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 runner runs in a straight line at a speed of 8.5 mi/hr for an entire race, interrupted only by a 3.0 minute rest stop. If the runner's average speed for the entire race is 7.7 mi/hr, how long (distance) was the race?

Part 1	Part 2	Total
$\Delta x_1 = ?$	$\Delta x_2 = 0$	$\Delta x_{TOT} = ?$
$\bar{v}_1 = 8.5$ mi/hr	$\bar{v}_2 = 0$	$\bar{v}_{TOT} = 7.7$ mi/hr
$t_1 = ?$	$t_2 = .05$ hr	$t_{TOT} = ?$

$$7.7 = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2} = \frac{\bar{v}_1 t_1 + 0}{t_1 + .05}$$

$$7.7 = \frac{8.5 t_1}{t_1 + .05}$$

$$7.7(t_1 + .05) = 8.5 t_1$$

$$7.7 t_1 + .385 = 8.5 t_1$$

$$.385 = 0.8 t_1$$

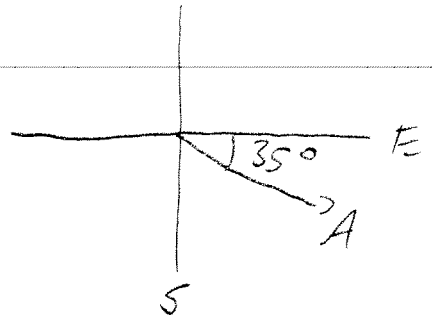
$$t_1 = 0.48 \text{ hr}$$

$$\Delta x_1 = \bar{v}_1 t_1$$

$$= (8.5)(.48)$$

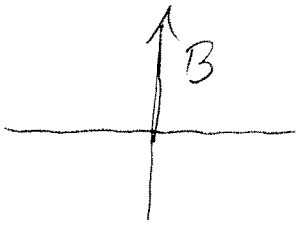
$$= \boxed{4.1 \text{ mi}}$$

2. (30 pts) A plane flies first 120 miles in a direction 35° South of East, then 230 miles due North, then 440 miles in a direction 38° West of North. What is the magnitude and direction of the resultant displacement?



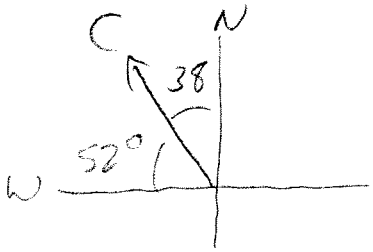
$A_x = 120 \cos 35 = 98.3$

$A_y = 120 \sin 35 = -68.8$



$B_x = 0$

$B_y = 230$



$C_x = -440 \cos 52 = -270.9$

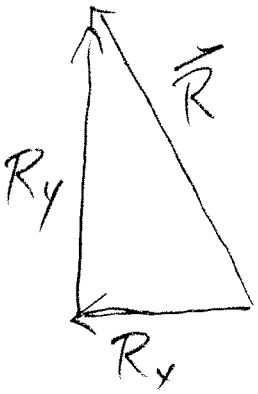
or $-440 \sin 38$

$C_y = 440 \sin 52 = 346.7$

or $440 \cos 38$

$R_x = A_x + B_x + C_x = 98.3 + 0 - 270.9 = -172.6$

$R_y = A_y + B_y + C_y = -68.8 + 230 + 346.7 = 507.9$



$|R| = \sqrt{172.6^2 + 507.9^2} = \boxed{540 \text{ mi}}$

$\theta = \tan^{-1}\left(\frac{507.9}{172.6}\right) = \boxed{71° \text{ N of W}}$

3. (40 pts) A model rocket starts from rest at ground level and accelerates in a straight line at a rate of 45 meters/sec^2 for 2.5 seconds in a direction 75° above the horizontal, then it enters free fall. The boy who launched the rocket is hoping to beat his record maximum height of 700 meters.

a) Does the rocket break the record? By how many meters does it beat or fall short of the record?

b) In order to measure the rocket's height, the boy must place a measuring device on the ground directly below the point where the rocket will reach maximum height. What horizontal distance does the rocket travel from the launch point until the time it reaches maximum height?

Part 1

$\Delta s = ?$
$V_0 = 0$
$V = ?$
$a = 45\ m/s^2$
$t = 2.5\ s$

$\Delta s = V_0 t + \frac{1}{2} a t^2$
$= 0 + \frac{1}{2}(45)(2.5)^2$
$= 140.625$

$V = V_0 + at$
$= 0 + (45)(2.5)$
$= 112.5$

$\Delta x = 140 \cos 75$
$= 36.4\ m$

$V_x = 112.5 \cos 75$
$= 29.1$

$\Delta y = 140 \sin 75$
$= 135.2\ m$

$V_y = 112.5 \sin 75$
$= 108.7$

Free fall to max height

x	y
$\Delta x =$	$\Delta y = ?$
$V_{0x} = 29.1$	$V_{0y} = 108.7$
$V_x = 29.1$	$V_y = 0$
$a_x = 0$	$a_y = -9.8$
$t = ?$	$t = ?$

$V_y^2 = V_{0y}^2 + 2 a_y \Delta y$
$0 = 108.7^2 + 2(-9.8)\Delta y$
$\Delta y = 602.8$

$\Delta y_{TOT} = 602.8 + 135.2$
$= 738\ m$, beat record by 38 m

$V_y = V_{0y} + a_y t$
$0 = 108.7 - 9.8t$
$t = 11.1\ s$

$\Delta x = V_{0x} t$
$= 322.8$

$\Delta x_{TOT} = 36.4 + 322.8 = \boxed{360\ m}$