# SECOND YEAR PHYSICS TEST - APRIL 2004

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. Unless otherwise stated assume ideal conditions including no friction with the air, no internal resistance in batteries, and no resistance in connecting wires. The direction of "current" is the direction of flow of positive charge.
Sketches are NOT to scale in any way.

Some data which may be of use....

$\mu$ = micro = $10^{-6}$ n = nano = $10^{-9}$
p = pico = $10^{-12}$

$\epsilon_0 = 8.85 \times 10^{-12}\ C^2/Nm^2$
$\mu_0 = 4\pi \times 10^{-7} Tm/A$
$e^- = 1.6 \times 10^{-19}\ C$
$k = 9 \times 10^9 Nm^2/C^2$
$m_{proton} = 1.67 \times 10^{-27}$ kg $m_e = 9.11 \times 10^{-31}$kg

1. Given four point charges, all equal in magnitude. Each one is located at a corner of a square. Two are positive, and two are negative. One charge is removed leaving the other three corners still occupied. As a result of removing one of the charges, the magnitude of the electric field, E, at the center of the square ____.

A. must increase.
B. cannot increase.
C. must decrease
D. cannot decrease.
E. may increase or decrease.

2. Given two identical small metal spherical masses suspended from light threads of equal length, R. The threads are attached at the same height, and the two masses are "side-by-side", although 0.5 R apart. The sphere on the left is given an electric charge, +Q, and the sphere on the right is given a charge, +3Q. The thread on the left makes an angle $\theta$ with the vertical. The thread on the right makes an angle ___ with the vertical.

A. $Sin^{-1}[(Sin\theta)/3]$ B. $\theta/3$ C. $\theta$

D. $Sin^{-1}(3Sin\theta)$ E. $3\theta$

***The following description applies to items 3 and 4.***

Given a horizontal uniform electric field created by two vertical, parallel metal capacitor plates located in a vacuum. The electric field between the plates is 1,500 Newtons/Coulomb. The separation between the plates is 0.02 m. The positive charge is on the left, the negative charge on the right.

3. The work done in moving an electron horizontally from left to right in the field from 0.005m to 0.015m is _____ the work done in moving a proton horizontally from right to left from 0.015 m to 0.005 m.

A. approximately 1/ 2000 as much as
B. approximately 1/45 as much as
C. the same as
D. approximately 45 times as much as
E. approximately 2,000 times as much as

4. The potential difference required to produce the electric field is ___ volts.

A. 75,000 B. 750 C. 300 D. 75 E. 30

5. Given a uniform electric field. A long, hollow, thin-walled metal cylinder of radius, R, is placed at rest in the field perpendicular to the field. A small positive test charge is placed at the center of the cylinder. Then this test charge is moved to a new position half-way between the center and the outer wall of the cylinder. The electric force on the charge when in its second position is ____ the electric force when it was in the center.

A. 0.25 times B. 0.5 times C. equal to D. double E. 4 times

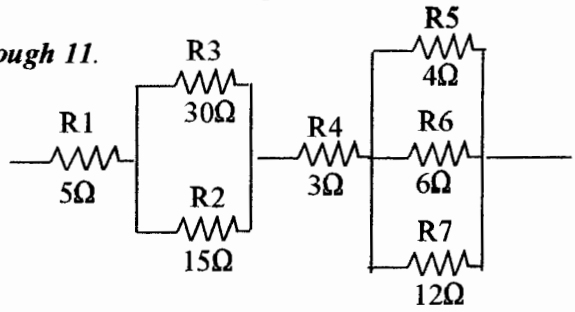
6. Given four identical resistors. They are combined in a variety of ways. Their equivalent resistance when all four are in parallel is 2.5 ohms. Of the following values, which is/are the value(s) of the equivalent resistance for a combination of the four resistors?

25 Ω 16.67 Ω 13.33 Ω 10Ω

A. 10 Ω only. B. Only 13.33 Ω and 16.67 Ω C. All but 16.67 Ω

D. All of them are possible. E. There is an error here...none is possible.

***The following diagram and description applies to items 7 through 11.***
Given the combination of 7 resistors shown....




7. The equivalent resistance for the combination of resistors is _____ ohms.

A. over 47 B. 20 C. 18.2
D. 10.1 E. 8.3

8. If the current in the 4 Ω resistor is 0.60 Ampere, then the power dissipated by the 12 Ω resistor is approximately _____ Watts.

A. 38.9 B. 12.6 C. 4.3 D. 0.48 E. 0.05

9. If the current in the 4 Ω resistor were doubled to 1.2 Ampere, then the emf of the ideal battery providing the emf to the circuit would have to be ___ times the original value.

A. 2 (double) B. 2.8 C. 4 D. 5.6 E. 8

10. If the resistors were replaced by identical bulbs and sockets, rank order the bulbs in terms of brightness, listing brightest first. Indicate equal brightness with an equal (=) sign.

A. All are equally bright
B. R1=R4, R2=R3=R5=R6=R7
C. R1=R4, R2=R3, R5=R6=R7
D. R1, R2=R3, R4, R5=R6=R7
E. R5=R6=R7, R2=R3, R1=R4

11. If bulbs R2 and R6 burn out or are removed from their sockets, rank order the brightness of the remaining five bulbs, listing brightest first. Indicate equal brightness with an equal (=) sign.
A. All are equally bright.
B. R1, R3, R4, R5, R7
C. R1=R3=R4, R5=R7
D. R1=R4, R3, R5=R7
E. R5=R7, R3, R1=R4

***The following description applies to items 12 through 15.***
Electrons are accelerated from rest to a speed of $10^7$ m/s. Then, they enter a constant magnetic field perpendicular to the field, where they travel in circular paths of radius 0.10 m.

12. The potential difference that accelerated the electrons to a speed of $10^7$ m/s was approximately ____ volts.

A. $10^{-17}$ B. $10^{-4}$ C. 110 D. 196 E. 280

13. Protons are also singly charged. The potential difference required to accelerate a proton from rest to $10^7$ m/s would be approximately ___ the potential difference required for the electron.

A. the same as B. 1 /2000 C. 1/45 D. 45 times E. 2,000 times

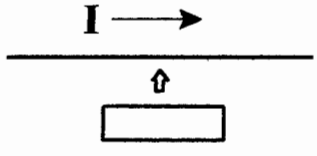
14. The magnitude of the magnetic field required for the electron to travel in the circle was approximately ___ T.

A. $10^{-7}$ B. $10^{-3}$ C. 0.1 D. 10 E. 100

15. After completing one circle the increase in the electron's kinetic energy was approximately ____ J.

A. 10 B. 1 C. 0.1 D.0.01 E.0

16. Given a horizontal wire with current from left to right. A wire loop in the shape of a rectangle with the long sides parallel to the wire and the shorter sides perpendicular to the wire is moved slowly toward the wire from the bottom as shown in the sketch.




A. No potential difference is induced in the loop.
B. A current is induced in the loop first in one direction and then another.
C. The induced potential difference is across the wire and results in no current.
D. The induced current in the loop is in a direction such that in the long side closest to the wire it is in the same direction as the current in the wire.
E. The induced current in the loop is in a direction such that in the long side closest to the wire it is in the direction opposite to the current in the wire.

17. Given an ideal transformer with two coils of wire. The input has 500 turns or coils of wire and the output has 250 turns or coils. The input is attached to a battery functioning as an ideal source of emf of 10 volts. After one minute the induced emf from the output coils would be ___ volts.

A. 20 B. 5 C. 2 D. 0.5 E. 0

18. Given a parallel plate capacitor charged so that both plates have positive charge on them. The plates are slowly moved apart. The electrostatic energy stored in the plates _____.

A. increases B. remains the same C. decreases

19. Given a horizontal uniform magnetic field. A magnetic dipole is placed in the field at 30° to the direction of the field. The net force on the dipole is ____.

A. upward perpendicular to the magnetic field.
B. downward perpendicular to the magnetic field.
C. zero
D. toward the north magnetic pole
E. toward the south magnetic pole

***The following description applies to items 20 through 22.***
Given a 53 pF ($53 \times 10^{-12}$ Farad) parallel plate capacitor with square plates 1.0 cm apart and air or vacuum between the plates. The capacitor is fully charged to 20 volts by connecting it to a battery acting as an ideal emf.

20. The length of a side of the capacitor is approximately ____ m.

A. 0.06 B. 0.12 C. 0.18 D. 0.24 E. 0.30

21. The charge on the capacitor is approximately ____ Coulomb.

A. $10^{-9}$ B. $10^{-5}$ C. 0.10 D. 1.0 E. 10

22. If the plate separation had been double its original value, the potential difference required to get the same amount of charge on the capacitor would be ___ volts.

A. 10 B. 14.1 C. 20 D. 28.2 E. 40

23. Given an air-core coil in series with a light bulb and a sinusoidal 80 Hz source of potential difference. The light bulb glows. An iron core is inserted into the coil. As a result, the light from the bulb ___.

A. is unchanged B. goes out C. dims D. brightens E. dims, brightens, dims, brightens...

***The following description applies to items 24 and 25.***
Given a frictionless track made of very thin rods and shaped similar to a U, except that all three sides are straight lines. It is in a horizontal plane, which is perpendicular to a uniform constant 0.50 T magnetic field that points vertically upward. The track has no resistance except that in the side forming the base of the U there is a 10 Ω resistor. A thin rod lays across the track, perpendicular to the long sides. It slides perpendicular to the magnetic field at a speed of 0.20 m/s along the track toward the open end of the track. The length of the sliding rod between the long sides of the track is 0.15 m.

24. The current in the 10.0 Ω resistor is approximately ___ Ampere.

A. 0.002 B. 0.20 C. 2 D. 20 E. 200

25. If the rod were not sliding, but was at rest in such a position that it formed a 0.15 m side of a rectangle with 0.20 m as the other side (area of the rectangle is therefore 0.030 $m^2$), and in addition the magnetic field were increasing uniformly at a rate of 0.15 T/s, the induced emf in the rectangular track would be ___ volts.
A. over 10 B. between 5 and 10 C. between 1 and 5
D. between 0.01 and 1 E. less than 0.01

## SECOND YEAR PHYSICS TEST - APRIL, 2004

Answer Key

| | | | |
|---|---|---|---|
| 1. | E | 14. | B |
| 2. | C | 15. | E |
| 3. | C | 16. | E |
| 4. | E | 17. | E |
| 5. | C | 18. | C |
| 6. | D | 19. | C |
| 7. | B | 20. | D |
| 8. | D | 21. | A |
| 9. | A | 22. | E |
| 10. | C | 23. | C |
| 11. | C | 24. | A |
| 12. | E | 25. | E |
| 13. | E | | |

**Testing Dates for the New Jersey Science League Competitions**
**THURSDAY JANUARY 13, 2005**
**THURSDAY FEBRUARY 10, 2005**
**THURSDAY MARCH 10, 2005**
**THURSDAY APRIL 14, 2005**