Name____

Physics 110 Quiz #1, April 4, 2020

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. A standard baseball has a circumference of approximately $23cm$. If a baseball had the same mass per unit volume as a neutron or a proton, about what would the mass of the baseball be? Suppose that a neutron or a proton is a ball that has a diameter of $1 \times 10^{-15}m$ and a mass of $1 \times 10^{-27}kg$. Hint: The volume of a sphere is $\frac{4}{3}\pi r^3$.

$$\frac{m_{bb}}{V_{bb}} = \frac{m_p}{V_p} \rightarrow m_{bb} = m_p \frac{V_{bb}}{V_p} = m_p \frac{\frac{4}{3}\pi r_{bb}^3}{\frac{4}{3}\pi r_p^3} = m_p \left(\frac{r_{bb}}{r_p}\right)^3$$

$$m_{bb} = m_p \left(\frac{r_{bb}}{r_p}\right)^3 = 1 \times 10^{-27}kg \left(\frac{0.04m}{0.5 \times 10^{-15}m}\right)^3 = 5.1 \times 10^{14}kg$$

where $C_{bb} = 2\pi r_{bb} \rightarrow r_{bb} = \frac{C}{2\pi} = \frac{0.23m}{2\pi} = 0.04m$

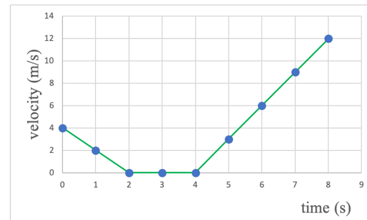
2. In the late 1800s Jules Verne wrote a book about the adventures of Captain Nemo and his submarine called the Nautilus, as he (and two others) traveled around the world under the sea. The book was called *20,000 Leagues Under the Sea*. A league is a unit of distance equal to about three miles. How many feet *under the sea* did Captain Nemo travel if there $5280ft = 1mi$?

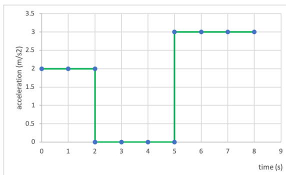
$$2 \times 10^4 leagues \times \frac{3miles}{1league} \times \frac{5280ft}{1mile} = 3.2 \times 10^8 ft$$

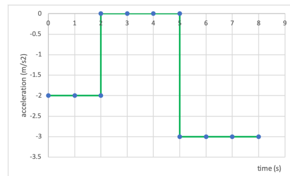
3. In the equation $d = ct + b$, d is measured in furlongs (1 furlong$\sim 200m \sim 600ft$) and t is measured in fortnights (1 fortnight$\sim$14 days). What are the dimensions (units) of *c* and *b*?

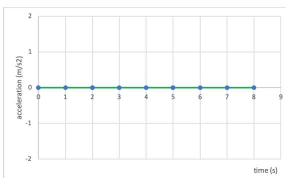
c is the slope of the line so its units are $\frac{\Delta d}{\Delta t}$, or furlongs per fortnight?
b is the y-intercept so it has the same units as d, or furlongs.

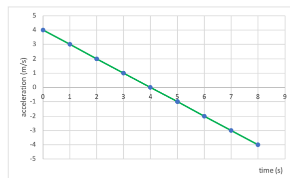
4. An object is observed to undergo motion in 1D along the x-axis. The velocity of the object as a function of time is shown on the right. Which of the following graphs below gives the acceleration of the object as a function of time?

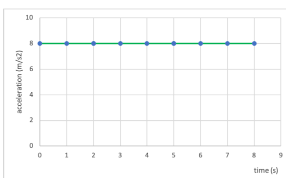


a. 

b. 

c. 

d. 

e. 

f. None of the choices are correct.

5. From the velocity versus time graph in question 4, what is the displacement of the object between the time interval 4s and 8s?

$$\Delta x = v_{avg}\Delta t = \left(\frac{v_f + v_i}{2}\right)\left(t_f - t_i\right) = \left(\frac{12\frac{m}{s} + 0\frac{m}{s}}{2}\right)(8s - 4s) = 24m$$

Physics 110 Formulas

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

Uniform Circular Motion

$F_r = ma_r = m\frac{v^2}{r}; \quad a_r = \frac{v^2}{r}$

$v = \frac{2\pi r}{T}$

$F_G = G\frac{m_1 m_2}{r^2}$

Geometry /Algebra

Circles *Triangles* *Spheres*

$C = 2\pi r \quad A = \frac{1}{2}bh \quad A = 4\pi r^2$

$A = \pi r^2 \quad V = \frac{4}{3}\pi r^3$

Quadratic equation : $ax^2 + bx + c = 0$,

whose solutions are given by : $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

magnitude of a vector: $v = |\vec{v}| = \sqrt{{v_x}^2 + {v_y}^2}$

direction of a vector: $\phi = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

Useful Constants

$g = 9.8\, m/s^2 \quad G = 6.67\times10^{-11}\, Nm^2/kg^2$

$N_A = 6.02\times10^{23}\, atoms/mole \quad k_B = 1.38\times10^{-23}\, J/K$

$\sigma = 5.67\times10^{-8}\, W/m^2K^4 \quad v_{sound} = 343\, m/s$

Linear Momentum/Forces

$\vec{p} = m\vec{v}$

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

$\vec{F} = m\vec{a}$

$\vec{F}_s = -k\vec{x}$

$F_f = \mu F_N$

Work/Energy

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

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

$U_g = mgh$

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

$W_T = FdCos\theta = \Delta E_T$

$W_R = \tau\theta = \Delta E_R$

$W_{net} = W_R + W_T = \Delta E_R + \Delta E_T$

$\Delta E_R + \Delta E_T + \Delta U_g + \Delta U_S = 0$

$\Delta E_R + \Delta E_T + \Delta U_g + \Delta U_S = -\Delta E_{diss}$

Heat

$T_C = \frac{5}{9}[T_F - 32]$

$T_F = \frac{9}{5}T_C + 32$

$L_{new} = L_{old}(1 + \alpha\Delta T)$

$A_{new} = A_{old}(1 + 2\alpha\Delta T)$

$V_{new} = V_{old}(1 + \beta\Delta T):\ \beta = 3\alpha$

$PV = Nk_B T$

$\frac{3}{2}k_B T = \frac{1}{2}mv^2$

$\Delta Q = mc\Delta T$

$P_C = \frac{\Delta Q}{\Delta t} = \frac{kA}{L}\Delta T$

$P_R = \frac{\Delta Q}{\Delta T} = \varepsilon\sigma A\Delta T^4$

$\Delta U = \Delta Q - \Delta W$

Rotational Motion

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

$\omega_f = \omega_i + \alpha t$

$\omega^2{}_f = \omega^2{}_i + 2\alpha\Delta\theta$

$\tau = I\alpha = rF$

$L = I\omega$

$L_f = L_i + \tau\Delta t$

$\Delta s = r\Delta\theta:\ v = r\omega:\ a_t = r\alpha$

$a_r = r\omega^2$

Fluids

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

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

$P_d = P_0 + \rho gd$

$F_B = \rho gV$

$A_1 v_1 = A_2 v_2$

$\rho_1 A_1 v_1 = \rho_2 A_2 v_2$

$P_1 + \frac{1}{2}\rho v^2{}_1 + \rho gh_1 = P_2 + \frac{1}{2}\rho v^2{}_2 + \rho gh_2$

Simple Harmonic Motion/Waves

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

$T_S = 2\pi\sqrt{\frac{m}{k}}$

$T_P = 2\pi\sqrt{\frac{l}{g}}$

$v = \pm\sqrt{\frac{k}{m}}A\left(1 - \frac{x^2}{A^2}\right)^{\frac{1}{2}}$

$x(t) = A\sin\left(\frac{2\pi t}{T}\right)$

$v(t) = A\sqrt{\frac{k}{m}}\cos\left(\frac{2\pi t}{T}\right)$

$a(t) = -A\frac{k}{m}\sin\left(\frac{2\pi t}{T}\right)$

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

$f_n = nf_1 = n\frac{v}{2L}$

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

Sound

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

$\beta = 10\log\frac{I}{I_0}; \quad I_o = 1\times10^{-12}\,\frac{W}{m^2}$

$f_n = nf_1 = n\frac{v}{2L}; \quad f_n = nf_1 = n\frac{v}{4L}$