Gravity race:

A challenge is issued to see who can move an object from one side of the Earth to a point located diametrically opposite from the starting line and then back again in the least time. The object cannot have an on-board energy source.

Two groups of former Phys 160 students, who by-the-way are now billionaires, take up the challenge and select radically different methods. The first method is to climb to the top of a high mountain and fire a projectile with sufficient speed to move in a circular orbit around the earth. The projectile would win the race by traveling along a circumference of the Earth. The other group decides to drill a hole through the Earth and drop an object. The object would fall through the center of the Earth emerge on the surface “on the other side” and then return.

Your job is to first predict which group wins the race and state why. Now calculate (analytically) both 1) the orbital period of the projectile and 2) the period of traversal for the dropped object. For the second method you can assume a constant density in the Earth and use the Shell Theorem. This will allow you to proceed analytically.

After the race has been completed a current 160 student gets the bright idea of aiming the projectile cannon in the diametric hole so that instead of simply dropping the object, it is given the same initial velocity as for the circular orbit. Describe the motion of this object by drawing a graph of r vs. time.