

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. (20 pts) A car travels East with a speed of 65 miles/hour for 45 minutes, then stops for 22 minutes, then travels West at a speed of 37 miles/hour for a distance of 21 miles.

What is the average velocity for the entire trip?

$$\Delta x_1 =$$

$$t_1 = 0.75 \text{ hr}$$

$$\bar{v}_1 = 65 \text{ mi/hr}$$

$$\Delta x_1 = (65)(.75) = 48.75$$

$$\Delta x_2 = 0$$

$$t_2 = .367 \text{ hr}$$

$$\bar{v}_2 = 0$$

$$\Delta x_3 = -21$$

$$t_3 = ?$$

$$\bar{v}_3 = -37 \text{ mi/hr}$$

$$t_3 = \frac{-21}{-37} = .568 \text{ hr}$$

$$\Delta x_{\text{TOT}} = 48.75 + 0 - 21 = 27.75 \text{ mi}$$

$$t_{\text{TOT}} = .75 + .367 + .568 = 1.69 \text{ hr}$$

$$\boxed{\bar{v}_{\text{TOT}} = 16 \text{ mi/hr}}$$

2. (30 pts) A boy is trying to build a rocket that will reach a target height of ~~400~~⁴⁰⁰ meters. From rest, the rocket is launched from ground level. The rocket accelerates directly upward at a rate of 32 m/s^2 for 2.5 seconds, then the engines cut off and the rocket is in free fall for its remaining time in the air.

- a) Does the rocket's maximum height exceed the ~~400~~⁴⁰⁰ meter target?
 b) How many seconds elapse from the moment of launch until the rocket hits the ground?

Part 1

$$\Delta y = ?$$

$$v_{0y} = 0$$

$$v_y = ?$$

$$a_y = 32$$

$$t = 2.5 \text{ s}$$

$$\Delta y_1 = 0 + \frac{1}{2}(32)(2.5)^2 = 100 \text{ m}$$

$$v_{y1} = 0 + 32(2.5) = 80 \text{ m/s}$$

Part 2 (to max ht)

$$\Delta y = ?$$

$$v_{0y} = 80$$

$$v_y = 0$$

$$a_y = -9.8$$

$$t = ?$$

$$0^2 = 80^2 + 2(-9.8)\Delta y_2$$

$$\Delta y_2 = 326$$

$$t_2: 0 = 80 - 9.8 t_2$$

$$t_2 = 8.16 \text{ s}$$

$$\Delta y_{\text{TOT}} = 426$$

so yes, it exceeds 400 m

Part 3 (from max to ground)

$$\Delta y = -426$$

$$v_{0y} = 0$$

$$v_y = ?$$

$$a_y = -9.8$$

$$t = ?$$

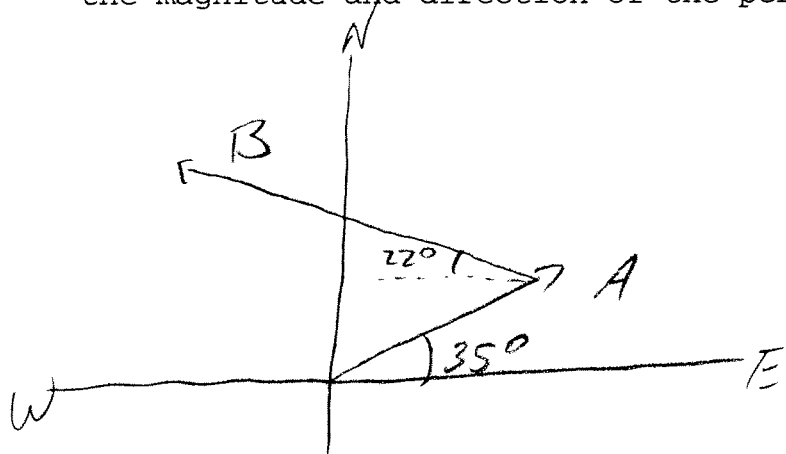
$$-426 = 0 + \frac{1}{2}(-9.8)t_3^2$$

$$t_3 = 9.32 \text{ s}$$

$$t_{\text{TOT}} = 2.5 + 8.16 + 9.32$$

$$= \boxed{20 \text{ s}}$$

3. (20 pts) A person walks 170 meters in a direction 35° North of East, then 330 meters in a direction 22° North of West. What is the magnitude and direction of the person's total displacement?



$$A_x = 170 \cos 35 = 139.3$$

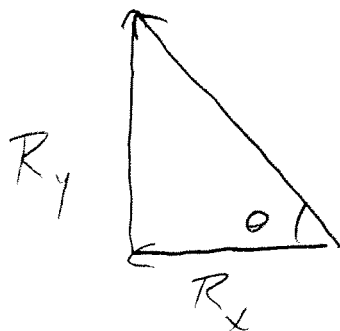
$$A_y = 170 \sin 35 = 97.5$$

$$B_x = -330 \cos 22^\circ = -306.0$$

$$B_y = 330 \sin 22^\circ = 123.6$$

$$R_x = 139.3 - 306 = -166.7$$

$$R_y = 97.5 + 123.6 = 221.1$$



$$|R| = \sqrt{166.7^2 + 221.1^2}$$

$$= \boxed{280 \text{ m}}$$

$$\theta = \tan^{-1}\left(\frac{221.1}{166.7}\right) = \boxed{53^\circ \text{ N of W}}$$

4. (30 pts) A t-shirt cannon fires a balled-up shirt into the stands from ground level at an angle of 53° above the horizontal. The shirt lands in the stands 12 meters above ground level after 2.3 seconds.

a) What is the initial speed of the t-shirt?

b) What is the speed of the t-shirt when it is at its maximum height?

<u>X</u>	<u>Y</u>
$\Delta x =$	$\Delta y = 12$
$v_{0x} = v_0 \cos 53^\circ$	$v_{0y} = v_0 \sin 53^\circ$
$v_x = v_0 \sin 53^\circ$	$v_y = ?$
$a_x = 0$	$a_y = -9.8$
$t = 2.3$	$t = 2.3$

Find v_{0y} : $12 = v_{0y}(2.3) + \frac{1}{2}(-9.8)(2.3)^2$

$$12 = 2.3 v_{0y} - 25.9$$

$$v_{0y} = \frac{37.9}{2.3} = 16.47 \text{ m/s}$$

$$\text{So } v_0 = \frac{v_{0y}}{\sin 53} = 20.6 \rightarrow \boxed{21 \text{ m/s}}$$

At max ht, $v_y = 0$

$$v_x = v_0 \cos 53 = 12.4$$

$$\boxed{12 \text{ m/s}}$$