

Memo for Practical 3

Gravity

1. The gravity of the Earth, given that $r = R = 6371\text{km}$ at the Earth's surface and $m_E = 5.97 \times 10^{24}\text{kg}$ is: [2]

$$g = \frac{6.67 \times 10^{-11} \cdot 5.97 \times 10^{24}}{6371,002^2} \frac{m^3 \cdot kg}{kg \cdot s^2 \cdot m^2} = 9.81 \frac{m}{s^2}$$

2. The derivative of equation (3) is: [3]

$$g = \frac{Gm_2}{r^2} = \frac{Gm_E}{r^2} \Rightarrow \frac{\partial g}{\partial r} = \left| -2 \frac{Gm_E}{r^3} = -\frac{2}{R} g \right.$$
$$\frac{\partial g}{\partial r} = -2 \frac{6.67 \times 10^{-11} \cdot 5.97 \times 10^{24}}{6371,000^3} = 3.08 \times 10^{-6} \frac{m/s^2}{m}$$
$$= -0.3086 \text{ mgal/m}$$

3. What's the difference in the value of gravity on top of Mt. Everest compared to sea level? Peak of Everest is 8850 m above sea level gravity at sea level is 981,000 mGal. $981,000 \text{ mGal} + (8850 \text{ m} \times -0.3086 \text{ mGal/m}) = 978,269 \text{ mGal}$ or 2,731 mGal less. [3]

4. The Earth is not round (nor spherical)... It is a lumpy oblate spheroid.

(a). The earth spin on its own axis. Due to centrifugal force, it bulges at the equator and flattens at the poles. The uneven distribution of mass of the rock gives different densities and therefore different gravity. These factor cause uneven topography. [3]

(b). Gravity corrections

- i. **Eotvos correction** – corrections are performed to gravity measurement made on a moving vehicle. These corrections depend on the horizontal speed, latitude and the flight altitude. They are positive on East-West direction.

- ii. **Drift correction** – variations result from the gradual change in the readings while the instrument is kept at the same place. Corrections are done by returning periodically to the base to take a reading.
- iii. **Free Air Correction** – this accounts for decreasing gravity with increasing distance from the centre of the Earth. Adjustments are made for the differences in height between the point of measurement and sea-level.
- iv. **Other corrections include:** elevation, latitude, terrain and bouguer. Refer to lecture notes on gravity for definitions.

[7]