Worksheet 1: **Charges and the $\vec{E}$ Field**

1 Conductors & Insulators

(a) What makes an insulator different from a conductor?

(b) Can an insulator still become electrically charged? Discuss an experiment you could do to determine the answer.

(c) Two neutral metal spheres on wood stands are touching. A negatively charged rod is held directly above the top of the left sphere, not quite touching it. While the rod is there, the right sphere is moved so that the spheres no longer touch. Then the rod is withdrawn. Afterward, what is the charge state of each sphere? Use charge diagrams to explain your answer.

2 Understanding $\vec{E}$

(a) Describe, in as much detail possible, what the electric field ($\vec{E}$) is.

- What are the units of the $\vec{E}$ field?
- What is the equation that governs the $\vec{E}$ field? Units?
- What are some other examples of fields in physics? Similarities/differences?

(b) An electron is placed at the position marked by the dot. What direction is the force on the electron?
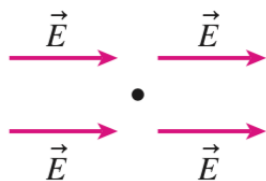
(c) An electron experiences a force of magnitude F when it is x distance away from a very long, charged wire with a linear charge density λ. If the charge density is doubled, at what distance from the wire will a proton experience a force of the same magnitude F?

(d) Two protons are 2.0 fm apart.

- What is the magnitude of the electric force on one proton due to the other proton?
- What is the magnitude of the gravitational force on one proton due to the other proton?

(e) Write the electric field at point P in component form.
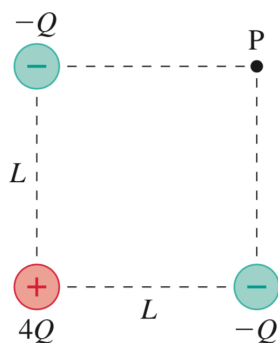
3   The Electric Dipole $\vec{p}$

(a) Write down the equations for $\vec{E}_{dipole}$ from the textbook.

(b) What happens to an electric dipole in a **uniform** electric field?

4   Charged Particle Field Interaction

An electron is at the origin at $t = 0$ with an initial velocity $\vec{v} = 2\vec{x} + 1\vec{y}$ m/s, moving through a uniform electric field $\vec{E} = 3\vec{y}$ N/C. What is the electron's position at $t = 5$ s?

Hint: Do you remember kinematics from 40A?