Physics 10154 - Summer 2013 - Exam #1A

Instructions: Be sure to SHOW ALL WORK and clearly indicate your answers. I will not give full credit if I cannot logically follow how you got your answer, even if the answer is correct. Partial credit will be given provided you are solving parts of the problem correctly. Clearly indicate your final answer, including correct units and significant figures.

1. (30 pts) A car drives North in a straight line with a constant speed of 67 miles/hour. At some point during the trip, the driver takes a 43 minute rest stop. The average velocity for the entire trip, including the rest stop, is 58 miles/hour. How far did the car travel, and what was the total time spent on the trip?

$\Delta x_1 = \bar{v}_1 t_1 = 67 t_1$ $\quad t_2 = \frac{43}{60} = 0.717 hr$

$\Delta x_2 = \bar{v}_2 t_2 = 0$

sub ↳ $\Delta x_{TOT} = \frac{\Delta x_1 + \Delta x_2}{t_1 + t_2}$

$58 = \frac{67 t_1 + 0}{t_1 + 0.717}$

$58 t_1 + 41.57 = 67 t_1$

$41.57 = 9 t_1$

$t_1 = 4.62 hr$

$\Delta x_1 = (67)(4.62) = \boxed{310 \text{ miles}}$

$t_{tot} = 4.62 + .717 = \boxed{5.3 hr}$

2. (35 pts) A child builds a rocket, hoping to beat a local record height of 320 meters. From rest, the rocket is launched from ground level, accelerating vertically upward at a rate of 25 m/s² for 2.2 seconds, then the engines cut off and the rocket is in free fall for its remaining time in the air. Does the rocket's maximum height exceed the 320 meter target height?

Part 1

$\Delta y_1 = ?$

$v_{01} = 0$

$v_1 = ?$

$a_1 = 25$

$t_1 = 2.2$

$\Delta y_1 = v_{01} t_1 + \frac{1}{2} a_1 t_1^2$

$= 0 + \frac{1}{2}(25)(2.2)^2 = 60.5 \text{ m}$

$v_1 = v_{01} + a_1 t_1$

$= 0 + (25)(2.2) = 55 \text{ m/s}$

Part 2

$\Delta y_2 = ?$ (not 320 or 259.5, max height not known)

$v_{02} = 55 \text{ m/s}$ (v_1)

$v_2 = 0$ (max height)

$a_2 = -9.8 \text{ m/s}^2$ (free fall, up +, down −)

$t_2 = ?$

$$v_2^2 = v_{02}^2 + 2 a_2 \Delta y_2$$

$$0 = 55^2 + 2(-9.8)\Delta y_2$$

$$\Delta y_2 = \frac{-55^2}{2(-9.8)} = 154.3$$

$$\Delta y_{TOT} = 60.5 + 154.3 = 214.8 < 320$$

no

3. (35 pts) A projectile is fired with an initial speed of 33 meters/sec in a direction 17° below the horizontal from the top of a cliff. It hits a target on the ground below 2.8 seconds later.

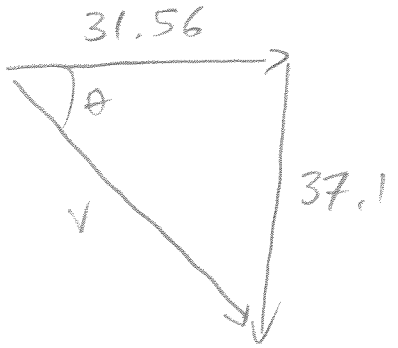
a) How far from the base of the cliff (horizontal distance) does the projectile hit the ground?

b) What is the magnitude and direction of the velocity of the projectile the instant before it hits the ground?

x	y
$\Delta x = ?$	$\Delta y = ?$
$v_{0x} = 33\cos 17°$	$v_{0y} = +33\sin 17°$
$= 31.56$	$= 9.65\ m/s$
$v_x = 31.56$	$v_y = ?$
$a_x = 0$	$a_y = 9.8\ m/s^2$
$t = 2.8\ s$	$t = 2.8\ s$

a) $\Delta x = v_{0x}t + \frac{1}{2}a_x t^2 = (31.56)(2.8) = 88\ m$

b) $v_y = v_{0y} + a_y t = 9.65 + (9.8)(2.8) = 37.1\ m/s$



$|\vec{v}| = \sqrt{(31.56)^2 + (37.1)^2}$

$= 48.7$

$\theta = \tan^{-1}\left(\frac{37.1}{31.56}\right) = 49.6°$

$v = 49\ m/s,\ 50°$ below $+x$