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Lecture: 16 (iq14)

1. N dependence of DV for E=Kr^N, N=-3, -2 ... Clicker **Ch17.h2:8**.
2. Uniformly charged sphere,
   a. DV=V(0)-V(R),
   b. V(r).muon final kinetic energy **Ch17.h2.16-17**.
3. Potential difference VA-VB is path independent. **Clicker 16-1**
4. Energy stored in a capacitor. **Clicker 16-2**
5. Capacitor filled with dielectric medium: K: E', V', C' and U'. **Clicker 16-6**

Announcement:

- My office hour: 9:15 to 10:15.
- You may setup a time to meet with me to discuss your midterm1 performance. (Bring your redo midterm1 work when you come.)

iq14

1. N dependence of ΔV for $E = Kr^N$

For $E = Kr^N$, different geometric shape of the source leads diff. N value

Dipole: $E = \frac{K}{r^3}$ $\Rightarrow N = -3$

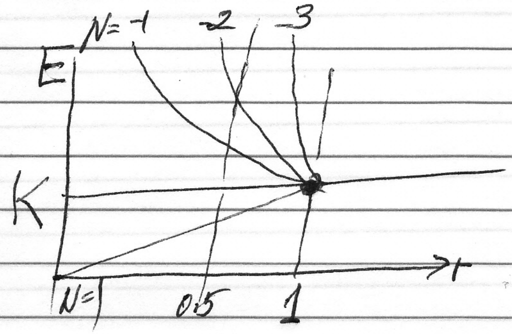
pt charge $\Rightarrow N = -2$

long rod $r > R$: $N = -1$

long rod solid $r < R$: $N = +1$

$2\pi r h E_? = \rho \left(\frac{\pi r^2 h}{\pi R^2 h}\right) / \epsilon_0$

$E_? \propto r$



Potential difference from 0.5 to 1:

E is to the right. $\Delta V = V(0.5) - V(1) > 0$, climb up from 1 to 0.5

$$\Delta V = -\int_1^{0.5} E\,dr = \int_{0.5}^{1} E\,dr$$

How should ΔV vary with increase of N? (by inspection)

Notice ΔV is given by area under E curve

Clicker Ch17 h2: 8

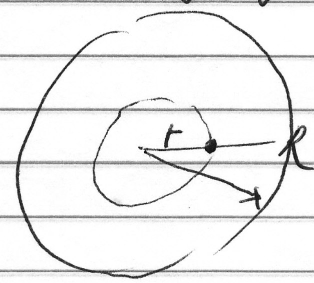
ΔV increases with increase of N

ΔV is const. "

ΔV decreases "

ΔV does not vary monotonically with increase of N

2. Given: Uniformly charged sphere, Q, R. Find: $\Delta V = V(0) - V(R)$.



Assume $Q > 0$,

at any r, E is pointing radially outward.

Climbing upward, when going from R to 0.

$\therefore \Delta V$ is positive

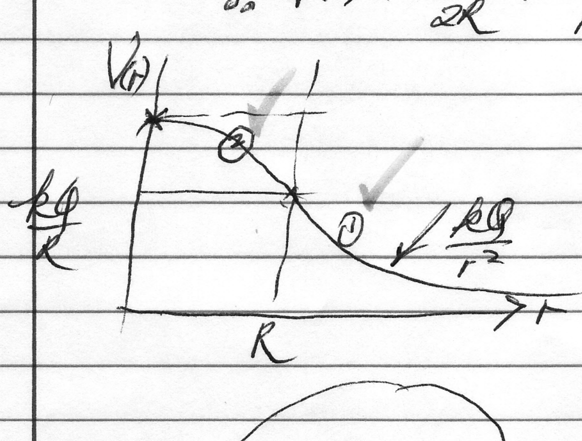
$$\Delta V = V(0) - V(R) = -\int_R^0 E_r\, dr$$

Gauss Law

$$4\pi r^2 E_r = \frac{Q\left(\frac{r}{R}\right)^3}{\epsilon_0}, \quad E_r = \frac{kQ}{R^3} r \xrightarrow[r=R]{} \frac{kQ}{R^2} \quad \text{checks}$$

$$\Delta V = V(0) - V(R) = \frac{-kQ}{R^3}\int_R^0 r\, dr = \frac{kQ}{R^3} \cdot \frac{R^2}{2} = \frac{kQ}{2R}$$

$$\therefore V(0) = \frac{kQ}{2R} + \frac{kQ}{R} = \frac{3}{2} \cdot \frac{kQ}{R},$$

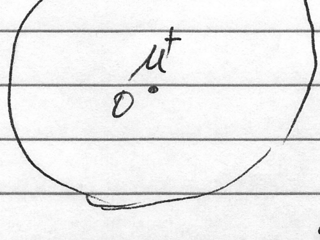


HW: h2.16

At $t=0$, μ^+ created at $r=0$

with K_i, initial KE

Find: K_f. Hint use cons. of eng



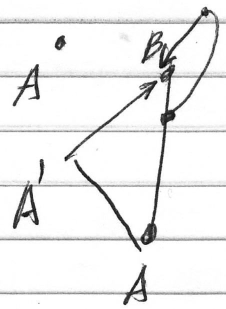
$$K_i + U(0) = K_f + \underbrace{U(\infty)}_{0}$$

$$e\left[\underbrace{\Delta V}_{②} + \underbrace{V(R)}_{①}\right], \text{ where } V(R) = \frac{kZe}{R}$$

3.

B. $\Delta U = U(B) - U(A)$

Independent on the path how pt B is reached



Different paths to reach B

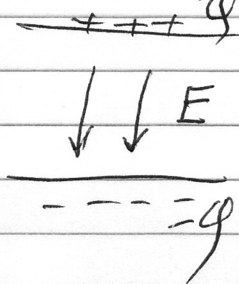
$\Delta U_{loop} = 0$. Clicker 16-1

W against friction will lead to extra work

Read on your own,

4.

Capacitor & Capacitance —



Capacitance: $C = \frac{Q}{V} = \frac{Q}{Ed} = \frac{\epsilon_0 A}{d}$.

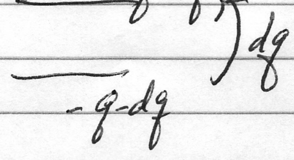
$E = \frac{Q/A}{\epsilon_0}$

Energy stored:

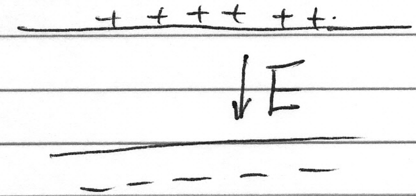
(1) Mechanical separation: $U = F_{attractive} \times d$

$$= Q E_{\text{one plate}} d = Q \times \left(\frac{Q/A}{2\epsilon_0}\right) d = \frac{Q^2}{2C}.$$

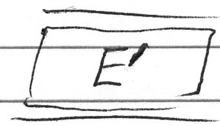
(2) Charging: $\Delta U = V \Delta q$, $U = \int_0^Q \frac{q}{C} dq = \frac{q^2}{2C}\Big|_0^Q = \frac{Q^2}{2C}$.



5. Dielectrics –



Insert electric material



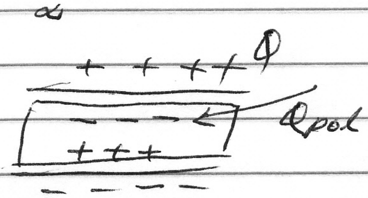
Field becomes weaker

$E' = E/K$

Example of K

	K
vac	1
Air	1.0006
plastic	5
Water	80
Semicond.	300
Conductor	∞

$$E = \frac{Q/A}{\epsilon_0}$$

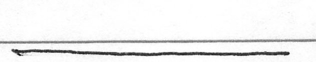


$$E' = \frac{(Q - Q_{pol})/A}{\epsilon_0} = \frac{Q/A}{K\epsilon_0}$$

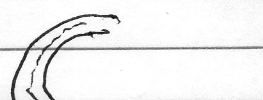
$$\therefore (Q - Q_{pol}) = \frac{Q}{K}$$

$$\therefore Q_{pol} = Q - \frac{Q}{K} = Q\left(1 - \frac{1}{K}\right)$$

$$C = \frac{Q}{V}, \quad C' = \frac{Q}{V'} = \left(\frac{Q}{E'd} = \frac{Q}{\frac{E}{K}d} = \right) \frac{Q}{\frac{V}{K}} = K\frac{Q}{V} = KC$$



Dielectric sheet: $U = \frac{Q^2}{2C}$



clicker 16b $U' = \frac{Q^2}{2C'} = \frac{Q^2}{2C}\frac{1}{K} = \frac{U}{K}$.