PART 4

ELECTRICITY AND MAGNETISM

Electric Fields

Gauss's Law

Electric Potential

Capacitance and Dielectrics

Current and Resistance

Direct-Current Circuits

Magnetic Fields

Sources of the Magnetic Field

Faraday's Law

Inductance

Alternating-Current Circuits

Electromagnetic Waves

Name: S.Betul Polat

Course Name: Physics

Group: COM-18

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Beside from my lecturer, I like to thank my other students for their effort.

Completing their report and for carrying the spirit of solidarity.

We, the students, believe that we will be successful citizens and educators if we receive the necessary education to guarantee our future.

In order to accomplish some things, it is necessary to work hard and make efforts.

We need an environment where we can work hard to survive the challenges and go on new and bright days, and we need supporters who trust us.

But success starts with self-confidence, so first of all thanks to our family and friends and of course our teachers.

INTRODUCTION

In this universe we live in, there are structures of things around us and many science-based formations we cannot see.

For example, I would like to talk briefly about Physics, such as electricity, light, sound, magnetic formations, and most importantly,

the structure and formations of atoms. We have a lot to learn from physics in our lives.

The rules of physics have a great place in our normal life.

Weight, gravity, force, distance, speed, height, electronic light, and so on, these are part of physics,

and a lot of inventions about them are also available on the internet.

p a r t 4 - Electricity and Magnetism
Electric Fields

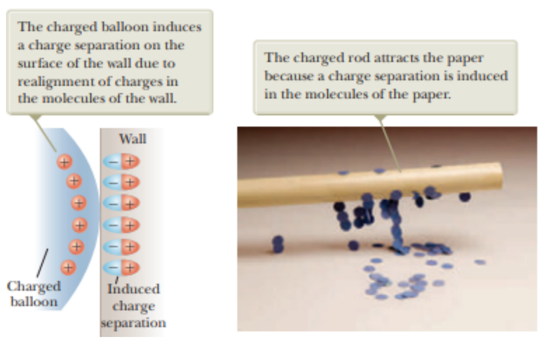
Charging Objects by Induction

There are many ways to charge an object in Physics, one of these methods is called as induction.

The situation is as follows, the charged object is brought next to the neutral conductor, but that conductor is not touched.

Electrical conductors are materials in which some of the electrons are free electrons that are not bound to atoms and can move relatively freely through the material;

electrical insulators are materials in which all electrons are bound to atoms and cannot move freely through the material.



Coulomb's Law

The coulombs are briefly expressed as the magnitude of the electrostatic attraction or thrust force between the two points is directly proportional to the magnitude of the charges and inversely proportional to the square of the distance between them.

From experimental observations, they find that the magnitude of the electric force (sometimes called the Coulomb force) between two point charges is given by Coulomb's law.

$$Fe = \frac{ke|q1||q2|}{r^2}$$

$$ke = 8.9876x10^9 N.m2/C2$$

Example 23.2 **Find the Resultant Force**

Consider three point charges located at the corners of a right triangle as shown in Figure 23.7, where $q_1 = q_3 = 5.00\ \mu C$, $q_2 = -2.00\ \mu C$, and $a = 0.100$ m. Find the resultant force exerted on q_3.

$$F = ke\frac{|q1||q2|}{a^2}$$

$$= F_1 3 = \frac{8,9x10^9.25x10^-1}{\sqrt{2}x10^-1^2} = 11,125N.r_1 2$$

Gauss's Law

Electric Flux

From the SI units of E and A, we see that FE has units of newton meters squared per coulomb (N . m2/C). Electric flux is proportional to the number of electric field lines penetrating some surface.

If the surface under consideration is not perpendicular to the field, the flux through it must be less than that given by

Example 24.1 **Flux Through a Cube**

Consider a uniform electric field $\vec{\mathbf{E}}$ oriented in the x direction in empty space. A cube of edge length ℓ is placed in the field, oriented as shown in Figure 24.5. Find the net electric flux through the surface of the cube.

$$Fe = El^2.cos180 = -El^2$$

$$F_e 2 = El^2.cos0 = El^2$$

$$Fe1 + Fe_2 = El^2 - El^2 = 0$$

chapter 25 - Electric Potential

Electric Potential and Potential Difference

When a charge q is placed in an electric field E created by some source charge distribution, the particle in a field model tells us that there is an electric force q E acting on the charge.

This force is conservative because the force between charges described by Coulomb's law is conservative.

If the charge is free to move, it will do so in response to the electric force.

Therefore, the electric field will be doing work on the charge.

This work is internal to the system.

This situation is similar to that in a gravitational system: When an object is released near the surface of the Earth, the gravitational force does work on the object.

Change in potential energy is :

$$\Delta U = -q \int_{Ⓐ}^{Ⓑ} \vec{\mathbf{E}} \cdot d\vec{\mathbf{s}}$$

electric potential is :

$$V = \frac{U}{q}$$

Because electric potential is a measure of potential energy per unit charge, the SI unit of both electric potential and potential difference is joules per coulomb, which is defined as a volt (V):

$$1V = \frac{1J}{C}$$

Potential Difference in a Uniform Electric Field

The formula for calculating the electric potential difference is:

V = Ed, V is expressed as volts, that is the potential difference and E is the electric field

Example 25.2 **Motion of a Proton in a Uniform Electric Field**

A proton is released from rest at point Ⓐ in a uniform electric field that has a magnitude of 8.0×10^4 V/m (Fig. 25.6). The proton undergoes a displacement of magnitude $d = 0.50$ m to point Ⓑ in the direction of $\vec{\mathbf{E}}$. Find the speed of the proton after completing the displacement.

$$E = 8x10^4 V/m$$

$$\frac{1}{2mv^2} = qV$$

$$Ki + Ui = K_f + U_f$$

$$0 + qV_i = \frac{1}{2mV_f^2 + qV_f}$$

$$V = \sqrt{2gV/m}$$

As shown in Figure 25.10a, a charge $q_1 = 2.00\ \mu$C is located at the origin and a charge $q_2 = -6.00\ \mu$C is located at (0, 3.00) m.

(A) Find the total electric potential due to these charges at the point P, whose coordinates are (4.00, 0) m.

$$V_p = k_e(\frac{q_1}{q_2} + \frac{q_2}{r_2})$$

$$V_p = (8.988x10^9 N.m^2/C^2)(\frac{2.00x10^-6C}{4.00m} + \frac{-6.00x10^-6C}{5.00m} = -6.29x10^3 V)$$

c h a p t e r 26 - Capacitance and Dielectrics

The capacitance C of a capacitor is defined as the ratio of the magnitude of the charge

on either conductor to the magnitude of the potential difference between the conductors:

Calculating Capacitance

$$C = \frac{Q}{\Delta V}, V = V_b - V_a$$

$$K_e = \frac{1}{4}\pi E_0$$

Example 26.1 **The Cylindrical Capacitor**

A solid cylindrical conductor of radius a and charge Q is coaxial with a cylindrical shell of negligible thickness, radius $b > a$, and charge $-Q$ (Fig. 26.4a). Find the capacitance of this cylindrical capacitor if its length is ℓ.

$$E.A = \frac{Q}{E_0}$$

$$E.2\pi rl.E_0 = \frac{l}{2\pi rlE_0} = \frac{l}{2k_e ln(b/a)}$$

Combinations of Capacitors

When capacitors are connected in series, the magnitude of charge Q on each capacitor is same.

The potential difference across C1 and C2 is different i.e., V1 and V2.

The ratio Q/V is called as the equivalent capacitance C between point a and b.

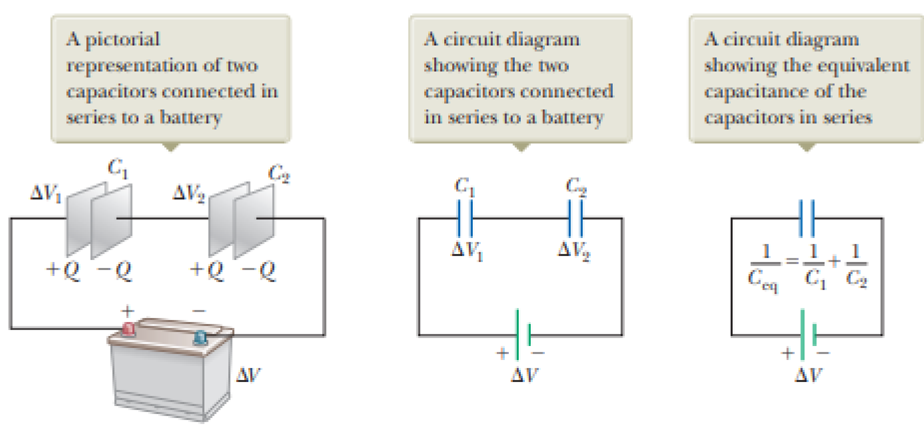
$$C = \frac{Q}{\Delta V} = Q = CV$$

$$Ceq = ?$$

$$\Delta V = \Delta V_1 = \Delta V_2$$

$$Ceq = \frac{C_1.\Delta V + c_2 \Delta V_2}{\Delta V}$$

$$Ceq = C_1 + C_2$$



Example 26.3 **Equivalent Capacitance**

Find the equivalent capacitance between *a* and *b* for the combination of capacitors shown in Figure 26.9a. All capacitances are in microfarads.

$$\frac{1}{C_eq} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{4.0} + \frac{1}{4.0}$$
$$C_eq = 2.0$$

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chapter- 27 Current and Resistance

Electric Current

Electric current is a flow of electrons or electric charge in a given circuit and carried negative or positive charged electrons.

$$I_avg = \frac{\Delta Q}{\Delta t}, I = \frac{dq}{dt}$$

$$V = \delta IR$$

$$1A = 1C/s$$

Example 27.1 **Drift Speed in a Copper Wire**

The 12-gauge copper wire in a typical residential building has a cross-sectional area of 3.31×10^{-6} m^2. It carries a constant current of 10.0 A. What is the drift speed of the electrons in the wire? Assume each copper atom contributes one free electron to the current. The density of copper is 8.92 g/cm^3.

$$I = n.A.V_1.q$$

$$V_d = \frac{I}{n.Aq} =$$

$$n = \frac{N_A}{V} = 6x10^23$$
$$V_d = 2.23x10^-4m/s$$

27.2 Resistance

It helps us to measure the current flow in an electrical circuit. Resistance is measured in ohms.

$$R = \frac{V}{I}$$

$$\Delta V = El$$

$$1\Omega = 1V/A$$

Example 27.4 **Power in an Electric Heater**

An electric heater is constructed by applying a potential difference of 120 V across a Nichrome wire that has a total resistance of 8.00 Ω. Find the current carried by the wire and the power rating of the heater.

$$I = \frac{\Delta V}{R} =$$

$$\frac{120V}{8.00\Omega} = 15.0A$$

$$P = I^2R = (15.0A)^2(8.00\Omega) = 1.80kW$$

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c h a p t e r - 28 Direct-Current Circuits

28.1 Electromotive Force

ElectroMotive force can be described as 'emf' or 'E' means energy per unit, its can be electric generator or a battery

The emf e of a battery is the maximum possible voltage the battery can provide between its terminals.

$$\Delta V = IR = E - Ir$$

$$E = I(R + r)$$

$$I = \frac{E}{R + r}$$

$$P = I.\Delta V$$

$$P = I^2(R + r)$$

Example 28.1 **Terminal Voltage of a Battery**

A battery has an emf of 12.0 V and an internal resistance of 0.050 0 Ω. Its terminals are connected to a load resistance of 3.00 Ω.

$$I = \frac{E}{R + r} = \frac{12.0V}{3\Omega + 0.05\Omega} = 3.95A$$

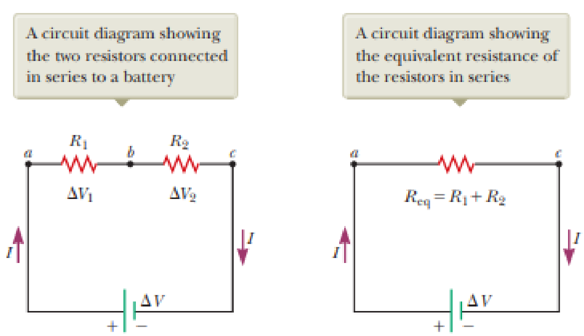
$$\Delta V = E - Ir = 12.0V - (3.93A)(0.05\Omega) = 11.8V$$

28.2 Resistors in Series and Parallel

$$I = I_1 = I_2$$

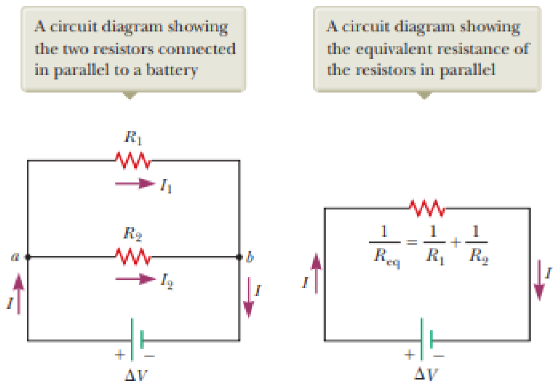
Resistors in series:

$$R_eq = R_1 + R_2 + R_3 + ...$$



Resistors in parallel:

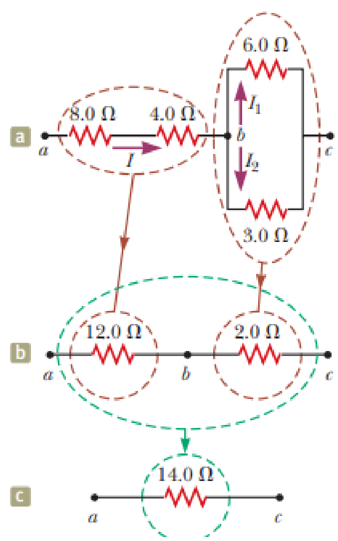
$$R_eq = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$



Example 28.4 Find the Equivalent Resistance

Four resistors are connected as shown in Figure 28.10a.

(A) Find the equivalent resistance between points *a* and *c*.



$$R_eq = 8\Omega + 4\Omega = 12\Omega$$

$$\frac{1}{R_eq} = \frac{1}{6\Omega} + \frac{1}{3\Omega} = \frac{3}{6\Omega} = 2\Omega$$
$$R_eq = 12\Omega + 2\Omega = 14\Omega$$