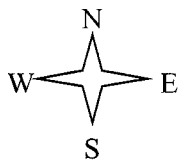
Phys 1402: General Physics II **Name:** Key

Fall 2014 **Exam 2 – Version A**

1. What is the symbol for magnetic field?
   a. A b. B c. T d. E e. Z
2. What is the unit of capacitance? Farad
   a. V b. C c. Ω d. H e. F
3. A proton moves in a circular path in the xy plane. The only field is a uniform, constant magnetic field. Which of the following must be true?
   a. The magnetic field is zero.
   b. The magnetic field is in the $\pm x$ direction.
   c. The magnetic field is in the $\pm y$ direction.
   d. The magnetic field is in the $\pm z$ direction.
   e. The magnetic field is parallel to the velocity.
4. A positively charged particle is traveling toward the top of the page. A magnetic field is pointing to the right. What is the direction of the magnetic force?
   a. Toward the top of the page.
   b. Out of the page.
   c. Into the page.
   d. Leftward.
   e. Rightward.
5. A magnetic field is pointing west. A wire can be oriented in any direction you want. In what direction must a current flow in order to levitate the wire?

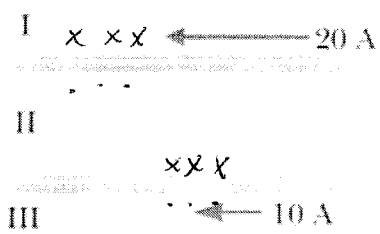


   a. Upward
   b. Downward
   c. Eastward
   d. Westward
   e. Northward
6. A long, straight wire is carrying a constant DC current. The magnetic field at one point near the wire 0.024 T. What is the magnetic field strength at a distance half as far from the wire?

$B = \mu_0 I/(2\pi r)$

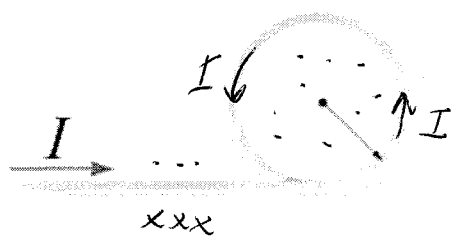
Inversely proportional to distance.

   a. 0.006 T
   b. 0.012 T
   c. 0.024 T
   d. 0.048 T
   e. 0.096 T
7. In the diagram to the right, in which region could you find a place where the magnetic field is zero?



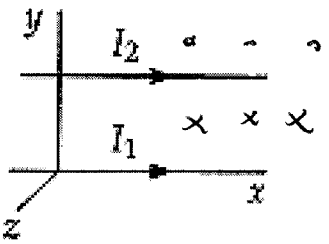
B_{20} is out, B_{10} is in.

   a. Region I only.
   b. Region II only.
   c. Region III only.
   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?



   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_1?



I_1 feels B_2 into page,
Force is $+\hat{y}$ for I = right, B = in ($+x$, $B = -z$)

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 0.01 N, what is the minimum magnitude magnetic field that can exert a force on the wire equal to the wire's weight?

$F_g = F_B = I\ell B$
$(0.01\ N) = (0.1\ A)(0.5\ m)\ B$

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

11. A certain mass spectrometer uses ions that are all traveling with the same speed and have one missing electron. Carbon ions (m = 12 u) are observed to bend with a radius of 0.090 m. Some other ions bend with a radius of 0.12 m. What is the mass of these other ions?

$r = \frac{mv_\perp}{qB}$ $\quad r \propto m$

$\frac{x}{12\ u} = \frac{0.12\ m}{0.09\ m}$

a. 6.8 u
b. 9.0 u
c. 12 u
d. 16 u
e. 21 u

12. A proton enters a constant magnetic field of magnitude 0.50 T and travels in an arc of radius 0.03 m before leaving the field. What is the proton's speed?

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

$0.03\ m = \frac{(1.67\times10^{-27}\ kg)\,v}{(1.6\times10^{-19}\ C)(0.5\ T)}$

a. 1.4×10^6 m/s
b. 5.7×10^6 m/s
c. 1.6×10^9 m/s
d. 2.6×10^9 m/s
e. 1.7×10^{-7} m/s

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 0.05 T. At what speed must the object be traveling to go through the region in a straight line?

$F_E = F_B$
$qE = qvB$
$(0.5\ N/C) = v\,(0.05\ T)$

a. 10 m/s
b. 20 m/s
c. 40 m/s
d. 0.1 m/s
e. 0.025 m/s

14. To build a velocity selector, what must be true?
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?
    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.
    b. It becomes two times larger.
    c. It is unchanged.
    d. It becomes one-half as large.
    e. It becomes one-fourth as large.

$\mathcal{E}_{max} = NBA\omega$ $\omega_{doubled}$

17. A DC motor has coils with a resistance of 4.0 Ω and operates from a voltage of 12 V. When the motor is operating at full speed, the current is 2 A. What is the back EMF generated by the coils in the motor at this speed?
    a. 12 V
    b. 10 V
    c. 8 V
    d. 4 V
    e. 2 V

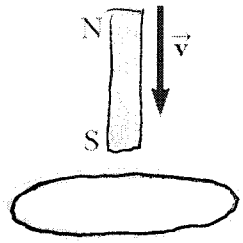
$12V = \mathcal{E}_{Back} = V_R$ $V_R = IR = 8V$

$\mathcal{E}_{Back} = 4V$

18. When is the back EMF of a motor the greatest?
    a. When the motor is just starting up.
    b. When the motor is halfway to the operating speed.
    c. When the motor is at full operating speed.
    d. When the motor is slowed down by friction.
    e. At all times, because the EMF is constant as long as the motor is running.

$\mathcal{E}_{Back} = NBA\omega$

19. A flat coil of wire is placed in a uniform magnetic field that is pointing in the $+\hat{z}$ direction. For what orientation of the coil (not the normal vector to the coil) is the magnetic flux magnitude the greatest?
    a. If the coil is lying in the yz plane.
    b. If the coil is lying in the xz plane.
    c. If the coil is lying in the xy plane.
    d. Both (a) or (b) have the same large flux.
    e. None of the above.
20. 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?
    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. According to Faraday's Law, what is most directly responsible for EMF?
    a. Electric Field
    b. Electric Current
    c. Magnetic Field
    d. Magnetic Flux
    e. Changing Magnetic Flux

22. For a resistor 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.
    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. 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.
    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.
24. An AC voltage source produces a peak voltage of 14 V. What is the rms value of the voltage?
    a. 7.1 V
    b. 10 V
    c. 14 V
    d. 20 V
    e. 28 V

$\frac{V_{max}}{\sqrt{2}} = V_{rms}$

25. When a particular capacitor 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
    b. 6.0 A
    c. 4.2 A
    d. 3.0 A
    e. 1.5 A

V_{rms} is fixed.

$X_C = \frac{1}{2\pi f C}$ is halved

$V_{rms} = Z\, I_{rms}$ (halved ↗, must double)

26. Which device allows AC current to flow easily at low frequencies?
    a. Resistor
    b. Inductor
    c. Capacitor
    d. Transistor
27. The "outer coil" we used in lab has an impedance of about 78 μH. What capacitor is can be combined with it to have a resonant frequency of 60 Hz?
    a. 283 mF
    b. 283 μF
    c. 283 nF
    d. 2.83×10^{-10} F
    e. 2.83×10^{13} F

$X_L = X_C$

$2\pi f L = \frac{1}{2\pi f C}$

$C = \frac{1}{(2\pi f)^2 L} = 0.09\ F$

28. 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 decreases. What is the unknown combination?
    a. A resistor.
    b. A resistor-inductor combination.
    c. A resistor-capacitor combination.
    d. Either (a) or (b).
    e. Either (a) or (c).

There must be an inductor.

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 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?

$P = I^2 R$
$= (0.4A)^2 (20\Omega)$
$= 3.2\ W$

a. 3.2 W
b. 5.0 W
c. 7.6 W
d. 8.2 W
e. 21 W

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?

$X_L = 2\pi f L = 377\Omega$
$X_C = \frac{1}{2\pi f C} = 424.4\Omega$
$Z = \sqrt{R^2 + (X_L - X_C)^2} = 51.45\Omega$

$V = I Z$
$(120V) = I(51.45\Omega)$

a. 0.0 A
b. 2.3 A
c. 4.8 A
d. 6.0 A
e. 8.2 A

31. 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?

$X_L = X_C$
$Z = R$
$(120\ V) = I(20\Omega)$

a. 0.0 A
b. 2.3 A
c. 4.8 A
d. 6.0 A
e. 8.2 A

32. An ideal transformer has 200 turns of wire in the primary and 12 turns of wire in the secondary. If the power input to the transformer is 120 W, what is the power output?

$P_{in} = P_{out}$

a. 0.6 W
b. 7.2 W
c. 10 W
d. 120 W
e. 240 W

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?

$\frac{V_{S\,Rms}}{120\ V} = \frac{30}{300}$

$V_{S\,Rms} = 12\ V$
$V_{S\,max} = (12V)\sqrt{2}$

a. 1700 V
b. 850 V
c. 17 V
d. 12 V
e. 8.5 V