PHY2054 Formulas: Sheet 1

Chapter 15 (Electric forces and fields, Gauss' law)

Coulomb's Law	$\mathbf{F} = \frac{kQq}{r^2}\hat{\mathbf{r}} \equiv \frac{Qq}{4\pi\varepsilon_0 r^2}\hat{\mathbf{r}}$ (point charge) $\hat{\mathbf{r}}$ = unit vector from Q to q.
Electric field	$\mathbf{F} = q\mathbf{E}$ (general) $\mathbf{E} = \frac{kQ}{r^2}\hat{\mathbf{r}} \equiv \frac{Q}{4\pi\varepsilon_0 r^2}\hat{\mathbf{r}}$ (single point charge Q)
	$\mathbf{E} = \sum_i \frac{kq_i}{r_i^2}\hat{\mathbf{r}}_i$ (sum over point charges)
Gauss' law	$\Phi_E = \sum_i \mathbf{E}_i \cdot \mathbf{A}_i = \frac{Q_{\text{encl}}}{\varepsilon_0}$ $\Phi_E =$ "electric flux"

Chapter 16 (Electric potential, capacitors)

Work	$W = \mathbf{F}\cdot\left(\mathbf{x}_f - \mathbf{x}_i\right) = K_f - K_i = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
Conservative force	$U_f - U_i = -\mathbf{F}\cdot\left(\mathbf{x}_f - \mathbf{x}_i\right) = -\left(K_f - K_i\right) \rightarrow U_i + K_i = U_f + K_f$ (energy conservation)
Electric potential	$V = \frac{U}{q}$ (general) $V = \frac{kQ}{r} \equiv \frac{Q}{4\pi\varepsilon_0 r}$ (point charge Q)
Potential difference	$\Delta V \equiv V_f - V_i = -\mathbf{E}\cdot\left(\mathbf{x}_f - \mathbf{x}_i\right)$
Capacitors	$C = \frac{\varepsilon_0 A}{d}$ $q = CV$ $U_E = \frac{1}{2}CV^2 = \frac{q^2}{2C}$ (energy) $u_E = \frac{1}{2}\varepsilon_0 E^2$ (energy density)
Capacitors (cont)	$E \rightarrow \frac{E}{\kappa}$ $V \rightarrow \frac{V}{\kappa}$ $C \rightarrow \kappa C$ $C_{\text{eq}} = C_1 + C_2$ (parallel) $\frac{1}{C_{\text{eq}}} = \frac{1}{C_1} + \frac{1}{C_2}$ (series)

Chapter 17 – 18 (Electric current, circuits)

Current	$i \equiv \frac{\Delta q}{\Delta t}$ (basic def) $i = Aen_e v_d$ (drift velocity)
Resistance	$V = iR$ $R = \frac{\rho L}{A}$ $R_{\text{eq}} = R_1 + R_2$ (series) $\frac{1}{R_{\text{eq}}} = \frac{1}{R_1} + \frac{1}{R_2}$ (parallel)
Temp dependence	$\rho - \rho_0 = \rho_0 \alpha \left(T - T_0\right)$
RC circuits	$\tau_{RC} = RC$ $q = q_{\max}\left(1 - e^{-t/\tau_{RC}}\right)$ (charging) $q = q_{\max} e^{-t/\tau_{RC}}$ (discharging)
Circuits	(1) Current entering junction = current leaving junction (2) $\sum_i V_i = 0$ (over loop)
Power in circuit	$P = iV$ (general power eqn) $P = i^2 R$ (power lost in resistor)