Physics 241
Fall 2009
Exam 2

November 10, 2009

Giving information to or receiving information from another person while taking this exam is cheating. To intentionally do anything that would cause the level of your knowledge of the material to be misrepresented is cheating. Anyone found to be cheating will receive an F for the course and their names will be forwarded to the Dean of Students.

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Sign Name **Student ID**

If during the exam you feel there is an equation that should be on the equation sheet contact one of the exam proctors. Your request will be considered and placed before all the students, if your request is deemed acceptable.

If you feel any of the questions are ambiguous or unclear, complete the problems according to your interpretation of the problem. Include all your work and calculations clearly. Turn in the paper version of the exam along with your optical scan sheet. This will allow you to argue your case, if your solution does not agree with that given as the answer.

VERSION 2

Physics 241, Exam 1
Equation Sheet

$k = 9 \bullet 10^9 \frac{Nm^2}{C^2}$ $\quad k = \frac{1}{4\pi \varepsilon_o}$ $\quad \varepsilon_o = 9 \bullet 10^{-12} \frac{C^2}{Nm^2}$ $\quad 1eV = 1.6 \bullet 10^{-19} J$ $\quad e = 1.6 \bullet 10^{-19} C$

$\vec{F} = k\frac{q_1 q_2}{r^2}\hat{r}$ $\quad \vec{E} = k\frac{q_1}{r^2}\hat{r}$ $\quad \vec{E}(p) = \sum \vec{E}_{ip}$ $\quad d\vec{E} = k\frac{dq_1}{r^2}\hat{r}$ $\quad E = \frac{\sigma}{\varepsilon_o}$ $\quad \Delta E = \frac{\sigma}{\varepsilon_o}$

$\phi = \int_S \vec{E} \bullet \hat{n}\, dA$ $\quad \oint_S \vec{E} \bullet \hat{n}\, dA = \frac{Q}{\varepsilon_o}$ $\quad \Delta V = V_b - V_a = -\int_a^b \vec{E} \bullet d\vec{l}$ $\quad dU = -\vec{F} \bullet d\vec{l}$ $\quad \vec{F} = q\vec{E}$

$dV = \frac{dU}{q_o} = -\vec{E} \bullet d\vec{l}$ $\quad V = \frac{kq}{r}$ $\quad V = \sum \frac{kq_i}{r_i}$ $\quad E_x = -\frac{dV}{dx}$ $\quad E_y = -\frac{dV}{dy}$ $\quad E_z = -\frac{dV}{dz}$

$\vec{E} = -\frac{\Delta V}{\Delta \vec{r}}$ $\quad V = \int \frac{k\,dq}{r}$ $\quad C = \frac{Q}{V}$ $\quad C = \frac{\varepsilon_o A}{d}$ $\quad V = \frac{Qd}{\varepsilon_o A}$ $\quad U = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}QV = \frac{1}{2}CV^2$

$u = \frac{1}{2}\varepsilon_o E^2$ $\quad \varepsilon = \kappa \varepsilon_o$ $\quad \vec{E} = -\vec{\nabla} V$ $\quad R = \rho\frac{L}{A}$ $\quad P = IV$ $\quad \alpha = \frac{(\rho - \rho_0)/\rho_0}{T - T_0}$

$\int \cos(\theta)\, d\theta = \sin(\theta)$ $\quad \int \sin(\theta) d\theta = -\cos(\theta)$ $\quad \int \sin^2(\theta) d\theta = \frac{\theta}{2} - \frac{\sin(2\theta)}{4}$ $\quad \int \cos^2(\theta) d\theta = \frac{\theta}{2} + \frac{\sin(2\theta)}{4}$

$\int \frac{dr}{r^2} = -\frac{1}{r}$ $\quad \int \frac{dr}{r} = \ln(r)$ $\quad \int r\, d\theta = r\theta$ $\quad \int dr = r$ $\quad \int r\, dr = \frac{r^2}{2}$

$$\tau = RC$$

$$I = \frac{\mathcal{E}_o}{R}\exp\left(\frac{-t}{RC}\right)$$

$$Q(t) = Q_0 \exp\left(\frac{-t}{RC}\right)$$

$$Q(t) = C\mathcal{E}\left[1-\exp\left(\frac{-t}{RC}\right)\right]$$

$$\vec{F} = q\,\vec{v}\times\vec{B}$$

$$d\vec{F} = I\,d\vec{l}\times\vec{B}$$

$$v = \frac{E}{B}$$

$$\vec{\mu} = N\,I\,A\,\hat{n}$$

$$\vec{\tau} = \vec{\mu}\times\vec{B}$$

$$U = -\vec{\mu}\cdot\vec{B}$$

$$d\vec{B} = \frac{\mu_o}{4\pi}\frac{I\,d\vec{l}\times\hat{r}}{r^2}$$

$$\oint_{Surface} \vec{B}\cdot d\vec{A} = 0$$

$$\oint_{Loop} \vec{B}\cdot d\vec{l} = \mu_o I_{Enclosed}$$

$$\vec{B} = \mu_o\vec{M}$$

$$\vec{B} = \vec{B}_{App} + \mu_o\vec{M}$$

$$\vec{M} = \frac{d\vec{\mu}}{dV}$$

$$\phi_M = \int_S \vec{B}\cdot d\vec{A}$$

$$\phi_M = L\,I$$

$$\phi_{M_1} = L_1 I_1 + M I_2$$

$$\phi_{M_2} = L_2 I_2 + M I_1$$

$$\mathcal{E} = -\frac{d\phi_M}{dt}$$

$$\mathcal{E} = \oint_{Loop} \vec{E}\cdot d\vec{l}$$

$$\mathcal{E} = -L\frac{dI}{dt}$$

$$L = \frac{\phi_M}{I}$$

$$L = \mu_o n^2 A l$$

$$M = \frac{\phi_{M_{21}}}{I_2} = \frac{\phi_{M_{12}}}{I_1}$$

$$U = \frac{1}{2}L I^2$$

$$u_B = \frac{B^2}{2\mu_o}$$

$$\tau = \frac{L}{R}$$

$$I = \frac{\mathcal{E}_o}{R}\left[1-\exp\left(\frac{-t}{L/R}\right)\right]$$

$$I = \frac{\mathcal{E}_o}{R}\exp\left(\frac{-t}{L/R}\right)$$

$$I_{rms} = \sqrt{\langle I^2\rangle_{Avg}}$$

$$I_{rms} = \frac{1}{\sqrt{2}}I_{Max}$$

$$V_{rms} = \frac{1}{\sqrt{2}}V_{Max}$$

$$X_L = \omega L$$

$$X_C = \frac{1}{\omega C}$$

$$N_1 I_1 = N_2 I_2$$

$$V_1 I_1 = V_2 I_2$$

$$V = N\frac{d\phi_{turn}}{dt}$$

$$P = I_{rms}V_{rms}$$

$$P = \frac{1}{2}I_{max}V_{max}$$

$$1G = 10^{-4}\,T$$

$$\mu_o = 4\pi\times10^{-7}\,Tm/A$$

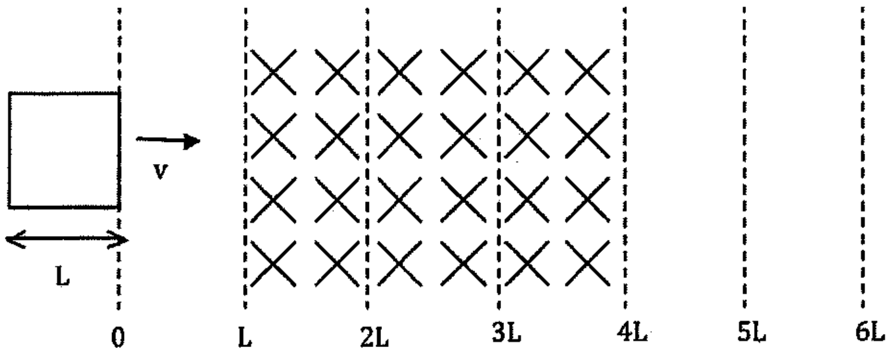
$$1Wb = 1Tm^2$$

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}$$

$$\vec{M} = \chi_m\frac{\vec{B}_{app}}{\mu_0}$$

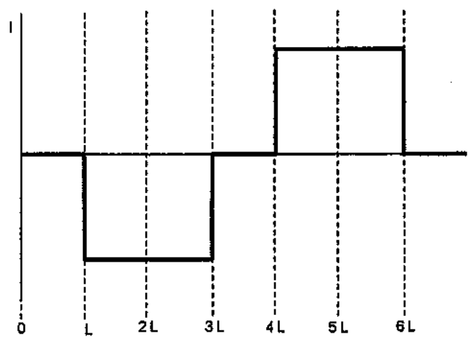
$$\vec{B} = \kappa_m\vec{B}_{app}$$

Question 1.

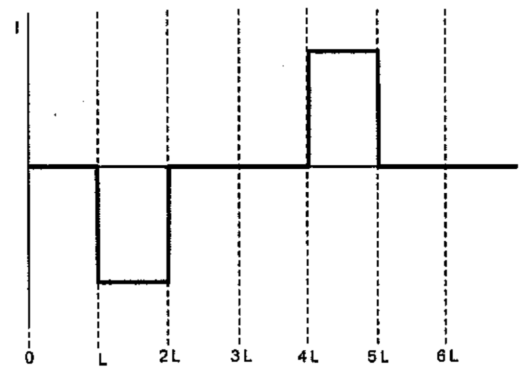


A coil of wire with an area of L^2 -m^2, enters a region of with magnetic field, 5-Tesla pointing into the page. The right edge of the coil of wire starts at 0 as shown. Which of the following graphs correctly shows the induced current in the coil of wire and also the direction of the current as a function of the right edge of the loop of wire? (Positive current is defined as in the clockwise direction around the coil of wire.)

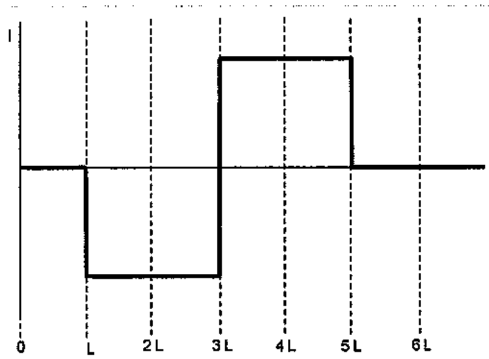
A)



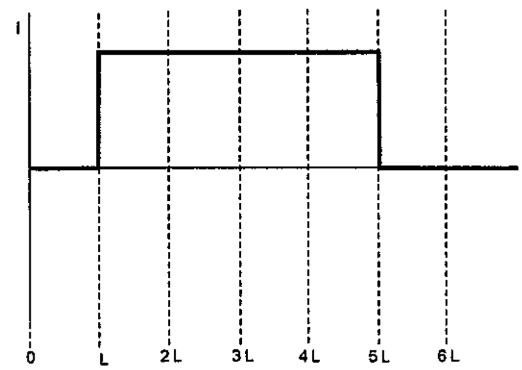
D)



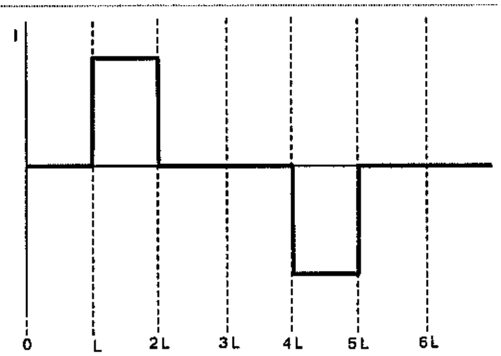
B)



E)

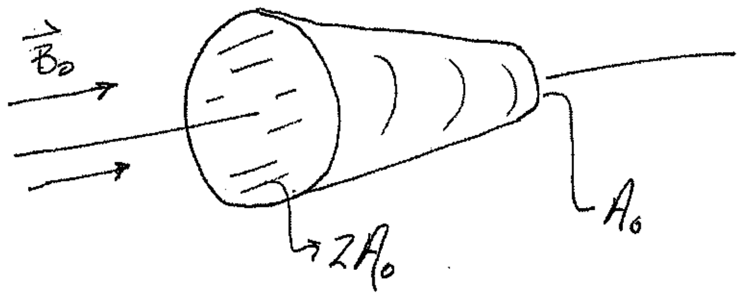


C)



V2

Question 2.



A uniform B-field, B_0 enters a closed surface through a face of area $2A_0$. The same field lines exit uniformly through the back surface of area A_0. What is the strength of the exiting B-field?

[*a*] B_0 [*b*] $\frac{B_0}{4}$ [*c*] $\frac{B_0}{2}$ [*d*] $2B_0$ [*e*] $4B_0$

Question 3.

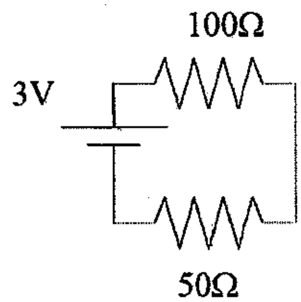
The magnetic field of the earth at its surface is of order;

[*a*] 10^{-2} *gauss* [*b*] 1 *gauss* [*c*] 100*gauss* [*d*] 1 *Tesla* [*e*] 10 *Tesla*

V2

Question 4.

What is the power dissipated by the 100 ohm resistor?



[a] 40mW

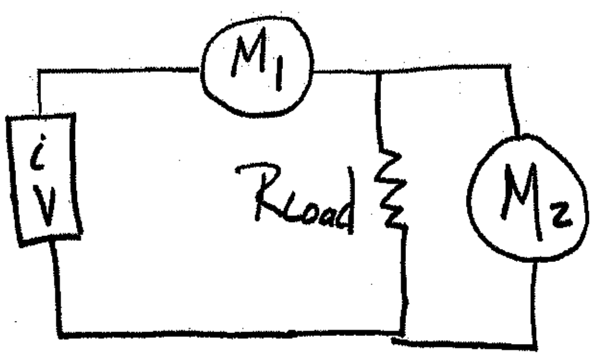
[b] 0.02 W

[c] 20 mA

[d] 1 V

[e] 0.18 W

Question 5.



When connecting amp-meters or volt-meters in a circuit which is the correct way to measure the current and voltage in the load?

[a] M1 -Amp or Volt meter, M2- Amp or Volt meter

[b] M1- Volt meter , M2 Amp meter

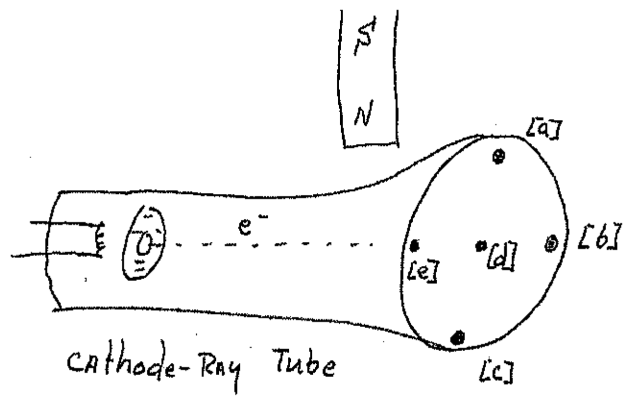
[c] M1 –Amp meter, M2 Volt meter

[d] M1-Amp or Volt meter, M2 Volt-only

[e] M1- Volt only, M2- Amp or Volt meter

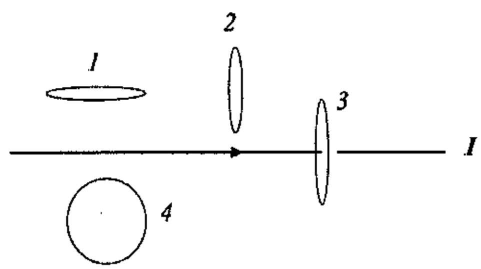
Question 6.

A magnet as shown is brought near a cathode ray tube. The electrons emitted from the cathode follow a path through the field and then hit the screen. Where on the cathode rays screen do the electrons hit?



Question 7.

A number of circular loop of wire are near a straight wire carrying a current I as shown. When I is increasing, which loops are subject to a repulsive magnetic force? (Narrow profiles mean that they are actually perpendicular to the page, seen edge on)



[a] 1 and 2

[b] 3 only

[c] 4 only

[d] all of them

[e] none of them

V2

Question 8.

A cross section of a long conductor of a type called a coaxial cable is shown in the figure and gives the radii (a, b, c). Equal but opposite currents I are uniformly distributed in the two conductors colored gray. The expression for the magnetic field B(r) in the ranges of b < r < a is

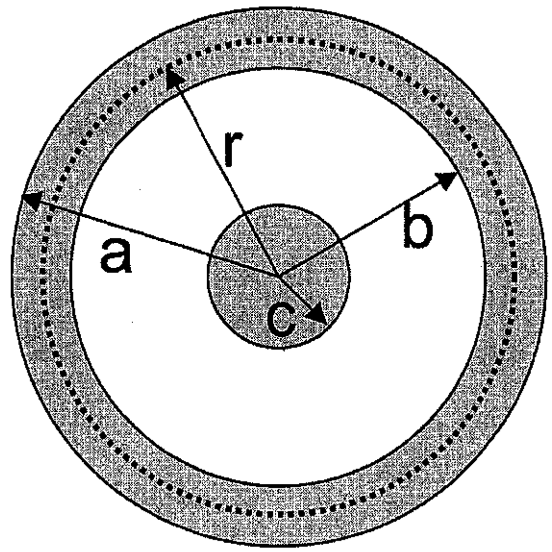
$a]\ \dfrac{\mu_0 I\,(a^2 - r^2)}{2\pi\, r(a^2 + b^2)}$

$[b]\ \dfrac{\mu_0 I}{2\pi\, a}$

$[c]\ \dfrac{\mu_0 I(a^2 - r^2)}{2\pi\, r(a^2 - b^2)}$

$[d]\ \dfrac{\mu_0 I\, r}{2\pi\, ab^2}$

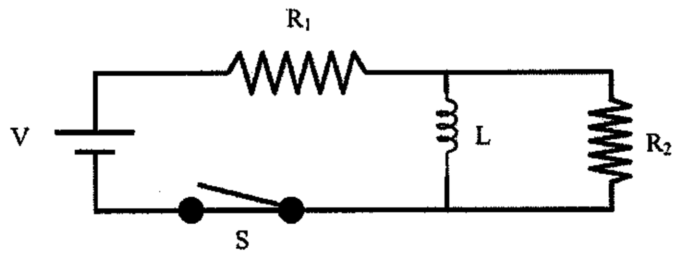
$[e]\ \dfrac{\mu_0 I(a^2 - r^2)}{2\pi(a^2 - b^2)}$



V2

Question 11.

A circuit has a battery with a voltage of 10 V, resistor R_1 = 10 Ω, resistor R_2 = 15 Ω, and inductor L = 20 H. Switch S is closed for a very long time and then opened to form an RL circuit. If R_2 is a light bulb, how long would the light bulb stay lit? (Assume the light bulb stays lit until the current from the inductor is 10% of the initial current from the inductor once switch S is opened)



[a] 0.1404 s

[b] 4.605 s

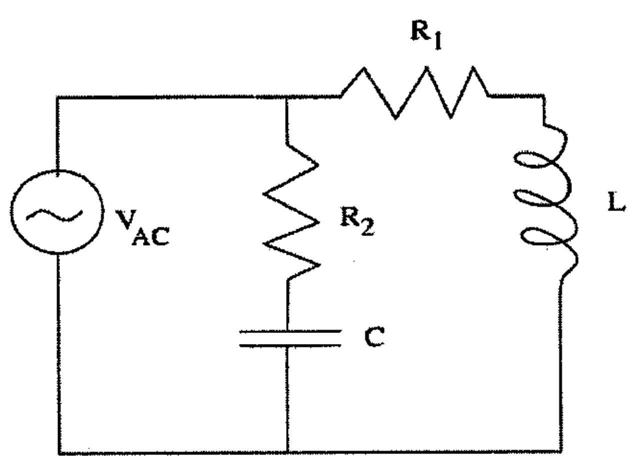
[c] 3.070 s

[d] 1.727 s

[e] 1.151 s

Question 12.

An ac source provides an emf of $V_{AC}(t) = V_0 \sin(\omega t)$. When the angular frequency ω is very large, what is the peak voltage across R_2?



[a] *Zero*

[b] V_0

[c] $\frac{V_0 R_2}{R_1 + R_2}$

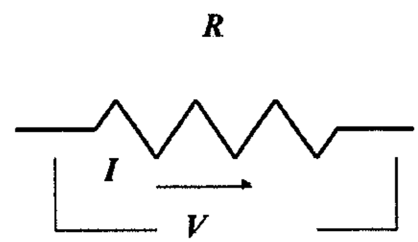
[d] $\frac{V_0}{2}$

[e] $\frac{V_0}{\sqrt{LC}}$

V2

Question 9.

The potential drop is 6.4μV across a resistor of resistance 1.0Ω. How many electrons enter the wire in 5 seconds? (note e = 1.6×10^{-19}C)



[a] 3.2×10^{19}

[b] 8.0×10^{15}

[c] 2.5×10^{12}

[d] 2.0×10^{14}

[e] 1.6×10^{19}

Question 10.

A 2 cm by 15 cm rectangular coil has 300 turns and rotates through the plane of the loop in a region of uniform magnetic filed of 0.4 Tesla. The magnetic field is perpendicular to the axis of rotation. What must its rotational speed, cycles/sec, be to generate a maximum emf of 110Volts?

[a] 49 cycles/sec

[b] 0.36 cycles/sec

[c] 5 cycles/sec

[d] 305 cycles/sec

[e] 1 cycle/sec

V2

Question 15.

For the circuit shown find the current through the resistor R_A.

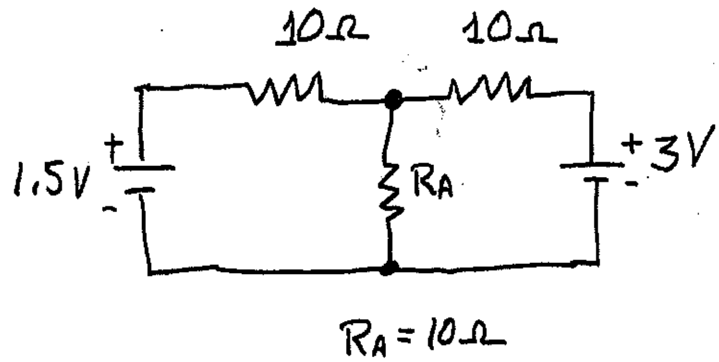
[a] 0.15 A

[b] 0.3 A

[c] 0.45 A

[d] 0.67 A

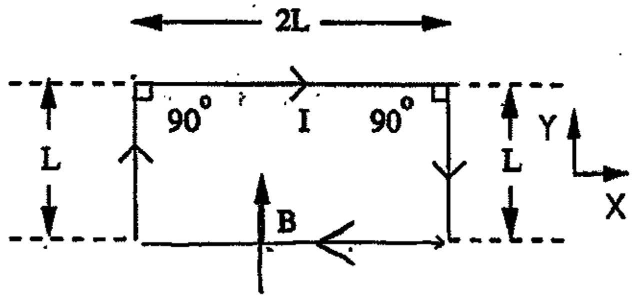
[e] 0.75 A



V2

Question 13.

A straight wire carrying a current I is bent into the shape shown. Determine the net magnetic force on the wire, if the wire is in a uniform magnetic field B directed along the y-axis (j-axis)



[a] 2IBL in the +z direction

[b] 2IBL in the -z direction

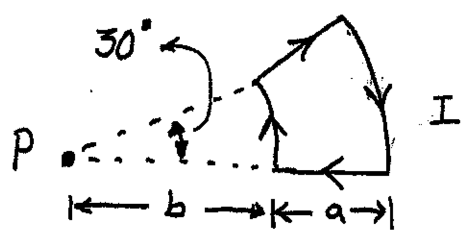
[c] 4IBL in the +z direction

[d] 6IBL in the +z direction

[e] zero

Question 14.

In the figure shown what is the magnitude of the magnetic field at the point P if a = 2.0-cm, b = 5.0-cm and I = 20 Amps?



[a] 4.5 μT

[b] 7.5 μT

[[c] 9.0 μT

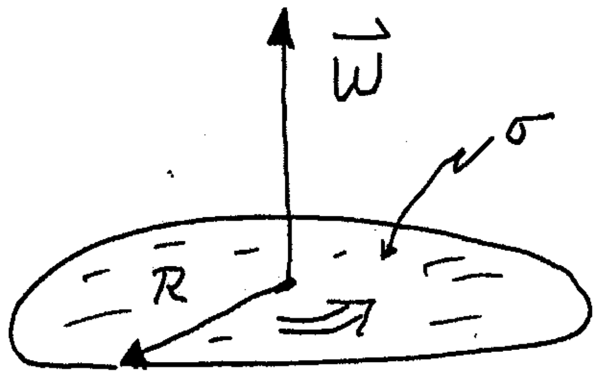
[d] 6.0 μT

[e] 3.6 μT

V2

Question 16.

A thin nonconducting disk as a radius R and a uniform surface charge per unit area σ, spins with angular velocity ω, about an axis through the center of the disk and perpendicular to the plane of the disk. Find the magnetic moment μ of the spinning disk.



[a] $\frac{1}{4}\pi\sigma\omega R^4$

[b] $\frac{2\pi\sigma\omega}{R^2}$

[c] $\frac{1}{2}\pi R^2\sigma\omega$

[d] $\frac{1}{2\pi\sigma}R^2\omega^2$

[e] $\frac{1}{6\pi}\sigma^2\omega^2 R$

V2