Physics 202 Midterm Exam 2
Nov 2, 2011

Name: ________________________________  Student ID: ____________

Section: ______________________________

TA (please circle):

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Instructions:

1. Don't forget to write down your name, student ID#, and section number. You need to do this on (this page of your test book and on your Scantron sheet as well, where you should fill in your student ID number under Identification number and your three digit section number starting with 3 under special codes).

2. Answer all multiple questions in this test book by indicating the best answer among choices. You must do this both on your test book and on your Scantron sheet. Follow instructions on the Scantron sheet on how to mark valid answers.

3. When you finish, you need to turn in both this test book and the Scantron sheet.

4. Use the blank side of question pages as additional draft spaces. An extra blank sheet is provided at the end of the test book.

5. Only one answer is allowed per problem/question/ All problems have equal weight.

Constants: Permeativity of free space (mu_0) = 4 \pi \times 10^{-7} \text{ N/A}^2, 
\text{g}=9.81\text{m/s}^2
1. Two copper wires have the same volume, but wire 2 is 1.2 times longer than wire 1. The ratio of the resistances of the two wires $R_2/R_1$ is
   A) 1.2
   B) 0.8
   C) 1.1
   D) 0.9
   E) 1.4

2. A 6-V storage battery supplies energy to a simple circuit at the constant rate of 48 W. The resistance of the circuit is
   A) 8 Ω
   B) $\sqrt{8}$ Ω
   C) 3/2 Ω
   D) 4/3 Ω
   E) 3/4 Ω

3. In the circuit shown, the power dissipated in the 18-Ω resistor is
   ![Circuit Diagram](image)
   A) 0.15 kW
   B) 98 W
   C) 33 W
   D) 0.33 kW
   E) 47 W
4. The circuit in the figure contains a cell of emf $\varepsilon$ and four resistors connected as shown. Let the currents in these resistances be designated by $I_1, I_2, I_3, I_4$, respectively. Which of the following equations is correct? 

![Circuit Diagram]

A) $I_1 = I_2$  
B) $I_2 = I_3$  
C) $I_3 = I_4$  
D) $I_1 = I_4$  
E) $I_1 = I_2 + I_3$

5. A 0.120-$\mu$F capacitor, initially uncharged, is connected in series with a 10.0-k$\Omega$ resistor and a 12.0-V battery of negligible internal resistance. The charge on the capacitor after a very long time is approximately

A) 28.8 $\mu$C  
B) 14.4 $\mu$C  
C) 144 $\mu$C  
D) 2.88 $\mu$C  
E) 1.44 $\mu$C

6. A wire 0.30 m long with an east–west orientation carries a current of 3.0 A eastward. There is a uniform magnetic field perpendicular to this wire. If the force on the wire is 0.18 N upward, what are the direction and magnitude of the magnetic field?

A) 0.20 T up  
B) 0.20 T north  
C) 0.20 T south  
D) $2.0 \times 10^{-3}$ T north  
E) $2.0 \times 10^{-3}$ T up
Use the following to answer question 7.

Electrons traveling at a speed of \( v_0 = 3 \times 10^7 \) m/s pass through the deflection plates. The electric field between the plates is \( E = 5000 \) V/m and spans a distance of \( x_1 = 5 \) cm. The electrons then travel a further distance of \( x_2 = 40 \) cm along the x-axis. Path b indicates how an electron would be deflected by the electric field.

7. In which direction should the magnetic field be applied so that the electron lands undeflected at \( a' \)?
A) 1  
B) 2  
C) 3  
D) 4  
E) 5

8. The radius of curvature of the path of a charged particle moving perpendicular to a magnetic field is given by
A) \( qE/m \)  
B) \( Bm/(qv) \)  
C) \( Bv/(qm) \)  
D) \( mv/(qB) \)  
E) \( Bq/(mv) \)
9. A circular 1-turn coil with a radius of 5.0 cm carries a current of 5.0 A. It lies in the $xy$ plane in a uniform magnetic field $\vec{B} = 0.05 \, \hat{i} + 0.12 \, \hat{k}$. (Ignore the B-field indicated in the figure). The potential energy of the system is

A) –4.7 mJ
B) –5.1 mJ
C) –6.3 mJ
D) 4.7 mJ
E) 5.1 mJ

10. The rectangular aluminum strip in the figure is in a uniform magnetic field, $\vec{B}$. The current $I$ is flowing perpendicular to surface 1. Negative charges will accumulate on

A) surface 1.
B) surface 2.
C) surface 3.
D) the surface opposite surface 2.
E) none of these surfaces.
11. A point charge of \( q_1 = 3.6 \text{ nC} \) is moving with speed \( 4.5 \times 10^7 \text{ m/s} \) parallel to the \( y \) axis along the line \( x = 3.0 \text{ m} \). The magnetic field produced by this charge at the origin when it is at the point \( x = 3.0 \text{ m}, y = 4.0 \text{ m} \) is approximately

\[
\vec{v} = 4.5 \times 10^7 \text{ m/s} \hat{j}
\]

A) 0.39 nT \( \hat{k} \)
B) -0.78 nT \( \hat{k} \)
C) -0.39 nT \( \hat{k} \)
D) 0.78 nT \( \hat{k} \)
E) 2.0 nT \( \hat{k} \)

12. A solenoid carries a current \( I \). An electron is injected with velocity \( \vec{v} \) along the axis \( AB \) of the solenoid. When the electron is at \( C \), it experiences a force that is

A) zero.
B) not zero and along \( AB \).
C) not zero and along \( BA \).
D) not zero and perpendicular to the page.
E) None of these is correct.
13. Calculate the magnetic field and its direction at point $P$, which is 2.0 cm away from the top wire and 4.0 cm from the bottom wire. Assume both wires are infinitely long and each carries a current of 1.5 A.

$$\text{A)} \ 2.3 \times 10^{-5} \text{T directed OUT of the page}$$

$$\text{B)} \ 7.5 \times 10^{-6} \text{T directed INTO the page}$$

$$\text{C)} \ 2.3 \times 10^{-5} \text{T directed INTO the page}$$

$$\text{D)} \ 7.5 \times 10^{-6} \text{T directed OUT of the page}$$

$$\text{E)} \ 1.1 \times 10^{-5} \text{T directed OUT of the page}$$

14. The graph that best represents $B$ as a function of $r$ for a long wire of radius $R$ carrying a current $I$ uniformly distributed over its cross-sectional area is

$$\text{A)} \ 1$$

$$\text{B)} \ 2$$

$$\text{C)} \ 3$$

$$\text{D)} \ 4$$

$$\text{E)} \ 5$$
15. A coaxial cable consists of a solid inner cylindrical conductor of radius 2.0 mm and an outer cylindrical shell of inner radius 3.0 mm and outer radius 3.5 mm. A current of 15 A flows down the inner wire and an equal return current flows in the outer conductor. If we assume that the currents are uniform over the cross section of the conductors, then calculate the magnitude of the enclosed current for use in Ampere's Law at a radius of 3.25 mm.

A) 7.2 A  
B) 3.8 A  
C) 7.8 A  
D) 11 A  
E) 7.5 A

16. A long straight wire carries a constant current $I$. The magnitude of the magnetic flux through the illustrated rectangular loop of wire is

$$\frac{\mu_0}{4\pi} \ln\left(\frac{b}{a}\right)$$

A) $(\mu_0/4\pi)2Il \ln(b/a)$  
B) $(\mu_0/4\pi)4Il \ln((a+b)/a)$  
C) $(\mu_0/4\pi)Il \ln[(a + b)/(b - a)]$  
D) $(\mu_0/4\pi)4Il \ln[(b - a)/(b + a)]$  
E) $(\mu_0/4\pi)2Il \ln[(b - a)/(b + a)]$

17. You place a coil that has 200 turns and a cross-sectional area of 0.050 m$^2$ so that its plane is normal to a field of 3.0 T. If the field is uniformly decreased to zero in 5.0 s, what EMF is induced in the coil?

A) 0.15 kV  
B) 0.12 kV  
C) 6.0 V  
D) 50 mV  
E) 10 mV
18. A copper ring lies in the $yz$ plane as shown. The magnet's long axis lies along the $x$ axis. Induced current flows through the ring as indicated. The magnet

![Diagram of a copper ring and a magnet]

A) must be moving away from the ring.
B) must be moving toward the ring.
C) must be moving either away from or toward the ring.
D) is not necessarily moving.
E) must remain stationary to keep the current flowing.

Use the following to answer question 19.

![Diagram of a rectangular coil and a magnetic field]

19. A rectangular coil moving at a constant speed $v$ enters a region of uniform magnetic field from the left. While the coil is entering the field, the direction of the magnetic force is

A) 1
B) 2
C) 3
D) 4
E) 5
20. A classic demonstration illustrating eddy currents is performed by dropping a permanent magnet inside a conducting cylinder. The magnet does not go into free fall. Instead it reaches terminal velocity and can take a few seconds to drop a length of about a meter. Suppose the mass of the magnet is 70 g and it has a terminal velocity of 10 cm/s. The length of the pipe is 80 cm. What is the magnitude of the magnetic force on the magnet when it is falling at the terminal velocity?

A) 0.35 N
B) 0.79 N
C) 0.97 N
D) 0.69 N
E) None of these is correct.
Answer Key - Midterm2

1. E
2. E
3. B
4. A
5. E
6. B
7. E
8. D
9. A
10. B
11. A
12. A
13. B
14. C
15. C
16. A
17. C
18. B
19. C
20. D