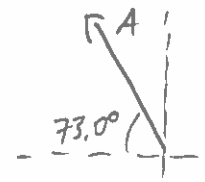
Physics 10154 - Fall 2018 Exam #1B

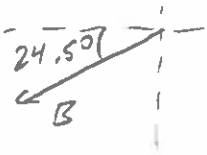
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A car drives from the origin to point A, 25.0 miles in a direction 73.0° North of West, then to point B, 87.4 miles in a direction 24.5° South of West. Point C is located 103.0 miles due West of the origin. If the car is to drive a straight line distance from point B to point C, what would be the magnitude and direction of the necessary displacement?



$A_x = -25.0 \cos 73.0° = -7.309$

$A_y = +25.0 \sin 73.0° = +23.908$



$B_x = -87.4 \cos 24.5° = -79.531$

$B_y = -87.4 \sin 24.5° = -36.244$

Resultant: $R_x = -103.0$

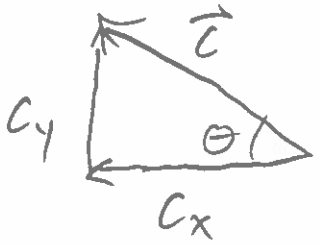
$R_y = 0$

Need $A_x + B_x + C_x = -103.0$

$-86.84 + C_x = -103.0 \Rightarrow C_x = -16.16$

Need $A_y + B_y + C_y = 0$

$-12.336 + C_y = 0 \Rightarrow C_y = 12.336$



$|\vec{C}| = \sqrt{C_x^2 + C_y^2} =$ **20.3 miles**

$\theta = \tan^{-1}\left(\left|\frac{C_y}{C_x}\right|\right) =$ **37.4° N of W**

2. (35 pts) A person walks 4.2 miles/hour in the +x direction at a constant velocity for some unknown time, pausing at some point along the way for a 6.00 minute rest stop. If the walker's average velocity for the entire trip is 3.8 miles/hour in the +x direction, how far did the walker travel?

$\Delta x_1 = ?$ $\quad \Delta x_2 = 0$ $\quad \Delta x_{tot} = ?$

$v_1 = 4.2\ mi/hr$ $\quad v_2 = 0$ $\quad v_{tot} = 3.8\ mi/hr$

$t_1 = ?$ $\quad t_2 = 0.1\ hr$ $\quad t_{tot} = ?$

$$v_{tot} = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2}$$

$$= \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2}$$

$$3.8 = \frac{4.2 t_1 + 0}{t_1 + 0.1}$$

$$3.8 t_1 + 0.38 = 4.2 t_1$$

$$0.38 = 0.4 t_1$$

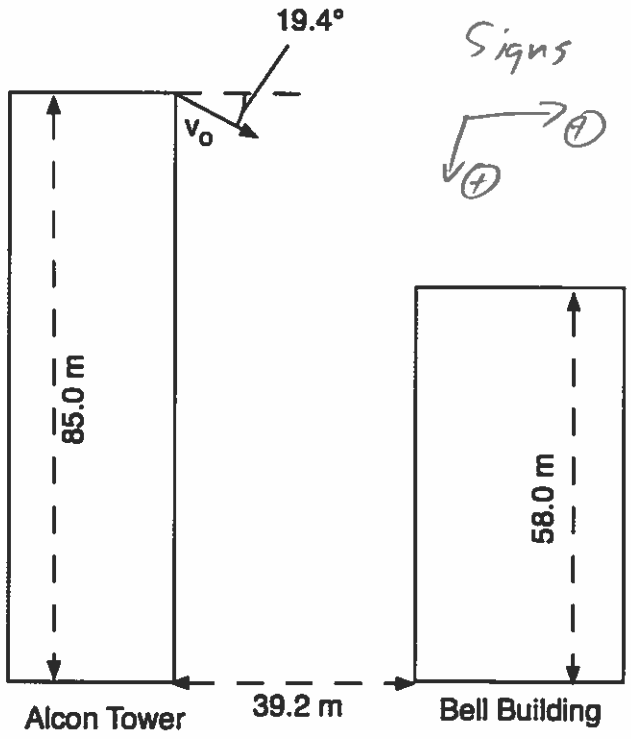
$$t_1 = 0.95\ hr$$

$$\Delta x_1 = (4.2)(0.95) = 3.99 \text{ or } \boxed{4.0 \text{ miles}}$$

Check: $\frac{\Delta x_1 + \Delta x_2}{t_1 + t_2} = \frac{3.99 + 0}{.95 + .1} = 3.8\ mi/hr$ ✓

3. (35 pts) A rock is thrown from the edge of the 85.0-meter high Alcon Tower with an initial velocity of 17.0 m/s directed 19.4° below the horizontal. 39.2 meters away is the Bell Building, with a vertical height of 58.0 meters.

a) Does the rock go above the wall and land on the roof of the Bell Building or does the rock hit the side of the building?
b) When the rock has traveled 39.2 meters horizontally and either hits the wall or passes above it, what is the magnitude and direction of the rock's velocity?



Signs

Find Δy when $\Delta x = 39.2$m, compare to difference in heights (27.0m),

If $\Delta y > 27.0$m, hits wall

$\Delta y < 27.0$m, lands on roof

$V_{0x} = 17 \cos 19.4°$

$= 16.035$ m/s

$t = \frac{\Delta x}{V_{0x}} = 2.445$ s

$\Delta y = ?$

$V_{0y} = 5.647$ m/s

$V_y = ?$

$a_y = 9.8$ m/s^2

$t = 2.445$s

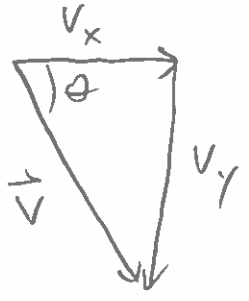
$\Delta y = (5.647)(2.445) + \frac{1}{2}(9.8)(2.445)^2$

$= 13.806 + 29.292$

$= \boxed{43.1\text{m} > 27.0\text{m, hits wall}}$

$V_y = V_{0y} + a_y t = 29.608$

$V_x = V_{0x} = 16.035$ m/s



$|\vec{V}| = \sqrt{V_x^2 + V_y^2} = \boxed{33.7 \text{ m/s}}$

$\theta = \tan^{-1}\left(\left|\frac{V_y}{V_x}\right|\right) = \boxed{61.6° \text{ below } +x}$