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## Physics 3710 – Problem Set #7

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1. The orbital period of Moon about Earth is about 27.3 d, with a radius  $r = 3.85 \times 10^8$  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  $M_{\text{earth}} = 6 \times 10^{24}$  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  $g_{\text{inside}}(x) = g_E x / R_E$  (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<sup>2</sup>,  $R_E =$  radius =  $6.4 \times 10^6$  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  $T_{\text{LEO}} = 2\pi \sqrt{\frac{R_E^3}{GM_E}}$ . What is the relationship of the period of the oscillator found in (a) to  $T_{\text{LEO}}$ ?

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  $\frac{d^2 s_n}{dt^2} = -\frac{GM_E}{r^3} s_n$ . 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  $6.8 \times 10^6$  m. (Hint: the only difference between the LEO period and that of the ISS is the radii of the orbits.)