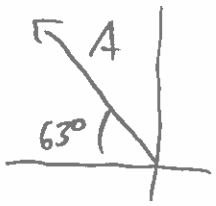
Physics 10154 - Fall 2018 Exam #1D

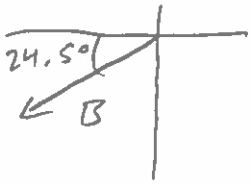
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct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

1. (30 pts) A car drives from the origin to point A, 26.0 miles in a direction 63.0° North of West, then to point B, 33.4 miles in a direction 24.5° South of West. Point C is located 37.0 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?



$A_x = -26.0 \cos 63.0° = -11.804$

$A_y = +26.0 \sin 63.0° = +23.166$



$B_x = -33.4 \cos 24.5° = -30.393$

$B_y = -33.4 \sin 24.5° = -13.851$

Resultant: $R_x = -37.0$

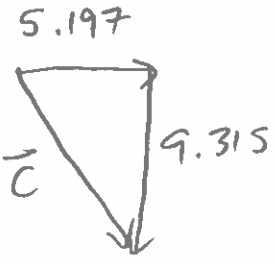
$R_y = 0$

Want $A_x + B_x + C_x = -37.0$

$-42.197 + C_x = -37.0 \Rightarrow C_x = +5.197$

Want $A_y + B_y + C_y = 0$

$9.315 + C_y = 0 \Rightarrow C_y = -9.315$



$|\vec{C}| = \sqrt{C_x^2 + C_y^2} =$ **10.7 miles**

$\theta = \tan^{-1}\left(\left|\frac{C_y}{C_x}\right|\right) =$ **60.8° below +x**

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?

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

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

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

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

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

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

$$3.8 t_1 + 0.38 = 4.2 t_1$$

$$0.38 = 0.4 t_1$$

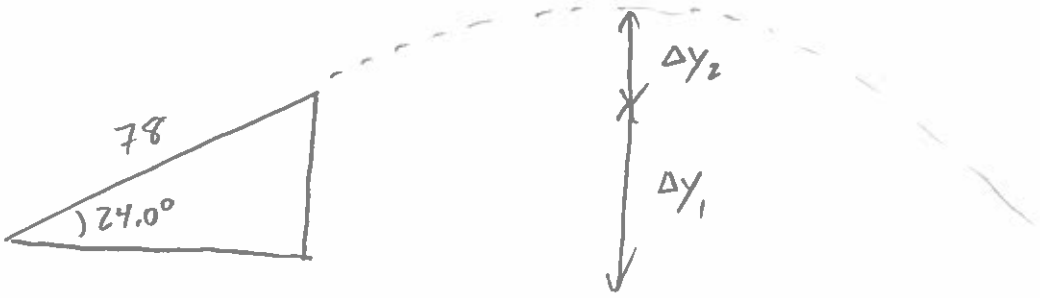
$$t_1 = 0.95\ hr$$

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

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) Starting from rest and ground level at the base of a ramp, a car accelerates up a ramp that is 78.0 meters long and inclined 24.0° above the horizontal. The acceleration is 12.5 m/s² directed up the ramp. Upon leaving the ramp, the car is in free fall.

a) To what maximum height above the ground does the car rise? Don't neglect to include the height of the ramp.
b) What is the magnitude and direction of the car's velocity when it is at its maximum height?



$\Delta y_1 = 78 \sin 24° = 31.725$ m

On ramp:

$\Delta s = 78.0$
$v_0 = 0$
$v = ?$
$a = 12.5\ m/s^2$
$t = ?$

$v^2 = v_0^2 + 2a\Delta s$

$v^2 = 1950$

$v = 44.159$ directed 24.0° above +x

↑ use this as v_0 for free fall

Free fall $v_{0x} = 44.159 \cos 24.0° = 40.341$ m/s

$v_{0y} = 44.159 \sin 24.0° = 17.961$ m/s

$\Delta y_2 = ?$
$v_{0y} = 17.961$
$v_y = 0$
$a_y = -9.8$
$t = ?$

$v_y^2 = v_{0y}^2 + 2a\Delta y$

$0^2 = 322.598 + 2(-9.8)\Delta y$

$\Delta y_2 = 16.459$ $\Rightarrow \Delta y_1 + \Delta y_2 = \boxed{48.2\ m}$

At max ht $v_x = 40.3$
$v_y = 0$

$\Rightarrow \boxed{v = 40.3\ m/s, +x\ dir}$