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. (30 pts) A car accelerates uniformly from rest for 8.0 seconds, reaching a speed of 44 miles/hour. At that time, the driver takes her foot off the gas, and the car coasts with frictional forces providing an acceleration of 1.0 m/s^2 in the direction opposite the motion until the car stops. What is the average velocity for the entire trip?

Part 1

$44\ mi/hr \cdot 1\ hr/3600s \cdot 1609\ m/mi = 19.67\ m/s$

$\Delta x =$

$v_0 = 0$

$v = 19.67\ m/s$

$a =$

$t = 8.0\ s$

$\Delta x = \frac{1}{2}(v + v_0)t$

$= \frac{1}{2}(0 + 19.67)(8.0) = \underline{78.67\ m}$

Part 2

$\Delta x =$

$v_0 = 19.67\ m/s$

$v = 0$

$a = -1.0\ m/s^2$

$t =$

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

$0 = (19.67)^2 - 2\Delta x$

$\Delta x = \underline{193.45}$

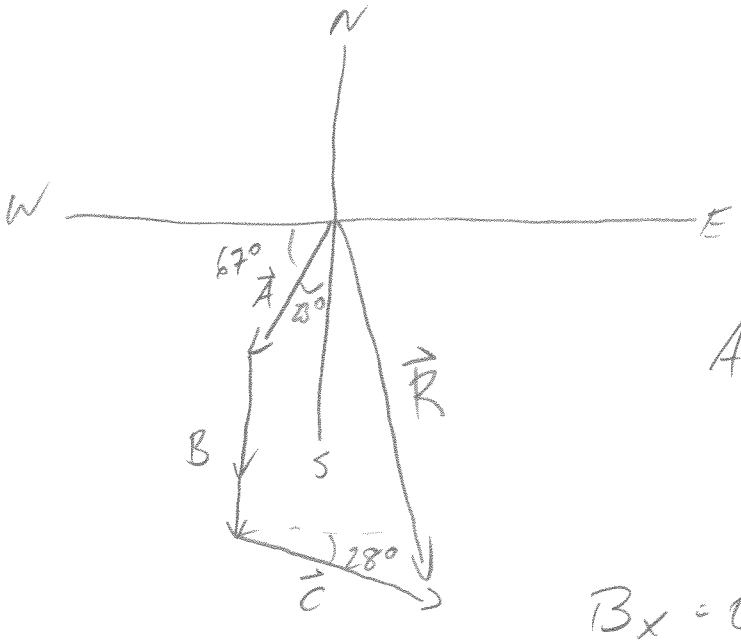
$v = v_0 + at$

$0 = 19.67 - t \qquad t = \underline{19.67\ s}$

$\bar{v}_{TOT} = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2} = \frac{78.67 + 193.45}{8.0 + 19.67}$

$= \frac{272.12}{27.67} = \boxed{9.8\ m/s}$ or 22 mi/hr

2. (30 pts) A hiker walks 1.2 miles in a direction 23° West of South, then 1.7 miles South, then 2.1 miles in a direction 28° South of East. What is the magnitude and direction of the total displacement for this hike?



$A_x = -1.2 \cos 67°$

or $-1.2 \sin 23°$

$= -0.469$

$A_y = -1.2 \sin 67°$

or $-1.2 \cos 23°$

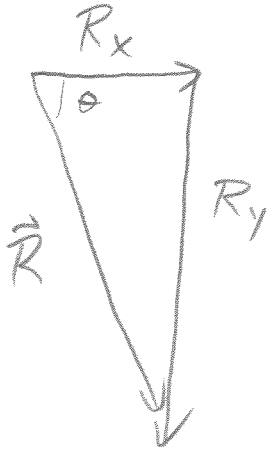
$= -1.105$

$B_x = 0 \quad B_y = -1.7$

$C_x = 2.1 \cos 28° = 1.854 \quad C_y = -2.1 \sin 28° = -0.986$

$R_x = -0.469 + 0 + 1.854 = 1.385$

$R_y = -1.105 - 1.7 - 0.986 = -3.791$



$|\vec{R}| = \sqrt{1.385^2 + 3.791^2}$

$= \boxed{4.0 \text{ miles}}$

$\theta = \tan^{-1}\left(\frac{3.791}{1.385}\right) = \boxed{70° \text{ S of E}}$

3. (40 pts) A stone is thrown from the top of a tall building with an initial speed of 7.5 m/s in a direction 22° above the horizontal. After 4.6 seconds, the stone hits the ground.

a) How tall is the building?

b) When the stone reaches its maximum height above the ground, what is the magnitude and direction of its velocity?

c) What is the magnitude and direction of the final velocity of the stone the instant before it hits the ground?

a) $\Delta y =$

$V_{oy} = 7.5 \sin 22° = 2.81 \text{ m/s}$

$V_y = ?$

$a_y = -9.8 \text{ m/s}^2$

$t = 4.6 \text{ s}$

$\Delta y = V_{oy} t + \frac{1}{2} a_y t^2 = (2.81)(4.6) + \frac{1}{2}(-9.8)(4.6)^2$

$= 12.92 - 103.68$

$= -90.76$

Building is 91 m tall

b) At max height $V_y = 0$ $V_x = V_{ox} = V_0 \cos 22°$

$= 6.954 \text{ m/s}$

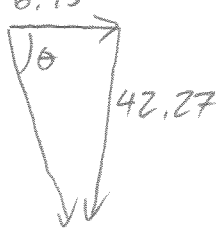
$\vec{V} = 7.0 \text{ m/s}$, +x dir

c) $V_y = V_{oy} + a_y t$

$= 2.81 - 9.8(4.6)$

$= -42.27 \text{ m/s}$

$V_x = 6.954 \text{ m/s}$



$V = \sqrt{V_x^2 + V_y^2}$

$= \boxed{43 \text{ m/s}}$

$\theta = \tan^{-1}\left(\frac{42.27}{6.954}\right)$

$= \boxed{81° \text{ below } +x}$