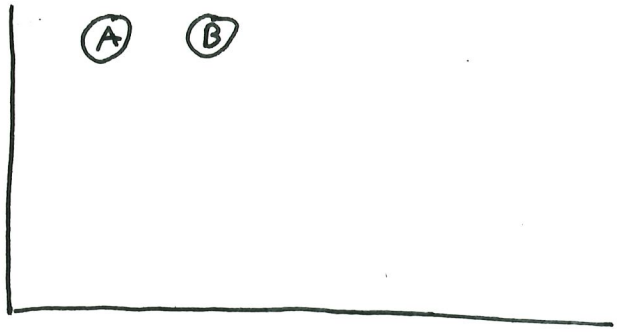
Electric Potential

To understand electric potential let us first consider gravitational potential.

Consider two balls each 5.0m above the ground, ball A has mass of 2.0 kg, ball B has mass of 5.0 kg.



Which ball has more potential energy?

B or 6, it has more mass

Which ball have more potential energy per unit of mass?

They would be the same

Gravitational potential would be given by

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

or in a non-uniform field by

$$\frac{-\frac{GM_1M_2}{r}}{M} \rightarrow -\frac{GM}{r}$$

Electric potential

Electric potential is defined as electric potential energy per unit of charge

$$\frac{\frac{kq_1q_2}{r}}{q} \rightarrow \frac{kq}{r}$$

q ← generating charge

r ← distance from generating charge

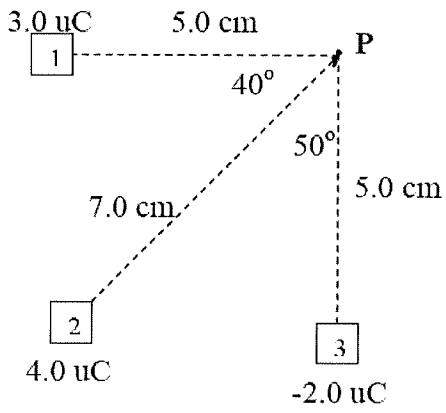
Electric potential is defined by the direction of a positive charge's motion so

positive charges move towards − potential

negative charges move towards + potential

The unit for electric potential is volt, electric potential is a scalar.

Example 1: Determine the electric potential at the point P.



① $V = \frac{kq}{r} = \frac{8.988\times10^{9}\times3\times10^{-6}}{0.050m}$

$= 539280V$

② $\frac{8.988\times10^{9}\times4\times10^{-6}}{0.070m}$

$= 514000V$

③ $\frac{8.988\times10^{9}\times-2\times10^{-6}}{0.050m}$

$= -359500V$

693700

690000V

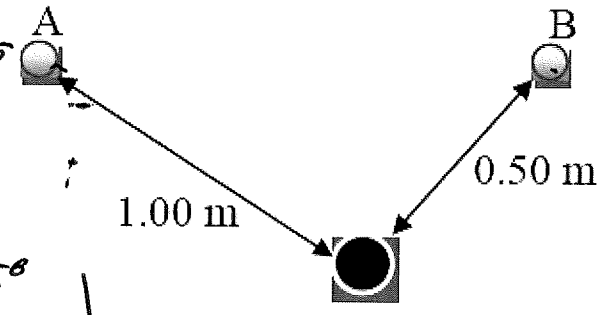
$6.9\times10^{5}V$

Potential Difference

We often want to talk about the difference in electric potential between two points. Given two points (A and B) the electric potential difference between A and B is given by:

$$\Delta V = V_B - V_A$$

What is the electric potential difference between A and B?



Pot at A: $\frac{kq}{r} = \frac{8.99 \times 10^9 \times 8 \times 10^{-6}}{1}$

$= 71904\ V$

Pot at B $= \frac{8.988 \times 10^9 \times 8 \times 10^{-6}}{0.5}$

$= 143808\ V$

$143808 - 71904$

$= 71904\ V \approx 72000\ V$

What is the electric potential difference between B and A?

$-72000\ V$

What is the work to move a 2.0 C change from A to B?

$W = \Delta E = E_{pf} - E_{pi} = \frac{kq_1q_2}{r_f} - \frac{kq_1q_2}{r_i} = q_2\left(\frac{kq_1}{r_f} - \frac{kq_1}{r_i}\right)$

$= q_2(V_f - V_i)$

$= q\Delta V$

$W = 2.0\,C \times 71904\,V = 140000\,J$

What is the work to move a 2.0 C change from B to A?

$W = q\Delta V$

$= 2.0\,C \times (-71904\,V)$

$= -140000\,J$