Instructor(s): *P. Kumar*

PHYSICS DEPARTMENT

PHY 2049 Exam 1 June 6, 2011

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) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID 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. **Circle your answers on the test form.** 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.
(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 some answers may be counted as incorrect.
(5) **The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

Constants: $e = 1.6 \times 10^{-19}$ C $\quad m_p = 1.67 \times 10^{-27}$ kg $\quad m_e = 9.1 \times 10^{-31} kg \quad g = 9.8 m/s^2 \quad$ micro $= 10^{-6}$

$\epsilon_o = 8.85 \times 10^{-12} C^2/N \cdot m^2 \quad k = 1/(4\pi\epsilon_o) = 9 \times 10^9\, N \cdot m^2/C^2 \quad \mu_o = 4\pi \times 10^{-7} T \cdot m/A \quad$ nano $= 10^{-9} \quad$ pico $= 10^{-12}$

Coulomb's Law: $|\vec{F}| = \dfrac{|q_1||q_2|}{4\pi\epsilon_o r^2}$ (point charge)

Electric field: $\vec{E} = \dfrac{\vec{F}}{q} \qquad \vec{E} = \dfrac{q}{4\pi\epsilon_o r^2}\hat{r}$ (point charge) $\qquad \vec{E} = \int \dfrac{dq}{4\pi\epsilon_o r^2}\hat{r}$ (general) $\qquad E = \dfrac{\sigma}{2\epsilon_o}$ (plane)

Gauss' law: $\Phi = \hat{n} \cdot \vec{E}\, A = \oint \hat{n} \cdot \vec{E}\, dA = \dfrac{q_{enc}}{\epsilon_o}$

Energy: $W = \int \vec{F} \cdot d\vec{s} = \dfrac{1}{2}mv_f^2 - \dfrac{1}{2}mv_i^2 = K_f - K_i \qquad P = \vec{F} \cdot \vec{v}$ (mechanical power)

For conservative forces $U_f - U_i = -\int \vec{F} \cdot d\vec{s} \rightarrow K_i + U_i = K_f + U_f$

Electric potential: $V = \dfrac{U}{q} \qquad V = \dfrac{q}{4\pi\epsilon_o r}$ (point charge) $\qquad V = \int \dfrac{dq}{4\pi\epsilon_o r}$ (general)

$V_b - V_a = -\int_a^b E_x dx = -\int_a^b \vec{E} \cdot d\vec{s} \qquad E_x = -\dfrac{\partial V}{\partial x}, \qquad E_y = -\dfrac{\partial V}{\partial y}, \qquad E_z = -\dfrac{\partial V}{\partial z}$

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1. Two small, positively charged spheres have a combined charge of 50μC. If each sphere is repelled from the other by an electrostatic force of 1N when the spheres are 2.0 m apart, what is the charge (in μC) on the sphere with the smallest charge?

   (1) 11.6 (2) 1.2 (3) 25 (4) 19.8 (5) none of these

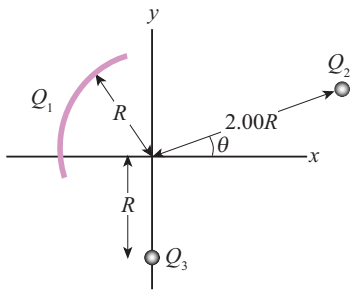
2. What is the magnitude (in pC) of a point charge whose electric field 50 cm away has a magnitude of 2V/m?

   (1) 55.6 (2) 111 (3) 27.8 (4) 18.5 (5) none of these

3. A proton is a distance $d/2$ directly above the center of a square of side d. What is the magnitude of the electric flux (in $\text{nN}\cdot\text{m}^2/\text{C}$) through the square?

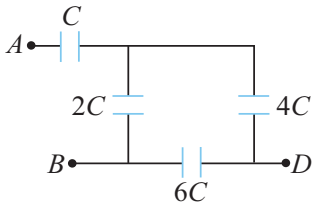
   (1) 3 (2) 9 (3) 18 (4) 4.25 (5) none of these

4. What is the net electric potential (in mV) at the origin due to the circular arc of charge $Q_1 = +7.21$ pC and the two particles of charges $Q_2 = 4.00Q_1$ and $Q_3 = -2.00Q_1$? The arc's center of curvature is at the origin and its radius is $R = 2.00$ m; the angle indicated is $\theta = 20.0°$. The potential is taken to be zero at infinity.

   (1) 32.5
   (2) 162
   (3) 227
   (4) 16.2
   (5) none of these

5. The capacitances of the four capacitors shown are given in terms of a certain quantity C. In ratio to C, what is the equivalent capacitance between points A and B? (*Hint:* First imagine that a battery is connected between those two points; then reduce the circuit to an equivalent capacitance.)

   (1) 0.82 (2) 0.41 (3) 13 (4) 0.63 (5) none of these

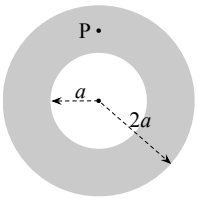
6. In the above problem, now consider a battery connected between points A and D. What fraction of the charge is stored on the 4C capacitor? Express your answer as a ratio to the charge stored on the C capacitor.

   (1) 0.73 (2) 1.0 (3) 0.52 (4) 4.0 (5) none of these

7. Two charges, $q_1 = -1$C and $q_2 = -4$C, are placed along the x-axis a distance L apart with charge q_1 at the origin and q_2 at $x = L$. A third charge, $q_3 = +4/9$C, is also placed along the x-axis such that there is no net Coulomb force on any of the charges. What is the position of this charge along the x axis in units of L *i.e.,* what is x/L?

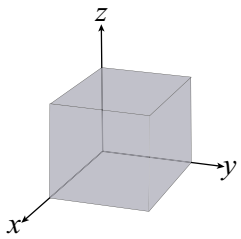
   (1) $\frac{1}{3}$ (2) $\frac{1}{2}$ (3) 1 (4) 2 (5) 3

8. The figure shows a uniformly charged, nonconducting spherical shell of inner radius a and outer radius 2a. If the electric field at the outer radius is E, what is the electric field at point P with radius r = 1.5a?



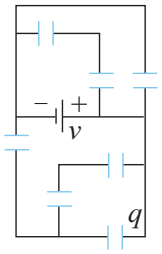
(1) 0.6E (2) 1.2E (3) 0.4E (4) 0.8E (5) none of these

9. A non-uniform electric field given by $E = (5.5\hat{i} - 2.1\hat{j} + (4.6z^2 - 3)\hat{k})$N/C pierces a cube with sides 3 m, as shown in the figure. The cube has its rear corner at the origin. What is the total charge inside the cube?



(1) +3.3 nC
(2) −3.3 nC
(3) +1.5 nC
(4) −1.5 nC
(5) none of these

10. In the circuit shown, all capacitors are 6.0μF and the power supply is 12V. The charge (in μC) on the capacitor labeled q is:

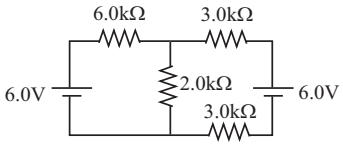


(1) 29
(2) 18
(3) 38.5
(4) 12
(5) none of these

11. A copper wire and a nichrome wire of the same length and cross-section are connected in series across a large battery. If the resistivity of the copper wire is $1.7 \times 10^{-8}\Omega \cdot m$ and the resistivity of the nichrome wire is $1.1 \times 10^{-6}\Omega \cdot m$, what is the power dissipated in the copper wire divided by the power dissipated in the nichrome wire?

(1) 0.015 (2) 2 (3) 4 (4) 0.5 (5) not enough information

12. In the multi-loop circuit shown the current through the 2.0kΩ resistor is (in mA),



(1) 1.2 (2) 0.4 (3) 2.4 (4) 0.8 (5) not enough information

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 6