**Lectures 4-5**

**Problem 1: What are key physical constants related to gravitation and the gravity field of a planet and how well are these known?**

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| **The Fundamental Constants** |
| **Fundamental quantity** | **Symbol** |
| Velocity of light | c |
| Elementary charge | e |
| Mass of the electron | me |
| Mass of the proton | mp |
| Avogadro constant | NA |
| Planck's constant | h |
| Universal gravitational constant | G |
| Boltzmann's constant | k |

The above constants are quite well known, the original gravitational constant as proposed by Newton was dependent on forces acting at a distance in absolute time and space was challenged by Einstein’s theory of a gravitational field when he make the speed of light a constant and instead time-space itself was curving. As modern day work in the field of physics is being conducted it is quite possible that new “constants” could be determined.

**Problem 2: Name and characterize the main equations related to the gravity potential.**

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| --- | --- |
| *Fg* =  | *Gm*1*m*2 *r*2 |

* m1, m2 are the masses of two bodies
* G is the universal gravitational constant which has a value of 6.67300 × 10-11 m3 kg-1 s-2
* r is distance between the two bodies

Gravitational Potential Energy = mgh

Here 'm' is the mass of the object, 'g' is the acceleration due to gravity (9.81 m/s2) and 'h' is the height of the object above Earth's surface.

**Problem 3: How large are the deviations of the geoid from the reference ellipsoid and how are these deviations explained?**

The deviation between the Geoid and an ellipsoid is called the ***geoid separation*** (N) or geoid undulation. The biggest presently known undulations are the minimum in the Indian Ocean with N = -100 meters and the maximum in the northern part of the Atlantic Ocean with N = +70 meters. The deviations are explained by the known mass deficiency, where the geoid dips below the mean ellipsoid, and where there is a mass surplus the Geoid will rise above the main ellipsoid.

**Problem 4: Explain in simple words the origin of tides.**

The tides originated due to the gravitational attraction between the earth and both the sun and the moon.

**Problem 5: Why do we see ocean tides?**

We see ocean tides due to the orbit of the moon with respect to its location to earth; when the moon is at apogee tides tend to be lower because the pull of the moon is less; conversely when the moon is at perigee the moon tends to have a greater affect on the earth because it is closer resulting in higher tides. (Note: tides do occur on a micro scale on even very small bodies of water.)

**Problem 6: Why are the amplitude and phases of semidiurnal and diurnal tides varying irregularly in space?**

There are several different possible reasons why the amplitude and phase of semidiurnal and diurnal tides vary including “variations in tidal forcing, particularly the effect of latent heating in the troposphere on nonmigrating diurnal tides, variations in the background mean wind or temperature, which affect tidal propagation; interactions with large scale waves such as planetary waves or other tides; and interactions with gravity waves or dissipative regions associated with gravity wave breaking.”(Smith, Pancheva, Mitchell, Marsh, Russell, Mlynczak; Geophysical Research Letters, Vol 38, 2007)

**Problem 7: How large is the largest equilibrium tide on Earth?**

In most locations, the four largest amplitude tidal components turn out to be:

Symbol Name period

M2 Principal lunar 12.42 h

K1 Luni-solar diurnal 23.93

S2 Principal solar 12.00

O1 Principal lunar diurnal 25.82

With the world’s highest tide occurring in the Bay of Fundy’s minas Basin; in the twon of Wolfville, Nova Scotia.

**Problem 8: Why does the Moon keep the same face toward the Earth?**

The Moon keeps only one face to the Earth because of a force called tidal friction. Just as the Moon’s gravity affects the Earth, convexly the Earth’s gravity affects the Moon. The gravitational affect of the Earth on the Moon causes a distortion to the Moon’s shape causing an elongation of the Moon along a line pointing towards earth; this is referred to as the Earth raising “tidal bulges” on the Moon. The gravity of the Earth pulls on the closest tidal bulge, as the Moon rotates the gravitational pull of the Earth crates a friction within the Moon slowing the Moon’s rotation until it matches its orbital period resulting in tidal synchronization. With the Moon in tidal synchronization the Moon’s tidal bulge is always aligned with Earth, leading to the same face of the Moon always pointed towards Earth.

**Problem 9: How large is the tidal bulge of the Moon?**

The tidal bulge of the Moon is roughly 20 times greater than that of the tidal bulge on Earth.

**Problem 10: What are the main rotational eigenmodes of the Earth and to which parts of the Earth are they mainly attributed?**

The Chandler wobble is one of the main components of motion of the Earth’s rotation axis relative to the Earth’s surface, also called Polar motion. The CW is one of the main eigenmodes of the Earth’s rotation, and investigates amplitude and phase variations in the Earth.

The “nearly diurnal free wobble” is another of the main rotational eigenmodes of Earth, and is caused by different coupling mechanisms between the mantle and the outer core of the Earth.