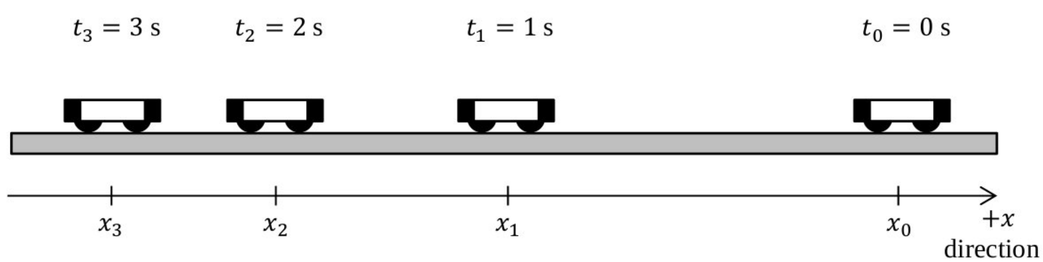
Physics 131-01 Test 1

I pledge that I have neither given nor received unauthorized assistance during the completion of this work.

Signature ______________________________

Questions (8 pts. apiece) Answer in complete, well-written sentences WITHIN the spaces provided.

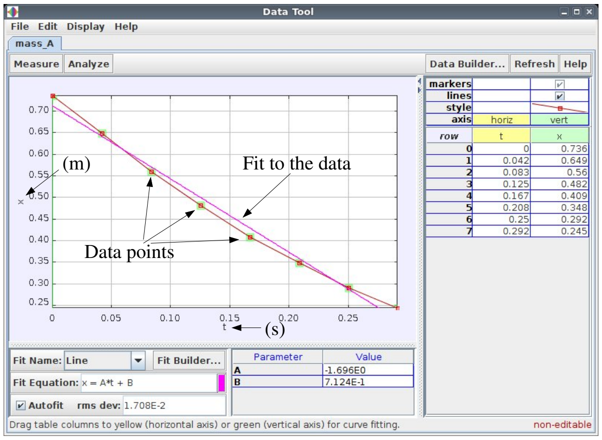
1. At each indicated time on the figure below, sketch, and label, a vector above the cart which might represent the velocity of the cart at that time while it is moving toward the motion detector and slowing down. Show how you would find the vector representing the change in velocity between the times 2 s and 3 s using those vectors. What is the sign of the acceleration? Clearly state the vector equations you are applying.



2. For our study of toy airplanes flying in circles, how are the position vector and velocity vector related? What is your evidence?

3. What advantages do histograms have over just calculating the average and standard deviation?

4. The plot below shows the results of a student's analysis of the x component of projectile motion with *Tracker*. They ask you if it looks right. What do you answer? Explain.



5. While riding in a moving car, you toss an egg directly upward. Does the egg land behind you, in front of you, or back in your hands if the car is decreasing in speed? Explain.

Problems. Clearly show all reasoning for full credit. Use a separate sheet to show your work.

Note: Derivatives should be calculated using the the definition in terms of a limit.

1. 15 pts. A particle's velocity is described by the function $v_x = t^2 + 4t - 12\ m/s$, where t is in seconds. At what times does the particle reach its turning points?

2. 20 pts. A rifle is aimed horizontally at a target a distance $d_x = 40\ m$ away. The bullet hits the target a distance $d_y = 0.02\ m$ below the aim point. What was the bullet's flight time? Sketch the bullet's position versus time plots for the vertical and horizontal components.

3. 25 pts. A rocket is fired vertically from rest and ascends with a constant acceleration $a = 4.0\ m/s^2$ for a time $t_1 = 5.0\ s$. It's fuel is then exhausted and it continues as a free-fall particle. Starting from the equations for the vertical position and velocity of the rocket, what is the maximum altitude y_{max} and the total time t_{max} elapsed from takeoff until the rocket reaches its highest point?

Physics 131-01 Equations

$$\Delta x = x_{finish} - x_{start} \qquad \Delta\vec{r} = \vec{r}_{finish} - \vec{r}_{start} \quad \Delta\vec{v} = \vec{v}_{finish} - \vec{v}_{start}$$

$$\bar{v} = \langle v \rangle = \frac{\Delta x}{\Delta t} \quad v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \lim_{\Delta t \to 0} \frac{x(t+\Delta t) - x(t)}{\Delta t} = \frac{dx}{dt}$$

$$\bar{a} = \langle a \rangle = \frac{\Delta v}{\Delta t} \quad a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \lim_{\Delta t \to 0} \frac{v(t+\Delta t) - v(t)}{\Delta t} = \frac{dv}{dt}$$

$$x = \frac{1}{2}at^2 + v_0 t + x_0 \qquad v = at + v_0 \qquad a_g = -g$$

$$\vec{A} = A_x\hat{\imath} + A_y\hat{\jmath} + A_z\hat{k} \quad \vec{A} + \vec{B} = (A_x + B_x)\hat{\imath} + (A_y + B_y)\hat{\imath} + (A_z + B_z)\hat{\imath}$$

$$\vec{v} \perp \vec{r} \qquad \vec{v} \perp \vec{a}_c$$

$$\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{\imath} + \frac{dy}{dt}\hat{\jmath} + \frac{dz}{dt}\hat{k} \qquad \vec{a} = \frac{d\vec{v}}{dt} = \frac{dv_x}{dt}\hat{\imath} + \frac{dv_y}{dt}\hat{\jmath} + \frac{dv_z}{dt}\hat{k}$$

$$\theta = \frac{s}{r} \quad \sin\theta = \frac{opp}{hyp} \quad \cos\theta = \frac{adj}{hyp} \quad \tan\theta = \frac{opp}{adj} \quad \cos^2\theta + \sin^2\theta = 1 \quad x^2 + y^2 + z^2 = R^2$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \mathrm{C} = 2\pi r \quad \mathrm{Area} = \pi r^2 \quad \mathrm{Area} = \frac{1}{2}bh \quad \mathrm{Area} = 4\pi r^2$$

$$\mathrm{Volume} = \frac{4}{3}\pi r^3 \quad \mathrm{Volume} = \pi r^2 l \quad \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} \quad c^2 = a^2 + b^2 - 2ab\cos C$$

Physics 131-01 Constants

Speed of Light (c)	$2.9979 \times 10^8\ m/s$	proton/neutron mass	$1.67 \times 10^{-27}\ kg$
R	$8.31 J/K - mole$	g	$9.8\ m/s^2$
Gravitation constant	$6.67 \times 10^{-11}\ N - m^2/kg^2$	Earth's radius	$6.37 \times 10^6\ m$
Earth-Moon distance	$3.84 \times 10^8\ m$	Electron mass	$9.11 \times 10^{-31}\ kg$