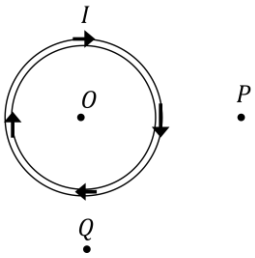
Practice Problems for Exam 02 PHYS-1200 SPRING 2024



Questions **1** – **3** deal with a current loop as given in the figure at right. The loop lies in the *x*-*y* plane, and the current circulates clockwise, as seen in the figure. Also shown are points O, P, and Q, which lie in the same plane as the current loop.

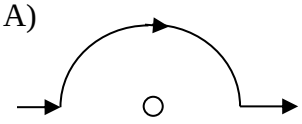
1) The direction of the magnetic field at the point O is
A) to the right. B) to the left. C) up the page. D) down the page.
E) out of the page. F) into the page. G) cannot be found.

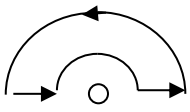
2) The direction of the magnetic field at the point P is
A) to the right. B) to the left. C) up the page. D) down the page.
E) out of the page. F) into the page. G) cannot be found.

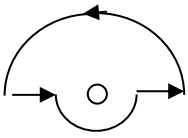
3) The direction of the magnetic field at the point Q is
A) to the right. B) to the left. C) up the page. D) down the page.
E) out of the page. F) into the page. G) cannot be found.

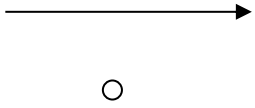
4) A point charge *Q* moves on the *x*-axis in the positive direction with a speed of 370 m/s. A point *P* is on the *y*-axis at $y = +80$ mm. The magnetic field produced at point *P*, as the charge moves through the origin, is equal to -0.80 μT $\hat{\boldsymbol{k}}$. When the charge is at $x = +40$ mm, what is the magnitude of the magnetic field at point *P*?
A) 0.57 μT B) 0.74 μT C) 0.92 μT D) 1.1 μT E) 1.3 μT

5) The same current flows through each of the wires sketched below. For which case is the magnitude of the magnetic field at point O the largest? (All segments are circular or straight and the drawings are to scale. When wires point off along straight lines, they continue to infinite distance.)

A) 

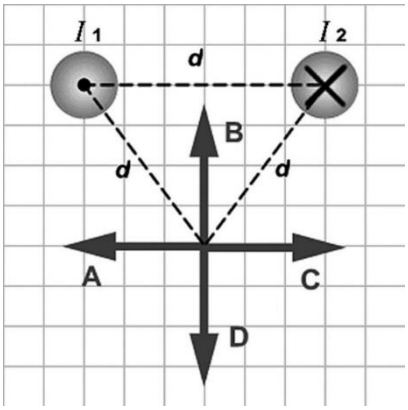
B) 

C) 

D) 

E) They are all the same.

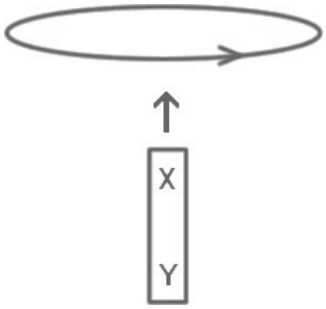
6) A long, straight wire with 3.0 A current flowing through it produces magnetic field strength 1.0 T at its surface. If the wire has a radius *R*, where within the wire is the field strength equal to 36.0% of the field strength at the surface of the wire? Assume that the current density is uniform throughout the wire.
A) 0.36 *R* B) 0.060 *R* C) 0.64 *R* D) 0.030 *R*



7) The figure shows two long wires carrying equal currents I_1 and I_2 flowing in opposite directions. Which of the arrows labeled A through D correctly represents the direction of the magnetic field due to the wires at a point located at an equal distance d from each wire?
A) A B) B C) C D) D
E) The magnetic field is zero at that point.

8) You are given a solenoid of length 0.6 m and radius 0.08 m. It has 4000 turns of wire with resistance of 0.10 ohms. You wish to generate a magnetic field of 0.15 T. The current to which your power supply should be set is closest to:
A) 0.02 A B) 0.2 A C) 2 A D) 20 A E) 200 A

9) The figure shows a bar magnet moving vertically upward toward a horizontal coil. The poles of the bar magnets are labeled X and Y. As the bar magnet approaches the coil it induces an electric current in the direction indicated on the figure (counterclockwise as viewed from above). What are the correct polarities of the magnet?



A) X is a south pole, Y is a north pole.
B) X is a north pole, Y is a south pole.
C) Both X and Y are north poles.
D) Both X and Y are south poles.
E) The polarities of the magnet cannot be determined from the information given.

10) A 96-mH solenoid inductor is wound on a form 0.80 m in length and 0.10 m in diameter. A coil is tightly wound around the solenoid at its center. The coil's resistance is 9.9 ohms. The mutual inductance of the coil and solenoid is 31 μH. At a given instant, the current in the solenoid is 540 mA, and is decreasing at the rate of 2.5 A/s. At the given instant, what is the magnitude of the induced current in the coil?
A) 7.8 μA B) 6.3 μA C) 9.4 μA D) 11 μA E) 13 μA

11) In an inductor, energy is stored
A) as heat. B) in the electric field. C) in the magnetic field.
D) in the voltage. E) in the gravitational field.

12) How much energy is stored in a room 3.0 m by 4.0 m by 2.4 m due to the earth's magnetic field with a strength of 5.0×10^{-5} T?
A) 570 mJ B) 29 mJ C) 10 mJ D) 100 mJ E) 57 mJ

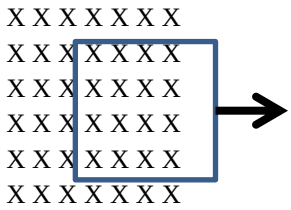
13) An energy of U_0 is stored in an inductor when the current flowing through it is I_0. If the current is doubled to $2I_0$, the energy stored is closest to:
A) zero. B) U_0 C) $2\,U_0$ D) $4\,U_0$ E) $U_0/2$.

14) A capacitor is being charged up by 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 no magnetic field between the capacitor plates because no charge travels between the plates.
C) 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.
D) 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.
E) The magnetic field between the capacitor plates is increasing with time because the charge on the plates is increasing.

15) A coil of wire having N turns, each of cross-sectional area A, is initially in a magnetic field of strength B, with the axis of the coil parallel to the magnetic field lines. The coil is then removed from the magnetic field (in a time interval Δt) and brought to a region where there is no magnetic field. What is the magnitude of $\int_0^{\Delta t} \varepsilon\, dt$ for this procedure, where ε is the emf induced in the coil as it is removed from the field?

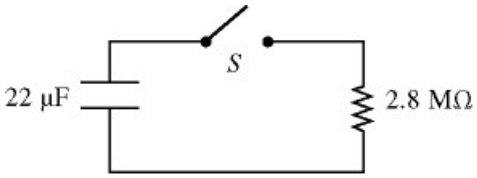
A) $\frac{d\Phi_B}{dt}$ B) NBA C) $2NBA$ D) zero E) BA

16) A square loop of wire is pulled to the right out of a region where the magnetic field points into the paper as shown. The direction of the current in the section of wire at the top of the square is:
A) Left. B) Right. C) There is no current.



17) An inductor has a current $I(t) = (0.500\text{ A})\cos[(275\text{ s}^{-1})t]$ flowing through it. If the maximum emf across the inductor is equal to 0.500 V, what is the self-inductance of the inductor?
A) 4.37 mH B) 3.64 mH C) 2.75 mH D) 0.73 mH E) 1.43 mH

18) For the circuit shown in the figure, the switch *S* is initially open, and the capacitor voltage is 80 V. The switch is then closed at time *t* = 0. How long after closing the switch will the current in the resistor be 7.0 μA?



A) 87 s B) 95 s C) 78 s D) 69 s E) 61 s

19) In an *LC* circuit containing a 40-mH ideal inductor and a 1.2-mF capacitor, the maximum charge on the capacitor is 45 mC during the oscillations. What is the maximum current through the inductor during the oscillations?

A) 3.7 A B) 42 A C) 10 A D) 6.5 A E) 2.5 A

20) A resistor *R* and capacitor *C* are wired in series and driven with a harmonic voltage of amplitude V_0 and frequency 60 Hz. The amplitude of the voltage across the resistor is 3 V and the amplitude across the capacitor is 4 V. The driving voltage amplitude V_0 is closest to:

A) 1 V. B) 3 V. C) 4 V. D) 5V. E) 7 V.

21) The resistance in the previous question is 30 ohms. The reactance of the capacitor is closest to:

A) 40 microfarads. B) 40 ohms. C) 70 ohms. D) 70 microfarads.

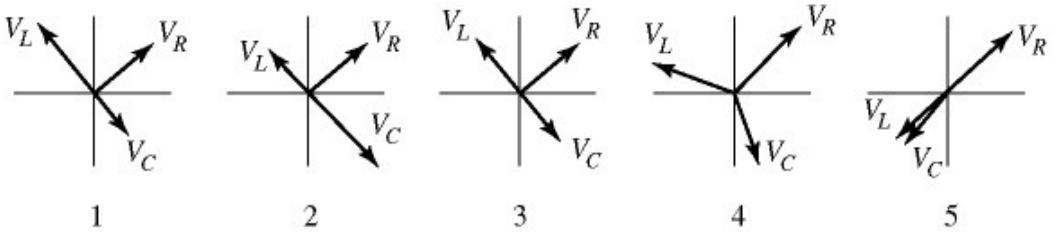
22) A power supply delivers a sinusoidal voltage of root mean square value V_0 to a capacitor *C*, independent of frequency *f*. The average power dissipated in the capacitor is closest to:

A) $V_0^2\omega C$. B) $V_0^2\omega C/2$. C) $V_0^2/\omega C$. D) $V_0^2/4\omega C$. E) zero.

23) In an ac circuit, if the peak value of the voltage is 100 V, what is the rms value of the voltage?

A) 141 V B) 100 V C) 71 V D) 210 V E) 120 V

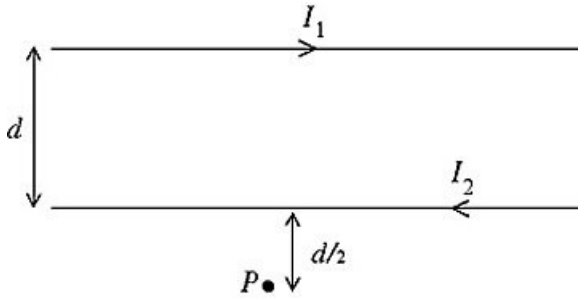
24) Which of the phasor diagrams shown below best represents a series *LRC* circuit driven at resonance?



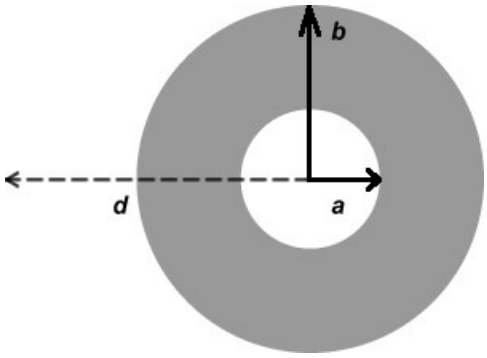
A) 1 B) 2 C) 3 D) 4 E) 5 F) None of them.

Part B

B1) As shown in the figure, two long straight wires are separated by a distance $d = 0.80$ m. The currents are $I_1 = 2.0$ A to the right in the upper wire and $I_2 = 7.0$ A to the left in the lower wire. What are the magnitude and direction of the magnetic field at point P, which is a distance $d/2 = 0.40$ m below the lower wire?

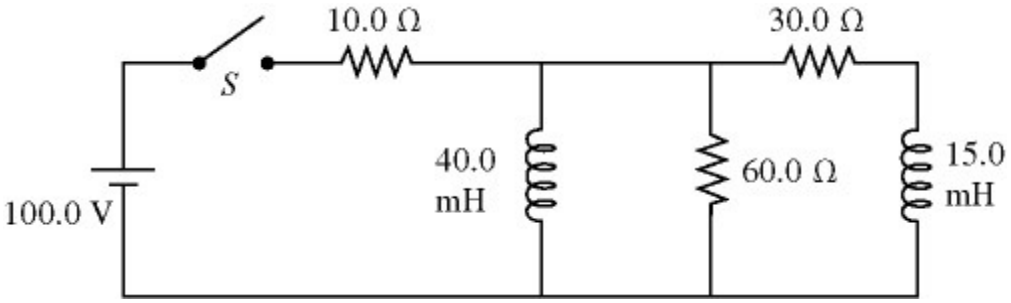


B2) The figure shows the cross-section of a hollow cylinder of inner radius $a = 5.0$ cm and outer radius $b = 7.0$ cm. A uniform current density of 1.0 A/ cm^2 flows through the cylinder parallel to its axis. Calculate the magnitude of the magnetic field at a distance of $d = 10$ cm from the axis of the cylinder.



B3) A 200-loop coil of cross-sectional area 8.5 cm^2 lies in the plane of the page. An external magnetic field of 0.060 T is directed out of the plane of the page. The external field decreases to 0.020 T in 12 milliseconds.
(a) What is the magnitude of the change in the external magnetic flux enclosed by the coil?
(b) What is the magnitude of the average voltage induced in the coil as the external flux is changing?
(c) If the coil has a resistance of 4.0 ohms, what is the magnitude of the average current in the coil?

B4) For the circuit shown in the figure, the inductors have no appreciable resistance and the switch has been open for a very long time.



(a) The instant after closing the switch, what is the current through the 60.0-Ω resistor?
(b) The instant after closing the switch, what is the potential difference across the 15.0-mH inductor?
(c) After the switch has been closed and left closed for a very long time, what is the potential drop across the 60.0-Ω resistor?

B5) A series *LRC* circuit consists of a 12.0-mH inductor, a 15.0-μF capacitor, a resistor, and a 110-V (rms) ac voltage source. If the impedance of this circuit is 45.0 Ω at resonance, what is its impedance at a frequency twice the resonance frequency?