Physics 3710 – Problem Set #7 *Newtonian gravity*

1. The orbital period of Moon about Earth is about 27.3 d, with a radius $r =$ 3.85X10^8 m.

(a) Calculate the *centripetal acceleration* of Moon (the orbit is almost circular).
(b) Compare that with the *gravitational field strength* of Earth at the center of Moon, given that M_{earth} = 6x10^{24} kg.
(c) Any comment?

2. Suppose a shaft could be drilled from the North Pole to the South Pole through the center of Earth. Use the expression $g_{inside}(x) = g_E x / R_E$ (page 3, GR1) for the gravitational field strength in the shaft at a distance x from the center of Earth. (g_E = surface gravitational field strength = 9.8 m/s^2, R_E = radius = 6.4x10^6 m)

(a) Calculate the time for the object to go from one pole to the other. (Hint: the motion is simple harmonic: $a = -\omega^2 x$.)

(b) The orbital period of a satellite in low earth orbit is $T_{LEO} = 2\pi\sqrt{\dfrac{R_E^3}{GM_E}}$. What is the relationship of the period of the oscillator found in (a) to T_{LEO} ?

3. A pencil in the International Space Station (ISS) is displaced 1 cm from the center of the Station in the "normal" direction (s_n) as described GR2, p1. It subsequently moves relative to the center according to the oscillator equation $\dfrac{d^2 s_n}{dt^2} = -\dfrac{GM_E}{r^3} s_n$. The pencil travels 4 cm in one complete oscillation. How far does the ISS travel in the same amount of time? Assume the ISS is in a circular orbit of radius equal to 6.8x10^6 m. (Hint: the only difference between the LEO period and that of the ISS is the radii of the orbits.)