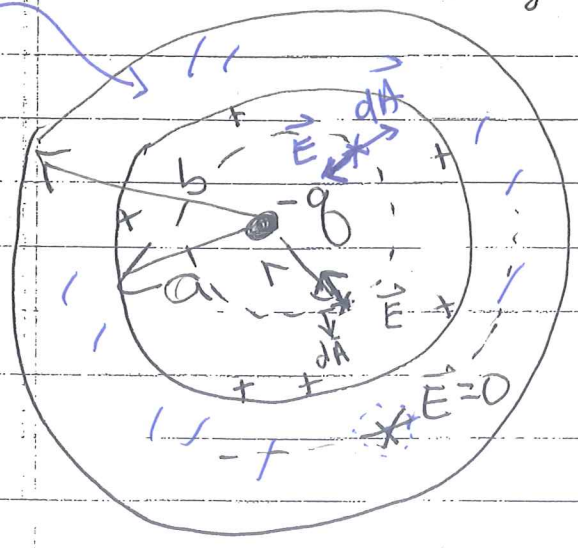
EX] A spherical conducting shell in electrostatic equilibrium w/ net charge +Q. Inner radius 'a', outer radius 'b'. A charge (-q) is placed in the center cavity.

Find $\vec{E}$ everywhere.

Find the charge densities on the surfaces.



for $r < a$

[spherical surface radius r

$$\oint \vec{E} \cdot d\vec{A} = q_{enc.}$$

$$|\vec{E}| 4\pi r^2 (-1) = \frac{-q}{\varepsilon_0}$$

$$|\vec{E}| = \frac{q}{4\pi\varepsilon_0 r^2}$$ ☺

for $a < r < b$

[Spherical surface]

$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{enclosed}}{\varepsilon_0}$$

($q_{enclosed} = -q + q_{inner\ surface}$)

$\oint \vec{E} \cdot d\vec{A}$ = 0!!! → 0

$$0 = -q + q_{inner\ surface}$$

$$+q = q_{inner\ surface}$$

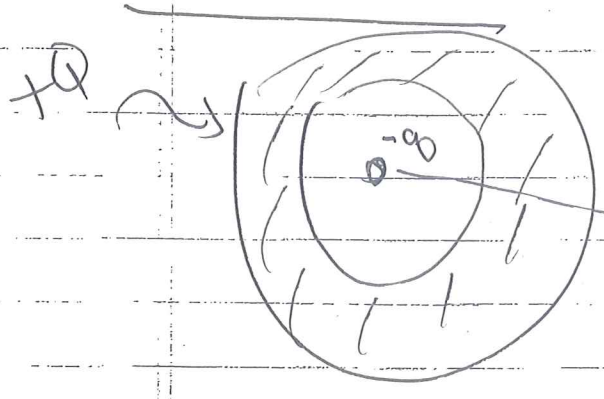
$$\sigma_{\text{inner surface}} = \frac{\text{charge}}{\text{area}} = \frac{+q}{4\pi a^2}$$

We know: $+Q = q_{\text{inner surface}} + q_{\text{outer surface}}$

$+Q = +q + q_{\text{outer surface}}$

$\therefore +Q - q = q_{\text{outer surface}}$ ☆ ☺

for $r > b$



$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enclosed}}}{\varepsilon_0}$$

$$|\vec{E}|(4\pi r^2) = \frac{(+Q-q)}{\varepsilon_0}$$

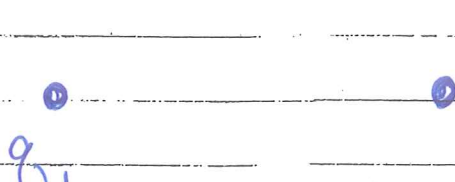
$$|\vec{E}| = \frac{(+Q-q)}{4\pi\varepsilon_0 r^2}$$

Comments on HW due Today ☺

Flux ⇒ $\oint \vec{E} \cdot d\vec{A} = \int_0^a \int_0^a 5.77\, y\, dz\, dy$

$= 5.77 \int_0^a dz \int_0^a y\, dy$ ☺

$\int_0^a dz = a$; $\int_0^a y\, dy = a^2/2$



$\vec{E}_1$ is field produced by q_1.

$$\vec{F}_{on\ q_2} = q_2 \vec{E}_1$$

Forces do work to transfer and/or transform energy from one object (or kind) to another. Amt. of work done ≡ amt. of Energy transferred/transformed.

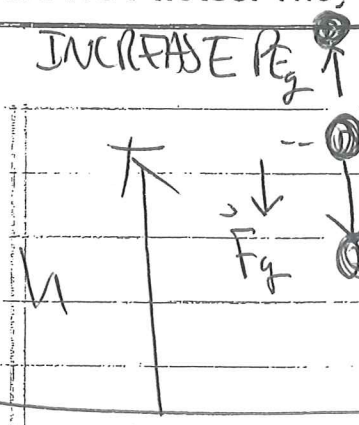
$$\text{Work} = \int \vec{F} \cdot d\vec{s}$$

$$|\vec{F}||d\vec{s}|\cos(\theta)$$

"+" sign ⇒ Force is in direction of displacement ($d\vec{s}$)

"−" sign ⇒ ... opposite

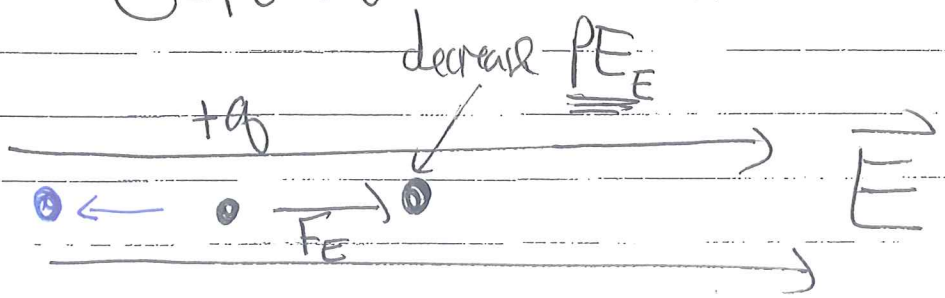
A potential energy is associated with the electric force. (Just like a potential energy is associated w/ the gravitational force)



M --- $PE_g = mgh$

--- Decrease in PE_g.

Ground (Earth)



Increase in $PE_{electric}$.

$\vec{F} = q\vec{E}$

If q is negative, $\vec{F} = -q\vec{E}$

↑ opposite the direction of $\vec{E}$!!

END EXAM Content