THE IUG — PHYSB 1301 — DEPT. OF PHYSICS

DATE:8-5-2011 — SECOND MID EXAM. — TIME:1-Hr

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PART I: choose the correct answer (15×4=60 pts)

1) Conduction electrons move to the right in a certain wire. This indicates that:

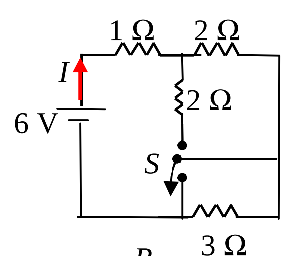
a) current and electric field point right.
b) current points right while electric field points left.
c) current and electric field point left.
d) current points left while electric field points right.

2) A cylindrical copper wire of radius r and length l has resistance R. If r and l is doubled the resistance of the wire is:

a) R b) $0.5R$ c) $2R$ d) $4R$

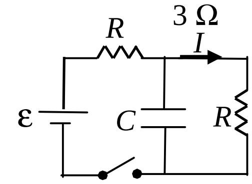
3) A light bulb is marked 60 W and 120 V. Its resistance is

a) 60 Ω b) 120 Ω c) 180 Ω d) 240 Ω



4) For the circuit shown, if the double-throw switch S is thrown to its lower position, the current I is:

a) 1 A b) 2 A c) 1.2 A d) zero



5) Consider the circuit shown. Just after the switch is closed (t=0), the current I shown in the figure (in the right resisitor) is:

a) $\frac{e}{2R}$ b) $\frac{2e}{R}$ c) $\frac{e}{R}$ d) zero

6) The unit of the magnetic field might be:

a) C.m/s b) C.s/m c) N/C.m d) kg/C.s

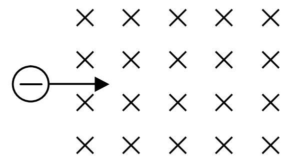
7) The magnetic force on a charged particle is in the direction of its velocity:

a) if it is moving in the direction of the field.
b) if it is moving perpendicular to the field.
c) if it is moving opposite to the direction of the field.
d) never.

8) A charged particle moves with velocity ***v*** in a uniform magnetic field ***B***. The magnetic force on the particle is maximum when:

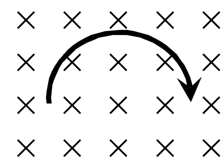
a) ***v*** parallel to ***B***. b) ***v*** perpendicular to ***B***. c) when ***v*** is zero. d) v makes 45^o with *B*.

9) After entering the magnetic field, the electron will deflect:



a) up b) down
c) out of page d) into the page

10) A wire is bent into the form of a semicircle of radius *R*. If the wire has a current *I* and present in a uniform magnetic field *B* directed into the page as shown. The magnetic force acting on the wire is:

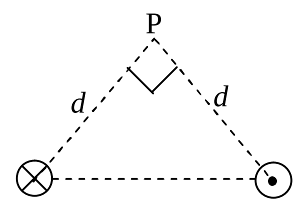


a) 2*RIB* up. b) 2*RIB* down. c) π*RIB* up. d) π*RIB* down.

11) A charge *q* of mass *m* inters a region of uniform magnetic field *B* with speed *v* perpendiculat to ***B***. The radius of its motion is:

a) $r = \frac{mv}{qB}$ b) $r = \frac{mq}{vB}$ c) $r = \frac{qBr}{m}$ d) $r = \frac{qB}{mv}$

12) the figure shows two long parallel wires of equall currents directed as shown. The direction of the magnetic field at point P is:

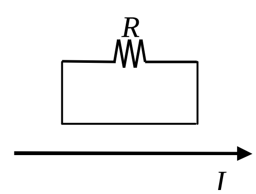


a) up b) down c) left d) right

13) A loop of area *A* exists in a uniform magnetic field *B*. For an induced current to be set up in the loop:

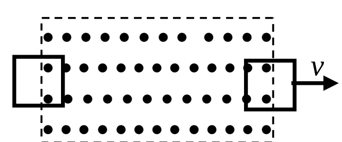
a) the magnetic fileld must vary with time. b) the area must vary with time.
c) the loop must rotate with time. d) all of them.

14) If the current in the figure shown is **decreasing**, the direction of the induced current in the resistor *R* is:



a) right. b) left. c) zero. d) not known.

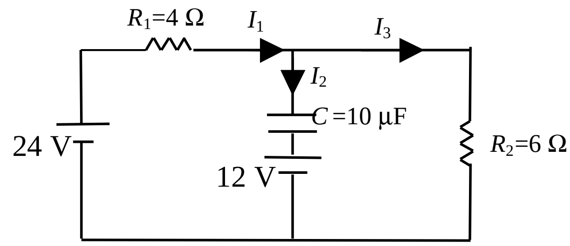
15) The figure shows a rectangular loop moves at constant velocity through a region of uniform magnetic field directed out of the page. For the two indicated positions of the loop, which of the following is correct ?



a) the induced currents are in the same direction for both positions.
b) the magnetic fux through both positions is constant.
c) the magnetic forces on both positions are in the same directions.
d) the magnetic forces on both positions are in opposite directions.

PART II: Solve the following problems (4×10=40 pts)

Q1) In the *RC* circiut shown, find the maximum charge on the capacitor.



At t→∞, the capacitor acts as an open circuit⇒ $I_2=0.$ ⇒

$$I_1 = I_3 = \frac{24}{(6+4)} = 2.4A$$

To find the charge on the capacitor we need the voltage across it. Now applying Kirchoff's second rule to the left loop we have

$$V_C = 24 - I_1R_1 - 12 = 24 - 9.6 - 12 = 2.4V$$

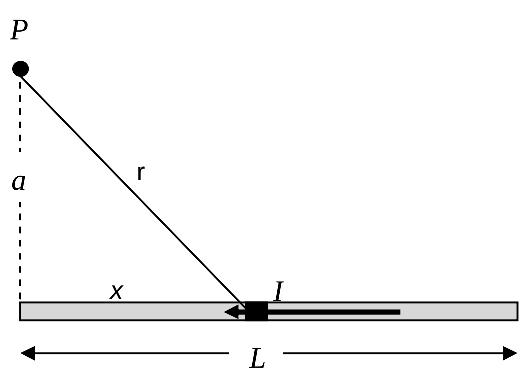
$$\Rightarrow Q = V_C C = 2.4(10\mu F) = 24\,\mu C$$

Note that by applying Kirchoff's second rule to the lright loop we have

$$V_C = 12 - I_3R_2 = 12 - 14.4 = 2.4V$$

Q2) A straight wire of length *L* carries a current *I* as shown. Using Biot & savart law, calculate the mgnetic field at point *P*, a diatance *a* from one end.

You are given $\int \frac{dx}{\left(x^2+a^2\right)^{3/2}} = \frac{x}{a^2\sqrt{x^2+a^2}}$



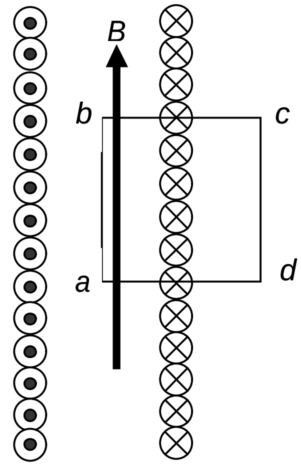
Now applying Biot-Savart law we have

$$dB = \frac{\mu_o I}{4\pi}\frac{dl \sin\theta}{r^2} = \frac{\mu_o a I}{4\pi}\frac{dl}{r^3}$$

Since the direction of B is the same for all the elements we can integrate to get

$$B = \frac{\mu_o a I}{4\pi}\int_0^L \frac{dl}{r^3} = \frac{\mu_o a I}{4\pi}\int_0^L \frac{dl}{\left(x^2+a^2\right)^3} = \frac{\mu_o a I}{4\pi}\left[\frac{x}{a\sqrt{x^2+a^2}}\right]_0^L = \frac{\mu_o I}{4\pi}\left(\frac{L}{\sqrt{L^2+a^2}}\right)$$

Q3) A long solenoid has n turns per unit length and current I directed as shown in the figure. Find the magnetic filed inside such an ideal solenoid.



$$\oint \vec{B}\cdot d\vec{l} = \mu_o I_{enc} \quad \Rightarrow$$

$$\int_a^b \vec{B}\cdot d\vec{l} + \int_b^c \vec{B}\cdot d\vec{l} + \int_c^d \vec{B}\cdot d\vec{l} + \int_d^a \vec{B}\cdot d\vec{l} = \mu_o I$$

For the portions bc and da $\vec{B} \perp d\vec{l}$ and for the portion cd $\vec{B} = 0 \Rightarrow$

$$\int_a^b \vec{B}\cdot d\vec{l} = \mu_o I_{enc}$$

Now for the portion ab $\vec{B} \,//\, d\vec{l}$ and its magnitude is constant along this portion $\Rightarrow$

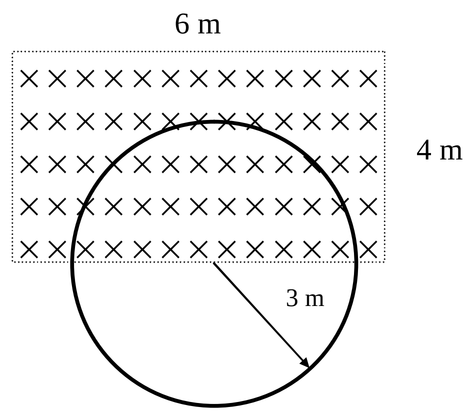
$$Bl = \mu_o I_{enc}$$

But the current crossing the surface enclosed by the loop is I multiplied by the No. of turns bounded by the loop $\Rightarrow$

$$Bl = \mu_o NI \Rightarrow B = \mu_o \frac{N}{l} I = \mu_o n I$$

With n is the No. of turns per unit length.

Q4) A uniform magnetic field, directed into the page, changes with time according to $B=(4-t)$, with t in s and B in T. The field is confined in a region of length 6 m and width 4 m. A circular loop of radius R= 3 m is placed in the field with its half is out of the field, as shown.



a) Calculate the induced emf in the circular loop.

First we want to find the flux through the circular loop

$$\Phi = B \cdot A = (4-t)\left(\tfrac{1}{2}\pi R^2\right)$$

Now using Faraday'e law we get

$$e = -\frac{d\Phi}{dt} = \tfrac{1}{2}\pi R^2 = 4.5\pi V$$

b) Indicate the direction of the induced current in the circular loop. Explain.

Since $\frac{d\Phi}{dt}$ is negative the induced m.f is in the same direction as the original m.f.This means that the induced current must be clockwise.