#1 LET V_{sc} BE POTENTIAL DUE TO INDUCED SURFACE CHARGE AT CAVITY WALL.

$$V_{sc}(\vec{r}) = \sum_{\ell=0}^{\infty} \left(A_\ell r^\ell + \frac{B_\ell}{r^{\ell+1}} \right) P_\ell(\cos\theta)$$

$V_{sc}(\vec{r})$ FINITE @ $r=0 \Rightarrow B_\ell = 0$, All ℓ.

ON CAVITY WALL $V_{TOT} = V_{DIP} + V_{sc} = \text{const}$

$$V_{TOT}(\vec{r}) = \frac{1}{4\pi\varepsilon_0} \frac{\vec{p}\cdot\hat{r}}{r^2} + \sum_{\ell=0}^{\infty} A_\ell r^\ell P_\ell(\cos\theta)$$

$$V(r) = \frac{p\cos\theta}{4\pi\varepsilon_0 a^2} + A_0 + A_1 a P_1 + A_2 a^2 P_2 + \ldots$$

$= C_0$ (WHATEVER POTENTIAL IS @ WALL.)

$\Rightarrow A_0 = C_0$

$$A_1 = -p/4\pi\varepsilon_0 a^3$$

$$A_2 = A_3 = A_4 = A_5 = \ldots = 0$$

$$V_{sc}(\vec{r}) = C_0 - \frac{p r P_1(\cos\theta)}{4\pi\varepsilon_0 a^3}$$

#7.

$$V_{sc}(r,\theta) = C_0 - \frac{p z}{4\pi\varepsilon_0 a^3} \qquad \text{w/ } r\cos\theta = z$$

SWITCH TO CARTESIAN COORDS.

$$\underset{\sim}{E}_{sc} = -\underset{\sim}{\nabla} V_{sc} = -\frac{\partial}{\partial z} V_{sc}\, \hat{z}$$

$$\boxed{\underset{\sim}{E}_{sc} = +\frac{p}{4\pi\varepsilon_0 a^3}\, \hat{z}}$$

#2.

$Q_{TOT} = 0$ (monopole TERM)

$\underset{\sim}{p} = +qd\,\hat{y}$ (DIPOLE MOMENT)

$$V(\underset{\sim}{r}) = \frac{1}{4\pi\varepsilon_0}\,\frac{\underset{\sim}{p}\cdot\hat{r}}{r^2}$$

$$V(r) = \frac{+qd}{4\pi\varepsilon_0\, r^2}\,\sin\theta\sin\varphi$$