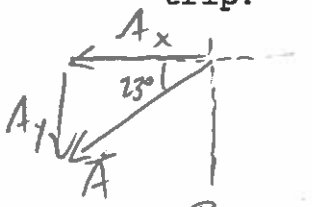
Physics 10154 - Exam #1B

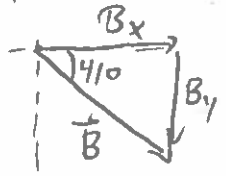
Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct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

1. (30 pts) A hiker walks 2.8 miles in a direction 23° South of West, then 7.1 miles in a direction 41° South of East, 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 6.0 miles due South for the entire trip?



$A_x = -2.8 \cos 23^\circ = -2.58$ mi

$A_y = -2.8 \sin 23^\circ = -1.09$ mi



$B_x = 7.1 \cos 41^\circ = +5.36$ mi

$B_y = -7.1 \sin 41^\circ = -4.66$ mi

$\downarrow C$

$C_x = 0$

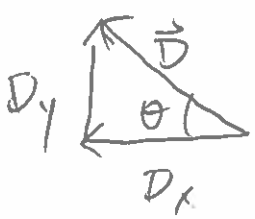
$C_y = -1.50$ mi

Need $A_x + B_x + C_x + D_x = 0$

$-2.58 + 5.36 + 0 + D_x = 0 \Rightarrow D_x = -2.78$

Need $A_y + B_y + C_y + D_y = -6.0$

$-1.09 - 4.66 - 1.50 + D_y = -6.0 \Rightarrow D_y = +1.25$



$|\vec{D}| = \sqrt{D_x^2 + D_y^2} =$ **3.0 miles**

$\theta = \tan^{-1}\left|\frac{1.25}{2.78}\right| =$ **24° N of W**

2. (30 pts) A getaway car leaving the scene of a crime is moving in a straight line at 93.0 miles/hour. A superhero capable of extreme speed starts after the car from rest when the car is already 542 meters away. What must be the superhero's acceleration in order to catch the car in 25.0 seconds?

$93.0\ mi/hr = 41.57\ m/s$ ↙ same t for both

car: $\Delta x_{car} = 41.57t$

hero: $\Delta x_{hero} = 0 + \frac{1}{2}at^2$

Also, $\Delta x_{hero} = \Delta x_{car} + 542$

$\Rightarrow \frac{1}{2}a(25)^2 = 41.57(25) + 542$

$312.5a = 1581.25$

$$\boxed{a = 5.06\ m/s^2}$$

3. A car starts from rest and accelerates at a constant rate up a 25.0 degree inclined ramp for 6.35 seconds. After the car leaves the ramp, it is in "free fall," and it reaches a maximum height of 22.0 meters above the end of the ramp.

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

Part 1: $\Delta s = ?$

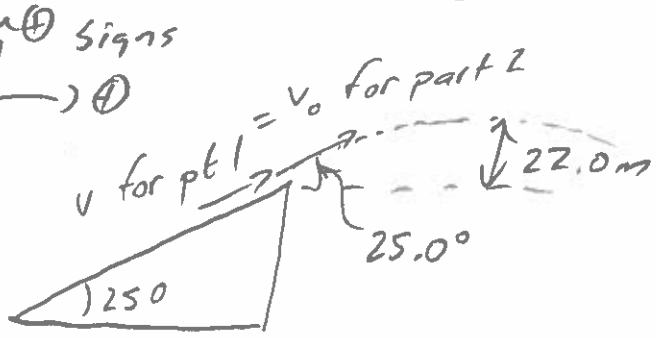
$v_0 = 0$

$v = ?$

$a = ?$

$t = 6.35\,s$

+ signs



Part 2: $\Delta y = 22.0\,m$

$v_{oy} = ?$

$v_y = 0$

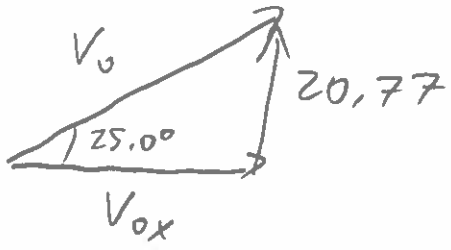
$a_y = -9.8\ m/s^2$

$t = ?$

$v_y^2 = v_{oy}^2 + 2a_y \Delta y$

$0^2 = v_{oy}^2 + 2(-9.8)(22)$

$v_{oy} = +20.77\ m/s$



$\sin 25.0° = \frac{20.77}{V_0}$

$\Rightarrow V_0 = 49.14\ m/s$

From part 1 $v = v_0 + at$

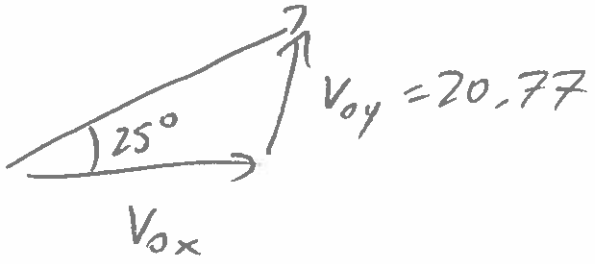
$49.14 = 0 + a(6.35)$

$\boxed{a = 7.74\ m/s^2}$

3. A car starts from rest and accelerates at a constant rate up a 25.0 degree inclined ramp for 6.35 seconds. After the car leaves the ramp, it is in "free fall," and it reaches a maximum height of 22.0 meters above the end of the ramp.

b) (20 pts) What is the magnitude and direction of the car's velocity when it reaches its maximum height?

From part 1:



$$\tan 25.0^\circ = \frac{20.77}{V_{ox}}$$

$$\Rightarrow V_{ox} = 44.54 \text{ m/s}$$

$V_x = 44.54$ m/s since $a_x = 0$

$V_y = 0$

So $\boxed{\vec{V} = 44.5 \text{ m/s}, +x \text{ dir}}$