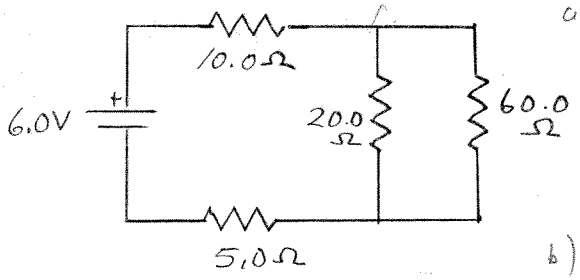
PHYSICS 203 **EXAM #1** NAME KEY
9 October 2009

General Instructions: For each problem your solution must be readable and your logic followable. Put a box around any numerical answers. Show your work.

$\mu_0 = 1.26 \times 10^{-6}$ H/m $\epsilon_0 = 8.85 \times 10^{-12}$ F/m $e = 1.60 \times 10^{-19}$ C

**PART I - SHORT ANSWER QUESTIONS.**
Do the five short questions/problems. Worth 8 points each.

1. For the circuit shown:
a) What is the equivalent resistance of the combination of resistors?
b) What power is provided by the battery?




a) parallel part: $\frac{1}{20\Omega} + \frac{1}{60\Omega} = \frac{3}{60} + \frac{1}{60} = \frac{4}{60} = \frac{1}{R_p}$

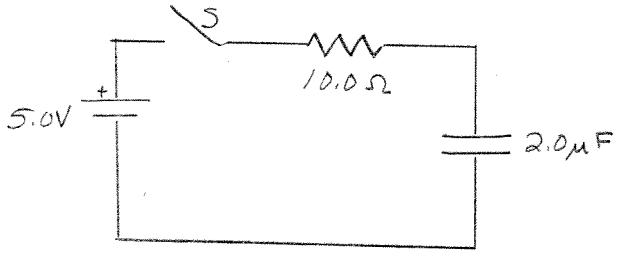
$R_{eq,p} = 15\Omega$

it's in series with others, so

$R_{eq} = 10\Omega + 15\Omega + 5\Omega = \boxed{30.0\Omega}$

b) $P = V^2/R = (6.0V)^2/30\Omega = \boxed{1.2W}$

2. For the circuit show, how long does it take for the charge on the capacitor to reach half of its maximum value? (after S is closed)




$V_c = \frac{q}{C} = \mathcal{E}(1 - e^{-t/RC})$

at half of max q, $V_c = \frac{1}{2}\mathcal{E}$

so $\frac{1}{2}\mathcal{E} = \mathcal{E}(1 - e^{-t/RC})$

$e^{-t/RC} = \frac{1}{2}$

$-t/RC = \ln\frac{1}{2}$

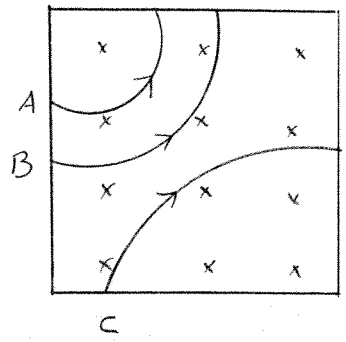
$t = (-\ln\frac{1}{2})RC = (-\ln\frac{1}{2})(10\Omega)(2.0\times10^{-6}F)$

$= \boxed{1.39\times10^{-5}s}$

3. Three charged particles are shot into a region of uniform magnetic field that is directed into the page, as shown. The three particles all have the same mass and the absolute value of the charge on each is the same.

a) Fill in the blank with + or - to indicate whether the sign of the charge is positive or negative.

3pts A + B + C −




5pts b) Which charge is moving at the highest speed? Explain your answer.

C $r = \frac{mv}{qB}$ so largest radius has largest v

4. Two solenoids, with self inductances of $L_1$ and $L_2$ are connected in series. If far apart, the equivalent self inductance of the combination is simply $L_{equiv} = L_1 + L_2$. If brought near to each other, will the equivalent inductance be:

a) equal to $L_1 + L_2$,

b) less than $L_1 + L_2$,

c) greater than $L_1 + L_2$,

2pts d) or it depends on how they are placed.

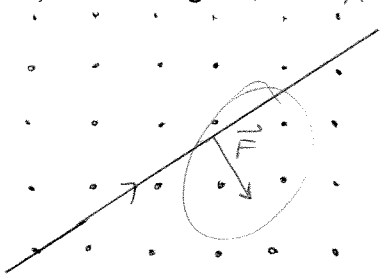
Explain your answer.

6pts When close, mutual inductance can occur. It will depend on how much field produced by $L_1$ passes thru $L_2$ (+ vice versa). The induced emf can oppose or add to those of $L_1 + L_2$.

5. A straight wire carries a current of 1.50 A as shown. It lies in a uniform magnetic field given directed up out of the paper having magnitude 0.250 T.

6 a) What is the magnitude of the force on a 0.050 m section of the wire?

2 b) On the diagram, use and arrow to indicate the direction of the force.




$\vec{F} = i\vec{L} \times \vec{B}$

$L \perp B$ so $F = iLB = (1.50A)(0.050m)(0.250T)$

$= 0.0188N$

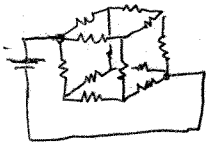
**Part II - Problems.**
Do all three. Worth 20 points each. Show and explain your work.

7. Answer **any five** of the short questions below. If more than 5 are attempted, I will grade the first 5 only. No answer should take more than a few lines (and some less).

a) Which scientist felt that while science is ever changing, faith is not? Faraday

b) Which scientist felt that science does not dictate religion but can enrich it and that we can study science to better praise God? Maxwell

c) Can the equivalent resistance of the cube of resistors shown be found by applying the rules for combining resistors in series and/or parallel? Explain.

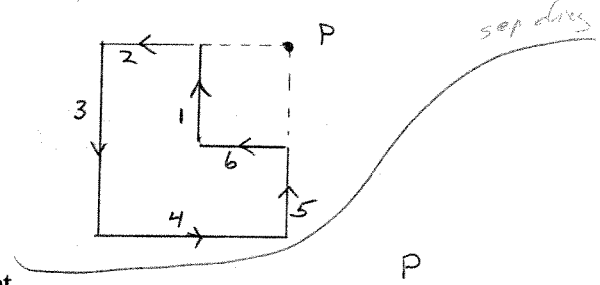


No - no 2 resistors are in series, nor are any in parallel.

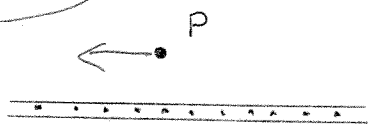
d) According to Ryan, is Fischer's discussion in chapters 1 &2 of **God Did It, But How?** completely in agreement with a reformed view of science? Explain.

No - Fischer does not go far enough to agree w/ Calvin or Kuyper.

e) Electrical current flows in the wire loop shown. Of the six segments labeled, which do not contribute to the magnetic field at point P? 2 & 5




f) The segment shown is part of an infinite conducting sheet which carries a uniform current directed up out of the page. Draw an arrow at point P to indicate the direction of the magnetic field.




g) What does it mean to say the God is transcendent? That He is immanent?

Trans → God exists beyond the creation, He's not limited by time or space.
Imm → God exists in & acts in the creation.

h) What is Fischer's working definition of science?

Science is the body of knowledge obtained by methods based on observation

g) Fischer stated that the statement that we accept the Bible as reliable and authoritative is not a simple statement. What does he mean by this?

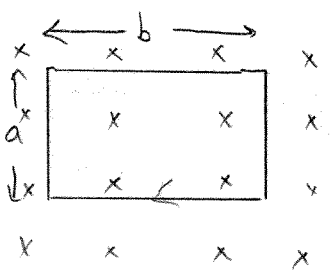
While Christians might agree with this statement, deciding what the words mean is not always easy — there can be disagreements.

8. A rectangular loop of wire of dimensions a and b has a total resistance of R. It sits in a region of spatially uniform but time varying magnetic field which is directed into the page. Its time dependance is give by $B = B_0/(1+kt)$. $B_0$ and k are constants. $\left[B = \frac{B_0}{1+kT}\right]$

4 pts a) What is the magnetic flux through the loop?

8 pts b) What is the current that flows in the loop?

8 pts c) What direction does the current flow (clockwise or counter clockwise)? Explain your answer.




a) Since $\Phi = AB = \boxed{\frac{abB_0}{1+kT}}$

b) $|\mathcal{E}| = \left|\frac{d\Phi}{dt}\right| = iR$

$$i = \frac{-1}{R}\frac{d\Phi}{dt} = \frac{abB_0k}{R(1+kT)^2}$$

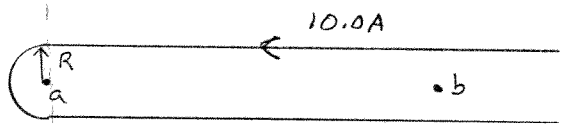
c) Since B is decreasing in magnitude as t increases, $i_{induced}$ flows to create a field that opposes the change. Induced must also point into the page inside the loop.

So $\boxed{\text{Clockwise}}$

9. In the diagram, a 10.0 A current is sent through a hairpin shaped conductor formed by bending a long wire into a semi-circle at one end of radius R = 0.00500 m. The point labeled b is midway between the wires and is far enough from the loop that the straight sections of wire can be considered to be infinite in length.

12 pts a) What is the magnitude and direction of the magnetic field at point a?

8 pts b) What is the magnitude and direction of the magnetic field at point b?




a) From RHR, all contributions are up out of the page at a

$B_{tot}$ = (B for $\frac{1}{2}$ of infinite wire) + (B for $\frac{1}{2}$ of infinite wire) + B for $\frac{1}{2}$ circle

$= \frac{\mu_0 i}{2\pi R} + \frac{\mu_0 i (\pi)}{4\pi R} = \frac{\mu_0 i}{R}\left(\frac{1}{2\pi} + \frac{1}{4}\right)$

$= \frac{(1.26\times10^{-6}\ H/m)(10\ A)}{0.00500\ m}\left(\frac{1}{2\pi} + \frac{1}{4}\right)$

$= \boxed{1.03\ mT\ up}$

b) $B_{tot}$ = 2 × infinite wire

$= 2 \cdot \frac{\mu_0 i}{2\pi r} = \frac{(1.26\times10^{-6}\ H/m)(10A)}{\pi(0.00500m)} = \boxed{0.802\ mT\ up}$