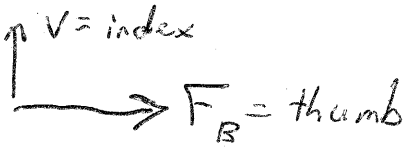
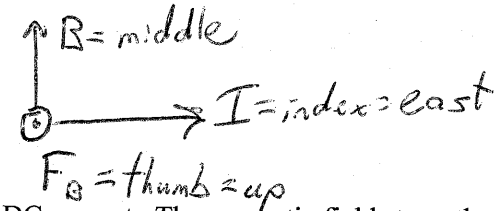
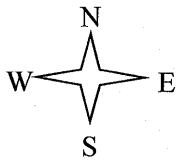
Phys 2426: University Physics II **Name:** Key
Fall 2014 **Exam 2 – Version A**

1. What is the symbol for inductance? 91%
   a. C (b.) L c. R d. V e. Z
2. What is the unit of capacitance? 46%
   a. V b. C c. Ω d. H (e.) F
3. A proton moves in a straight line through a region of space. The only possible field is a magnetic field. (There is no electric field and no gravitational field.) Which of the following *must* be true? 32%
   a. The magnetic field is zero.
   (b.) The magnetic field in that region has a zero component perpendicular to the particle's velocity.
   c. The magnetic field in that region has a zero component parallel to the particle's velocity.
   d. The magnetic force is parallel to the particle's velocity.
   e. The magnetic force is perpendicular to the particle's velocity.
4. A positively charged particle is traveling horizontally forward. A magnetic force is pointing to the right. What is the direction of the magnetic field? 46%
   a. Forward
   (b.) Upward
   c. Downward
   d. Leftward
   e. Rightward



5. A magnetic field is pointing northward. A wire can be oriented in any direction you want. In what direction must a current flow in order to levitate the wire? 34%
   a. Upward
   b. Downward
   (c.) Eastward
   d. Westward
   e. Northward

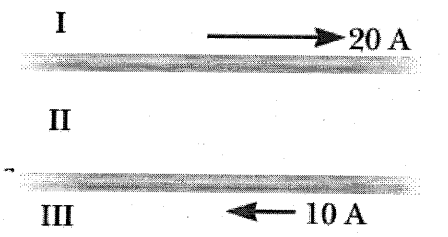




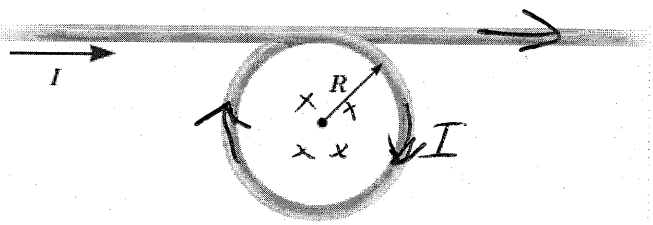
6. A long, straight wire is carrying a constant DC current. The magnetic field strength at a distance r_1 from the wire is 0.12 T. What is the magnetic field strength at a distance $r_2 = 2r_1$ from the wire? 60%
   a. 0.03 T
   (b.) 0.06 T
   c. 0.12 T
   d. 0.24 T
   e. 0.48 T

$B = \frac{\mu_0 I}{2\pi r}$ Double r, B cut in half.

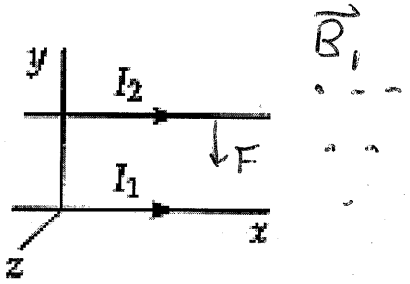
7. In the diagram to the right, in which region could you find a place where the magnetic field is zero? 17%
   a. Region I only. — Opposite B's, but B_{20} stronger.
   b. Region II only. — Same dir B's
   (c.) Region III only. — Opposite B's and B_{10} can = B_{20}.
   d. Region I and Region III.
   e. Any of the regions.



8. In the diagram to the right, what is the direction of the magnetic field at the center of the circle? 57%
   a. Toward the right.
   b. Toward the left.
   c. Out of the page.
   (d.) Into the page.
   e. Clockwise.



9. Two long, parallel conductors are arranged in the figure to the right. They carry currents in the same direction. What is the direction of the force on I_2?



35% a. $-\hat{y}$
b. $+\hat{y}$
c. $-\hat{z}$
d. $+\hat{z}$
e. $+\hat{x}$

10. A wire of length 0.5 m carries a current of 0.10 A in the positive x-direction, parallel to the ground. If the wire has a weight of 1.0×10^{-2} N, what is the minimum magnitude magnetic field that can exert a force on the wire equal to the wire's weight?

58% a. 0.01 T
b. 0.10 T
c. 0.20 T
d. 0.40 T
e. 0.50 T

$F = I\ell B$

$B = \frac{F}{I\ell} = \frac{0.01\,N}{(0.1A)(0.5m)} = 0.2\,T$

11. A proton enters a constant magnetic field of magnitude 0.050 T and travels in an arc of radius 1.0 mm before leaving the field. What is the proton's speed?

68% a. 4.8×10^3 m/s
b. 2.3×10^3 m/s
c. 1.6×10^3 m/s
d. 1.8×10^2 m/s
e. 2.8×10^4 m/s

$r = \frac{mv_\perp}{qB}$

$v_\perp = \frac{rqB}{m}$

12. A mass spectrometer is used to measure the relative amounts of carbon dioxide ($m = 44.01$ u) and propane ($m = 44.10$ u) in a gas sample. All of the molecules are singly ionized, and they are all traveling at the same speed. If the radius of curvature in the mass spectrometer for the carbon dioxide molecules is 12.00 cm, what is the radius of curvature for the propane molecules? (The beam had better be pretty narrow!)

72% a. 11.95 cm
b. 11.98 cm
c. 12.02 cm
d. 12.05 cm

$r = \frac{mv_\perp}{qB}$

$r \propto m$

13. A charged object is directed into a region where both an electric and magnetic field are present. The electric field has a magnitude of 0.5 V/m, while the magnetic field has a magnitude of 0.025 T. At what speed must the object be traveling to go through the region in a straight line?

65% a. 20 m/s
b. 40 m/s
c. 80 m/s
d. 0.05 m/s
e. 0.0125 m/s

$E = vB$

$v = E/B$

14. To build a velocity selector, what must be true?

51% a. The electric and magnetic fields must be in opposing directions.
b. The electric and magnetic fields must be perpendicular to each other. ✓
c. The electric and magnetic forces must be in opposing directions. ✓
d. Both (a) and (c).
e. Both (b) and (c).

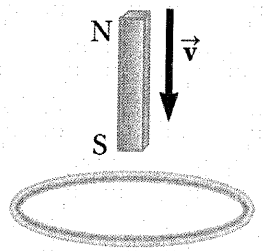
15. A generator experiences a magnetic torque with a peak value of $\tau = NBAI$. What is the effect of this torque?
35%
a. It keeps the generator from spinning at all.
b. It makes the generator spin.
(c.) It opposes whatever mechanical torque is making the generator spin.
d. It helps whatever mechanical torque is making the generator spin.

16. What happens to the amplitude of the induced emf when the rate of rotation of a generator coil is doubled?
a. It becomes four times larger.
68% (b.) It becomes two times larger.
c. It is unchanged.
d. It becomes one-half as large.
e. It becomes one-fourth as large.

17. A DC motor has coils with a resistance of 5.0 Ω and operates from a voltage of 12 V. When the motor is operating at full speed, the current is 2.0 A. What is the back EMF generated by the coils in the motor at this speed?
78%
a. 12 V
b. 10 V
c. 5 V
d. 2.5 V
(e.) 2 V

18. A flat coil of wire is placed in a uniform magnetic field that is pointing in the $+\hat{y}$ direction. For what orientation of the coil (not the normal vector to the coil) is the magnetic flux magnitude the greatest?
51%
a. If the coil is lying in the xy plane.
b. If the coil is lying in the yz plane.
(c.) If the coil is lying in the xz plane.
d. Both (a) or (b) have the same large flux.
e. None of the above.

19. A small magnet is lowered with a constant speed through a loop of wire, as pictured to the right. At what point is the magnetic flux through the loop the greatest?



43%
a. As the magnet is entering the top of loop.
(b.) When the magnet is fully inside the loop.
c. As the magnet exits the bottom of the loop.
d. Both (a) and (c).

20. A small magnet is lowered with a constant speed through a loop of wire, as pictured in the previous question. At what point is the induced EMF in the coil the greatest?
49%
a. As the magnet is entering the top of loop.
b. When the magnet is fully inside the loop.
c. As the magnet exits the bottom of the loop.
(d.) Both (a) and (c).

21. For a resistor connected to an AC voltage source, the power used is:
48%
a. Always equal to the peak power used.
(b.) Varying between the peak power used and zero, with an average of half of the peak power.
c. Sometimes positive and sometimes negative, with an average of zero.
d. Always equal to zero.
e. Always negative, because the device only provides power.

22. For an inductor connected to an AC voltage source, the power used is:
    a. Always equal to the peak power used.
    b. Varying between the peak power used and zero, with an average of half of the peak power.
11% c. Sometimes positive and sometimes negative, with an average of zero.
    d. Always equal to zero.
    e. Always negative, because the device only provides power.
23. An AC voltage source produces a peak voltage of 14 V. What is the rms value of the voltage?
    a. 7.1 V
89% b. 10 V
    c. 14 V
    d. 20 V
    e. 28 V
24. When a particular inductor is connected to an AC voltage source with a frequency of 60 Hz, the rms current is 3.0 A. What is the rms current if the source frequency is doubled?
    a. 12 A
40% b. 6.0 A
    c. 4.2 A
    d. 3.0 A
    e. 1.5 A
25. Which device allows AC current to flow easily at high frequencies?
    a. Resistor
52% b. Inductor
    c. Capacitor
    d. Transistor
26. The "outer coil" we used in lab has an impedance of about 78 μH. The capacitors we used for the RC circuits lab had a value of 1.0 F. What is their resonant frequency together?
    a. 78 μHz
77% b. 0.57 Hz
    c. 2.04 Hz
    d. 18 Hz
    e. 2040 Hz

$f = \frac{1}{2\pi\sqrt{LC}}$

27. An unknown R, RL, or RC combination is connected to an AC voltage source and the current is measured. The frequency is increased without changing the voltage, and the current increases. What is the unknown combination?
    a. A resistor.
29% b. A resistor-inductor combination.
    c. A resistor-capacitor combination.
    d. Either (a) or (b).
    e. Either (a) or (c).

28. A series RLC circuit contains a resistor of 20 Ω, an inductor of 120 mH, and a capacitor of 0.75 μF. An AC rms current of 0.4 A is flowing at a frequency of 5.0×10^2 Hz. What is the average power is used by the circuit?
    a. 3.2 W
    b. 5.0 W
    c. 7.6 W
    d. 8.2 W
    e. 21 W

66%

$P_R = I^2 R$

29. A series RLC circuit contains a resistor of 20 Ω, an inductor of 120 mH, and a capacitor of 0.75 μF. An AC rms voltage of 120 V is applied to this circuit, and the frequency is the resonant frequency. What is the rms current that flows?
    a. 0.0 A
    b. 2.3 A
    c. 4.8 A
    d. 6.0 A
    e. 8.2 A

69%

30. A series RLC circuit contains a resistor of 20 Ω, an inductor of 120 mH, and a capacitor of 0.75 μF. An AC rms voltage of 120 V is applied to this circuit at a frequency of 5.0×10^2 Hz. What is the rms current that flows?
    a. 0.0 A
    b. 2.3 A
    c. 4.8 A
    d. 6.0 A
    e. 8.2 A

63%

$R = 20\,\Omega$

$Z_L = 376.99\,\Omega$, $Z_C = 424.41\,\Omega$ $\Rightarrow X = -47.42\,\Omega$ $\Rightarrow Z = 57.47\,\Omega$

31. A series RLC circuit contains a resistor of 20 Ω, an inductor of 120 mH, and a capacitor of 0.75 μF. A DC battery with voltage of 120 V has been hooked up to this circuit for a long time. What is the steady-state current that flows?
    a. 0.0 A
    b. 2.3 A
    c. 4.8 A
    d. 6.0 A
    e. 8.2 A

32%

32. A 6.0 V battery is connected across the 50 turn primary coil of a transformer. The secondary coil of the transformer has 100 turns of wire. How much voltage appears across the secondary?
    a. 24 V
    b. 12 V
    c. 6 V
    d. 3 V
    e. None of the above.

2%

With DC, there is no $\frac{d\Phi_B}{dt}$ to generate EMF in the secondary.

33. A transformer has 300 turns of wire in the primary and 30 turns of wire in the secondary. If it is connected to a wall outlet with an RMS voltage of 120 V, what is the peak voltage across the secondary?
    a. 1700 V
    b. 850 V
    c. 17 V
    d. 12 V
    e. 8.5 V

60%