Course 141: MECHANICS

Problem Set 8

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1. A small stone is thrown inside a large round room which rotates about a central vertical axis OZ with constant angular velocity $\vec{\omega}$. The axes OX and OY are fixed along the floor of the room. Derive the equations of motion of the stone relative to the rotating axes. (Do not try to solve!)

2. A particle of mass m is constrained to move in a vertical plane which rotates with constant angular velocity ω. Find the equations of motion of the particle, including the force of gravity.

3. A bead slides on a smooth helix, shaped like a spring, whose central axis is vertical. The helix is forced to rotate about its central axis with constant angular velocity $\vec{\omega}$. Find the equations of motion of the bead relative to the helix. (Do not try to solve!)

4. A spherical planet of radius R rotates with a constant angular velocity ω. The effective gravitational constant g_{eff} is some constant, g, at the poles and 0.8 g at the equator. Find g_{eff} as a function of the polar angle θ and g.

5. A particle of mass m moves in a smooth straight horizontal tube which rotates with constant angular velocity $\vec{\omega}$ about a vertical axis which intersects the tube. Set up the equations of motion in polar coordinates and derive an expression for the distance of the particle from the rotation axis. If the particle is at $r = r_0$ at $t = 0$, what velocity must it have along the tube in order that it will be very close to the rotation axis after a very long time?

6. A particle moves with velocity v on a smooth horizontal plane. Show that the particle will move in a circle due to rotation of the earth; find the radius of the circle.