Exam III, vers. 0001 - Physics 1120 - Spr, 2001

NAME__________________________

Signature________________________________________

Student ID #_____________________________________

Circle your TA’s Name: Mike Dima, Jenn Gannon, Shawn Campbell, Eric Hudson, Charles Baily

What time does your Tues recitation begin (8am, noon, 1pm, etc.)? 

Please do not open the exam until you are told to.
Your exam should have 7 pages, numbered 1 thru 7. This exam consists of 25 questions, worth 4 points each for a total of 100 points. Fill in the bubble sheet with a #2 pencil.

You must fill out your bubble sheet according to the following instructions or you will automatically lose 10 points. Check each box as you complete the instructions.

☐ Please circle your TA’s name above.

☐ Print and bubble in your name on the bubble sheet.

☐ Print and bubble in your student Identification Number.

☐ Print and bubble in your Exam version, 0001 or 0002, in the upper left of your bubble sheet in the area marked 1234.

☐ Erase mistakes as thoroughly as possible. Ask for a fresh bubble sheet if you fear you cannot thoroughly erase mistakes.

☐ As you take the exam, circle the correct answers on your exam and mark them on the bubble sheet. That way we can grade the exam, if your bubble sheet is lost.

☐ At the end of the exam, check that you have filled in the first 25 questions on the bubble sheet, with only one bubble filled in for each question.

I have read and followed the instructions above.
Signature________________________________________

Possibly useful information: e = 1.6 \times 10^{-19} \text{C}, \quad \varepsilon_0 = 8.85 \times 10^{-12} (\text{SI units}), \quad k = 1/(4\pi\varepsilon_0)
\mu_0 = 4\pi \times 10^{-7} (\text{SI units})

Vers.0001
1. A step-down transformer has $N_p = 100$ turns in the primary coil and $N_s = 10$ turns in the secondary coil. The primary side is plugged into a standard 120 V AC outlet, and the secondary side is attached to a $R = 1 \Omega$ resistor. To two-place precision, what is the rms current drawn from the outlet?
   a) 24 A  b) 12 A  c) 1.2 A  d) 2.4 A  e) None of these.

The next two questions refer to this situation: Two long, straight, parallel wires, a distance $d$ apart, are both carrying current. The bottom wire carries a current to the LEFT, as shown. There are no other currents nearby. At a point which is in the plane of the wires and a distance $d/2$ above the top wire, the magnetic field is zero.

2. What is the direction of the current in the TOP wire?
   a) to the right $\rightarrow$  b) to the left $\leftarrow$  c) impossible to tell.

3. Compared to the current in the bottom wire, the current in the top wire is
   a) 3 times greater  b) half as large  c) twice as large  d) 1/3 as large  e) None of these.

4. A long straight wire carries a current $I_a$. Another wire in the shape of a long U carries a current $I_b$. The bottom of the U is parallel to the straight wire, has length $L$, and is a distance $r$ away from the straight wire, as shown. The top ends of the U-shaped wire are so far away that one can assume they are at infinity. What is the magnitude of the net force on the U-shaped wire due to the B-field from the straight wire?
   a) $\mu_0 I_a I_b L/(2\pi r)$  b) $\mu_0 I_a I_b r/L$  c) $\mu_0 I_a L/(2\pi r)$  d) $\mu_0 I_a I_b L/r$
   e) None of these
5. A single circular loop of wire of radius $R$ surrounds a long solenoid of radius $r$, turns per length $n$, carrying a current $I$. The diagram shows the end-on view of the situation. What is the magnetic flux through the single wire loop?

a) $\mu_0 n I \pi R^2$  

b) $\mu_0 n L/(2R)$  

c) $\pi R^2 (\mu_0 n I/2\pi R)$  

d) $\mu_0 n I \pi r^2$  

e) None of these.

6. A long straight wire, carrying a current $I$, is near a circular wire loop. The straight wire is perpendicular to the plane of the loop. The current $I$ is increasing with time and is into the page as shown. The emf induced in the loop ..

a) causes a clockwise current in the loop  

b) causes a counter-clockwise current in the loop  

c) is zero.

7. A circular wire loop of radius $R=5.0$ cm is rotating at a constant rate in a constant external magnetic field. The flux $\Phi$ through the loop vs. time is shown in the plot. To 2-place precision, what is the magnitude of the maximum emf induced in the loop?

a) 12 V  

b) 18 V  

c) 0.80 V  

d) 1.3 V  

e) 4.1 V

8. Two long, straight perpendicular wires, each carry a current $I$. The wires are so close that they can be assumed to lie in the same plane (but they are not touching). Consider the imaginary line $AB$ shown in the diagram which is in the plane of the wires and is tilted at $45^\circ$ so that every point on the line is equi-distant from the two wires. What can you say about the B-field along the line $AB$?

a) $B$ is out of the page everywhere along $AB$.  

b) $B$ is into the page everywhere along $AB$.  

c) $B$ is zero everywhere along $AB$.  

d) $B$ is non-zero everywhere along $AB$ and its direction varies with position along $AB$.  

e) None of these statements is true.
9. A thick wire of square cross-section and edge length L carries a total current I (I out of the page). The current density is uniform throughout this square wire. Consider the (imaginary) circular loop of radius r within the wire and oriented with its plane perpendicular to the current flow as shown. What is the line integral of the magnetic field $\mathbf{B}$·d$\mathbf{l}$ around the loop?

a) $\mu_0 I r/L$  
 b) $\mu_0 I$  
 c) $\mu_0 I L/(r^2)$  
 d) $\mu_0 I \pi r^2/(L^2)$  
 e) None of these.

10. As shown in the diagram, a circular loop of wire is moving at constant speed parallel to a long straight wire which carries a constant current I. The loop and the straight wire are in the same plane (the plane of the page). The induced current in the loop is.

a) zero.  
 b) clockwise.  
 c) counter-clockwise.

11. A straight wire carrying current I is in a uniform magnetic field $\mathbf{B}$. The directions of the current and $\mathbf{B}$-field are as shown in the diagram. The direction of the force on the wire is.

a) right $\rightarrow$  
 b) up $\uparrow$  
 c) into page $\otimes$  
 d) out of page $\oslash$  
 e) None of these.

12. The diagram shows two concentric conducting loops. The outer loop is connected to a battery and a switch, as shown. The switch has been closed for a long time and then is opened. When the switch opens, the induced current in the inner loop is.

a) clockwise  
 b) counter-clockwise  
 c) zero.

13. As shown in the diagram, a square loop of wire enters a region where there is a magnetic field into the page. As the plate enters the field from below, the force on the plate is.

a) right $\rightarrow$  
 b) up $\uparrow$  
 c) left $\leftarrow$  
 d) down $\downarrow$  
 e) None of these.
The **following three questions** refer to the circuit shown which has two resistors, both with resistance $R$, an inductor with inductance $L$, a battery with constant voltage $V$, and a switch which can be in position A or B. Suppose the switch has been in position A for a long time and is then switched to position B.

14. Immediately after the switch is thrown to B, what is the current in the inductor?
   a) zero   b) $V/R$   c) $V/(2R)$   d) $2V/R$   e) None of these.

15. Immediately after the switch is thrown to B, what is the voltage across the inductor $L$?
   a) zero   b) $V$   c) $2V$   d) $V/2$   e) None of these.

16. Immediately after the switch is thrown to B, the current in the resistors begins to decay exponentially according to $I(t) = I_0 e^{-t/\tau}$. What is the time constant $\tau$?
   a) $L/R$   b) $R/L$   c) $L/(2R)$   d) $2R/L$   e) None of these.

17. A coil of wire with $N=100$ turns and area $A = 0.010$ m$^2$ is oriented so that its plane is perpendicular to a uniform magnetic field $B$ which is increasing at a rate of $0.010$ T/s. The coil is connected to a resistor $R = 10\Omega$. What is the power dissipated in the resistor?
   a) $0.1$ W   b) $10^{-2}$ W   c) $10^{-4}$ W   d) $10^{-5}$ W
   e) None of these.

18. The bar magnet shown is broken in half and then the right half is rotated $180^\circ$. The two pieces must...
   a) repel   b) attract   c) impossible to tell.

19. A $600$W hairdryer is designed to be plugged into a standard $120$V AC electrical outlet. To 2-place precision, what is the electrical resistance $R$ of the hairdryer?
   (Hint: $600$W is the average power dissipated.)
   a) $29\Omega$   b) $58\Omega$   c) $24\Omega$   d) $48\Omega$   e) $17\Omega$
20. The same current I is flowing through solenoid A and solenoid B. The solenoids have circular cross-section and have the same diameter. Solenoid B is twice as long, and has 4 times as many turns as solenoid A. What is the ratio of the magnetic energy contained in solenoid A to that in solenoid B, that is, what is \( \frac{U_A}{U_B} \)?

(Hint: for a solenoid \( B = \mu_0 n I \))

a) 1/2 b) 1/4 c) 1/8 d) 1/16 e) None of these.

21. A solenoid has circular cross-section and radius R. The current of the solenoid is steadily increasing, creating a uniform magnetic field within the solenoid which is increasing at a steady rate, \( dB/dt = \text{constant} \). What is the magnitude of the electric field \( E \) at a point a distance \( r \) (\( r < R \)) from the center of the solenoid?

\[ a) \frac{r \ dB}{2 \ dt} \quad b) \pi R^2 \frac{dB}{dt} \quad c) \frac{R^2 \ dB}{2r \ dt} \quad d) \frac{2\pi r \ dB}{R \ dt} \quad e) \text{None of these.} \]

22. A hand-cranked electrical generator is attached to a resistor R. The generator is turned at a constant rate which causes an AC current to flow in the resistor. Suddenly, the value of the resistance R increases. Does the generator get easier or harder to turn?

a) Easier. b) Harder. c) No change in difficulty.

23. Two particles, labeled A and B, with identical charge and mass are both executing circular orbits in the same uniform magnetic field. The orbit of particle A has a larger radius than the orbit of particle B. The speed of particle A, compared to the speed of particle B, is

a) larger b) smaller c) the same d) impossible to tell from the information given.
The **following two questions** refer to the circuit shown which has a resistor R, a capacitor C, and an inductor L in series with a battery of voltage V and a switch. Initially, the switch has been open for a long time and the capacitor is uncharged. Then, at t=0, the switch is closed.

24. Immediately after the switch is closed, at t = 0+, what is the current through the resistor R? a) zero b) V/R c) 2V/R d) CVR/L e) None of these.

25. Immediately after the switch is closed, at t = 0+, what is the magnitude of the voltage across the inductor? a) zero b) V c) 2V d) LR/C e) None of these.