Last Name: First Name:

Physics 102 Spring 2007: Exam #2 —Multiple-Choice Questions

1. A parallel-plate capacitor is attached to a battery that maintains a constant potential difference V between the plates. While the battery is still connected, a glass slab with dielectric constant $\kappa > 1$ is inserted so as to partially fill the space between the plates. The stored energy

   (A) increases.

   (B) remains the same.

   (C) decrease.

2. Compare the effective capacitance between the points represented by the black dots of the three circuits below. Assume all capacitors have the same capacitance. Rank the effective capacitance of the circuits labeled A, B, and C from highest to lowest.

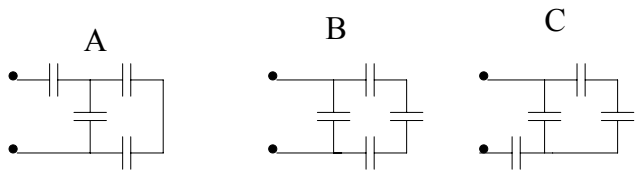
   (A) $A > C > B$.

   (B) $A = C > B$.

   (C) $A > C = B$.

   (D) $B = C > A$.

   (E) $B > C = A$.



3. Consider the arrangement of two capacitors connected by wires depicted below. A charge of $+Q$ is ripped from the bottom wire and added to the top. For the case $C_1 > C_2$, compare the charge on each capacitor's top plate (Q_1 and Q_2) and the voltage difference (V_1 and V_2) across each capacitor. Which of the statement(s) below is (are) true?

   I. $Q_1 > Q_2$.

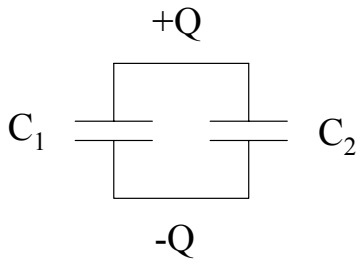
   II. $Q_1 = Q_2$.

   III. $Q_1 < Q_2$.

   IV. $V_1 > V_2$.

   V. $V_1 = V_2$.

   VI. $V_1 < V_2$.



   (A) Only I and VI are correct.

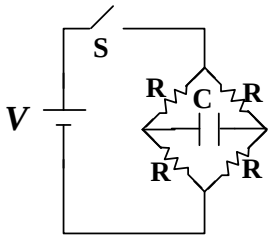
   (B) Only II and VI are correct.

   (C) Only I and IV are correct.

   (D) Only III and VI are correct.

   (E) Only I and V are correct

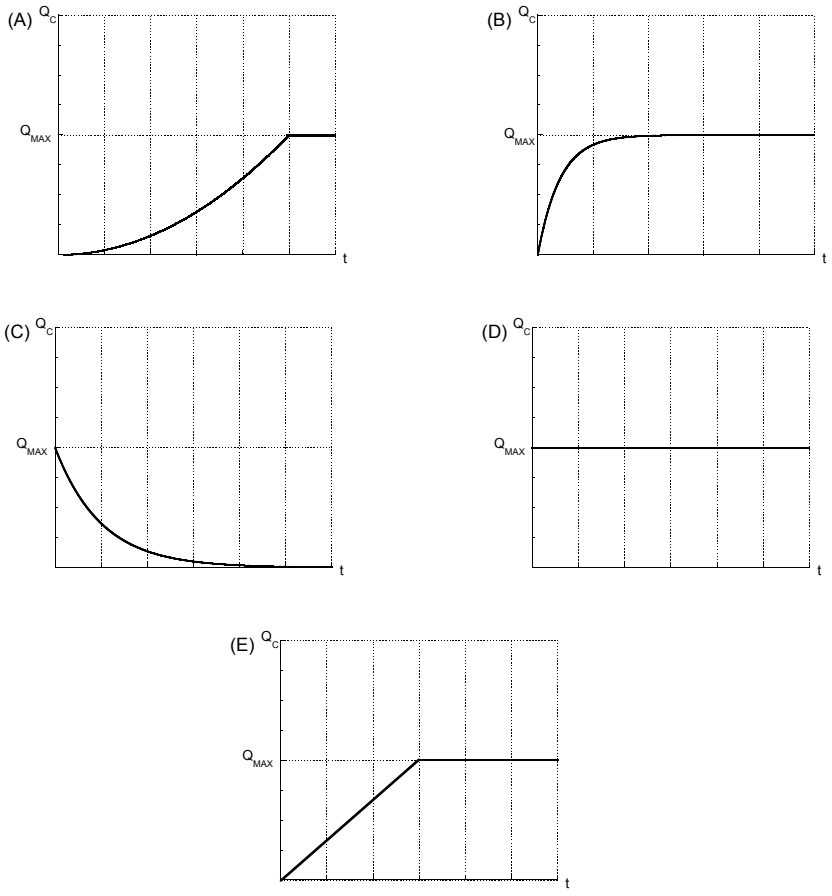
For questions 4 and 5, refer to the circuit below involving a battery V, a switch S, four identical resistors, R, and a capacitor, C. Initially the capacitor is uncharged and the switch is open.



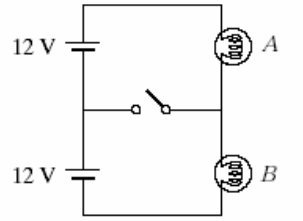
4. What is the current provided by the battery immediately after the switch is closed?

   (A) $I = 4\,V/R$
   (B) $I = 2\,V/R$
   (C) $I = V/R$
   (D) $I = V/2\,R$
   (E) $I = V/4\,R$

5. Which of the graphs most accurately depicts the charge on the capacitor as a function of time?

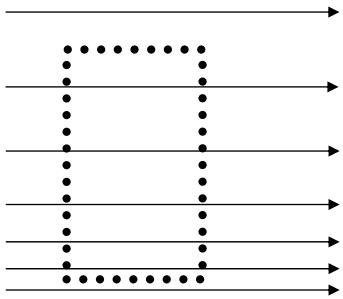


6. The light bulbs in the circuit are identical (i.e., equal resistors) and assumed to be Ohmic. When the switch is closed,



(A) The intensity of light bulb A increases.
(B) The intensity of light bulb A decreases.
(C) The intensity of light bulb B increases.
(D) The intensity of light bulb B decreases.
(E) nothing changes.

7. For the magnetic field and loop depicted to the right, which (if any) of the following statements is NOT true?



(A) The line integral of the magnetic field around the loop is positive when taken in the counterclockwise direction.
(B) If a current was flowing around the loop, there would be a net force on the loop.
(C) If a current was flowing around the loop, there would be a net torque on the loop.
(D) There must be some current encircled by the loop going out of the page to produce such a magnetic field.
(E) All statements are true.

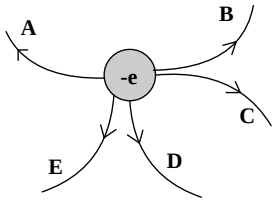
8. In a recent lab experiment, a student measured the resistivity of Play-Doh to be $\rho = 25\,\Omega\,cm$. She first constructed a cylinder of Play-Doh with a uniform radius r, and length L. If she creates a new cylinder of Play-Doh that has a uniform radius $r/2$ and length $4\,L$, how does the resistance of the new cylinder of Play-Doh (R_1) compare to the resistance of the original cylinder of Play-Doh (R_0).

(A) $R_1 = 16R_0$.
(B) $R_1 = 8R_0$.
(C) $R_1 = R_0$.
(D) $R_1 = R_0/8$.
(E) $R_1 = R_0/16$.

9. A fixed resistor of resistance R is in series with a variable resistor and an ideal battery (potential difference V). Originally the fixed and variable resistors have the same resistance. As the resistance of the variable resistor is *decreased*, the power dissipated through the fixed resistor

   (A) increases.
   (B) decreases.
   (C) remains the same.
   (D) cannot be determined without more information.

10. An electron is released from rest in a region of space where a uniform electric field $\vec{\mathbf{E}}$ exists pointing *up* the page and a uniform magnetic field $\vec{\mathbf{B}}$ is pointing *out* of the page. Which path in the figure below best represents the motion of the electron after if is released?

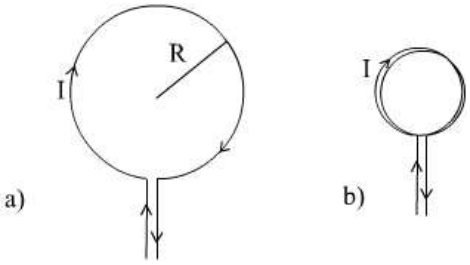


11. Consider a solenoid with radius R and length L ($R \ll L$). The magnetic field at the center of the solenoid is B_0. A second solenoid is constructed that has twice the radius, twice the length, and carries twice the current as the original solenoid, but has the same number of turns per meter. The magnetic field at the center of the second solenoid is

   (A) $B_0/4$.
   (B) $B_0/2$.
   (C) B_0.
   (D) $2\,B_0$.
   (E) $4\,B_0$.

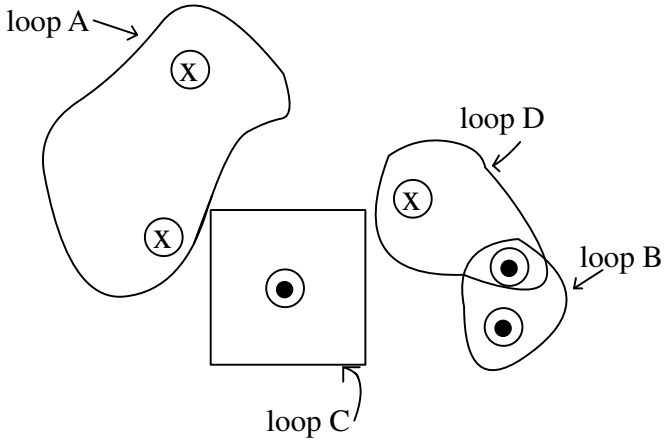
12. A loop of wire of length L carrying a current I can be wound once as in the figure (a) below, or twice as in figure (b). The ratio of the magnitude of the magnetic field B_1 at the center of the single loop to the magnitude B_2 (B_1/B_2) at the center of the double loop is

   (A) 1/4.
   (B) 1/2.
   (C) 1.
   (D) 2.
   (E) 4.

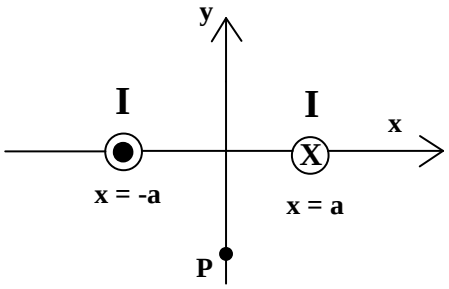


13. Consider four equal currents going into or out of the page as indicated in the figure below. Rank the line integral of the magnetic field $\oint \vec{B} \cdot d\vec{l}$ (from greatest to least) integrated in the clockwise direction.

(A) $A = B > C > D$.
(B) $A > C > B > D$.
(C) $D > B > C > A$.
(D) $A > D > C > B$.
(E) $A > D > B > C$.



14. Two very long wires carrying equal current, I, are placed parallel to the z-axis. One wire is located at (-a,0) and the other is located at (a,0). The wire located at (-a,0) carries current out of the page, and the wire located at (a,0) carries current into the page. The arrow that best describes the direction of the magnetic field at point P, equidistant from both wires, located at (0, -P) is



A). 0

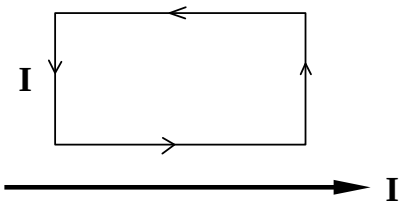
B). ↓

C). ↑

D). ←

E). →

15. A rectangular loop of wire of length l and width w carrying current I is placed near a very long wire carrying current I in the +x direction as shown in the figure below. Which of the following statement(s) is (are) correct?



I. The current loop experiences a net force.

II. The current loop experiences no net force.

III. The magnetic dipole moment of the current loop, $\vec{\mu}$, points into the page.

IV. The magnetic dipole moment of the current loop, $\vec{\mu}$, points out of the page.

V. The current loop experiences no net torque.

VI. The current loop experiences a net torque.

(A) Only II and V are correct.

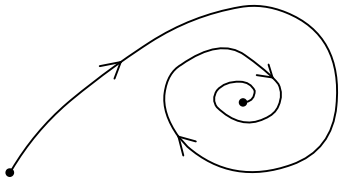
(B) Only I and VI are correct.

(C) Only I, III and IV are correct.

(D) Only I, IV and V are correct.

(E) Only II IV and VI are correct.

16. A piece of wire is wound into a flat spiral as shown in the figure below. If a current is passed through the coil (supplied by an external battery that is not shown but connected to the two dots shown in the figure), what will happen to the wire?

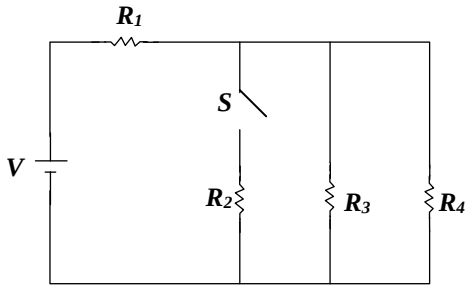


(A) The coil will tighten up.

(B) The coil will become looser.

(C) Nothing will happen to the coil.

17. The circuit shown below consists of four identical resistors labeled R_1, R_2, R_3 and R_4, an ideal battery V, and a switch S. What happens to the voltage difference across the resistor labeled R_4, when the switch is closed?



(A) The voltage difference across R_4 increases after the switch is closed.

(B) The voltage difference across R_4 decreases after the switch is closed.

(C) The voltage difference across R_4 stays the same after the switch is closed.

(D) The values of R_1, R_2, R_3 and R_4 are needed in order to answer this question.