UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

PH 106-4 / LeClair Fall 2008

Sample Exam 1 Questions

1. A charge of $100\,\mu$C is at the center of a cube of side 0.8 m. What is the flux through one face of the cube?

- □ $1.9 \times 10^6\,\mathrm{N \cdot m^2/C}$
- □ $3.7 \times 10^4\,\mathrm{N \cdot m^2/C}$
- □ $2.5 \times 10^12\,\mathrm{N \cdot m^2/C}$
- □ 0

2. Suppose three positively charged particles are constrained to move on a fixed circular track. If all the charges were equal, an equilibrium arrangement would obviously be a symmetrical one with the particles spaced $120°$ apart around the circle. Suppose two of the charges have equal charge q, and the equilibrium arrangement is such that these two charges are $90°$ apart rather than $120°$. What is the *relative* magnitude and sign of the third charge?

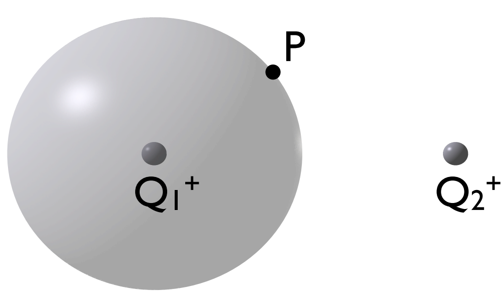
- □ larger than either q_1 or q_2 and positive
- □ smaller than either q_1 or q_2 and positive
- □ larger than either q_1 or q_2 and negative
- □ smaller than either q_1 or q_2 and negative

3. A positive charge of q and a negative charge of $-5q$ are placed a distance d apart. For reference, let us say the charges are along a horizontal line, with the positive charge on the right and the negative charge on the left. Determine one point (other than infinity) at which the total electric field is zero.

- □ to the right of the negative charge
- □ to the right of the positive charge
- □ to the right of the negative charge
- □ to the left of the negative charge

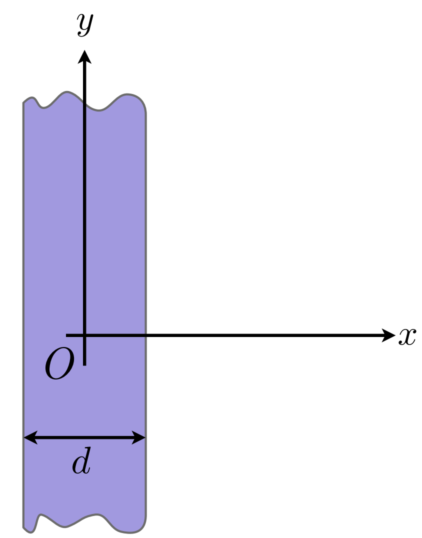
4. If the net flux through a closed surface is *zero*, the following four statements *could be true.* Which of the statements *must be true?*

- □ There are no charges inside the surface
- □ The net charge inside the surface is zero
- □ The electric field is zero everywhere on the surface
- □ The number of electric field lines entering the surface equals the number leaving the surface



5. In the figure above, a point charge $1Q^+$ is at the center of an imaginary spherical Gaussian surface and another point charge $2Q^+$ is outside of the Gaussian surface. Point P is on the surface of the sphere. Which one of the following statements is true?

- ☐ Both contribute to the net electric flux through the sphere but only $1Q^+$ contributes to the electric field at point P.
- ☐ Both charges contribute to the net electric flux through the sphere but only $2Q^+$ contributes to the electric field at point P.
- ☐ Only $1Q^+$ contributes to the net electric flux through the sphere but both charges contribute to the electric field at point P.
- ☐ Only $2Q^+$ contributes to the net electric flux through the sphere but both charges contribute to the electric field at point P.
- ☐ Only $1Q^+$ contributes to the net electric flux through the sphere and to the electric field at point P on the sphere.
- ☐ Only $2Q^+$ contributes to the net electric flux through the sphere and to the electric field at point P on the sphere.
- ☐ I don't know (this answer is worth 1/10 of full credit)



6. A slab of insulating material, infinite in two of its three dimensions, has a uniform positive charge density ρ, shown at left. Suppose an electron of charge $-e$ and mass m_e can more freely within the slab, and is released from rest at a distance x from the center. The electron will subsequently undergo simple harmonic motion; which expression gives the correct variation of frequency with ρ, e, and m_e?

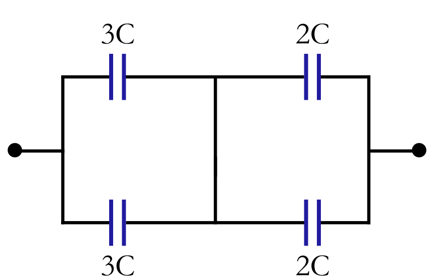
- ☐ $f \propto \sqrt{\rho e/m_e}$
- ☐ $f \propto \sqrt{\rho m_e/e}$
- ☐ $f \propto \rho m_e/e$
- ☐ $f \propto \rho e/m_e$
- ☐ $f \propto \sqrt{\rho e m_e}$

7. A sphere the size of a basketball is charged to a potential of $-1000\,\text{V}$. About how many extra electrons are on it, per cm^2 of surface?

- ☐ 4×10^3
- ☐ 5×10^7
- ☐ 8×10^{10}
- ☐ 9×10^{21}

8. A spherical balloon contains a positively charged object at its center. As the balloon is inflated to a greater volume while the charged object remains at the center, does the electric **flux** at the surface of the balloon:

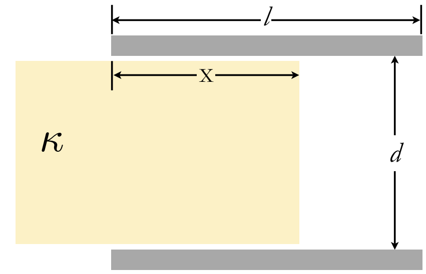
- ☐ increase
- ☐ decrease
- ☐ remain the same



9. Find the equivalent capacitance for the combination of capacitors shown at left.

- ☐ $10C$
- ☐ $1.2C$
- ☐ $2.4C$
- ☐ C

10. A capacitor is constructed from two square plates of sides l and separation d. A dielectric is inserted a distance x into the capacitor, as shown at right. In what direction is the force on the dielectric?



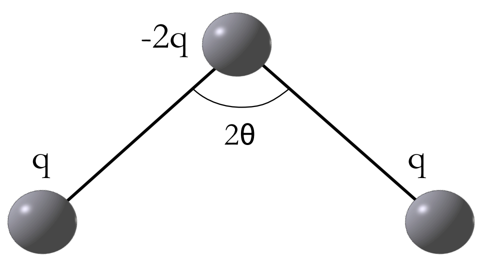
- □ up
- □ to the right
- □ to the left
- □ down
- □ there is no net force

11. Referring to the figure above, in what direction would the force be if the inserted section were a *conductor* instead of a dielectric?

- □ up
- □ to the right
- □ to the left
- □ down
- □ there is no net force

12. An electron (of charge $-e$ and mass m_e) enters a region of uniform electric field $\vec{\mathbf{E}} = 800\,\hat{\mathbf{x}}$ [N/C] with velocity $\vec{\mathbf{v}}_i = 1.5 \times 10^5\,\hat{\mathbf{x}}$ [m/s]. What is magnitude the acceleration $|\vec{\mathbf{a}}|$ of the electron due to the electric field?

- □ $-3.5 \times 10^{13}\ \left[\mathrm{m/s^2}\right]$
- □ $4.6 \times 10^{8}\ \left[\mathrm{m/s^2}\right]$
- □ $-1.4 \times 10^{14}\ \left[\mathrm{m/s^2}\right]$
- □ $6.8 \times 10^{12}\ \left[\mathrm{m/s^2}\right]$



13. In the figure at left, three point charges are connected by unbreakable strings of length d. What is the equilibrium angle 2θ?[a]

- □ 90°
- □ 180°
- □ 135°
- □ 90°

[a]Note that $\frac{d}{dx}\frac{1}{\sin x} = -\frac{\cos x}{\sin^2 x}$ and $\frac{d}{dx}\frac{1}{\cos x} = \frac{\sin x}{\cos^2 x}$.