DEPARTMENT OF PHYSICS

PHYCS 102

TEST # 2

Time: 11:00 – 11:55 am

Question	Marks
MCQ	(/50)
Problem 1	(/25)
Problem 2	(/25)
Total	(/100)
Total	(/15)

Use BLOCK LETTERS:

Full Name:______________________________

Student ID #.:_____________________________

Section :______________________________

Student Signature:_________________________

Date: 30/5/2006

*** Use:** $\pi = 3.14$ Charge of an electron or a proton $= 1.6\times10^{-19}$C,

$m_e = 9.11\times10^{-31}$ kg, $m_p = 1.67\times10^{-27}$ kg

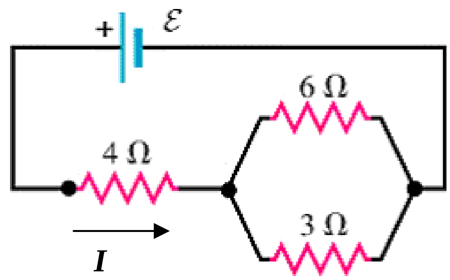
$k = 9\times10^{9}$ N.m^2/C^2, $\varepsilon_0 = 8.84\times10^{-12}$ C^2/N.m^2 $\mu_0 = 4\pi\times10^{-7}$ Wb/A.m

PART A: MCQs

*** Choose the correct answer.**
*** Each one of the 10 questions carries the same weight (5 Marks).**

1) If the current passing through the 4 Ω resistor is 1A, then the emf of the battery ε (in V) is:

a) 3
b) 6
c) 12
d) 18
e) 24



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2) A 100 W light bulb operates using a 200V potential difference. The amount of charge (in C) passing through the light bulb in 3 minutes is:

a) 30
b) 60
c) 90
d) 120
e) 150

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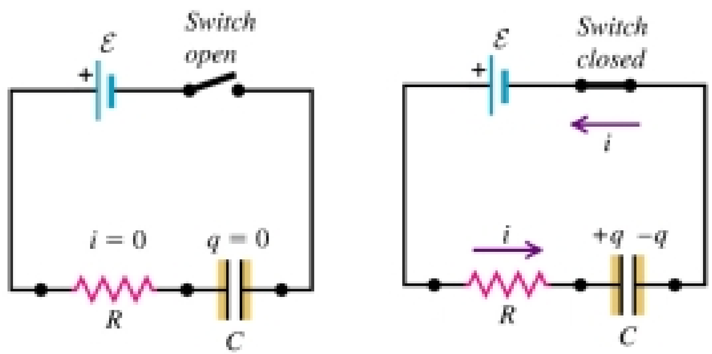
3) In the figure shown R= 1kΩ, C = 10 μF and ε = 10 V. If, initially, the capacitor was uncharged, after closing the switch for a time $t = 5x10^{-3}$ s the current i (in mA) is:

a) 6.07
b) 3.68
c) 2.23
d) 1.35
e) zero



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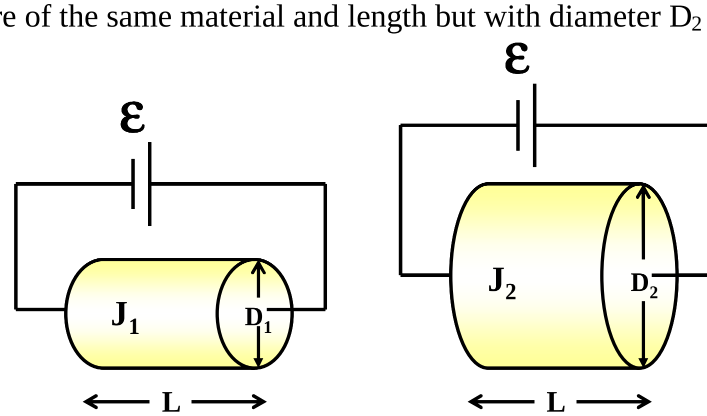
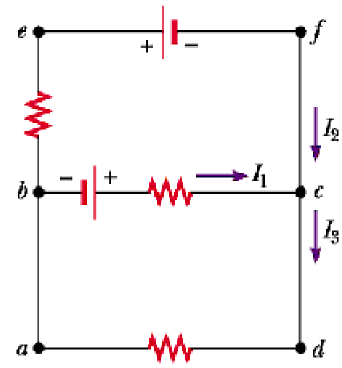
4) A wire of diameter D_1 and length L is connected to a battery with an emf ε. The current density in the wire is J_1. If the wire is replaced by another wire of the same material and length but with diameter $D_2 = 2D_1$, the current density J_2 is equal to:

a) $2J_1$
b) J_1
c) $J_1/2$
d) $4J_1$
e) $J_1/4$



5) In the circuit shown, at junction c the currents I_1 and I_2 are entering, while the current I_3 is leaving. Which of the following is correct?



a) $I_1 + I_2 + 2\,I_3 = 0$
b) $-I_1 + I_2 - I_3 = 0$
c) $-I_1 - I_2 + I_3 = 0$
d) $I_1 - I_2 - I_3 = 0$
e) $2I_1 + 3I_2 - I_3 = 0$

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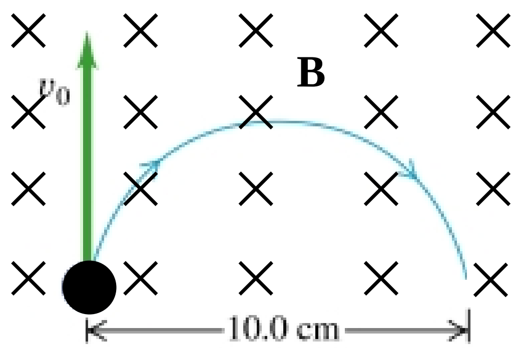
6) An ion is moving with $\upsilon_0 = 2\text{x}10^6$ m/s enters a uniform magnetic field B = 500 mT directed into the page. If the ion is deflected as shown in the figure, then the ratio of its charge to mass (in C/kg) is:



a) $-6\text{x}10^7$
b) $8\text{x}10^7$
c) -4×10^7
d) 4×10^7
e) -8×10^7

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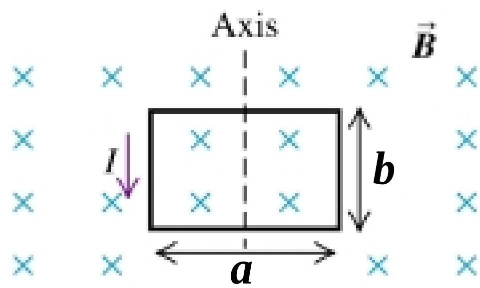
7) A rectangular loop carrying a current I is placed in a uniform magnetic field B pointing into the page, as shown in the figure. If the loop is free to rotate about the axis shown, then the net force and torque on the current loop is:



a) $F = 0, \tau = 0$
b) $F = 0, \tau \neq 0$
c) $F \neq 0, \tau = 0$
d) $F \neq 0, \tau \neq 0$
e) None of the above

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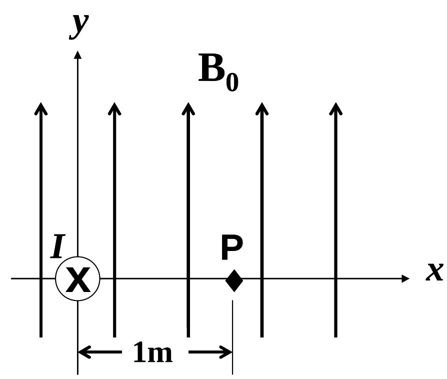
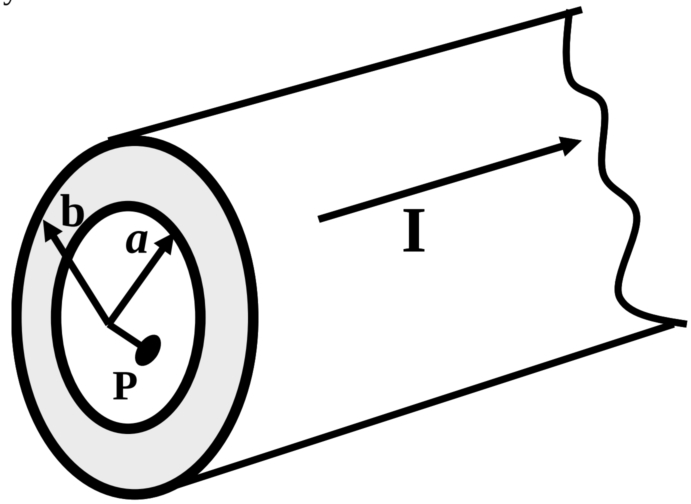
8) A long straight wire carries current I = 10 A pointing into the page at the origin. In addition to the magnetic field due to the wire, there is a uniform external magnetic field $B_0 = 2\ \mu T$ directed along the positive y-axis as shown in the figure. The total magnetic filed (in μT) at point **P** is:



a) zero
b) 2
c) 4
d) 8
e) 16

9) An infinitely long hollow conductor has an inner radius *a* and an outer radius b. The conductor carries current I uniformly distributed across a section of the shell as shown in the figure. The magnetic filed at point P located in the hollow region is given by:

a) $\frac{\mu_0 I}{2\pi b}$
b) $\frac{\mu_0 I}{2\pi a}$
c) $\frac{\mu_0 I}{2b}$
d) $\frac{\mu_0 I}{2a}$
e) zero



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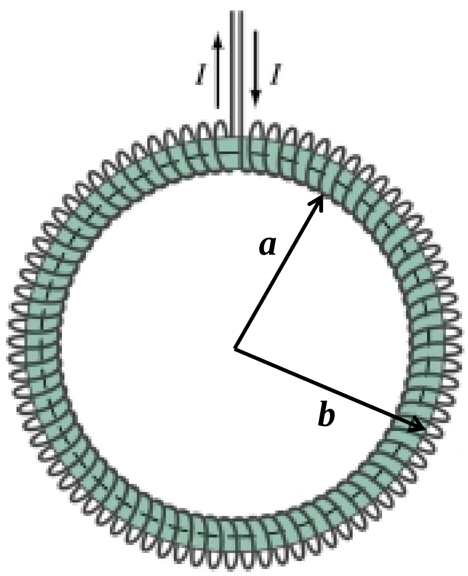
10) A toroid has inner radius a = 9 cm and outer radius b = 11 cm as shown in the figure. If the toroid consists of 100 turns and carries current of 3 A, the magnetic field (in μT) at radius r = 10 cm from its center is:

a) 200
b) 400
c) 600
d) 800
e) zero



Answers for multiple choices (MCQ) of test two

MCQ #	1	2	3	4
Ans	B	C	A	B

MCQ #	5	6	7	8
Ans	C	E	A	A

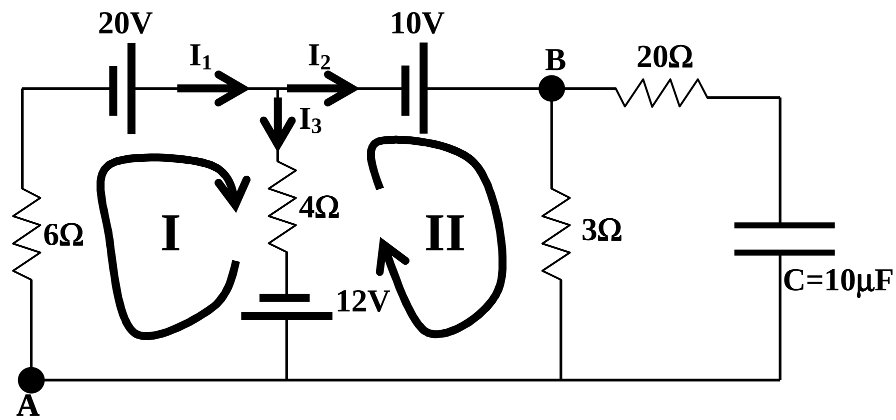
MCQ #	9	10
Ans	E	C

PART B: Problems

- **Each problem carries 25 marks.**

Problem # 1:

Consider the circuit shown in the figure. The circuit is kept running for a very long time.



[15 Marks] (a) Find the currents I_1, I_2, and I_3.

$$\because \sum I = 0 \Leftrightarrow I_1 = I_2 + I_3 ....(1)$$
$$Loop\ I : \sum \varepsilon = \sum IR \Rightarrow 20 + 12 = 6I_1 + 4I_3 \Rightarrow 32 = 6I_1 + 4I_3.....(2)$$
$$Loop\ II : \sum \varepsilon = \sum IR \Rightarrow 10 - 12 = 3I_2 - 4I_3 \Rightarrow 2 = -3I_1 + 4I_3.....(3)$$
$$Substitute\ \ Eqn(1)\,\text{int}\,o\ (2):$$
$$32 = 6I_2 + 10I_3.....(4)$$
$$Multiply\ Eqn(3)\,by\,2 \Rightarrow 4 = -6I_2 + 8I_3.....(5)$$
$$Add\ Eqn(5)\ and\ Eqn(4):$$
$$36 = 18I_3 \Rightarrow \therefore I_3 = 2\ A$$
$$Substitute\ I_3\ \text{int}\,o\ Eqn(5) \Rightarrow I_2 = 2\ A$$
$$Substitute\ I_2\ and\ I_3\ \text{int}\,o\ Eqn(1) \Rightarrow I_1 = 4\ A$$

[5 Marks] (b) Determine the voltage V_{AB}.

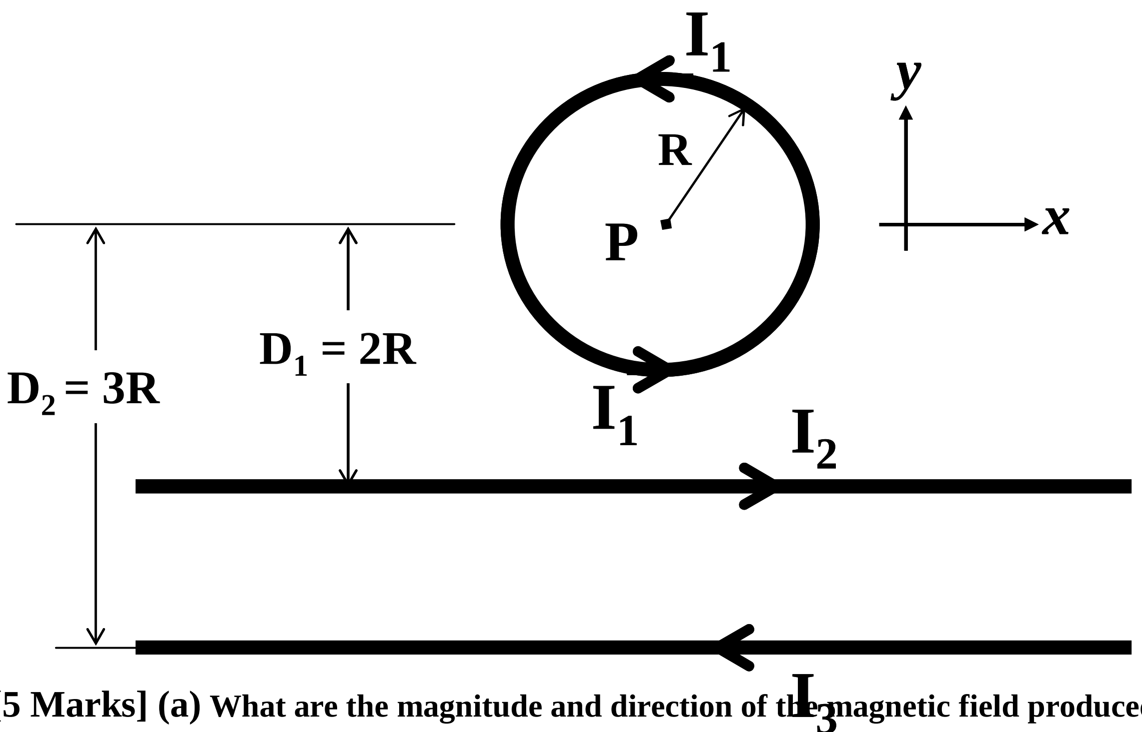
$$V_{AB} = -10V - 20V + (6 \times 4)V = -6\,V$$

[5 Marks] (c) Calculate the final charge on the capacitor.

$$\because C = \frac{Q}{V_{AB}} \Rightarrow \therefore Q = CV_{AB} = (10 \times 10^{-6})(6) = 60\mu C$$

Problem # 2:

Three current-carrying conductors are arranged in the same plane as shown in the figure. A circular loop with radius R = 10 cm carries current I_1 = 4 A. The centre of the loop is a distance D_1 = 2R and D_2 = 3R above the two -very long- straight wires which are carrying equal but opposite currents $I_2 = I_3$ = 10 A.



[5 Marks] (a) What are the magnitude and direction of the magnetic field produced by current I_1 at point P?

$$\because\ B = \frac{\mu_0 I}{2R},\ \therefore\ B_{I_1} = \frac{(4\pi \times 10^{-7}\ Wb/A.m)(4\ A)}{2(0.1\,m)} = 25.12\ \mu T$$

The field is directed out of the page.

[5 Marks] (b) What are the magnitude and direction of the magnetic field produced by currents I_2 at point P?

$$\because\ B = \frac{\mu_0 I}{2\pi D_1}$$

$$\therefore\ B_{I_2} = \frac{(4\pi \times 10^{-7}\ Wb/A.m)(10\ A)}{2(3.14)(0.2\ m)} = 10\ \mu T$$

The field is directed out of the page.

[5 Marks] (c) What are the magnitude and direction of the magnetic field produced by current I_3 at point P?

$$\because\ B = \frac{\mu_0 I}{2\pi D_2},\quad \therefore\ B_{I_3} = \frac{(4\pi \times 10^{-7}\ Wb/A.m)(10\ A)}{2(3.14)(0.3\,m)} = 6.67\ \mu T$$

The field is directed into the page.

[5 Marks] (d) Determine the magnitude and direction of the net magnetic field at point P.

$$\because\ B_{net} = B_{I_1} + B_{I_2} - B_{I_3}$$

$$\therefore\ B_{net} = (25.12 + 10 - 6.67)\ \mu T$$

$$\therefore\ B_{net} = 28.5\ \mu T$$

The field is out of the page.

[5 Marks] (e) If at point P an electron is projected along the positive x-axis with υ = 2x10^6 m/s, determine the magnitude and direction of the magnetic force acting on it due to the net magnetic field produced by currents I_1, I_2 and I_3.

$$\because\ \vec{F} = q\vec{\upsilon} \times \vec{B}$$

$$\therefore\ \vec{F} = (-1.6 \times 10^{-19}\ C)\{(2 \times 10^{6}\ m/s)(28.5 \times 10^{-6}\ T)(\hat{i} \times \hat{k})\}$$

$$\therefore\ \vec{F} = (-1.6 \times 10^{-19})\{-57\,\hat{j}\}$$

$$\therefore\ \vec{F} = 9.12 \times 10^{-18}\ \hat{j}N$$

$$\therefore\ F = 9.12 \times 10^{-18}\ N \text{ along the positive } y-axis.$$