$\boxed{\Delta KE = \text{Work done by all forces.}}$

Work done by conservative forces + Work done by non-conservative force.

$\Rightarrow \Delta KE - \text{Work done by conservative force} = \text{Work done by non-conservative force.}$

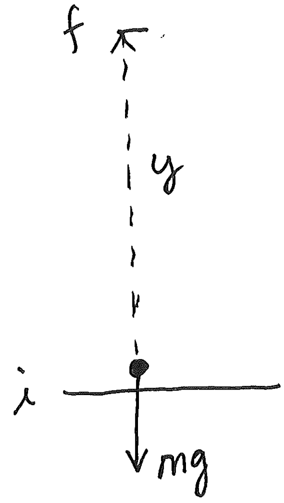
ΔPE

$\Delta PE = -\text{Work done by conservative force.}$

$\Delta KE + \Delta PE = \text{Work done by non-Conservative force}$

If no non-conservative force,

$\Delta KE + \Delta PE = 0.$



Work done by weight

$$= mg \cdot y \cdot \cos 180^\circ$$

$$= -mgy.$$

$$\Delta PE = U_f - U_i$$

$$= mgy - 0.$$

$$= mgy.$$

$$[E] = [\text{Work done}] = Nm$$

$$\left[G\frac{M_1M_2}{r^2}\right] = N$$

$$\left[G\frac{M_1M_2}{r}\right] = Nm \equiv J.$$

$$F = G\frac{m_1 m_2}{r^2}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}.$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}.$$

Force depends on E and test charge.

Potential Energy depends on both ~~test +~~ source + Test charges.

Potential is a properties of the field (source charges) only.

$$\Delta U = -\int_i^f \vec{F}_E \cdot d\vec{r}$$

$$\Delta V = \frac{\Delta U}{q} = -\int_i^f \frac{\vec{F}_E}{q} \cdot d\vec{r}$$

Test charge

$$= -\int_i^f \vec{E} \cdot d\vec{r}$$

$[V] = V$ or Volt. $\equiv J/C$.

$\vec{F}$ is conservative if

(1) $\oint \vec{F} \cdot d\vec{r} = 0$ for any loop.

OR

(2) $\nabla \times \vec{F} = 0.$

In Cartesian coordinate

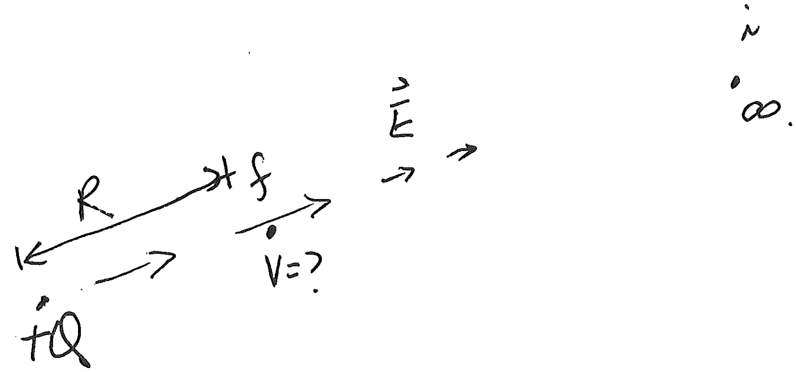
$$\nabla \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_x & F_y & F_z \end{vmatrix}$$

$\nabla \times \vec{E} = 0$

only in electrostatic case.

In future.

$\nabla \times \vec{E} \neq 0.$

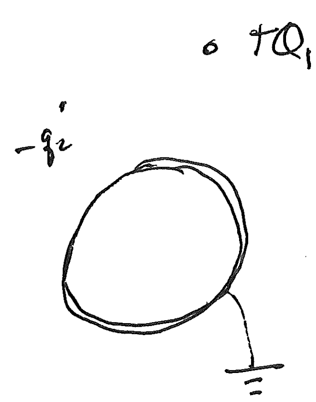


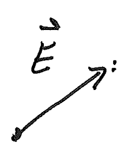
$$V - 0 = \Delta V = -\int_i^f \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\,dr$$

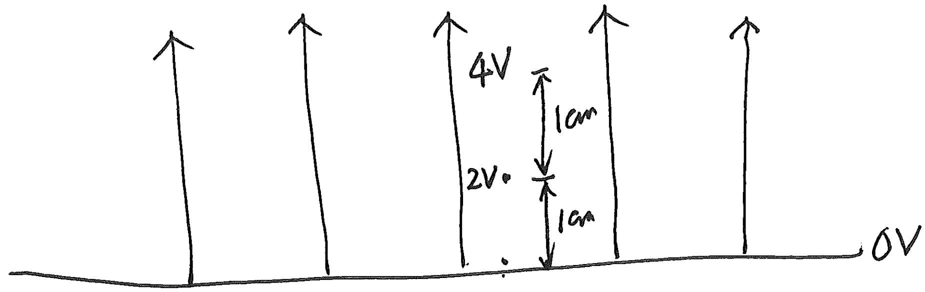
$$= -\int_\infty^R \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}\,dr.$$

$$= \left[\frac{1}{4\pi\varepsilon_0}\frac{Q}{r}\right]_\infty^R$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}.$$







~~Elective~~ Electric field is conservative

$$\Rightarrow \nabla \times \vec{E} = 0.$$

$$\nabla \times (\nabla \phi) = 0 \qquad \vec{E} = \nabla \phi.$$

$$\text{or } \vec{E} = -\nabla V$$