Solutions

Physics 1320
Exam 3
MONDAY, APRIL 25, 2022

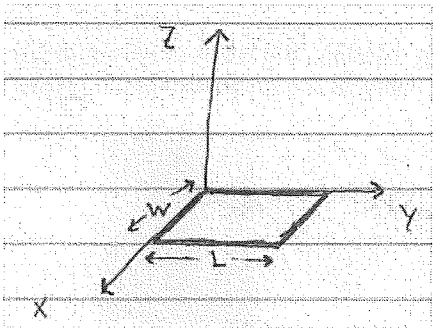
Directions: This is a multiple choice exam, having 18 problems, 1 of which is a bonus, all with the same weight. Mark the best/closest answer on the scantron sheet. Please be sure to record both your UNM id number and your UNM email address as well as the test version on the scantron, and pass it in when you are through. Keep this test, so that you can check your answers.

Data Table:
$\mu_0 = 4\pi \times 10^{-7}$ Tm^2/A
$m_e = 9.1 \times 10^{-31}$ kg
$m_p = 1.67 \times 10^{-27}$ kg
$e = 1.6 \times 10^{-19}$C
$\hat{i} \times \hat{j} = \hat{k}, \hat{j} \times \hat{k} = \hat{i}, \hat{k} \times \hat{i} = \hat{j}$
$\hat{j} \times \hat{i} = -\hat{k}, \hat{k} \times \hat{j} = -\hat{i}, \hat{i} \times \hat{k} = -\hat{j}$
$$\vec{A} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

(1) A straight segment of wire carrying current of 1 Ampere in the $\hat{k}$ direction is placed in a uniform magnetic field $\vec{B} = 1\text{T}\ \hat{j}$. What is the force on the segment if it has a length of 1 meter?
(a) -1 N $\hat{i}$+2 N $\hat{j}$
(b) 2 N $\hat{i}$+2 N $\hat{j}$+1 N $\hat{k}$
(c) 1 N $\hat{j}$+3 N $\hat{k}$
(d) -1 N $\hat{i}$

(2) Two infinitely long straight wires each carry a steady current. One wire carries a current of 1 Ampere in the $\hat{i}$ direction, and the other wire carries a current of 2 Ampere in the $-\ \hat{i}$ direction. If the distance between the two wires is 4 meters, the magnetic force between them, per meter of wire, is
(a) 2×10^{-7} N/m (repulsive).
(b) 1×10^{-7} N/m (repulsive).
(c) 0.5×10^{-7} N/m (attractive).
(d) 0.25×10^{-7} N/m (attractive).

(3) A rectangular wire loop with width $w = 1$ m and length $L = 2$ m having a resistance of 1 Ω lies in the xy plane as shown. The loop is subjected to a time-dependent magnetic field $\vec{B} = 2\text{T}(1 - \omega t)\,\hat{k}$, where the angular frequency $\omega = 1$ rad/s.What is the current induced in the loop? (Ignore self inductance.)

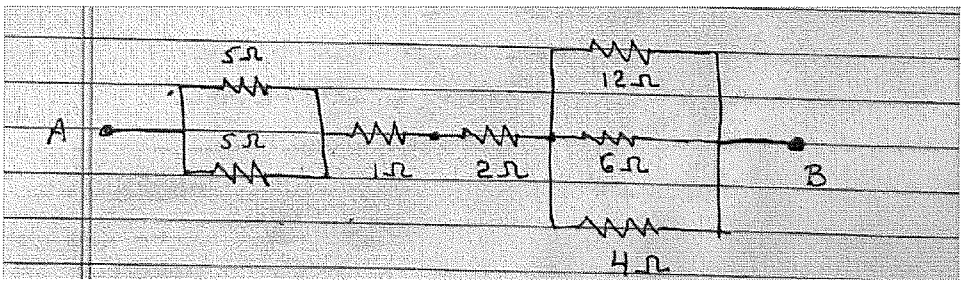


(a) 1 A
(b) 2 A
(c) 3 A
(d) 4 A

(4) A proton moves with a speed of 3000 m/s in the x y plane in a uniform magnetic field of 1×10^{-3} T in the z direction. What is the radius of its circular orbit?
(a) 1.1 cm

(b) 2.1 cm
(c) 3.1 cm
(d) 4.1 cm

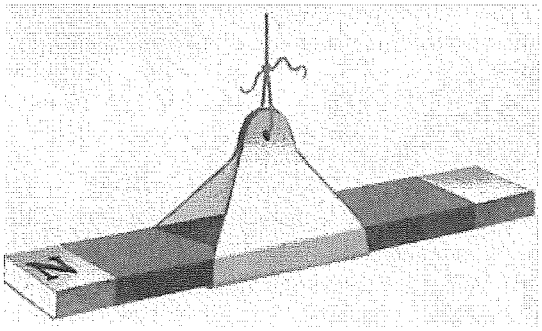
(5) What is the equivalent resistance between points A and B in the figure?



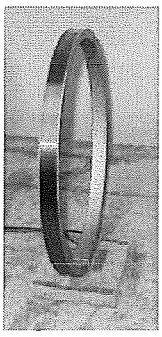
(a) 1.5 Ω
(b) 4.5 Ω
(c) 6.5 Ω
(d) 7.5 Ω
(e) 9.5 Ω

(6) A thin cylindrical bar magnet with length 10 cm has a magnetic charge at the N and S ends of $\pm 5 \times 10^3$Cm/s respectively. What is the magnetic dipole moment of the magnet?

(a) 300 Am^2
(b) 400 Am^2
(c) 500 Am^2
(d) 600 Am^2
(e) 700 Am^2



(7) An electromagnet is made by winding 100 turns of wire in a circular coil with 20 cm radius. If the wire carries a current of 40 Amperes, what is the magnetic dipole moment of the coil?



(a) 300 Am^2
(b) 400 Am^2
(c) 500 Am^2

(d) 600 Am^2
(e) 700 Am^2

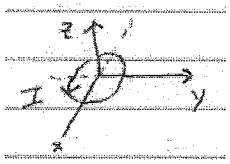
(8) The total voltage drop across two resistors in series is 5 Volts. One has a resistance of 3 Ω and the other has a resistance of 5 Ω. What is the voltage drop across the 5 Ω resistor?
(a) 2.5 V
(b) 2.7 V
(c) 2.9 V
(d) 3.1 V

(9) Who is credited with the discovery of the electron?
(a) Michael Faraday
(b) J. J. Thompson
(c) H. C. Oersted
(d) Biot and Savart
(c) Ampere

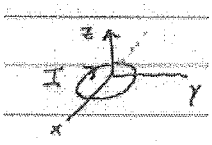
(10) The resistivity of copper is 2.0×10^{-8} Ωm. What length of copper wire with radius 1.0 mm has a resistance of 2.0 Ω?
(a) 314 m
(b) 231 m
(c) 167 m
(d) 133 m

(11) A *long* solenoid with length 20 cm and radius 2.0 cm is wrapped with 5000 turns of wire, and has core with premeability $\mu = 100\mu_0$. What is the magnetic field in the solenoid for a current of 1 Amp ?
(a) 3.1 T
(b) 4.2 T
(c) 5.1 T
(d) 6.2 T

(12) A circular wire loop lies in the xy plane, in a uniform magnetic field in positive z direction. If the magnet responsible for the field is removed, which of the following will occur in response?
(a) Current will flow in the wire in the clockwise direction, as shown below.



(b) Current will flow in the wire in the counter clockwise direction, as shown below.



(c) No current will flow in the wire.

(13) The flux through the coil of an ac generator is given by

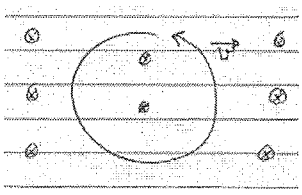
$$\Phi = NBA\cos(\omega t)$$

where $B = 1.0$ T, $A = 1$ m^2, $N = 100$, and $\theta = \omega t$ is the angle in radians between $\vec{B}$ and $\vec{A}$. If the coil is rotated uniformly at a frequency of 60 Hz (cycles per second), what is the maximum (peak) voltage?
(a) 5 kV.
(b) 22 kV
(c) 27 kV
(d) 38 kV

(14) The susceptibility of a paramagnetic material (such as aluminum) is on the order of
(a) -1×10^{-5}
(b) $+1\times10^{-5}$
(c) -1×10^{3}
(d) $+1\times10^{3}$

(15) A *long* solenoid with length 20 cm and radius 2.0 cm is wrapped with 5000 turns of wire, and has core with permeability $\mu = 100\mu_0$. What is the magnetic intensity H for a current of 1 Amp ?
(a) 15,000 A/m
(b) 20,000 A/m
(c) 25,000 A/m
(d) 30,000 A/m

(16) A charged particle traveling in a magnetic field moves in the circle shown below. The magnitude of the magnetic field is 9 mT, and the charge is -1.6×10^{-19}C.If the period of the circular orbit is 1.4 μs, what is the mass of the particle?



(a) 6.3×10^{-28}kg.
(b) 4.9×10^{-28}kg.
(c) 3.2×10^{-28}kg.
(d) 1.6×10^{-28}kg.

(17) Which of the four equations expresses Faraday's law?
(a) $\oint \vec{B} \cdot d\vec{\ell} = \mu_0 I_{\text{enclosed}}$
(b) $\oint \vec{E} \cdot d\vec{\ell} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{A}$
(c) $\oint \vec{E} \cdot d\vec{A} = \frac{Q_{\text{enclosed}}}{\epsilon_0}$
(d) $\oint \vec{B} \cdot d\vec{A} = 0$

(18) Who discovered that a magnetic field is generated by wire carrying current?
(a) Oersted
(b) Ampere
(c) Biot and Savart
(d) Faraday
(e) Edison

Version AA