Physics Exam I Corrections

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1) Convert the following to standard SI units. State the dimension.
c. $\frac{3.33Nms}{h} = \frac{3.33Nms}{6.63x10^{-34}Js} = 5.02x10^{33}$ No units, Dimensionless.
d. $\frac{1.0eV}{watts} = \frac{1.6x10^{-19}CoulumbVolt}{1Joule/second} = 1.6x10^{-19}seconds$, Dimension = T.

2) A water balloon is dropped from 14m above ground level.
d. Determine the position 0.2 seconds before hitting the ground.
Time to hit the ground:

$$0 = 14 - 4.9^2$$

$$t = \sqrt{\frac{14}{4.9}} = 1.69s - 0.2s = 1.49s$$

Position at this time:

$$y(t) = y_0 + V_0t + \frac{1}{2}a_yt^2$$

$$y(1.49) = 14 - 4.9(1.49)^2 = 3.12meters$$

3) A toy rocket is shot straight up from the ground and reaches a max height of 20m. The rocket is then shot at the same speed at 25 degrees above the ground.
a. Determine the horizontal and vertical components of V_0.
To determine V_0:

$$V^2 - V_0^2 = 2ad$$

At the peak, $V = 0$, $a = -9.8m/s^2$, and $d = 20m$.

$$0 - V_0^2 = 2(-9.8)(20)$$

$$V_0 = 19.8m/s$$

Now we can solve for V_{0x} and V_{0y}

$$V_{0x} = V_0cos(\theta) \text{ and } V_{0y} = V_0sin(\theta)$$
$$V_{0x} = 19.8cos(25) \text{ and } V_{0y} = 19.8sin(25)$$
$$V_{0x} = 17.9 \text{ m/s and } V_{0y} = 8.3 \text{ m/s}$$

b. Determine the average velocity for the flight.

$$< \vec{v} >= \begin{bmatrix} < v_x > \\ < v_y > \end{bmatrix}$$

$$< v_y >= \frac{\Delta y}{\Delta t} < v_x >= \frac{\Delta x}{\Delta t}$$

$$< \vec{v} >= \begin{bmatrix} 17.9 \\ 0 \end{bmatrix} m/s$$

c. Determine the maximum height and range of the flight.

$$V_y^2 - V_{0y} = 2a(\Delta y)$$

$$\text{At the peak:}$$

$$0 - (8.375)^2 = 2(-9.8)\Delta y$$

$$70.1406 = 19.6\Delta y$$

$$Y_{max} = 3.58m$$

$$\text{For the range:}$$

$$\Delta x = < V_x > t_{flight}$$

$$\Delta x = 17.9(1.71) = 30.6m$$

d. Determine the velocity (magnitude and direction) for the rocket 1.0 second before it hits the ground.

$$t = 1.71 - 1 = 0.71s$$

$$\hat{V}(0.71) = \begin{bmatrix} 17.9 \\ 1.42 \end{bmatrix}$$

$$V = \sqrt{(17.9)^2 + (1.42)^2} = 17.9m/s$$

4. A rad car races around a circular track at a radius of 40 meters and a speed of 50 m/s. The car starts at zero angular position. The car then increases its speed (at a constant rate) from 50 m/s to 60 m/s over 2 seconds.
c. Determine the magnitude of the acceleration half way through this maneuver.

$$\hat{a} = a_{rad}\hat{r} + a_{cent}\hat{r} + a_{Cor}\hat{\theta} + a_{tan}\hat{\theta}$$

$$\text{The car is not moving in the radial direction, so}$$

$$\hat{a} = \frac{-v^2}{r}\hat{r} + a_{tan}\hat{\theta}$$

$$\text{The velocity halfway through} = 55 \text{ m/s.}$$

$$\hat{a} = \frac{-55^2}{40}\hat{r} + 5\hat{\theta}$$

$$\hat{a} = 75.6\hat{r} + 5\hat{\theta}$$

$$a = \sqrt{(75.6)^2 + (5)^2} = 75.8m/s^2$$

d. Determine the magnitude of the displacement during the 2 second maneuver.
Displacement is the difference between the starting and ending position, not distance traveled.

$$S = \theta r$$

$$\frac{110}{40} = 2.75rad = \theta$$

$$\hat{r}_{final} = \begin{bmatrix} 40cos(2.75rad) \\ 40sin(2.75rad) \end{bmatrix}$$

$$\hat{r}_{initial} = \begin{bmatrix} 40 \\ 0 \end{bmatrix}$$

$$\Delta\hat{r} = \begin{bmatrix} \hat{r}_f - \hat{r}_i \\ \hat{r}_f - \hat{r}_i \end{bmatrix} = 40 \begin{bmatrix} cos(2.75rad) - 1 \\ sin(2.75rad) \end{bmatrix}$$

$$|\Delta\hat{r}| = 40\sqrt{(cos(2.75rad))^2 + (sin(2.75rad))^2} = 78.4m$$