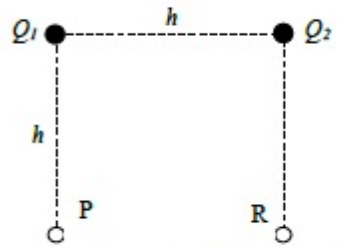
Electromagnetism and Optics. Assignment 1

Module code: PHY2004. Lecturer Dr. G. Sarri.

Remember: Your total assignment scores contribute 20% of the total module mark. Submit an electronic copy of your assignment in the relevant assignment section on QoL by 22:00 on the 11th of February.

1. Two positive point charges Q_1 and Q_2 are separated by a distance h as shown below.



Derive expressions for the magnitude and direction of the electric field at point P and the potential at R. **[20/100]**

2. Two infinitely long concentric conducting cylinders of radii $r = a$ and $r = b$ ($b > a$) carry **equal and opposite** charges λ per unit length. The space between them is filled with a dielectric of relative permittivity ε_r. Using the most general form of Gauss' law:

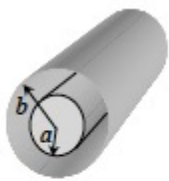
   a. Determine expressions for the radial fields $\underline{D}$, $\underline{E}$ and $\underline{P}$ in the dielectric between the cylinders. **[30/100]**

   b. Determine an expression for the potential difference between the two cylinders. **[10/100]**

   c. Calculate their joint capacitance *per unit length*. **[10/100]**

   d. What are $\underline{D}$, $\underline{E}$ and $\underline{P}$ outside of the cylinders, r > b? **[15/100]**

   e. Comment on the existence and location of any *bound* surface and volume charges. **[15/100]**



If you wish, you may assume that in cylindrical polar co-ordinates (r, θ, z):-

$$\nabla \cdot \underline{P} = \frac{1}{r}\frac{\partial}{\partial r}(rP_r) + \frac{1}{r}\frac{\partial P_\theta}{\partial \theta} + \frac{\partial P_z}{\partial z}$$