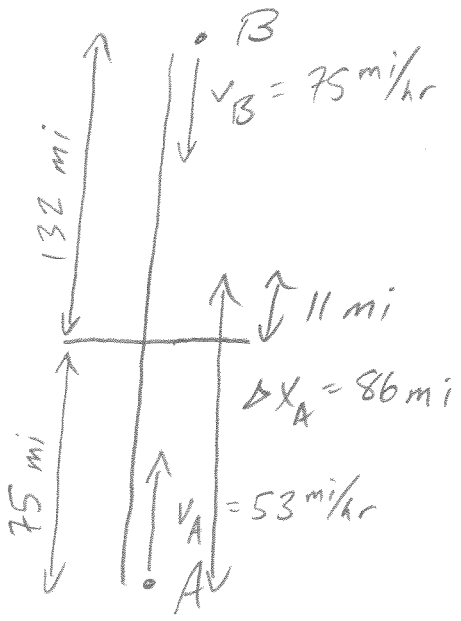
Physics 10154 - Exam #1c

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) For the purposes of this problem, assume Fort Worth and Oklahoma city are connected by a straight North-South highway. Car A starts in Fort Worth, which is 75 miles South of the Oklahoma-Texas border, driving North with a constant speed of 53 miles/hour. Car B starts in Oklahoma City, 132 miles north of the Oklahoma-Texas border, driving South with a constant speed of 75 miles/hour.

How far North or South of the border do the cars pass one another? Give both a distance (in miles) and a direction.



$|\Delta x_A| = v_A t = 53t$

$|\Delta x_B| = v_B t = 75t$

$|\Delta x_A| + |\Delta x_B| = 207\ mi$

$53t + 75t = 207$

$t = \frac{207}{128} = 1.617\ hr$

$|\Delta x_A| = (53)(1.617) = 86\ mi$

$86 - 75 =$ **11 miles North of border**

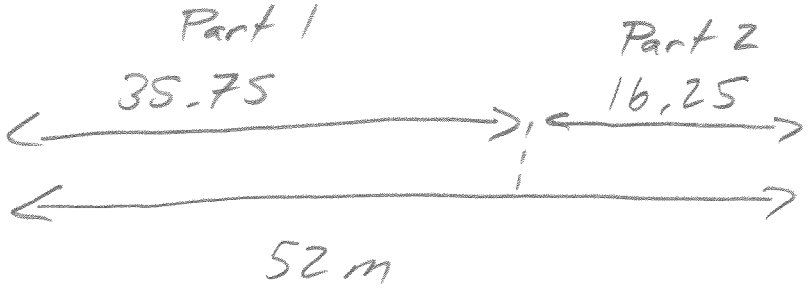
$|\Delta x_B| = (75)(1.617) = 121\ mi$, also 11 miles from border

2. (30 pts) A car starts from rest and accelerates uniformly to a final velocity of 13 m/s in 5.5 seconds, then the driver realizes that the road will abruptly end in a cliff. The driver hits the brakes and decelerates at a rate of -8.5 m/s^2. If the end of the road is 52 meters from the starting point, can the driver stop before the end of the road?

Part 1

$\Delta x = ?$
$v_0 = 0$
$v = 13$ m/s
$a = ?$
$t = 5.5$ s

$$\Delta x = \frac{1}{2}(v + v_0)t$$
$$= \frac{1}{2}(13 + 0)(5.5) = 35.75 \text{ m}$$



Part 2

$\Delta x_2 = ?$
$v_{02} = 13$ m/s
$v = 0$
$a = -8.5$ m/s^2
$t = ?$

Compare Δx_2 to 16.25 m
If $\Delta x_2 < 16.25$, then car stops in time

$$v^2 = v_0^2 + 2a\Delta x$$
$$0 = 13^2 + 2(-8.5)\Delta x$$
$$\Delta x_2 = \frac{-169}{-17} = 9.94 \text{ m}$$

Since 9.94 m < 16.25 m, car stops

3. (40 pts) A stunt car starts from rest at ground level and accelerates at a rate of 14 m/s² up a 75 meter long ramp inclined 22° above the horizontal. Once the car reaches the end of the ramp, it follows a standard free fall trajectory.

a) What maximum height above ground level does the car reach?

b) What is the car's velocity (magnitude and direction) when it reaches maximum height?

Part 1

$\Delta s = 75$

$v_0 = 0$

$v = ?$

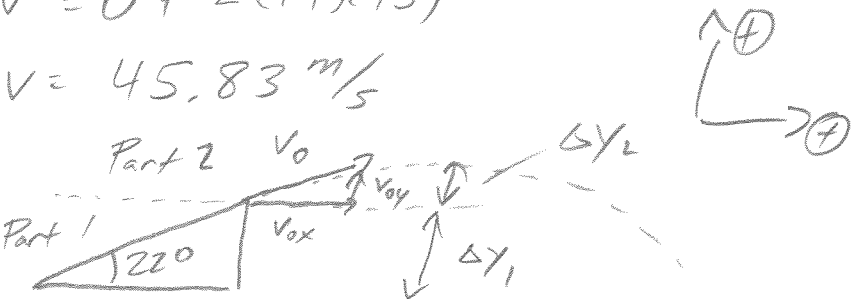
$a = 14\ m/s^2$

$t = ?$

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

$v^2 = 0 + 2(14)(75)$

$v = 45.83\ m/s$



$\Delta y_1 = \Delta s \sin 22°$

$= 28.1\ m$

Part 2 (to max height)

x	y
$\Delta x = ?$	$\Delta y = ?$
$v_{ox} = 45.83 \cos 22°$ $= 42.49$	$v_{oy} = 45.83 \sin 22°$ $= 17.17$
$v_x = 42.49$	$v_y = 0$
$a_x = 0$	$a_y = -9.8$
$t = ?$	$t = ?$

$v_y^2 = v_{oy}^2 + 2a_y\Delta y_2$

$0 = 294.75 + 2(-9.8)\Delta y$

$\Delta y_2 = 15.0\ m$

$\Delta y_{TOT} = \Delta y_1 + \Delta y_2$

$= 28.1 + 15.0$

$= 43\ m$

At max ht: $v_x = 42.49$

$v_y = 0$

$v = 42\ m/s$, +x dir