

**Notre Dame University**  
 Faculty of Natural and Applied Sciences  
 Department of Sciences  
**PHS 212: Electricity and Magnetism**  
 Test#1 Summer 2004, Duration: 60 minutes  
 Instructor: M. El Tahchi, PhD

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 ID# \_\_\_\_\_

Date \_\_\_\_\_  
**OPEN BOOK**

**Problem I (35 pts)**

A thick, nonconducting, spherical shell, of centre O, of inner radius  $a$  and outer radius  $b$ , carries the charge density  $\rho$  given by:  $\rho = k/r$ , where  $k$  is a constant and  $r$  is the distance from O.

A charge  $Q$  is placed at the centre O of the shell. What should be the value of the constant  $k$  that gives a uniform electric field (of constant modulus) in the region  $a < r < b$ .

**Problem II (30pts)**

A thick spherical shell of inner radius  $R_2$  and outer radius  $R'_2$  surrounds (concentric) a conducting sphere  $S_1$  of radius  $R_1$ . The sphere  $S_1$  is under a given potential  $V_1$ . Find the charge  $q$  of  $S_1$  function of  $V_1$ ,  $R_1$ ,  $R_2$  and  $R'_2$ .

**Problem III (35pts)**

Consider a "parallel-plate capacitor" having two square plates of side  $a$  separated by a distance  $d$ . These plates are not perfectly parallel; they have a very small angle  $\theta$  between them (see Figure 1). Show that the capacitance of the system is given by:

$$C = \frac{\epsilon_0 a^2}{d} \left( 1 - \frac{a\theta}{2d} \right)$$

given that:  $\lim_{x \rightarrow 0} \ln(1+x) = x - \frac{1}{2}x^2 + \dots$

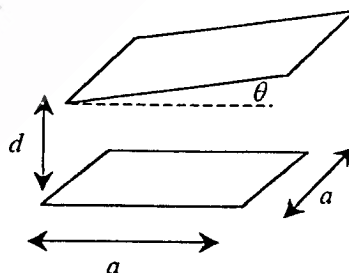


Figure 1