

Name: _____

Date: _____

Instructions

All Students at SMU are under the jurisdiction of the Honor Code, which you have already signed a pledge to uphold upon entering the University. For this particular exam, you may not give help to nor receive help from any other student. You are bound by the Honor Code to report any infractions to me or the Honor Council.

This is an open book, open note test. You may use any text and your class notes. Access to the internet is limited to WileyPlus; internet searches are strictly forbidden.

Part I of the exam is comprised of 40 multiple choice questions worth 2.5 points each. Part II of the exam is comprised of 5 multiple choice bonus questions worth 2 points each. A perfect score is 100 points with a maximum possible score of 110 points. Incorrect bonus question responses will not detract from your score.

Write your name and mark your responses on both the exam and the Scantron form. Be sure to use a No. 2 pencil. There is one correct answer per question. Upon completing the test, turn in the exam, the Scantron form and all scratch papers.

1 The direction of the magnetic field in a certain region of space is determined by firing a test charge into the region with its velocity in various directions in different trials. The field direction is:

- A) one of the directions of the velocity when the magnetic force is zero
- B) the direction of the velocity when the magnetic force is a maximum
- C) the direction of the magnetic force
- D) perpendicular to the velocity when the magnetic force is zero
- E) none of the above

2. A magnetic field exerts a force on a charged particle:

- A) always
- B) never
- C) if the particle is moving across the field lines
- D) if the particle is moving along the field lines
- E) if the particle is at rest

3. A beam of electrons is sent horizontally down the axis of a tube to strike a fluorescent screen at the end of the tube. On the way, the electrons encounter a magnetic field directed vertically downward. The spot on the screen will therefore be deflected:

- A) upward
- B) downward
- C) to the right as seen from the electron source
- D) to the left as seen from the electron source
- E) not at all

4. In the formula $\vec{F} = q\vec{v} \times \vec{B}$:

- A) \vec{F} must be perpendicular to \vec{v} but not necessarily to \vec{B}
- B) \vec{F} must be perpendicular to \vec{B} but not necessarily to \vec{v}
- C) \vec{v} must be perpendicular to \vec{B} but not necessarily to \vec{F}
- D) all three vectors must be mutually perpendicular
- E) \vec{F} must be perpendicular to both \vec{v} and \vec{B}

5. A static magnetic field CANNOT:

- A) exert a force on a charge
- B) accelerate a charge
- C) change the momentum of a charge
- D) change the kinetic energy of a charge
- E) exist

6. J. J. Thomson's experiment, involving the motion of an electron beam in mutually perpendicular \vec{E} and \vec{B} fields, gave the value of:

- A) the mass of an electron
- B) the charge of an electron
- C) the Earth's magnetic field
- D) the charge/mass ratio for an electron
- E) Avogadro's number

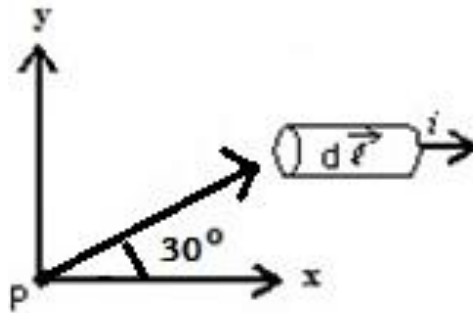
7. The Hall effect can be used to calculate the charge-carrier number density in a conductor. If a conductor carrying a current of 2.0 A is 0.5 mm thick, and the Hall effect voltage is 4.5 μV when it is in a uniform magnetic field of 1.2 T, what is the density of charge carriers in the conductor?

- A) $1.0 \times 10^{28}/\text{m}^3$
- B) $6.7 \times 10^{27}/\text{m}^3$
- C) $4.6 \times 10^{27}/\text{m}^3$
- D) $1.7 \times 10^{27}/\text{m}^3$
- E) $1.2 \times 10^{27}/\text{m}^3$

8. A loop of wire carrying a current of 2.0 A is in the shape of a right triangle with two equal sides, each 15 cm long. A 0.7 T uniform magnetic field is in the plane of the triangle and is perpendicular to the hypotenuse. The resultant magnetic force on the two equal sides has a magnitude of:

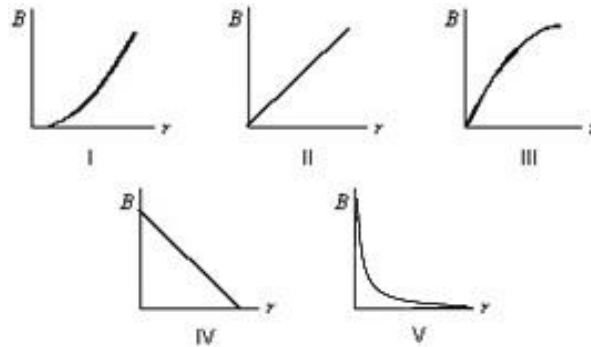
- A) 0 N
- B) 0.21 N
- C) 0.30 N
- D) 0.41 N
- E) 0.51 N

9. In the figure, if the current element has a length of 1.0 mm, carries a current of 2.5 A, and is a distance of 4.8 cm from the point P, what is the magnitude of the magnetic field at point P?



- A) 0 T
- B) 2.6×10^{-9} T
- C) 5.4×10^{-8} T
- D) 9.4×10^{-8} T
- E) 1.1×10^{-7} T

10. Which graph correctly gives the magnitude of the magnetic field outside an infinitely long, very thin, straight current-carrying wire as a function of the distance r from the wire?

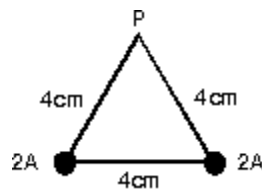


- A) I
- B) II
- C) III
- D) IV
- E) V

11. Two long straight wires are parallel and carry current in the same direction. The currents are 8.0 and 12 A and the wires are separated by 0.40 cm. The magnetic field at a point midway between the wires is:

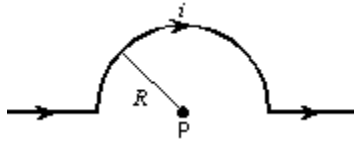
- A) 0 T
- B) 4.0×10^{-4} T
- C) 8.0×10^{-4} T
- D) 12×10^{-4} T
- E) 20×10^{-4} T

12. Two long straight wires pierce the plane of the paper at vertices of an equilateral triangle as shown below. They each carry 2.0 A, out of the paper. The magnetic field at the third vertex (P) has magnitude:



- A) 5.0×10^{-6} T
- B) 8.7×10^{-6} T
- C) 1.0×10^{-5} T
- D) 1.7×10^{-5} T
- E) 2.0×10^{-5} T

13. The magnitude of the magnetic field at point P, at the center of the semicircle shown, is given by:



- A) $2\mu_0 i/R^2$
- B) $\mu_0 i/2\pi R$
- C) $\mu_0 i/4\pi R$
- D) $\mu_0 i/2R$
- E) $\mu_0 i/4R$

14. Two parallel long wires carry the same current and repel each other with a force F per unit length. If both these currents are doubled and the wire separation tripled, the force per unit length becomes:

- A) $2F/9$
- B) $4F/9$
- C) $2F/3$
- D) $4F/3$
- E) $6F$

15. A long straight wire carrying a 3.0 A current enters a room through a window 1.5 m high and 1.0 m wide. The path integral $\oint \vec{B} \cdot d\vec{s}$ around the window frame has the value:

- A) 0.20 T·m
- B) 2.5×10^{-7} T·m
- C) 3.0×10^{-7} T·m
- D) 3.8×10^{-6} T·m
- E) none of these

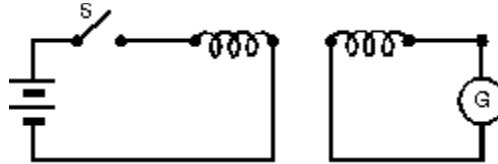
16. Two long ideal solenoids (with radii 20 mm and 30 mm respectively) have the same number of turns of wire per unit length. The smaller solenoid is mounted inside the larger, along a common axis. It is observed that there is zero magnetic field within the inner solenoid. The current in the inner solenoid must be:

- A) two-thirds the current in the outer solenoid
- B) one-third the current in the outer solenoid
- C) twice the current in the outer solenoid
- D) half the current in the outer solenoid
- E) the same as the current in the outer solenoid

17. The magnetic flux Φ_B through a surface:

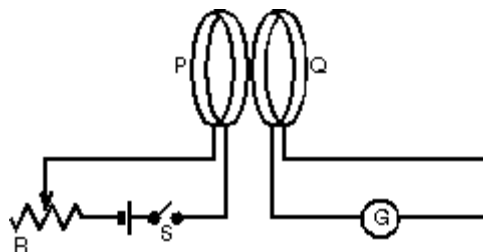
- A) is the amount of magnetic field piercing the surface.
- B) is the magnetic field multiplied by the area.
- C) does not depend on the area involved.
- D) is the line integral of the magnetic field around the edge of the surface.
- E) is the amount of magnetic field skimming along the surface.

18. In the experiment shown:



- A) there is a steady reading in G as long as S is closed
- B) a motional emf is generated when S is closed
- C) the current in the battery goes through G
- D) there is a current in G just after S is opened or closed
- E) since the two loops are not connected, the current in G is always zero

19. Coils P and Q each have a large number of turns of insulated wire. When switch S is closed, the pointer of galvanometer G is deflected toward the left. Now that S is closed, to make the pointer of G deflect toward the right one could:

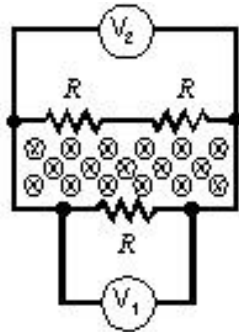


- A) move the slide of the rheostat R quickly to the right
- B) move coil P toward coil Q
- C) move coil Q toward coil P
- D) open S
- E) do none of the above

20. A rectangular loop of wire has area A . It is placed perpendicular to a uniform magnetic field B and then spun around one of its sides at frequency f . The maximum induced emf is:

- A) $BAf/2\pi$
- B) BAf
- C) $2BAf$
- D) $2\pi BAf$
- E) $4\pi BAf$

21. A changing magnetic field pierces the interior of a circuit containing three identical resistors. Two voltmeters are connected as shown. V_1 reads 1 mV across R . V_2 reads the voltage across the other two resistors, which is:



- A) 0 V
- B) $1/3$ mV
- C) $1/2$ mV
- D) 1 mV
- E) 2 mV

22. A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page. The induced current in the loop is:

- A) counterclockwise
- B) clockwise
- C) zero
- D) up the left edge and from right to left along the top edge
- E) through the middle of the page

23. A long narrow solenoid has length ℓ and a total of N turns, each of which has cross-sectional area A . Its inductance is:

- A) $\mu_0 N^2 A \ell$
- B) $\mu_0 N^2 A / \ell$
- C) $\mu_0 N A / \ell$
- D) $\mu_0 N^2 \ell / A$
- E) none of these

24. A 0.20-cm radius cylinder, 3.0 cm long, is wrapped with wire to form an inductor. At the instant the magnetic field in the interior is 5.0 mT, the energy stored in the field is:

- A) 0 J
- B) 3.8×10^{-6} J
- C) 7.5×10^{-6} J
- D) 7.5×10^{-4} J
- E) 9.9 J

25. An LC circuit has an inductance of 15 mH and a capacitance of 10 μF . At one instant the charge on the capacitor is 25 μC . At that instant the current is changing at the rate:

- A) 0 A/s
- B) 1.7×10^{-7} A/s
- C) 5.9×10^{-3} A/s
- D) 3.8×10^{-2} A/s
- E) 170 A/s

26. A charged capacitor and an inductor are connected in series. At time $t = 0$ the current is zero, but the capacitor is charged. If T is the period of the resulting oscillations, the next time, after $t = 0$ that the voltage across the inductor is a maximum is:

- A) $T/4$
- B) $T/2$
- C) T
- D) $3T/2$
- E) $2T$

27. A charged capacitor and an inductor are connected in series. At time $t = 0$ the current is zero, but the capacitor is charged. If T is the period of the resulting oscillations, the next time, after $t = 0$ that the energy stored in the magnetic field of the inductor is a maximum is:

- A) $T/4$
- B) $T/2$
- C) T
- D) $3T/2$
- E) $2T$

28. The electrical analog of a spring constant k is:

- A) L
- B) $1/L$
- C) C
- D) $1/C$
- E) R

29. An LC circuit consists of a 1 μF capacitor and a 4 mH inductor. Its oscillation frequency is approximately:

- A) 0.025 Hz
- B) 25 Hz
- C) 60 Hz
- D) 2500 Hz
- E) 16,000 Hz

30. Radio receivers are usually tuned by adjusting the capacitor of an LC circuit. If $C = C_1$ for a frequency of 600 kHz, then for a frequency of 1200 kHz one must adjust C to:

- A) $C_1/2$
- B) $C_1/4$
- C) $2C_1$
- D) $4C_1$
- E) $\sqrt{2}C_1$

31. The main reason that alternating current replaced direct current for general use is:

- A) ac generators do not need slip rings
- B) ac voltages may be conveniently transformed
- C) electric clocks do not work on dc
- D) a given ac current does not heat a power line as much as the same dc current
- E) ac minimizes magnetic effects

32. For a power transmission line, the transmission should be at low current and high voltage because:

- A) this is the least dangerous to electrical workers
- B) this gives the least dose of electromagnetic radiation to the public
- C) this minimizes transmission losses
- D) low current and high voltage is easier to transform than high current and low voltage
- E) household appliances run at low current and high voltage

33. Gauss' law for magnetism, $\oint \vec{B} \cdot d\vec{A} = 0$, tells us:

- A) the net charge in any given volume
- B) that the line integral of a magnetic field around any closed loop must vanish
- C) the magnetic field of a current element
- D) that magnetic monopoles do not exist
- E) charges must be moving to produce magnetic fields

34. A 1-A current is used to charge a parallel plate capacitor. A large square piece of paper is placed between the plates and parallel to them so it sticks out on all sides. The value of the integral $\oint \vec{B} \cdot d\vec{s}$ around the perimeter of the paper is:

- A) 2 T·m
- B) $4\pi \times 10^{-7}$ T·m
- C) 8.85×10^{-12} T·m
- D) 10^{-7} T·m
- E) not determined from the given quantities

35. A cylindrical region contains a uniform electric field that is along the cylinder axis and is changing with time. If r is the distance from the cylinder axis the magnitude of the magnetic field within the region is:
- A) uniform
 - B) proportional to $1/r$
 - C) proportional to r^2
 - D) proportional to $1/r^2$
 - E) proportional to r
36. A sinusoidal emf is connected to a parallel plate capacitor. The magnetic field between the plates is:
- A) zero
 - B) constant
 - C) sinusoidal and its amplitude does not depend on the frequency of the source
 - D) sinusoidal and its amplitude is proportional to the frequency of the source
 - E) sinusoidal and its amplitude is inversely proportional to the frequency of the source
37. An electron is on the z axis moving toward the xy plane but it has not reached that plane yet. At that instant:
- A) there is only a true current through the xy plane
 - B) there is only a displacement current through the xy plane
 - C) there are both true and displacement currents through the xy plane
 - D) there is neither a true nor a displacement current through the xy plane
 - E) none of the above are true
38. Two of Maxwell's equations contain a path integral on the left side and an area integral on the right. For them:
- A) the path must pierce the area
 - B) the path must be well-separated from the area
 - C) the path must be along a field line and the area must be perpendicular to the field line
 - D) the path must be the boundary of the area
 - E) the path must lie in the area, away from its boundary
39. A 1.2-m radius cylindrical region contains a uniform electric field along the cylinder axis. It is increasing uniformly with time. To obtain a total displacement current of 2.0×10^{-9} A through a cross section of the region, the magnitude of the electric field should change at a rate of:
- A) 5.0 V/m·s
 - B) 12 V/m·s
 - C) 37 V/m·s
 - D) 50 V/m·s
 - E) 4.0×10^7 V/m·s

40. If an electron has zero orbital angular momentum, the magnitude of its magnetic dipole moment equals:
- A) zero
 - B) half the Bohr magneton
 - C) a Bohr magneton
 - D) twice a Bohr magneton
 - E) none of these

Bonus Questions

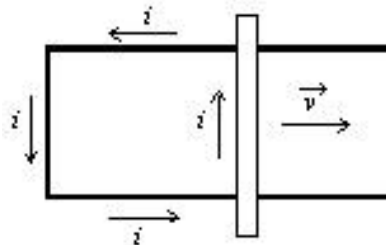
B1. The magnetic dipole moment of a current-carrying loop of wire is in the positive z direction. If a uniform magnetic field is in the positive x direction the magnetic torque on the loop is:

- A) zero
- B) in the positive y direction
- C) in the negative y direction
- D) in the positive z direction
- E) in the negative z direction

B2. A solenoid is 3.0 cm long and has a radius of 0.50 cm. It is wrapped with 500 turns of wire carrying a current of 2.0 A. The magnetic field at the center of the solenoid is:

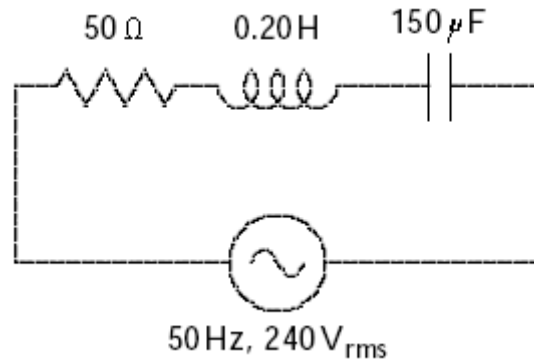
- A) 9.9×10^{-8} T
- B) 1.3×10^{-3} T
- C) 4.2×10^{-2} T
- D) 16 T
- E) 20 T

B3. The figure shows a bar moving to the right on two conducting rails. To make an induced current i in the direction indicated, a constant magnetic field between the rails should be in what direction?



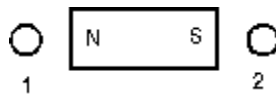
- A) Right
- B) Left
- C) Into the page
- D) Out of the page
- E) Impossible, cannot be done with a constant magnetic field

B4. The impedance of the circuit shown is:



- A) $21\ \Omega$
- B) $50\ \Omega$
- C) $63\ \Omega$
- D) $65\ \Omega$
- E) $98\ \Omega$

B5. The diagram shows two small diamagnetic spheres, one near each end of a bar magnet. Which of the following statements is true?



- A) The force on 1 is toward the magnet and the force on 2 is away from the magnet
- B) The force on 1 is away from the magnet and the force on 2 is away from the magnet
- C) The forces on 1 and 2 are both toward the magnet
- D) The forces on 1 and 2 are both away from the magnet
- E) The magnet does not exert a force on either sphere