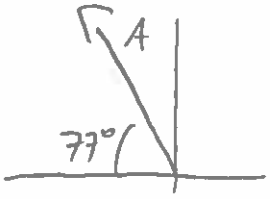
Physics 10154 - Fall 2018 Exam #1C

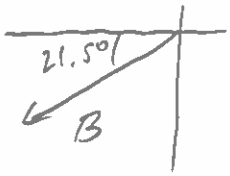
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct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

1. (30 pts) A car drives from the origin to point A, 65.0 miles in a direction 77.0° North of West, then to point B, 31.4 miles in a direction 21.5° South of West. If the car is to drive a straight line distance from point B back to the origin, what would be the magnitude and direction of the necessary displacement?



$A_x = -65 \cos 77° = -14.622$

$A_y = +65 \sin 77° = +63.334$

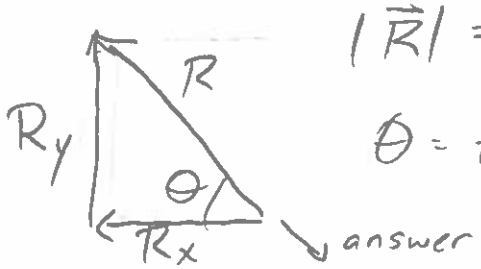


$B_x = -31.4 \cos 21.5° = -29.215$

$B_y = -31.4 \sin 21.5° = -11.508$

$R_x = A_x + B_x = -43.837$

$R_y = A_y + B_y = +51.826$



$|\vec{R}| = \sqrt{R_x^2 + R_y^2} = 67.879$ mi

$\theta = \tan^{-1}\left(\left|\frac{R_y}{R_x}\right|\right) = 49.774°$ above $-x$

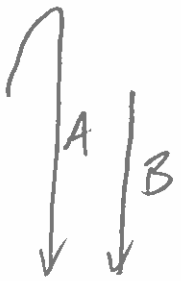
To return to origin, you must travel same $|\vec{R}|$ but in opposite direction.

67.9 mi, 49.8° below $+x$

or S of E

2. (35 pts) Two identical pellet guns are fired simultaneously from the edge of a cliff of unknown height above the ground. Both guns impart a speed of 26.4 m/s to the pellet. Gun A is fired straight up, with the pellet going up and then falling back down, eventually hitting the ground beneath the cliff. Gun B is fired directly downward.

How long after pellet B hits the ground does pellet A hit the ground?



Motions of A & B pellets are identical once A falls through its original elevation, so the delay will be the time it takes for A to go up & back down so that $\Delta y_A = 0$. After that, the cliff height is irrelevant, motion identical.

$\Delta y = 0$

$v_{0y} = 26.4\ m/s$

$v_y = ?$

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

$t = ?$

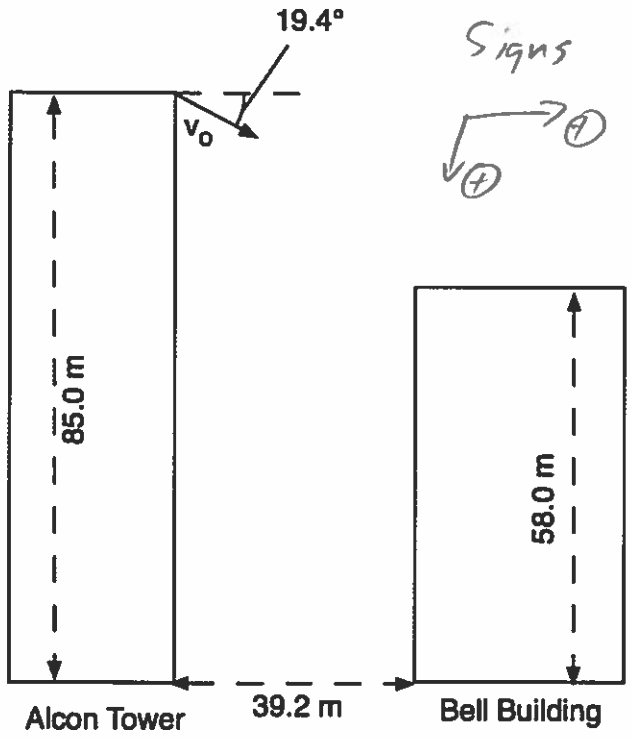
$0 = 26.4t - 4.9t^2$

$0 = t(26.4 - 4.9t)$

$t = 0$ or $\frac{26.4}{4.9} = \boxed{5.39\ s}$

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

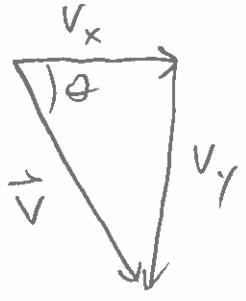
$\Delta y = (5.647)(2.445) + \frac{1}{2}(9.8)(2.445)^2$

$= 13.806 + 29.292$

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

$v_y = v_{0y} + a_y t = 29.608$

$v_x = v_{0x} = 16.035$ m/s



$|\vec{v}| = \sqrt{v_x^2 + v_y^2} = \boxed{33.7 \text{ m/s}}$

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