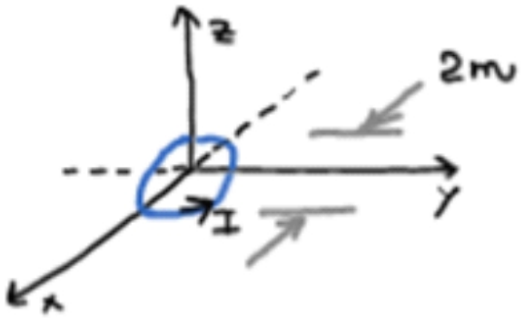
Physics 161
Exam 3

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

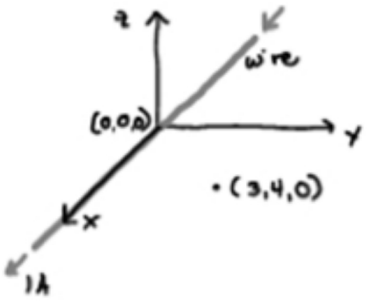
(1) A 2.0 m diameter circular loop of wire lies in the horizontal (xy) plane and carrys a current of 0.32 Amperes. What is the torque on the loop when it is subjected to a uniform magnetic field $\vec{B}$ = 2.0T $\hat{\imath}$+1.0T $\hat{\jmath}$+3.0T $\hat{k}$? Assume that the current is in the direction indicated in the figure.

(a) −1 Nm $\hat{\imath}$+2 Nm $\hat{\jmath}$+0 Nm $\hat{k}$
(b) 2 Nm $\hat{\imath}$+2 Nm $\hat{\jmath}$+1 Nm $\hat{k}$
(c) 0 Nm $\hat{\imath}$+1 Nm $\hat{\jmath}$+3 Nm $\hat{k}$
(d) −1 Nm $\hat{\imath}$+3 Nm $\hat{\jmath}$+1 Nm $\hat{k}$

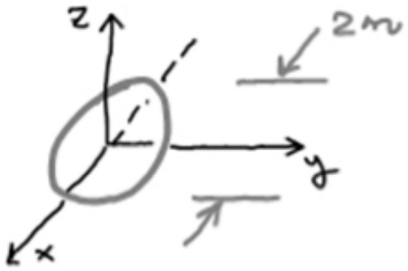


(2) A long straight wire aligned with the x-axis and passing through the origin, (x,y,z)=(0,0,0), carries a steady current of 1 Ampere in the $\hat{\imath}$ direction. What is the magnetic field produced by the wire at location (x,y,z)=(3,4,0) meters?

(a) -2×10^{-7} $\hat{k}$ T.
(b) 1×10^{-7} $\hat{\jmath}$ T.
(c) 0.5×10^{-7} $\hat{k}$ T.
(d) 0.25×10^{-7} $\hat{\imath}$ T.



(3) A circular wire loop with radius 1 meter having a resistance of 2.0 Ω lies in the xy plane as shown. The loop is subjected to a time-dependent magnetic field $\vec{B} = 0.30\text{T}(1 + \omega t)\,\hat{k}$, where the constant $\omega = 0.10$ s^{-1}.What is the current induced in the loop? (Ignore the loop's self inductance.)



(a) 47 mA
(b) 56 mA
(c) 66 mA
(d) 40 mA

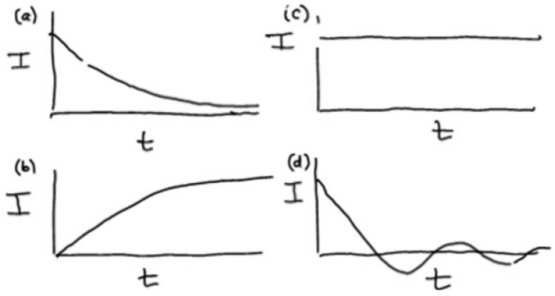
(4) A proton moves with a speed of 3000 m/s in the x y plane in a uniform magnetic field of 1.0×10^{-3} T in the z direction. What is the period* of its circular orbit? (*time to travel around the circle)

(a) 4.7×10^{-5} s
(b) 5.6×10^{-5} s
(c) 6.6×10^{-5} s
(d) 4.0×10^{-5} s

(5) An inductor and a resistor are connected in series with a battery in a closed loop circuit as shown.

Initially the switch is open. What graph best represents the current in the circuit after the switch is closed?

(6) A current of 2 Amperes passes through a circuit element consisting of two resistors in parallel. One has a re



sistance of 4 Ω, and the other has a resistance of 8 Ω. What is the drop in voltage across the 8 Ω resistor?

(a) 1.5 V
(b) 2.3 V
(c) 5.3 V
(d) 6.2 V

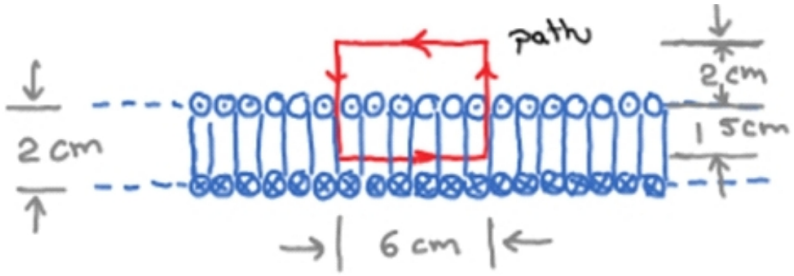
(7) The voltage drop across two resistors in series is 5.6 Volts. One has a resistance of 2 Ω and the other has a resistance of 5 Ω. What is the current in the 5 Ω resistor?

(a) 0.62 A
(b) 0.75 A
(c) 0.53 A
(d) 0.80 A

(8) A magnetic field $\vec{B}$ is produced by a long straight wire carrying a current of 2 Amperes. A cross section of the wire is shown in the figure below, with the current coming out of the plane of the page. Consider a square with each side having a length of 1 meter in the plane of the page. If the wire is at the center of the square, what is the value of the line integral, $\oint \vec{B} \cdot d\vec{\ell}$ taken around the perimeter of the square in the counter-clockwise direction?

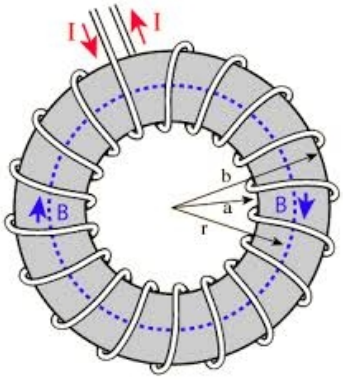
(a) $-2\pi \times 10^{-7}$ Tm
(b) $8\pi \times 10^{-7}$ Tm
(c) $-4\pi \times 10^{-7}$ Tm
(d) $6\pi \times 10^{-7}$ Tm

(9) A cross-sectional view of a segment of a long solenoid is shown in the figure below. The current comes out of the page on top, and goes into the page on the bottom. If the current in the equally-spaced windings *(as shown in the figure)* is 3 Amperes, what is the value of the integral $\oint \vec{B} \cdot d\vec{\ell}$ taken over the rectangular 6 cm by 3.5 cm path shown?



(a) 2.26×10^{-5} T m
(b) -2.26×10^{-5} T m
(c) 4.52×10^{-5} T m
(d) -4.52×10^{-5} T m

(10) The toroidal magnet shown in the figure below carries a current of 1 Amp. Its inner radius a=1 cm, and its outer radius b=3 cm. What is the strength of the magnetic field at the radius $r = 2$ cm from the center if the permeability of the core is 5000 times larger than the permeability of free space?



3

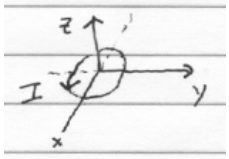
(a) 0.6 T
(b) 0.7 T
(c) 0.8 T
(d) 0.9 T

(11) A solenoid with length 20 cm and radius 2.0 cm is wrapped with 5000 turns of wire, and has a ferromagnetic core with premeability $\mu = 5000\mu_0$. What is the magnetic intensity $H = \eta I$ in the solenoid for a current of 1 Amp ?

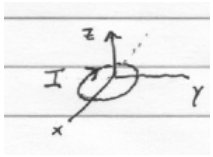
(a) 2.5×10^4 A/m
(b) 3.2×10^4 A/m
(c) 4.0×10^4 A/m
(d) 5.5×10^4 A/m

(12) A circular wire loop lies in the xy plane, in a uniform external magnetic field in the positive z direction with strength 1.0 T. If the external magnetic field increases, 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

$$\Phi = N\ BA\cos\theta$$

where $B = 0.25$ T, $A = 0.5$ m^2, $N = 100$, and θ 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 peak voltage of the generated emf?

(a) 3.1 kV.
(b) 4.7 kV
(c) 5.1 kV
(d) 6.5 kV

(14) The susceptibility of a diamagnetic material (such as copper) is on the order of

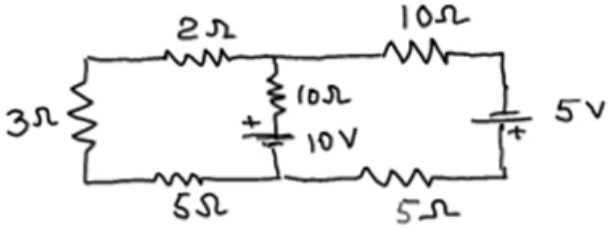
(a) -1×10^{-5}

(b) $+1\times10^{-5}$
(c) -1×10^{3}
(d) $+1\times10^{3}$

(15) A circular loop of wire with radius 1.0 m carries a current of 1.0 A. What is the strength of the magnetic field at the center of the loop?
(a) 0.13 μT.
(b) 0.21 μT.
(c) 0.52 μT.
(d) 0.63 μT.

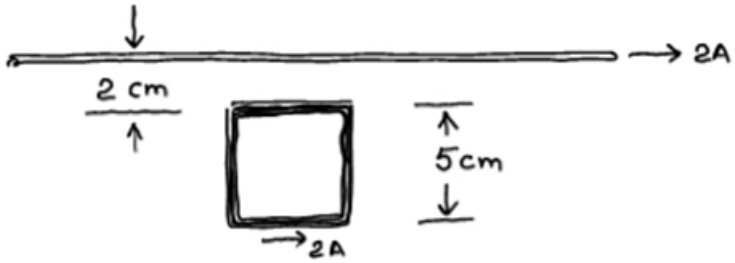
(16) At time $t = 0.00000$ a proton with initial velocity $\vec{v} = 1.0$ m/s $\hat{\imath} + 2.0$ m/s $\hat{\jmath} + 3.0$ m/s $\hat{k}$ moves in a uniform magnetic field $\vec{B} = 2 \times 10^{-4}$ T $\hat{k}$ What is the velocity in the $\hat{k}$ direction at $t = 0.00033$ s.
(a) 1.0 m/s.
(b) 3.0 m/s.
(c) 2.2 m/s.
(d) 3.6 m/s.

(17) Consider the two-loop circuit shown below. What is the power disspatted by the 3Ω resistor?



(a) 1.3 W.
(b) 2.4 W.
(c) 5.1 W.
(d) 6.6 W.

(18) The current in a square coil of wire is 2.0 Amperes. The coil consists of 100 turns of thin wire wound around the perimeter of a 5 cm × 5 cm square. A second long straight wire carrying a current of 2.0 Amperes is aligned with one side of the square loop, 2 cm away, as shown in the figure. What force is exerted on the straight wire by the field produced by the square loop? Currents are in the directions shown.



(a) 4.3×10^{-6} N (attractive).
(b) 4.3×10^{-6} N (attractive).
(c) 1.4×10^{-4} N (repulsive).
(d) 1.4×10^{-4} N (repulsive).