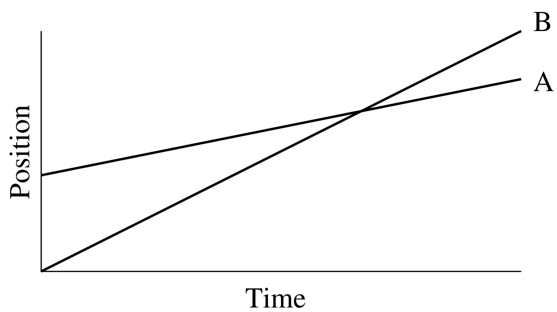
Physics 131-01 Test 1

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

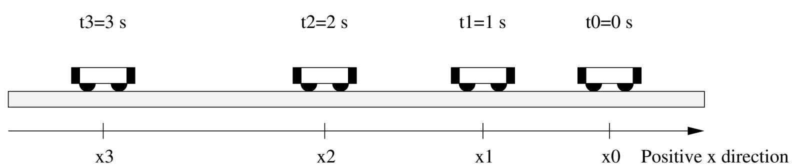
Name ______________________ Signature ______________________

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

1. Which object is moving faster in the graph below? Which one starts ahead? What does the intersection mean? Explain.



2. The diagram below shows the positions of a cart at equal time intervals. (This is like taking snapshots of the cart at equal time intervals.) At each indicated time, sketch 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 speeding up. Explain.

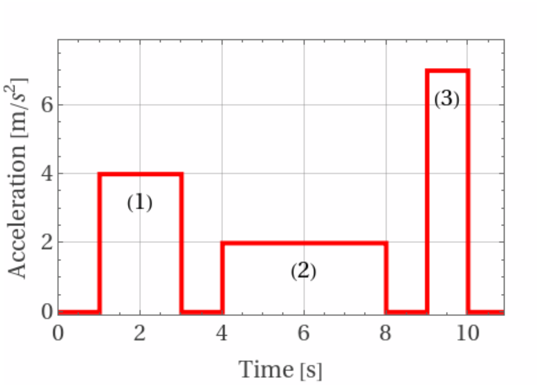


3. For our study of pigs flying in circles, how are the position vector and velocity vector related? What is your evidence?

DO NOT WRITE ON THIS PAGE BELOW THE LINE.

4. A ball is thrown through the air by one physics student to another person and filmed by a third. They obtain a good fit to the vertical component of the data with the equation $y = -(4.72\ m/s^2)t^2 - (1.31\ m)$. What is the physical interpretation of the coefficients in the equation? Is this result consistent with the ball being thrown from one person to another? Explain.

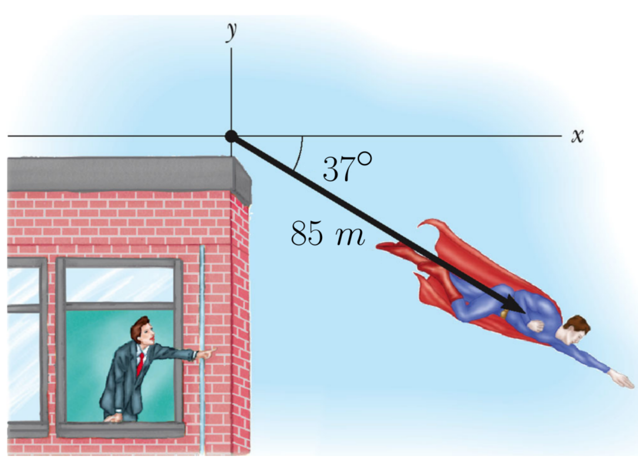
5. The figure below shows a particle moving along the x-axis that undergoes three periods of acceleration. Rank the acceleration periods according the size of the increase in the particle's velocity. Explain.



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

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

1. 15 pts. Find the horizontal and vertical components of the $|\vec{r}_1| = 85\ m$ displacement of a superhero who flies from the top of a tall building following the path shown in the figure. Write your result in vector form using the $\hat{i}$ and $\hat{j}$ unit vectors. Add the vector $\vec{r}_2 = (12\ m)\hat{i} + (-25\ m)\hat{j}$ to your previous result using the $\hat{i}, \hat{j}$ notation.



2. 20 pts. A particle's velocity is described by the function $v = t^2 - 7t\ m/s$, where t is in seconds. (a) At what times, if any, does the particle's velocity go to zero? (b) What is the acceleration at those times? Do NOT use any derivative formulas for specific functions you might remember from calculus. Use the definition of the derivative.

3. 25 pts. Cars now carry 'black boxes' that collect data on speed, brake status, and other information in a collision. A driver claims he was driving at the speed limit of $v_0 = 15.6\ m/s$ when a car came out of a driveway in front of him. He slammed on the brakes which decelerate the car at a rate $|\vec{a}| = 8\ m/s^2$. He hit the brakes at a point $22\ m$ from the crash. The 'black box' recorded a speed $v_1 = 2\ m/s$ at the moment of impact. From the black box data, what is the initial velocity when the driver hit the brakes? Is he lying? Explain. Start your solution from the equations $x(t)$ and $v(t)$ for one-dimensional motion on the equation sheet.

DO NOT WRITE ON THIS PAGE BELOW THE LINE.

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	$9.11 \times 10^{-31}\ kg$

Physics 131-01 Equations

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

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

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

$$x(t) = \frac{1}{2}at^2 + v_i t + x_i \qquad v(t) = at + v_i \qquad a_g = -g$$

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

$$a_c = \frac{v^2}{r} \qquad \vec{v} \perp \vec{r} \qquad \vec{v} \perp \vec{a}_c$$

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

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

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \text{C} = 2\pi r \quad \text{Area} = \pi r^2 \quad \text{Area} = \frac{1}{2}bh \quad \text{Area} = 4\pi r^2 \quad \text{Volume} = \frac{4}{3}\pi r^3$$

$$\text{Volume} = \pi r^2 l$$

ratio of sides of similar triangles

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c} \quad c^2 = a^2 + b^2 - 2ab\cos C$$