The exam will cover Chapters 22-25 from the text. You will be allowed one 8.5 x 11 inch sheet of notes to refer to during the exam. (You may write on both sides). You will also need a calculator for the exam. You will have the entire class period to complete the exam, (Date: Mon., Feb. 16, 4:00 PM)

The following topics may be helpful in guiding you as you study for the exam:

**Chapter 22 Electric Charge**

**Coulomb’s Law: point(like) charges**
- Like charges repel, opposite charges attract
- \( F = \frac{k|q_1 q_2|}{r^2} \)
- The force acts along the line between the two charges
- When there are more than two charges, the electric force is equal to the vector sum of the electric forces from each of the other particles

**Charge is Quantized**
- Charge comes in discreet units, \( e = 1.60 \times 10^{-19} \text{ C} \)
- Electron = -e, Proton = +e, Neutron = 0

**Charge is conserved**
- The net charge in closed system never changes

**Chapter 23 Electric Fields**

**Electric Fields**
- Electric force on a test charge \( q_o \)
- \( F = q_o E \)

**Point Source Charge, Q**
- \( E = \frac{k|Q|}{r^2} \)
- Points away from positive charge and toward negative charge

**Multiple Charges**
- \( \vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \ldots \)

**Chapter 24 Gauss’ Law**

**Electric Flux, \( \Phi \)**
- \( d\Phi = \vec{E} \cdot d\vec{A} \)
- \( d\vec{A} \) is a small piece of the surface the direction is perpendicular to the surface
- Total flux through a closed surface: \( \Phi = \oint \vec{E} \cdot d\vec{A} \)

**Gauss’ Law**
- \( \oint \vec{E} \cdot d\vec{A} = \Phi = \frac{Q_{\text{enc}}}{\epsilon_0} \)

**Symmetries**
- Spherical \( E = k|Q_{\text{enc}}|/r^2 \), Direction is radial, away from positive \( Q_{\text{enc}} \), toward negative \( Q_{\text{enc}} \)
- Cylindrical (infinite line) \( E = 2k|\lambda|/r \), Direction is along the shortest distance to the line
- \( \lambda \) = charge per unit length of the line of charge
- Single Planar (infinite sheet) \( E = |\sigma|/2\epsilon_0 \), Direction is perpendicular to the surface
- \( \sigma \) = charge per unit area of the sheet of charge

**Conductors**
- \( E = 0 \) inside an isolated (no current) conductor
- All excess charge is distributed over the outside surface of the conductor.
- The net charge inside a cavity combined with the charge on the wall of the cavity is 0
Chapter 25 Electric potential  (Unit = Volt = Joule/Coulomb)

Electric Potential Energy, \( \Delta U_e = -\int F_e \cdot d\vec{s} \)

Electric Potential
\[ \Delta V = \Delta U_e/q_o = -\int \vec{E} \cdot d\vec{s} \] = change in electrical potential energy/unit test charge

Coulomb Potential of a point charge Q (or outside a spherically symmetric distribution):
\[ V = kQ/r \quad \text{as } r \to \infty , \]

Superposition:
\[ V = kQ/r_1 + kQ/r_2 + kQ/r_3 + \ldots \]

Uniform Electric Fields
\[ \Delta V = -\vec{E} \cdot \Delta \vec{r} = -\vec{E} |\Delta \vec{r}| \cos \theta \]
where \( \Delta \vec{r} \) is the displacement, and \( \theta \) is the angle between the displacement and the electric field

Equipotential Surface
Surfaces along which the potential is constant, \( \Delta V = 0 \)
Electric field lines are everywhere perpendicular to Equipotential surfaces.

Isolated, static conductors
The electric potential inside an isolated, static (no current) conductor is everywhere the same.

Motion of a test charge in an electric potential
Electrical potential energy of a test charge, \( q_o \):
\[ U_e = q_o V \]
Conservation of energy
\[ \Delta K = -\Delta U_e \quad \Delta U_e = q_o \Delta V \\
\Delta K = K_f - K_i \quad K = (1/2)mv^2 \]