

Physics 350 – Undergraduate Classical Mechanics

Pre-Test, August 20, 2008

Time allowed: 50 minutes. Total points possible: 20.

The primary purpose of this pre-test is to see what you already know of the course material you are going to cover; I expect that you will be able to answer very few of the problems below, though I would be quite happy to be pleasantly surprised. You will receive 20 points credit for a “college try,” meaning you really give it your best and don’t turn it in before a half hour. Those who make no serious attempt at the pre-test will receive a zero. There will be no partial credit.

1. Suppose you threw a ball very high up in the air. Would it take the same amount of time on the way up as on the way down? Why or why not?
2. Trace the trajectory in phase space of an under-damped harmonic oscillator. Make sure to label and explain your drawing (phase space is defined as a plot of position vs. momentum).
3. Explain what a quality factor is in terms of a resonance in a forced damped oscillator. Give an example of a high and a low quality factor in natural systems.
4. Sketch the gravitational equipotential surfaces due to two unequal point masses $m_1 \neq m_2$ separated by distance d .
5. Write down Lagrange’s equations of motion and explain what they mean physically.
6. What is the basic concept of generalized coordinates? Give an example in which the generalized position and momentum are not simply x and p .
7. When is the Hamiltonian equal to the total energy? Why?
8. Sketch how you would go about deriving Kepler’s Third Law, assuming circular orbits.
9. Trace the path of an artillery shell fired from the deck of an aircraft carrier, parallel to the sea. You can assume a high initial velocity, so that the shell travels far enough to “notice” the earth’s curvature. What forces act on it, and what are their origin?
10. Explain what the inertia tensor is, and write down a non-trivial physical example.