$$T\left({}^{o}C\right)=\frac{5}{9}\left(T\left({}^{o}F\right)-32\right)$$
$$T\left(K\right)=T\left({}^{o}C\right)+273.15$$
$$\Delta L=\alpha L_0\Delta T$$
$$\Delta V=\beta V_0\Delta T$$
$$Q=mc\Delta T=nC\Delta T$$
$$Q_{F/V}=\pm mL_{F/V}$$
$$H=\frac{dQ}{dt}=k\frac{A}{L}\left(T_H-T_C\right)$$
$$pV=nRT$$
$$K_{tr}=\frac{3}{2}nRT$$
$$C_V=\frac{3}{2}R \quad \text{ideal monatomic gas}$$
$$C_V=\frac{5}{2}R \quad \text{ideal diatomic gas w/o vibration}$$
$$W=\int_{V_1}^{V_2}pdV$$
$$\Delta U=Q-W$$
$$e=\frac{W}{Q_H}=1-\left|\frac{Q_C}{Q_H}\right|$$
$$e_{Carnot}=1-\left|\frac{T_C}{T_H}\right|$$
$$\Delta S=\int_1^2\frac{dQ}{T}$$
$$S=k\ln w$$
$$R=8.314\,J/mol\cdot K$$
$$N_A=6.02\times10^{23}\,molecules/mole$$
1 atm = 101 325 N / (m^2)

$1/4\pi\varepsilon_0$ = 8.99 x 10^9 Nm^2/C^2

e = -1.602 x 10^{-19} C
$$\vec{F}_E=q\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{qQ}{r^2}\hat{r}$$
$$\Phi_E=\oint\vec{E}\cdot d\vec{A}=\frac{q_{enc}}{\varepsilon_0}$$
$$V_b-V_a=-\int_a^b\vec{E}\cdot d\vec{l}$$
$$\Delta U=q\Delta V$$
$$\vec{E}=-\left(\hat{i}\frac{\partial V}{\partial x}+\hat{j}\frac{\partial V}{\partial y}+\hat{k}\frac{\partial V}{\partial z}\right)$$
$$Q=CV$$
$$\frac{1}{C_{eq}}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\ldots \quad \text{series}$$
$$C_{eq}=C_1+C_2+C_3+\ldots \quad \text{parallel}$$
$$U=\frac{1}{2}CV^2$$
$$u_E=\frac{1}{2}\varepsilon_0E^2$$
$$E=\frac{E_0}{K}$$
$$I=\frac{dq}{dt}$$
$$\vec{J}=nq\vec{v}_d$$
$$\rho=\frac{E}{J}$$
$$V=IR$$
$$P=VI$$
$$R_{eq}=R_1+R_2+R_3+\ldots \quad \text{series}$$
$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\ldots \quad \text{parallel}$$
$$q=C\mathcal{E}\left(1-e^{-t/RC}\right) \quad \text{charging}$$
$$q=Q_0e^{-t/RC} \quad \text{discharging}$$
$$\vec{F}=q\vec{v}\times\vec{B}$$
$$\Phi_B=\int\vec{B}\cdot d\vec{A}$$
$$d\vec{F}=Id\vec{l}\times\vec{B}$$
$$\vec{\tau}=\vec{\mu}\times\vec{B},\quad \vec{\mu}=NI\vec{A}$$
$$U=-\vec{\mu}\cdot\vec{B}$$
$$\vec{B}=\frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}$$
$$d\vec{B}=\frac{\mu_0}{4\pi}\frac{Id\vec{l}\times\hat{r}}{r^2}$$
$$\oint\vec{B}\cdot d\vec{l}=\mu_0\left(i_C+i_D\right)$$
$$\oint\vec{\mathrm{E}}\cdot d\vec{l}=\mathcal{E}=-\frac{d\Phi_B}{dt}$$

$$i_D = \varepsilon \frac{d\Phi_E}{dt}$$

$$\mathcal{E}_2 = -M\frac{di_1}{dt} \text{ and } \mathcal{E}_1 = -M\frac{di_2}{dt}$$

$$M = \frac{N_2\Phi_{B2}}{i_1} = \frac{N_1\Phi_{B1}}{i_2}$$

$$\mathcal{E} = -L\frac{di}{dt},$$

$$L = \frac{N\Phi_B}{i}$$

$$U = \frac{1}{2}LI^2, \qquad u_E = \frac{1}{2\mu_0}B^2$$

$$\frac{di}{dt} = \frac{\mathcal{E}}{L}e^{-Rt/L}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$I_{RMS} = \frac{1}{\sqrt{2}}I \quad \text{for } i = I\cos(\omega t)$$

$$V_{RMS} = \frac{1}{\sqrt{2}}V \quad \text{for } v = V\cos(\omega t)$$

$$V_R = IR$$

$$V_L = IX_L, \quad \text{where } X_L = \omega L$$

$$V_C = IX_C, \quad \text{where } X_C = \frac{1}{\omega C}$$

$$V = IZ, \quad \text{where } Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$P_{\text{Avg}} = \frac{1}{2}VI\cos\varphi, \quad \tan\varphi = \frac{X_L - X_C}{R}$$

$$V_s = V_p\frac{N_s}{N_p}$$

Calculus

Derivatives:

$$\frac{d}{dx}x^n = nx^{n-1} \qquad \frac{d}{dx}\ln ax = \frac{1}{x} \qquad \frac{d}{dx}e^{ax} = ae^{ax}$$

$$\frac{d}{dx}\sin ax = a\cos ax \qquad \frac{d}{dx}\cos ax = -a\sin ax$$

Integrals:

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1) \qquad \int \frac{dx}{x} = \ln x \qquad \int e^{ax}\,dx = \frac{1}{a}e^{ax}$$

$$\int \sin ax\,dx = -\frac{1}{a}\cos ax \qquad \int \cos ax\,dx = \frac{1}{a}\sin ax \qquad \int \frac{dx}{\sqrt{a^2 - x^2}} = \arcsin\frac{x}{a}$$

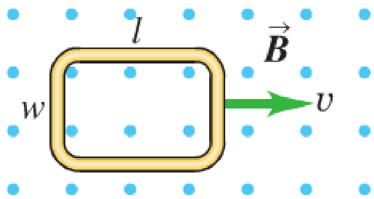
$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right) \qquad \int \frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} \qquad \int \frac{dx}{(x^2 + a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2 + a^2}}$$

$$\int \frac{x\,dx}{(x^2 + a^2)^{3/2}} = -\frac{1}{\sqrt{x^2 + a^2}}$$

Physics 161-001 Spring 2013 Exam 4

Name: ___________________________________ Box#_____________

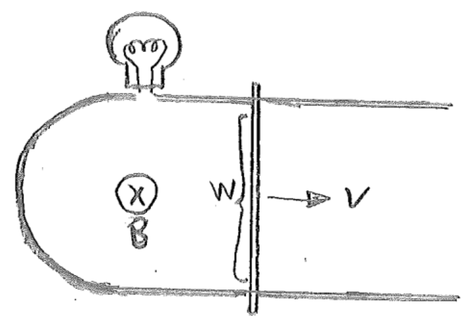
1) A flat rectangular coil of dimensions l = 4.0m and w = 2.0m is pulled with uniform speed v = 2.0m/s through a uniform magnetic field B = 2.0T with the plane of its area perpendicular to the magnetic field as shown. The coil has a resistance of 10.0 Ω. What is the current induced in this coil?



A) 1.6 A
B) 3.2 A
C) 8.0 A
D) 0.0 A
E) 4.0 A

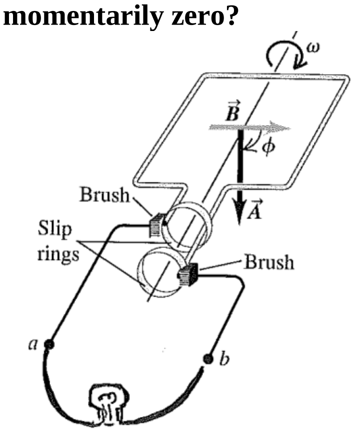
2) A copper bar pulled with speed *v* along parallel copper tracks separated by a distance w in a uniform B field, into the page. What is the direction of the emf induced?

A) clockwise
B) counterclockwise
C) it depends on the sign of the charge carriers
D) there is no emf, because copper is not a magnetic metal like iron.

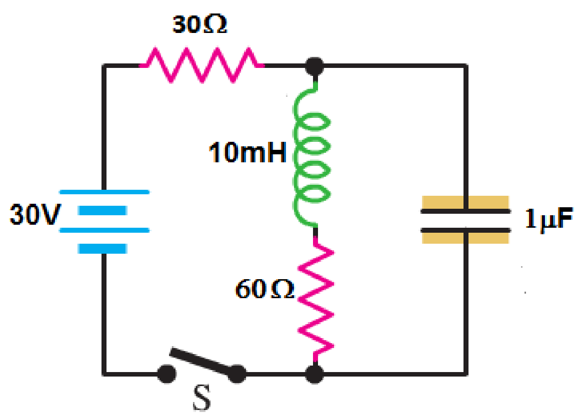


3) A rectangular coil is rotated at angular speed ω in a uniform horizontal B field, as shown. What is the position of the coil when the emf around the loop is momentarily zero?

A) in the orientation shown
B) 90° clockwise (loop vertical)
C) 180° flipped from what is shown
D) the EMF is never zero through the loop
E) at an intermediate position



4) In the DC circuit shown, immediately after the switch is closed, what is the current through the capacitor?

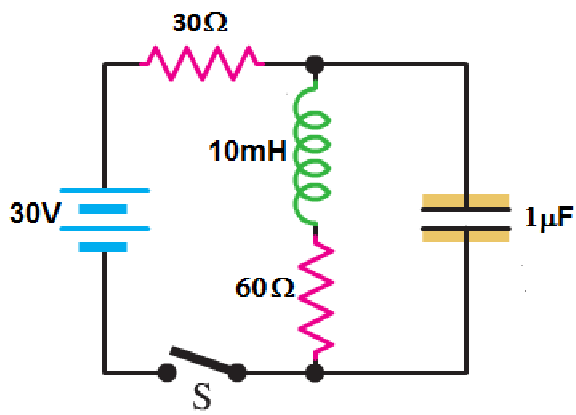


A) 0
B) 1/3 A
C) 1 A
D) 10^6 A
E) 30 x 10^6 A
F) cannot determine

5) In the same circuit, what is the rate of change of the current, di/dt, through the inductor immediately after the switch is closed?

A) 0 A/s
B) 3×10^3 A/s
C) cannot determine
D) 3×10^4 A/s
E) 1 A/s

6) A long time later (after the circuit has reached a steady state), the switch is opened. What happens in this circuit?



A) all currents stop immediately
B) the current through the inductor decays gradually and monotonically
C) the current through the inductor oscillates without decay
D) the current through the inductor oscillates and gradually decays

7) In the previous problem, assuming that the damping factor is small enough to ignore, what is the approximate angular frequency of the subsequent oscillation, if any?

A) there is no oscillation
B) 10^{-8} rad/s
C) 6 krad/s
D) 60×10^6 rad/s
E) 10^4 rad/s

8) You are given a solenoid of length 1m and cross-sectional area of $0.01m^2$. If you double the current through the solenoid, what happens to the self inductance of the solenoid?

A) Nothing.
B) It goes up by a factor of 2.
C) It goes up by a factor of 4.
D) It goes down by a factor of 2.
E) It goes down by a factor of 4.

9) In an LC circuit, with L = 10H and C = 1mF, the capacitor has an initial total energy stored in its electric field of 1mJ, and the inductor initially has no current through it. 157ms later, what is the total energy stored in the inductor?

A) 0J
B) 1mJ
C) -1mJ
D) 0.5mJ
E) -0.25mJ

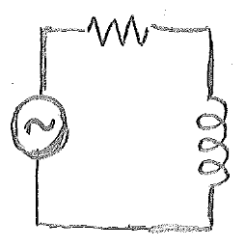
10) A capacitor is charging in a simple RC circuit with a dc battery. Which one of the following statements about this capacitor is accurate?

A) There is a magnetic field between the capacitor plates because charge travels between the plates by jumping from one plate to the other.
B) There is a magnetic field between the capacitor plates, even though no charge travels between them, because the magnetic flux between the plates is changing.
C) There is no magnetic field between the capacitor plates because no charge travels between the plates.
D) The magnetic field between the capacitor plates is increasing with time because the charge on the plates is increasing.
E) There is a magnetic field between the capacitor plates, even though no charge travels between them, because the electric flux between the plates is changing.

11) For a long ideal solenoid having a circular cross-section, the magnetic field strength within the solenoid is given by the equation B(t) = 2.0t T, where t is time in seconds. If the induced electric field outside the solenoid is 3.0 V/m at a distance of 3.0 m from the axis of the solenoid, find the radius of the solenoid.

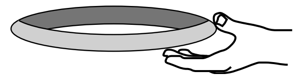
A) 2.2m
B) 3.0m
C) 3.6m
D) 4.0m
E) 1.0m

12) In the AC circuit shown, the amplitude of the voltage across the inductor is 8 V; the amplitude of the voltage across the resistor is 6 V. Use a phasor diagram to determine the amplitude of the voltage provided by the source.



A) Cannot determine without R and L.
B) 2 V
C) 6 V
D) 8 V
E) 10 V

13) A conducting loop is held fixed in place, as shown.



At time $t = t_o$, it is observed that there is a current in the loop.

Which of the following best accounts for the existence of the current in the loop?

A) There is a non-zero magnetic flux through the loop due to an external field.

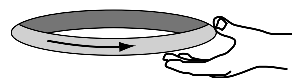
B) The magnetic flux through the loop due to an external field is changing.

C) A magnet is held in place nearby.

D) There is another wire carrying constant current nearby.

E) None of the above.

14) Suppose it is known that at time t_o the current in the loop is in the indicated direction.



Which of the following statements I–III about an external magnetic field through the loop at time t_o could be true?

I. The external magnetic field is directed upward.

II. The external magnetic field is directed downward.

III. The external magnetic field is zero.

A. Only I could be true.

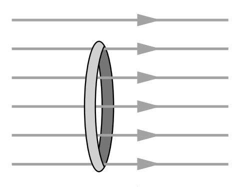
B. Only II could be true.

C. Only III could be true.

D. Either I or II could be true, but not III.

E. Any of I, II, or III could be true.

15) A different conducting loop is placed in a spatially uniform magnetic field. At time $t = t_1$ the magnitude of the magnetic field is increasing.



What is the direction of the current in the loop at time $t = t_1$?