Physics 308: Advanced Classical Mechanics
Fall 2007
Problem Set 1

Due: Tue 11 Sep 2007, at the start of class.

Reading: Please read all of Chapter 1 and Sections 3.1–3.3 of Chapter 3 in Taylor for Thursday. For Tuesday, please finish Chapter 3 and read Sections 4.1–4.2 of Chapter 4.

Problems:

1. Cross product of two vectors. Taylor Problem 1.15. This problem illustrates the advantage of a strategic choice of coordinate system.

2. Newton’s second law. Taylor Problem 1.40. A cannonball with increasing $|\mathbf{r}|$.

3. The unit vectors $\hat{r}, \hat{\phi}$ and their derivatives. Taylor Problem 1.43. In part (a), please draw a diagram clearly showing the cartesian components of the unit vectors $\hat{r}, \hat{\phi}$ located at the point $(r, \phi)$ in polar coordinates. Also, as a check of your result for part (a), verify that $\hat{r} \cdot \hat{\phi} = 0$ by using the definition (1.7) of the dot product: $a \cdot b = a_x b_x + a_y b_y$.

4. Numerical integration of equations of motion. Taylor Problem 1.50. This numerical problem will give you a sense of how good the small angle approximation $\sin \phi \simeq \phi$ is for $\phi \leq 20^\circ$. It requires that you learn how to use the NDSolve function in Mathematica and how to plot the results. (We’ll use Mathematica regularly in this course—please see me if you’d like some help getting started.)

5. Momentum conservation for a system of three particles. Taylor Problem 1.28.

6. Elastic collisions. Taylor 3.5. In this problem, you will show that in an elastic collision between two particles of equal mass, one of which is initially at rest, the particles emerge from the collision at right angles to one another.