Instructor(s): *Acosta/Woodard*

PHYSICS DEPARTMENT

PHY 2049, Fall 2015 Midterm 1 September 29, 2015

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!!!

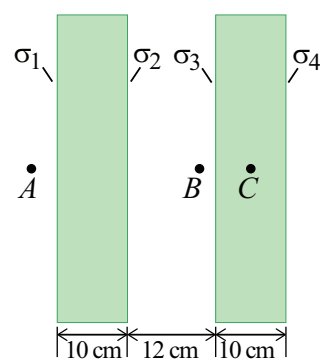
>>>>>>>>**WHEN YOU FINISH** <<<<<<<<

Hand in the answer sheet separately.

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}

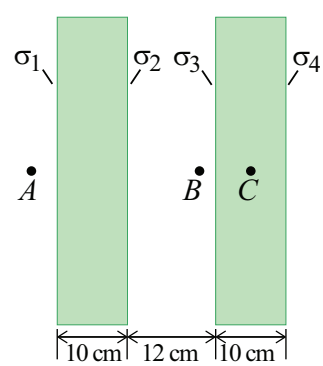
---

1. Two very large, nonconducting plastic sheets, each 10 cm thick, carry uniform charge densities σ_1, σ_2, σ_3, and σ_4 on their surfaces as shown in the figure. These surface charge densities have the values (in μC/m^2): $\sigma_1 = -6$, $\sigma_2 = 4$, $\sigma_3 = 2$, and $\sigma_4 = -1$. Find the magnitude of the electric field at point B, far from the edges of these sheets.



(1) 1.7×10^5 N/C
(2) 5.6×10^4 N/C
(3) 2.8×10^5 N/C
(4) 7.3×10^5 N/C
(5) 0 N/C

2. Two very large, nonconducting plastic sheets, each 10 cm thick, carry uniform charge densities σ_1, σ_2, σ_3, and σ_4 on their surfaces as shown in the figure. These surface charge densities have the values (in μC/m^2): $\sigma_1 = -6$, $\sigma_2 = 4$, $\sigma_3 = 2$, and $\sigma_4 = -1$. Find the magnitude of the electric field at point A, far from the edges of these sheets.



(1) 5.6×10^4 N/C
(2) 1.7×10^5 N/C
(3) 2.8×10^5 N/C
(4) 7.3×10^5 N/C
(5) 0 N/C

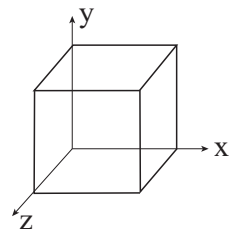
3. A very small object with mass 8×10^{-9} kg and positive charge 6×10^{-9} C is projected directly toward a very large insulating sheet of positive charge that has a uniform surface charge density of 5×10^{-8} C/m^2. The object is initially 0.5 m from the sheet, and its initial speed is 40 m/s. What is the distance of closest approach to the sheet?

(1) 0.12 m (2) 0.21 m (3) 0.31 m (4) 0.38 m (5) 0 m

4. A hollow, conducting sphere with an outer radius of 0.5 m and an inner radius of 0.25 m has a uniform surface charge density of $+3\times10^{-6}$ C/m^2. A charge of $-3\,\mu$C is now introduced into the center of the cavity inside the sphere. Calculate the magnitude of the electric field just outside the sphere.

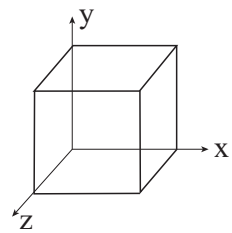
(1) 2.3×10^5 N/C (2) 4.5×10^5 N/C (3) 3.4×10^5 N/C (4) 1.1×10^5 N/C (5) 0 N/C

5. What is the net enclosed charge in the shown cube if the electric field is given by $\vec{E} = 4\,\hat{\imath} + (y-2)\,\hat{\jmath}$ and the cube has a side length of 4?



(1) $64\,\epsilon_0$ (2) 0 (3) $4\,\epsilon_0$ (4) $128\,\epsilon_0$ (5) $32\,\epsilon_0$

6. What is the net enclosed charge in the shown cube if the electric field is given by $\vec{E} = 4\,\hat{\imath} + 2(y-2)\,\hat{\jmath}$ and the cube has a side length of 4?



(1) $128\,\epsilon_0$ (2) 0 (3) $4\,\epsilon_0$ (4) $64\,\epsilon_0$ (5) $32\,\epsilon_0$

7. Two identical raindrops, each with a radius of 1 mm and a charge of -2.8×10^{-12} C, collide and merge into one larger and spherical raindrop. What is the potential at the surface of this merged raindrop if its charge is distributed over its volume?

(1) -40 V (2) -25 V (3) -50 V (4) -20 V (5) -12.5 V

8. Two identical raindrops, each with a radius of 1 mm and a charge of -1.4×10^{-12} C, collide and merge into one larger and spherical raindrop. What is the potential at the surface of this merged raindrop if its charge is distributed over its volume?

(1) -20 V (2) -25 V (3) -50 V (4) -40 V (5) -12.5 V

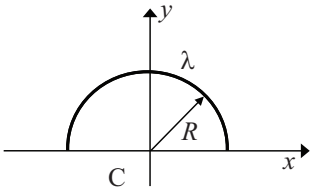
9. In a certain region of space, the electric potential is $V(x,y,z) = Ay^2 - Bxy + Cx$, where A, B, and C are positive constants. At which of the following points is the electric field equal to zero?

(1) $x = 2AC/B^2$, $y = C/B$, $z = 0$
(2) $x = 0$, $y = 0$, $z = 0$
(3) $x = A/(B-C)$, $y = 1$, $z = 0$
(4) $x = -2BC/A^2$, $y = -C/A$, $z = 0$
(5) $x = -2AC/B^2$, $y = -C/B$, $z = 0$

10. How much work is required (as measured in eV) to assemble three electrons into an equilateral triangle with a side length of 10^{-9} m? The electrons are initially separated infinitely far from one another.

(1) 4.3 eV (2) 1.4 eV (3) 4.3×10^{9} eV (4) 2.3×10^{-19} eV (5) 2.9 eV

11. A charged glass rod is bent into the shape of a semicircle of radius R and has a linear charge density of λ. What is the potential at point C at the center of the semicircle? (Take $V = 0$ infinitely far away.)



(1) $\lambda/(4\epsilon_0)$ (2) $\lambda/(4\pi\epsilon_0 R)$ (3) $-\lambda/(2\pi\epsilon_0 R)$ (4) $\lambda/(2\epsilon_0)$ (5) 0

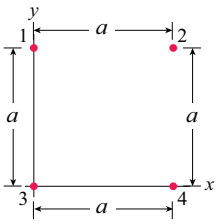
12. Three particles are fixed on the x axis. Particle 1 of charge q_1 is at $x = -a$, and particle 2 of charge q_2 is at $x = +a$. If their net electrostatic force on particle 3 of charge $+Q$ is to be zero, what must be the ratio q_1/q_2 when particle 3 is at $x = 1.5a$?

(1) -25 (2) -9 (3) -1 (4) $+9$ (5) $+25$

13. Three identical conducting spheres initially have the following charges: sphere A, $+4Q$; sphere B, $-6Q$; and sphere C, 0. Sphere A and B are fixed in place with a center-to-center separation that is much larger than the spheres. Two experiments are conducted. In experiment 1, sphere C is touched to sphere A and then (separately) to sphere B, and then it is removed. In experiment 2, starting with the same initial states, the procedure is reversed: sphere C is touched to sphere B and then (separately) to sphere A, and then it is removed. What is the ratio of the electrostatic force between A and B at the end of experiment 2 to that at the end of experiment 1?

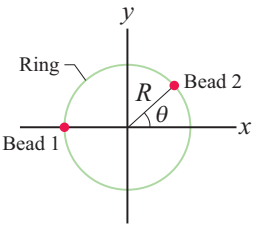
(1) 3/8 (2) 8/3 (3) 1/1 (4) 4/1 (5) 1/4

14. Four particles form a square as shown. The charges are $q_1 = q_4 = Q$ and $q_2 = q_3 = q$. What is Q/q if the net electrostatic force on particles 1 and 4 is zero?



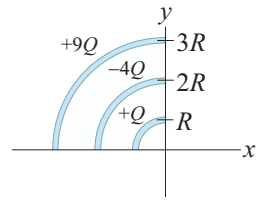
(1) $-\sqrt{8}$
(2) $+\sqrt{8}$
(3) -2
(4) $+2/2$
(5) -1

15. The figure shows a plastic ring of radius $R = 50.0$ cm. Two small charged beads are on the ring. Bead 1 of charge $+2.00\ \mu$C is fixed in place at the left side; bead 2 of charge $+6.00\ \mu$C can be moved along the ring. The two beads produce a net electric field of magnitude $E = 2.00 \times 10^{5}$ N/C at the center of the ring. What is the angle θ in degrees?



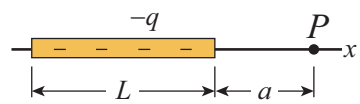
(1) 67.8 (2) 22.2 (3) 20.7 (4) 69.3 (5) 53.1

16. The figure shows three circular arcs centered on the origin. On each arc, the uniformly distributed charge is given in terms of $Q = 2.00\ \mu$C. The radii are given in terms of $R = 10.0$ cm. What is the value of the x component of the electric field (in 10^6 N/C) at the origin?



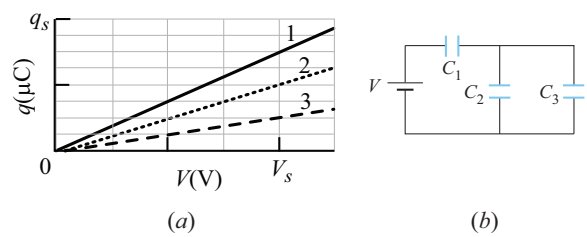
(1) +1.14
(2) −1.14
(3) 0
(4) +1.80
(5) −1.80

17. A nonconducting rod of length $L = 8.15$ cm has a charge $-q = 4.23$ fC uniformly distributed along its length. What is the magnitude of the electric field (in 10^{-3} N/C) produced at point P a distance $a = 12.0$ cm from the rod?



(1) 1.57 (2) 0.94 (3) 2.64 (4) 8.23 (5) 2.64

18. The line labelled 1 on figure (a) gives the charge q that can be stored on capacitor 1 versus the electric potential V set up across it. The vertical scale is set by $q_s = 16.0\ \mu C$, and the horizontal scale is set by $V_s = 2.0\ V$. The lines labelled 2 and 3 are similar plots for capacitors 2 and 3, respectively. Figure b shows a circuit with these three capacitors and a 6.0 V battery. What is the charge (in μC) stored on capacitor 2 in that circuit?



(1) 12 (2) 24 (3) 16 (4) 32 (5) 8

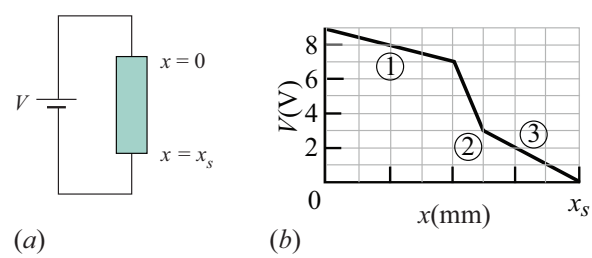
19. The parallel plates in a capacitor, with plate area of 8.50 cm^2 and an air-filled separation of 3.00 mm, are charged by a 6.00 V battery. They are then disconnected from the battery and pulled apart (without discharge) to a separation of 8.00 mm. Neglecting fringing, what is the potential difference between the plates?

(1) 16 V (2) 6 V (3) 2 V (4) 12 V (5) 8 V

20. The space between two concentric conducting spherical shells of radii $b = 1.70$ cm and $a = 1.20$ cm is filled with a substance of dielectric constant $\kappa = 23.5$. A potential difference of $V = 73.0$ V is applied across the inner and outer shells. What is the free charge (in nC) on the inner shell?

(1) 7.78 (2) 7.45 (3) 0.33 (4) 2.29 (5) 3.24

21. A 9.00 V battery is connected to a resistive strip that consists of three sections with the same cross-sectional areas but different conductivities. The graph shows the electric potential $V(x)$ versus position x along the strip. The horizontal scale is set by $x_s = 8.00$ mm. Section 3 has conductivity $3.00 \times 10^7 (\Omega\text{m})^{-1}$. What is the conductivity of section 1 in units of $10^7\ (\Omega\text{m})^{-1}$?

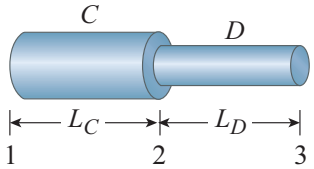


(1) 6 (2) 4 (3) 1 (4) 2 (5) 1/2

22. A certain wire has resistance R. What is the resistance of a second wire, made of the same material, that is half as long and has half the diameter?

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

23. Wire C and D are made from different materials and have length $L_C = L_D = 1.0$ m. The resistivity and diameter of wire C are 2.0×10^{-6} Ωm and 1.00 mm, and those of wire D are 1.0×10^{-6} Ωm and 0.50 mm. The wires are joined as shown, and a current of 2.0 A is set up in them. What is the rate at which energy is dissipated in wire C?



(1) 10 W (2) 20 W (3) 8 W (4) 32 W (5) 16 W

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 1
Q# S 2
TYPE 2
Q# S 5
Q# S 6
TYPE 3
Q# S 7
Q# S 8