Physics 2140 Exam 2 Outline

Potential Energy and Potential

- Work done by an electric field
- Electric potential energy
- Spontaneous motion = decreasing potential energy
- Potential energy of two point charges
- Arbitrary constant PE_∞
- Higher/lower PE not larger/smaller PE
- PE of a set of charges: calculate for *all* bonds
- PE of a target charge: ignore bonds between sources
- Electric potential V
- Electric potential vs electric potential *energy*
- Potential as height
- Positive targets go downhill, negative targets go uphill
- Positive sources are peaks, negative sources are pits
- Equipotential surface
- Potential can be shifted everywhere by the same amount
- Electric field is perpendicular to equipotential surface
- Electric field points downhill
- Electric field is the negative gradient of the potential
- Potential is a negative path integral of the electric field

Capacitors

- Conductors in equilibrium are at a single potential
- Capacitance $C = Q/\Delta V$
- Farads
- Energy in a capacitor
- When to use $PE = \frac{1}{2}C(\Delta V)^2$ and when to use $PE = \frac{1}{2}\frac{Q^2}{C}$
- Isolated capacitor
- Capacitors vs batteries
- Parallel plate capacitors
- Dielectric constant κ
- Electric field inside an insulator
- Electric breakdown

$$PE = k\frac{q_1 q_2}{r} + PE_\infty$$

$$PE = q_t V$$

$$\Delta PE = q_t \Delta V$$

$$V = k\frac{q_{S1}}{d_1} + k\frac{q_{S2}}{d_2} + \ldots + V_\infty$$

$$\vec{E} = -\nabla V$$

$$\Delta V = -\int \vec{E} \cdot d\vec{r}$$

$$Q = C\Delta V$$

$$C_{sphere} = \frac{R}{k}$$

$$PE_{cap} = \frac{1}{2}Q\Delta V$$

$$= \frac{1}{2}C(\Delta V)^2$$

$$= \frac{1}{2}\frac{Q^2}{C}$$

$$C_{pp} = \kappa\epsilon_0\frac{A}{d}$$

$$\epsilon_0 = \frac{1}{4\pi k}$$

$$= 8.85 \times 10^{-12}\frac{\mathrm{C}^2}{Nm^2}$$

$$E' = \frac{1}{\kappa}E$$

Current

- Batteries
- Charge carriers
- Current and Amperes
- Current flows in closed loops
- Conservation of current
- Kirchhoff's Junction Law
- Current flows downhill
- Conductance G and resistance R
- Conductivity σ and resistivity ρ
- Ohms and mhos
- Ohmic and non-ohmic devices
- Power provided by battery $P = I\Delta V$
- Power lost in resistor
- Watts
- Schematic Circuit diagrams
- Internal resistance of a real battery
- Ground
- Current is not used up by a battery
- Tally Method (ladybug)
- Kirchhoff's Loop Rule
- Resistors in series: resistances add
- Resistors in parallel: conductances add
- Identifying series and parallel resistors
- Equivalent or effective resistance
- Identifying the currents in a circuit
- "Simple loops"
- Voltmeters and ammeters

$I = G\Delta V$ and $\Delta V = IR$

$G = \sigma \dfrac{A}{L}$ and $R = \rho \dfrac{L}{A}$

$P = I\Delta V$

$P = I^2 R = (\Delta V)^2 / R$

$R_{eq,s} = R_1 + R_2 + \dots$

$G_{eq,p} = G_1 + G_2 + \dots$