1. (25%) Find the capacitance C of two concentric spherical metal shells, with radii R and $2R$.

2. (25%) Find the magnetic field **B** at a distance z above the center of a circular loop of radius R, which carries a steady current I.

3. (a) (10%) Can the vector field $\vec{E} = (yz - 2x)\,\hat{\imath} + xz\,\hat{\jmath} + xy\,\hat{k}$ possibly be an electrostatic field? Please verify it.
(b) (15%) What is the charge distribution in this electric field $\vec{E} = (yz - 2x)\,\hat{\imath} + xz\,\hat{\jmath} + xy\,\hat{k}$?

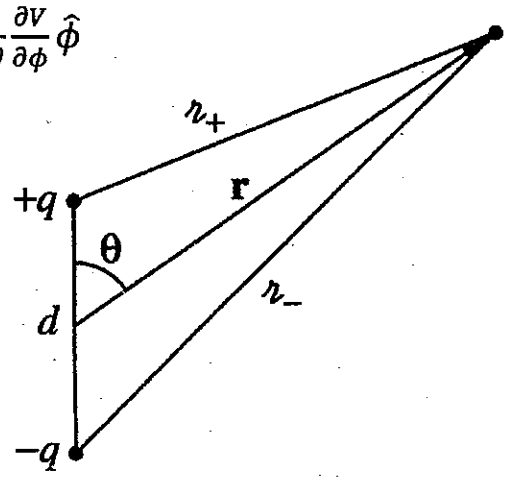
4. (a) (10%) Please explain why we can use $\vec{E} = -\nabla V$ in electrostatics? $\vec{E}$: electric field, V: potential.

(b) (15%) A (physical) electric dipole consists of two equal and opposite charges +q and –q, which are separated by a distance d. The approximate potential at points far from the dipole is

$$V(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{qd\cos\theta}{r^2}$$

Please derive the electric field $\vec{E}$.

Hint: $\vec{E} = -\nabla V = -\frac{\partial V}{\partial r}\hat{r} - \frac{1}{r}\frac{\partial V}{\partial \theta}\hat{\theta} - \frac{1}{r\sin\theta}\frac{\partial V}{\partial \phi}\hat{\phi}$



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