Name____

Physics 110 Quiz #1, April 1, 2022

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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1. Suppose that you were out for a walk one day and that you wanted to determine your average walking speed. To determine your walking speed, you time yourself walking a known distance and you find that it takes you $2.2min$ to walk $\frac{1}{8}$ of a mile. What is your average walking speed in $\frac{m}{s}$ if there are $5280ft$ in 1 $mile$ and there are $3.28ft$ in $1m$?

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{\frac{1}{8}mi \times \frac{5280ft}{1mi} \times \frac{1m}{3.28ft}}{2.2min \times \frac{60s}{1min}} = 1.5\frac{m}{s}$$

2. The earth has a radius of $R = 6.4 \times 10^6 m$. How many days would it take you to walk in a circular path around the earth one time? Assume that your average walking speed was what you determined in part 1 and that you walk $12hr$ per day.

$\Delta x_{total} = n\Delta x_{day}$ where $\Delta x_{total} = 2\pi R$ and n the number of days. To do this we need to know how many meters we walk per day, Δx_{day}.

$$v_{avg} = \frac{\Delta x_{day}}{\Delta t} \rightarrow \Delta x_{day} = v_{avg}\Delta t = 1.5\frac{m}{s} \times \left(12\frac{hr}{day} \times \frac{3600s}{1hr}\right) = 64800\frac{m}{day}$$

$$n = \frac{2\pi R}{\Delta x_{day}} = \frac{2\pi \times 6.4 \times 10^6 m}{64800\frac{m}{day}} = 620.6\ days$$

3. Suppose you constructed a velocity versus time graph from some data that you collected, and you found that the velocity as a function of time data could be fit by an equation $v(t) = ct^2 + d$, where the velocity v is measured in units of $\frac{hands}{min}$, for the time t measured in min. What are the units of the constants c and d? (Note: This is not needed for the problem, but a $hand$ is unit used to measure the height of horses with $1 hand \sim 4 inches \sim 10.2 cm$.)

   To get $\frac{hands}{min}$ for the units of velocity, we need the coefficient of c to have velocity units divided by time squared units. Thus, we have $c = \frac{\frac{hands}{min}}{min^2} = \frac{hands}{min^3}$. Since d is the y-intercept, it needs to be in units of $\frac{hands}{min}$, so $d = \frac{hands}{min}$.

4. Since the velocity in part 3 varies as $v(t) = ct^2 + d$, what can you say about the acceleration of the object? Be as specific as possible and this part does not require any calculation.

   For motion with constant acceleration, the velocity varies linearly in time according to $v(t) = v_i + at$. Since the equation in part 3 varies quadratically in time, the acceleration is thus not constant, but varies with time.

Physics 110 Formula sheet

Vectors

$v = \sqrt{v_x^2 + v_y^2}$

$\phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Motion Definitions

Displacement: $\Delta x = x_f - x_i$

Average velocity: $v_{avg} = \frac{\Delta x}{\Delta t}$

Average acceleration: $a_{avg} = \frac{\Delta v}{\Delta t}$

Equations of Motion

displacement: $\begin{cases} x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2 \\ y_f = y_i + v_{iy}t + \frac{1}{2}a_y t^2 \end{cases}$

velocity: $\begin{cases} v_{fx} = v_{ix} + a_x t \\ v_{fy} = v_{iy} + a_y t \end{cases}$

time-independent: $\begin{cases} v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \\ v_{fy}^2 = v_{iy}^2 + 2a_y\Delta y \end{cases}$

Rotational Motion Definitions

Angular displacement: $\Delta s = R\Delta\theta$

Angular velocity: $\omega = \frac{\Delta\theta}{\Delta t} \to v = R\omega$

Angular acceleration: $\alpha = \frac{\Delta\omega}{\Delta t} \to \begin{cases} a_t = r\alpha \\ a_c = r\omega^2 \end{cases}$

Rotational Equations of Motion

$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$

$\omega_f = \omega_i + \alpha t$

$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

Momentum & Force

$\vec{p} = m\vec{v} \to p_x = mv_x;\ p_y = mv_y$

$\Delta\vec{p} = \vec{F}\Delta t \to \vec{p}_f = \vec{p}_i + \vec{F}\Delta t$

$\vec{F} = \frac{d\vec{p}}{dt} = m\vec{a} \to F_x = ma_x; F_y = ma_y$

$F_{fr} = \mu F_N$

$F_w = mg$

$F_s = -kx$

$F_G = G\frac{M_1 M_2}{r^2}$

$F_c = ma_c = m\frac{v^2}{R}$

Work & Energy

$\begin{cases} W_T = \int \vec{F}\cdot d\vec{r} = Fdr\cos\theta = \Delta K_T \\ W_R = \int \vec{\tau}\cdot d\vec{\theta} = \tau d\theta = \Delta K_R \end{cases}$

$W_{net} = W_T + W_R = \Delta K_T + \Delta K_R = -\Delta U$

$K_T = \frac{1}{2}mv^2$

$K_R = \frac{1}{2}I\omega^2$

$U_g = mgy$

$U_s = \frac{1}{2}kx^2$

$\Delta E = \Delta E_R + \Delta E_T$

$\Delta E = \Delta K_R + \Delta K_T + \Delta U_g + \Delta U_s = \begin{cases} 0 \\ W_{fr} \end{cases}$

Rotational Momentum & Force

$\vec{\tau} = \vec{r}\times\vec{F};\ \tau = r_\perp F = rF_\perp = rF\sin\theta$

$\tau = \frac{\Delta L}{\Delta t} = I\alpha$

$L = I\omega$

$\Delta\vec{L} = \vec{\tau}\Delta t \to \vec{L}_f = \vec{L}_i + \vec{\tau}\Delta t$

Fluids

$\rho = \frac{m}{V}$

$P = \frac{F}{A}$

$P_y = P_{air} + \rho g y$

$F_B = \rho g V$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$; compressible

$A_1 v_1 = A_2 v_2$; incompressible

$$P_1 + \tfrac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \tfrac{1}{2}\rho v_2^2 + \rho g y_2$$

Simple Harmonic Motion

$$\omega = 2\pi f = \frac{2\pi}{T}$$

$$T_s = 2\pi\sqrt{\frac{m}{k}}; \quad \omega = \sqrt{\frac{k}{m}}$$

$$T_p = 2\pi\sqrt{\frac{l}{g}}; \quad \omega = \sqrt{\frac{g}{l}}$$

Geometry/Algebra

Circles:	$A = \pi r^2$	$C = 2\pi r = \pi D$
Spheres:	$A = 4\pi r^2$	$V = \frac{4}{3}\pi r^3$
Triangles:	$A = \frac{1}{2}bh$	
Quadratics:	$ax^2 + bx + c = 0 \rightarrow x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	

Common Metric Prefixes

$nano = 1 \times 10^{-9}$

$micro = 1 \times 10^{-6}$

$milli = 1 \times 10^{-3}$

$centi = 1 \times 10^{-2}$

$kilo = 1 \times 10^{3}$

$mega = 1 \times 10^{6}$

Sound

$v_s = f\lambda = (331 + 0.6T)\frac{m}{s}$

$\beta = 10 \log \frac{I}{I_o}$

$f_n = n f_1 = n\frac{v}{2L}; n = 1,2,3,\ldots$ open pipes

$f_n = n f_1 = n\frac{v}{4L}; n = 1,3,5,\ldots$ closed pipes

Waves

$$v = f\lambda = \sqrt{\frac{F_T}{\mu}}$$

$f_n = n f_1 = n\frac{v}{2L}; \ n = 1,2,3,\ldots$

$I = 2\pi^2 f^2 \rho v A^2$

Equations of Motion for SHM

$$x(t) = \begin{cases} x_{max}\sin\left(\frac{2\pi}{T}t\right) \\ x_{max}\cos\left(\frac{2\pi}{T}t\right) \end{cases}$$

$$v(t) = \begin{cases} v_{max}\cos\left(\frac{2\pi}{T}t\right) \\ -v_{max}\sin\left(\frac{2\pi}{T}t\right) \end{cases}$$

$$a(t) = \begin{cases} -a_{max}\sin\left(\frac{2\pi}{T}t\right) \\ -a_{max}\cos\left(\frac{2\pi}{T}t\right) \end{cases}$$

$$v = \pm v_{max}\sqrt{1 - \left(\frac{x}{x_{max}}\right)^2}$$

$$v = \pm \omega x_{max}\sqrt{1 - \left(\frac{x}{x_{max}}\right)^2}$$

Periodic Table of the Elements