Electric Potential

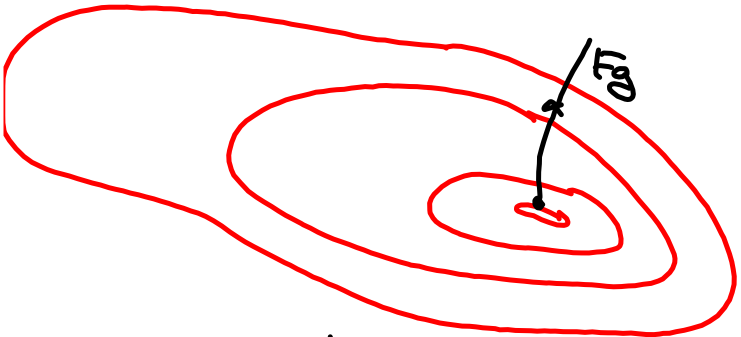
Gravitational Potential Energy and Gravitational Potential

Near surface of Earth

$PE_g = mgh$

$$V_g = \frac{PE_g}{m} = \frac{mgh}{m} = gh$$

Gravitational Potential

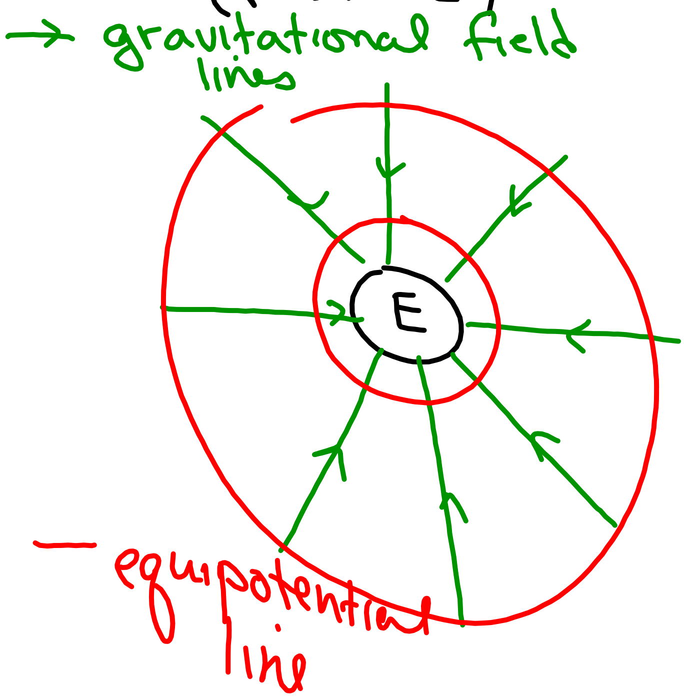


map of equipotential lines

F lines ⊥ to equipotential lines

Far from Earth

$(r >> R_E)$



$$V_g = \frac{PE_g}{m}$$

$$= \frac{\frac{-GM_E m}{r}}{m}$$

$$= -\frac{GM}{r}$$

No work done moving a mass along an equipotential line.

So. . .Electric Potential

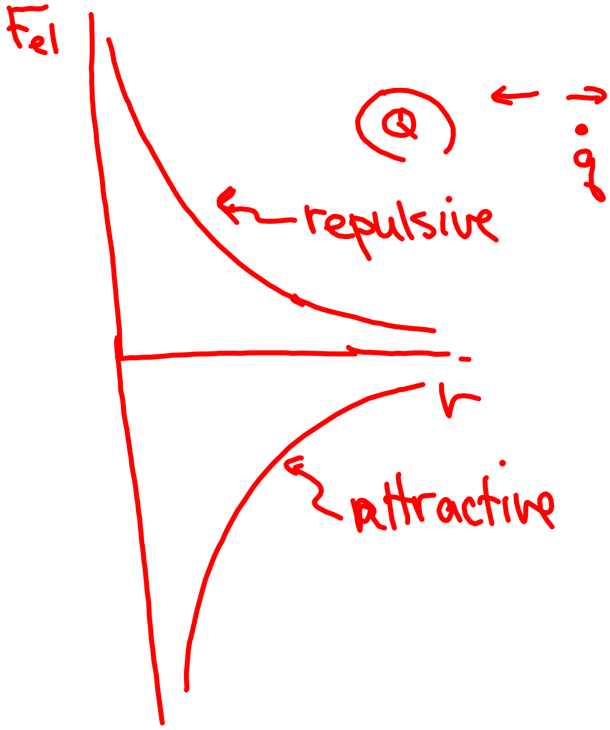
$$PE_{el} = \frac{KQq}{r}$$

$$V_{el} = \frac{PE_{el}}{q}$$

From a point charge Q

$$V_{el} = \frac{\frac{KQq}{r}}{q} = \frac{KQ}{r}$$

$$F_{el} = \frac{KQq}{r^2}$$



Units of Electric Potential

$$V(r) = \frac{PE}{q} \Rightarrow [V_{el}] = \frac{J}{C} = V \text{ (Volt)}$$

Potential Difference

$$\Delta V = \frac{PE_f}{q} - \frac{PE_i}{q} = V_f - V_i$$

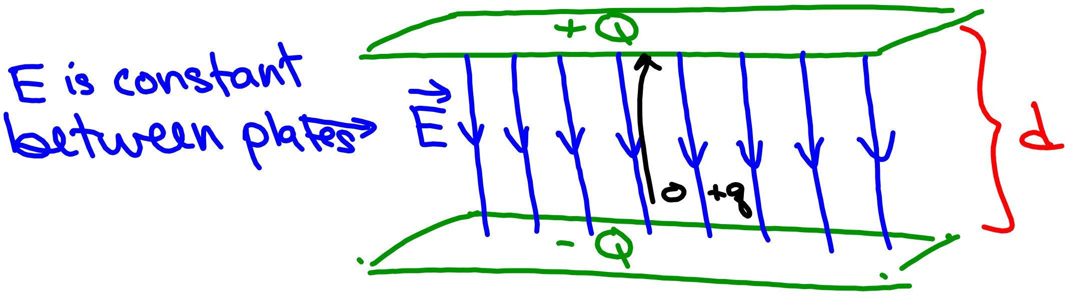
$$= V(r_2) - V(r_1)$$

$$= \frac{\Delta PE}{q}$$

$$\Downarrow$$

$$V = \frac{W}{q} \Rightarrow W = qV = q(V_2 - V_1)$$

Parallel Plates



$$W = Fd$$
$$= qEd$$

$$\rightarrow W = qV$$
$$qEd = qV$$
$$V = Ed$$

The electron-volt - a unit of energy

$$1\ eV = (1.602\times10^{-19}\ \cancel{C})(1\ \frac{J}{\cancel{C}})$$
$$= 1.602\times10^{-19}\ J$$

An electron is accelerated through a potential difference of 1000 V. What is its speed?

$$W = qV$$
$$= (1e^-)(1000V)$$
$$= 1000\ eV = KE$$

So $\frac{1}{2}mv^2 = 1000(1.602\times10^{-19}\ J)$

$$\frac{1}{2}(9.11\times10^{-31}\ kg)\ v^2 = 1.602\times10^{-16}\ J$$

$$v^2 = \frac{3.204\times10^{-16}\ J}{9.11\times10^{-31}\ kg}$$

$$v = 1.88\times10^{7}\ m/s$$