Exam 2 PHYS-241
November 4, 2004

1.- Two 8 1/2" x 11" crib sheets are allowed. It must be of your own creation.

2.- Please print your name on the top edge of the op-scan sheet and sign it.

3.- Use a #2 pencil to fill in your full name, your student identification number,your recitation division number, and finally the answers for problems 1–12.

$$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^{9}\ \frac{\mathrm{N\cdot m^2}}{\mathrm{C^2}}$$

$$\varepsilon_0 = 8.85\times10^{-12}\ \frac{\mathrm{C^2}}{\mathrm{N\cdot m^2}}$$

$$\mu_0 = 4\pi\times10^{-7}\ \frac{\mathrm{N}}{\mathrm{A^2}}$$

$$e = 1.602\times10^{-19}\ \mathrm{C}$$

$c = 2.99792458\times10^{8}$ m/s (speed of light)

$N_{Avogadro} = 6.022\times10^{23}$ (number of atoms in 12 g of ^{12}C)

$\mathrm{m}\Rightarrow10^{-3}\quad \mu\Rightarrow10^{-6}\quad \mathrm{n}\Rightarrow10^{-9}\quad \mathrm{p}\Rightarrow10^{-12}\quad \mathrm{f}\Rightarrow10^{-15}$

$\mathrm{k}\Rightarrow10^{3}\quad \mathrm{M}\Rightarrow10^{6}\quad \mathrm{G}\Rightarrow10^{9}\quad \mathrm{T}\Rightarrow10^{12}\quad \mathrm{P}\Rightarrow10^{15}$

For $ax^2+bx+c=0$

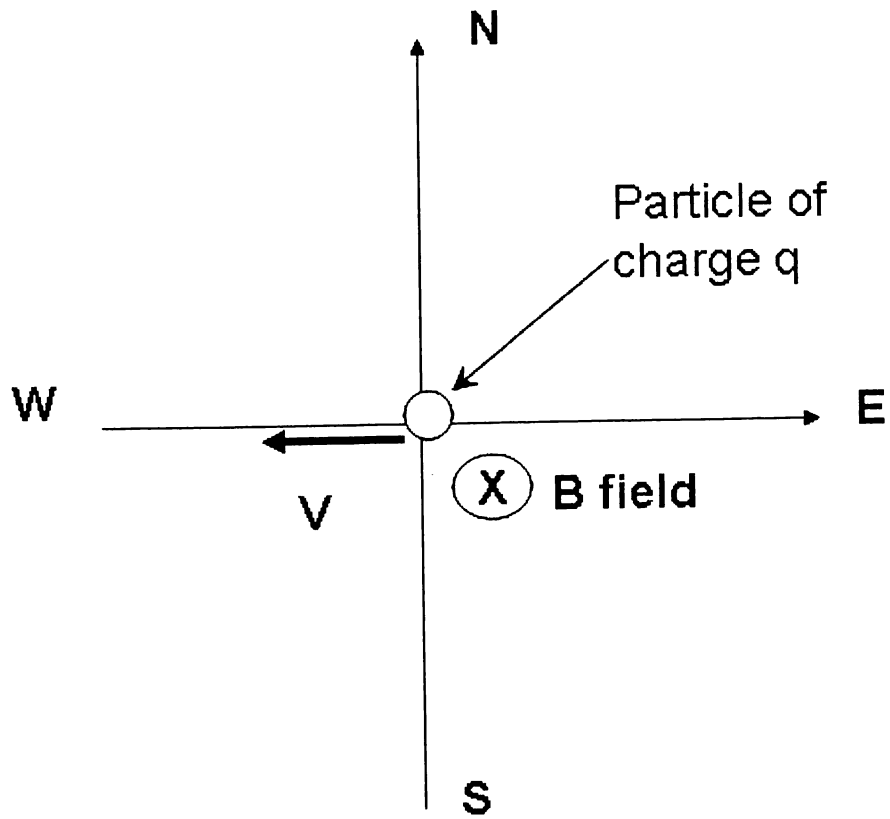
$$x = \frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

1. Two copper wires have the same volume, but wire 2 is 10% longer than wire 1 (Hint: If the volume remains constant but the length increases, does the cross-sectional area change?). The ratio of the resistances of the two wires R_2/R_1 is:

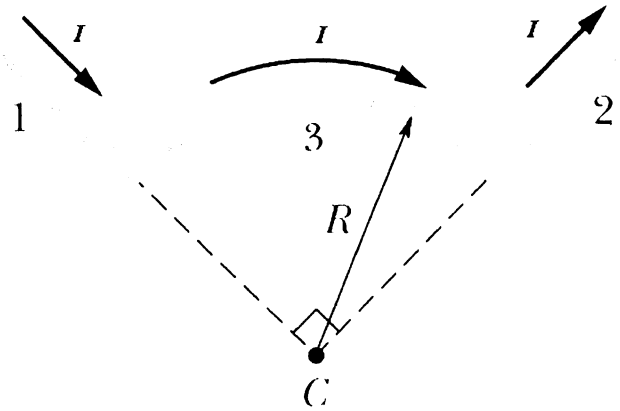
A) 1.2
B) 1.1
C) 0.82
D) 0.91
E) 1.0

2. A charged particle is moving horizontally westward with a velocity of 3.5×10^{6} m/s in a region where there is a magnetic field of magnitude 5.6×10^{-5} T directed vertically downward. The particle experiences a force of 7.8×10^{-16} N northward. What is the charge on the particle?

A) $+4.0 \times 10^{-18}$ C
B) -4.0×10^{-18} C
C) $+4.9 \times 10^{-5}$ C
D) -1.2×10^{-14} C
E) $+1.4 \times 10^{-11}$ C



3. The wire in the figure carries a current I and consists of a circular arc of radius R and central angle $\pi/2$ rad, and two straight sections whose extensions intersect the center C of the arc. What magnetic field $\vec{B}$ does the current produce at C?



A) $\frac{\mu_o I}{R}\left(\frac{1}{\pi}+\frac{1}{8}\right)$

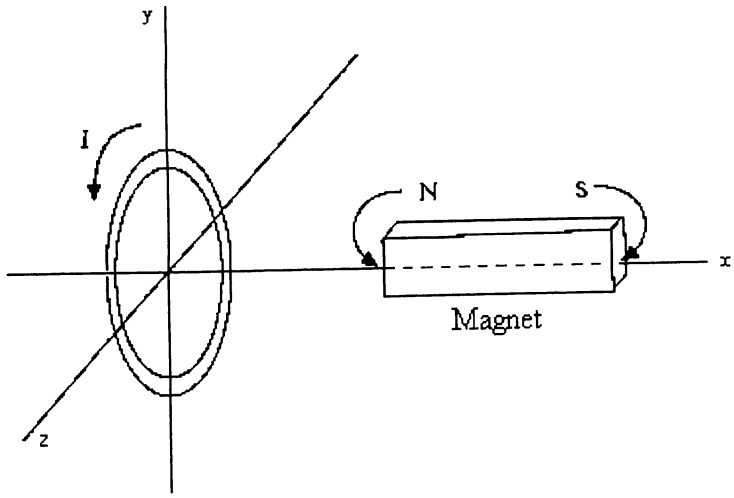
B) $\frac{90\mu_o I}{4\pi R}$

C) $\frac{\mu_o I}{4\pi R}$

D) $\frac{\mu_o I}{8R}$

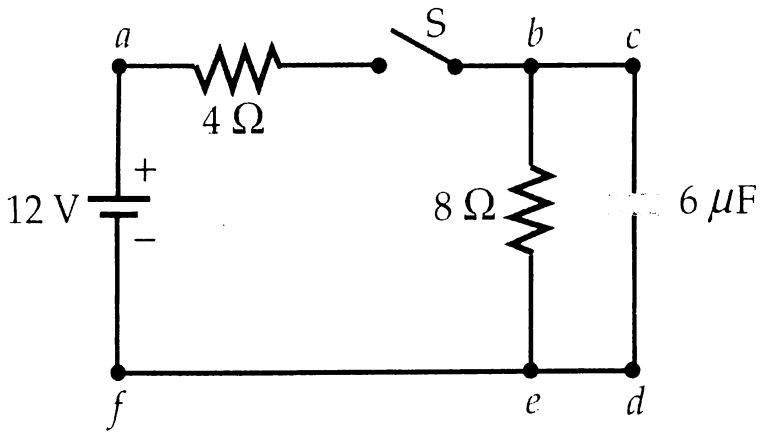
E) 0

4. A copper ring lies in the *yz* plane as shown. The magnet's long axis lies along the *x* axis. Induced current flows through the ring as indicated. The magnet



A) must be moving away from the ring.
B) must be moving toward the ring.
C) must be accelerating away from the ring
D) is not necessarily moving.
E) must remain stationary to keep the current flowing.

5. The 6-μF capacitor in the circuit shown in the figure is initially uncharged. Find the current through the 4-Ω resistor and the current through the 8-Ω resistor:
(i) immediately after the switch is closed,
(ii) a long time after the switch is closed,
(iii) Find the charge on the capacitor a long time after the switch is closed.



A) (i) $I_{4\Omega} = I_{8\Omega} = 1A$; (ii) $I_{4\Omega} = 3A$ *and* $I_{8\Omega} = 0A$; (iii) $0\mu C$

B) (i) $I_{4\Omega} = I_{8\Omega} = 1A$; (ii) $I_{4\Omega} = I_{8\Omega} = 1A$; (iii) $48\mu C$

C) (i) $I_{4\Omega} = 3A, I_{8\Omega} = 0A$; (ii) $I_{4\Omega} = 3A$ *and* $I_{8\Omega} = 0A$; (iii) $0\mu C$

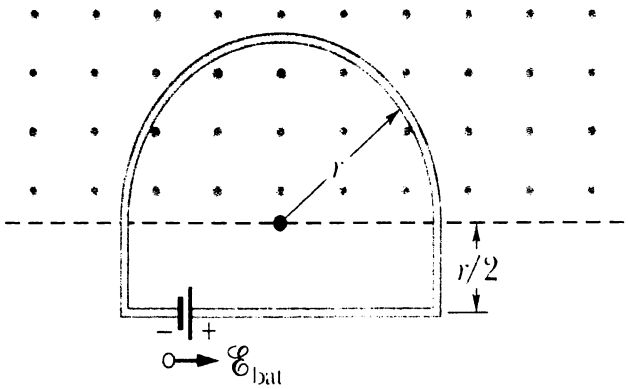
D) (i) $I_{4\Omega} = 3A, I_{8\Omega} = 0A$; (ii) $I_{4\Omega} = I_{8\Omega} = 1A$; (iii) $48\mu C$

E) (i) $I_{4\Omega} = 0A, I_{8\Omega} = 3A$; (ii) $I_{4\Omega} = I_{8\Omega} = 3A$; (iii) $144\mu C$

6. The figure shows a conducting loop consisting of a half-circle of radius r = 0.20 m and three straight sections. The half-circle lies in a uniform magnetic field of $\vec{B}$ that is directed out of the page; the field magnitude is given by $B = 4.0t^2 + 2.0t + 3.0$, with B in teslas and t in seconds. An ideal battery with emf $\varepsilon_{bat} = 2.0$ V is connected to the loop. The resistance of the loop is 2.0 Ω.

(i) What is the magnitude of the emf ε_{ind} induced around the loop by field $\vec{B}$ at $t = 10$ s?

(ii) What are the magnitude and direction of the current in the loop at $t = 10$ s?



A) (i) 1.3 V; (ii) 0.63 A clockwise

B) (i) 1.3 V; (ii) 0.63 A counterclockwise

C) (i) 0 V; (ii) 0 A

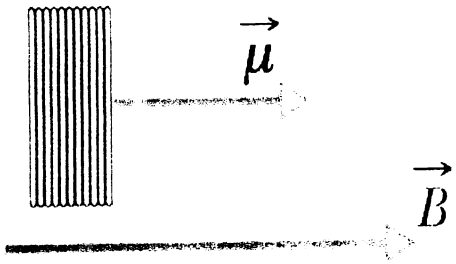
D) (i) 5.2 V; (ii) 1.6 A clockwise

E) (i) 5.2 V; (ii) 1.6 A counterclockwise

7. Two long, straight, parallel wires 11 cm apart carry currents of equal magnitude I. They repel each other with a force per unit length of 4.2 nN/m. Are the currents "parallel" or "antiparallel"? What is the magnitude of the current I?

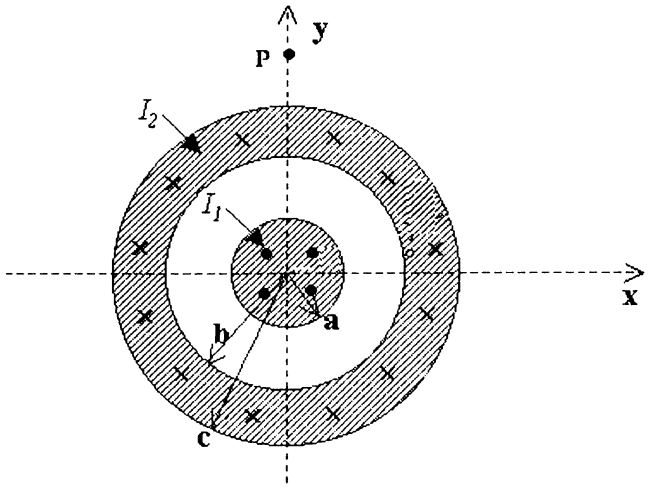
A) antiparallel; I=0.096A
B) parallel; I=0.0023A
C) antiparallel; I=0.0023A
D) parallel; I=0.048A
E) antiparallel; I=0.048A

8. The figure shows a circular coil with 250 turns, an area A of 2.52 x 10^{-4} m^2, and a current of 100 μA. The coil is at rest in a uniform magnetic field of magnitude B = 0.85 T, with its magnetic dipole moment $\vec{\mu}$ initially aligned with $\vec{B}$. How much work would the torque applied by an external agent have to do on the coil to rotate it 90° from its initial orientation, so that $\vec{\mu}$ is perpendicular to $\vec{B}$ and the coil is again at rest?



A) -10.72 μJ
B) -5.36 μJ
C) 0 μJ
D) 10.72 μJ
E) 5.36 μJ

9. Two very long coaxial cylindrical conductors are shown in cross-section below. The inner cylinder has radius $a = 2$ cm and carries a total current of $I_1 = 1.2$ A in the positive z-direction (pointing out of the page). The outer cylinder has an inner radius $b = 4$ cm, outer radius $c = 6$ cm and carries a current of $I_2 = 2.4$ A in the negative z-direction (pointing into the page). You may assume that the current is uniformly distributed over the cross-sectional area of the conductors. What are the magnitude and direction of the magnetic field B at point P which lies on the y axis at y = 8 cm?



A) $0T$

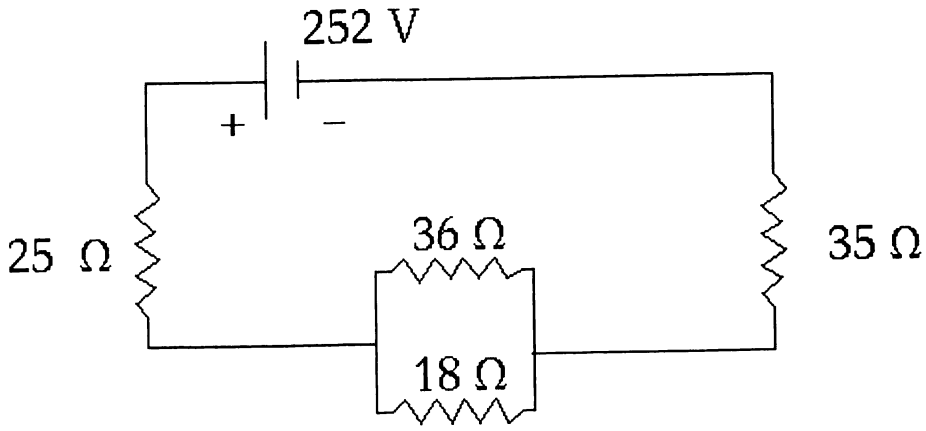
B) $9\times10^{-6}T$ in the negative x direction

C) $9\times10^{-6}T$ in the positive x direction

D) $3\times10^{-6}T$ in the negative x direction

E) $3\times10^{-6}T$ in the positive x direction

10. In the circuit shown, the power dissipated in the 18-Ω resistor is



A) 0.15 kW
B) 98 W
C) 33 W
D) 0.33 kW
E) 47 W

11. A parallel-plate capacitor has square plates of side 12 cm and a separation of 6.0 mm. A dielectric slab of constant $\kappa = 2.0$ has the same area as the plates but has a thickness of 3.0 mm. What is the capacitance of this capacitor with the dielectric slab between its plates?

A) 28 pF
B) 21 pF
C) 16 pF
D) 37 pF
E) 53 pF

12. An electric field of 3.0 kV/m is perpendicular to a magnetic field of 0.20 T. An electron moving in a direction perpendicular to both $\vec{E}$ and $\vec{B}$ is not deflected if it has a velocity of

A) 6 km/s
B) 9 km/s
C) 12 km/s
D) 15 km/s
E) 6.7 m/s

Answer Key

1. A
2. B
3. D
4. B
5. D
6. D
7. E
8. E
9. E
10. B
11. A
12. D