1. C

2. C (potential is uniform, but not zero)

3. B $V_{12} = E d = 10 \times 10^{3} \times 10^{-3} = \underline{\underline{10\ V}}$

4. D

$$V = \cos\varphi \Rightarrow \underline{E} = -\nabla V = -\underline{a}_\varphi \left(\frac{1}{r}\frac{\partial V}{\partial \varphi} \right) = +\underline{a}_\varphi \frac{1}{r}\sin\varphi$$

$$\rho_p = -\nabla . \underline{P} = -\nabla . (\underline{D} - \varepsilon_0 \underline{E}) = \underbrace{\cancel{-\nabla . \underline{D}}}_{=\rho=0} + \nabla . \varepsilon_0 \underline{E}$$

$$= \varepsilon_0 \nabla . \left(\underline{a}_\varphi \frac{1}{r} \sin\varphi \right) = \underline{\underline{\frac{\varepsilon_0}{r^2} \cos\varphi}}$$

5. (a) Gauss: $\oint_S \underline{D}.d\underline{s} = Q \Rightarrow (D_{R1} + D_{R2})\, 2\pi R^2 = Q$ — (1)

Interface between dielectrics: $\underline{E}_{1t} = \underline{E}_{2t} \Rightarrow E_{R1} = E_{R2}$

$$\Rightarrow \frac{D_{R1}}{\varepsilon_0 \varepsilon_{r1}} = \frac{D_{R2}}{\varepsilon_0 \varepsilon_{r2}} \quad -(2)$$

From (1) & (2): $\left(1 + \frac{\varepsilon_{r2}}{\varepsilon_{r1}}\right) D_{R1} = \frac{Q}{2\pi R^2}$

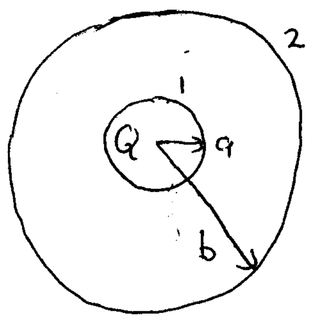
$$\Rightarrow D_{R1} = \frac{\varepsilon_{r1}}{(\varepsilon_{r1} + \varepsilon_{r2})} \frac{Q}{2\pi R^2}$$

$$\& \quad D_{R2} = \frac{\varepsilon_{r2}}{(\varepsilon_{r1} + \varepsilon_{r2})} \frac{Q}{2\pi R^2}$$

(b) $$E_{R1} = E_{R2} = \frac{D_{R1}}{\varepsilon_0 \varepsilon_{r1}} = \frac{Q}{2\pi\varepsilon_0 (\varepsilon_{r1} + \varepsilon_{r2}) R^2}$$

$\underline{E} = \underline{a}_R E_{R1}$ everywhere between spheres

(c)



$$V_{12} = -\int_{R=b}^{a} E_R \, dR$$

$$= -\frac{Q}{2\pi\varepsilon_0 (\varepsilon_{r1} + \varepsilon_{r2})} \left[-\frac{1}{R} \right]_b^a$$

$$= \frac{Q}{2\pi\varepsilon_0 (\varepsilon_{r1} + \varepsilon_{r2})} \left(\frac{1}{a} - \frac{1}{b} \right)$$

$$C = \frac{Q}{V_{12}} = \frac{2\pi\varepsilon_0 (\varepsilon_{r1} + \varepsilon_{r2})}{\left(\frac{1}{a} - \frac{1}{b} \right)} = 2\pi\varepsilon_0 (\varepsilon_{r1} + \varepsilon_{r2}) \frac{ab}{b-a}$$