Physics 10154 - Exam #1d

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) Car A is driving due West at 68 miles/hour on I-30 starting from Dallas, 15 miles away from Arlington. Car B is driving due East at 38 miles/hour on I-30 starting from Fort Worth, 12 miles away from Arlington.

   How far away from Arlington do the two cars meet, and do they meet East or West of Arlington?

$|v_B| = 38\ mi/hr$ $\quad |v_A| = 68\ mi/hr$

$|\Delta x_A| = 68t$

$|\Delta x_B| = 38t$

$|\Delta x_A| + |\Delta x_B| = 15 + 12$

$68t + 38t = 27$

$106t = 27, \quad t = 0.255\ hr$

$\Delta x_B = (38)(.255) = 9.68\ mi$

Diff = 2.3 mi West

To check $\Delta x_A = (68)(.255) = 17.3\ mi$ ✓

2. (35 pts) A projectile is launched at an angle of 33° above the horizontal from ground level towards a 22 meter high wall. The wall is 54 meters horizontally away from the launch point, and the projectile passes directly over the wall (some unknown distance above the wall) 3.0 seconds after launch.

a) What is the initial speed of the ball?
b) When the ball passes over the wall, how many meters above the wall is it?

X	Y
$\Delta x = 54$	$\Delta y = ?$
$v_{0x} = v_0 \cos 33°$	$v_{0y} = v_0 \sin 33° = 11.69\ m/s$
$v_x = v_0 \cos 33°$	$v_y = ?$
$a_x = 0$	$a_y = -9.8\ m/s^2$
$t = 3.0s$	$t = 3.0\ s$

a) $\Delta x = (v_0 \cos 33°)(3) + \frac{1}{2}(0)(3)^2$

$54 = (v_0 \cos 33°)(3)$

$v_0 = 21.46\ m/s$

b) $\Delta y = v_{0y} t + \frac{1}{2} a_y t^2$

$= (11.69)(3) + \frac{1}{2}(-9.8)(3)^2$

$= -9.03$, so it doesn't clear wall

3. (35 pts) Starting from rest at ground level, a stunt car drives up a 75 meter long ramp inclined 21° above the horizontal with an acceleration of 25 m/s². Upon leaving the ramp, the car is in free fall until it hits the ground.

a) How many seconds elapse from the time the car leaves the ramp until the time it hits the ground?
b) What is the magnitude and direction of the car's velocity the instant before it hits the ground?

On ramp

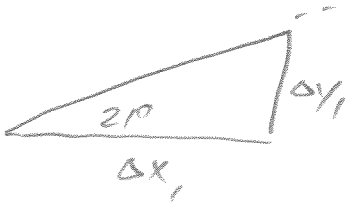
$\Delta s = 75$

$v_0 = 0$

$v = ?$

$a = 25$

$t = ?$



$v^2 = 0^2 + 2(25)(75)$

$v = +61.24 \text{ m/s}$

$\Delta y_1 = 75 \sin 21°$

$= 26.88 \text{ m}$

In air

x

$\Delta x = ?$

$v_{ox} = 61.24 \cos 21°$

$v_x = 61.24 \cos 21°$

$= 57.17$

$a_x = 0$

$t = ?$

y

$\Delta y = -26.88$

$v_{oy} = 61.24 \sin 21°$

$= 21.95$

$v_y = ?$

$a_y = -9.8$

$t = ?$

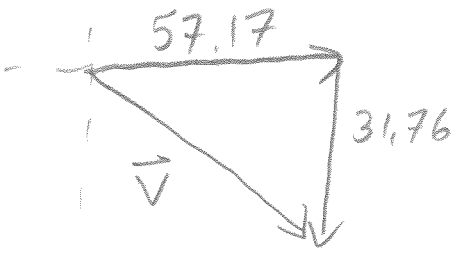
$v_y^2 = (21.95)^2 + 2(-9.8)(-26.88)$

$= 1008.49$

$v_y = -31.76$

$-31.76 = 21.95 - 9.8t$

$t = 5.5 \text{ s}$



$|\vec{v}| = \sqrt{v_x^2 + v_y^2} = 65 \text{ m/s}$

$\theta = \tan^{-1}\left(\frac{31.76}{57.17}\right) = 29° \text{ below } +x$