PHYS1120 Exam I review

Things to remember for PHYS1110:

- algebra, trig (sin, cos, ..)
- vector math, especially vector addition
- \( \mathbf{F}_{\text{net}} = m \mathbf{a} \) problems, free-body diagrams

Ch.21 Charges and Fields

- Coulomb's Law: \( \mathbf{F} = k \frac{|q_1 q_2|}{r^2} \)
- Definition of electric field: \( \mathbf{E} = \frac{\mathbf{F}_{\text{on } q}}{q} \), \( \mathbf{F}_{\text{on } q} = q \mathbf{E} \)
- E-field due to a point charge: \( \mathbf{E} = k \frac{Q}{r^2} \) (derived from Coulomb + definition of \( \mathbf{E} \))
- E-field due to many charges: \( \mathbf{E}_{\text{tot}} = \sum_i \mathbf{E}_i = \mathbf{E}_1 + \mathbf{E}_2 + \mathbf{E}_3 + ... \)
  (fields add like vectors, not numbers)
- Know how to set up an integral: \( \mathbf{E}_{\text{tot}} = \int \mathbf{E} \), \( E_{\text{tot, x}} = \int dE_x \), \( dE = k \frac{dQ}{r^2} \),
  \( dQ = \lambda \, dx \) or \( \sigma \, dA \) or \( \rho \, dV \) depending on geometry
- Field line diagrams

Ch.22 Gauss's Law

- Electric flux: \( \Phi = \mathbf{E} \cdot \mathbf{A} \) (if \( \mathbf{E} \) constant, surface flat), \( \Phi = \int \mathbf{E} \cdot d\mathbf{a} \)
- Gauss's Law: \( \oint \mathbf{E} \cdot d\mathbf{a} = \frac{Q_{\text{enclosed}}}{\varepsilon_0} \)
- Main results for spherical, cylindrical, and planar symmetry
  \( \mathbf{E} \) inside charged spherical shell = 0
  \( \mathbf{E} \) outside charged spherical charge = same as point charge
  \( \mathbf{E} \) outside cylindrical charge distribution \( \propto \frac{1}{r} \)
  infinite plane: \( \mathbf{E} = \frac{\sigma}{2 \varepsilon_0} \)
• Metals in equilibrium:

\[ E = 0 \text{ inside metal, } q_{\text{net,inside}} = 0, \text{ qnet on surface only, } E \perp \text{ surface, } E_{\text{outside}} = \frac{\sigma}{\varepsilon_0} \]