Physics 501: Classical Mechanics

Read: LL 25-26, 31-36;

Problems with stars are not for credit and will NOT be graded.

Homework 6

Exercise 1
Estimate quality factors of a church bell and of a simple children’s toy bell (nothing fancy, just make an educated guess).

Exercise 2
Calculate the inertia tensor of a molecule consisting of 12 identical atoms of the mass \( m \) each forming an icosahedron (the radial size of the icosahedron is \( R \)).

Figure 1: To Exercise 2.

Exercise 3
A solid homogeneous cube occupies the region of space given in some reference frame by \( 0 \leq x, y, z \leq a \). Calculate the inertia tensor of the cube in this reference frame.
Exercise 4

A solid homogeneous ball of the radius $R$ has a spherical cavity of the radius $r$ with the center at the distance $a$ from the center of the ball. Choose a convenient reference frame and calculate the inertia tensor of this body.

Exercise 5

A neutron star of the mass $M = 3 \times 10^{30}$ kg and radius $R = 10$ km rotates with the frequency $f = 100$ Hz. The star (pulsar) has a magnetic moment and radiates electromagnetic energy with power $P = 3.8 \times 10^{32}$ W. Find the rate with which it slows down its rotation. For example, you can find the relative change of the frequency of rotation for the period $\Delta f/f$.

Exercise 6 (JS 8.3)

Calculate the rotation matrix $R(\theta)$ that results from a rotation of $\theta$ about the 3 axis followed by another of $\theta$ about the 2 axis. Now calculate the result of applying them in the opposite order. Note the difference. Specialize to $\theta = \pi/2$. Find the axes and angles of the resulting $\pi/2$ rotations.