Physics 1E03 Late V3

Test 2

March 26, 2008

Name: Solutions

Student Number:__________________________

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Instructor:_________________________________

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Write your name and student number on your paper before you begin. Multiple-choice questions are worth 2 marks each, and problems are worth 3 marks each.
Only the McMaster standard calculator is allowed. Notes and formula sheets are not permitted. A sheet of formulae is attached as the last page.

Answers for the multiple-choice questions (Part A) must be marked on the optical scan sheet, using an HB pencil. Before you begin, **print your name on this paper and on the optical scan sheet. Code your student number in the spaces provided on the scan sheet as well. You must code your student number correctly, and correctly answer the first question (which asks for your test version) to receive full marks.**

Problems (Part B) are to be answered directly on this test paper in the spaces provided. Clear and complete solutions are required for full marks.

PLEASE DO NOT WRITE IN THIS AREA

Part A (18)	11 (3)	12 (3)	13 (3)	14 (3)	Part B (12)

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Part A: Indicate the best or most nearly correct answer by filling in the corresponding circle on the optical scan sheet with an HB pencil. Each correct answer is worth 2 marks. An incorrect answer or unanswered question counts as zero marks.

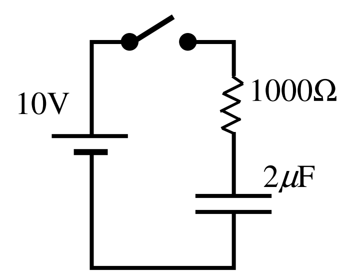
1) Your test is version 3. Fill in the circle "C" or "3" on your scan sheet as the answer to Question 1. Now proceed to question 2 below and fill in the circle corresponding to the answer of your choice for it.

2) The current through a beaker of salt water is held constant while more salt is added, doubling the number of mobile charges in the water. As the number of ions doubles,

J : constant $= n q v_d$

A) the drift speed of the ions doubles
B) the drift speed of the ions decreases by half
C) the drift speed of the ions stays approximately constant.
D) none of the above is correct.

3) The switch is closed at time t = 0, with the capacitor initially uncharged. After 1 ms, the voltage across the capacitor will be



$\tau = RC = 2\,\text{ms}$

A) 10 V
B) 6 V
C) 4 V
D) zero

$10(1 - e^{-\frac{1}{2}}) = 3.93$ volts

4) A current is flowing through a straight uniform wire. If the magnitude of the magnetic field outside the wire at a distance r from the centre of the wire is given by B_o, what is the magnitude at twice of this distance?

$B \propto \frac{1}{r}$

A) $2B_o$
B) B_o
C) ½ B_o
D) We need to know the current in the wire.

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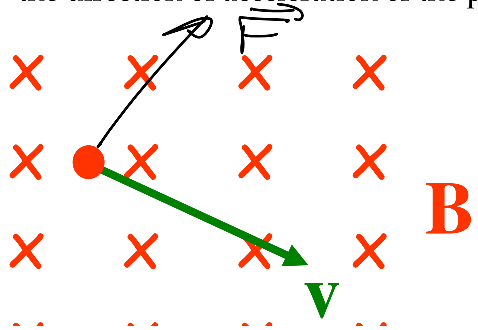
5) For a proton moving with the velocity and external magnetic field shown below, what would be the direction of acceleration of the proton.



$$\vec{F} = +e\,\vec{v} \times \vec{B} = m\vec{a}$$

A) out of the page
B) into the page
C) 
D) 

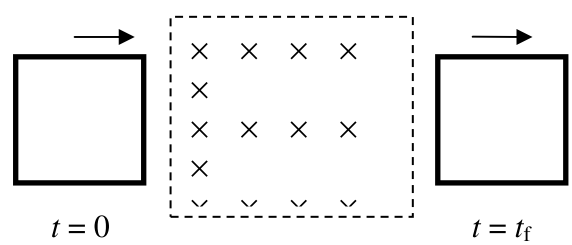
6) An electron is moving in a circular orbit in a uniform magnetic field that is perpendicular to its motion. If the magnitude of the field is decreased by a factor of two the cyclotron frequency would:

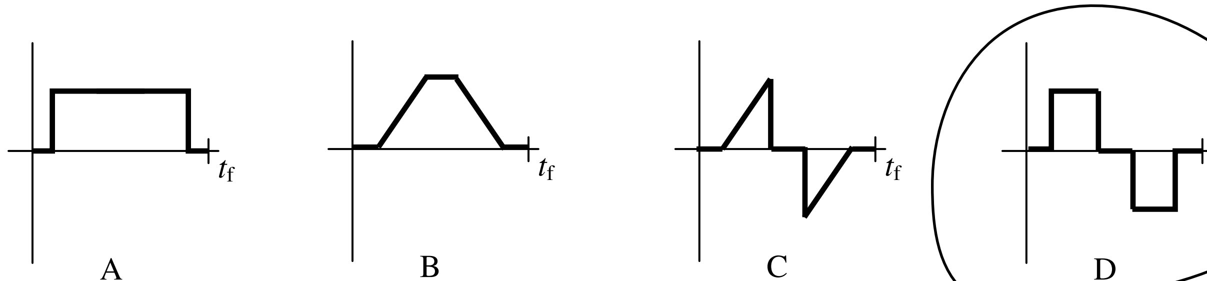
A) decrease by a factor of four
B) decrease by a factor of two
C) remain unchanged
D) increase by a factor of two

$$2\pi f_c = \omega_c = \frac{eB}{m_e}$$

7) The square loop of wire moves at constant speed through a region of uniform magnetic field **B** (into the page). The field is zero outside the dashed rectangle. Which graph best represents the emf induced in the square loop as a function of time?

$$\mathcal{E} = -\frac{d\Phi}{dt} = vBl$$





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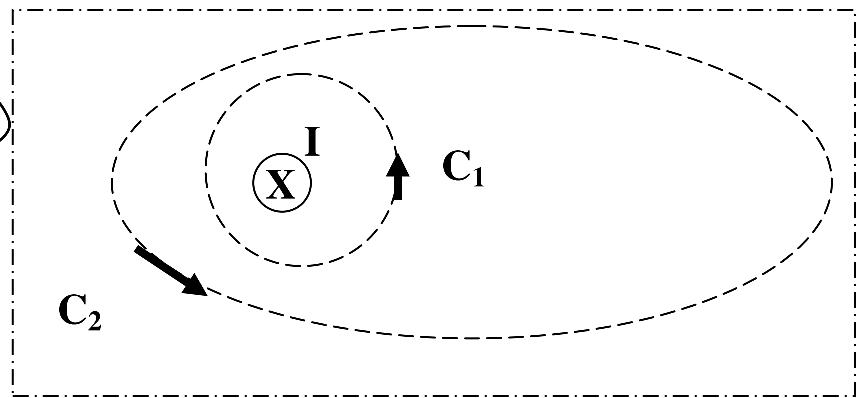
8) A current I, shown as the X, is going into the page producing a magnetic field B. Enclosing this current are two paths called C_1 and C_2. Which of the following statements is true?

A) $\oint_{C_1} \vec{B} \bullet d\vec{S} < \oint_{C_2} \vec{B} \bullet d\vec{S}$

B) $\oint_{C_1} \vec{B} \bullet d\vec{S} = \oint_{C_2} \vec{B} \bullet d\vec{S}$

C) $\oint_{C_1} \vec{B} \bullet d\vec{S} > \oint_{C_2} \vec{B} \bullet d\vec{S}$

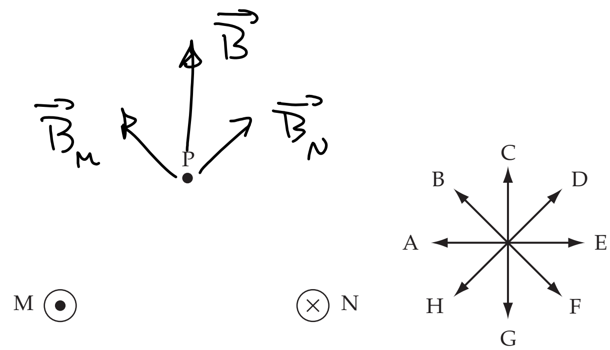
D) Cannot be determined.



9) Equal currents of magnitude *I* travel out of the page in wire M and into the page in wire N. Eight directions are indicated by letters A, B etc.

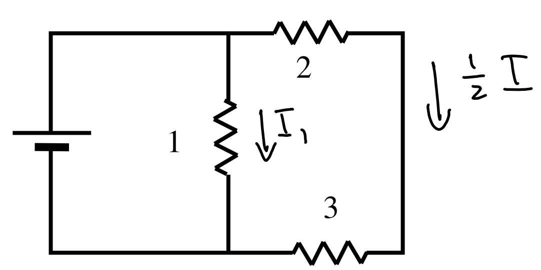
The direction of the magnetic field at point P is

A) A
B) B
C) C
D) D



10) Three identical resistors, labeled 1, 2, and 3, are connected to a battery as shown. If we label the power dissipated in the resistors as P_1, P_2, and P_3, then:

A) $P_1 = P_2 = P_3$
B) $P_1 = P_2 > P_3$
C) $P_1 > P_2 = P_3$
D) $P_1 = P_3 > P_2$
E) $P_1 > P_3 > P_2$



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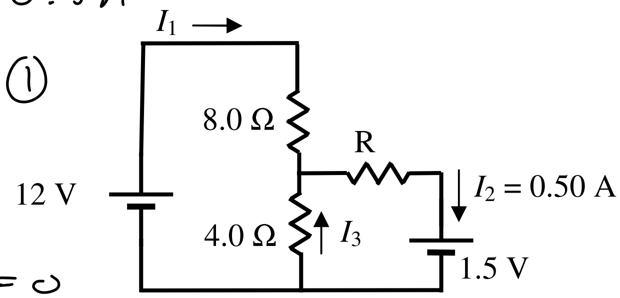
Part B (Problems): Write a clear solution showing how the answer is obtained. Each problem is worth 3 marks.

11) The circuit shown is used to charge a 1.5-volt battery from a 12-volt battery. Apply Kirchhoff's circuit rules to find the value of *R* which will give a charging current $I_2 = 0.50$ A.



junction: $I_1 + I_3 = 0.5A$

$\Rightarrow I_1 = 0.5A - I_3 \quad \cdots (1)$

Loop:

$12V - (8\Omega) I_1 + (4\Omega) I_3 = 0$

$\Rightarrow 8 I_1 - 4 I_3 = 12A$

substitute using (1): $\Rightarrow 8(0.5A - I_3) - 4I_3 = 12A$

$\Rightarrow I_3 = -\frac{2}{3} A$

Small loop: $-4\Omega \cdot I_3 - (0.5A)R - 1.5V = 0$

$\Rightarrow R = \frac{7}{3} \Omega = 2.3 \Omega$

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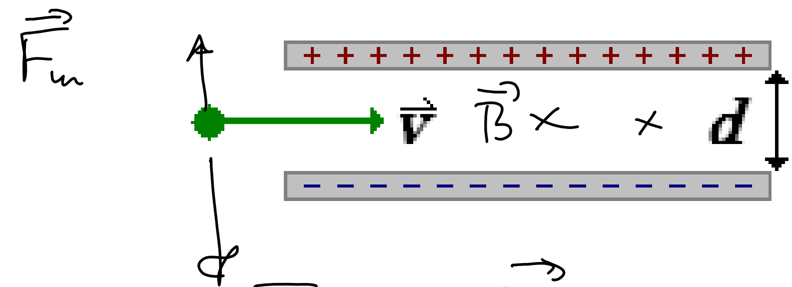
12) A proton travels with a speed of 7.50×10^{6} m/s between the two parallel charged plates shown below. The plates are separated by d=0.550 cm and are charged by a 275.0 V battery. Determine what magnetic field strength *and* direction will allow the proton to pass between the plates without being deflected (ignore gravity).



$$F_E = q\vec{E}$$

$\vec{B}$ into the page so that $q\vec{v}\times\vec{B}$ is up

$$F_{net} = 0 \Rightarrow q\vec{v}\times\vec{B} = -q\vec{E}$$

$$\Rightarrow vB = |\vec{E}| = \frac{\Delta V}{d} = 50\ kV/m$$

$$B = \frac{\Delta V}{v\cdot d} = 6.67\times10^{-3}\ T$$

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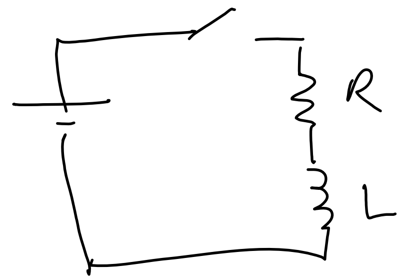
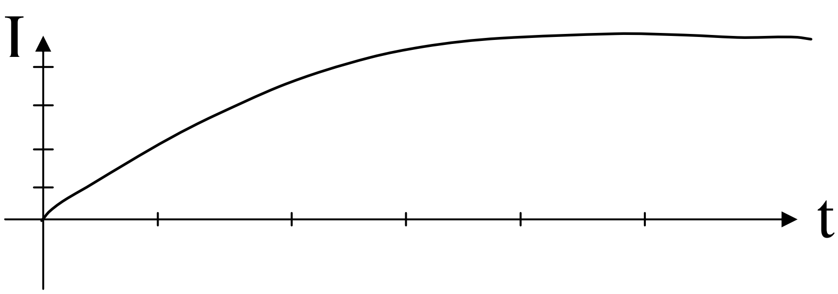
13) A 20.0 mH inductor is connected in series with a 10.0 ohm resistor, a switch and a 12.0 volt battery.

a) What is the time constant, τ, of the circuit?

$$\tau = \frac{L}{R} = \underline{\underline{2\ ms}}$$



b) Make a sketch of the current vs time graph after the switch is closed, at *t=0 s*.



$$I \rightarrow \frac{12V}{10\Omega} = 1.2A$$

as $t \rightarrow \infty$

c) What is the current at *t=2τ* after the switch is closed?

$$I(t) = 1.2A\left(1 - e^{-2}\right)$$

$$= (1.2A)(0.865) = \underline{\underline{1.04\ A}}$$

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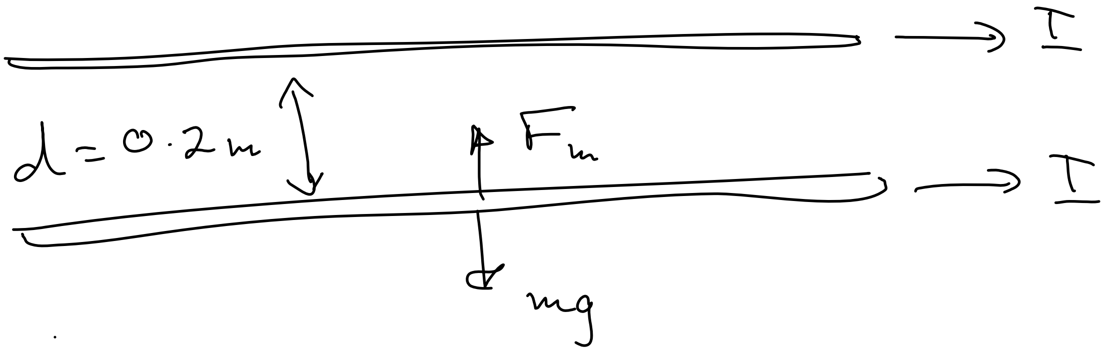
14) Two horizontal wires, each having a mass per unit length of 1.0×10^{-5} kg/m, are strung parallel, one 0.2 m above the other. If the wires carry the same current, in the same direction, how great must the current in each wire be for the magnetic force of the upper wire to balance the weight of the lower wire?



for length l of wire: $F_m = \frac{\mu_0 I}{2\pi d} \cdot I l$

Equilibrium when $F_m = mg$

$$\Rightarrow \quad \frac{\mu_0 I^2}{2\pi d} = \left(\frac{m}{l}\right) g \Rightarrow I = \sqrt{\frac{2\pi}{\mu_0}\left(\frac{m}{l}\right) g d}$$

$$= \underline{\underline{9.9 A}}$$

$$\simeq \underline{\underline{10 A}}$$

THE END