Geophysics 4133
Introduction to Magnetic Methods
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Name: _____

For each of the following problems neatly show all steps of your work (partial credit may be given if your work can be easily followed). Clearly indicate your final answers and answer all parts of the question including the 'describe' and 'why' questions.

1. Coulomb's Law states $\vec{F} = k_e \frac{m_1 m_2}{r^2} \hat{r}$ to describe force between magnetic poles where r is distance between the poles, m_i is the strength of the poles, and k_e is the Coulomb constant (8.987x $10^9 N m^2 C^{-2}$). *(20 pt.)*

   a) Compare and contrast Newton's 4^{th} law (Universal Graviatation) to Coulomb's Law. Include similarities and differences.

   b) An electron has a charge of -1.602176x10^{-19} C, a proton has the same charge, but positive. When working with magnetic properties of atoms (important for instrumentation, medical devices, and nuclear physics) we often consider hydrogen because it is simple, with a proton and electron only. Given that the average radius of a hydrogen atom (often called the Bohr radius) is 5.3x10^{-9}cm, what is the force between the electron and proton? Is it attractive or repulsive?

2. According to the National Geophysical Data Center the estimated magnetic field in Norman for October, 2011 consists of the following componets (+ indicates north, east, and down, - indicates south, west, and up):

Componet	Intensity [nT]
North	22,457.3
East	1707.4
Vertical	45,653.0

Calculate the declination, inclination, and magnitude of the horizontal and total field vectors for Norman. Is the inclination downward or upward? Is the declination east or west of north? (If you do not show all your work and just provide answers you will receive no credit for this problem) *(20 pt.)*

3. Since more that 90% of the Earth's magnetic field can be explained by a dipole model, we often use the dipole equations to do magnetic computations. The radial and tangential componets of the field are represented by $H_r = -\frac{dV}{dr} = \frac{2Mcos\theta}{r^3}$ and $H_\theta = -\frac{1}{r}\frac{dV}{d\theta} = \frac{Msin\theta}{r^3}$ where r is radius and *theta* is colatitude. It is clear that the radial field H_r is equal to the vertical field Z_e and the tangential field H_θ is equal to the horizontal field H_E.

   Using this information determine the vertical gradient of the vertical componet of the Earth's field in Norman. The average vertical componet strength in Norman is 45,653 nT and the Earth's radius is 6.355x10^6m. Based on your answer why do we often not consider an elevation correction in ground based magnetic surveys? *(20 pt.)*

4. Intensity of magnetization in magnetic field H can be described by $I = kH$, where k is a contast of proportionality called magnetic susceptibility. In the lab we place a sample of rock salt ($k = -1\text{x}10^7$) in a magnetically shielded room, and turn on a set of coils. The field generated by the coils is equal to that expected from a pole of strength 2.5 C. The sample is 0.5m from the effective pole location. What is the intensity of magnetization of the salt? Hint: $H = \frac{m}{r^2}$ *(20 pt.)*

5. Describe the differences between B (magnetic flux density) and H (magnetic field strength). How are the units different? How are the fields related? *(15 pt.)*

6. What counts as academic misconduct? What are the penalties for academic midconduct at the university? *(5 pt.)*

On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exercise.

Name: _____

Date: _____