Ngā Whetū Resources

Physics Year 13 (Level 8)

Summary Electricity

Summary Electric Field
(Compare with Gravity Field)

Unit	***Gravity Field***	*Concept*	***Electric Field***	**A. UNIT**
	On mass m	**Force**	On charge q	Unit of q is C
(N)	F=mg		F=qE	(N)
	Force per unit mass	Field Strength	Force per unit charge	
(Nkg^{-1})	g=F/m		E=F/q	(NC^{-1})
Field Strength generally varies throughout the field, e.g. according to the inverse square law in a radial field (global gravity field)				
		Work = Force x Distance		
	W=mgd		W=qEd	(J)
	Gravity Potential is Work per unit mass	Potential	Electric Potential is Work per unit charge **V_E=Work/q**	
	V_G=gd	Potential = Field Strength x Distance	**V_E=Ed**	(V) or (JC^{-1})
In a **Uniform Field** the field strength is constant. Hence Potential and distance are proportional.				
		Field Strength **in a Uniform Field**		
	g=V_G/d		**E=V_E/d**	(Vm^{-1})
		Note that the units for Electric Field Strength NC^{-1} and Vm^{-1} are equivalent		

Exam formula sheet:

ΔE=Vq	Work = Potential x Charge
V=Ed	Potential = Field Strength x distance

TV Tube ("Electron gun")

Hot filament emits electrons (thermionic emission). Anode has a large + voltage. The electrons are accelerated in the E-field between – filament and + anode. Those who pass through hole in anode form the electron beam.

Milikan's Experiment

Equilibrium between weight force of charged particle (down) and electric force in E-field (up).

$mg = F = qE$ thus $q = \frac{mg}{E}$. With $E = \frac{V}{d}$ this gives $q = \frac{mgd}{V}$; *q* is charge of electron

Capacitors store charge

$\boxed{Q = CV}$. *Q* is charge (C), *V* is voltage across terminals (V), *C* is capacitance (Farad).

Capacitance usually in $\mu F \rightarrow 10^{-6}$ or $nF \rightarrow 10^{-9}$ or $pF \rightarrow 10^{-12}$

Geometry of capacitance $\boxed{C = \frac{r\varepsilon_0 A}{d}}$

r is dielectric constant

ε_0 is vacuum permittivity

A is common area of plates

d is distance between plates.

Charging / Discharging a capacitor (see separate handout)

Charging: Current decays exponentially (from I_0 to zero): $\boxed{I_n = \frac{1}{e^n} I_0}$

Voltage grows exponentially (from zero to V_{cap}): $\boxed{V_n = (1 - \frac{1}{e^n}) V_{cap}}$

Discharging: Current decays exponentially (from $-I_0$ to zero): $\boxed{I_n = (1 - \frac{1}{e^n}) I_0}$

Voltage decays exponentially (from V_{cap} to zero): $\boxed{V_n = \frac{1}{e^n} V_{cap}}$

time is calculated from: $\boxed{t = n\tau}$ where τ is time constant: $\boxed{\tau = RC}$

Energy stored in capacitor: $\boxed{E_p = \frac{1}{2} CV^2} = \frac{1}{2} QV$