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) A car on a straight road starts from rest at a stoplight, acceleration at 4.4 m/s² for 75 meters. At that point, the driver sees a light turn red 42 meters away and hits the brakes, decelerating at a rate of -6.0 m/s². Can the driver stop the car before reaching the red light?

Part 1

$\Delta x = 75\ m$

$v_0 = 0$

$v = ?$

$a = 4.4\ m/s^2$

$t = ?$

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

$v^2 = 0^2 + 2(4.4)(75)$

$v = \pm 25.69$

Use $v_0 = 25.69$ for part 2

Part 2

$\Delta x = ?$ ← solve, compare answer to 42m

$v_0 = 25.69$

$v = 0$

$a = -6.0\ m/s^2$

$t = ?$

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

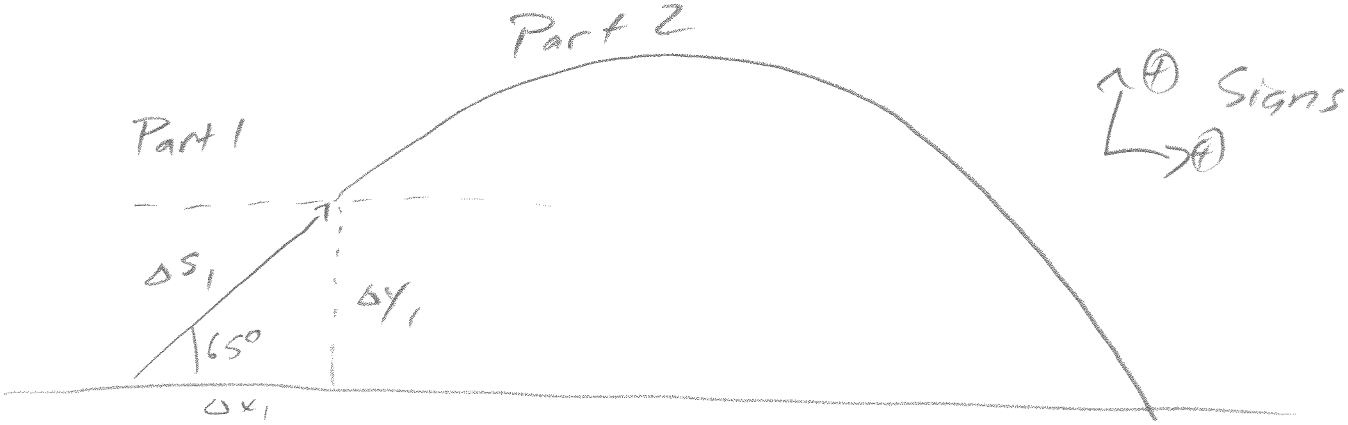
$0^2 = (25.69)^2 + 2(-6)\Delta x$

$\Delta x = \frac{-(25.69)^2}{-12} = 55m$

Since $\Delta x = 55m > 42m$ limit,

car does not stop in time.

2. (40 pts) A rocket is launched from rest at an angle of 65° above the horizontal and accelerates for 4.5 seconds at a rate of 44 m/s² in a straight line along this trajectory. After that initial 4.5 seconds, the engines cut out and the rocket is in free fall. Assuming the rocket hits the ground at the same elevation from which it was launched, what is the total horizontal displacement from the launch point to the point of impact?



Part 1

$\Delta s = ?$

$v_0 = 0$

$v = ?$

$a = 44\ m/s^2$

$t = 4.5\ s$

$\Delta s = v_0 t + \frac{1}{2}at^2 = 0 + \frac{1}{2}(44)(4.5)^2$
$= 445.5$

so $\Delta x_1 = 445.5 \cos 65° = 188.28$

use in part 2 → $\Delta y_1 = 445.5 \sin 65° = 403.76$

$v = v_0 + at = 0 + (44)(4.5)$
$= 198$

$v_x = 198 \cos 65° = 83.68$ ← use in part 2

v_{0x}, v_{0y} for part 2 → $v_y = 198 \sin 65° = 179.45$

Part 2

using result from part 1

x	y
$\Delta x_2 = ?$	$\Delta y = -403.76$
$v_{0x} = 83.68$	$v_{0y} = 179.45$
$v_x = 83.68$	$v_y = ?$
$a_x = 0$	$a_y = -9.8$
$t = ?$	$t = ?$

$v_y^2 = v_{0y}^2 + 2a_y \Delta y$
$= (179.45)^2 + 2(-9.8)(-403.76)$

$v_y = \pm 200.29$, use -200.29 since it hits ground heading down

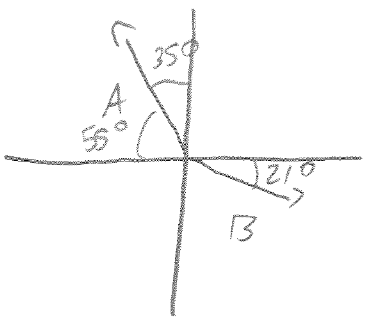
$v_y = v_{0y} + at \Rightarrow$
$-200.29 = 179.45 - 9.8t$
$t = \frac{379.74}{9.8} = 38.75\ s$

$\Delta x_2 = v_{0x} t_2 + \frac{1}{2} a t_2^2$
$= (83.68)(38.75) = 3242.51$

$\Delta x_{tot} = \Delta x_1 + \Delta x_2$
$188.28 + 3242.51 = $ **3400 m**

3. (30 pts) In a reality TV show competition, three contestants are trying to push a heavy block in different direction. Player A is pushing with a force of 420 N in a direction 35° West of North. Player B is pushing with a force of 220 N in a direction 21° South of East.

What must be the magnitude and direction of the force exerted by Player C in order for there to be no net force acting on the block?



Need $\vec{A} + \vec{B} + \vec{C} = 0$

Find $\vec{R} = \vec{A} + \vec{B}$, then vector $\vec{C}$ must have same magnitude as $\vec{R}$ but opposite direction.

$A_x = -420 \cos 55°$ (or $\sin 35°$) $= -240.90$

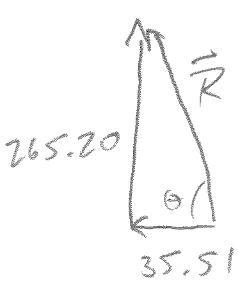
$A_y = +420 \sin 55°$ (or $\cos 35°$) $= +344.04$

$B_x = +220 \cos 21° = +205.39$

$B_y = -220 \sin 21° = -78.84$

$R_x = A_x + B_x = -35.51$

$R_y = A_y + B_y = 265.20$



$|\vec{R}| = \sqrt{R_x^2 + R_y^2} = 267.57$ ← C has same mag

$\theta = \tan^{-1}\left(\frac{265.20}{35.51}\right) = 82.37°$ N of W ← opp direction

$\vec{C} = 270\,N,\ 82°$ S of E