SECOND YEAR PHYSICS TEST - APRIL, 2005

DIRECTIONS: For each statement or question, completely fill in the appropriate space on the answer sheet. Use the letter preceding the word or phrase or sketch which best completes the statement or answers the question. Each question is worth 4 points. Use 9.8 m/s^2 as the value of the acceleration due to gravity. Unless otherwise stated assume ideal conditions including no friction with the air. Sketches are not to scale. All current, unless otherwise described, is traditional current in the direction of flow of positive charge.

Proton mass = 1.67×10^{-27} kg; Electron mass = 9.1×10^{-31} kg; Charge on electron = 1.6×10^{-19} C

The following is used for items 1 through 3. A charged particle of mass, m, is fired to the right with a velocity, $v = 10^6$ m/s into a constant uniform magnetic field, B, of 0.2 T. The velocity is at a right angle to the magnetic field B. The magnetic field, B, is directed into the page. The charged particle experiences a force, $F = 1.6 \times 10^{-13}$ Newton due to its motion in the magnetic field. The mass of the particle is 1.6×10^{-26} kg.

1. If a free compass needle were placed in the magnetic field, the North end would point _____.

   A) to the right
   B) to the left
   C) to the top of the page
   D) toward the bottom of the page
   E) perpendicular to the page point downward to the page.

2. The charge on the particle is ___ X 10^{-19} Coulomb.

   A) 8 B) 6.4 C) 4.8 D) 3.2 E) 1.6

3. The radius of the path of the charged particle in the magnetic field is ___ m.

   A) 0.10 B) 0.15 C) 0.20 D) 0.25 E) 0.30

The following is used for items 4 through 7. A capacitor is charged to 10 V and then discharged through a resistor. The initial current at the start of discharge is 20 microamperes. The characteristic time for the discharge is 8 seconds.

4. The resistance is _____ ohms.

   A) 0.002 B) 200,000 C) 500,000 D) 1,000,000 E) 2,000,000

5. The capacitance is ___ microfarad.

   A) 0.2 B) 0.4 C) 2 D) 4 E) 16

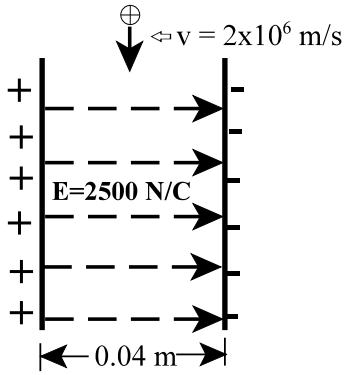
6. If the charging potential were 5 volts instead of 10 volts, the characteristic time would be ___ seconds.

   A) 1 B) 2 C) 4 D) 8 E) 16

7. If the charging potential were 20 volts instead of 10 volts, the initial discharge current would be ____ microamperes.

   A) 80 B) 40 C) 20 D) 10 E) 5

The following description and sketch is used for items 8 through 11. Given a parallel plate capacitor with air or a vacuum between the plates. The capacitor is charged and then removed from the charging source. The electric field in the space between the plates is uniform. There is an excess of plus charge, +Q, on the plate to the left and an excess of negative charge, -Q, on the right hand plate. The plates are 4 cm (0.04 m) apart. The magnitude of the electric field is two-thousand five-hundred Newtons per Coulomb (2500 N/C). A proton is moving downward toward the middle of the gap between the plates as shown. The proton has a velocity of 2,000,000 m/s (2 x 10^6 m/s). Consider the motion non-relativistic.



8. The potential difference across the plates is ___ V.

A) 100 B) 200 C) 500 D) 1,000 E) 10,000

9. The acceleration of the proton by the electric field between the capacitor plates would be approximately ___ m/s^2.

A) 10^{13} B) 10^{12} C) 10^{11} D) 10^{10} E) 10^9

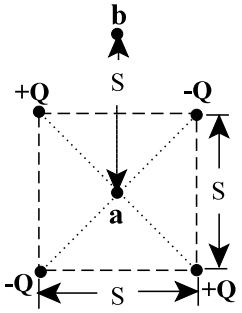
10. The potential difference which accelerated the proton from essentially rest to 2,000,000 m/s was approximately ____ V.

A) 500 B) 1,000 C) 10,000 D) 20,000 E) Over 20,000

11. If the electric field between the plates were twice as strong, 5000 N/C, then the positive charge would be _____ .

A) 0.25 Q B) 0.5 Q C) Q D) 2Q E) 4Q

The following description and sketch is used for items 12 through 14. Given four point charges, all equal in magnitude, located at the corners of a square, two at opposite corners are positive, +Q, and the other two at opposite corners are negative, -Q. Point **a** is in the middle of the square. Point **b** is a distance S directly above point **a** in the plane of the square, where S is the length of a side of the square. (This means **b** is directly above **a** and S/2 above the line joining the upper two charges.)



12. The electric potential at point **a** is _____ the electric potential at point **b**.

A) more than B) the same as C) less than

13. The electric field strength, E, at point **a** _____.

A) points in the same direction as that at point **b**
B) is greater in magnitude than that at point **b**
C) would be greater if one of the positive charges were removed
D) All of the above are true.
E) None of the above are true.

14. If one +Q and one -Q "traded places giving a situation with two minus charges at the lower corners and two positive charges at the upper corners, the electric potential at point **b** would ___.

A) increase and be rotated through ninety degrees
B) remain the same in magnitude but be rotated through ninety degrees
C) increase
D) remain the same
E) decrease

The following description is used for items 15 and 16. Given a wire 5 meters long and circular in cross-section. The cross-sectional area is 10^{-5} square meters. Assume the temperature of the wire is constant. The resistance of the wire is 0.02 ohms.

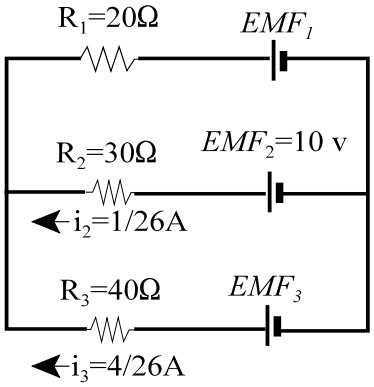
15. The resistivity of the wire is ____ x 10^{-9} ohm-meter.

A) 40 B) 30 C) 10 D) 5 E) 4

16. If the radius of the wire were doubled, the resistivity would be ____ its original value.

A) four times B) double C) the same as D) half E) one-quarter

The following description and diagram is used for items 17 and 18. Given three resistors, R_1, R_2, and R_3, of 20Ω, 30Ω, and 40Ω respectively. The currents through the resistors R_2 and R_3 are 1/26 Ampere and 4/26 Ampere respectively. EMF_2 is 10 volts.



17. EMF_3 is ____ volts.

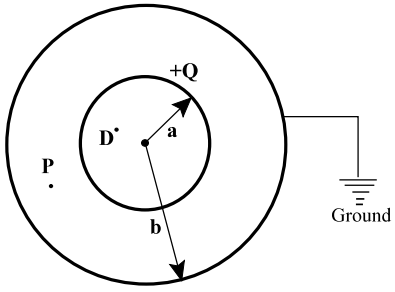
A) 45 B) 40 C) 30 D) 15

E) 7.5

18. EMF_1 is ____ volts.

A) 22.5 B) 20 C) 15 D) 10 E) 5

The following description and diagram is used for items 19 through 21. Given a hollow metal sphere of radius **a** concentric with another hollow metal sphere of radius **b**, where **b** is larger than **a**. The inner sphere has a charge +Q. The outer hollow sphere is grounded.



19. The magnitude of the electric field, E, at point D located inside the inner sphere at a distance = a/2 from the center is ___.

A) zero B) kQ/a^2 C) $4kQ/a^2$ D) $kQ(1/a^2-1/b^2)$ E) $kQ(1/b^2-1/ab)$

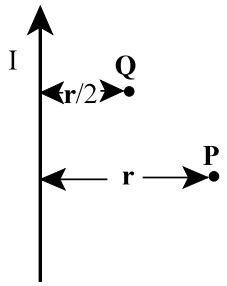
20. At point P a distance from the center halfway between the spheres, the electric potential is ___.

A) zero B) 2kQ/(b+a) C) kQ/a D) kQ(1/a-1/b) E) kQ[-1/b+2/(a+b)]

21. The charge density on the outer sphere is ____.

A) zero B) $-Q/(4\pi b^2)$ C) $Q/4\pi a^2$ D) -Q/b2 E) $-Qa^2/(4\pi b^2)$

The following description and diagram is used for items 22 and 23. Given a wire with a current I toward the top of this page. The magnetic field strength at point P, a distance r from this wire, resulting from the current in the wire is B.



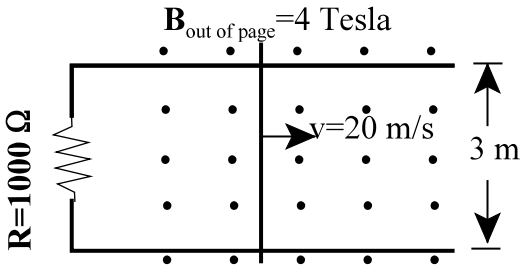
22. At point Q, half the distance, r/2, the magnetic field strength is ___.

A) 4B B) 2B C) B D) B/2 E) B/4

23. If the current were halved, the magnetic field strength at point P would be _____.

A) 4B B) 2B C) B D) B/2 E) B/4

The following description and diagram is used for items 24 and 25. A 0.010 kg wire rod slides to the right at a speed of 20 m/s on a set of parallel horizontal frictionless metal rails 3 meters apart. There is a magnetic field in the region pointing vertically upward and perpendicular to the velocity of the rod, (up and out of the page as indicated by the "·" symbols in the sketch). The magnitude of the magnetic field is 4 Tesla. The rails are connected by a 1000 Ω resistor. The resistance of the rod and rails is negligible.



24. The current in the resistor while the rod is moving is approximately ____ A.

A) 1 B) 0.2 C) 0.03 D) 0.002 E) 0.0001

25. Given the same apparatus except that the rod is at rest on the rails. The rod, rails, and resistor form a loop. The area of the loop is 3 m^2 and is entirely within the magnetic field. At time zero the magnetic field is 4 T. Then the magnetic field increases at a constant rate of 0.1 T/s. While the magnetic field is increasing, there will be a current in the resistor of ___ mA.

A) 6 B) 3 C) 0.6 D) 0.3 E) 0.06