

Physics 10154 - Exam #1a

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 drives along a straight road for 25 minutes at a speed of 55 miles/hour toward the East. The car stops for 22 minutes, then travels East again for a distance of 43 miles in 1.0 hours.

- a) What is the total displacement for the trip, in miles?
b) What is the average velocity for the trip, in miles/hour?

<u>Part 1</u>	<u>Part 2</u>	<u>Part 3</u>
$\Delta x_1 = ?$	$\Delta x_2 = 0$	$\Delta x_3 = 43$
$t_1 = .417 \text{ hr}$	$t_2 = .367 \text{ hr}$	$t_3 = 1.0$
$v_1 = 55 \text{ mi/hr}$	$v_2 = 0$	$v_3 =$

$$\Delta x_1 = 55(.417) = 22.9$$

$$a) \Delta x_{TOT} = 23 + 0 + 43 = \boxed{66 \text{ mi}}$$

$$b) \bar{v} = \frac{\Delta x_{TOT}}{t_{TOT}} = \frac{66}{.417 + .367 + 1.0} = \boxed{37 \text{ mi/hr}}$$

2. (30 pts) A rocket at ground level is launched directly upwards from rest. The rocket accelerates directly up at a rate of 25 m/s^2 for 4.0 seconds. The rocket then goes into free fall until it hits the ground.

- a) What maximum height above ground level does the rocket attain, in meters?
 b) For how many seconds is the rocket airborne?

Part 1

$$\Delta y_1 = ? \quad \underline{200 \text{ m}}$$

$$v_{01} = 0$$

$$v_1 = ? \quad \underline{100 \text{ m/s}}$$

$$a_1 = 25$$

$$t_1 = 4.0 \text{ s}$$

$$\begin{aligned} \Delta y_1 &= v_{01} t_1 + \frac{1}{2} a_1 t_1^2 \\ &= 0 + \frac{1}{2} (25) (4)^2 \\ &= 200 \text{ m} \end{aligned}$$

$$\begin{aligned} v_1 &= v_{01} + a_1 t_1 \\ &= 0 + 25(4) = 100 \text{ m/s} \end{aligned}$$

Part 2 - max height

$$\Delta y_2 = ?$$

$$v_{02} = 100 \text{ m/s}$$

$$v_2 = 0$$

$$a_2 = -9.8$$

$$t = ?$$

$$0 = 100 - 9.8t \quad t = 10.2 \text{ s}$$

$$\Delta y_2: v_2^2 = v_{02}^2 + 2a\Delta y$$

$$0 = 100^2 + 2(-9.8)\Delta y$$

$$\Delta y_2 = 510 \text{ m}$$

$$\Delta y_{\text{TOT}} = 200 + 510 = \boxed{710 \text{ m}}$$

Going down

$$\Delta y = -710$$

$$v_0 = 0$$

$$v = ?$$

$$a = -9.8$$

$$t = ?$$

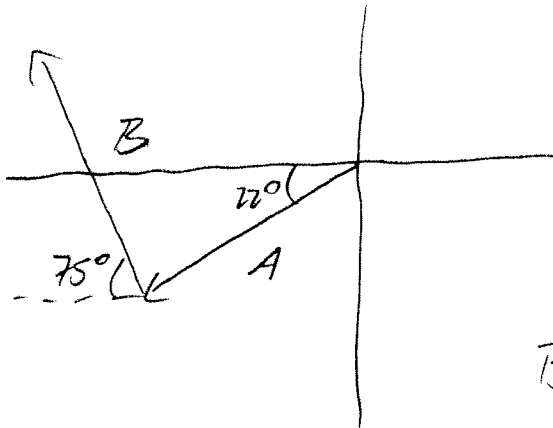
$$t: \Delta y = v_0 t + \frac{1}{2} a t^2$$

$$-710 = 0 - 4.9t^2$$

$$t = 12 \text{ s}$$

$$t_{\text{TOT}} = 12 + 4 + 10 = \boxed{26 \text{ s}}$$

3. (20 pts) A person walks 340 meters in a direction 22° South of West, then 440 meters in a direction 75° North of West. What is the magnitude and direction of the person's total displacement?



$$A_x = -340 \cos 22 = -315$$

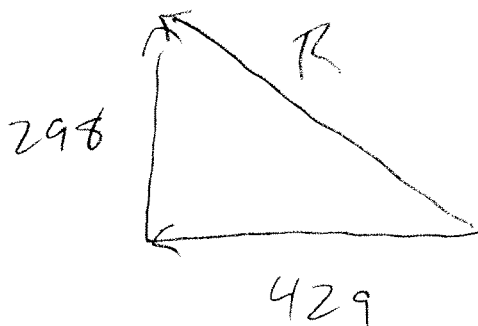
$$A_y = -340 \sin 22 = -127$$

$$B_x = -440 \cos 75 = -114$$

$$B_y = 440 \sin 75 = 425$$

$$R_x = -315 - 114 = -429$$

$$R_y = -127 + 425 = 298$$



$$|R| = \sqrt{298^2 + 429^2}$$

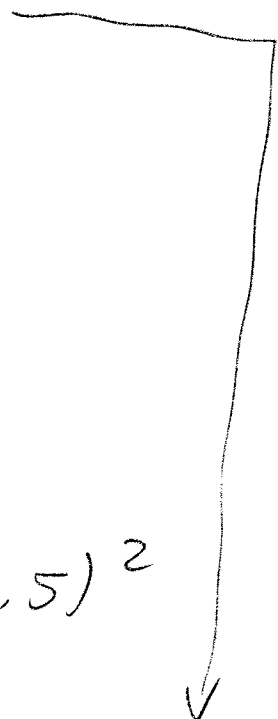
$$= \boxed{520 \text{ m}}$$

$$\theta = \tan^{-1} \left(\frac{298}{429} \right)$$

$$= \boxed{35^\circ \text{ N of W}}$$

4. From the top of a 12 meter tall building, a ball is given an initial velocity in a direction 23° above the horizontal. It is in the air (in free fall) for 2.5 seconds before hitting the ground.

- a) What is the initial speed of the ball?
 b) What is the speed of the ball when it is at maximum height?

<u>X</u>	<u>Y</u>	
$\Delta x =$	$\Delta y = -12$	
$V_{0x} = V_0 \cos 23$	$V_{0y} = V_0 \sin 23$	
$V_x = V_0 \sin 23$	$V_y = ?$	
$a_x = 0$	$a_y = -9.8$	
$t = 2.5$	$t = 2.5 \text{ s}$	

$$V_{0y} : \Delta y = V_{0y} t + \frac{1}{2} a_y t^2$$

$$-12 = V_{0y} (2.5) - 4.9 (2.5)^2$$

$$18.625 = V_{0y} (2.5)$$

$$V_{0y} = 7.45 \quad V_0 = \frac{7.45}{\sin 23} = \boxed{19 \text{ m/s}}$$

At max ht, speed = $V_x = V_{0x}$ since $V_y = 0$

$$V_{0x} = 19 \cos 23 = 17.55 = \boxed{18 \text{ m/s}}$$