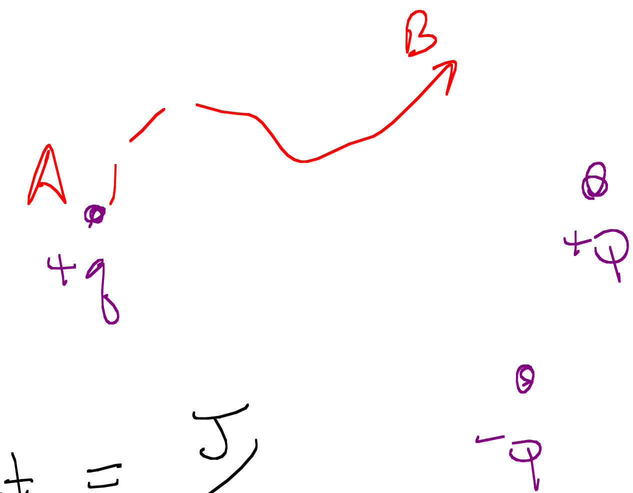
Phys 2120 - 4 9/12/12

Note Title 9/12/2012

Electrical Potential V



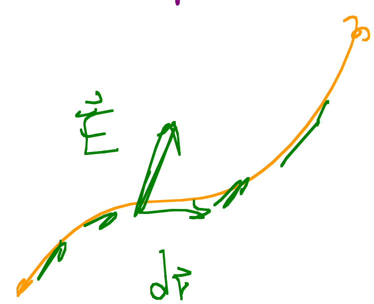
$$W_{AB} = -\Delta U_{AB}$$

$$\frac{\Delta U_{AB}}{q} = \Delta V_{AB}$$

Units Volt = J/C

E = V/m

$$\Delta V_{AB} = -\int_A^B \vec{E} \cdot d\vec{r}$$

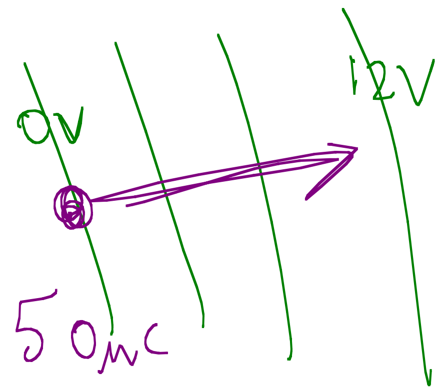


22.15 How much work does it take to move a 50-μC charge against a 12 V potential diff?

$$\Delta U = q\Delta V$$

$$= (50\times10^{-6}\,C)(+12\,V)$$

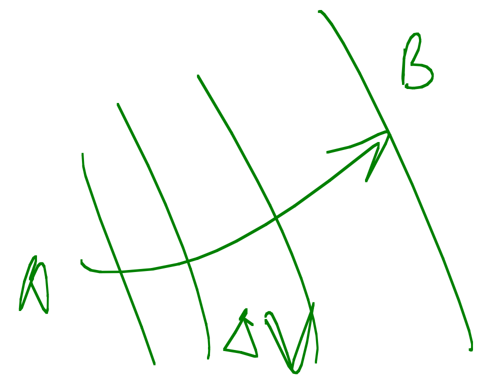
$$= 6.0\times10^{-4}\,J$$



$\Delta V = +12V$

Def $\underline{\Delta V_{AB}}$ (only for difference)

22.17 It takes 45 J to move 15 mC charge from A to B, what's pot'l diff?



$$\Delta U = 45\ \text{J} = q\Delta V$$

$$\Delta V = \frac{45\ \text{J}}{(15\times10^{-3}\ \text{C})} = 3.0\times10^{3}\ \text{V}$$

22.44 Proton beam therapy. Cylclotron acc's protons, repeatedly thru 15 kV pot'l diff.

a) How many passes need to given KE 1.2×10^{-11} J ?

$$\Delta U = q \, \Delta V$$

e — 1.6×10^{-19} C

volts

$(e)(1V)$ = electron Volts
= energy
= 1.602×10^{-19} J

With each pass proton loses 15 keV of energy.

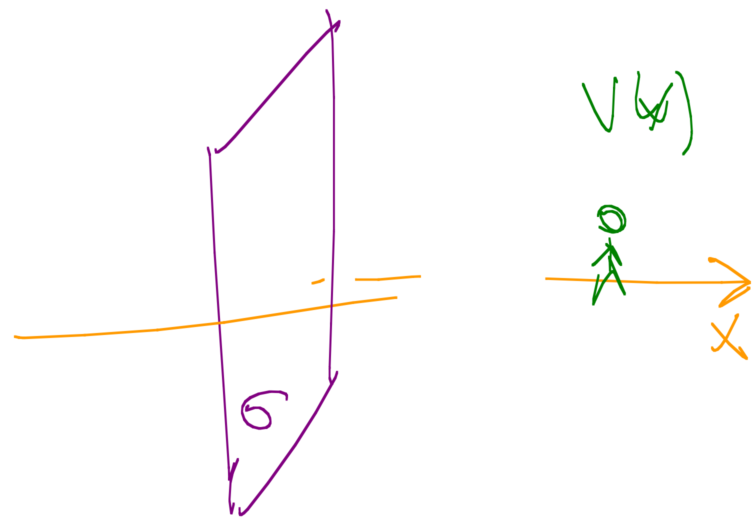
$$= 15\ \text{keV} \left(\frac{1.6\times10^{-13}\ \text{J}}{1\ \text{keV}} \right) = 2.40\times10^{-15}\ \text{J}$$

To get $1.2\times10^{-11}\ \text{J}$

$$\#\ \text{pass} = \frac{1.2\times10^{-11}\ \text{J}}{2.4\times10^{-15}\ \text{J}} = \boxed{5.0\times10^{3}}\ (\text{times})$$

b) $1.2\times10^{-11}\ \text{J} \left(\frac{1\ \text{eV}}{1.6\times10^{-19}\ \text{J}} \right) = \boxed{75\ \text{MeV}}$

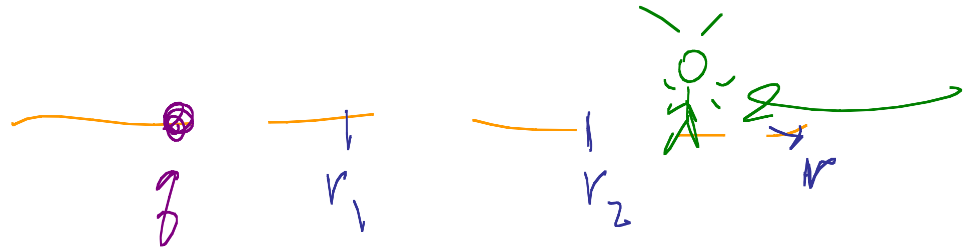
$$\Delta V = -\int_A^B \vec{E} \cdot d\vec{r}$$



$$E_x = \frac{\sigma}{2\epsilon_0}$$

$$\Delta V = -\int_0^x \frac{\sigma}{2\epsilon_0}\, dx' = -\frac{\sigma x}{2\epsilon_0}$$

Point charge:



$$\Delta V = -\int_1^2 k \frac{q}{r^2}\, dr$$

$r \to \infty$

$$= kq \frac{1}{r}\Big|_{r_1}^{r_2} = kq\left(\frac{1}{r_2} - \cancel{\frac{1}{r_1}}\right)$$

Scalar

V

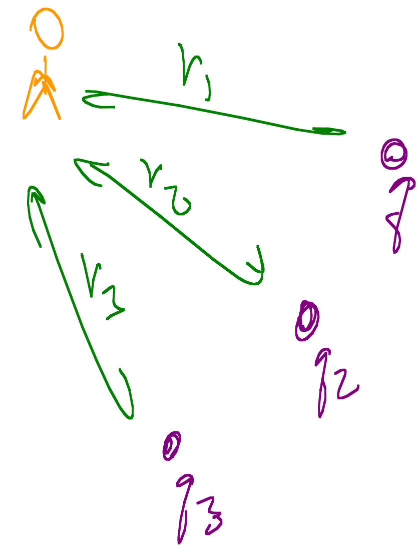
Take $r_1 = \infty$ $\quad V = kq/r$

p. 376

To find potential from bunch of charges

$$V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} + \dots$$

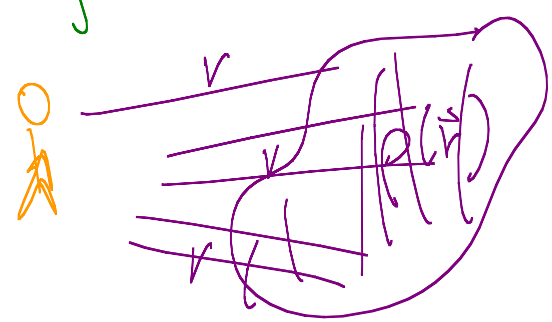
$$= k\left[\frac{q_1}{r_1} + \dots\right]$$



$$k = \frac{1}{4\pi\epsilon_0}$$

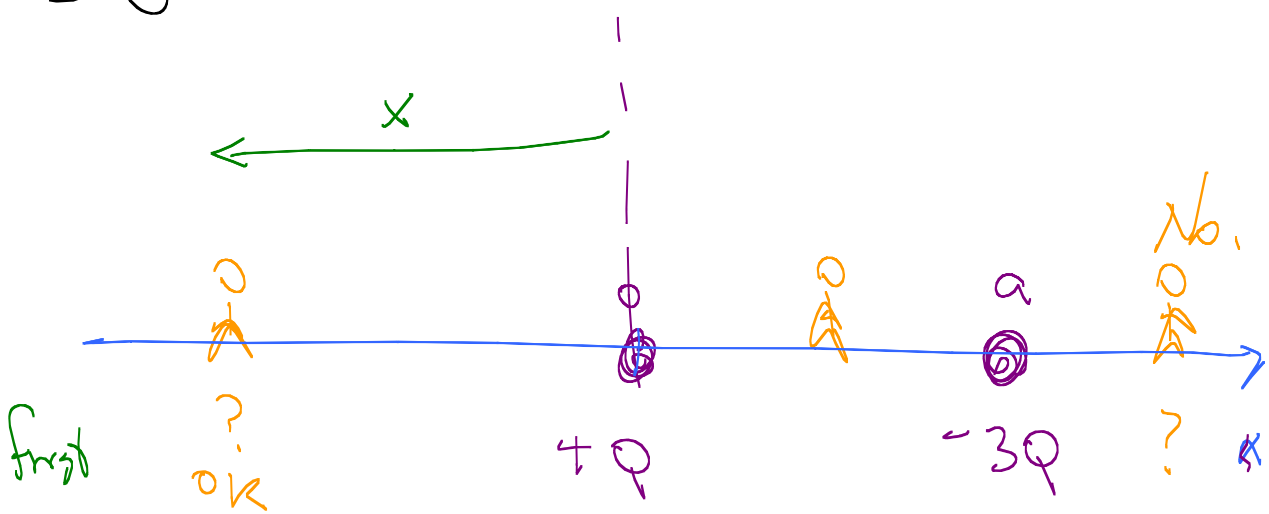
continuous

$$V = k\int_V \frac{\rho(\vec{r})\, d^3r}{r}$$



22.51 A charge $+Q$ lies at origin and $-3Q$ at $x = a$. Find points on the x-axis where $V = 0$

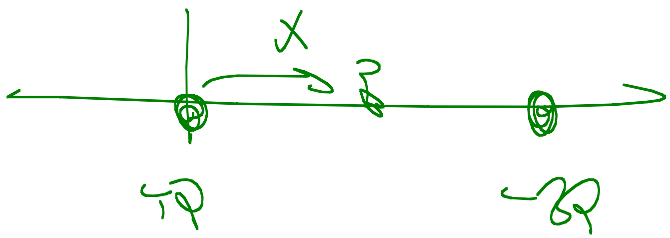
$$V = k \sum \frac{q_i}{r_i}$$



$$0 = k\left(\frac{Q}{x} - \frac{3Q}{(x+a)}\right) \qquad Q(x+a) = 3Qx$$

$$x = a/2$$

2nd case



$$V = 0 = k\left\{\frac{Q}{x} - \frac{3Q}{(a-x)}\right\} \Longrightarrow x = a/4$$

22.70 A uranium nucleus (mass 238 u, charge +92e)

Decay emit α particle (mass 4u charge +2e)

Leaves Thorium nucleus (234 u, +90 e)

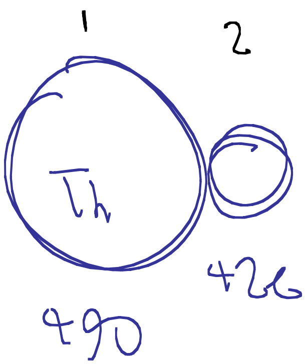
Assume

fm = 10^{-15} m

Treating them as points charges. Find speeds when far apart.

Conservation of energy   Pot'l E → Kinetic E

$$U \qquad\qquad\qquad K$$



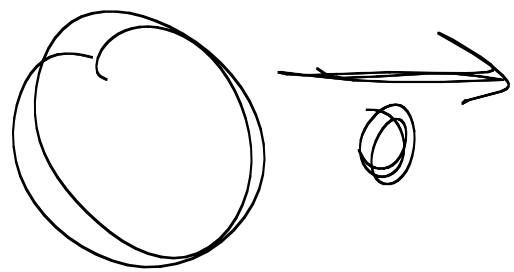
$$V = k\frac{q_1}{r} = k\frac{(90)(1.6\times10^{-19}C)}{(7.4\times10^{-15}m)}$$

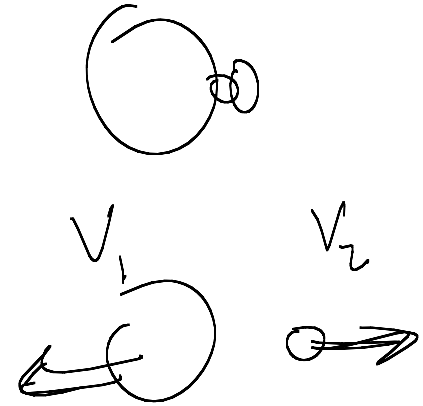
$$U = q_2 V = k\frac{q_1 q_2}{r} = k\frac{(90)(1.6\times10^{-19}C)^2(2)}{(7.4\times10^{-15}m)}$$

$$= 5.6\times10^{-12}\,J$$

$U = \frac{1}{2} m_\alpha v_\alpha^2$

Th hardly mag





Mom is conserved

$m_\alpha = 4u = 6.64\times10^{-27}$ kg

etc.

so solve for V

Final speed of α

$\boxed{v = 4.15\times10^{7}\ \frac{m}{s}}$

prob OK