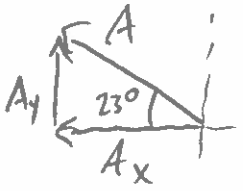
Physics 10154 - Exam #1A

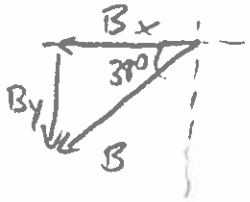
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct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

1. (35 pts) A hiker walks 2.3 miles in a direction 23° North of West, then 3.4 miles in a direction 38° South of West, then 1.5 miles due South. What must be the vector displacement of the hiker during the fourth part of the trip in order for the total displacement to be 5.5 miles due West for the entire trip?



$A_x = -2.3 \cos 23° = -2.12 \text{ mi}$

$A_y = +2.3 \sin 23° = +0.90 \text{ mi}$



$B_x = -3.4 \cos 38° = -2.68 \text{ mi}$

$B_y = -3.4 \sin 38° = -2.09 \text{ mi}$

C

$C_x = 0$

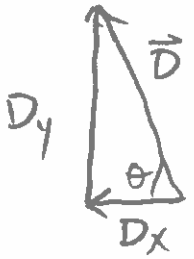
$C_y = -1.5 \text{ mi}$

Need $A_x + B_x + C_x + D_x = -5.5$

$-2.12 - 2.68 + 0 + D_x = -5.5 \Rightarrow D_x = -0.70$

Need $A_y + B_y + C_y + D_y = 0$

$0.90 - 2.09 - 1.5 + D_y = 0 \Rightarrow D_y = +2.69$



$|\vec{D}| = \sqrt{D_x^2 + D_y^2} = \boxed{2.8 \text{ mi}}$

$\theta = \tan^{-1}\left|\frac{2.69}{0.70}\right| = \boxed{75° \text{ N of W}}$

2. (30 pts) A person drives along a straight road at a rate of 74.0 miles/hour for some unknown time. During the trip, the driver stops for a 12.0 minute rest stop. If the average velocity for the entire trip is 67.4 miles/hour, how far did the driver travel?

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

$v_1 = 74.0\ mi/hr$ $\quad v_2 = 0$ $\quad v_{tot} = 67.4$

$t_1 = ?$ $\quad t_2 = 0.20\ hr$ $\quad t_{tot} = ?$

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

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

$$67.4 = \frac{74.0\, t_1 + 0}{t_1 + 0.200}$$

$$67.4\, t_1 + 13.48 = 74.0\, t_1$$

$$13.48 = 6.6\, t_1$$

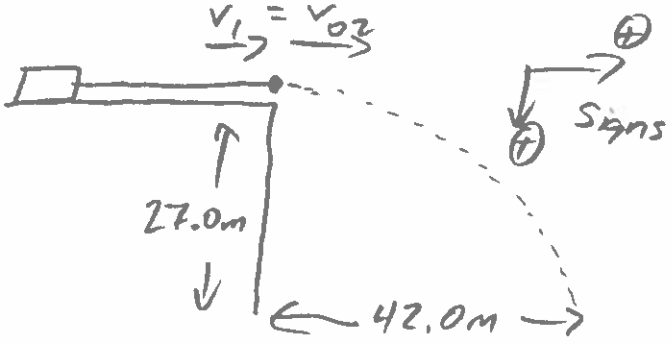
$$t_1 = 2.04\ hr$$

$$\Delta x_1 = \Delta x_{tot} = v_1 t_1 = (74.0)(2.04)$$

$$= \boxed{151\ miles}$$

3. A car starts from rest and accelerates at a constant rate down a horizontal road for 4.50 seconds. The road ends at the top of a vertical cliff, 27.0 meters above ground level. When the car leaves the cliff, it is in free fall, and it lands 42.0 meters from the base of the cliff.

a) (20 pts) What was the car's acceleration on the horizontal road?



Part 1

$\Delta x = ?$
$v_0 = 0$
$v = ?$
$a = ?$
$t = 4.50\,s$

Part 2

$\Delta x = 42.0\,m$ $\quad \Delta y = 27.0\,m$
$v_{0x} = ?$ $\quad v_{0y} = 0$
$v_x = ?$ $\quad v_y = ?$
$a_x = 0$ $\quad a_y = 9.8\,m/s^2$
$t = ?$ $\quad t = ?$

$\Delta y = v_{0y} t + \frac{1}{2} a_y t^2$

$27.0 = 0 + 4.9t^2 \rightarrow t = 2.35\,s$ ← use for x

$\Delta x = v_{0x} t + \frac{1}{2} a_x t^2$

$42.0 = v_{0x}(2.35) \Rightarrow v_{0x} = 17.89\,m/s$ ← use as v for pt 1

For part 1: $v = v_0 + at$

$17.89 = 0 + a(4.50)$

$\boxed{a = 3.98\,m/s^2}$

3. A car starts from rest and accelerates at a constant rate down a horizontal road for 4.50 seconds. The road ends at the top of a vertical cliff, 27.0 meters above ground level. When the car leaves the cliff, it is in free fall, and it lands 42.0 meters from the base of the cliff.

b) (20 pts) What is the magnitude and direction of the car's final velocity the instant before it hits the ground?

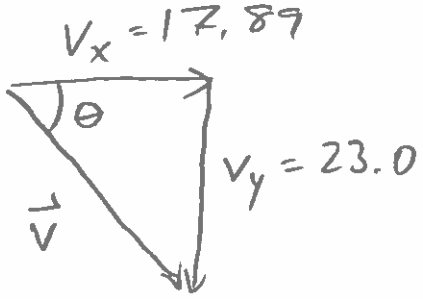
From a, we know v_{0x} for part 2 is 17.89 m/s

this is also v_x since $a_x = 0$

Find v_y: $v_y^2 = v_{0y}^2 + 2a_y \Delta y$

$= 0 + 2(9.8)(27)$

$v_y = \pm 23.0$ m/s $\Rightarrow$ use $v_y = +23.0$ m/s (down)



$\vec{v} = \sqrt{v_x^2 + v_y^2} =$ **29.1 m/s**

$\theta = \tan^{-1}\left|\frac{23.0}{17.89}\right| =$ **52.1° below +x**