Instructions: Work in groups of 2 or 3 students. Each student must complete their own copy. Be aware that this review sheet is only a sparse sample of the wide variety of problems that you are expected to be able to answer on the exam. Your best resources for studying and practicing are the homework, worksheets, and problems in the book that weren’t assigned.

1] An infinitely long thick conducting wire of radius $a$ has a uniform charge per unit length $\lambda$ on it. In addition a hollow infinite cylinder with the same axis of symmetry (with inner radius $b$, outer radius $c$, where $b > a$) is composed of nonconducting material and contains a uniform charge per unit volume $\rho$.

Find the magnitude of the electric field at a distance $r$ from the common axis. Draw a clear diagram as part of your explanation. I will expect this from you on the exam.
2 Sketch the electric field lines due to the electric dipole shown. Show eight field lines touching each charge. Also include five equipotential lines, equally spaced in potential, shown as dashed curves. Your sketch should be qualitatively correct.

3 4\mu C of charge is distributed uniformly over an arc of a circle of radius 10 cm subtending an angle of $3\pi / 2$ radians, as shown. Find the electric field at the origin in the coordinate system shown.
Three charged particles are located at the vertices of an equilateral triangle as shown in the figure.

(a) Calculate the electric potential (taking the convention $V = 0$ at “infinity” as usual) at the location of the $-4 \mu C$ charge due to the other two charges.

(b) Calculate the electric field (give $x$ and $y$ components) at the location of the $-4 \mu C$ charge due to the other two charges.

(c) Calculate the electric force (give $x$ and $y$ components) on the $-4 \mu C$ charge.

(d) Calculate the potential energy of the configuration.
A particle with charge $Q$ is located at the center of a cube of edge length $L$. In addition, six other identical charges $q$ are positioned symmetrically around $Q$ as shown in the figure. Determine the electric flux through one face of the cube.

The electric potential as a function of position in an $xyz$-coordinate system is given by $V = 2xz^3 + xyz$ where $x, y,$ and $z$ are in meters and $V$ is in volts.

(a) Find the electric field at the point $(x, y, z)$.

(b) How much work must I do to move a proton from $(0,0,0)$ to $(3,0,1)$?
(a) Find the equivalent capacitance $C_{eq}$ of the combination of capacitors between the terminals of the battery.

(b) Find the charge $Q_{2\mu F}$ on the $2\mu F$ capacitor.

A parallel plate capacitor consists of identical parallel circular plates of area 0.1 m$^2$ submerged in silicone oil (dielectric constant 2.5, breakdown strength $15\times10^6$ V/m). It is initially charged to a potential difference of $2\times10^5$ V.

(a) What is the maximum distance that the plates can be separated by that will allow a spark to jump between the plates?

(b) If the separation is as in (a), what is the capacitance of this configuration?

(c) If power supply is removed and the plate separation is tripled, by what factor does the potential energy stored in the capacitor change? (Give an answer like “Goes down by a factor of 4” or “no change”.)
\[ d\vec{E} = \frac{k \, dq}{r^2} \, \hat{r} \]

any closed surface

\[ V_B - V_A = -\oint_{A} \vec{E} \cdot d\hat{l} \]

\[ \vec{E} = -\frac{\partial V}{\partial x} \hat{i} - \frac{\partial V}{\partial y} \hat{j} - \frac{\partial V}{\partial z} \hat{k} \]

\[ dV = \frac{k \, dq}{r} \]

\[ U = k \left( \frac{q_1 q_2}{r_{12}} \right) \]

\[ Q = C \Delta V \]

\[ U = \frac{1}{2} C(\Delta V)^2 \]

\[ u_E = \frac{1}{2} \varepsilon_0 E^2 \]

\[ \vec{E} = \frac{\vec{E}_0}{\kappa} \]

\[ C = \kappa C_0 \]

\[ C = \frac{A \varepsilon_0}{d} \]

\[ e = 1.602 \times 10^{-19} \, \text{C} \]

\[ m_{\text{proton}} = 1.672 \times 10^{-27} \, \text{kg} \]

\[ m_{\text{electron}} = 9.109 \times 10^{-31} \, \text{kg} \]

\[ k = \frac{1}{4\pi \varepsilon_0} = 8.987 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \]