Electricity, Waves & Quantum Physics Definitions

Electric current is the net rate of flow of charged particles. [The unit is amperes (A) where 1 A = 1 Cs^{-1}]

One coulomb is the amount of charge which flows past a point in 1 second when there is a current of 1 A.

Elementary charge *e* is the charge carried by one proton.

Kirchhoff's First Law: The sum of the currents entering any junction in a circuit is equal to the sum of the currents leaving the junction.

Mean drift velocity is the average displacement per second of charged particles along the length of a conductor.

Potential difference (p.d.) is the energy transferred per unit charge when electrical energy is converted into another form of energy.

Electromotive force (e.m.f.) is the energy transferred per unit charge when another form of energy is converted into electrical energy.

1 volt is 1 joule per coulomb.

Resistance of a component is the potential difference across the component divided by the current passing through it.

Ohm's Law: The electric current through a conductor is proportional to the potential difference across it, provided physical conditions such as temperature remain constant.

Resistivity is the product of the resistance and the cross-sectional area of a wire divided by its length.

Power is the rate of energy transfer. It can be found from $P = IV$ or $P = I^2R$ or $P = V^2/R$

1 kilowatt-hour is the energy transferred in one hour by a 1000 W device and is equal to 3.6 MJ.

Kirchhoff's Second Law: The sum of the e.m.f.s around any loop in a circuit is equal to the sum of the p.d.s around the loop.

A potential divider is used to reduce the output voltage of an e.m.f. The output voltage is shared between two resisters in proportion to their resistance.

In a **longitudinal wave** the medium oscillates in a direction parallel to the direction of energy transfer.

In a **transverse wave** the medium oscillates in a direction perpendicular to the direction of energy transfer.

Displacement is the distance of a point from the equilibrium position.

Amplitude is the maximum displacement from the equilibrium position.

Wavelength is the distance from any point on a wave to the next identical point with the same phase.

Period is the time taken for one complete oscillation.

Frequency is the number of oscillations per unit time.

Wave speed is the distance travelled by the wave per unit time.

The **intensity** of a wave is the energy transmitted per unit area per unit time at right angles to the direction of the velocity. ie: intensity = power/cross-sectional area. **Intensity α amplitude^2**

A **Polarised wave** oscillates in only one direction which is perpendicular to the direction of energy transfer. It must be a transverse wave.

Path difference is the difference in the distances travelled by two waves from coherent sources at a particular point.

Phase difference ϕ (of two points on a wave) is the difference by which the oscillation at one point on a wave leads or lags that at another point on the wave as a fraction of the wave length expressed as an angle in degrees or radians.

Phase difference ϕ (of two different waves) is the difference by which the oscillation of one wave leads or lags that of another wave at a particular point as a fraction of the wave length expressed as an angle in degrees or radians.

Refractive index $n = \frac{speed\ of\ light\ in\ a\ vacuum}{speed\ of\ light\ in\ the\ medium} = \frac{c}{v}$

At a boundary: $n \sin\theta$ = constant or $\boldsymbol{n_1 \sin\theta_1 = n_2 \sin\theta_2}$

Critical angle C is the angle of incidence that gives an angle of refraction of 90°. $\sin C = 1/n$

The **principle of superposition of waves**: When two or more waves meet at a point, the resultant displacement is the sum of the displacements of the individual waves.

Interference is the superposition of two coherent waves with the resultant displacement equal to the sum of the individual displacements.

Diffraction is the spreading out of wave paths when a wave passes through a gap or around an obstacle.

Coherent waves have a constant phase difference.

A **progressive** wave caries energy through a medium or vacuum as a result of oscillations.
A **stationary** wave is an oscillation in which energy is trapped in fixed positions.

A **node** is a point on a stationary wave that always has zero amplitude.
An **antinode** is a point on a stationary wave that has maximum amplitude.
Distance between adjacent nodes is $\frac{1}{2}\lambda$

The **fundamental mode** of vibration is the stationary wave with a single antinode. It is the minimum frequency of a standing wave for a given system.

Harmonics are whole number multiples of the fundamental frequency of a stationary wave.

A **photon** is a quantum of energy of electromagnetic radiation.

One electron volt (1 eV) is the energy transferred when an electron is accelerated through a potential difference of one volt. (So 1 eV = 1.6×10^{-19} J)

The **photoelectric effect** is the emission of electrons from the surface of a metal when photons with sufficient energy strike it.

The **work function** ϕ is the <u>minimum</u> energy required to release an electron from the surface of the metal.

The **threshold frequency** f_0 is the lowest frequency of electromagnetic radiation that will cause the emission of photoelectrons from the surface of a metal. $f_0 = \phi/h$