Last Name: First Name:

Physics 102 Spring 2002: Final—Multiple-Choice Questions

1. A hollow metal sphere is electrically neutral (no excess charge). A small amount of negative charge is suddenly placed at one point P on this metal sphere. If we check on this excess charge a few seconds later we will find one of the following possibilities.

   (a) All of the excess charge remains right around P.

   (b) The excess charge has distributed itself evenly over the outside surface of the sphere.

   (c) The excess charge is evenly distributed over the inside and outside surface.

   (d) Most of the charge is still at point P, but some will have spread over the sphere.

   (e) There will be no charge left.

2. A rectangular loop of wire lies in the same page as a wire carrying a constant current. The rectangular loop has a length (parallel to wire) ℓ and width w; the wire carries a current I. The mutual inductance of the system will be doubled in which of the following cases?

   I. I is doubled
   II. w is doubled
   III. l is doubled
   IV. d is halved

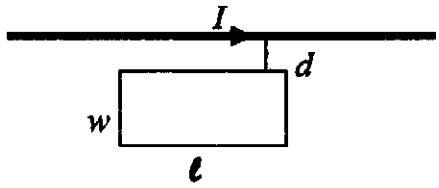
   (a) I and III

   (b) II and III

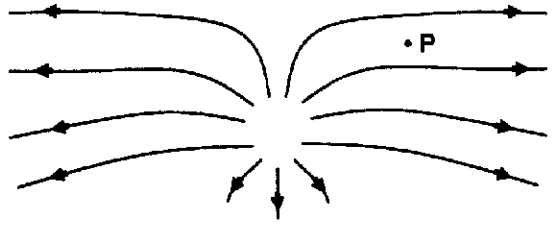
   (c) II, III and IV

   (d) I, II, III and IV

   (e) None of the options above.



3. Consider the diagram below which depicts the electric field lines in a region of space. What is the direction of the electric force on a negative charge at point P in the diagram above.



(a) ← (b) ↙ (c) → (d) ↗ (e) the force is zero

For next two questions a positive charge is placed at rest at the center of a region of space in which there is a electric field of uniform strength and direction.

4. When the positive charge is released from rest in the uniform electric field, what will its subsequent motion be?

   (a) It will move at a constant speed.

   (b) It will move at a constant velocity.

   (c) It will move at a constant acceleration.

   (d) It will move with a linearly changing acceleration.

   (e) It will remain at rest in its initial position.

5. Which of the following statements correctly describe the electric potential energy of the positive charge after the charge is released from rest in the uniform electric field?

   (a) It will remain constant because the electric field is uniform.

   (b) It will remain constant because the charge remains at rest.

   (c) It will increase because the charge will move in the direction of the electric field.

   (d) It will decrease because the charge will move in the opposite direction of the field.

   (e) It will decrease because the charge will move in the direction of the electric field.

6. An electron starts out moving horizontally toward a screen. The electron enters a region of magnetic field and follows the path depicted below. In what direction does that magnetic field point?

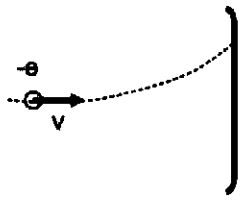
   (a) toward the top of the page

   (b) toward the bottom of the page

   (c) into the page

   (d) out of the page

   (e) the magnetic field is in the direction of the path



7. A resistor, inductor and parallel plate capacitor are connected in series across an AC emf source. The frequency of the AC source is tuned so maximum power is dissipated in the resistor. Then a dielectric slab ($\kappa > 1$) is inserted between the plates of the capacitor. Which of the following statements is (are) true?

   I. The frequency of the AC emf source must be decreased to increase the power dissipated in the resistor.

   II. If the frequency of the AC emf source is not changed, the current in the inductor leads the voltage of the emf source.

   III. After the dielectric is inserted, the sum of the instantaneous voltages across the circuit elements equals the instantaneous voltage of the emf source.

   (a) I

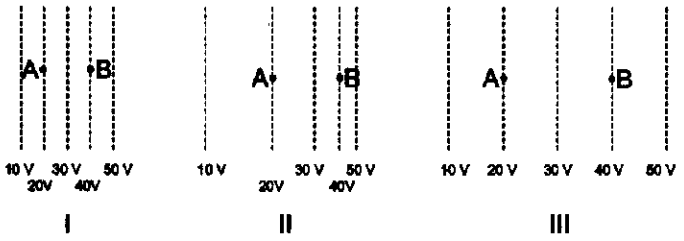
   (b) I and II

   (c) I and III

   (d) II and III

   (e) I, II and III

The following three questions refer to the figures below. In the figures below, the dotted lines show the equipotential lines of electric field lines. A charged object is moved directly from point A to point B. The charge on the object is $+1\ \mu$C.



6. How does the amount of work needed to move this charge compare for the above cases?

   (a) The least work required in I.
   (b) The least work required in II.
   (c) The least work required in III.
   (d) I and II require the same amount of work, which is less than III.
   (e) All three would require the same amount of work.

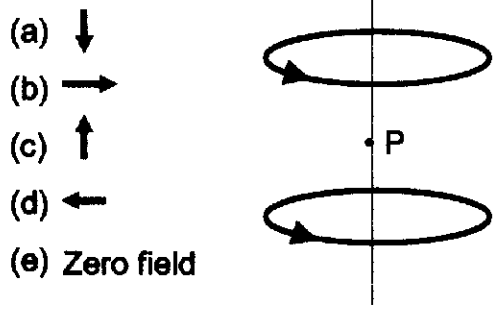
7. Rank the magnitudes of the electric fields at point B in these three cases.

   (a) I>II>III
   (b) III>I>II
   (c) III>II>I
   (d) II>I>III
   (e) I=II=III

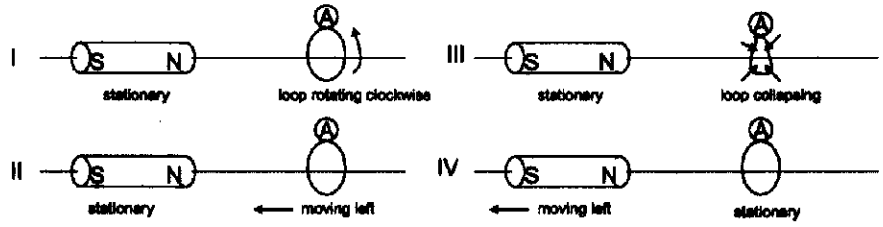
8. For case III, what is the direction of the electric force exerted by the field on the $+1\ \mu$C charged object when at A and when at B?

   (a) left at A and left at B
   (b) right at A and left at B
   (c) left at A and right at B
   (d) right at A and left at B
   (e) no electric force at either

9. Two identical loops of wire carry identical currents I. The loops are located as shown in the diagram. Which arrow represents the direction of the magnetic field at the point P midway between the two loops?

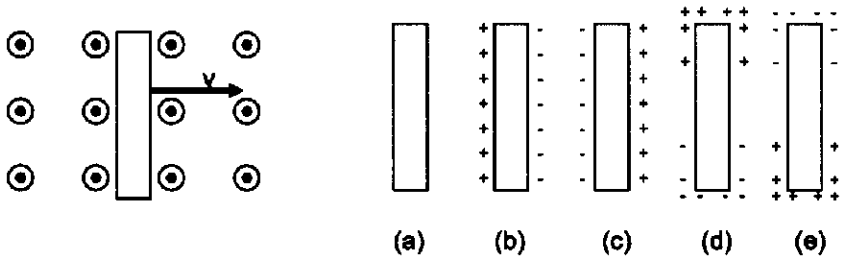


10. The four separate figures below involve a cylindrical magnet and a sensitive ammeter connected to the ends of a loop of copper wire. The plane of the wire is perpendicular to the reference axis. The states of motion of the magnet and the loop of wire are indicated in the diagram. In which of the figures will the ammeter detect current?

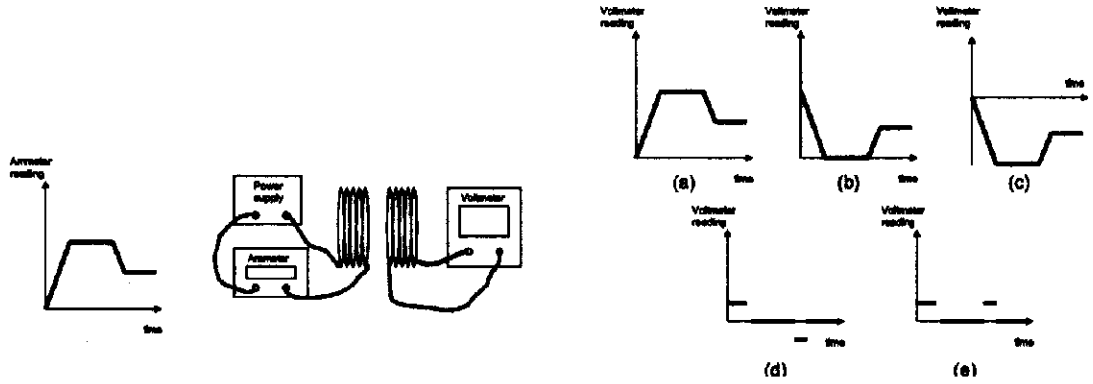


(a) I, II, IV (b) II (c) II, III, IV (d) II, IV (e) all four cases

11. A neutral metal bar is moving at constant velocity to the right through a region where there is a uniform magnetic field pointing out of the page. Which of the following diagrams best describes the charge distribution on the surface of the metal bar?



12. A variable power supply is connected to a coil and an ammeter and the time dependence of the ammeter is shown. A nearby coil is connected to a voltmeter. Which of the following graphs correctly shows the time dependence of the voltmeter reading?



13. What is the total flux through the rectangular prism surface due to charge configuration in the figure below?

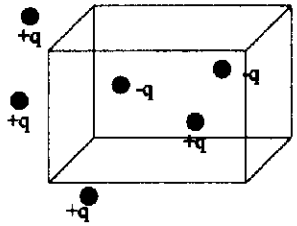
(a) $-q/\epsilon_0$

(b) 0

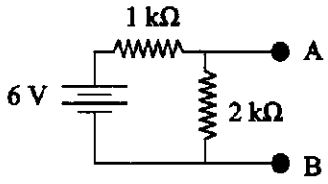
(c) q/ϵ_0

(d) $2q/\epsilon_0$

(e) Not enough symmetry to easily calculate.



The following two questions refer to the figure to the right in which a capacitor is charged to 12 V and then connected between points A and B in the figure below, with its positive plate to A.



16. What is the current through the 2 kΩ resistor immediately after the capacitor is connected?

(a) 0 mA

(b) 1 mA

(c) 2 mA

(d) 3 mA

(e) 6 mA

17. What is the current through the 2 kΩ resistor a long time after the capacitor is connected?

(a) 0 mA

(b) 1 mA

(c) 2 mA

(d) 3 mA

(e) 6 mA

18. Two point sources of electromagnetic radiation (otherwise identical) are such that the power of source 1 (P_1) is three times the power of source 2 (P_2). If an observer is 7 m from source 1, and measures the peak electric fields from each source to have the same magnitude, how far is that observer from source 2?

    (a) 0.78 m
    (b) 2.33 m
    (c) 3.50 m
    (d) 4.04 m
    (e) 4.95 m

19. For the magnetic field and loop depicted to the right, which (if any) of statements (a)-(d) is NOT true?

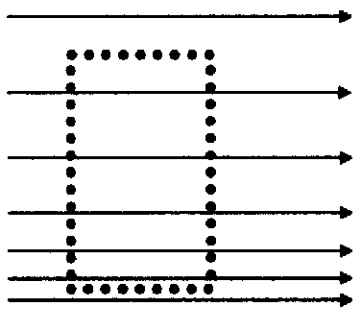
    (a) The line integral of the magnetic field around the loop is positive when taken in the counterclockwise direction.

    (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) None of the above statements are false.



20. When a switch is closed, a solenoid with inductance L and resistance R is connected to a battery with voltage V_0. Which of the following statements is (are) true?

    I. After the switch is closed, the current through the solenoid decreases exponentially to zero with a time constant $\tau = L/R$.

    II. After the switch is closed, the voltage drop across the solenoid decreases exponentially to zero with a time constant $\tau = L/R$.

    III. After the switch is closed, an electric field that circles the axis of the solenoid is induced with a magnitude that decreases exponentially to zero with a time constant $\tau = L/R$.

    (a) I
    (b) II
    (c) III
    (d) I and II
    (e) I, II and III