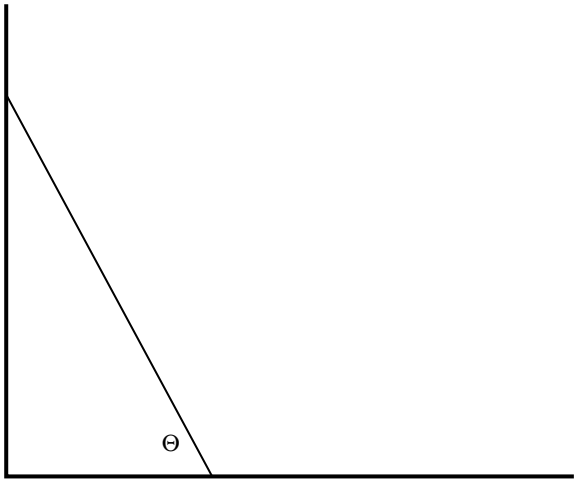
Physics 10310 — General Physics I

Final Exam – Fall 2010
There are 8 problems. Please do all problems. Please show all work.

1. 

A piece of plywood leans against a wooden wall which with it has a coefficient of static friction of $\mu_s = 0.28$. A) If the coefficient of static friction between the plywood and the floor is 0.35, what is the minimum angle that the board can make with the *floor* and not slip? B) What happens if the coefficient of friction between the plywood and the floor is zero?

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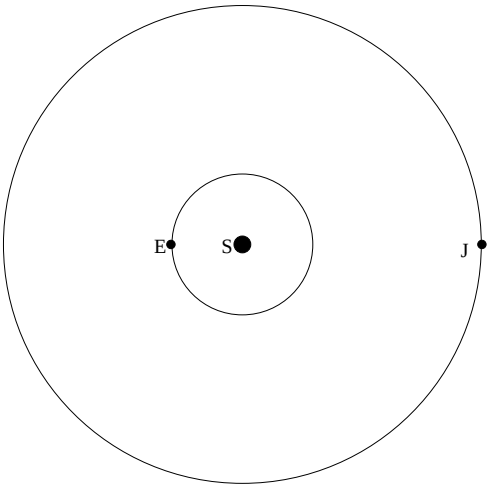
2. 

Astrologers claim that a person's life is influenced by the position of the planets at the moment of that person's birth. To check whether this influence could be due to gravity, compare the following two quantities: the change in the gravitational force on a baby in a hospital due to the change in the position of Jupiter and the change due to the presence or absence of a 4000 kg truck parked near the hospital at a distance of 75 m. Jupiter has a mass of 1.90×10^{27} kg. Assume a circular orbit of radius 0.78×10^9 km for Jupiter and 1.5×10^8 km for Earth from the Sun. For convenience compare the gravitational difference between the point of closest approach and farthest separation between the planets to the presence or absence of the truck.

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3. **Consider the simple harmonic motion of a mass on the end of a spring, $x = 0.35 \sin(\omega t + \delta)$. At $t = 0$s the position is -0.080m, and the velocity is 2.1 m/s in the $-x$ direction. The total energy of the motion is 6 J. What is the value of the A) phase (δ), B) frequency, f, C) acceleration at $t = 0$, D) spring constant K, and E) mass m.**

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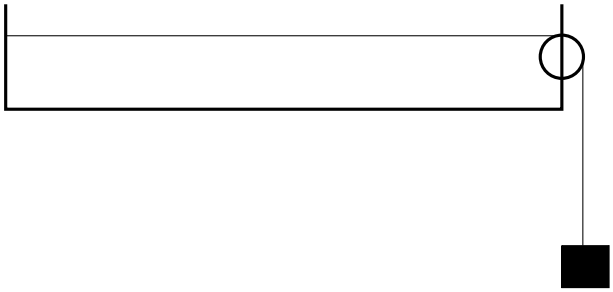
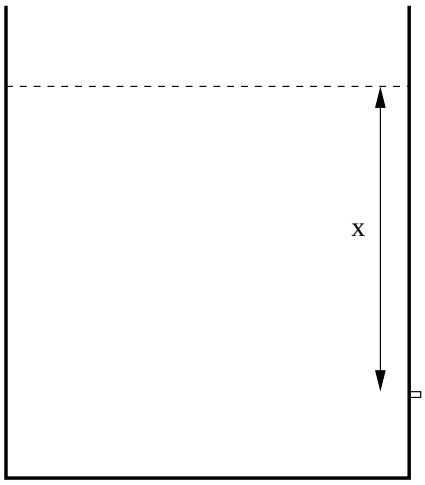
4. **A string is stretched between a pulley and a wave generator consisting of a plate vibrating up and down with small amplitude and frequency 120 Hz. A standing wave with two intermediate nodes is generated when the**



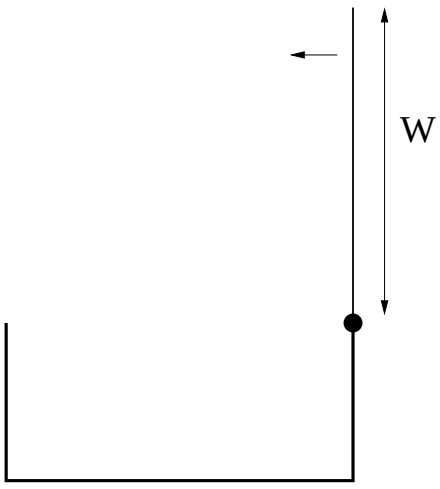
string has a mass of 215 grams attached to it. How large a load is needed to generate standing waves with one and with four nodes?

5.



A cylindrical tank of surface area A is filled with water to a height x above the position of a hole of area σ, and the water flows out. Assume throughout that the fluid speed is negligible at the top surface. A) How much water flows out in the first time interval Δt after the hole is opened? B) How large is the drop in water level Δx during that time interval? C) use the results of parts A and B in the limit of small Δt to express a relation of the form $\frac{dx}{dt} = f(x)$. This is a differential equation for the height as a function of time. Take care to get the right signs, noting that x decreases with time, so that Δx is a negative quantity. D) Show that this equation is solved by the formula: $x(t) = [\sqrt{x_0} - \frac{1}{2}(\frac{\sigma}{A})t\sqrt{2g}]^2$. Where x_0 is the initial value of x. E) How long will it take for the water to drop to the level of the hole?

6.



The lid of a box is balanced vertically on its hinges. The slightest displacement from the vertical leads to its falling shut. If the lid is of uniform density and it is $W = 30$ cm wide what will be its angular velocity when it does fall shut, that is when it is in the horizontal position. Take $I = \frac{1}{3}MW^2$ about the pivot point.

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7. **Two students sit on opposite sides of a 4 meter long sled that is initially at rest on frictionless ice. Each student has a mass of 65 kg. The sled's mass is 30 kg. The student at one end slides a 3 kg mass on the sled to the other at a uniform speed of 6 m/s relative to the sled. The**

mass moves friction free. A) What is the sled's speed relative to the ice before the second student catches the mass? B) What is the sled's speed relative to the ice after the student catches the mass? C) Over what distance does the sled move while the mass slides over it? D) Over what distance does the center of mass move while the object slides across?

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8. A bicyclist rides a flat course at constant speed V with respect to the ground into a stiff but steady headwind of of speed V_w, also with respect to the ground. A) draw a free body diagram for the cyclist-cycle system. List the forces acting on this system including the wind resistance which pushes on his face and the frictional forces with the ground which propel him forward. B) If you are observing the cyclist from a reference frame at rest with respect to the ground, what is the vector sum of all the forces? C) If you are observing the cyclist from the frame at rest with respect to the bicycle, what are the speed of the cyclist, the speed of the wind and the vector sum of all forces? D) If you are observing the cyclist from the frame at rest with respect to the air, what are the speed of the cyclist, the speed of the wind and the vector sum of all forces?