ELECTRIC POTENTIAL

When we talk about force and displacement, we must consider the WORK done against a force

$$W = \int F_{\parallel}\, ds$$

If we move a charge in an electric field we have a force $\vec{F} = q\vec{E}$ and a displacement. When we make a motion from point $a \to b$ we do work

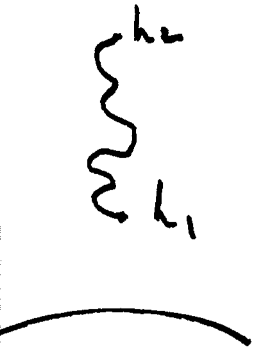
$$W = \int_a^b F_{\parallel}\, ds$$

This is a "line integral" along the path from $a \to b$. If, for example we talk about pushing a heavy crate from one part of campus to another the work W depends very definitely upon the path we take.

e.g. we push a big crate from TLH 107 to the HL. Working against friction the work done depends upon the path taken. In this case

$$F_k = \mu_k N \qquad W = F_{\parallel} s = \mu_k N \cdot s$$

However for a certain class of forces the work done depends only upon the endpoints of the path. For all paths connecting points a + b ~~the~~ work is the same. Gravity is such a force. and we have seen that for gravity we may describe the work done in terms of a "Potential Energy" When we move a mass from one altitude to another



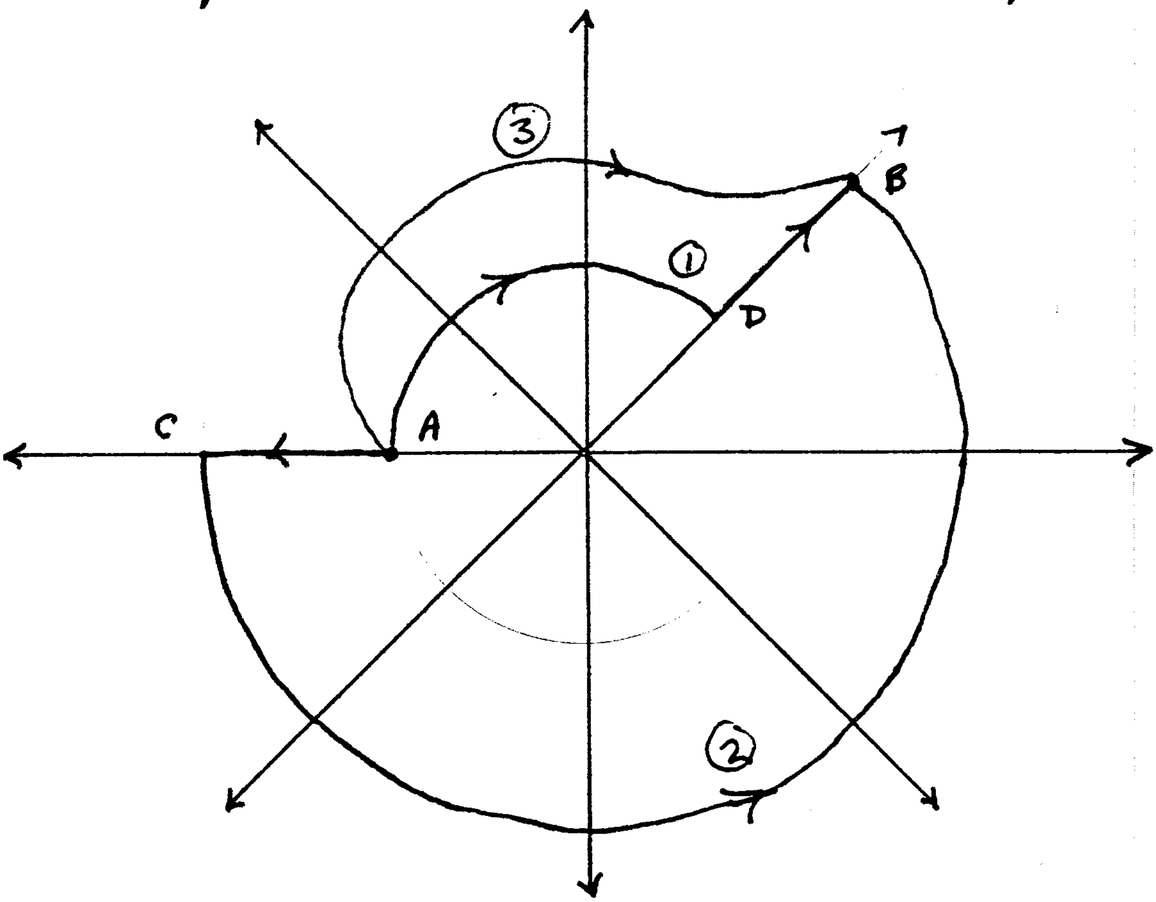
the work done does not depend on the details of the way in which we have moved the it, but only upon the height when the motion began and the height upon completion of the motion. For motions near the earth's surface

$$W = mg(h_2 - h_1)$$

And for greater motions

$$W = \Delta E_p = -\left(\frac{Gmm_e}{r_2} - \frac{Gmm_e}{r_1}\right)$$

Work done on q depends only on r at beginning and r at end of path. Work is ind. of path $\Rightarrow$ Electric force is conservative force



Path ① $W_{A\cdot B} = W_{A-D} + W_{D-B}$

$A \to D \quad \theta = \text{const} = \frac{\pi}{2}\ (90°) \qquad \cos\theta = 0$

$W_{A-D} = kqq' \int \frac{\cos\theta\, ds}{r^2} = 0$

$D \to B \quad \theta = \text{const} = 0 \qquad \cos\theta = 1$

$W_{D-B} = kqq' \int_{r_a}^{r_b} \frac{dr}{r^2} = kqq'\left(-\frac{1}{r}\right)\Big|_{r_a}^{r_b} = kqq'\left(\frac{1}{r_a} - \frac{1}{r_b}\right)$