Physics 10154 - Exam #1c

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) An experimental race car is trying to complete a 325 mile race in 120 minutes. During the first 118 minutes, the car moves at a constant speed of 161 miles/hour. For the last two minutes of the race, an experimental rocket ignites, providing the car with a maximum possible acceleration of 0.45 m/s^2 for the final two minutes of the race. Can the car finish the 325 mile race in time? Justify your answer.

Part 1

$\Delta x_1 = \bar{v}_1 t_1 = (161 \frac{mi}{hr})(118\,min)(\frac{1\,hr}{60\,min}) = 316.63\,miles$

Part 2

Need to travel at least $325 - 316.63 = 8.37$ miles $= 13462$ meters

$\Delta x = ?$

$v_0 = 161 \frac{mi}{hr} = 71.96\ m/s$

$v = ?$

$a = 0.45\ m/s^2$

$t = 120\,s$

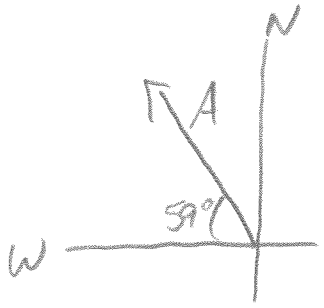
$\Delta x = (71.96)(120) + \frac{1}{2}(.45)(120)^2$

$= 8635 + 3240 = 11875 < 13462$

No

2. (30 pts) A car travels with a constant speed of 45 miles/hour for 2.0 hours in a direction 59° North of West, then travels 58 miles due West in 1.3 hours, then travels with a constant speed of 57 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?

Part A $\Delta s_A = (45)(2) = 90$ miles



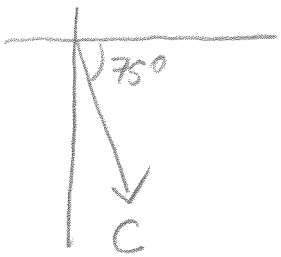
$A_x = -90\cos 59° = -46.35$

$A_y = +90\sin 59° = +77.15$

Part B $B_x = -58$

$B_y = 0$

Part C $\Delta s_C = (57)(.75) = 42.75$ miles



$C_x = +42.75\cos 75° = 11.06$

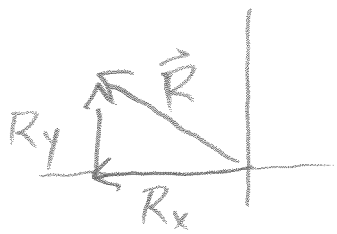
$C_y = -42.75\sin 75° = -41.29$

$\vec{R}_{TOT}$: $R_x = -46.35 - 58 + 11.06 = -93.29$

$R_y = +77.15 + 0 - 41.29 = +35.86$

$t_{TOT} = 2.0 + 1.3 + .75 = 4.05$ hrs

$|\vec{R}| = \sqrt{R_x^2 + R_y^2} = 99.94$ miles



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

$\theta = \tan^{-1}\left(\frac{35.86}{93.29}\right) = \boxed{21° \text{ N of W}}$

3. (40 pts) A toy cannon is located 15.0 meters horizontally away from the base of a 10.3 meter high building. A ball is fired from the cannon at an angle of 57.0°, and it passes some unknown distance above the top edge of the building 1.50 seconds after it is fired.

a) How far above the edge of the building is the ball when it passes over the top edge of the building?

b) Is the ball on its way up or on its way down when it passes over the top edge of the building? Justify your answer.

c) If the launch point is at the origin, what are the x,y coordinates of the location at which the ball strikes the roof of the building?

Launch → wall

$\Delta x = 15.0$ $\quad \Delta y = ?$

$V_{ox} = V_0 \cos 57°$ $\quad V_{oy} = V_0 \sin 57°$

$V_x = V_0 \cos 57°$ $\quad V_y = ?$

$a_x = 0$ $\quad a_y = -9.8\ m/s^2$

$t = 1.50\ s$ $\quad t = 1.5\ s$

$\Delta x = V_{ox} t + \frac{1}{2} a_x t^2$

$15 = (V_0 \cos 57)(1.50)$

$V_0 = 18.36\ m/s$

$\Delta y = V_{oy} t + \frac{1}{2} a_y t^2$

$= (18.36 \sin 57)(1.5) - 4.9(1.5)^2$

$= 12.07\ m$

Last part

$\Delta x = V_{ox} t$

$= (18.36 \cos 57)(2.18$

$= 21.8\ m$

$(x, y) = (21.8, 10.3)$

a) Diff in y is $12.07 - 10.3 = 1.77\ m$

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

$= (18.36 \sin 57°) - 9.8(1.5) = 0.70$, positive

so on way up

c) Find x when $y = 10.3\ m$

$V_y^2 = V_{oy}^2 + 2 a_y \Delta y$

$V_y^2 = (18.36 \sin 57)^2 + 2(-9.8)(10.3)$

$= 35.2$

$V_y = -5.93 \rightarrow V_y = V_{oy} + a_y t$

$-5.93 = 18.36 \sin 57 - 9.8t$

$t = 2.18\ s$