Second Homework Corrections

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1 1-D Kinematics

A toy rocket is launched straight up from the ground and lands 7.2 seconds later. Determine: the initial velocity, the maximum height, average speed and average velocity.

1.1 Initial Velocity = ?

$$t_{ypeak} = \frac{1}{2} \times t_{xmax}$$

$$t_{ypeak} = .5 \times 7.2s$$

$$\boxed{t_{ypeak} = 3.6s}$$

$$V(t) = V_o + at$$

$$V(t) = V_o - gt$$

$$\boxed{Vt = V_o - 9.8t}$$

$$\boxed{V_y(3.6) = 0}$$

$$0 = V_o - 9.8 \times 3.6$$

$$V_o = 9.8 \times 3.6$$

$$\boxed{V_o = 35.3\frac{m}{s}}$$

1.2 Maximum height = ?

$$y(t_{ymax}) = y_o + V_o t_{ymax} + \frac{1}{2}at_{ymax}^2$$

$$y(3.6) = (35.3)(3.6) - 4.9(3.6)^2$$

$$\boxed{y_{max} = 65.3m}$$

1.3 Average Speed = ?

$$AverageSpeed = \frac{(35.3)}{2}$$

$$\boxed{AverageSpeed = 17.6\frac{m}{s}}$$

1.4 Average Velocity = ?

$$AverageVelocity = \frac{V_o + V_f}{2}$$

$$AverageVelocity = \frac{(0) + (0)}{2}$$

$\boxed{AverageVelocity = 0}$

2 1-D Kinematics

A coin is dropped down a well and heard hitting the bottom 7.2 seconds later. Assuming the sound travels at 335 meters per second, determine the depth of the well.

$$Depthofwell = D =?$$

$$t_1 = 0$$

$$t_2 = 7.2s$$

$$a = 9.8\frac{m}{s^2}$$

$$V_o = 0$$

$$t_1 + t_2 = 7.2s$$

$$t_2 = 7.2 - t_1$$

$$Coin : \Delta y = V_o t + \frac{at^2}{2}$$

$$Coin : D = \frac{9.8t^2}{2}$$

$$Sound : \Delta y = Vot$$

$$Sound : D = 335(7.2 - t_1)$$

$$\frac{9.8t^2}{2} = 395(7.2 - t_1)$$

$$t_1 = 6.6seconds$$

$$t_2 = 7.2 - (6.6) = .6s$$

$$D = 335(t_2)$$

$$D = 335(.6)$$

$$\boxed{D = 201meters}$$

3 1-D Kinematics Continued

You are driving through Bronxville at 12.0 m/s when suddenly a ball rolls out in front of you. You apply the breaks and begin accelerating at -3.50 m/s**.

- Determine how far you travel before stopping.

$$V(t) = V_o + at$$

$$0 = 12\frac{m}{s} - 1.75\frac{m}{s^2}t$$

$$t = 6.86s$$

$$AverageVelocity = \frac{V_o + V}{2}$$

$$AverageVelocity = \frac{12 + 0}{2}$$

$$AverageVelocity = 6\frac{m}{s}$$

$$\Delta x = AverageVelocity \times t$$

$$\Delta x = 6 \times 6.86s$$

$$\boxed{\Delta x = 41.16m}$$

- Determine your velocity when you have travelled half the stopping distance.

$$V^2 - V_o^2 = 2a(x - x_o)$$

$$V^2 - (12)^2 = 2(-3.5)(41.16 - 20.8)$$

$$V^2 = \sqrt{1.6}$$

$$V(t) = V_o + at$$

$$V(\frac{6.86}{2}) = 12\frac{m}{s} - 1.75\frac{m}{s^2}(\frac{6.86}{2})$$

$$\boxed{V(3.43) = 6.00\frac{m}{s}}$$

4 Projectile Motion

While waiting on hold with customer service, a physics teacher builds a paper clip launcher that releases the clips from a table, .75 m above the floor. The clips are launched from the edge of the table at an angle of 30 degrees above the horizontal and land on the floor 1.9m out from a point under the launcher. Determine the initial velocity of the launched clips.

$$V_o = ?$$

$$\theta = 30°$$

$$V_{ox} = V_o = V_o cos30 = Vo(.866)$$

$$V_{oy} = Vosin30 = \frac{V_o}{2}$$

$$X : x(t) = V_{ox}t + \frac{at^2}{2}$$

$$X : x(t) = V_o cost(30)t$$

$$Y : y(t) = y_o + V_{oy}t + \frac{at^2}{2}$$

$$Y : y(t) = .75 + V_o sin(30)t - \frac{9.8t^2}{2}$$

$$t = T$$

$$y(T) = 0 = .75 + V_o sin(30)T - 4.9T$$

$$x(T) = 1.9 = V_o cost(30)T$$

$$T = \frac{1.9}{V_o cost(30)} = \frac{2.19}{V_o}$$

$$y(T) = 0 = .75 + V_o sin(30)\frac{2.19}{V_o} - 4.9\frac{2.19}{V_o}$$

$$y(T) = 0 = .75 + 1.05 - \frac{23.5}{V_o^2}$$

$$\boxed{V_o = 3.6\frac{m}{s}}$$

5 Projectile Motion

Tiger Woods golfs a hole where the tee area is 7.5 meters above the ground. He smacks the ball with an inital velocity of 35 m/s at an angle of 25 degrees above the ground around the tee. Determine the following:

- The horizontal and vertical components of the initial velocity of the ball.

$$V_{ox} = V_o cos(\theta)$$

$$35cos(25) = \boxed{31.72\frac{m}{s}}$$

$$V_{oy} = V_o sin(\theta)$$

$$35sin(25) = \boxed{14.79\frac{m}{s}}$$

- The height the ball rises above the tee

$$y = y_o + V_{oy}t - \frac{gt^2}{2}$$

$$0 = 7.5 + 14.79t - 4.9t^2$$

$$t_{xmax} = 3.46s$$

$$y = 7.5m + 14.79(\frac{3.46}{2}) - 4.9(\frac{3.46}{2})^2$$

$$\boxed{y_{max} = 18.42m}$$

- the time the ball is in the air

$$\boxed{t_{xmax} = 3.46seconds}$$

- the distance down the fairway that the ball lands

$$x_{max} = x_o + V_{ox}t_{xmax}$$

$$x_{max} = 0 + 31.72(3.46)$$

$$\boxed{x_{max} = 109.75m}$$

- the horizontal and vertical components of the ball's velocity just before the ball lands

$$\boxed{V_x = V_{ox} = 31.72\frac{m}{s}}$$

$$\boxed{V_y = V_{oy} + a_yt = -19.12\frac{m}{s}}$$

6 Earth's Rotation

Consider the rotation of the earth around its central axis. State the period of the earth's rotation. Determine the angular velocity of the earth's rotation. Determine the velocity of the earth's surface at the equator relative to the center. Determine the centripetal acceleration at the equator relative to the center. Determine the velocity of the earth's surface below Sarah Lawrence relative to the center. Determine the centripetal acceleration of Sarah Lawrence relative to the center.

$$T = 24hrs \times \frac{60minutes}{1hour} \times \frac{60seconds}{1minute} = \boxed{86400seconds}$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{1day} = \frac{2\pi}{24 \times 60 \times 60seconds} = \boxed{7.27 \times 10^{-5}\frac{rad}{sec}}$$

$$latitude = 40.9^\circ$$

$$cos(40.9) = \frac{r}{6.4 \times 10^6}$$

$$\boxed{r = 4.84 \times 10^6 meters}$$

$$V_{equator} = 6.4 \times 10^6 \times 7.27 \times 10^{-5} = \boxed{456\frac{m}{s}}$$

$$V_{SLC} = 4.84 \times 10^6 \times 7.27 \times 10^{-5} = \boxed{353\frac{m}{s}}$$

$$a_{equator} = \frac{V^2}{R} = \frac{465^2}{6.4 \times 10^6} = \boxed{3.4 \times 10^{-2}\frac{m}{s}}$$

$$a_{SLC} = \frac{V^2}{r} = \frac{352^2}{4.84 \times 10^6} = \boxed{2.56 \times 10^{-2}\frac{m}{s}}$$

7 Merry-Go-Round

A Merry-Go-Round measures 8.0 meters in diameter and has a rotational period of 3 seconds. The operator walks at constant velocity from the center to the edge of the platform at a rate of 2.0m/s.

- Determine his total acceleration when he is half way to the edge.

$$V_r = 2\frac{m}{s}$$

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{3} = 2.09\frac{rad}{sec}$$

$$\vec{a} = -\frac{V_{tan}^2 \hat{r}}{r} + +\frac{2V_{tan}V_{rad}\hat{r}}{r}$$

$$\vec{a} = \frac{= (4.18)^2 \hat{r}}{2} + \frac{2(4.18)(2)\hat{\theta}}{2}$$

$$\vec{a} = -8.74\hat{r} + 8.36\hat{\theta}$$

$$a = \sqrt{(8.74)^2 + (8.36)^2}$$

$$\boxed{a = 12.1\frac{m}{s^2}}$$

- The MGR is then shut-off and slows down at a constant angular acceleration requiring 10 rotations to come to a complete stop. During the slowdown the operator walks back, starting from rest at the edge, to the center at a constant acceleration of 0.5m/s2. Determine his total acceleration when he is halfway back to the center.

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{-2.09}{60.1} = -.035\frac{m}{s^2}$$

$$\Delta r = V_o t + \frac{a_r t^2}{2}$$

$$2 = \frac{(.5)t^2}{t}$$

$$t = 2.82s$$

$$\omega_f = 2.09 + \alpha t$$

$$\omega_f = 2.09 + (-.035)(2.82)$$

$$\omega_f = 2.0\frac{rad}{sec}$$

$$V_{rad} = V_{or} + a_{rad}t$$

$$V_{rad} = (-.5)(2.82) = -1.41\frac{m}{s}$$

$$\vec{a} = r\alpha\hat{\theta} - r\omega^2\hat{r} + 2V_r\omega\hat{\theta} + a_r\hat{r}$$

$$\vec{a} = (2)(-.035)\hat{\theta} - (2)(2)^2\hat{r} + 2(-1.41)(2)\hat{\theta} + (.5)\hat{r}$$

$$\boxed{\vec{a} = -5.71\hat{\theta} - 7.5\hat{r}}$$

$$\boxed{a = \sqrt{(-5.71)^2 + (-7.5)^2} = 9.43\frac{m}{s^2}}$$