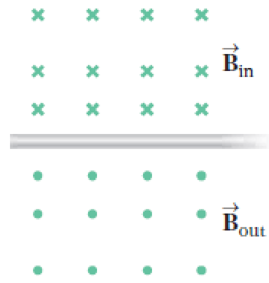
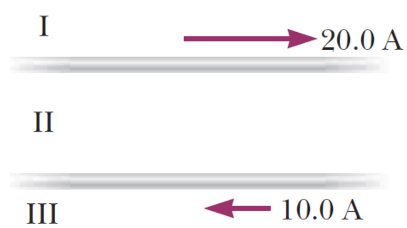
Phys 1402: University Physics II **Name: ________________________**

Fall 2016 **Exam 2 – Practice**

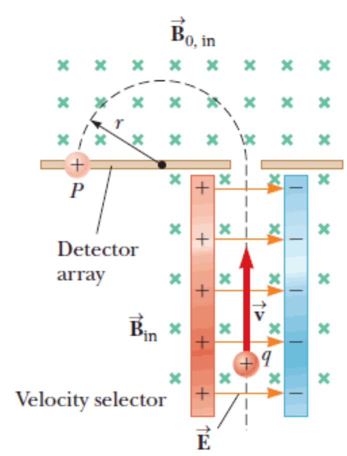
1. What is the symbol for impedance?
   - Z
2. What is the unit of inductance?
   - henries, H
3. In the image to the right, the magnetic field is caused by a current in the wire that stretches across the middle of the diagram. What is the direction of the current in the wire?



   a. Into the page
   b. Out of the page
   c. Left
   d. Right
   e. Cannot be determined.
4. A wire is carrying a current that flows horizontally northward. If you want to levitate the wire with magnetism, in what direction should the **magnetic force** point?
   - Magnetic Force should be Up (toward the sky).
5. A wire is carrying a current that flows horizontally northward. If you want to levitate the wire with magnetism, in what direction should the **magnetic field** point?
   - Magnetic field should be West (Left on a map).
6. When looking along the axis of a coil, it is producing a magnetic field that is pointing away from you. In what direction is the current in the coil?
   - Clockwise
7. A solenoid like the "outer coil" in our laboratory has 3000 turns of wire spread out over the 10 cm length. The wire is wrapped around a plastic core with a radius of 2 cm. If the current in the coil is 2 A, what is the magnetic field?
   - $B = \frac{\mu_0 N I}{\ell} = \frac{\mu_0 (3000)(2\text{ A})}{0.1\text{ m}} = 0.0754\text{ T} = 75.4\text{ mT}$
8. In the diagram to the right, two wires are carrying currents in opposite directions. What is the direction of the magnetic field in Region II?

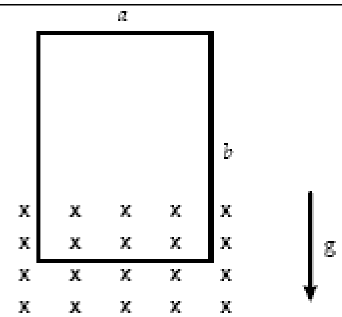


   - Upper current causes B to be into page in Region II.
     Lower current also causes B to be into page in Region II.
     Together, B is into the page in Region II.
9. A proton enters a region of uniform magnetic field with a velocity of $\vec{v} = 5 \times 10^6\text{ m/s}$ in the $+\hat{y}$ direction. The magnetic field has a magnitude of 3.0 T and points in the $-\hat{z}$ direction. What is the magnetic force exerted on the proton?
   - Magnitude: $F_B = qv_{\perp}B = (1.6 \times 10^{-19})(5 \times 10^6)(3.0) = 2.4 \times 10^{-12}$ N
   - Direction: Leftward, $-\hat{x}$
10. In the mass spectrometer shown to the right, the electric field has a magnitude of 2000 V/m and the magnetic field (in both parts) has a magnitude of 0.005 T. What is the speed of the particles that get through the velocity selector?



    - The electric and magnetic forces must be equal and opposite.
      $qE = qvB$, so $(2000) = v(0.005)$ and $v = 400{,}000\text{ m/s}$.
11. In the mass spectrometer in the previous question, what is the radius of the path of protons in the mass spectrometer region?
    - In a mass spec, the radius is $r = \frac{mv}{qB} = \frac{(1.67\times10^{-27})(400{,}000)}{(1.6\times10^{-19})(0.005)} = 0.835\text{ m}$

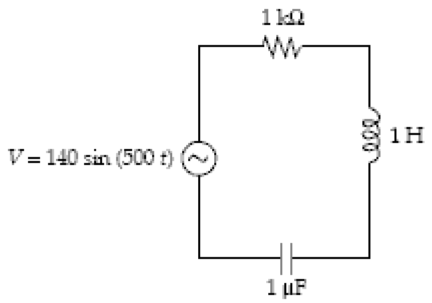
12. A uniform magnetic field of 0.50 T is directed along the $\hat{x}$ axis. A proton is moving with a speed of 60 km/s in a direction that is partly $\hat{x}$ and partly $\hat{z}$. What is the shape of the path of the proton?
    a. Circular
    b. Linear
    c. Helical (because the velocity is partly parallel and partly perpendicular to $\vec{B}$.)
    d. Cannot be determined.
13. If a magnetic field and an electric field are pointing in opposite directions, how can the net force (electric plus magnetic) on an electron be equal to zero?
    a. If the electron is stationary.
    b. If the electron is moving in the direction of the electric field vector.
    c. If the electron is moving in the direction of the magnetic field vector.
    d. If the electron is moving perpendicular to the electric field vector.
    e. It is not possible for the net force to be zero. (Because the magnetic force can only be perpendicular to $\vec{B}$.)
14. A rectangular loop with mass 0.6 kg is 2.0 m wide and 3.0 m high. It is dropped so that the bottom leg of the loop is in a magnetic field $B_{in} = 6.0$ T, while the top leg is out of the magnetic field. If the resistance of the loop is 40 Ω, what is the current in the loop?



    a. 5.9 N
    b. 19.6 V
    c. 6 m²
    d. 0.5 A (because this is the only choice with the correct units)
    e. 1.6 m/s
15. In the previous question, when the loop is in the position shown, in what direction does the current flow in the loop?
    a. Clockwise
    b. Counter-clockwise
    c. Up
    d. Down
    e. Inward
    - In the bottom segment of the loop, $\vec{v}$ is toward the bottom of the page, $\vec{B}$ is into the page, so the force is to the right. This pushes ⊕ charges rightward in the bottom segment, and they bend CCW to follow the loop.
16. A coil is wrapped with 300 turns of wire on the perimeter of a square frame (side length = 20 cm). Each turn has the same area as the frame, and the total resistance of the coil is 1.5 Ω. A uniform magnetic field perpendicular to the plane of the coil changes in magnitude at a constant rate from 0.50 T to 0.90 T in 2.0 s. What is the magnitude of the induced emf in the coil while the field is changing?
    - $\mathcal{E} = NA\frac{\Delta B}{\Delta t} = (300)(0.2)^2\left(\frac{0.9-0.5}{2.0}\right) = 2.4\text{ V}$
17. A current may be induced in a coil by
    a. moving one end of a bar magnet through the coil.
    b. moving the coil toward one end of the bar magnet.
    c. holding the coil near a second coil while the electric current in the second coil is increasing.
    d. all of the above. (Any change in magnetic flux induces EMF.)
    e. none of the above.

18. An 8 mH inductor is modified by unwinding half of the loops of wire (without changing the radius or length of the inductor). What is the new inductance of the inductor?
    - The magnetic field is proportional to N, and the magnetic flux is $\Phi_B = NBA$, which brings in another factor of N. This makes the inductance proportional to N^2. Halving the number of loops would reduce the inductance to 2 mH.
19. An AC generator consists of 6 turns of wire. Each turn has an area of 0.040 m^2. The loop rotates in a uniform field (B = 0.20 T) at a constant angular frequency of 314 rad/s. What is the maximum induced emf?
    - $\mathcal{E}_{\max} = NBA\omega = (6)(0.20)(0.040)(314) = 15\text{ V}$
20. What is the average power used by a 10 Ω resistor when supplied by $V_{RMS} = 12$ V at a frequency of 1000 Hz?
    - $I_{RMS} = \frac{V_{RMS}}{R} = \frac{12\text{ V}}{10\ \Omega} = 1.2$ A, then $P_{avg} = V_{RMS}I_{RMS} = (12\text{ V})(1.2\text{ A}) = 14.4\text{ W}$
    - If this was an inductor or capacitor, $P_{avg} = 0$.
21. An AC voltage source is connected across a capacitor, and 4.0 mA of current flows. If the frequency is tripled while keeping the RMS voltage constant, what happens to the current through the capacitor?
    - For a capacitor, frequency and reactance are inversely proportional, so X_C decreases 3×.
    - The current and reactance are inversely proportional, so $\boxed{I \text{ increases } 3\times}$.
22. A transformer is plugged into the wall ($V_{RMS} = 120$ V, $f = 60$ Hz) and provides an output of $V_{RMS} = 12$ V. If the source is changed to DC 120 V, what will the output voltage be?
    - The output voltage is 0 when DC is applied to a transformer.
23. The primary winding of an electric train transformer has 400 turns and the secondary has 50. If the input RMS voltage is 120 V what is the output RMS voltage?
    - $\frac{V_S}{V_P} = \frac{N_S}{N_P}$, so $\frac{V_S}{120} = \frac{50}{400}$, and $V_S = 15$ V.

All of the questions on this page use this circuit formed from a 1 kΩ resistor, a 1 H inductor, and a 1 μF capacitor. The voltage of the source is 140 sin(500 *t*).



24. Determine the rms voltage for the signal generator in this circuit.
    - $V_{RMS} = \frac{V_{max}}{\sqrt{2}} = \frac{140}{\sqrt{2}} = 99\text{ V}$
25. Determine the overall impedance for the circuit.
    - From the sine, $2\pi f = 500$ (in rad/s).
    - Inductor: $X_L = 2\pi f L = (500)(1.0\text{ H}) = 500\ \Omega$
    - Capacitor: $X_C = \frac{1}{2\pi f C} = \frac{1}{(500)(1.0\times10^{-6}\text{ F})} = 2000\ \Omega$
    - Reactance: $X = X_L - X_C = -1500\ \Omega$
    - Impedance: $Z = \sqrt{R^2 + X^2} = \sqrt{1000^2 + 1500^2} = \boxed{1803\ \Omega}$
26. Determine the resonant frequency of the circuit.
    - $f_R = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(1.0)(1.0\times10^{-6})}} = 159\text{ Hz}$
27. Determine the RMS current in this circuit.
    - $I_{RMS} = \frac{V_{RMS}}{Z} = \frac{99\text{ V}}{1803\ \Omega} = 0.0549\text{ A}$
28. Determine the rms voltage drop across the capacitor in the circuit.
    - $V_C = IX_C = (0.0549\text{ A})(2000\ \Omega) = 109.8\text{ V}$
      Weird that it's more than the voltage of the power supply, but true! The inductor generates extra voltage.
29. Determine the power supplied by the signal generator in this circuit.
    - Power is only used by the resistor.

$$P = V_R I_R = I^2 R = (0.0549)^2(1000) = 3.01\text{ W}$$