# PHYSICS 241

Name:_____ID#:_____

This is a closed book exam. Print and encode your name, student ID number, and recitation number on the answer sheet. Answers to all the questions are to be recorded on the answer sheet. There are 10 multiple choice questions for a total of 100 points. Do not do the problems in the order in which they are given. Do the easy problems first. There is only one correct answer to each question. No penalty for a wrong answer. However, all credit for a question will be lost if more than one choice is marked for that question. You may use your crib sheet and calculator. Fill out the op-scan card gradually, as soon as you finish a problem. Do not wait filling out the op-scan card during the last hectic five minutes!

## USEFUL CONSTANTS:

$k_e \equiv 1/(4\pi\epsilon_0) = 8.99 \times 10^9 \ (Nm^2/C^2)$

$\epsilon_0 = 8.85 \times 10^{-12} \ (C^2/Nm^2)$

$\epsilon = 1.60 \times 10^{-19} \ (C)$

$m_e = 9.11 \times 10^{-31} \ (kg)$

$g = 9.81 \ (m/s^2)$

$m_p = 1.67 \times 10^{-27} \ (kg)$

proton charge = electron charge (in magnitude).
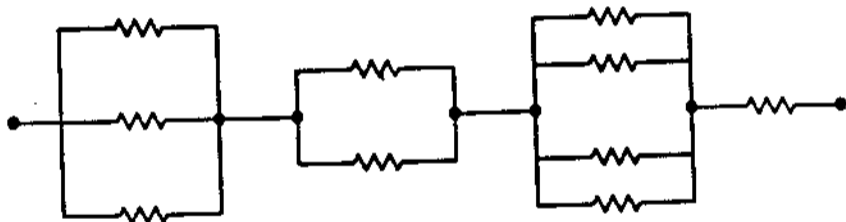
$\mu_0/4\pi = 10^{-7}$

$c = 3.00 \times 10^8 \ m/s$

Atomic Mass Unit (AMU) $= 1.66 \times 10^{-27} \ Kg$

1. (10 points) Each of the resistors in the diagram is 12 Ω. The resistance of the entire circuit is:

(A)( )   5.76 Ω
(B)( )   25 Ω
(C)( )   48 Ω
(D)( )   120 Ω
(E)( )   None of these

2. (10 points) In the circuit shown, the capacitor is initially uncharged. V = 9 Volts. At time $t = 0$, switch $S$ is closed. If $\tau$ denotes the time constant, the approximate current through the 3 $\Omega$ resistor when $t = \tau/100$ is:

(A)(  )  3/8 A
(B)(  )  1/2 A
(C)(  )  3/4 A
(D)(  )  1 A
(E)(  )  3/2 A
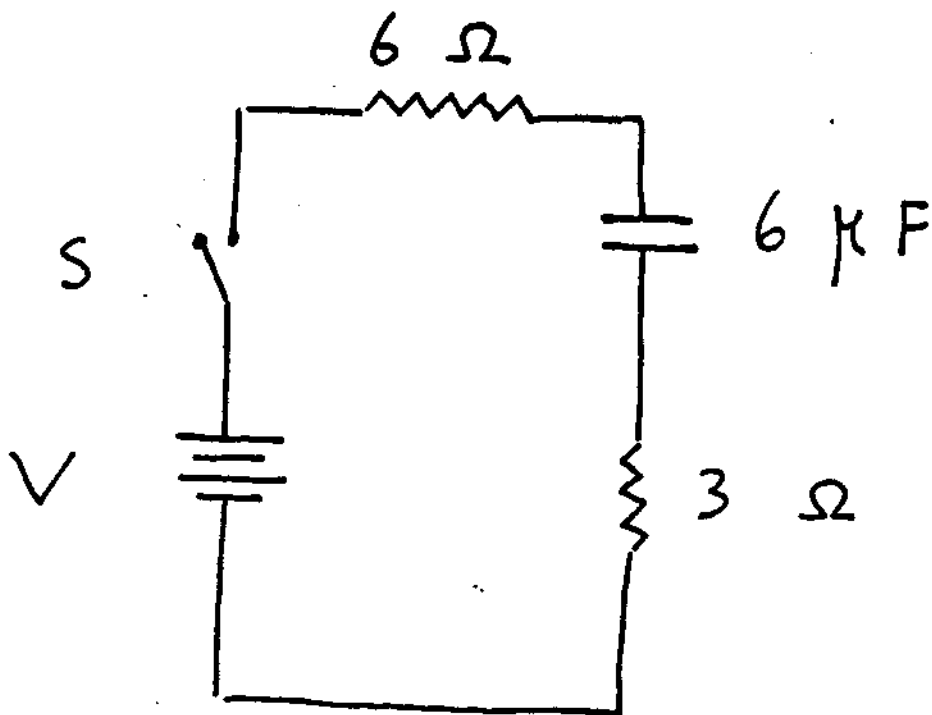
3. (10 points) At one instant an electron (charge $= -1.6 \times 10^{-19}$ C) is moving in the $xy$ plane, the components of its velocity being $v_x = 5 \times 10^5$ m/s and $v_y = 3 \times 10^5$ m/s. A magnetic field of 0.8 T is in the positive $z$ direction. At that instant the magnitude of the magnetic force on the electron is:

(A)(  )   0
(B)(  )   $3.8 \times 10^{-14}$ N
(C)(  )   $5.1 \times 10^{-14}$ N
(D)(  )   $6.4 \times 10^{-14}$ N
(E)(  )   $7.5 \times 10^{-14}$ N

4. (10 points) A loop of wire carrying a current of 2.0 A is in the shape of a right triangle with two equal sides, each 15 cm long. A 0.7 T uniform magnetic field is in the plane of the triangle and is perpendicular to the hypotenuse. The resultant magnetic force on the two sides has a magnitude of:

(A)(  )  0
(B)(  )  0.21 N
(C)(  )  0.30 N
(D)(  )  0.41 N
(E)(  )  0.51 N

5. (10 points) Two parallel wires, 4 cm apart, carry currents of 2 A and 4 A respectively, in opposite directions. The force per unit length in N/m of one wire on the other is:

(A)( )  $1 \times 10^{-3}$, repulsive
(B)( )  $1 \times 10^{-3}$, attractive
(C)( )  $4 \times 10^{-5}$, repulsive
(D)( )  $4 \times 10^{-5}$, attractive
(E)( )  none of these

6. (10 points) Two long straight wires enter a room through a window. One carries a current of 3.0 A into the room while the other carries a current of 5.0 A out. The magnitude in T·m of the path integral $\oint \vec{B} \cdot d\vec{s}$ around the window frame is:

(A)(  )  $2.5 \times 10^{-6}$
(B)(  )  $3.8 \times 10^{-6}$
(C)(  )  $6.3 \times 10^{-6}$
(D)(  )  $1.0 \times 10^{-5}$
(E)(  )  none of these

7. (10 points) A single loop of wire with a radius of 7.5 cm rotates about a diameter in a uniform magnetic field of 1.6 T. The axis of rotation is perpendicular to the magnetic field. To produce a maximum emf of 1.0 V, it should rotate at:

(A)( )  0
(B)( )  2.7 rad/s
(C)( )  5.6 rad/s
(D)( )  35 rad/s
(E)( )  71 rad/s

8. (10 points) A 6.0 mH inductor and a 3.0 $\Omega$ resistor are wired in series to a 12 V ideal battery. A switch in the circuit is closed at time 0, at which time the current is zero. 2.0 ms later the energy stored in the inductor is:

(A)( )  0
(B)( )  $1.92 \times 10^{-2}$ J
(C)( )  $1.1 \times 10^{-3}$ J
(D)( )  $1.8 \times 10^{-3}$ J
(E)( )  $2.2 \times 10^{-3}$ J

9. (10 points) An $LC$ circuit has a capacitance of 30 $\mu$F and an inductance of 15 mH. At time $t = 0$ the charge on the capacitor is 10 $\mu$C and the current is 20 mA. The maximum current is:

(A)(  )   18 mA
(B)(  )   20 mA
(C)(  )   25 mA
(D)(  )   35 mA
(E)(  )   42 mA

10. (10 points) What resistance $R$ should be connected in series with an inductance $L = 220$ mH and capacitance $C = 12.0$ $\mu$F for the maximum charge on the capacitor to decay to 99.0% of its initial value in 50.0 cycles? (Assume $\omega' \approx \omega$.)

(A)( )   $4.33 \times 10^{-2}$ $\Omega$
(B)( )   $4.33 \times 10^{-3}$ $\Omega$
(C)( )   $6.35 \times 10^{-4}$ $\Omega$
(D)( )   $8.66 \times 10^{-3}$ $\Omega$
(E)( )   $9.57 \times 10^{-6}$ $\Omega$

Exam 2

1) B
2) D
3) E
4) C
5) C
6) A
7) D
8) B
9) C
10) D