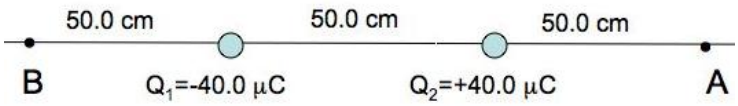
General Physics II **Exam 1 - Chs. 16,17 - Electric Fields & Potential** **Feb. 2, 2009**

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show the formulas you use, all the essential steps, and results with correct units and correct number of significant figures. Point values are given in parenthesis. For TF or MC questions, choose the best answer. Coulomb's Law constant $k = 8.988 \times 10^9$ Nm^2/C^2, permittivity of free space $\epsilon_0 = 8.854 \times 10^{-12}$ C^2/Nm^2= 8.854 pF/m, elementary charge $e = 1.602 \times 10^{-19}$ C, electron mass $m_e = 9.11 \times 10^{-31}$ kg, 1 electron-volt = 1.0 eV = 1.602×10^{-19} J.

1. (16) Two charges, $Q_1 = -40.0$ μC and $Q_2 = +40.0$ μC are arranged on the x-axis as shown. The charges produce an electric field in the surrounding region.



a) (6) Find the electric field that Q_1 produces at point A. Draw and label it it as an arrow $\vec{E}_1$ on the diagram.

b) (6) Find the electric field that Q_2 produces at point A. Draw and label it it as an arrow $\vec{E}_2$ on the diagram.

c) (4) From your results, get the net electric field at point A. Give its **magnitude** and **direction**.

2. (8) A water molecule (H_2O) floating in the air loses one electron, becoming an ion. At some instant, that lost electron is 1.0 mm from the water ion.

a) (2) The electric force between the electron and water ion is: a. attractive b. repulsive.

b) (6) What is the magnitude of the electric force between the electron and the water ion?

3. (2) Electrical conductors behave differently than electrical insulators because conductors have

a. net charge. b. free charge. c. induced charge.

4. (2) A tiny styrofoam ball is suspended on a thread. Some tests show it gets attracted to a positively charged rod, and repelled by a negatively charged rod. What can you can conclude about the tiny styrofoam ball?

a. It has a negative net charge b. It has zero net charge.
c. It has positive net charge. d. Its net charge changes when then rods are placed near it.

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5. (2) Another tiny styrofoam ball is suspended on a thread. Some tests show it gets attracted to a positively charged rod, and also attracted to a negatively charged rod. What can you can conclude about the tiny styrofoam ball?

a. It has a negative net charge b. It has zero net charge.
c. It has positive net charge. d. Its net charge changes when then rods are placed near it.

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6. (6) By rubbing fur on a piece of uncharged plastic, the plastic acquires an electric charge of $Q = -25\ \mu$C.

a) (2) During charging, the plastic

a. lost electrons b. gained electrons. c. lost protons. d. gained protons.

b) (4) How many "elementary charges" must have been transferred to or from the plastic?

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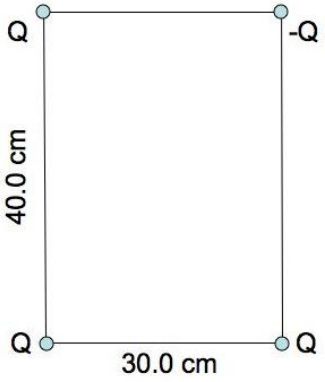
7. (10) Four charges are located at the corners of a rectangle as shown, with charge $Q = 22.0$ nC (nano-coulombs).

Using the symmetry of the situation, determine the net electric field at the center of the rectangle. Give its magnitude, and show its direction on the diagram with a vector labelled $\vec{E}_{\text{net}}$.



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8. (4) A charge $q = -1.0$ nC is instantaneously at a place where the electric field is 45 kN/C due east. What are the magnitude and direction of the electric force on this charge?

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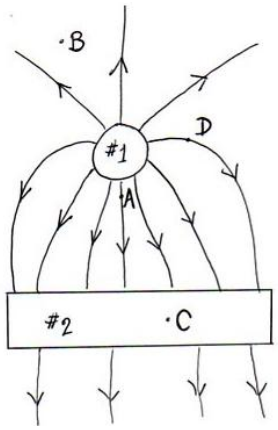
9. (10) The diagram shows the electric field lines surrounding two conductors.



a) (2) The net charge of conductor #1 is

a. negative b. zero c. positive d. unknown, no way to tell.

b) (2) The net charge of conductor #2 is

a. negative b. zero c. positive d. unknown, no way to tell.

c) (2) At which of these points is the electric field strength greatest?

a. A b. B c. C d. D e. unknown, no way to tell.

d) (2) A proton placed at point D will experience an electric force whose direction is most nearly

a. $\uparrow$ b. $\downarrow$ c. $\leftarrow$ d. $\rightarrow$

e) (2) A proton moves from D towards C. This causes the system's electric potential energy to

a. decrease. b. remain the same. c. increase. d. unknown, no way to tell.

10. (10) Questions about electric potential.

a) (2) **T F** The closer to a positively charged object, the higher the electric potential.

b) (2) **T F** On an equipotential surface, the electric field is a constant.

c) (2) **T F** Electric field lines point towards lower electric potential.

d) (2) **T F** An electron volt is the same as 1.602×10^{-19} joules.

e) (2) **T F** When equal and opposite charges move farther apart, their electric potential energy increases.

11. (12) An electron moves from point A where the potential is $V_A = +20.0$ kV to point B where the potential is $V_B = -40.0$ kV. (These potentials are caused by *other* charges.)

a) (4) What was the change of the system's electric potential energy?

b) (4) What change in kinetic energy did the electron experience? Give the result in joules.

c) (4) What change in kinetic energy did the electron experience, measured in electron-volts?

12. (4) A uniform electric field of 5.0 kN/C is produced between oppositely charged parallel plates separated by 0.50 mm. How large is the potential difference between the plates?

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13. (2) When an initially uncharged capacitor is charged up by connecting its terminals to a battery, its two electrodes acquire

a. equal charges of opposite signs.
b. unequal charges of opposite signs.
c. equal charges of the same sign.
d. unequal charges of the same sign.

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14. (2) The electric field inside a parallel plate capacitor points

a. from the positively charged plate towards the negatively charged plate.
b. from the negatively charged plate towards the positively charged plate.
c. parallel to the surfaces of the plates.

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15. (4) A capacitor is charged until the voltage difference between its plates changes is 360 V. During charging, +280 μC flows onto its positively charged plate. How large is its capacitance?

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16. (12) A capacitor has parallel metal plates of dimensions 12.0 cm $\times$ 24.0 cm, separated by an air-gap of 0.750 mm. The plates are given opposite charges of $\pm$25.0 μC.

a) (4) How large is the capacitance of this arrangement, in pF (picofarads)?

b) (4) How large is the potential difference between the plates?

c) (4) Find how much energy is stored in the capacitor.