Physics 116b Test 2a October 12, 2007

Name: Key Seat:_____

This is a 50 minute, closed book examination. Put answers in the boxes provided (if any). If numerical answers are needed, you must include units. Any work needed to justify the answer must be shown in the space provided, or as indicated on a separate piece of paper or elsewhere on the test. A correct answer without the necessary justifying work may not receive any credit. You may tear the formula sheet off the back of the exam.

Total points for each problem will appear in the table below and in ( ) beside each problem number. Do what is easiest first. AVOID glancing at anyone else's paper during the exam. No means of communication between other students or outside parties is allowed. **The honor code is in effect.**

You must do all the problems on the test.

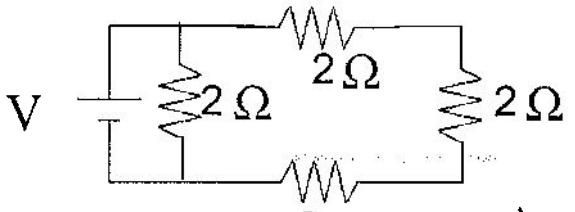
Problem	Description	Max Score	Score
1	Short Answer	38	
2	Induced EMF	13	
Total		51	

a

Alternate

1) Short Answer (50 points)

a) The battery in the circuit below delivers 10 Watts of power to the circuit. What is V of the battery? (5pts) How much current flows through the 3 Ohm resistor? (5pts)



V(battery) = 3.95V

I in 3 Ohm = 0.564A

$I_{in\,3\Omega} = 3.95V / 7\Omega = 0.564A$

check

$I_{2\Omega} = 3.95V / 2\Omega = 2.48A$

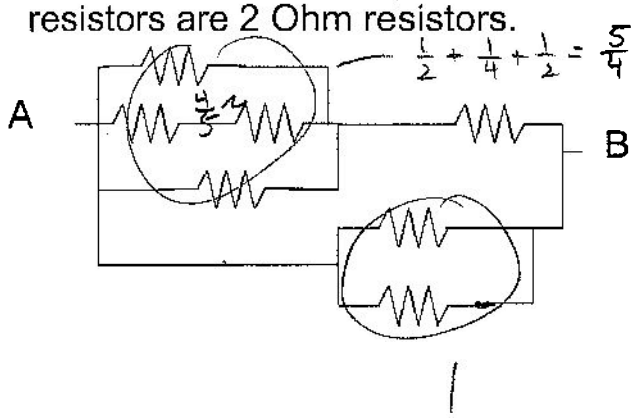
$I_{tot} = \sqrt{\frac{10}{1.56}} =$

$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{3\Omega} + \frac{1}{7} = \frac{1}{1.56}$

$R_{eq} = 1.56\Omega$

$10W = \frac{V_{batt}^2}{R_{eq}}$ $V_{batt} = \sqrt{15.6} = 3.95V$

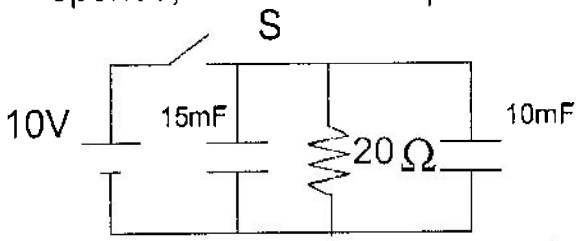
b) Calculate the resistance between points A and B. (5pts) Note: all resistors are 2 Ohm resistors.



R_{AB} = 0.74Ω

$\frac{1}{R_{AB}} = \frac{1}{2+\frac{4}{5}} + \frac{1}{1} = 0.74\Omega$

c) What is the charge on the 10mF capacitor 0.2s after the switch S is open? (5pts) (Assume that the switch S has been closed a very long time before it is opened, and that all capacitors are initially charged.)



$Q_{10mF} = 0.67 Q_{old}$
(0.067C)

on 10mF

$Q_{old} = 10V \cdot 10mF$
$= 0.1C$

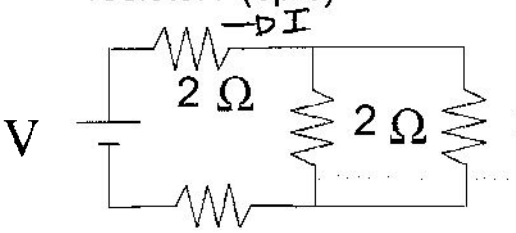
$RC = 25mF\,20\Omega = 0.5s$

$Q_{new} = Q_{old} e^{-0.25/0.5}$

$= Q_{old}(0.67)$

1) Short Answer (50 points)

a) The battery in the circuit below delivers 10 Watts of power to the circuit. What is V of the battery? (5pts) How much current flows through the 3 Ohm resistor? (5pts)



V(battery) = 7.21V

I in 3 Ohm = 0.55A

$R_{eq} = 2 + 2 + \frac{1}{\frac{1}{2}+\frac{1}{3}}$

$= 5.2\,\Omega$

$\frac{V_{Batt}^2}{R_{eq}} = 10W$ $\quad V_{Batt} = \sqrt{10W(5.2\Omega)}$

$= 7.21V$

$I = \frac{7.21V}{5.2\Omega}$

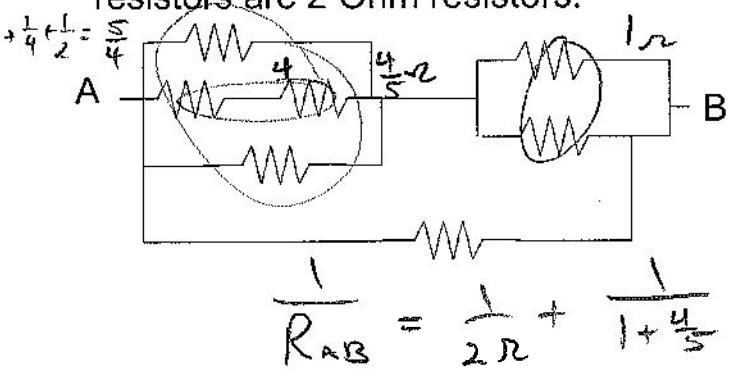
$= 1.39A$

$I = I_3 + \frac{3\Omega I_3}{2\Omega}$

$I_3 = I/2.5 = \frac{1.39}{2.5} = 0.55$

check $\frac{(1.39-0.55)2\Omega}{3\Omega} = .56$ OK!

b) Calculate the resistance between points A and B. (5pts) Note: all resistors are 2 Ohm resistors.



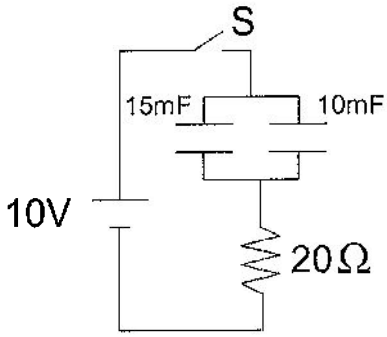
$\frac{1}{4}+\frac{1}{2} = \frac{5}{4}$

$\frac{1}{R_{AB}} = \frac{1}{2\Omega} + \frac{1}{1+\frac{4}{5}}$

$R_{AB} = 0.95\Omega$

R_{AB} = 0.95Ω

c) What is the charge on the 10mF capacitor 0.2s after the switch S is closed? (5pts) (Assume all capacitors are initially uncharged.)



Q_{10mF} = 0.033C

$Q = Q_0(1-e^{-t/RC})$

$RC = (25mF)(20\Omega)$

$= 0.5s$

$Q = (10V)10mF(1-e^{-0.25/0.5})$

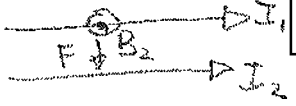
$= 0.033C$

1) Short Answer cont'd

d) What is the Force/(unit length) on a infinitely long conducting wire which carries 0.6A if it is 0.2 meters away and parallel to another infinitely long conducting wire with current 3.5 A flowing in the same direction to the first wire? (5 pts) Is this force attractive or repulsive with respect to the other wire?(3 pts)

$|F/\text{length}| = 2.1 \times 10^{-6} \frac{N}{m}$

$F_{12} = I_1 \ell B_2$



$$\frac{F_{12}}{\ell} = I_1 B_2 = \frac{I_1 I_2 \mu_0}{2\pi r}$$

$$= \frac{(0.6A)(3.5A)(4\pi \times 10^{-7} Tm/A)}{2\pi(0.2m)} = 2.1 \times 10^{-6} N/m$$

e) A particle, with a net charge equal to the charge on an electron, moves in a circular orbit in a 4.0 mT magnet field. If the particle makes 25,000 revolutions/s, what is the mass of the particle?(5 pts)

Mass= 4.07×10^{-27} kg

Forces balance

$$\underset{\sim}{mv} = q \underset{\sim}{v} B$$

$$mv = qvB$$

$$m = qB/v$$

$$= qB/2\pi f = \frac{(1.6 \times 10^{-19} C)(0.004T)}{2\pi\ (25000/s)} = 4.07 \times 10^{-27} kg$$

f) If the magnetic field in part e) is produced with a solenoid, suggest a design for a 1 m long solenoid and support your design with a quick calculation. (Does the area of the solenoid coils matter? Do you think it is better to have more coils or more current? (why/why not)) (5 pts)

depends on wire gauge etc. Saw in class, small wire heats up, but able to put more I in big wire. Solenoid demo in class had big wire & many layers

want 10A or less try 1 turn/2mm

$$0.004T = \left(4\pi \times 10^{-7} \frac{Tm}{A}\right) \frac{500}{m} I$$

$I = 6.37A$ ok

don't know A !

$w = \frac{v}{r}$ need v

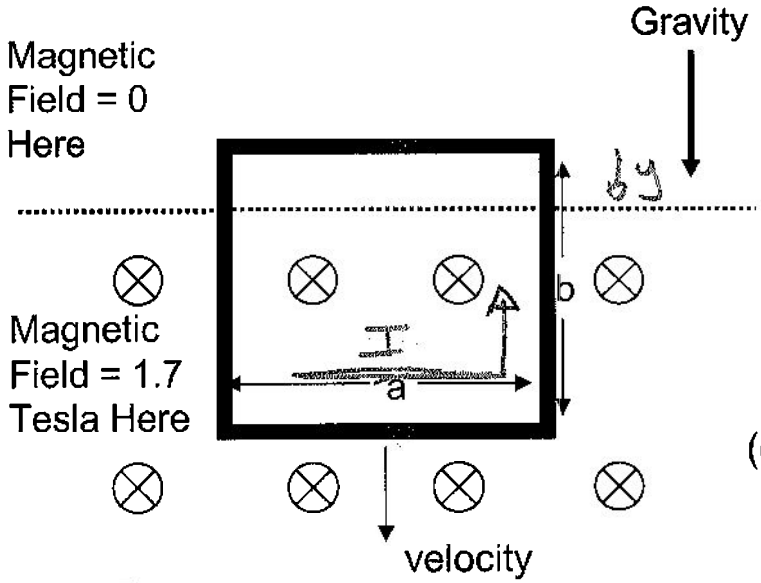
but $\Rightarrow$ is important for diag A

For fixed $\frac{I}{N}$ Power $\propto I$ $\propto 1/N$ < more turns, less power/heating

more uniform Field

2) Induced EMF (13 points) (Show Your Work!)

In the figure below, the conducting loop has fallen a short distance and is now falling at a constant velocity of 15 cm/s. The loop has sides of length a = 0.40 m and b = 0.45 m, and has a resistance of 1.05 Ohms. If the magnetic field into the page is 1.7 Tesla below the dashed line and zero above the dashed line, answer the following questions:



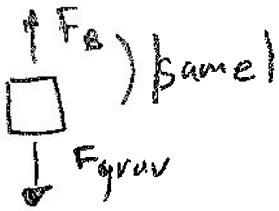
Since the loop is moving at a constant velocity, there must be an equal force acting to hold the loop up. What current do you need to flow in the loop to produce this force? (5 pts) Please indicate the direction of this current on the figure as well. (3 pts) (Hint: find EMF 1st)

Current = 0.097 A

(drawing direction of current on figure)

What is the magnitude of the force pulling down on the loop?(5 pts)

Force = 0.066 N



$$\mathcal{E} = -\frac{d\Phi}{dt} = -\frac{d}{dt}\left(B a (b-y)\right) = B a \frac{dy}{dt} = BaV$$

$$= 1.7\,T\,(0.40\,m)(0.15\,m/s)$$

$$= 0.102\,V$$

$$I = 0.102\,V / 1.05\,\Omega = 0.097\,A$$

$$F = I\ell B = I a B = (0.097\,A)(0.40\,m)(1.7\,T)$$

$$= 0.066\,N$$