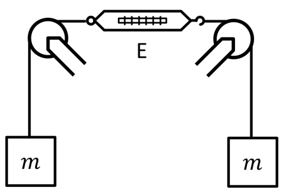
Physics 131-01 Test 2

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

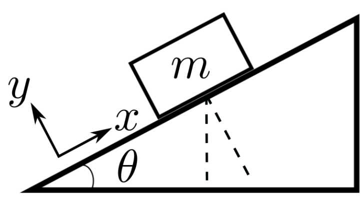
Signature ________________________________

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

1. Consider the spring scale in the configuration shown in the figure. If the mass $m = 1.0\ kg$, what is the reading of the force on the spring scale? Explain.



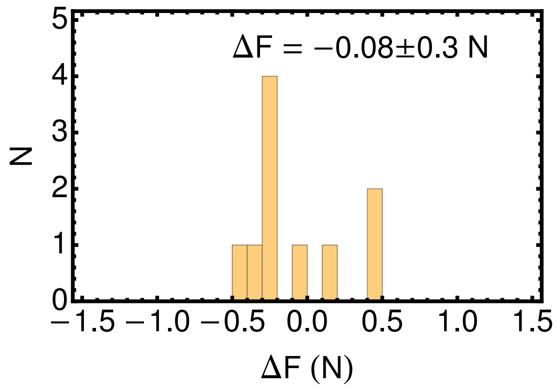
2. Consider the mass m sitting at rest on an incline plane. Draw a free-body diagram of the forces acting on the mass. What are the x and y components for the coordinate system shown of the forces acting on the box in terms of θ, m, and the coefficient of friction μ between the mass and the incline? Explain your reasoning.



3. What is Roche's Limit? Explain.

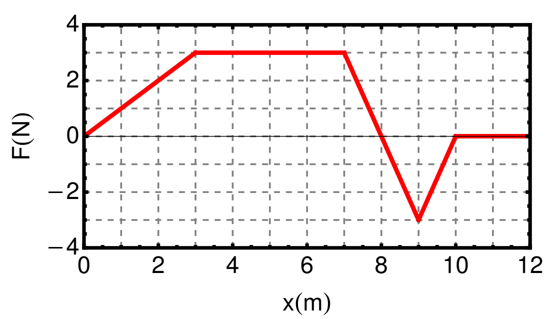
4. Recall the lab where we used toy airplanes to study centripetal force. In that lab we used video analysis to measure r, the radius of the airplane's circular path, and a ruler to measure R, the total length of the string that is actually rotating below the pivot point. Using these two distances (r and R), calculate the angle the string makes with the horizontal. Clearly show your reasoning. A drawing might help.

5. In our lab on the centripetal force acting on a toy airplane we extracted the force (1) using a spring scale attached to the string and (2) from the kinematic properties of the airplane (radius of orbit and period). We calculated the difference ΔF between these forces which, if our theory is correct, should be zero. The figure below shows the distribution of ΔF for a hypothetical class. You just completed your measurement and obtained $\Delta F = -0.58\ N$. Is your result consistent with the class results in the picture. Be quantitative in your answer.



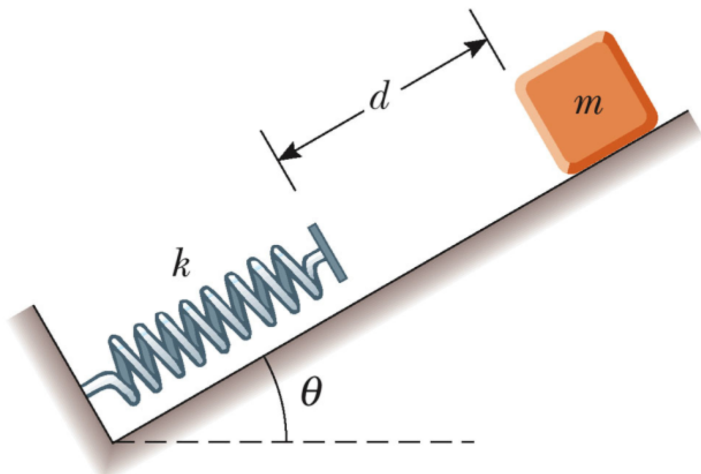
Problems. Clearly show all reasoning for full credit. Use a separate sheet to show your work. Note: Derivatives should be calculated using the the definition in terms of a limit.

1. 12 pts. A particle is subject to a force $\vec{F}$ that varies with position as shown in the figure. What is the total work done by the force over the distance $x = 0$ to $x = 12.0\ m$?



2. 20 pts. A simple accelerometer is constructed inside a car by suspending an object of mass m from a string of length L that is tied to the car's ceiling. As the car accelerates the string – object system makes a constant angle of θ with the vertical. (a) Assuming the string mass is negligible compared with m, derive an expression for the car's acceleration in terms of θ. (b) Determine the acceleration of the car when $\theta = 29.0°$.

3. 28 pts. An object of mass $m = 0.1\ kg$ starts from rest and slides a distance d down a frictionless incline of angle $\theta = 30°$ as shown in the figure. While sliding, it contacts the unstressed spring of negligible mass in the figure. The object slides an additional distance $x = 0.1\ m$ in the same direction as it is brought momentarily to rest by compression of the spring (of force constant $k = 15\ N/m$). Get an equation for the initial separation d between the object and the spring in terms of m, k, θ and x. Then, calculate the value of d. Does your result make sense? Explain.



DO NOT WRITE BELOW THIS LINE

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 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	$1.99 \times 10^{30}\ kg$

Physics 131-01 Equations and Constants

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

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

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

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

$$\vec{F}_{net} = \sum_i \vec{F}_i = m\vec{a} \qquad \vec{F}_{AB} = -\vec{F}_{BA} \quad |\vec{F}_e| = \frac{k_e q_1 q_2}{r^2} \quad |\vec{F}_G| = \frac{G m_1 m_2}{r^2} \quad d_{Roche} = \left(\frac{12M}{\pi\rho}\right)^{1/3}$$

$$|\vec{F}_k| = \mu_k N \quad |\vec{F}_s| \le \mu_s N \quad |\vec{F}_c| = m\frac{v^2}{r} \quad \vec{F}_s(x) = -k\Delta s\ \hat{i} \quad \vec{F}_g(y) = -mg\hat{j}$$

$$W = \int \vec{F}\cdot d\vec{s} = \int |\vec{F}||d\vec{s}|\cos\theta = \Delta KE = -\Delta PE \quad KE = \frac{1}{2}mv^2 \quad PE_g = mgh \quad PE_s = \frac{1}{2}k\Delta s^2$$

$$PE_G = -\frac{G m_1 m_2}{r} \quad ME = KE + PE \to ME_f = ME_i$$

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k} \quad \vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta = A_x B_x + A_y B_y$$

$$\frac{dA}{dt} = 0 \quad \frac{dt}{dt} = 1 \quad \frac{dt^2}{dt} = 2t \quad \int f(x)dx = \lim_{\Delta x\to 0}\sum_{i=1}^{k} f(x_i)\Delta x$$

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

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

$$V = \frac{4}{3}\pi r^3 \quad V = \pi r^2\ l \quad \theta = \frac{s}{r} \quad \rho = \frac{m}{V}$$