Unit 5
Fields & forces

An understanding of the principles in this unit and in the general requirements is expected in familiar and unfamiliar situations. In examination questions where the context is beyond the content of the specification it will be fully described.

Gravitational fields

Unit	Topic	Content
5.1	The concept of a field. Gravitational field strength.	Use of lines of force to describe fields Field strength understood as a vector *Gravitational field strength:* $g = F/m$
5.2	Force between point masses.	• Measurement of G is *not* required. • Gravitational field strength in radial fields. • Inverse square law for spherically symmetric masses • $g = Gm/r^2$ • Equipotential surfaces. (The relationship $V = -Gm/r$ is *not* required.) • Application to satellite orbits.

Electric fields

Unit	Topic	Content
5.3	Electrostatic phenomena and electric charge.	• Charging by contact (friction): • There are two kinds of charge. • The electronic charge, $e = 1.6 \times 10^{-19}$ C. • The discrete nature of charge to be understood. • Measurement of charge with coulombmeter. (Details of the • meter are *not* required.)
5.4	Electric field strength.	Electric field strength defined as Force per unit charge: $E = F/Q$ *Or as Volts per metre*: $E = V/d$
5.5	Force between point charges.	Force between charged bodies given by Coulomb's law: $F = k\frac{q_1 q_2}{r^2}$ Where k = $k = \frac{1}{4\pi\varepsilon_0}$ = 9 x 10^9 Nm^2C^{-2}
5.6	Electric field strength in radial fields.	Field strength in a radial field is an inverse square law. $E = kQ/r^2$
5.7	Electric field strength in uniform fields	Equipotential surfaces Electric potential difference: $V = W/Q$ Kinetic energy of an electron: $\Delta\left(\frac{1}{2} m_e v^2\right) = e\Delta V$

Capacitors

Unit	Topic	Content
5.8	Capacitance	Definition of capacitance: $C = Q/V$ Experimental investigation of charge stored. Appreciation of the significance of the area under an I-t graph.
5.9	Capacitors in series and parallel.	Equivalent capacitance formulae: Capacitors in series: $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ Capacitors in parallel: $C_T = C_1 + C_2 + C_3$
5.10	Energy stored in a charged capacitor.	Energy stored $E = 1/2\ CV^2 = 1/2\ QV$ Energy stored represented by the area under a V-Q graph.

Magnetic fields

Unit	Topic	Content
5.11	Permanent magnets	Use of field lines to describe magnetic fields Concept of a neutral point.
5.12	Magnetic flux density	Magnitude of *B* defined by $F = BIl$. Direction of *B* given by left-hand rule. Vector nature of *B*. Experimental study of the force on a current-carrying conductor in a magnetic field.
5.13	Magnetic effect of a steady current	Magnetic field in a solenoid and near a straight wire to be investigated experimentally using a pre-calibrated Hall probe. Magnetic field near a long straight conductor: $B = \frac{\mu_0 I}{2\pi r}$ Magnetic filed inside a solenoid: $B = \mu_0 n I$

Electromagnetic induction

Unit	Topic	Content
5.14	Magnetic flux & Flux linkage.	• Magnetic flux given by $\Phi = B \times A$
5.15	Electromagnetic induction	• Experimental demonstration that a change of flux induces an emf in a circuit. • Faraday's and Lenz's laws of electromagnetic induction. • Emf as equal to rate of change of magnetic flux linkage. • Lenz's law as illustrating energy conservation.
5.15	The transformer.	• The action of a transformer explained in terms of magnetic flux linkage. • For an ideal transformer: $V_p/V_s = N_p/N_s$