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. (30 pts) A car travels North at a speed of 55 mi/hr for 2.0 hours, stops for an hour, then travels South at a speed of 65 mi/hr for a distance of 41 miles. What is the car's average velocity (magnitude and direction) for the entire trip?

Part 1

$\Delta x_1 = ?$

$\bar{v}_1 = 55\ mi/hr$

$t_1 = 2.0\ hr$

$\Delta x_1 = \bar{v}_1 t_1$

$= 110\ mi$

Part 2

$\Delta x_2 = 0$

$\bar{v}_2 = 0$

$t_2 = 1.0\ hr$

Part 3

$\Delta x_3 = -41\ miles$

$\bar{v}_3 = -65\ mi/hr$

$t_3 =$

$t_3 = \frac{\Delta x_3}{\bar{v}_3} = 0.63\ hr$

$\Delta x_{TOT} = \Delta x_1 + \Delta x_2 + \Delta x_3$

$= 110 + 0 - 41 = 69\ miles$

$t_{TOT} = t_1 + t_2 + t_3$

$= 2.0 + 1.0 + 0.63 = 3.63\ hr$

$\bar{v}_{TOT} = \frac{69\ mi}{3.63\ hr} =$ **19 mi/hr, North**

2. (30 pts) A ball is kicked at an angle of 33° above the horizontal and just clears a 7.5 meter high wall when it is at its maximum height.

a) What is the initial speed of the ball?

b) How far away (horizontally) is the wall from the ball when the ball is first kicked?

a)

X	Y
$\Delta x = ?$	$a_y = 7.5\ m$
$V_{0x} = V_0 \cos 33°$	$V_{0y} = V_0 \sin 33°$
$V_x = V_0 \cos 33°$	$V_y = 0$
$a_x = 0$	$a_y = -9.8\ m/s^2$
$t = ?$	$t = ?$

$$V_y^2 = V_{0y}^2 + 2a_y \Delta y$$

$$0 = V_{0y}^2 + 2(-9.8)(7.5)$$

$$V_{0y} = 12.1\ m/s = V_0 \sin 33°$$

$$\text{So } V_0 = \frac{12.1}{\sin 33°} = \boxed{22\ m/s}$$

b) $\Delta y = V_y t - \frac{1}{2} a_y t^2$

$7.5 = 0 - \frac{1}{2}(-9.8) t^2$

$t = 1.24\ s$

$\Delta x = (V_0 \cos 33°) t$

$= \boxed{23\ m}$

3. (40 pts) In a factory assembly line, a small box starts from rest and accelerates down a 5.0 meter long ramp that is inclined 37° below the horizontal. The acceleration of the box while on the ramp is 4.5 m/s^2 directed along the ramp. At the end of the ramp, the box falls freely down to a conveyor belt in 1.2 seconds.

a) What is the vertical distance between the conveyor belt and the bottom of the ramp?

b) What is the magnitude and direction of the box's final velocity just before it hits the conveyor belt?

On ramp

$\Delta s = 5.0\ m$

$v_0 = 0$

$v = ?$

$a = 4.5\ m/s^2$

$t = ?$

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

$v^2 = 0 + 2(4.5)(5)$

$v = 6.71\ m/s$

$v_x = 6.71 \cos 37 = 5.36\ m/s$

$v_y = -6.71 \sin 37 = -4.04\ m/s$

Free fall

x	y
$\Delta x = ?$	$\Delta y = ?$
$v_{0x} = 5.36$	$v_{0y} = -4.04\ m/s$
$v_x = 5.36$	$v_y = ?$
$a_x = 0$	$a_y = -9.8\ m/s^2$
$t = ?$	$t = 1.2\ s$

$v_y = v_{0y} + a_y t$

$= -4.04 + (-9.8)(1.2)$

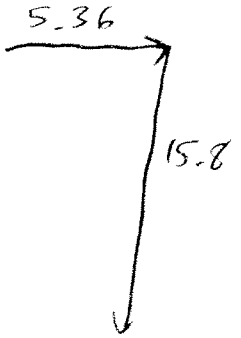
$= -15.8\ m/s$

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

$= (-4.04)(1.2) - 4.9(1.2)^2$

$= 11.9\ m = \boxed{12\ m}$

$v_x = 5.36 \quad v_y = -15.8$



$v = \sqrt{5.36^2 + 15.8^2}$

$= 16.7 = \boxed{17\ m/s}$

$\theta = \tan^{-1}\left(\frac{15.8}{5.36}\right)$

$= \boxed{71°\ \text{below}\ +x}$