Physics 131-01 Test 3

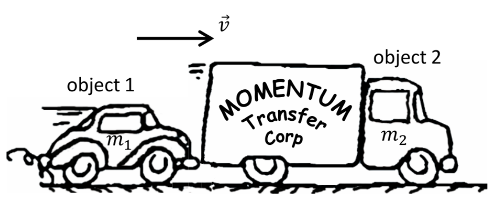
I pledge that I have neither given nor received unauthorized assistance during the completion of this work.

Name ________________________ Signature ________________________

Questions (5 for 8 pts. apiece) Answer in complete, well-written sentences WITHIN the spaces provided. You will be penalized for not following directions.

1. If you catch an egg of mass m that is heading toward your hand at speed v and bring it to a stop, what is the magnitude of the momentum change that it undergoes? Suppose the time you take to bring the egg to a stop is Δt. Would you rather catch the egg in such a way that Δt is small or large? Why?

2. Suppose the mass of object 1 is much less than that of object 2 and that it is pushing object 2, which has a dead motor. Both objects move in the same direction at speed v, so that $m_1 \ll m_2$ and $\vec{v}_1 = \vec{v}_2$. Explain.



___ Object 1 exerts more force on object 2.

___ They exert the same force on each other.

___ Object 2 exerts more force on object 1.

3. Recall the lab on the conservation of angular momentum where you dropped a stationary weight on a rotating disk. Would the procedure you followed change if the weight was moving horizontally at a constant velocity when you dropped it? If it changed, what would be different? Explain.

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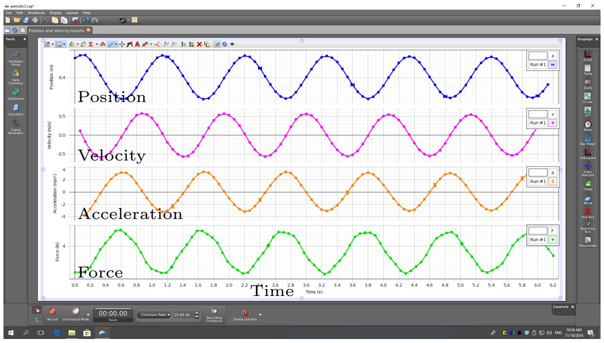
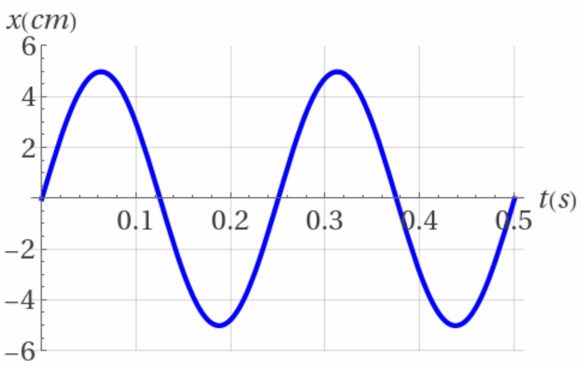
4. Recall the measurements you made of periodic motion like the ones in the figure below. Do the position and acceleration graphs have the same period? Do their peaks occur at the same times? If not, how are the peaks related in time, *i.e.* what fraction of a period is their phase difference? Explain your answers.



5. As the globe warms, some of the polar ice fields will melt and add to the water in the oceans. Where do you think that water will end up? Would this water change the moment of inertia of the Earth? Would the length of a day increase or decrease? Explain.

Problems (3). Clearly show all reasoning for full credit. Use a separate sheet to show your work.

1. 15 pts. What are the (a) amplitude, (b) frequency, and (c) phase constant (including sign) of the oscillation shown below? Write the function $x(t)$ using the cosine that describes the object's position. You can annotate the figure below, but you must explain your answer on another sheet.



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2. 20 pts. A uniform hollow cylinder of mass m with outer radius r_o and inner radius r_i is placed at the top of an incline of height h. What is the speed of the cylinder at the bottom of the incline in terms of m, r_o, r_i, and h?

3. 25 pts. A ${}^{4}_{2}\mathrm{He}$ nucleus of mass m_{He} with a speed v_0 scatters off an unknown, stationary target. The scattered ${}^{4}_{2}\mathrm{He}$ nucleus is observed at an angle θ_{He} relative to its original direction with a speed v_{He}. The other, recoiling particle has a velocity v_X. What is the direction, θ_X, of particle X in terms of known quantities m_{He}, v_0, θ_{He}, v_{He}, and v_X? Do NOT make any numerical calculations - get an equation for θ_X in terms of the list of known quantities.

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Physics 131-1 Equations and Constants, Test 3

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k} \quad \Delta\vec{r} = \vec{r}_{finish} - \vec{r}_{start} \quad \Delta\vec{v} = \vec{v}_{finish} - \vec{v}_{start}$$

$$\langle\vec{v}\rangle = \frac{\Delta\vec{r}}{\Delta t} \qquad \vec{v} = \frac{d\vec{r}}{dt} = \lim_{\Delta t\to 0}\frac{\Delta\vec{r}}{\Delta t} = \lim_{\Delta t\to 0}\frac{\vec{r}(t+\Delta t)-\vec{r}(t)}{\Delta t}$$

$$\langle\vec{a}\rangle = \frac{\Delta\vec{v}}{\Delta t} \qquad \vec{a} = \frac{d\vec{v}}{dt} = \lim_{\Delta t\to 0}\frac{\Delta\vec{v}}{\Delta t} = \lim_{\Delta t\to 0}\frac{\vec{v}(t+\Delta t)-\vec{v}(t)}{\Delta t}$$

$$x(t) = \frac{1}{2}at^2 + v_0t + y_0 \quad v = at + v_0 \quad a = g \quad a_c = \frac{v^2}{r} \quad (\vec{v}\perp\vec{r} \quad \vec{v}\perp\vec{a}_c)$$

$$\vec{F}_{net} = \sum_i \vec{F}_i = m\vec{a} = \frac{d\vec{p}}{dt} \qquad \vec{F}_{AB} = -\vec{F}_{BA} \quad \vec{p} = \sum m_i\vec{v}_i \quad \vec{p}_i = \vec{p}_f \quad \Delta\vec{p} = \vec{J} = \int_{t_1}^{t_2}\vec{F}dt = \langle\vec{F}\rangle\Delta t$$

$$|\vec{F}_f| = \mu N \quad |\vec{F}_c| = m\frac{v^2}{r} \quad |\vec{F}_G| = \frac{Gm_1m_2}{r^2} \quad \vec{F}_s(x) = -kx\hat{i} \quad \vec{F}_g(y) = -mg\hat{j}$$

$$W = \int\vec{F}\cdot d\vec{s} = \int|\vec{F}|\,|d\vec{s}|\,\cos\theta = \Delta KE = -\Delta U \quad KE = \frac{1}{2}mv^2 \quad KE_i = KE_f \;\; elastic$$

$$KE_i + U_i = KE_f + U_f \quad KE = KE_{cm} + KE_{rot} \quad KE_{rot} = \frac{1}{2}I\omega^2 \quad U_s(x) = \frac{1}{2}kx^2 \quad U_g(y) = mgy$$

$$\theta = \frac{s}{r} \quad \omega = \frac{v_\perp}{r} = \frac{d\theta}{dt} \quad \alpha = \frac{a_\perp}{r} = \frac{d\omega}{dt} \quad I = \sum m_ir_i^2 = I_{cm} + Mh^2 \quad \vec{r}_{cm} = \frac{\sum m_i\vec{r}_i}{\sum m_i}$$

$$\vec{L} = \sum_j I_j\vec{\omega}_j \quad \vec{L}_i = \vec{L}_f \quad \vec{\tau} = rF\sin\phi\,\hat{\theta} = I\vec{\alpha} = \frac{d\vec{L}}{dt} \approx \frac{\Delta\vec{L}}{\Delta t} \quad v_{cm} = r\omega \quad \theta = \frac{\alpha}{2}t^2 + \omega_it + \theta_i \quad \omega = \alpha t + \omega_i$$

$$x(t) = A\cos(\omega t + \phi) \quad \omega = \sqrt{\frac{k}{m}} = \frac{2\pi}{T} = 2\pi f \quad PE_s = \frac{1}{2}kx^2 \quad ME_s = \frac{1}{2}kA^2 \quad \sin\theta \approx \theta \quad \omega^2 = \frac{mg\ell}{I}$$

$$\frac{dA}{dt} = 0 \quad \frac{dt}{dt} = 1 \quad \frac{dt^2}{dt} = 2t \quad \frac{d}{dt}\cos\theta = -\sin\theta \quad \frac{d}{dt}\sin\theta = \cos\theta \quad \cos(\theta - \frac{\pi}{2}) = \sin\theta \quad \sin(\theta + \frac{\pi}{2}) = \cos\theta$$

$$\int f(x)dx = \lim_{\Delta x\to 0}\sum f(x_i)\Delta x \qquad \int dx = x + c \qquad \int xdx = \frac{x^2}{2} + c \quad \Delta(a+b) = \sqrt{\Delta a^2 + \Delta b^2}$$

$$\sin\theta = \frac{opp}{hyp} \quad \cos\theta = \frac{adj}{hyp} \quad \tan\theta = \frac{opp}{adj} = \frac{\sin\theta}{\cos\theta} \quad x^2 + y^2 + z^2 = R^2 \quad a^2 - b^2 = (a-b)\cdot(a+b)$$

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

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	$3.84 \times 10^{8}\ m$	Earth mass	$5.9742 \times 10^{24}\ kg$
Electron mass	$9.11 \times 10^{-31}\ kg$	Moon mass	$7.3477 \times 10^{22}\ kg$
1 newton	$0.2248\ lbs - force$	Moon radius	$1.74 \times 10^{6}\ m$
Solar radius	$6.96 \times 10^{8}\ m$	Solar mass	$1.99 \times 10^{30}\ kg$
Earth-Sun distance	$1.50 \times 10^{11}\ m$	1 u	$1.661 \times 10^{-27}\ kg$

Moments of Inertia