

Additional Topics for Semester Exam

Electricity

Electrical Charge is a natural characteristic of the particles that make up atoms.

Electrons are among the elementary particles called leptons. They are, as far as we know, not made of anything smaller.

Protons are Hadrons and are made up of smaller particles called quarks. In the case of a proton, they consist of two up quarks and one down quark.

The other major particle in an atom is the neutron which is electrically neutral. Neutrons are also hadrons and are made up of quarks. In the case of a neutron, there are two down quarks and one up quark,

Every electron has an electrical charge of -1 .

Every proton has an electrical charge of $+1$.

Every neutron is electrically neutral even though the quarks that combine to make a neutron are not neutral.

Protons and neutrons are found in the nuclei of atoms and are not involved directly in ordinary electrical processes.

Electrons are found in the electron shells on the outside of atoms and are the particles responsible for most electrical phenomena.

Static electricity is most commonly the result of friction, that is, the rubbing of one material against another.

An object, or even an atom, is charged when electrons are added to it or removed.

An object with an excess of electrons is negatively charged and an object from which electrons have been removed has a positive charge.

The size of the charge is directly proportional to the number of excess or missing electrons.

When two objects are rubbed together, the one with a greater “electron affinity” is the one that acquires electrons and becomes negatively charged. The object that loses electrons becomes positively charged.

Opposite charges attract and like charges repel.

The size of the electrical force between charged objects is proportional to each of the charges and inversely proportional to the square of the distance between the charges.

$$F_e = k \frac{q_1 q_2}{R^2}$$

Electrical potential energy and Electrical potential (voltage) are produced in ways analogous to the way mechanical potential energy is produced.

The work done in separating charges is available as electrical potential energy and when this energy is measured in terms of how much energy is available for each unit of charge, the quantity is called electrical potential or voltage.

The unit for electrical charge is the Coulomb (C). The unit for electrical potential is the joule/coulomb (j/C).

Batteries use a chemical reaction to “pump” electrons from one terminal of the battery to the other producing an electrical potential.

When the electrons are provided with a path outside the battery to return to the other terminal, a current is produced and the energy of the electrons is released to the device through which the current flows.

Current is measured in Amperes (C/s)

Resistance converts electrical energy to heat. Resistance, in addition, will reduce the current produced by a voltage.

Resistance is measured in ohms (Ω).

Ohm's Law states the relation among voltage, current and resistance:

$$V = IR$$

Where V is voltage in volts, I is current in amps and R is resistance in ohms.

Incandescent light bulbs produce light using resistance. The resistance of the filament produces heat which causes the filament to glow.

Series circuits are circuits in which all components are arranged so that any current that flows through one component must flow through the other components.

Parallel circuits are circuits in which the components are arranged so that the current that flows through each component (other than the power source) does not flow through the others.

The overall resistance of a series circuit is the sum of the resistances of the components.

The overall resistance of a parallel circuit is the reciprocal of the sum of the reciprocals of the components.

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$$

This just means to add up the reciprocals and then take the reciprocal of the result.

The power generated by an electrical component is equal to the voltage (V) across it times the current (I) through it.

$$P = VI$$