Last Name: First Name:

Physics 102 Spring 2002: Test 1—Multiple-Choice Questions

1. Three capacitors, each of identical capacitance C, are combined in a variety of ways using copper wires. What is the minimum effective capacitance that can be found in a combination that uses all three capacitors?

   (a) $C/6$
   (b) $C/3$
   (c) $C/2$
   (d) C
   (e) $3C/2$

2. Three pithballs are suspended from threads. Up to 3 of the pithballs are charged by contact of other charged objects. It is found that pithballs 1 and 2 attract each other and pithballs 2 and 3 repel each other. From this we can conclude with certainty that

   (a) pithballs 1 and 3 carry charge of opposite sign.
   (b) pithballs 1 and 3 carry charge of same sign.
   (c) all three pithballs carry charge of same sign.
   (d) one of the pithballs carries no charge.
   (e) we need more data to reach a conclusion with certainty.

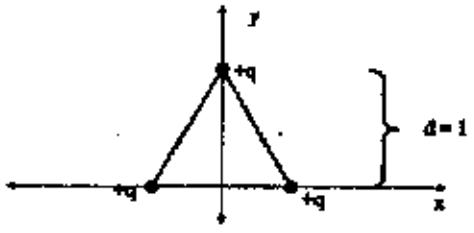
3. Call U_1 the work required to bring charges from infinitely far away and give a surface charge density σ to a conducting sphere of radius R. Call U_2 the work required to build up the same surface charge density σ on a conducting sphere with twice the radius. Which of the following is a true statement?

   (a) $U_2 = U_1/2$
   (b) $U_2 = U_1$
   (c) $U_2 = 2U_1$
   (d) $U_2 = 8U_1$
   (e) $U_2 = 16U_1$

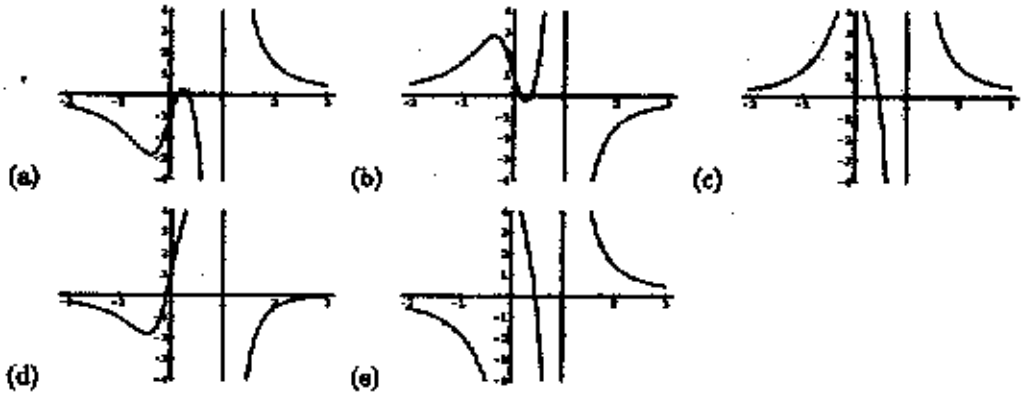
4. A parallel plate capacitor is first charged by connecting it, by means of wires and a switch, to a battery with a potential difference between its terminals of 120 V. After the capacitor is fully charged, the switch is opened. Another metal wire is now inserted between the charged plates to connect the surfaces of the two plates. What happens?

   (a) The positive and negative plates are reversed.
   (b) The electric field between the plates is reversed.
   (c) The electrostatic potential energy of the system is increased.
   (d) The electrostatic potential difference between the plates becomes zero.
   (e) None of the above.

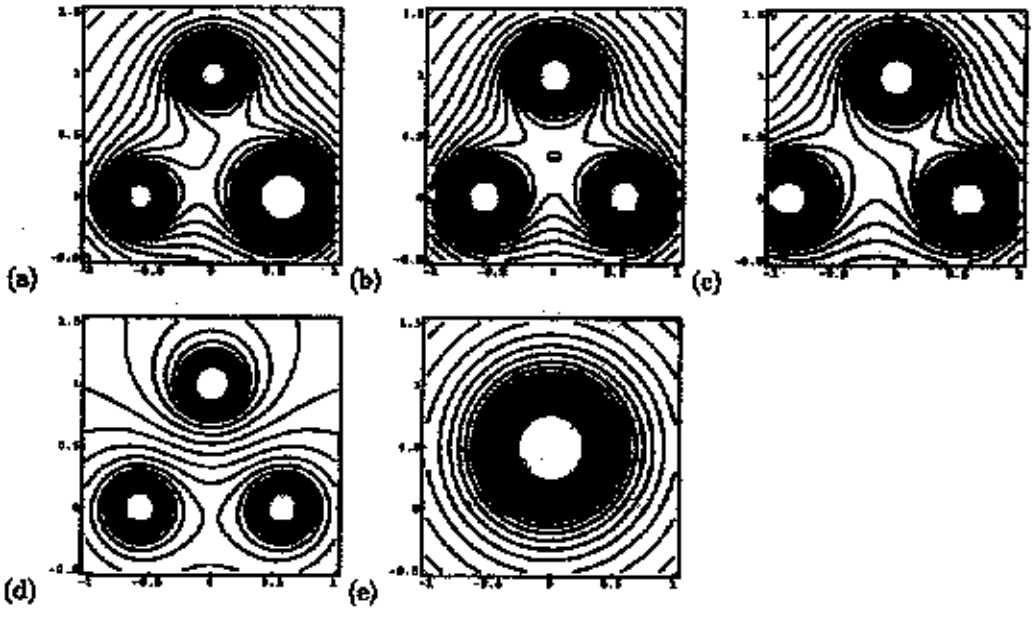
(Questions 5–6) The following two questions are concerned with the configuration of three equal positive point charges $+q$ placed at the vertices of an equilateral triangle lying in the x-y plane, as depicted to the right. The scale is set so that the altitude of the triangle is 1, in arbitrary units.



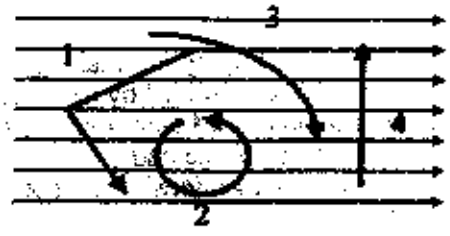
5. Which of the graphs below most accurately depicts the y-component of the electric field E_y on the y-axis due to this charge configuration?



6. Which of the graphs below most accurately depicts the equally-spaced equipotential surfaces in the plane of the triangle due to this charge configuration?



7. Consider the picture below which depicts four possible paths traced by an electron in a constant electric field directed to the right. Each path begins at the end without the arrow head and ends at the point of the arrow, and the drawing is to scale. Rank the change in electrostatic potential energy of the system for each of the paths the electron follows in order from greatest negative change to greatest positive change.



(a) 1, 2, 3, 4

(b) 1, 4, 2, 3

(c) 4, 3, 2, 1

(d) 3, 1, 2, 4

(e) 3, 2, 4, 1

8. A charge of $q = +6.0$ nC sits at the origin $(x = 0, y = 0)$. What is the ratio of the y-component of the electric field to the x-component of the electric field (that is, E_y/E_x) at the point $(x = 0.4$ m, $y = 0.3$ m)?

(a) 0.56

(b) 0.60

(c) 0.75

(d) 1.33

(e) 1.78

9. A parallel plate capacitor with capacitance C_0 is charged to a voltage V_0 by a battery. While still connected to the battery, a dielectric slab with dielectric constant κ is inserted and fills the space between the plates. Consider the following statements.

I. The charge density on the plates increases by a factor κ.

II. The electric field between the plates increases by a factor κ.

III. The energy stored in the capacitor increases by a factor κ.

Which of the above statements are true?

(a) I

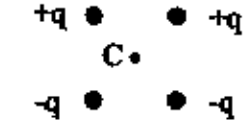
(b) I and II

(c) I and III

(d) II and III

(e) I, II and III

10. The figure below depicts four charges, two with positive charge $+q$ and two with negative charge $-q$, placed at the corners of a square. Which arrow below most accurately depicts the force on a positively charged particle at the center point C?



A. ↑ B. → C. ↓ D. ↗ E. ←