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PHYSICS DEPARTMENT

PHY 2049, Fall 2012 Midterm 1 October 1, 2012

Name (print): _____ 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 (errors can occur if too light)**. 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.
(4) Work the questions in any order. Incorrect answers are not taken into account in any way; you may guess at answers you don't know.
(5) If you think that none of the answers is correct, please choose the answer given that is closest to your answer.
(6) **Blacken the circle of your intended answer completely, using a number 2 pencil**. Do not make any stray marks or the answer sheet may not read properly. Completely erase all incorrect answers, or take a new answer sheet.
(7) As an aid to the examiner (and yourself), in case of poorly marked answer sheets, please circle your selected answer on the examination sheet. Please remember, however, that in the case of a disagreement, the answers on the bubble sheet count, NOT what you circle here. Good luck!!!

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

Hand in the answer sheet separately.

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**Constants:** $e = 1.6 \times 10^{-19}$ C $\quad m_p = 1.67 \times 10^{-27}$ kg $\quad m_e = 9.1 \times 10^{-31} kg \quad \epsilon_o = 8.85 \times 10^{-12} C^2/N \cdot m^2$

$k = 1/(4\pi\epsilon_o) = 9 \times 10^9\, N \cdot m^2/C^2 \quad$ nano $= 10^{-9} \quad$ micro $= 10^{-6} \quad$ pico $= 10^{-12}$

Sphere: $A = 4\pi R^2 \quad V = \frac{4\pi}{3} R^3$

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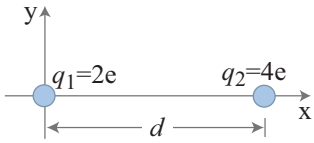
1. A particle with a charge of $5.5 \times 10^{-8}$C is fixed at the origin. A particle with a charge of $-2.3 \times 10^{-8}$C is moved from $x = 3.5$ cm on the $x$ axis to $y = 4.3$ cm on the $y$ axis. The change in potential energy of the two-particle system is:

(1) 0 (2) $6.0 \times 10^{-5}$J (3) $-6.0 \times 10^{-5}$J (4) $-3.1 \times 10^{-3}$J (5) $3.1 \times 10^{-3}$J

2. Two charges, $q_1$ and $q_2$ lie a distance $d = 3$ cm apart on the x-axis. Charge $q_1$ is located at the origin and $q_2$ is located at $x = 3$ cm. At what position on the x-axis (in cm) is the magnitude of the electric field equal to zero?

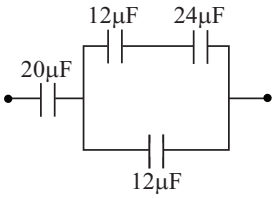



(1) There is no position where the electric field is equal to zero. (2) $-7.24$ (3) 1.00 (4) 4.24 (5) 1.24

3. An air-filled parallel-plate capacitor has a capacitance of 3 pF. The plate separation is then tripled and a wax dielectric is inserted, completely filling the space between the plates. As a result, the capacitance becomes 6 pF. The dielectric constant of the wax is:

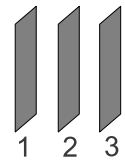
(1) 0.33 (2) 2.0 (3) 6.0 (4) 0.5 (5) 8.0

4. What is the equivalent capacitance of the combination shown?




(1) 10$\mu$F
(2) 12$\mu$F
(3) 40$\mu$F
(4) 29$\mu$F
(5) 25$\mu$F

5. Three large parallel charged insulating sheets have charge per unit area of $\sigma_1 = 2\mu\text{C/m}^2$, $\sigma_2 = -4\mu\text{C/m}^2$, $\sigma_3$. What is the charge density of sheet 3, in order for the electric field to be zero in the region between sheets 2 and 3?




(1) $6\mu\text{C/m}^2$ (2) $4\mu\text{C/m}^2$ (3) $-2\mu\text{C/m}^2$ (4) $2\mu\text{C/m}^2$ (5) $-4\mu\text{C/m}^2$

6. A 3.5-cm radius hemisphere contains a total charge of $6.6 \times 10^{-7}$ C. The flux through the rounded portion of the surface is $9.8 \times 10^4$ N·m$^2$/C. The flux through the flat base is:

(1) $+2.3 \times 10^4\text{N·m}^2/\text{C}$ (2) 0 (3) $-2.3 \times 10^4\text{N·m}^2/\text{C}$ (4) $+9.8 \times 10^4\text{N·m}^2/\text{C}$ (5) $-9.8 \times 10^4\text{N·m}^2/\text{C}$

7. Two conducting spheres have radii of $R_1$ and $R_2$. If they are far apart, the capacitance is proportional to:

(1) $R_1^2 + R_2^2$ (2) none of these (3) $R_1^2 - R_2^2$ (4) $R_1R_2/(R_1 + R_2)$ (5) $(R_1 + R_2)/R_1R_2$

8. A 15Ω resistor and a 16$\mu$F capacitor are connected in series to a 12 V battery. At $t = 0.6$ ms after the connection is made, what is the current in the circuit?

(1) 0.027 A (2) 0.013 A (3) 0.035 A (4) 0.048 A (5) 0.066 A

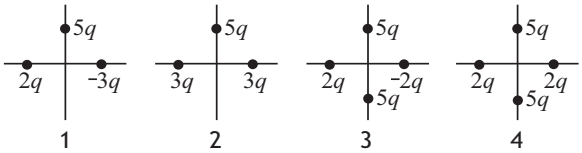
9. Charge $Q$ is distributed uniformly throughout an insulating sphere of radius $R$. The magnitude of the electric field at a point $2R/3$ from the center is:

(1) $Q/3\pi\epsilon_0R^2$ (2) $3Q/4\pi\epsilon_0R^2$ (3) none of these (4) $Q/6\pi\epsilon_0R^2$ (5) $3Q/8\pi\epsilon_0R^2$

10. A certain wire has resistance $R$. Another wire, of the same material, has half the length and half the diameter of the first wire. The resistance of the second wire is:

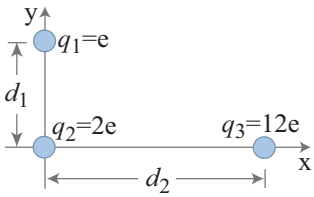
(1) $R$ (2) $4R$ (3) $2R$ (4) $R/2$ (5) $R/4$

11. The diagrams below depict four different charge distributions. The charged particles are all the same distance from the origin. The electric field at the origin:




(1) is greatest for situation 2
(2) is downward for situation 3
(3) is greastest for situation 3
(4) is zero for situation 4
(5) is downward for situation 1

12. In the figure shown, what is the magnitude of the net electric force (in N) exerted on charge $q_2$ by charges $q_1$ and $q_3$, given that $d_1 = 3$ nm and $d_2 = 6$ nm?

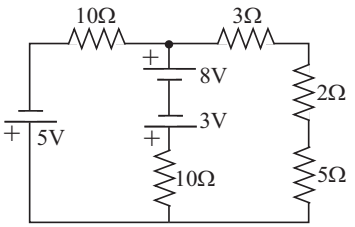



(1) $1.0 \times 10^{-10}$
(2) 0
(3) $6.1 \times 10^{-10}$
(4) $2.0 \times 10^{-10}$
(5) $1.6 \times 10^{-10}$

13. A certain resistor dissipates 0.5 W when connected to a 3 V potential difference. When connected to a 1 V potential difference, this resistor will dissipate:

(1) 0.5 W (2) 0.25 W (3) 1.5 W (4) 0.056 W (5) 0.167 W

14. In the figure shown, what is the current through the 5Ω resistor?




(1) 1.5 A
(2) 0.25 A
(3) 0 A
(4) 1 A
(5) 0.5 A

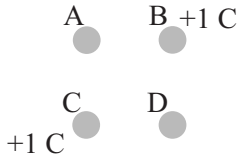
15. Two conducting spheres are far apart. The smaller sphere carries a total charge of $Q$. The larger sphere has a radius three times that of the smaller sphere and is neutral. After the two spheres are connected by a conducting wire, the charges on the smaller and larger spheres, respectively, are:

(1) zero and $Q$ (2) $Q/3$ and $2Q/3$ (3) $Q/4$ and $3Q/4$ (4) $Q/2$ and $Q/2$ (5) $-Q$ and $2Q$

16. A conducting sphere of radius 1 cm is surrounded by a conducting spherical shell of inner radius 3 cm and outer radius 4 cm. If the electric field at $r = 2$ cm is going outwards with magnitude 300 V/cm and at $r = 5$ cm is also going outwards with magnitude 300 V/cm. What is the net charge on conducting spherical shell?

(1) 8 nC (2) 9 nC (3) 10 nC (4) 7 nC (5) 0 nC

17. Four charges are at the corners of a square, with B and C on opposite corners. Charges A and D, on the other two corners, have equal charge, while both B and C have a charge of +1.0 C. What is the charge on A so that the force on B is zero?




(1) −0.25 C (2) −0.50 C (3) −0.71 C (4) −1.0 C (5) −0.35 C

18. In separate experiments, four different particles each start from far away with the same speed and impinge directly on a gold nucleus. The masses and charges of the particles are ($q_0 > 0$)

particle 1: mass $m_0$, charge $q_0$
particle 2: mass $2m_0$, charge $2q_0$
particle 3: mass $2m_0$, charge $q_0/2$
particle 4: mass $m_0/2$, charge $2q_0$

Rank the particles according to the distance of closest approach to the gold nucleus, from smallest to largest.

(1) 4, 1 and 2 tie, then 3 (2) 3, 1 and 2 tie, then 4 (3) 1, 2, 3, 4 (4) 4, 3, 2, 1 (5) 1 and 2 tie, then 3, 4

19. Two identical conducting spheres A and B carry equal charge Q. They are separated by a distance much larger than their diameters. A third identical conducting sphere C carries charge 2Q. 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) $5F/8$ (2) $3F/4$ (3) $2F$ (4) $15F/8$ (5) $F/16$

 21111

20. Choose the INCORRECT statement:

(1) According to Gauss' law, if a closed surface encloses no charge, then the electric field must vanish everywhere on the surface.
(2) Gauss' law applies to a closed surface of any shape.
(3) Gauss' law can be derived from Coulomb's law.
(4) Coulomb's law can be derived from Gauss' law and symmetry.
(5) Gauss' law states that the net number of lines crossing any closed surface in an outward direction is proportional to the net charge enclosed within the surface.