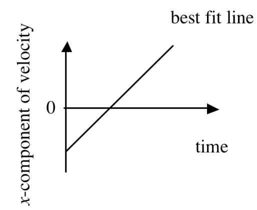
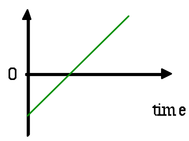
Name________________________________

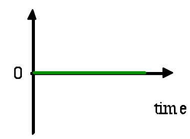
Physics 120 Quiz #2, January 20, 2012

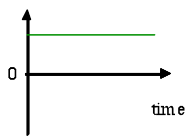
Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

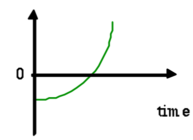
1. The x-component of a particle's velocity is sampled every 5 seconds. The data are fit with a straight line as shown in the figure to the right. Assuming the fit is a good approximation to the motion, which of the following best represents the x-component of the force on the particle as a function of time?



a. 

c. 

(b.) 

d. 

2. A ball of mass $m = 50g$ is thrown at the floor with a velocity $\vec{v}_i = \langle 4,-5,0 \rangle \frac{m}{s}$. It rebounds from the floor with a velocity of $\vec{v}_f = \langle 4,5,0 \rangle \frac{m}{s}$ and is in contact with the floor for a time of $1.5x10^{-3}s$.

   a. What is the force that the *ball exerts on the floor*?

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}\Delta t \Rightarrow \frac{\vec{p}_f - \vec{p}_i}{\Delta t} = \vec{F}_{\text{floor on ball}}$$

$$\frac{0.05kg \times \left(\langle 4,5,0 \rangle \frac{m}{s} - \langle 4,-5,0 \rangle \frac{m}{s}\right)}{1.5 \times 10^{-3} s} = \langle 0,333,0 \rangle N = \vec{F}_{\text{floor on ball}}$$

$$\vec{F}_{\text{ball on floor}} = -\vec{F}_{\text{floor on ball}} = \langle 0,-333,0 \rangle N$$

   b. After the ball loses contact with the floor it is subjected to a constant force due to gravity given by $\vec{F}_{net} = \langle 0,-0.49,0 \rangle N$. How high does the ball rise above the floor, taken to be at $y = 0$?

$$p_{fy} = p_{iy} + F_{net,y}\Delta t_{rise} \Rightarrow 0 = mv_{iy} + F_{net,y}\Delta t_{rise} = 0.25\tfrac{m}{s} - 0.49\tfrac{m}{s^2}\Delta t_{rise} \rightarrow \Delta t_{rise} = 0.51s$$

$$y_y = y_i + v_{avg,y}\Delta t_{rise} = y_i + \left[\frac{v_{i,y} + v_{f,y}}{2}\right]\Delta t_{rise} = 0m + \left[\frac{5\frac{m}{s} + 0\frac{m}{s}}{2}\right] \times 0.51s = 1.3m$$

Useful formulas:

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

$k_{eff,parallel} = n_{parallel} k_{individual}$

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$k_{eff,series} = \frac{k_{individual}}{n_{series}}$$

$$\vec{v}_{avg} = \frac{\vec{v}_i + \vec{v}_f}{2}$$

$$stress = Ystrain \rightarrow \frac{F}{A} = Y\frac{\Delta L}{L}$$

$\vec{F}_g = m\vec{g}$

$$\vec{F}_{gravity} = \frac{GM_1M_2}{r_{12}^2}\hat{r}_{12}$$

$\vec{F}_{spring} = -k\vec{s}; \quad \vec{s} = (L - L_o)\hat{s}$

$W = \int \vec{F}\cdot d\vec{r} = \Delta KE = -\Delta U$

$$U_g = -\frac{GM_1M_2}{r}$$

$U_g = mgy$

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

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

$KE = (\gamma - 1)mc^2$

Momentum Principle:

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}\Delta t; \quad \Delta t = \text{large}$$

$$\vec{p}_f = \vec{p}_i + \vec{F}_{net}dt; \quad dt = \frac{\Delta t}{n} = \text{small}$$

Position-update:

$$\vec{r}_f = \vec{r}_i + \vec{v}_{avg}\Delta t = \vec{r}_i + \frac{\vec{p}}{m\sqrt{1 + \frac{p^2}{m^2c^2}}}\Delta t; \quad \Delta t = \text{large}$$

$$\vec{r}_f = \vec{r}_i + \vec{v}_f dt; \quad dt = \frac{\Delta t}{n} = \text{small}$$

$\Delta E = W = \Delta U_g + \Delta U_s + \Delta KE$

Energy principle:

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: $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors

magnitude of a vector: $|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

writing a vector: $\vec{a} = \langle a_x, a_y, a_z\rangle = |\vec{a}|\hat{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$

Useful Constants

$g = 9.8\,\frac{m}{s^2}$

$G = 6.67\times10^{-11}\,\frac{Nm^2}{kg^2}$

$1e = 1.6\times10^{-19}C$

$k = \frac{1}{4\pi\varepsilon_o} = 9\times10^9\,\frac{C^2}{Nm^2}$

$\varepsilon_o = 8.85\times10^{-12}\,\frac{Nm^2}{C^2}$

$1eV = 1.6\times10^{-19}J$

$\mu_o = 4\pi\times10^{-7}\,\frac{Tm}{A}$

$c = 3\times10^8\,\frac{m}{s}$

$h = 6.63\times10^{-34}Js$

$m_e = 9.11\times10^{-31}kg = \frac{0.511MeV}{c^2}$

$m_p = 1.67\times10^{-27}kg = \frac{937.1MeV}{c^2}$

$m_n = 1.69\times10^{-27}kg = \frac{948.3MeV}{c^2}$

$1amu = 1.66\times10^{-27}kg = \frac{931.5MeV}{c^2}$

$N_A = 6.02\times10^{23}$

$Ax^2 + Bx + C = 0 \rightarrow x = \dfrac{-B \pm \sqrt{B^2 - 4AC}}{2A}$