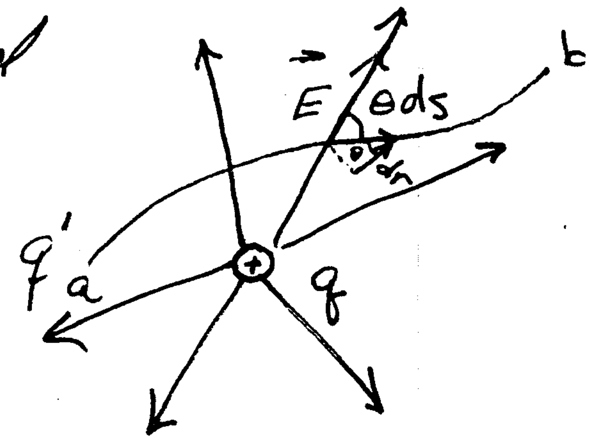
Such forces are called conservative forces and if all forces acting on a body are conservative then the <u>total mechanical energy</u> of the body is conserved

$$(KE+PE)_1 = (KE+PE)_2$$

Now for electric field

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



$$W_{a\to b} = \int_a^b F_{\parallel}\, ds$$

$$= \int_a^b q' E \cos\theta\, ds$$

But $ds\cos\theta = dr$ (Component of motion ∥ to force is radial, any displacement ⊥ to r no work is done

$$W_{a\to b} = q' \int_{r_a}^{r_b} \frac{kq}{r^2}\, dr = kqq' \int_{r_a}^{r_b} \frac{dr}{r^2}$$

$$= kqq'\left(\frac{1}{r_a} - \frac{1}{r_b}\right)$$

For a dist'n of charges

$$E_p = kq' \left(\frac{q_1}{r_1} + \frac{q_2}{r_2} + \frac{q_3}{r_3} + \dots \right)$$

$$\boxed{E_p = kq' \sum \frac{q}{r}}$$

N.B. For any path from $A \rightarrow A$
$W = q' \int E_{\parallel} ds = 0$

We call this the <u>LINE INTEGRAL</u>

$$\oint E_{\parallel} ds = 0$$

Line integral of $\vec{E}$ around any closed path in electrostatic field $= 0$

This result has some useful applications + can often draw inferences from it in manner similar to Gauss's law even w/o performing full integral

1) If $E \parallel$ to path l at all points $E_{\parallel} = E$

$$\int_a^b E_{\parallel} ds = El \,.$$

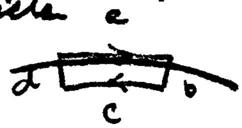
2) If $E \perp$ to path at all points $E_{\parallel} = 0$

$$\int E_{\parallel} ds = 0$$

3) If $E = 0$ at all points

$$\int E\, ds = 0$$

Dir of field of conductor



$$\int E_{\parallel}\, ds = 0$$

$E = 0$ in conductor

$$\Rightarrow \int_{bcd} E_{\parallel}\, ds = 0 \text{ sides}$$

Now $\int E_{\parallel}\, ds = 0$ around path

$$\Rightarrow \int E_{\parallel}\, ds = 0 \text{ for } a,$$

If $E \neq 0$ then E must be $\perp$ to a at all points $\Rightarrow$ <u>radial field</u>.

<u>ELECTRICAL POTENTIAL</u>

We've discussed the concept of electrical field = Force per unit charge. Useful to define similar concept for electrical potential energy $\Rightarrow$ potential energy per unit charge / <u>POTENTIAL</u>

$$\boxed{V = \frac{PE}{q'}}$$

Scalar quantity
units
$1\ J\ C^{-1} = $ VOLT