University of Alberta
Department of Physics

Phys 230 A01 Final Exam
Monday, December 11, 2006
09:00 – 11:00

Corbet Hall 2-44
Prof. I. Isaac

No notes or textbooks allowed
Formula sheet is provided with the exam
This exam has 15 questions; the value of each is indicated in the table below. Budget your time accordingly.
Show all your work in a neat and logical manner in the space provided
Messy work will not be marked

Do not separate the pages of the exam

Student Name:
Student ID:

Question	Value	Mark
1	1	
2	1	
3	1	
4	1	
5	4	
6	1	
7	1	
8	1	
9	1	
10	1	
11	1	
12	1	
13	10	
14	10	
15	10	
Total	45	

1. Two conductors are joined by a long copper wire. Thus
   a. Each conductor carries the same charge.
   b. Each conductor must be at the same potential.
   c. The electric field at the surface of each conductor is the same.
   d. No free charges can be present on each conductor.
   e. The potential on the wire is the average of the potential of each conductor.

2. For an electron moving in a direction opposite to the electric field:
   a. Its potential energy increases and its potential decreases.
   b. Its potential energy decreases and its potential increases.
   c. Its potential energy increases and its potential increases.
   d. Its potential energy decreases and its potential decreases.

3. The minimum capacitance that can be make using five 10-nF capacitors is:
   a. 50 nF
   b. 10 nF
   c. 0.2 nF
   d. 2 nF

4. A parallel plate capacitor is connected to a battery and becomes fully charged. The capacitor is then disconnected, and the separation between the plates is increased. The energy stored in the capacitor has:
   a. Increased.
   b. Decreased.
   c. Not changed.
   d. Become zero.

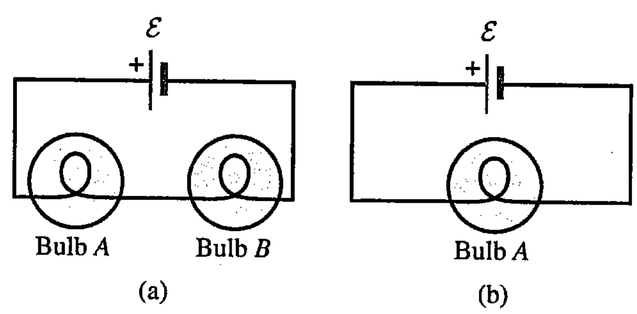
5. The plates of a parallel plate capacitor are connected to a battery and is left to charge. A slab of dielectric material is then inserted between the plates while the battery is still connected. Indicate how would each of the following quantities change when the dielectric is inserted:

	Increase	Decrease	Stay the same
Capacitance			
Charge			
Potential			
Stored energy			

6. A current density J is flowing in a resistor of resistivity ρ. The quantity $J^2\rho$ represents:
   a. The electric field in the resistor.
   b. The total power dissipated in the resistor.
   c. The rate at which heat is generated per unit volume of the resistor.
   d. The electrical energy stored in the resistor.
   e. The potential drop across the resistor.

7. Electrons in an electric circuit pass through a source of emf. The wire has the same diameter on each side of the source of emf. Compared to the drift speed of the electrons before entering the source of emf, the drift speed of the electrons after leaving the source of emf is:
   a. Faster
   b. Slower
   c. The same
   d. Not enough information given to decide

8. In the circuit shown in (a), the two bulbs A and B are identical. Bulb B is removed and the circuit is completed as shown in (b). Compared to the brightness of bulb A in (a), bulb A in (b) is:
   a. Brighter
   b. Less bright
   c. Just as bright
   d. Any of the above, depending on the rated wattage of the bulb.



9. A cylindrical copper rod has resistance R. It is reformed to twice its original length with no change of volume. Its new resistance is:
   a. R
   b. 2R
   c. 4R
   d. 8R
   e. R/2

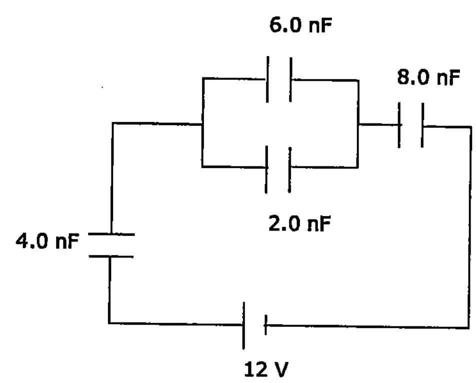
10. A charged particle moves across a constant magnetic field. The magnetic force on this particle:
    a. Changes the particle's speed.
    b. Causes the particle to accelerate.
    c. Is in the direction of the particle's motion.
    d. Both (a) and (b) are correct.

11. Which of the following is correct?
    a. When a current carrying wire is in your right hand, thumb in the direction of the magnetic field lines, your fingers point in the direction of the current.
    b. When a current carrying wire is in your left hand, thumb in the direction of the magnetic field lines, your fingers point in the direction of the current.
    c. When a current carrying wire is in your right hand, thumb in the direction of current, your fingers point in the direction of the magnetic field lines.
    d. When a current carrying wire is in your left hand, thumb pointing in the direction of the current, your fingers point in the direction of the magnetic field lines.

12. A circular loop of wire of cross-sectional area $0.12 m^2$ consists of 200 turns, each carrying 0.50 A. It is placed in a magnetic field of 0.050 T oriented at $30°$ to the plane of the loop. The torque acting on the loop (in N.m) is:
    a. 0.25
    b. 0.52
    c. 2.5
    d. 5.2

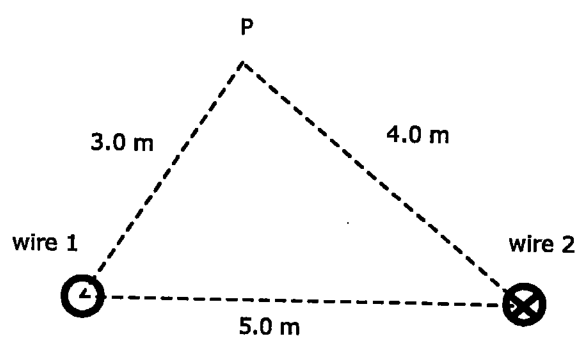
13. In the circuit shown below:

a. Find the equivalent capacitance.
b. Find the potential across the 4.0 nF capacitor.
c. Find the charge on the 6.0 nF capacitor.



14. Two very long straight parallel wires run perpendicular to the page and are separated by a distance of 5.0 m as shown in the figure. Wire 1 to the left carries a current of 50.0 A out of the page, while wire 2 to the right carries a current of 75.0 A into the page.

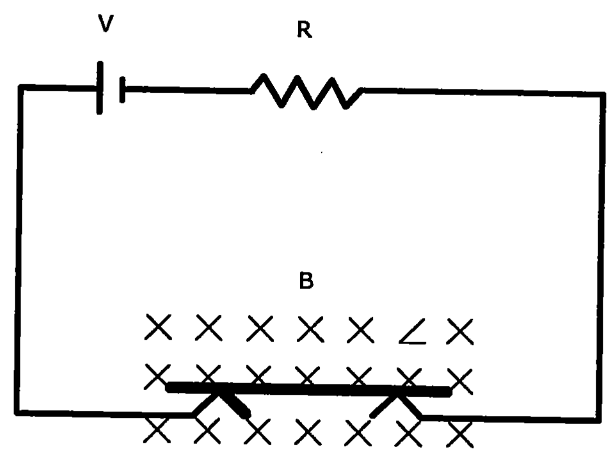
a. Find the magnitude force per unit length acting on wire 1.
b. Is this an attractive or repulsive force?
c. Find the magnetic field, magnitude and direction, at point P.
d. An electron moving horizontally with a speed of $3x10^5$ m/s passes through point P from left to right. At this particular instant, calculate the force on the electron, magnitude and direction.



15. A thin, 50.0-cm long metal bar with mass 750 g rests on, but is not attached to, two metallic supports in a uniform 0.450-T magnetic field as shown in the figure below. A battery and a 25.0-Ω resistor in series are connected to the supports.

a. What is the largest voltage the battery can have without breaking the circuit at the supports?

b. If the resistor suddenly gets partially short-circuited, decreasing its resistance to 2.0 Ω, find the initial acceleration of the bar.



Electrostatics

Coulomb's Law $\mathbf{F}=k\frac{q_1q_2}{r^3}\mathbf{r}$, Gauss's Law: $\Phi=\int_A \mathbf{E}\bullet d\mathbf{A}=\frac{q}{\varepsilon_0}$

E for a point charge: $\mathbf{E}=k\frac{q_i}{r^3}\mathbf{r}$.

E for a dipole at a distant point z along the dipole axis: $E=\frac{1}{2\pi\varepsilon_0}\frac{p}{z^3}$, where $p=qd$.

Electric potential energy of dipole: $U=-\mathbf{p}\bullet\mathbf{E}$.

Magnitude of Torque on dipole : $\tau=pE\sin(\theta)$, E for infinite plane conducting surface: $E=\frac{\sigma}{\varepsilon_0}$.

E for a plane non-conducting sheet of charge: $E=\frac{\sigma}{2\varepsilon_0}$.

E due to an infinite line charge: $E=\frac{\lambda}{2\pi\varepsilon_0 r}$

E outside a spherical charged conductor: $E=\frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$.

Electric Potential: $\Delta V=-\frac{W}{q}=V_f-V_i=-\int_i^f \mathbf{E}\bullet d\mathbf{l}$

Dielectric constant $K=\frac{C}{C_o}$, $\epsilon=\epsilon_o K$

Gauss's Law with dielectric $\oint K\vec{E}\cdot d\vec{A}=\frac{q_{encl\text{-}free}}{\epsilon_o}$

Electric Potential: $\Delta V=\int\frac{kdQ}{r}$, Electric potential due to a point charge: $V=k\frac{q}{r}$

Electric potential of electric dipole: $V=\frac{1}{4\pi\varepsilon_0}\frac{p\cos(\theta)}{r^2}$, where $p=qd$.

E calculated from V: $E_s=-\frac{dV}{ds}$

Capacitance: $q=CV$, Parallel plate $C=\frac{\varepsilon_0 A}{d}$, Cylindrical $C=\frac{2\pi\varepsilon_0 L}{\ln(b/a)}$,

Spherical $C=4\pi\varepsilon_0\frac{ab}{b-a}$, Electrostatic Energy $U=\frac{1}{2}CV^2$, Energy density $u=\frac{1}{2}\varepsilon_0 E^2$

Resistance $R=\rho\frac{L}{A}$. Ohm's Law $\vec{E}=\rho\vec{J}$

Magnetism

$\mathbf{F}_M=q\mathbf{v}\times\mathbf{B}$, $d\mathbf{F}=Id\mathbf{l}\times\mathbf{B}$, Gyroradius $r=\frac{mv}{qB}$, Magnetic torque $\tau=\mu B\sin(\theta)$,

Magnetic potential energy $U=-\mu B\cos(\theta)$, Hall effect: $ne=\frac{IB}{Vl}$, $v_d=\frac{J}{ne}=\frac{I}{neA}$

Biot–Savart: $d\mathbf{B}=\frac{\mu_0}{4\pi}\frac{id\mathbf{l}\times\mathbf{r}}{r^3}$, Ampere's Law: $\oint_l \mathbf{B}\bullet d\mathbf{l}=\mu_0 I$,

Expressions for B : Long straight wire $B=\frac{\mu_0 I}{2\pi r}$, Solenoid $B=\mu_0 nI$, Toroid $B=\frac{\mu_0 NI}{2\pi r}$,

B at center of current loop $B=\frac{\mu_0 I}{2r}$, B for a magnetic dipole $\mathbf{B}(z)=\frac{\mu_0}{2\pi}\frac{\mu z}{z^4}$

Faraday's Induction Law: $\varepsilon=-\frac{d\Phi}{dt}$, Faraday's Law: $\oint\mathbf{E}\bullet d\mathbf{l}=-\frac{d\Phi}{dt}$

Inductance: $L=\frac{\Phi}{I}$, Inductance of solenoid $L=l\mu_0 n^2 A$, Induced emf $\varepsilon=-L\frac{di}{dt}$,

Stored Magnetic energy $U=\frac{1}{2}LI^2$, Magnetic energy density $u=\frac{1}{2}\frac{B^2}{\mu_0}$.

Constants

$m_e=9.11\times10^{-31}kg$, $m_p=1.67\times10^{-27}kg$, $e=1.6\times10^{-19}C$

$\mu_0=4\pi\times10^{-7}Tm/A$, $\varepsilon_0=8.85\times10^{-12}C^2/Nm^2$, $k=8.99\times10^9 Nm^2/C^2$

$\int\frac{x\,dx}{(x^2+a^2)^{3/2}}=-\frac{1}{(x^2+a^2)^{1/2}}$, $\int\frac{dx}{(x^2+a^2)^{3/2}}=\frac{x}{a^2(x^2+a^2)^{1/2}}$