# Chapter 19 Summary Bare-bones Style

i.e. stuff you need down COLD

# Electric Potential Energy

- Analogous to gravitational potential energy
- As charge moves from A to B, work is done in same way work is done in gravitational field

$$W_{AB} = mgh_A - mgh_B$$

$$W_{AB} = GPE_A - GPE_B$$

$$W_{AB} = EPE_A - EPE_B$$

# Electric Potential Difference

- It is useful to express the work per-unit-charge as "voltage"
- Analogous to heat vs. temperature.
- Units are "volts"
- $q_o$=test charge

$$W_{AB} = EPE_A - EPE_B$$

$$\frac{W_{AB}}{q_0} = \frac{EPE_A}{q_0} - \frac{EPE_B}{q_0}$$

$$V = \frac{EPE}{q_0}$$

# Electric Potential and Work

- The voltage difference between two points is the opposite of the work done per charge, moving the test charge by the from A to B
- Useful because many practical applications

$$V_B - V_A = \frac{EPE_B}{q_0} - \frac{EPE_A}{q_0} = \frac{-W_{AB}}{q_0}$$

$$VW = \frac{VEPE}{q_0} = \frac{-W_{AB}}{q_0}$$

# Work done on a charge in an electric field

- Moving a charge in an electric field from a higher to a lower potential , $\Delta V$ is negative and the work done on the charge is positive (i.e., the charge speeds up)
- $-W=q(-\Delta V)$ or simply $W = qV$
- Likewise, moving a charge in an electric field from a lower to a higher potential, the work done is negative (i.e., the charge slows down)
- $-W=q(\Delta V)$

# Electric Potential Difference Created by Point Charges

- We assume point charge and test charge are positive. Using calculus, find work done in going A-B. Then, we can find the potential of that single charge.

$$W_{AB} = \frac{kqq_0}{r_A} - \frac{kqq_0}{r_B}$$

$$\mathrm{V}W = \frac{-W_{AB}}{q_0} = \frac{kq}{r_A} - \frac{kq}{r_B}$$

$$V = \frac{kq}{r}$$

# Capacitors

- Device used to store electric charge
- Each plate has same amount of charge
- Experiments show q and V are proportional.
- Constant of proportionality is C, the capacitance and has units called farads (F).

$$q = CV$$

# Dielectrics (parallel plate capacitor)

- Insulating material in between capacitor plates
- Increase charge stored by decreasing electric field and "tension" in capacitor
- Described mathematically by dielectric constant
- Assuming charge is kept fixed
- eo is the permittivity of free space

$$\kappa = \frac{E_0}{E}$$

$$E = \frac{V}{d} = \frac{E_0}{\kappa}$$

$$E_0 = \frac{q}{\varepsilon_0 A}$$

$$q = \varepsilon_0 A E_0$$

$$q = (V\frac{\kappa}{d}\varepsilon_0)A$$

$$q = CV$$

$$C = \frac{\kappa\varepsilon_0 A}{d}$$

# Energy of Capacitor

- Because of its configuration, a capacitance can store energy.
- Dielectrics increase the amount of energy stored.

$$E = \frac{1}{2} qV$$

$$E = \frac{1}{2}(CV)V = \frac{1}{2} CV^2$$

$$E = \frac{1}{2} q\left(\frac{q}{C}\right) = \frac{1}{2}\frac{q^2}{C}$$

# Summary of Equations

$$W_{AB} = EPE_A - EPE_B$$

$$V = \frac{EPE}{q_0}$$

$$V_B - V_A = \frac{EPE_B}{q_0} - \frac{EPE_A}{q_0} = -\frac{W_{AB}}{q_0}$$

$$V = \frac{kq}{r}$$

$$W = qV$$

$$q = CV$$

$$\kappa = \frac{E_0}{E}$$

$$C = \frac{\kappa \varepsilon_0 A}{d}$$

$$E = \frac{1}{2} qV = \frac{1}{2} CV^2 = \frac{1}{2} \frac{q^2}{C}$$