Physics 116b

Second Partial Examination October 10, 2002

Name: Key

Signature:

Please circle your section:(It's ok if you don't know your section)

Section 1 Section 2 Section 3 Section 4

Instructions

This is a one hour, closed book examination. Put answers in the boxes provided, or circle the best answer. If numerical answers are needed, you must include units. If required, any work needed to justify the answer must be shown in the space provided. A correct answer without the necessary justifying work may not receive any credit. You may use the formula sheet on the back of the exam.

Total point scores 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! **The honor code is in effect.**

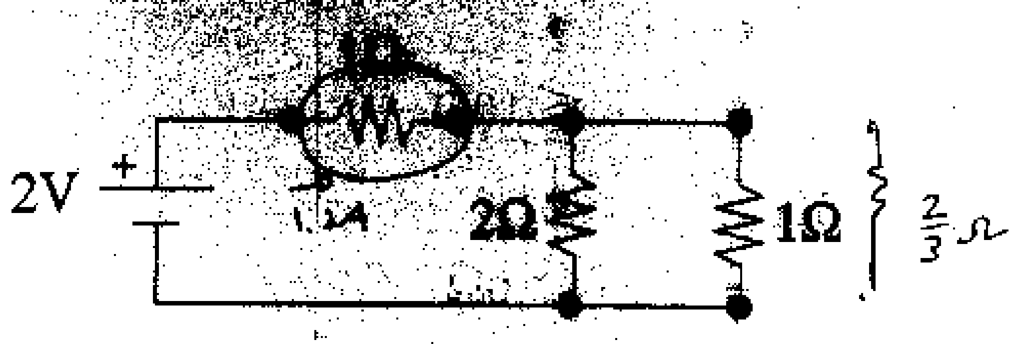
You must do all the problems in the exam.

Point Tallies for the Exam Problems

Problem	Description	Max Score	Actual Score
1	Short Answer Resistors	19	
2	Short Answer Magnetic Fields	19	
3	Magnetic Fields	24	
Total		62	

(Problem 1: [illegible] a Sketch):
(Showing [illegible]

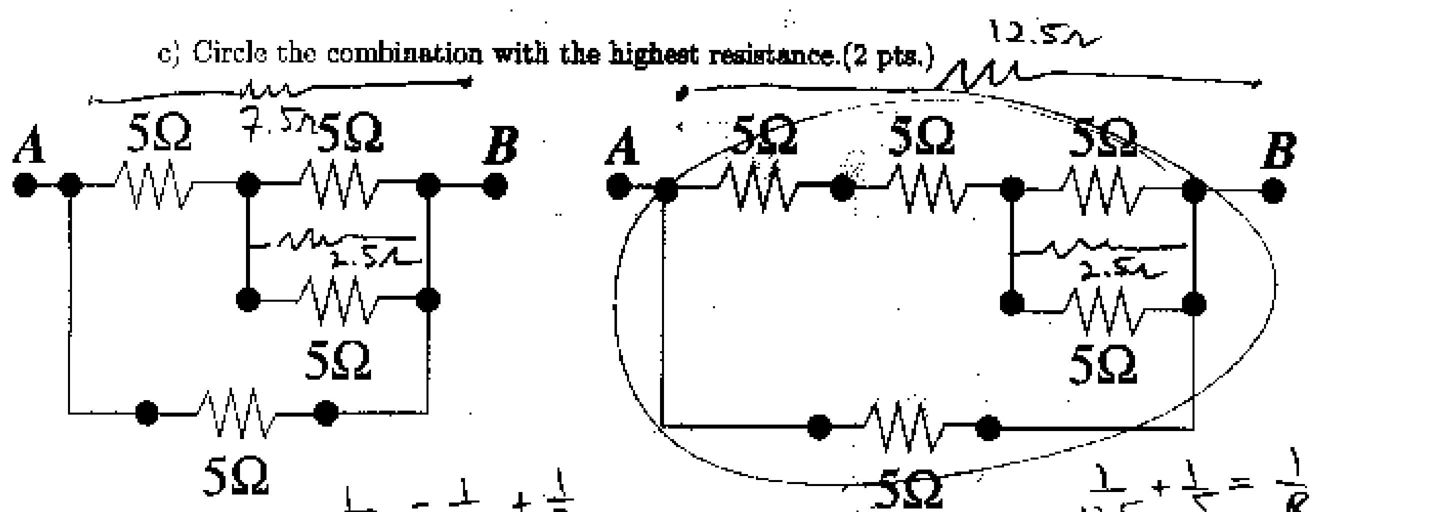
a) Circle the [illegible] the circuit below. (2 pts.)



b) Calculate the power for the resistor you indicated in part a). (3 pts.)

$I^2R = 1.44A^2 \cdot 1\Omega$ [P = 1.44W]

c) Circle the combination with the highest resistance. (2 pts.)



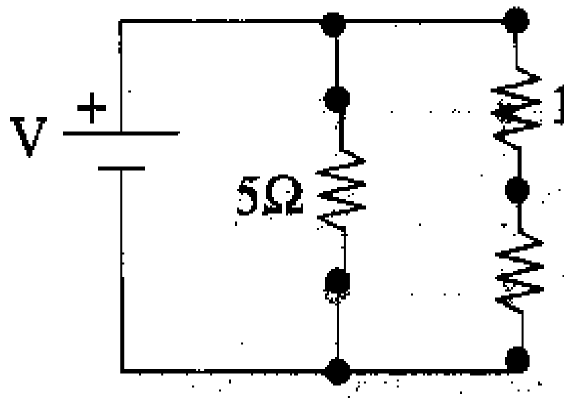
$\frac{1}{R_{eq}} = \frac{1}{7.5} + \frac{1}{5}$ $R_{eq} = 3$

$\frac{1}{12.5} + \frac{1}{5} = \frac{1}{R_{eq}}$

d) Calculate the resistance for the resistors you circled in part c). (3 pts.) $R_{eq} = 3.57$

[R = 3.57Ω]

e) What is the value of the potential difference supplied by the battery, V, if there is a current of 1.0 A passing through the 5Ω resistor. (4 pts.)



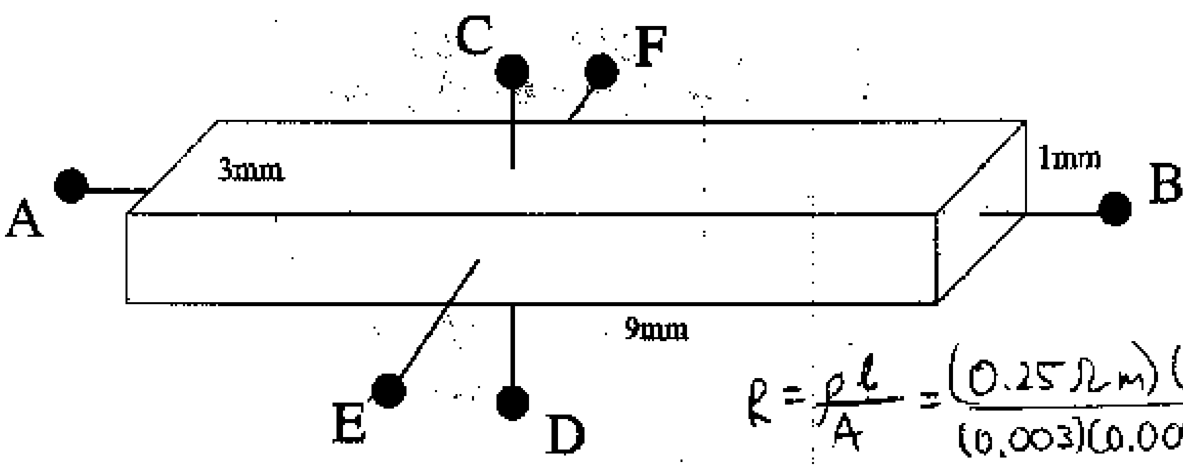
$10\Omega \cdot 1A = 10V$

$6\Omega \cdot 1A = 6V$

16V [V = 16 V]

f) Consider the figure below. Theoretically, which of the following set of connectons will give you the lowest resistance through the material.(2 pts.)

R_{AB} R_{CD} R_{EF}



$$R = \frac{\rho l}{A} = \frac{(0.25\,\Omega m)(.001m)}{(0.003)(0.009)}$$

g) Calculate the resistance for the set of connections you circled in part f). Assume the resistivity of the material is 0.025 Ωm with the dimensions shown in the figure. (3 pts.)

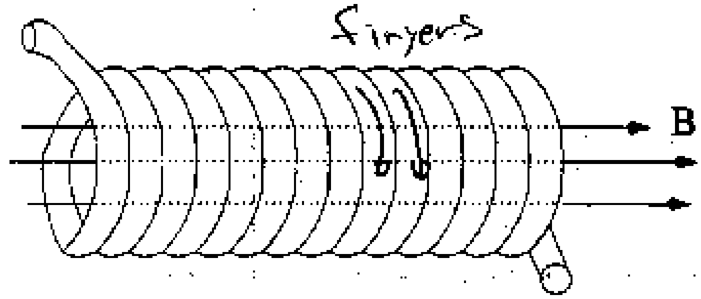
[R = 9.25Ω]

Check $R_{AB} = \frac{(0.25)(.009)}{(0.003)(0.001)} = 750\Omega$

$R_{EF} = \frac{(0.25)(0.003)}{(0.009)(0.001)} = 83.3\Omega$

(Problem 2: Circle the Correct Response, or Make a Sketch):
(Showing your work can get you partial credit!)

a) Indicate the direction that current should flow through the solenoid to make the B field shown in the figure below. (A dotted line indicates a field line inside the solenoid.)(2 pts.)

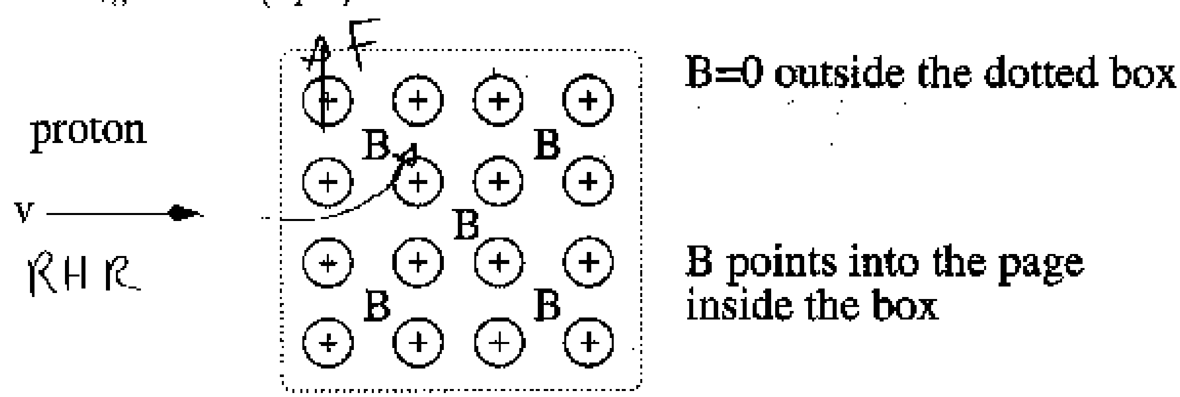


b) Estimate the Magnetic field in the center of the solenoid above if the current through the wire is 4.0 A and the diameter of the wire used is 8.0mm. (4 pts.)

$B = \mu_0 n I \quad n = \frac{1}{diam} \quad \left[B = 6.3\times10^{-4}T\right]$

$= \left(4\pi\times10^{-7}\frac{Tm}{A}\right)\left(\frac{1}{0.008m}\right)4A =$

c) Indicate on the figure the direction the proton will move when it enters the magnetic field.(2 pts.)



6.3×10^{-4} prev

d) Suppose for the previous problem the proton was already inside the magnetic field and stuck in a circular orbit. If the proton goes in a circle 10,000 times each second, what is the value of the magnetic field? (4 pts.)

[$B = 6.55\times10^{-4}\,T$]

$$f = \frac{10000}{s}$$

$$\omega = 2\pi f = \frac{v}{r}$$

$$\frac{mv^2}{r} = qvB \qquad \frac{qB}{m} = \frac{v}{r}$$

$$B = \left(\frac{m}{q}\omega\right) = \left(\frac{1.67\times10^{-27}\,kg}{1.6\times10^{-19}\,C}\right)(2\pi)(10{,}000) =$$

e) A magnetic field of 0.061 T makes an angle with respect to the velocity of a particle with charge 1.0×10^{-15} C traveling at 10,000 m/s. If the magnitude of the force on the particle due to the magnetic field is $1.0\times10^{-13}N$, what is the angle of the magnetic field with respect to the particle velocity? (4 pts.)

[$\theta = 9.44^\circ$]

$$F = qvB\sin\theta$$

$$\theta = \sin^{-1}\left(\frac{F}{qvB}\right) = \frac{1.0\times10^{-13}N}{(1\times10^{-15})(10{,}000)(0.061)}$$

$$= 9.44^\circ$$

f) What is the magnetic moment of a circular coil of wire 1.2 cm in diameter that carries a current of 0.55 A? (Note: A magnetic field of 10mT will produce a maximum torque of 6.22×10^{-9} Nm on this little coil.) (3 pts.)

[$\mu =$]

$$\mu = IA$$

$$= (0.55A)(\pi(.006)^2)$$

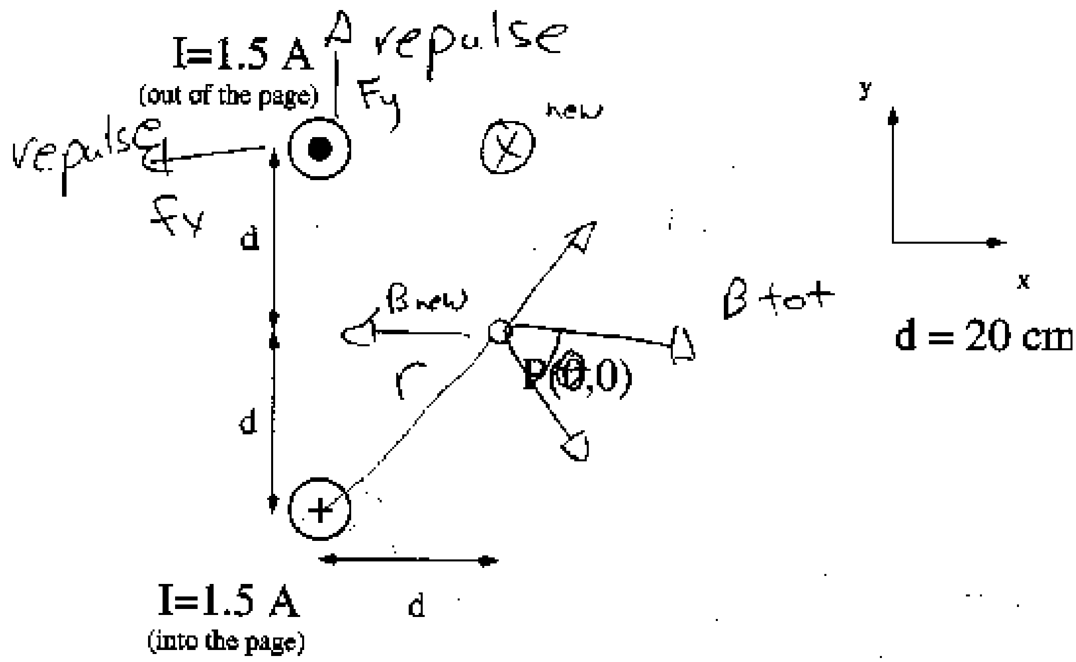
$$= 6.22\times10^{-5}\,Am^2$$

$$\tau_{max} = \mu B$$

$$\mu = \frac{\tau_{max}}{B} = \frac{6.22\times10^{-9}}{.01} = 6.22\times10^{-7}\,Am^2$$

3) Magnetic Fields (Vectors)(show your work)

Two infinite lines of current, one with current I = 1.5 A into the page, and one with current I = 1.5 A out of the page are placed as shown: the current out of the page at (-d,d) and the current into the page at (-d,-d). (assume d = 20 *cm* and that all lines of current are absolutely parallel.)



a) What are the components of the magnetic field at the point P (0,0)?

(4 pts. each)

$$B = \frac{\mu_0 I}{2\pi R}$$

$B_X = 1.5\mu T$

$B_Y = 0$

$$B_{tot} = 2\,\frac{\mu_0 I}{2\pi r}\cos\theta$$

$$= \frac{2\,(4\pi \times 10^{-7}\,\frac{Tm}{A})\,(1.5A)\,\cos 45^\circ}{(2\pi)(.20m\,\sqrt{2})}$$

$\cos 45^\circ = \frac{1}{\sqrt{2}}$

$$= 15 \times 10^{-7}\,T = 1.5\mu T$$

3) Magnetic Fields (cont'd)

b) Where should a third line of current, with I = 1.5 A into the page, be placed so that the total magnetic field vanishes (equals zero) at point P? (4 pts. each)

[X = 0]
[Y = 0.2m]

see pict

$$B = \frac{\mu_0 I}{2\pi(.2)} = 1.5\mu T$$

c) Now, with all three wires in place, what is the force/length on the wire with the current flowing out of the page due to the two wires with current flowing into the page? (4 pts. each)

[$F_x/\ell = -2.25\mu \frac{N}{m}$]
[$F_y/\ell = 1.13\mu \frac{N}{m}$]

need b@this wire
or one force/ℓ
notice both repulse

so $F_y = I B @ 0.4cm$

$$\frac{F_y}{\ell} = 1.5A\left(\frac{1.5\mu T}{2}\right) = 1.13\frac{\mu N}{m}$$

$$\frac{F_x}{\ell} = -IB@.2cm$$

$$= -1.5A(1.5\mu T) = -2.25\frac{\mu N}{m}$$

Equations

$$I = \frac{dq}{dt}, \quad I = \int \vec{J} \cdot d\vec{A}, \quad V = IR, \quad R = \frac{\rho l}{A}, \quad \rho = \frac{1}{\sigma}$$

$$\rho - \rho_0 = \rho_0 \alpha (T - T_0), \quad \rho = \frac{m}{e^2 n \tau}, \quad P = IV$$

$$R = R_1 + R_2 + R_3 \ldots, \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$(charging) \quad Q = Q_0(1 - e^{-\frac{t}{RC}}), \quad \tau = RC, \quad CV = Q, \quad I = \frac{V}{R} e^{-\frac{t}{RC}}$$

$$(discharging) \quad Q = Q_0 e^{-\frac{t}{RC}}, \quad I = -\frac{Q_0}{RC} e^{-\frac{t}{RC}}, \quad KE = \frac{1}{2} m v^2$$

$$\vec{F} = q\vec{v} \times \vec{B}, \quad n = \frac{BI}{Vle}, \quad qvB = \frac{mv^2}{r}, \quad \omega = 2\pi f, \quad \omega = \frac{v}{r}$$

$$\vec{F} = I\vec{l} \times \vec{B}, \quad d\vec{F} = Id\vec{l} \times \vec{B}, \quad \vec{\tau} = \vec{\mu} \times \vec{B}, \quad \vec{\tau} = \vec{r} \times \vec{F}$$

$$d\vec{B} = \left(\frac{\mu_0}{4\pi}\right) \frac{Id\vec{l} \times \vec{r}}{r^3} = \left(\frac{\mu_0}{4\pi}\right) \frac{Id\vec{l} \times \hat{r}}{r^2}, \quad \oint \vec{B} \cdot d\vec{s} = \mu_0 I_{enclosed}$$

$$B = \frac{\mu_0 I}{2\pi r} \quad (infinite\ wire)$$

$$B = \frac{\mu_0 I \phi}{4\pi R} \quad (center\ of\ circular\ arc\ of\ angle = \phi)$$

$$B = \frac{\mu_0 I}{2R} \quad (center\ of\ whole\ loop)$$

$$B = \mu_0 n I \quad (solenoid)$$

$$B = \frac{\mu_0 N I}{2\pi r} \quad (toroid)$$

Constants

$\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$

$\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$

$e = 1.60 \times 10^{-19}\ C$

$M_{proton} = 1.67 \times 10^{-27}\ kg$