Sample Exam 2

Physics 121

Name (Print): _____ **4 Digit ID:**_____ **Section:** _____

Honors Code Pledge: As an NJIT student I _____, pledge to comply with the provisions of the NJIT Academic Honor Code. I assert that I have not violated the NJIT Academic Honor Code.

Instructions:

- First, write your name and section number on both the Scantron form and this exam question book.
- There are 18 multiple choice questions on this exam, all worth the same amount. Sixteen answers correct yields a score of 100%. Questions 17 and 18 may be harder than the others.
- For most problems that require calculations you need should show how you got your answers on this exam book, using the back if needed. Instructors may assume that answers with no work are random guesses and indicate no understanding.
- Circle your choices on the exam paper and also answer each question on the Scantron card using a #2 pencil.
- Use the formula sheet (last exam page) and no other information sources of any kind for reference. It is the same as the one made available on the course web site. Calculators are allowed but sharing is not.
- If you have questions or need something call your proctor or instructor.
- As you know, NJIT has a zero-tolerance policy for ethics code violations. Turn off all cell phones, pagers, or similar electronic devices.

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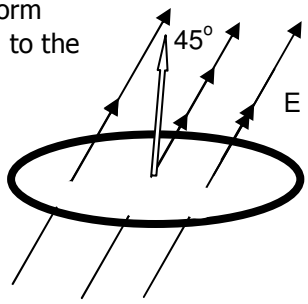
1. A point charge of 10 nano-coulombs is located at the center of a cube. Each of the six faces of the cube is 25 cm. by 25 cm. in size. What is the total electric flux through the surface of the cube?

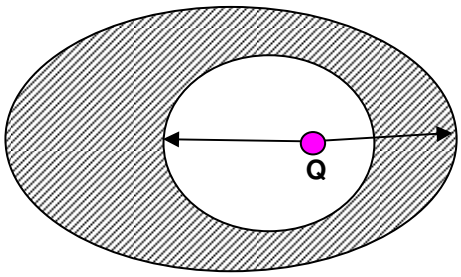
A) 8.85×10^{-12} N·m^2/C B) 1130 N·m^2/C C) 188 N·m^2/C D) 0.0 N·m^2/C
E) 94.2 N·m^2/C

2. The circular surface shown in the sketch has a radius of 10 cm. It is immersed in a uniform electric field with magnitude 120N/C. The field lines make a 45° angle with the vector normal to the surface, as shown in the sketch. What is the electric flux through the surface in N.m^2/C:



A) 7.1×10^{-3} B) 2.7 C) 3.8 D) -0.098 E) 9.4

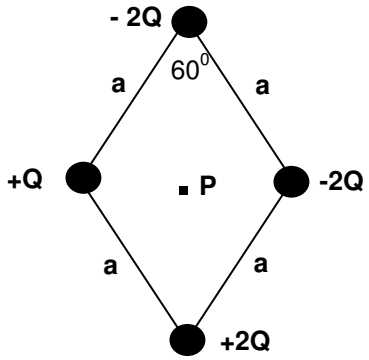
3. A positive charge Q = 25 nC is placed inside the cavity of an egg shaped, electrically neutral conducting shell as shown. How much charge will be induced on the inner and outer surfaces of the shell?



A. Q_{inner} = 25 C. Q_{outer} = 0 C
B. Q_{inner} = 0 nC. Q_{outer} = +25 nC
C. Q_{inner} = -25 nC. Q_{outer} = 0 C
D. Q_{inner} = - 25 nC. Q_{outer} = +25 nC
E. Q_{inner} = 25 nC. Q_{outer} = -25 nC

4. Four point charges are located at the corners of a diamond-shaped parallelogram as shown in the sketch. The value of Q = 20 μC. The length of each side of the figure is a = 30 cm, with an 60^0 angle located as shown. The potential at infinity is the zero reference level. Find an expression for the electric potential V at point P, the center of the diamond shape. Note: k_e is the constant $1 / 4\pi\varepsilon_0$

A) V = 0
B) V = $2k_eQ$ / a.sqrt(3)
C) V = $-4k_eQ$ / a
D) V = $-k_eQ$ / a.sqrt(3)
E) V = $-2k_eQ$ / a



5. Find the electric field 0.3 cm away from an infinitely long thin charged line with linear charge density λ = 2.0 μC/m.

A. 12×10^6 V/m
B. 12×10^7 V/m
C. 4.5×10^5 V/m
D. 9×10^9 V/m
E. 4.5×10^6 V/m

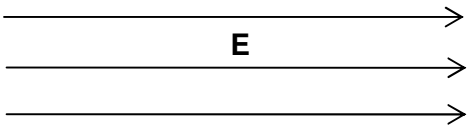
6. The equi-potential surfaces near an infinite charged sheet are planes. If the potential difference between a pair of equi-potentials that are 8 meters apart is 1200 volts, what is the magnitude of the electric field between the sheets?

A) 1.7×10^{-3} V/m
B) 300 V/m
C) 150 V/m
D) 2400 V/m
E) 1.7×10^{13} V/m

7. A metal sphere is charged to a potential of 300 volts. Its radius is 2 meters. The potential at a point 1 meter from the center of the sphere is:

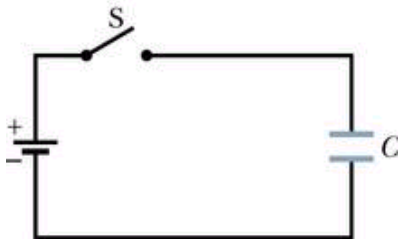
A) 300 V.
B) -100 V.
C) – 300 V.
D) 0 V.
E) 100 V.

8. An electron is moved through a displacement Δx parallel to the direction of a uniform electric field. During this displacement:



A) the potential energy of the electron and the electric potential do not change.
B) the potential energy of the electron increases, the electric potential increases.
C) the potential energy of the electron increases, the electric potential decreases.
D) the potential energy of the electron decreases, the electric potential decreases.
E) the potential energy of the electron decreases, the electric potential increases

9. The capacitor in the sketch has a capacitance of 24.0 μF and is initially uncharged. The battery maintains a potential difference of 3.0 V. How much total charge flows out of the battery until the capacitor is fully charged (the current stops flowing)?

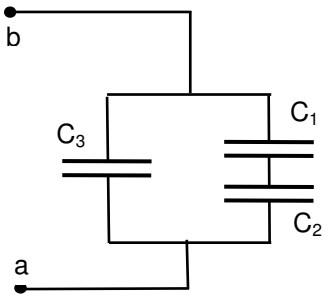


A) 3.20 μC
B) 8.00 μC
C) 72.0 μC
D) 12,000 μC
E) 30.0 μC

10. A parallel plate capacitor being designed is supposed to have a capacitance of 400 pF (1 pF = 10^{-12} F = 10^{-6} μF). It will be filled with a material whose dielectric constant is close to 1.5 (glass). The distance between plates will be 0.3mm. Approximately, what should the area of the plates be?

A) 1.10 m^2
B) 0.028 m^2.
C) 0.014 m^2.
D) 0.009 m^2.
E) 0.9 m^2.

11. Three capacitors are connected in the series/parallel arrangement shown in the sketch. Suppose C_1 = 30μF, C_2 = 30μF, and C_3 = 15μF. The potential difference across the combination V_{ab} = 40 V. The equivalent capacitance between points a and b is closest to:

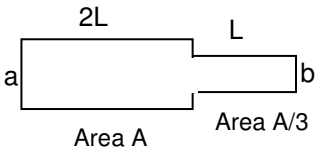


A) 15 μF
B) 30 μF
C) 7.5 μF
D) 45 μF
E) 12 μF

12. In problem 11, calculate the voltage across capacitor C_2 (in volts)

A) 60
B) 40
C) 10
D) 20
E) $6x10^{-4}$

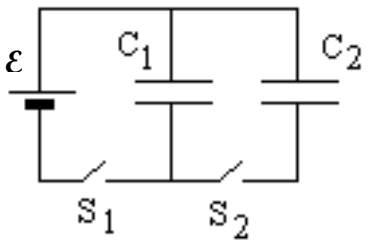
13. Two wires made of the same material are joined end-to-end and a potential difference is maintained across the combination, from a to b in the sketch. The thin wire has cross sectional area A/3 and length L. The fatter wire has area A and length 2L. Which of the following quantities are the same for both wires:



1. The resistivity of each wire
2. The resistance of each wire
3. The current density inside each wire
4. The current through each wire
5. The potential difference across each wire

A) 1, 2, and 3 B) 1, 2, 4, and 5 C) 1 only D) 2 only E) 1 and 4 only

14. In the circuit shown in the sketch, switches S_1 and S_2 are initially open. Capacitor C_1 = 30.0 nF is then charged by closing switch S_1 which connects it to the battery whose EMF $\mathcal{E}$ = 90 V. Switch S_1 is then opened, thereby disconnecting C_1 from the battery. Switch S_2 is then closed, thereby connecting the charged capacitor C_1 to the uncharged 15.0 nF capacitor C_2. Find the final potential difference across capacitors C_1 and C_2. (Hint: after being disconnected, the total charge on the combination C_1, C_2 remains constant).



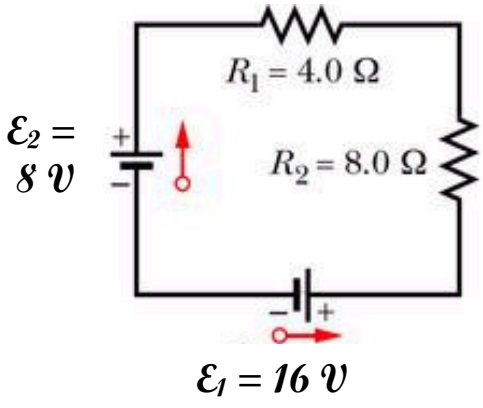
A. 60 V
B. 30 V
C. 4 V
D. 10 V
E. 120 V

15. For the previous problem, the final charge on capacitor C_1 is closest to:

A) 2.0 μC
B) 0.8 nC
C) 0.2 μC
D) 1.2 nC
E) 1.8 μC

16. Assume that the batteries in the figure have negligible internal resistance. Assume that the current flows counterclockwise. Find the magnitude of the current in the circuit and the power dissipated in resistor R_1.

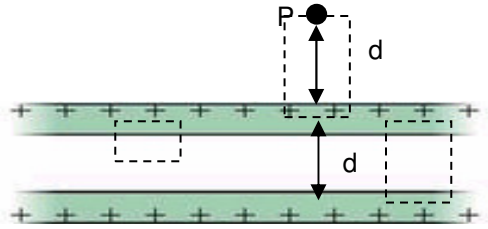
A) i = 0.67 A, P_1 = 2.7 watts
B) i = 1.33 A, P_1 = 5.4 watts
C) i = 1.5 A, P_1 = 24 watts
D) i = 0.67 A, P_1 = 1.8 watts
E) i = 1.5 A, P_1 = 9 watts



Extra Credit:

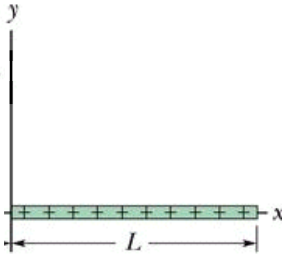
17. The sketch shows edge views of two parallel **conducting** sheets with identical positive charges Q = 4 μC. on each. The area of each plate area is 2 m^2. What is the electric field E_{IN} midway between the plates; also, what is E_P at point P, which is 1 mm above the upper plate as shown? Hint: The dashed line Gaussian surfaces may be helpful.

A) $E_{IN} = 0$, $E_P = 5.65 \times 10^4$ V/m
B) $E_{IN} = 0$, $E_P = 2.26 \times 10^5$ V/m
C) $E_{IN} = 1.1 \times 10^5$ V/m, E_P = zero
D) $E_{IN} = 0$, $E_P = 1.1 \times 10^5$ V/m
E) $E_{IN} = 0$, $E_P = 0$



18. The figure shows a plastic rod of length L = 2.5 m, with a non-uniform linear charge density $\lambda = \alpha\ x$ with $\alpha = 10^{-3}$ C/m^2. The rod is lying on the x axis. Assuming V = 0 at infinity, find the electric potential (in volts) at the left end of the rod – in other words, at the origin. Select the closest answer.

A) Zero
B) 2.7×10^{10} volts
C) 2.25×10^7 volts
D) 1.35×10^8 volts
E) Infinity



ANSWER KEY:

1. **B**
2. **B**
3. **D**
4. **E**
5. **A**
6. **C**
7. **A**
8. **C**
9. **C**
10. **D**
11. **B**
12. **D**
13. **E**
14. **A**
15. **E**
16. **D**
17. **B**
18. **C**