

Examination III for PHYS 6220/7220, Fall 2014

1. Three identical point masses, of magnitude m each, are located at $(a, 2a, 0)$, $(0, a, 2a)$ and $(2a, 0, a)$ at time $t = 0$ in a Cartesian frame. Together they comprise a rigid body.
 - (a) Find the principal moments of inertia in this frame. **(6 points)**
 - (b) Find the principal axes. **(3 points)**
 - (c) The motion is known to be torque-free in the principal axes frame. Identify the axis along which the component of rotational velocity ω does not change in time. **(1 point)**
 - (d) What is the time dependence of the other components in terms of the constant component? **(2 points)**

2. A simple pendulum of mass m is at rest in Toledo which has a latitude θ . The magnitude of the acceleration due to gravity is g . The duration of a day on earth is T .
 - (a) Draw a figure showing the earth and pendulum. Choose a convenient set of Cartesian axes located at the center of the earth. Clearly label important points on the figure. **(1 point)**
 - (b) Find in your frame the effective force acting on the bob at rest in terms of unit vectors and other known quantities. **(3 point)**
 - (c) From the answer in part (b) find the angle α the pendulum makes with the true vertical direction in Toledo. **(3 points)**
 - (d) Give a numerical estimate of the ratio α/θ if $\theta = \pi/3$. **(1 point)**