Physics 132 **Midterm** Spring 2002

Name ____________________________________________

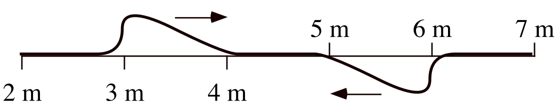
***PLEASE* READ THIS FIRST**: Work the problems on separate sheets of paper and staple *this* sheet to the front. Read each problem *carefully*. The credit you receive on each problem will depend at *least* as much on how you get your answer as on what answer you get. There is *no* need to be as "wordy" as I ask you to be on homework, but you must show your work or give at least a brief explanation for *every* answer. I give *no* credit for unsupported answers. I give partial credit for partially correct solutions, but *only* when I can figure out what you are doing, so be as clear as possible. Make *certain* that all numerical answers are given with a reasonable number of significant digits (when in doubt, three is usually a good compromise) and that you have included *appropriate* and *simplified* units. Check your answers for physical *reasonableness* whenever possible; I do deduct points for ridiculous answers that go uncommented upon.

1. [10 pts] Complete a table with the *SI units* and the *dimensions* of

   i) linear mass density, $\mu$  ii) angular frequency, $\omega$  iii) power, P

2. [10 pts] Find the mass of the Earth from the known values of $g$, $G$ ($6.67\times10^{-11}\,\mathrm{N\cdot m^2/kg^2}$), and $R_{\mathrm{earth}}$ ($6.37\times10^{6}$ m)

3. Two wave pulses travel toward each other as shown at right in a medium that has a wave speed of 50 m/s.




   a) [5 pts] *About* how long a *time* will it be before the "peaks" of the two pulses coincide spatially.

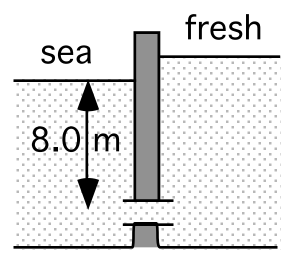
   b) [5 pts] Sketch the waveform *at* the time that the peaks coincide. [Be careful; this isn't *hard*, but it also isn't *trivial*.]

4. A particle in simple harmonic motion reaches its *maximum positive velocity* of 5.0 m/s at a time that is 150 milliseconds *before* it reaches its *maximum negative distance* from the equilibrium position.

   a) [5 pts] What is the *angular frequency* of oscillation? [Hint: You might want to sketch a graph of *x* versus *t* first.]

   b) [5 pts] What is the oscillation *amplitude*?

5. A dam is built to keep the very salty water of the Salton Sea (density $\rho_s$ = 1.060 g/cm$^3$) from intruding into a pond that is fed by freshwater (density $\rho_f$ = 1.000 g/cm$^3$) streams. In order to prevent the fresh water pond from filling and overflowing the dam, a small pipe is installed 8.0 m below the sea surface that is intended to allow fresh water to flow out of the pond.




   a) [6 pts] Explain why, in fact, salt water will flow *into* the pond if the surface levels on each side of the dam are the *same—unlike* what is shown in the drawing. [Hint: Consider the pressure on either end of the pipe in that situation.]

   b) [14 pts] Now suppose that there is *no* flow either way through the pipe. Find the *difference* in the surface levels on either side of the dam.

6. A sinusoidal wave with a frequency of 100 Hz and a wavelength of 40 cm travels along the thick part of a taut string made of two 5.0 m lengths of string joined in the middle. Both parts of the string are made of the same material and are under the same tension of 80 N, but the thin part has one half the diameter of the thick part.

   a) [5 pts] Explain briefly, but precisely why the thin part has one quarter the linear mass density of the thick part.

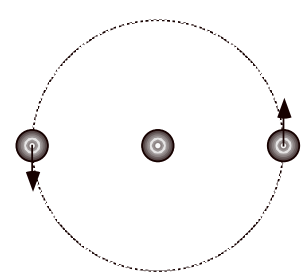
   b) [5 pts] Using the result of part a, how does the speed of the wave in the thinner string compare to that in the thicker string? (That is, simply find $v_{\mathrm{thin}} / v_{\mathrm{thick}}$.)

   c) [5 pts] How long a *time* does it take a wave to travel the full 10 m length of this string?

   d) [5 pts] What are the *frequency* and *wavelength* of the wave in the thinner part?

   EXTRA CREDIT [5 pts] What is the *total mass* of the composite string?

7. Consider a system of three *identical* stars—each with mass *M*—two of which orbit about a motionless third star along the same circular path of radius *R* as shown at right.



   a) [5 pts] Explain briefly but completely *how* the central star is *able* to *remain* motionless while the other two move around the circular path.

   b) [5 pts] Find the *magnitude* of the *net* force on either of the two orbiting stars (in terms, of course, of the givens—*M* and *R*.)

   c) [10 pts] Therefore, find the orbital period of either orbiting star (in terms of *M* and *R*.

   EXTRA CREDIT [5 pts] Suppose that *M* = the mass of the sun = $2\times10^{30}$ kg and *R* = the distance from the Earth to the Sun = $1.5\times10^{11}$ m. How would you *expect* the orbital period of this star system to compare to the orbital period of the Earth about the Sun? Specifically, should it be *longer*, *shorter*, or the *same*?



Score _____/100