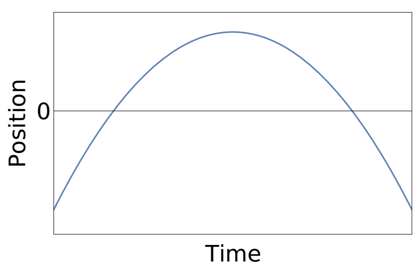
Physics 131-01 Test 1

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

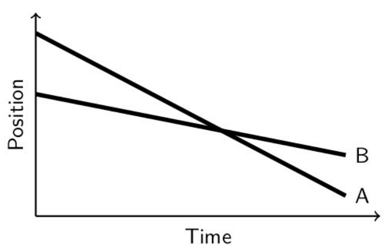
Signature ________________________________

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

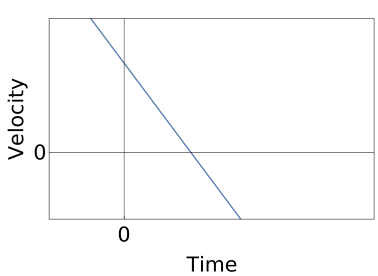
1. Consider the position versus time graph below. Is the object accelerating? If so, in what direction? Up is positive in the figure. Explain your answer.



2. Which object in the figure below is moving faster? Which starts ahead? What do you mean by 'ahead.' Explain your reasoning.

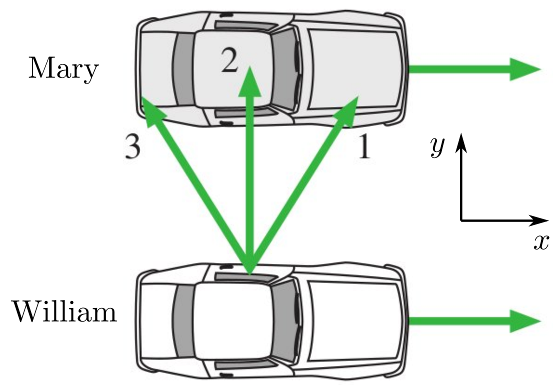


3. The figure below shows the velocity of a particle moving on the x axis. What are the initial and final directions of travel? Does the particle ever stop? Explain your reasoning.



4. In the circular motion lab the airplane moves in a circle. What is the direction of its acceleration? What is your evidence?

5. William and Mary are driving in their respective cars down the highway side by side with their windows down. William wants to toss his physics book out the window and have it land in Mary's front seat. Consider the three scenarios shown below and ignore air resistance. Should he direct his throw outward and toward the front of the car (throw 1), straight outward (throw 2), or outward and toward the back of the car (throw 3)? Explain your reasoning.



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.

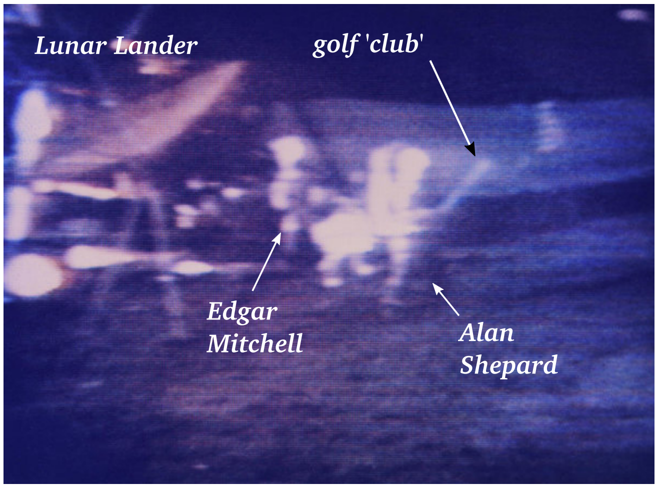
1. 12 pts. The position of a particle moving along the x axis is described by

$$x = 4t^2$$

where x is in meters and t is in seconds. What is the instantaneous velocity of the particle? Do NOT use any derivative formulas for specific functions you might remember from calculus.

2. 20 pts. A student throws a set of keys vertically upward to her roommate, who is in a window a height $y_f = 5.0\ m$ above. The keys are caught at a time $t_f = 1.75\ s$ later by the roommates outstretched hand. With what initial velocity v_i were the keys thrown?

3. 28 pts. In 1971 the Apollo 14 moon mission explored the Fra Mauro region of the Moon. During one moon walk astronaut Alan Shepard used a modified lunar excavation tool with a golf club head attached to it to 'play' golf on the moon. According to his report he hit one golf ball a distance of about $x_f = 200\ m$. Assume the ground was level and the initial velocity $\vec{v}_i$ made an angle $\theta = 35°$ with the ground. What was the initial velocity of the ball on the Moon? Start your solution from the equations of motion for two-dimensional, projectile motion (*i.e.* the equations for x, y, v_x, and v_y as functions of time t) and find an expression for the initial velocity. Compare your result with the typical ball speed of pro golfers of 80 m/s. The acceleration of gravity on the Moon is $a_M = 1.62\ m/s^2$.



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

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

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

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

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

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

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

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

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

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

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