Last Name: First Name:

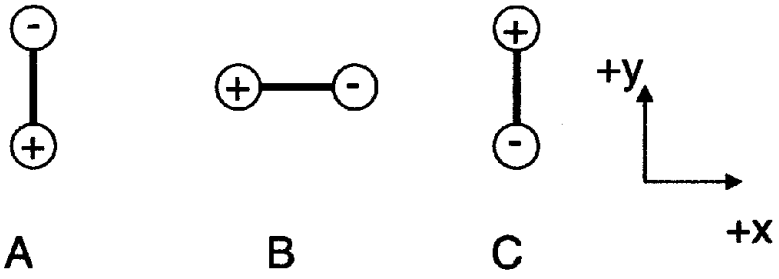
Physics 102 Spring 2003: Final — Multiple Choice Questions p.1

1. A cylindrical capacitor is constructed so that the space between the conducting cylinders is filled with an insulating fluid. The capacitor is attached to a battery so that the inner and outer conducting cylinders are held at a fixed potential difference. Then, while still connected to the battery, the fluid begins to leak out. (Oops!) Which of the following statements is (are) true after all the fluid has leaked out?

   I. The electric field in the region between the inner and outer cylinders has decreased.
   II. The potential difference between the inner and outer cylinders has decreased.
   III. The charge stored on the inner and outer cylinders has decreased.

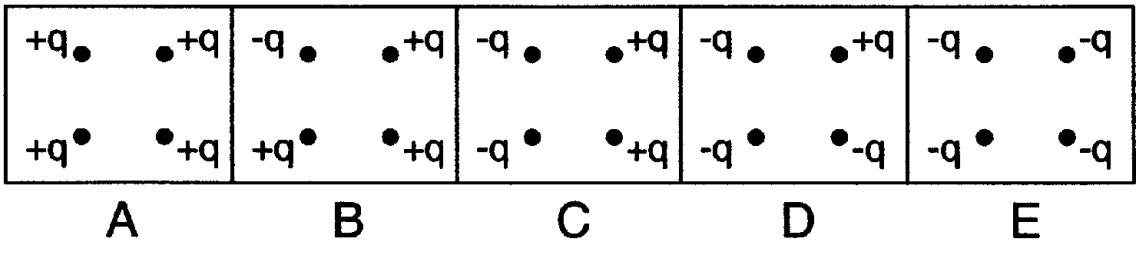
   a. Only one of these statements is true.
   b. Only I and II are true.
   c. Only II and III are true.
   d. Only I and III are true.
   e. I, II and III are all true.

2. Consider the three dipoles depicted below. If a uniform external electric field which points in the $+\hat{j}$ direction (i.e. toward the top of the page) is turned on, which dipole will experience the torque of largest magnitude and which dipole will have the greatest potential energy?

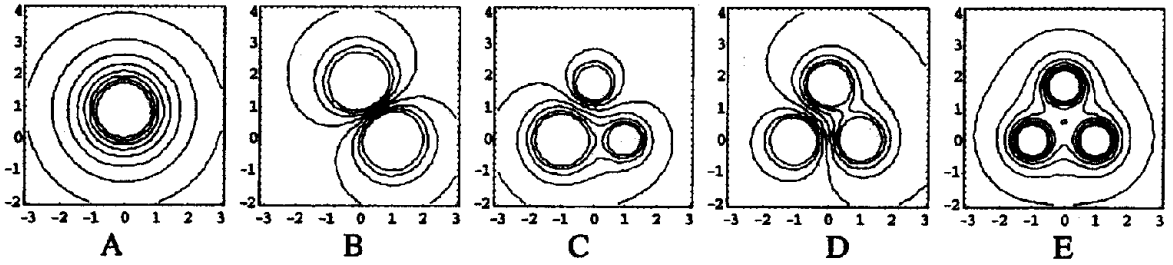


   a. Greatest magnitude of torque on A; greatest potential energy for B.
   b. Greatest magnitude of torque on B; greatest potential energy for A.
   c. Greatest magnitude of torque on B; greatest potential energy for C.
   d. Greatest magnitude of torque on A; greatest potential energy for C.
   e. Greatest magnitude of torque on B; greatest potential energy for C.

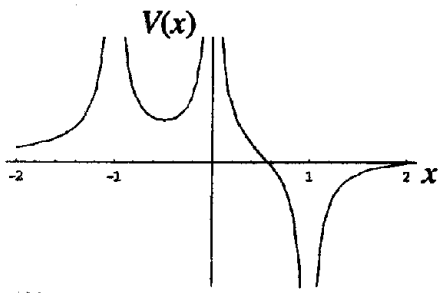
3. In which of the charge configurations depicted below is the magnitude of the force on an electron placed at the point in the center of the square the greatest?



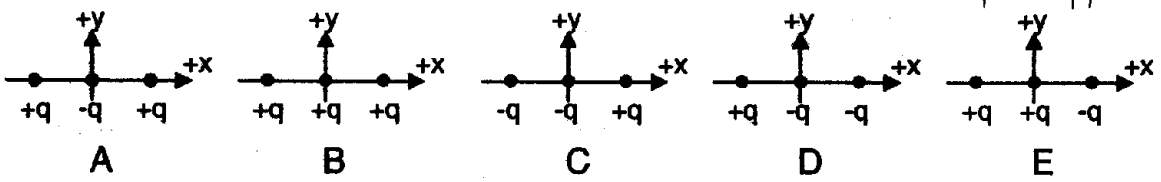
4. Three charges of equal magnitude are placed at the corners of an equilateral triangle. One charge has a sign opposite to the other two. Which of the graphs below correctly depicts the equally-spaced equipotential surfaces in the plane of the triangle? (All graphs to same scale.)



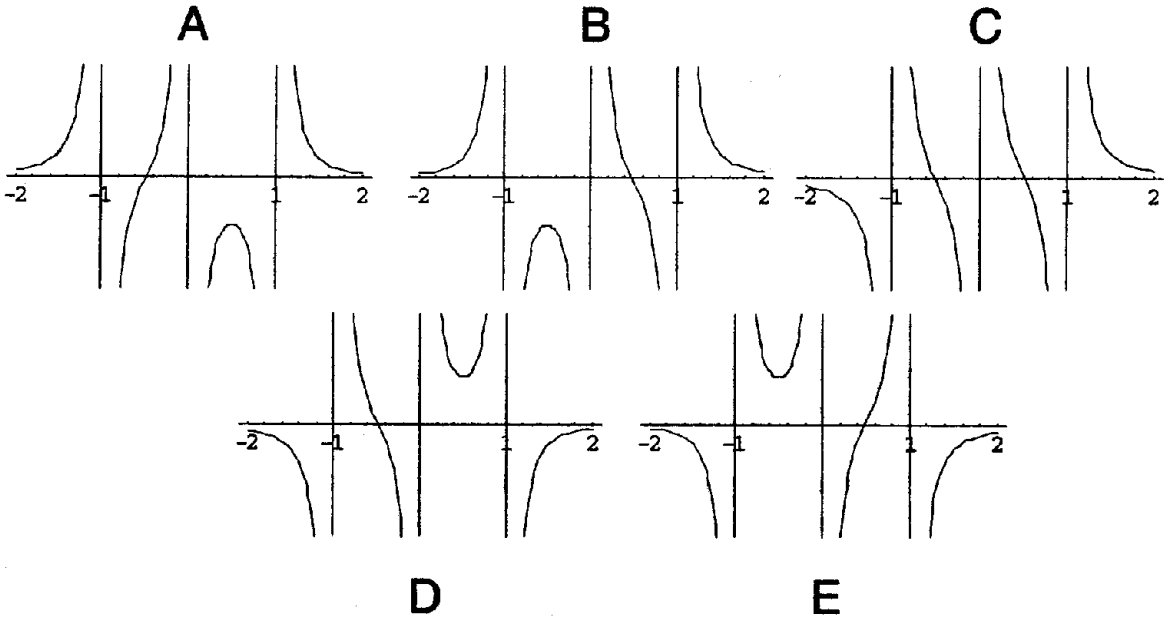
For the questions 5 and 6, refer to the graph to the right, depicting the potential on the x-axis as a function of x.



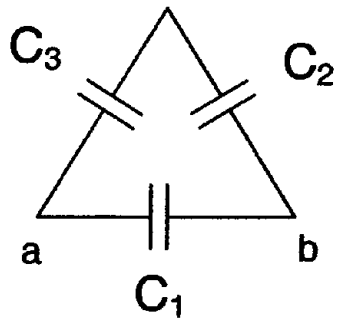
5. Which of the charge configurations depicted below would give rise to that potential?



6. What is the x-component of the electric field for points on the x-axis given the potential depicted above?

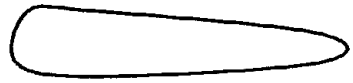


7. Consider the capacitor circuit depicted to the right. A potential difference is applied across points **a** and **b**. If $C_3=2C_2=4C_1$, which capacitor(s) carries(y) the most charge?



a. C_1
b. C_2
c. C_3
d. C_2 and C_3 carry the same amount that is greater than the charge on C_1
e. All carry the same charge.

8. An object made of an ideally conducting material with the shape depicted to the right is isolated from other charges and fields and given a positive net charge $+Q$. Which of the following statements are true?



a. The potential of the conductor is greatest on the surface of the pointy end.
b. The magnitude of the electric field is greatest just outside the surface of the pointy end.
c. The work required to add another charge to the conductor is greatest for a charge added to the pointy end.
d. The capacitance of the conductor is greatest at the surface of the pointy end.
e. The volume charge density is greatest for the material in the pointy end.

9. Consider a parallel pair of plates, one charged $+Q$, the other $-Q$. The area of the plates is A and their separation is d. Compare this arrangement to a similar arrangement of plates where the scale of the geometry has been increased by a factor of two but the amount of charge on the plates has remained fixed. In other words, lengths are increases by a factor of two, areas by a factor of four, etc. Which of the following is a true statement about the energy densities of the electric fields in the different arrangements?

a. $u_{little} = u_{big}$
b. $u_{little} = 2u_{big}$
c. $u_{little} = 4u_{big}$
d. $u_{little} = 8u_{big}$
e. $u_{little} = 16u_{big}$

10. Two charges Q and q, separated by a distance d, produce a potential V =0 at a point P somewhere on the line that connects them. (Note: the potential at infinity is zero in this question.) Which of the following statements is true?

a. No force would act on a test charge place at the point P.
b. Q and q must be of the same sign and different magnitudes.
c. The electric field is zero at the point P.
d. The net work needed to move Q to a distance d from q was zero.
e. The net work needed to bring a test charge from infinity to the point P is zero.