$$T\left({}^{o}C\right)=\frac{5}{9}\left(T\left({}^{o}F\right)-32\right)$$
$$T\left(K\right)=T\left({}^{o}C\right)+273.15$$
$$\Delta L=\alpha L_0\Delta T$$
$$\Delta V=\beta V_0\Delta T$$
$$Q=mc\Delta T=nC\Delta T$$
$$Q_{F/V}=\pm mL_{F/V}$$
$$H=\frac{dQ}{dt}=k\frac{A}{L}\left(T_H-T_C\right)$$
$$pV=nRT$$
$$K_{tr}=\frac{3}{2}nRT$$
$$C_V=\frac{3}{2}R \quad \text{ideal monatomic gas}$$
$$C_V=\frac{5}{2}R \quad \text{ideal diatomic gas w/o vibration}$$
$$W=\int_{V_1}^{V_2}pdV$$
$$\Delta U=Q-W$$
$$e=\frac{W}{Q_H}=1-\left|\frac{Q_C}{Q_H}\right|$$
$$e_{Carnot}=1-\left|\frac{T_C}{T_H}\right|$$
$$\Delta S=\int_1^2\frac{dQ}{T}$$
$$S=k\ln w$$
$$R=8.314\,J/mol\cdot K$$
$$N_A=6.02\times10^{23}\,molecules/mole$$
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
$$\vec{F}_E=q\vec{E}=\frac{1}{4\pi\varepsilon_0}\frac{qQ}{r^2}\hat{r}$$
$$\Phi_E=\oint\vec{E}\cdot d\vec{A}=\frac{q_{enc}}{\varepsilon_0}$$
$$V_b-V_a=-\int_a^b\vec{E}\cdot d\vec{l}$$
$$\Delta U=q\Delta V$$
$$\vec{E}=-\left(\hat{i}\frac{\partial V}{\partial x}+\hat{j}\frac{\partial V}{\partial y}+\hat{k}\frac{\partial V}{\partial z}\right)$$
$$Q=CV$$
$$\frac{1}{C_{eq}}=\frac{1}{C_1}+\frac{1}{C_2}+\frac{1}{C_3}+\dots \quad \text{series}$$
$$C_{eq}=C_1+C_2+C_3+\dots \quad \text{parallel}$$
$$U=\frac{1}{2}CV^2$$
$$u_E=\frac{1}{2}\varepsilon_0E^2$$
$$E=\frac{E_0}{K}$$
$$I=\frac{dq}{dt}$$
$$\vec{J}=nq\vec{v}_d$$
$$\rho=\frac{E}{J}$$
$$V=IR$$
$$P=VI$$
$$R_{eq}=R_1+R_2+R_3+\dots \quad \text{series}$$
$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}+\dots \quad \text{parallel}$$
$$q=C\mathcal{E}\left(1-e^{-t/RC}\right) \quad \text{charging}$$
$$q=Q_0e^{-t/RC} \quad \text{discharging}$$
$$\vec{F}=q\vec{v}\times\vec{B}$$
$$\Phi_B=\int\vec{B}\cdot d\vec{A}$$
$$d\vec{F}=Id\vec{l}\times\vec{B}$$
$$\vec{\tau}=\vec{\mu}\times\vec{B},\quad \vec{\mu}=NI\vec{A}$$
$$U=-\vec{\mu}\cdot\vec{B}$$
$$\vec{B}=\frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}$$
$$d\vec{B}=\frac{\mu_0}{4\pi}\frac{Id\vec{l}\times\hat{r}}{r^2}$$
$$\oint\vec{B}\cdot d\vec{l}=\mu_0\left(i_C+i_D\right)$$
$$\oint\vec{\mathrm{E}}\cdot d\vec{l}=\mathcal{E}=-\frac{d\Phi_B}{dt}$$

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

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

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

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

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

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

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

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

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

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

$$V_R = IR$$

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

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

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

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

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

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:

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

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

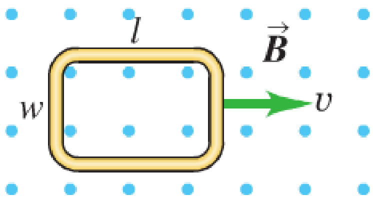
$$\int \frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right) \qquad \int \frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} \qquad \int \frac{dx}{(x^2 + a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2 + a^2}}$$

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

Physics 161-001 Spring 2013 Exam 4

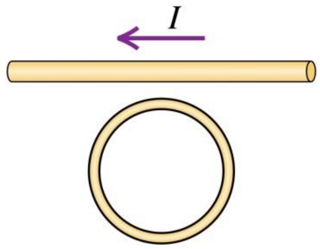
Name: ___________________________________ Box#_____________

1) A flat rectangular coil of dimensions l = 5.0 cm and w = 2.0 cm 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?



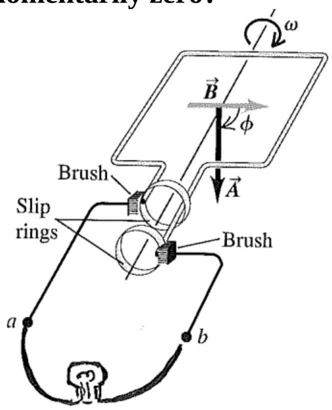
A) 0.0 A
B) 1.0 A
C) 2.0 A
D) 3.0 A
E) 4.0 A
F) 5.0 A
G) 6.0 A
H) 7.0 A
I) 8.0 A
J) 9.0 A

2) A circular loop of wire is initially held below a long straight wire carrying a constant current I. The loop is then released, so that it can fall. All this takes place near the earth's surface. A moment after the loop is released, the downward acceleration that the loop experiences is:



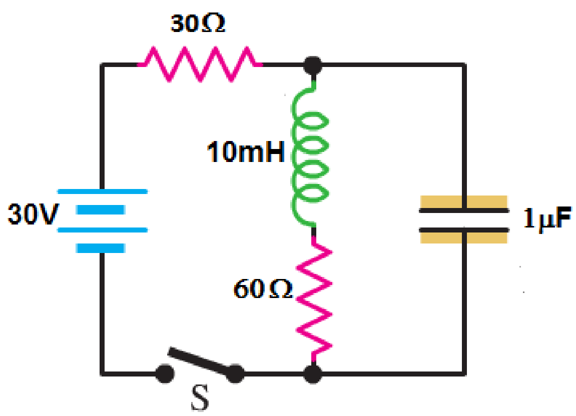
A) zero.
B) equal to g, the acceleration due to gravity near the earth's surface, and constant.
C) equal to g, the acceleration due to gravity near the earth's surface, and increasing.
D) equal to g, the acceleration due to gravity near the earth's surface, and decreasing.
E) greater than g, the acceleration due to gravity near the earth's surface, and constant.
F) greater than g, the acceleration due to gravity near the earth's surface, and increasing.
G) greater than g, the acceleration due to gravity near the earth's surface, and decreasing.
H) less than g, the acceleration due to gravity near the earth's surface, and constant.
I) less than g, the acceleration due to gravity near the earth's surface, and increasing.
J) less than g, the acceleration due to gravity near the earth's surface, and decreasing.

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

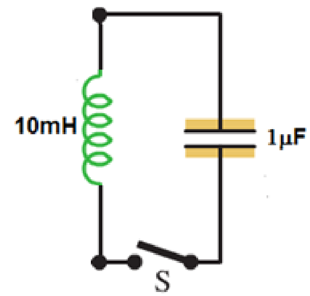
4) In the DC circuit shown, immediately after the switch is closed, what is the current through the capacitor?



A) 0 A
B) 10^{-6} A
C) 30 x 10^{-6} A
D) 0.3 A
E) 0.5 A
F) 1 A
G) 3 A
H) 30 A
I) 3 x 10^{5} A
J) cannot determine

5) In the same circuit, what is the potential across the inductor immediately after the switch is closed?
A) 0 V
B) 3 x 10^{-3} V
C) 0.1 V
D) 0.3 V
E) 0.5 V
F) 1 V
G) 5 V
H) 10 V
I) 30 V
J) cannot determine

6) In the circuit below, if the capacitor initially has a charge 10 x 10^{-6}C, what is the value of di/dt (the time rate of change of the current through the inductor) immediately after the switch is closed?



A) 0 A/s
B) 1.0 A/s
C) 5.0 A/s
D) 10 A/s
E) 20 A/s
F) 50 A/s
G) 100 A/s
H) 300 A/s
I) 600 A/s
J) 1000 A/s

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) 1 x 10^{-8} rad/s
C) 6 x 10^{-3} rad/s
D) 10 rad/s
E) 1 x 10^{2} rad/s
F) 3 x 10^{2} rad/s
G) 1 x 10^{4} rad/s
H) 4 x 10^{4} rad/s
I) 1 x 10^{6} rad/s
J) 6 x 10^{6} 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 $\sqrt{2}$.
C) It goes up by a factor of 2.
D) It goes up by a factor of 4.
E) It goes down by a factor of $\sqrt{2}$.
F) It goes down by a factor of 2.
G) It goes down by a factor of 4.

9) In an LC circuit, with L = 10 H and C = 1 mF, the capacitor has an initial total energy stored in its electric field of 1 mJ, and the inductor initially has no current through it. 314 ms later, what is the total energy stored in the inductor?

A) Not enough information to solve.
B) 0 J
C) 0.25 mJ
D) 0.33 mJ
E) 0.5 mJ
F) 1 mJ
G) -0.25 mJ
H) -0.33 mJ
I) -0.5 mJ
J) -1 mJ

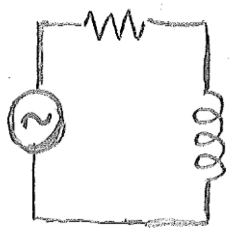
10) A capacitor is charging in a simple RC circuit with a dc battery. Which one of the following statements about this capacitor is accurate?

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) = (2.0 T/s)t, where t is time in seconds. If, at t = 2s, the induced electric field outside the solenoid is 1.0 V/m at a distance of 2.0 m from the axis of the solenoid, find the radius of the solenoid.

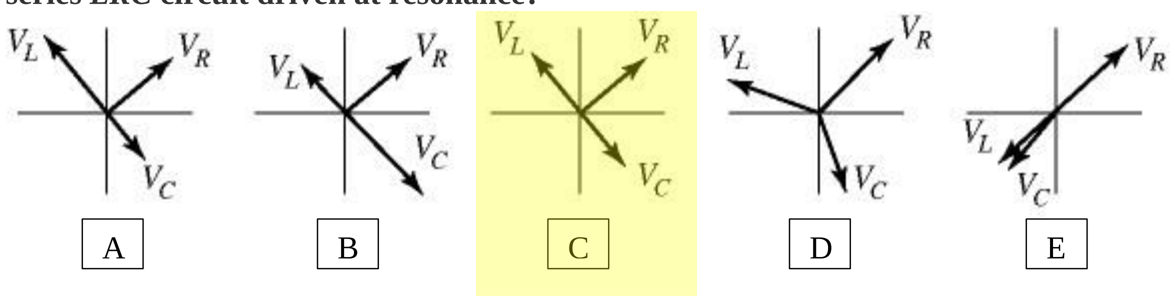
A) 0.2 m
B) 0.6 m
C) 0.9 m
D) 1.0 m
E) 1.2 m
F) 1.4 m
G) 1.6 m
H) 1.8 m
I) 2.0 m
J) Not enough information to solve.

12) In the AC circuit shown, the amplitude of the voltage across the inductor is 4 V; the amplitude of the voltage across the resistor is 3 V. Use a phasor diagram to determine the amplitude of the voltage provided by the source.

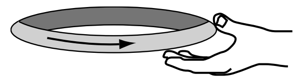


A) 1V
B) 2 V
C) 3 V
D) 4 V
E) 5 V
F) 6 V
G) 7 V
H) 8 V
I) 9 V
J) 10 V

13) Which one of the phasor diagrams shown below best represents a series *LRC* circuit driven at resonance?



14) Suppose it is known that at time t_o the current in a conducting loop held in place 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) An ideal transformer consists of a 500-turn primary coil and a 1500-turn secondary coil. If the current in the secondary is 3.0 A, what is the current in the primary?

A) 1 A
B) 2 A
C) 3 A
D) 4 A
E) 5 A
F) 6 A
G) 7 A
H) 8 A
I) 9 A
J) 10 A