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PHYSICS DEPARTMENT

PHY 2049 Exam 1 October 1, 2014

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.

DIRECTIONS

(1) **Code your test number on your answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your student number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout with scratch work most questions demand.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or the answer sheet may not read properly.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.

>>>>>>>>**WHEN YOU FINISH** <<<<<<<<

Hand in the answer sheet separately.

Constants			
$\epsilon_0 = 8.85 \times 10^{-12}$ F/m	$m_e = 9.11 \times 10^{-31}$ kg	$m_p = m_n = 1.67 \times 10^{-27}$ kg	$e = 1.6 \times 10^{-19}$ C
$k = 9 \times 10^9$ N m^2/C^2	$\mu_0 = 4\pi \times 10^{-7}$ T m/A	$N_A = 6.02 \times 10^{23}$ atoms/mole	$c = 3 \times 10^8$ m/s
m = milli = 10^{-3}	μ = micro = 10^{-6}	n = nano = 10^{-9}	p = pico = 10^{-12}

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1. Two identical conducting spheres A and B carry charges Q amd $2Q$ respectively. They are separated by a distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B, and finally removed. As a result, the electrostatic force between A and B, which was originally F, becomes:

(1) $5F/16$ (2) $F/4$ (3) $3F/8$ (4) $F/8$ (5) $7F/16$

2. A particle with charge 2μC is placed at the origin. Another particle, with charge 4μC, is placed 2m from the origin on the x axis, and a third particle, with charge 2μC, is placed 2 m from the origin on the y axis. The magnitude of the force on the particle at the origin is:

(1) 2.0×10^{-2} N (2) 6.4×10^{-3} N (3) 9.0×10^{-3} N (4) 4.6×10^{-2} N (5) 3.6×10^{-2} N

3. A particle with positive charge Q is on the y axis a distance $2a$ from the origin, and a particle with positive charge q is on the x axis a distance d from the origin. The value of d for which the x component of the force on the second particle is the greatest is:

(1) $\sqrt{2}a$ (2) $2a$ (3) $2\sqrt{2}a$ (4) a (5) $a/\sqrt{2}$

4. A 72 nC charge is located at $x = 1.50$ m on the x-axis and an 8.0 nC charge is located at $x = 3.5$ m. At what point on the x-axis is the electric field zero?

(1) 3.0 m (2) 2.0 m (3) -2.5 m (4) -4.5 m (5) 3.2 m

5. A point charge of 3.0μC is located on the y-axis at $y = 4.0$ m, and another point charge of 6.0μC is located on the x-axis at $x = 5.0$ m. What is the magnitude of the electric field at the position (5.0 m, 4.0 m)?

(1) 3.5×10^3 N/C (2) 2.7×10^3 N/C (3) 2.7×10^{-3} N/C (4) 3.5×10^{-3} N/C (5) 4.5×10^3 N/C

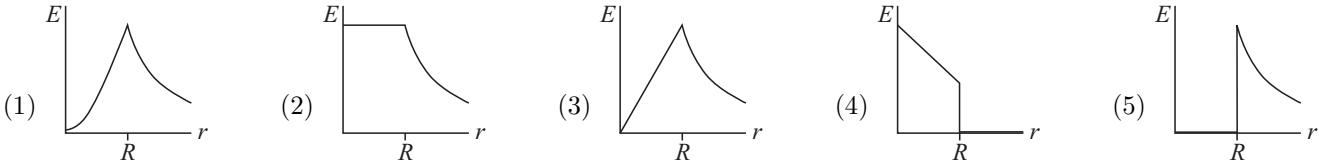
6. An electron gun sends electrons through a region with an electric field of 1.5×10^4 N/C for a distance of 2.5 cm. If the electrons start from rest, how long does it take for the electrons to traverse the gun?

(1) 4.4 ns (2) 1.1 μs (3) 2.2 ns (4) 2.2 μs (5) 1.1 ns

7. A 9.5-cm radius hemisphere contains a total charge of 3.3×10^{-7} C. The flux through the rounded portion of the surface is 4.9×10^4 N·m^2/C. The flux through the flat base is:

(1) -1.2×10^4N·m^2/C (2) $+1.2 \times 10^4$N·m^2/C (3) 0 (4) -4.9×10^4N·m^2/C (5) $+4.9 \times 10^4$N·m^2/C

8. A solid insulating sphere of radius R contains a positive charge that is distributed with a volume charge density that does not depend on angle but does increase with distance from the sphere center. Which of the graphs below correctly gives the magnitude E of the electric field as a function of the distance r from the center of the sphere?



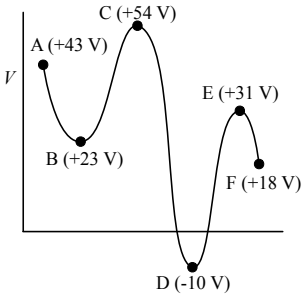
9. Four charges are placed along a straight line each separated by a distance L from its neighbor. The order of the charges is $+Q$, $-Q$, $+Q$, $-Q$. What is the total potential energy of the system (relative to infinity)?

(1) $-7kQ^2/3L$ (2) $+3kQ^2/2L$ (3) $-kQ^2/3L$ (4) $+2kQ^2/3L$ (5) $+kQ^2/2L$

10. Three identical particles of charge 1.5 mC and mass 250 g are held in place at the corners of an equilateral triangle of side 15 cm. They are then released simultaneously and fly apart. What are their velocities at the instant they are 60 cm from one another?

(1) 900 m/s (2) 26800 m/s (3) 635 m/s (4) 1040 m/s (5) 1560 m/s

11. Consider a particle with charge -20μC moving to the left from position E in the figure. How much kinetic energy does it need to reach B?

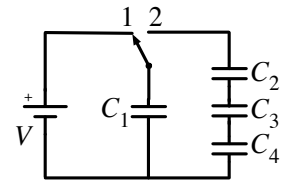


(1) 820 μJ
(2) 460 μJ
(3) 440 μJ
(4) 160 μJ
(5) 0

12. Two isolated conducting spheres are separated by a large distance. Sphere 1 has a radius of R and an initial charge $3Q$ while sphere 2 has a radius of $3R$ and an initial charge $7Q$. A very thin copper wire is now connected to the spheres to allow charge to flow between the spheres. How much charge will be transferred from sphere 2 to sphere 1? (Note that the charge transferred can be positive, negative or zero.)

(1) $-Q/2$ (2) $+2Q$ (3) $-Q/3$ (4) $+3Q$ (5) none of these

13. All capacitors are identical in the figure. Capacitor C_1 is charged to $48\,\mu$C by the emf source when the switch is in position 1. The switch is then moved to position 2 and the charge redistributes among all the capacitors. After this redistribution, the charge on C_1 is:



(1) 36 μC
(2) 12 μC
(3) 24 μC
(4) 16 μC
(5) 48 μC

14. Two rectangular parallel plates with dimensions $10\,\text{cm} \times 15\,\text{cm}$ are given charges of equal magnitudes 0.80 μC but opposite signs. The electric field within the dielectric material filling the space between the plates is 1.4×10^6 V/m. What is the dielectric constant of the material?

(1) 4.3 (2) 2.4 (3) 3.8 (4) 5.2 (5) 1.9

15. A proton located at $x = 1$ m is released along the positive x direction in a electric potential of the form $V(x) = 5 - 3/x$, where x is measured in meters and V is measured in volts. What is the x component of the force acting on the proton at $x = 3$?

(1) -5.3×10^{-20} N (2) $+5.3 \times 10^{-20}$ N (3) -1.8×10^{-19} N (4) $+1.8 \times 10^{-19}$ N (5) $+3.3 \times 10^{-20}$ N

16. A uniform electric field of 5,000 V/m is directed along the $-y$ direction. The potential at $y = 5.0$ m on the y-axis is 25,000 V. What is the change in the potential energy of a proton (in $J \times 10^{-15}$) when it is moved from the point $(3.0, 5.0)$ to the point $(3.0, 2.0)$?

(1) -2.4 (2) -0.8 (3) 1.9 (4) 500 (5) 0

17. A wire of length L has a resistance of 32Ω. The wire is uniformly stretched to four times its original length, maintaining constant volume. If a length L is now cut from the stretched wire, what is the resistance of the piece that was cut off?

(1) $128\,\Omega$ (2) $512\,\Omega$ (3) $32\,\Omega$ (4) $8.0\,\Omega$ (5) $2.0\,\Omega$

18. A heating element is made by maintaining a potential difference of 72.0 V across a Nichrome wire with diameter 2.06 mm. Nichrome has a resistivity of $5.00 \times 10^{-6}\,\Omega\cdot$m. If the element dissipates 5470 W, what is its length?

(1) 63 cm (2) 120 cm (3) 25 cm (4) 42 cm (5) 33 cm

19. Positive charge Q is distributed uniformly throughout an insulating sphere of radius R, centered at the origin. A particle with a positive charge $3Q$ is placed at $x = 2R$ on the x axis. The magnitude of the electric field at $x = R/2$ on the x axis is:

(1) $5Q/24\pi\epsilon_0 R^2$ (2) $Q/24\pi\epsilon_0 R^2$ (3) $Q/4\pi\epsilon_0 R^2$ (4) $11Q/24\pi\epsilon_0 R^2$ (5) none of these

20. A piece of wire is used as a heating element of a household heater. Its energy dissipation rate decreases 3.75% when the temperature of the wire is raised 100°C. What is the temperature coefficient of resistivity of the wire material?

(1) 3.9×10^{-4} °C^{-1} (2) 0.37°C^{-1} (3) 3.7×10^{-2} °C^{-1} (4) 3.9×10^{-3} °C^{-1} (5) 3.9°C^{-1}