1) (20 pts) A non-conducting spherical shell, with an inner radius of 4.0 cm and an outer radius of 7 cm, has charge spread nonuniformly through its volume between its inner and outer surfaces. The volume charge density is the charge per unit volume ($\text{C/m}^3$). For this shell, $\rho = b/r$ where $b = 5.0 \mu\text{C/m}^2$. What is the net charge on the shell?
2) (15 pts) What is the electric field in vector notation at the point (2.0 \text{i} + 3.0 \text{j} \ - \ 4.0 \text{k}) \text{ meters if the electric potential is given by } V = 2.0xy^3z^2, \text{ where } V \text{ is in volts and } x, y, \text{ and } z \text{ are in meters?}
3) (25 pts) The charges and coordinates of two charged particles held fixed in an xy plane are $q_1 = +5.0 \text{ nC}$, $x_1 = 3.0 \text{ cm}$, $y_1 = 0.75 \text{ cm}$ and $q_2 = -3.0 \text{ nC}$, $x_2 = -1.5 \text{ cm}$, $y_2 = 1.5 \text{ cm}$. Find (a) magnitude and (b) direction of the electrostatic force on particle one due to particle two. At what (c) x- and (d) y-coordinates should a third particle of charge $q_3 = +4.0 \text{ nC}$ be placed such that the net electrostatic force on particle 3 due to particles 1 and 2 is zero?

   a. Magnitude of $F$

   b. Direction of $F$

   c. X-coordinate

   d. Y-coordinate
4) (15 pts) Two particles are fixed to the x-axis: particle 1 of charge \( q_1 = 2.9 \times 10^{-9} \text{ C} \) at \( x = 10 \text{ cm} \) and particle 2 of charge \( q_2 = -3q_1 \) at \( x = 80 \text{ cm} \). At what coordinate on the axis is the net electric field produced by the particles equal to zero?
5) (10 pts) An alpha particle (the nucleus of a helium atom) has a mass of $6.64 \times 10^{-27}$ kg and a charge of $+2e$. What are the magnitude and direction of the electric field that will balance the gravitational force on the particle?
   a. Magnitude?
   b. Direction?
6) (15 pts) In this figure, what is the net electric potential at point P due to the four particles if $V=0$ at infinity, $q=5.0 \ \mu C$, and $d=2.0 \ \text{cm}$?