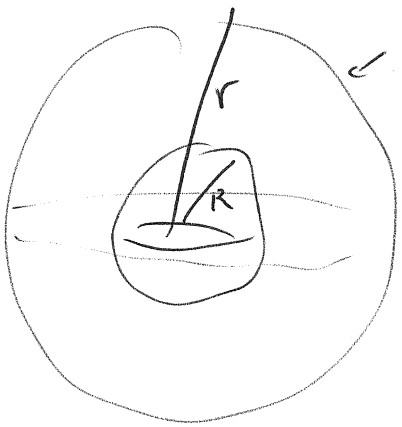
PROBLEM 1

a) OUTSIDE OF SPHERE



$$\Phi = 4\pi r^2 |E| = \frac{Q_{ENC}}{\varepsilon_0}$$

$$Q_{ENC} = \frac{4\pi R^3}{3}\rho$$

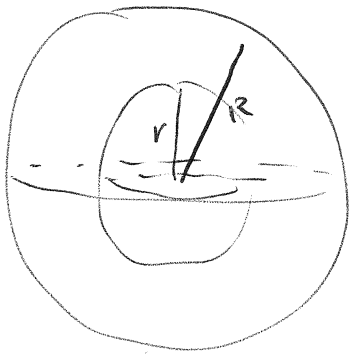
$$4\pi r^2 |E| = \frac{1}{\varepsilon_0}\frac{4\pi R^3}{3}\rho$$

$$|E| = \frac{1}{4\pi\varepsilon_0}\frac{4\pi R^3}{3r^2}\rho$$

$$|E| = \frac{R^3\rho}{3\varepsilon_0 r^2}$$

$$\vec{E} = \frac{R^3\rho}{3\varepsilon_0 r^2}\hat{r}$$

b)



GAUSS'S LAW

$$\Phi = \frac{Q_{ENC}}{\varepsilon_0}$$

$$\Phi = 4\pi r^2 |E|$$

$$Q_{ENC} = \frac{4\pi r^3}{3}\rho$$

$$4\pi r^2 |E| = \frac{4\pi r^3}{3}\rho \frac{1}{\varepsilon_0}$$

$$|E| = \frac{\rho r}{3\varepsilon_0}$$

$$\vec{E} = \frac{\rho r}{3\varepsilon_0}\hat{r}$$

c) POTENTIAL OUTSIDE AT $r = a$

TAKE

$$d\vec{\ell} = dr\,\hat{r}$$

$$\int_a^\infty \vec{E}\cdot d\vec{\ell} = V(a) - \cancel{V(\infty)}^{\,0} = \int_r^\infty \frac{R^3\rho}{3\varepsilon_0 r^2}\cdot dr\,\cancel{\hat{r}\cdot\hat{r}}^{\,1}$$

$$= \frac{R^3\rho}{3\varepsilon_0}\left(-\frac{1}{r}\Big]_a^\infty\right)$$

$$V(a) = \frac{R^3\rho}{3\varepsilon_0}\frac{1}{a}$$

d) INSIDE

$$V(a) - V(R) = \int_a^R \frac{\rho r}{3\varepsilon_0}\,dr$$

$$= \frac{\rho r^2}{6\varepsilon_0}\Big]_a^R = \frac{\rho(R^2 - a^2)}{6\varepsilon_0}$$

$$V(R) = \frac{R^3\rho}{3\varepsilon_0}\frac{1}{\cancel{R}} = \frac{R^2\rho}{3\varepsilon_0}$$

$$V(a) = \frac{\rho(R^2 - a^2)}{6\varepsilon_0} + \frac{R^2\rho}{3\varepsilon_0}$$

e) YES

PROBLEM 2

a) $\frac{\sigma}{\varepsilon_0}$

b) $|E|xd = \frac{\sigma}{\varepsilon_0} d$

c) E BY ONE PLATE $= \frac{\sigma}{2\varepsilon_0}$

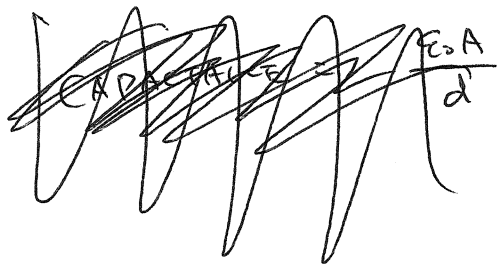
$$F = \frac{\sigma}{2\varepsilon_0} \cdot (\sigma \cdot A) = \frac{\sigma^2 A}{2\varepsilon_0}$$

(TOTAL CHARGE)

d) $$\text{WORK} = F \cdot d = \frac{\sigma^2 A d}{2\varepsilon_0}$$

e) $$W(x) = F \cdot x = \frac{\sigma^2 A}{2\varepsilon_0} x$$

$$\int_0^d W(x)\,dx = \int_0^d \frac{\sigma^2 A}{2\varepsilon_0} x\,dx = \frac{\sigma^2 A}{2\varepsilon_0} \cdot \frac{d^2}{2} = \frac{\sigma^2 A d}{4\varepsilon_0}$$



e) CAPACITANCE $= \frac{\varepsilon_0 A}{d}$

ENERGY STORED $= \frac{Q^2}{2C}$

PROBLEMS

a) FALSE!

$E = \frac{\sigma}{\varepsilon_0}$ ← NO DEPENDENCE ON d (DISTANCE BETWEEN PLATES)

b)

$\frac{\sigma}{\varepsilon_0} = E_{MAX}$ 3×10^6 V/m

$\sigma = E_M \varepsilon_0$

$R > r$

$4\pi R^2 \sigma > 4\pi r^2 \sigma$

TRUE

c)

V V_1 V_2

Q −Q Q −Q

$Q = CV_1$

$Q = C_2 V_2$

$V_1 + V_2 = V = \frac{Q}{C_1} + \frac{Q}{C_2}$

$V = Q \cdot \frac{C_1 + C_2}{C_1 C_2}$

$C_{TOTAL} = \frac{C_1 C_2}{C_1 + C_2}$

$C_1 = C_2$

$= \frac{C^2}{2C} = \frac{C}{2}$

FALSE

d) TRUE