PHY132H1F Introduction to Physics II
Class 11 – **Outline:**

- Motion of a Particle in an Electric Field
- Electric Potential Energy
- Electric Potential: V
- Voltage: ΔV

Quick Ch. 29 reading quiz..

What are the units of *Electric potential difference*?

A. Amperes
B. Potentiometers
C. Farads
D. Volts
E. Henrys

- Electric Charge, q
- Electric Force, F
- Electric Field, E
- Electric Potential, V ←You are here
- Current and Ohm's Law: $\Delta V = IR$

Motion of a Charged Particle in an Electric Field

The electric field exerts a force

$$\vec{F}_{\text{on } q} = q\vec{E}$$

on a charged particle. If this is the only force acting on q, it causes the charged particle to accelerate with

$$\vec{a} = \frac{\vec{F}_{\text{on } q}}{m} = \frac{q}{m}\vec{E}$$

In a uniform field, the acceleration is constant:

$$a = \frac{qE}{m} = \text{constant}$$

Electric Potential Energy

The **electric potential energy** of charge q in a uniform electric field is

$$U_{\text{elec}} = U_0 + qEs$$

where s is measured from the negative plate and U_0 is the potential energy at the negative plate ($s = 0$).

It will often be convenient to choose $U_0 = 0$, but the choice has no physical consequences because it doesn't affect ΔU_{elec}, the *change* in the electric potential energy.

Only the *change* in U is significant.

The Potential Energy of Point Charges

Consider two point charges, q_1 and q_2, separated by a distance r. The electric potential energy is

$$U_{\text{elec}} = \frac{Kq_1q_2}{r} = \frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r} \quad \text{(two point charges)}$$

This is explicitly the energy of *the system*, not the energy of just q_1 or q_2.

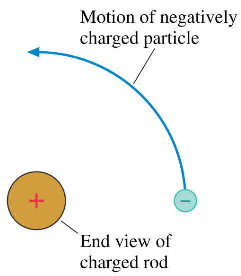
We have *arbitrarily* chosen the zero-point of potential energy to be when $r \to \infty$.

Note that the potential energy of two charged particles, according to this equation, approaches zero as $r \to \infty$.

The positive charge is the end view of a positively charged glass rod.

A negatively charged particle moves in a circular arc around the glass rod.

Is the work done on the charged particle by the rod's electric field positive, negative or zero?



A. Positive
B. Negative
C. Zero

Rank in order, from largest to smallest, the potential energies U_a to U_d of these four pairs of charges. Each + symbol represents the same amount of charge.

A. $U_a = U_b > U_c = U_d$
B. $U_b = U_d > U_a = U_c$
C. $U_a = U_c > U_b = U_d$
D. $U_d > U_c > U_b > U_a$
E. $U_d > U_b = U_c > U_a$

The Electric Potential

We define the electric potential V (or, for brevity, just the potential) as

$$V \equiv \frac{U_{q+\text{sources}}}{q}$$

Charge q is used as a probe to determine the electric potential, but the value of V is *independent of q*.

The electric potential, like the electric field, is a property of the source charges.

The unit of electric potential is the joule per coulomb, which is called the volt V:

$$1 \text{ volt} = 1 \text{ V} \equiv 1 \text{ J/C}$$

The Electric Potential Inside a Parallel-Plate Capacitor

The electric potential inside a parallel-plate capacitor is

$V = Es$ (electric potential inside a parallel-plate capacitor)

where **s is the distance from the *negative* electrode.**

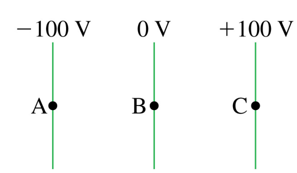
The electric potential, like the electric field, exists at *all points* inside the capacitor.

The electric potential is created by the source charges on the capacitor plates and exists whether or not charge q is inside the capacitor.

The electric potential inside a capacitor

A. is constant.
B. increases linearly from the negative to the positive plate.
C. decreases linearly from the negative to the positive plate.
D. decreases inversely with distance from the negative plate.
E. decreases inversely with the square of the distance from the negative plate.

A proton is released from rest at point B, where the potential is 0 V. Afterward, the proton



A. moves toward A with a steady speed.
B. moves toward A with an increasing speed.
C. moves toward C with a steady speed.
D. moves toward C with an increasing speed.
E. remains at rest at B.

Before Next Class:

•Try the suggested end-of-chapter problems for Chapter 29, posted on the Materials part of the web-site.

• Please finish reading Chapter 29 on Electric Potential before Monday's class. Also please look at the first 3 sections of Chapter 30, which starts in on circuits and DC batteries!

•In Practicals on Friday you will be lighting up little bulbs with your own DC battery.

See you Monday!