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 long-distance runner finishes a race with an average velocity of 6.20 miles/hour. If the runner takes a 12.0 minute break during the race, and runs with a constant speed of 6.35 miles/hour for the rest of the race time, how much distance did the runner cover during the race (in miles)?

Part 1	Part 2	Total
$\Delta x_1 = ?$	$\Delta x_2 = 0$	$\Delta x_{TOT} = ?$
$\bar{v}_1 = 6.35\ mi/hr$	$\bar{v}_2 = 0$	$\bar{v}_{TOT} = 6.20\ mi/hr$
$t_1 = ?$	$t_2 = 12\ min = 0.2\ hr$	$t_{TOT} = ?$

$$\bar{v}_{TOT} = \frac{\Delta x_{TOT}}{t_{TOT}} = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2}$$

$$6.20\ mi/hr = \frac{6.35 t_1 + 0}{t_1 + 0.2}$$

$$6.20 t_1 + 1.24 = 6.35 t_1$$

$$1.24 = 0.15 t_1$$

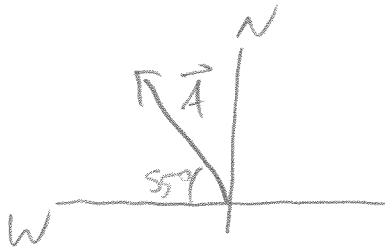
$$t_1 = 8.27\ hrs$$

$$\Delta x_1 = \Delta x_{TOT} = (6.35)(8.27)$$

$$= \boxed{52.5\ miles}$$

2. (30 pts) A car travels with a constant speed of 35 miles/hour for 2.0 hours in a direction 55° North of West, then travels 54 miles due West in 1.2 hours, then travels with a constant speed of 26 miles/hour for 45 minutes in a direction 15° East of South. What is the magnitude and direction of the car's average velocity during this time interval?

$\Delta x_1 = \bar{v}_1 t_1 = 70 \text{ miles} \leftarrow \vec{A} \quad t_1 = 2.0 \text{ hrs}$



$A_x = -70 \cos 55° = -40.15$

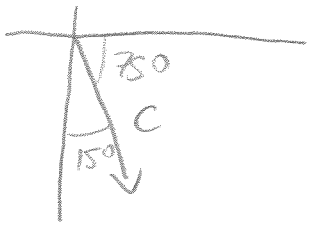
$A_y = 70 \sin 55° = +57.34$

$\Delta x_2 = 54 \text{ miles} \leftarrow B \quad t_2 = 1.2 \text{ hrs}$

$B_x = -54 \text{ miles}$

$B_y = 0$

$\Delta x_3 = \bar{v}_3 t_3 = 19.5 \text{ miles} \leftarrow \vec{C} \quad t_3 = 0.75 \text{ hrs}$



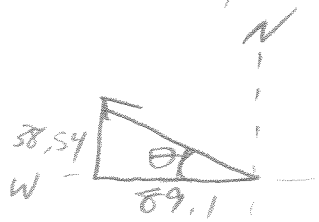
$C_x = +19.5 \cos 75° = +5.05$

$C_y = -19.5 \sin 75° = -18.8$

$R_x = A_x + B_x + C_x = -40.15 - 54 + 5.05 = -89.1$

$R_y = A_y + B_y + C_y = +57.34 + 0 - 18.8 = 38.54$

$\vec{R} = \sqrt{89.1^2 + 38.54^2} = 97.08 \text{ miles}$



$\bar{v} = \frac{\vec{R}}{t_{TOT}} = \frac{97.08}{3.95} = \boxed{25 \text{ mi/hr}}$

$\theta = \tan^{-1}\left(\frac{38.54}{89.1}\right) = \boxed{23° \text{ N of W}}$

3. (40 pts) A race car starts from rest and accelerates up a 35 meter long ramp at a rate of 17 m/s². The ramp is elevated 22° above the horizontal.

a) What is the magnitude and direction of the velocity of the car when it reaches its maximum height above ground level?

b) What is the maximum height above ground level achieved by the car?

On ramp

$\Delta s = 35\ m$

$v_0 = 0$

$v = ?$

$a = 17\ m/s^2$

$t = ?$

$v^2 = 0^2 + 2(17)(35)$

$v = 34.5\ m/s$

$\Delta y_1 = \Delta s \sin 22^\circ$

$= 13.11\ m$

From end of ramp to max height

x

$\Delta x = ?$

$v_{0x} = 34.5 \cos 22^\circ$

$= 31.98$

$v_x = 31.98$

$a_x = 0$

$t = ?$

y

$\Delta y = ?$

$v_{0y} = 34.5 \sin 22^\circ$

$= 12.92$

$v_y = 0$

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

$t = ?$

a) $v_x = 31.98$

$v_y = 0$

$\vec{v} = 32\ m/s$, +x dir

b) $v_y^2 = v_{0y}^2 + 2 a_y \Delta y$

$(12.92)^2 = 0 + 2(-9.8)\Delta y$

$\Delta y = 8.51$

$\Delta y_{TOT} = 13.11 + 8.51$

$= 22\ m$