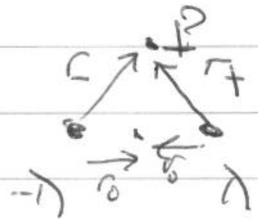
#1.

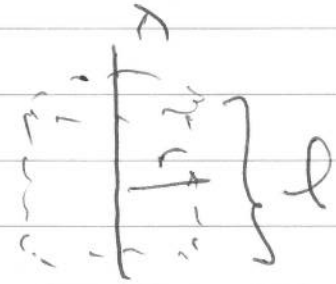


B/C OF SYMMETRY, USE

$$V(r) = -\int_0^r \underset{\sim}{E} \cdot d\underset{\sim}{l}$$

FROM GAUSS' law, $E \cdot 2\pi r l = Q_{enc}/\varepsilon_0$
$= \lambda l/\varepsilon_0$

$$\underset{\sim}{E} = \frac{\lambda}{2\pi\varepsilon_0 r}\hat{r}$$ WHERE r IS RADIUS OF cylinder ENCLOSING A PORTION OF THE LINE CHARGE



FOR $\lambda > 0$, $\underset{\sim}{E}$ RADIALLY OUTWARDS

$\lambda < 0$, $\underset{\sim}{E}$ RADIALLY INWARD

$$V(r_-) = -\int_{r_0}^{r_-} \underset{\sim}{E} \cdot d\underset{\sim}{l} = -\int \frac{-\lambda}{2\pi\varepsilon_0 r}\,dr$$

$$V(r_-) = \frac{\lambda}{2\pi\varepsilon_0} \ln r_-/r_0$$, w/ r_0 = RADIUS OF REF PT.

TAKE IT AS ½-WAY BETWEEN LINE CHARGES.

SIMILARLY,
$$V(r_+) = -\frac{\lambda}{2\pi\varepsilon_0} \ln r_+/r_0$$

NOTE ∇

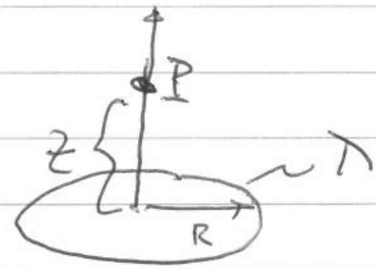
#1 CON'T.

V DUE TO BOTH LINE CHARGES IS THEN

$$V(r_-) + V(r_+) = \frac{-\lambda}{2\pi\varepsilon_0} \ln r_+/r_0 + \frac{\lambda}{2\pi\varepsilon_0} \ln r_-/r_0$$

$$\boxed{V(r_-) + V(r_+) = \frac{\lambda}{2\pi\varepsilon_0} \ln \left(r_-/r_+ \right)}$$

#2

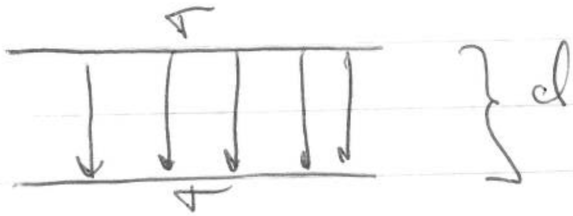


P IS EQUIDISTANT FROM <u>ALL</u> CHARGE ON RING!

$$V = \frac{1}{4\pi\varepsilon_0} \, q/s \quad \text{w/ } q = 2\pi\lambda R, \; s = \sqrt{R^2+z^2}$$

$$\boxed{V(z) = \frac{\lambda R}{2\varepsilon_0} \cdot \frac{1}{\sqrt{z^2+R^2}}}$$

#3.



EACH PLATE PRODUCES A FORCE ON THE OTHER DUE TO THE E FIELD PRODUCED BY ONE PLATE AND THE CHARGE OF THE OTHER. FOR THE FORCE PER UNIT AREA, WE HAVE

$$F/A = \left(Q/A\right)E = \frac{\sigma A}{A} \cdot \frac{\sigma}{2\varepsilon_0} = \frac{\sigma^2}{2\varepsilon_0}$$

DON'T USE $E = \frac{\sigma}{\varepsilon_0}$ SINCE THAT E-FIELD INCLUDES THE E FIELD FROM THE CHARGES BEING ACTED ON.

THIS F/A ACTS ON A MASS/A. FROM NEWTON'S 2ND LAW, WE HAVE FOR THE ACCELERATION a

$$\frac{m}{A} \cdot a = \eta a = \frac{\sigma^2}{2\varepsilon_0}$$

$$a = \frac{\sigma^2}{2\varepsilon_0 \eta}$$

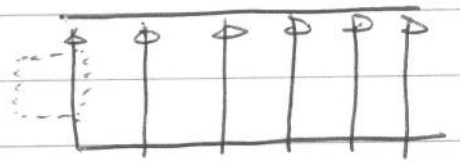
EACH PLATE IS ACCELERATED FROM REST.
PLATES MEET IN MIDDLE.

$$\frac{d}{2} = \frac{1}{2} a t^2$$

$$t = \sqrt{d/a}$$

$$\boxed{t = \sqrt{\frac{2 \varepsilon_0 \gamma d}{\sigma^2}}}$$

#4.



THE EDGE OF THE CAPACITOR VIOLATES THE CONDITION $\oint \underset{\sim}{E} \cdot d\underset{\sim}{\ell} = 0$ FOR STATIC CHARGES.

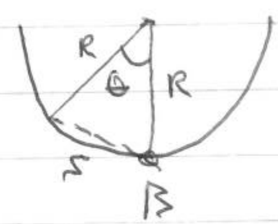
DRAW A CLOSED PATH AS ABOVE AND FOR THE FIELD $\oint \underset{\sim}{E} \cdot d\underset{\sim}{\ell} \neq 0$ SO THE FIELD SHAPE AT THE EDGES IS WRONG!

#5. PT A IS EASY. IT IS EQUIDISTANT FROM ALL THE CHARGE SINCE IT IS AT CENTER OF A SPHERE

$$V_A = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R} = \frac{1}{4\pi\varepsilon_0}\frac{2\pi R^2\sigma}{R}$$

$$\boxed{V_A = \frac{\sigma R}{2\varepsilon_0}}$$

PT B IS A BIT HARDER. USE LAW OF COSINES.



$$V_B = \frac{1}{4\pi\varepsilon_0}\int dq/s$$

$$V_B = \frac{1}{4\pi\varepsilon_0}\int\frac{\sigma\, R\,d\theta\; R\sin\theta\, d\varphi}{s}$$

$$= \frac{\sigma R^2}{2\varepsilon_0}\int\frac{\sin\theta\, d\theta}{s}$$

NOW, $s^2 = R^2 + R^2 - 2R^2\cos\theta$

$$= 2R^2(1-\cos\theta)$$

$$\Rightarrow 2s\,ds = 2R^2\sin\theta\, d\theta$$

$$\sin\theta\, d\theta = \frac{s\,ds}{R^2}$$

#5 CONT.

SUBSTITUTING FOR $\sin\theta\, d\theta$ AND REALIZING s SPANS $s=0$ TO $s=\sqrt{R^2+R^2}=\sqrt{2}R$,

$$V_B = \frac{\sigma R^2}{2\varepsilon_0}\int_{s=0}^{\sqrt{2}R} \frac{s\,ds}{sR^2}$$

$$= \frac{\sigma}{2\varepsilon_0}\, s \Big|_0^{\sqrt{2}R}$$

$$\boxed{V_B = \frac{\sigma R}{\sqrt{2}\varepsilon_0}}$$

SO,

$$V_B - V_A = \frac{\sigma R}{\varepsilon_0}\left(\frac{1}{\sqrt{2}} - \frac{1}{2}\right)$$

$$\boxed{V_B - V_A = \frac{\sigma R}{2\varepsilon_0}\left(\sqrt{2}-1\right)}$$

#6

$$F_G = -\frac{G m_e^2}{r^2}$$

$$F_{EM} = \frac{e^2}{4\pi\varepsilon_0 \; r^2}$$

TAKING ABSOLUTE VALUES,

$$F_E/F_G = e^2/m^2 \cdot \frac{1}{4\pi\varepsilon_0 G}$$

$$\boxed{F_E/F_G = 4.2 \times 10^{42}}$$

ELECTRICAL FORCES ARE <u>HUGE</u> COMPARED TO GRAVITATIONAL FORCES. BULK MATTER MUST BE VERY NEUTRAL OR GRAVITY WOULD BE SWAMPED BY ELECTRICAL FORCES.