Name & ID ______________________________________

PH 102 / LeClair Summer II 2011

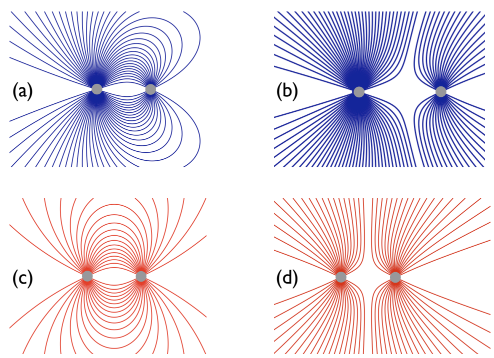
Quiz 2: Electrostatics

1. Two isolated identical conducting spheres have a charge of q and $-3q$, respectively. They are connected by a conducting wire, and after equilibrium is reached, the wire is removed (such that both spheres are again isolated). What is the charge on each sphere?

- □ q, $-3q$
- ■ $-q$, $-q$
- □ 0, $-2q$
- □ $2q$, $-2q$

When the conductors are connected with a conducting wire, the charges are perfectly mobile between the two conductors. That gives a net charge of $q+-3q=-2q$ spread out between the two conductors evenly, which means each will take $-q$.

2. Which set of electric field lines at right could represent the electric field near two charges of the *same sign*, but *different magnitudes*?



If the charges are the same sign, the field lines should repel each other. If they are different magnitudes, one charge should have more lines coming out of it than the other, and the graph should be asymmetric about the vertical axis. This leaves only **b** as a possible answer. Graphs a and c are clearly for opposite charges, since the field lines run from one to the other, and graph d is clearly symmetric, meaning the charges must be of the same magnitude.

3. A "free" electron and a "free" proton are placed in an identical electric field. Which of the following statements are true? *Check all that apply.* Note the electron mass and proton mass above.

- □ Each particle is acted on by the same electric force and has the same acceleration.
- □ The electric force on the proton is greater in magnitude than the force on the electron, but in the opposite direction.
- ■ The electric force on the proton is equal in magnitude to the force on the electron, but in the opposite direction.
- ■ The magnitude of the acceleration of the electron is greater than that of the proton.

- ☐ Both particles have the same acceleration.

Since both particles have the same magnitude of charge $|e|$, they both feel the same electric force F_e. The forces must be in opposite directions, since protons and electrons have charges of opposite sign. However, since the electron is far lighter than the proton, it feels a much larger acceleration, $a = F_e/m$

4. A point charge q is located at the center of a (non-conducting) spherical shell of radius a that has a charge $-q$ uniformly distributed on its surface. What is the electric field *for all points outside the spherical shell?*

- ■ $E = 0$
- ☐ $E = q/4\pi a^2$
- ☐ $E = k_e q/r^2$
- ☐ $E = k_e q/a^2$

Imagine a spherical surface of radius r centered on the point charge with a radius greater than that of spherical shell ($r > a$). Inside this sphere, we enclose a net charge $-q + q = 0$. Gauss's law says that the net flux through this sphere is proportional to the charge inside, so there is no flux through the sphere. Since the area of the sphere is clearly finite, $A = 4\pi r^2$, the flux $\Phi_E = EA$ can only be zero if the field E is zero. Since the radius r is arbitrary, the field anywhere outside (for $r > a$) must be zero.