Advanced Higher Physics

Electromagnetism

Study Guide

3.1 Fields

- ❑ 1 State Coulomb's Law, $F \propto \frac{1}{r^2}$ and $F \propto (Q_1 Q_2)$
- ❑ 2 Carry out calculations using $F = \frac{Q_1 Q_2}{4\pi\varepsilon_0 r^2}$
- ❑ 3 Use Coulomb's Law and force as a vector to find the resultant force, when two or more charges are present
- ❑ 4 Explain what is meant by an Electric Field
- ❑ 5 Define *Electric Field Strength*
- ❑ 6 State the units of Electric Field Strength
- ❑ 7 Carry out calculations using $E = \frac{F}{Q}$
- ❑ 8 Use the equation $E = \frac{Q}{4\pi\varepsilon_0 r^2}$ to find the electric field due to a point charge
- ❑ 9 Calculate the resultant Electric Field Strength at a point due to a number of point charges
- ❑ 10 Sketch the Electric field lines around a single point charge – positive or negative
- ❑ 11 Sketch the electric field pattern around two positive point charges or two negative point charges and around two opposite point charges
- ❑ 12 Sketch the electric field pattern in a uniform electric field
- ❑ 13 Define *Electrical Potential*
- ❑ 14 State that electric fields are conservative fields.
- ❑ 15 Use the equation $V = \frac{Q}{4\pi\varepsilon_0 r}$ to calculate potential at a point
- ❑ 16 Calculate the electrostatic potential due to a number of charges
- ❑ 17 Define *Potential Difference*
- ❑ 18 Derive the equation $E = \frac{V}{d}$ for a uniform Electric field
- ❑ 19 Describe the motion of charged particles in a uniform electric field

3.1 Fields contd

- ❑ 20 Carry out calculations to solve problems involving the motion of charged particles in uniform electric fields using
  $F = QE$ $V = Ed$ $W = QV$
- ❑ 21 Describe Millikan's experiment to find the value of e/m
- ❑ 21 Define *Electrostatic potential energy*
- ❑ 22 Define the *Electronvolt*
- ❑ 23 Convert Electronvolts to Joules

3.2 Magnetic Fields and Magnetic Induction

- ❑ 1 State that in addition to an electric field, a magnetic field exists around a moving charge.
- ❑ 2 State that a charged particle moving in a magnetic field experiences a force
- ❑ 3 Define Magnetic Induction, B
- ❑ 4 State and define the units of magnetic induction
- ❑ 5 Carry out calculations using $F = BIl\sin\theta$ for a current carrying conductor in a magnetic field
- ❑ 6 Calculate the field around a current carrying conductor using the equation $B = \frac{\mu_0 I}{2\pi r}$
- ❑ 7 Calculate $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$ for two parallel current carrying conductors
- ❑ 8 Use the equations $F = qvB$ and $F = \frac{mv^2}{r}$ to solve problems involving charged particles moving in magnetic fields
- ❑ 9 Describe and explain the *helical movement* of a charged particle in a magnetic field

3.3 Circuits

- ❑ 1 Describe how current varies with time in a CR circuit
- ❑ 2 Describe how voltage varies with time in a CR circuit
- ❑ 3 Define the time constant for a CR circuit
- ❑ 4 Determine the time constant for a CR circuit both numerically and graphically
- ❑ 5 Define capacitive reactance
- ❑ 6 Use the equations $X_c = \frac{V}{I}$ and $X_c = \frac{1}{2\pi fC}$ to solve problems
- ❑ 7 Sketch a graph showing the growth/decay of current in a dc circuit containing an inductor
- ❑ 8 Describe the principles of a method to illustrate the growth/decay of current in a dc circuit containing an inductor
- ❑ 9 State that an emf is induced across coil when the current in the coil is varied
- ❑ 10 Describe a method to determine the self-inductance of a coil
- ❑ 11 Use the equation $\varepsilon = -L\frac{dI}{dt}$ to solve problems involving back emf, inductance and rate of change of current
- ❑ 12 Explain the significance of the negative sign in the equation above
- ❑ 13 State Lenz's Law
- ❑ 14 Define the terms *Inductance* and *back EMF*
- ❑ 15 Explain how energy is stored in the magnetic field of an inductor
- ❑ 16 Carry out calculations using the equation $E = \frac{1}{2}LI^2$
- ❑ 17 Define Inductive Reactance
- ❑ 18 Describe the principles of a method to investigate the relationship between current, frequency and inductive reactance
- ❑ 19 Use the equations $X_L = \frac{V}{I}$ and $X_L = 2\pi fL$ in problems relating to inductive reactance, voltage, current, frequency and self-inductance
- ❑ 19 Describe and explain the function of an inductors in: induction cookers, electromagnetic braking, LC filters, tuned circuits etc.

3.4 Electromagnetic Radiation

- ❑ 1 State that the unification of electricity and magnetism resulted in the prediction of electromagnetic radiation
- ❑ 2 State that electromagnetic radiation exhibits wave-like properties
- ❑ 3 Describe electromagnetic radiation in terms electric and magnetic fields
- ❑ 4 Describe experiments to estimate the speed of light by determining permittivity of free space using a parallel plate capacitor and permeability of free space using a current balance
- ❑ 5 Use the equation $c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}}$ to solve problems involving the speed of light, the permittivity of free space and the permeability of free space
- ❑ 6 Explain what is meant by ferromagnetism
- ❑ 7 State that iron, nickel, cobalt and some rare earth metals exhibit ferromagnetism
- ❑ 8 Sketch the magnetic field of magnetic poles, solenoids and Earth
- ❑ 9 Compare gravitational, electrostatic, magnetic and nuclear forces in terms of strength and range.