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Physics Department

Phy 2054

Exam 1

September 27, 2012

Name (print, last first): ______________________________ Signature: ______________________________

On my honor, I have neither given nor received unauthorized aid on this examination.

Your test number is the 5-digit number at the top of each page.

1. On an isosceles triangle with the equal sides 5 m long and a base of length 6 m, the top vertex contains a charge 32 nC. The two vertices at the base contain a charge of -4 nC. Calculate the magnitude (in N/C) and direction of the electric field at point P, the midpoint of the base.

(1) 18, down  (2) 4.5, up  (3) 18, up  (4) 4.5, down  (5) none of these

2. For the charge distribution described above, calculate the work done (in nJ) in moving another test charge of 7 nC from far away to the midpoint of the base.

(1) 336  (2) 5  (3) 63  (4) 126  (5) 84

3. Consider the three electric charges A (-q), B (+q) and C (+q). They are arranged as shown in the figure. Rank these charges in order of increasing magnitude of the net force they experience (from the smallest force to strongest force).


4. A horizontal beam of electrons initially moving at $3.9 \times 10^7$ m/s is deflected vertically up by the vertical electric field between oppositely charged parallel plates. The magnitude of the field is $2.30 \times 10^4$ N/C. What is the vertical deflection $d$ of the positrons as they leave the plates?

(1) 0.531 mm  (2) 1.5 mm  (3) 3.5 mm  (4) 6.3 mm  (5) 0.153 mm

5. A metal sphere A has charge $Q$. Two other spheres, B and C, are identical to A except they have charge $-Q$. A touches B, then the two spheres are separated. B touches C, then those spheres are separated. Finally, C touches A, and those two spheres are separated. What is the magnitude of the force between the spheres A and C as a ratio to the force between them in the beginning?

(1) 1/16  (2) 1/8  (3) 1/12  (4) 1/24  (5) none of these
6. We have a hollow metallic sphere with charge \(-5.0 \mu C\) and radius 5.0 cm. We insert a \(+10 \mu C\) charge at the center of the sphere through a hole in the surface. What charge now rests on the outer surface of the sphere?

(1) \(+5 \mu C\)  (2) \(+10 \mu C\)  (3) \(+15 \mu C\)  (4) \(-5 \mu C\)  (5) zero

7. A Van de Graaff generator has a spherical dome of radius 20 cm. Operating in dry air, where “atmospheric breakdown” is at \(E_{\text{max}} = 3.0 \times 10^6\) N/C, what is the maximum charge that can be held on the dome?

(1) \(1.3 \times 10^{-5}\) C  (2) \(2.7 \times 10^{-5}\) C  (3) \(2.6 \times 10^{-6}\) C  (4) \(1.2 \times 10^{-6}\) C  (5) \(8.9 \times 10^{-6}\) C

8. There is a hollow, conducting, uncharged sphere with a negative charge inside the sphere. Consider the electrical potential at the inner and outer surfaces of the sphere. Which of the following is true?

(1) The potentials on both surfaces are equal but not zero.
(2) The potential on the inner surface is greater.
(3) The potential on the outer surface is greater.
(4) The potentials on both surfaces are zero.
(5) none of these

9. Using a 1-mF capacitor, a 2-mF capacitor, and a 3-mF capacitor, which of the following capacitances cannot be made by a combination that uses all three? (Hint: At most only 2 combinations must be considered to determine the correct answer).

(1) \(5/11\) mF  (2) 6 mF  (3) \(6/11\) mF  (4) \(11/3\) mF  (5) \(3/2\) mF

10. A capacitor is attached across a battery and charged. Then the battery is removed leaving the capacitor charged. The positive lead of the capacitor is then connected to one lead of a previously uncharged identical capacitor, and then the other lead of the charged capacitor is connected to the other lead of the second capacitor. How does the energy \(E_o\) stored in the originally charged capacitor compare to the energy \(E_f\) stored in the connected capacitors?

(1) \(E_o = 2E_f\)  (2) \(E_o < E_f\)  (3) \(E_o = E_f\)  (4) \(E_o = 4E_f\)  (5) none of these

11. A high voltage transmission line of diameter 2 cm and length 200 km carries a steady current of 1000 A. If the conductor is copper with a free charge density of \(8 \times 10^{28}\) electrons/m³, how long does it take one electron to travel the full length of the cable?

(1) \(8 \times 10^8\) s  (2) \(8 \times 10^2\) s  (3) \(8 \times 10^4\) s  (4) \(8 \times 10^6\) s  (5) \(8 \times 10^7\) s

12. How long is a wire made from 100 cm³ of copper if its resistance is 8.5 ohms? The resistivity of copper is \(1.7 \times 10^{-8}\)Ω·m.

(1) \(2.2 \times 10^2\) m  (2) \(1.7 \times 10^2\) m  (3) 7.1 m  (4) \(3.0 \times 10^3\) m  (5) 0.8 m

13. By what factor is the resistance of a copper wire changed when its temperature is increased from \(20^\circ\)C to \(120^\circ\)C? The temperature coefficient of resistivity for copper = \(3.9 \times 10^{-3}(^\circ\text{C})^{-1}\).

(1) 1.39  (2) 0.72  (3) 1.06  (4) 1.44  (5) 0.96
14. All resistances are 2 Ohms and the \textit{emf} is 10 V. Calculate the total current drawn from the \textit{emf}.

(1) 2.0A  (2) 5.0A  (3) 3.5 A  (4) 7.0A  (5) 10A

15. What is the potential difference between points a and b?

(1) 12 V  (2) 6.0 V  (3) 8.0 V  (4) 24 V  (5) 18 V

\textsc{the following questions, numbered in the order of their appearance on the above list, have been flagged as continuation questions: 2}