Name KEY

PHY 2049 Exam # 3 24 questions

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) In the Biot–Savart Law (see your formula sheet), the vector **r ^** is _____.

A) a vector that points from a small section of current to the observation point

B) a unit vector that points from the observation point to a small section of current

C) a vector that points from the observation point to a small section of current

(D) a unit vector that points from a small section of current to the observation point

SEE NOTES

2) At what distance from the central axis of a long straight thin wire carrying a current of 5.0 A is the magnitude of the magnetic field due to the wire equal to the strength of the Earth's magnetic field of about 5.0×10^{-5} T? ($\mu_0 = 4\pi \times 10^{-7}$ T • m/A)

$5*10^{-5} = \frac{\mu_0(5)}{2\pi r}$ ∴ r = 0.02

A) 4.0 cm (B) 2.0 cm C) 5.0 cm D) 1.0 cm E) 3.0 cm

3) A straight wire that is 0.60 m long is carrying a current of 2.0 A. It is placed in a uniform magnetic field of strength 0.30 T. If the wire experiences a force of 0.18 N, what angle does the wire make with respect to the magnetic field?

A) 25° B) 60° (C) 30° D) 35° E) 90°

$|F| = I|\ell||B|\sin\theta$ ∴ $\theta = \arcsin\left(\frac{.18}{2(.6)(.3)}\right)$

4) The voltage and power ratings of a particular light bulb, which are its normal operating values, are 110 V and 60 W. Assume the resistance of the filament of the bulb is constant and is independent of operating conditions. If the light bulb is operated with a current that is 50% of the current rating of the bulb, what is the actual power drawn by the bulb?

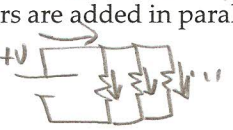
$P = V^2/R$ ∴ R = 201.7Ω

A) 25 W B) 30 W C) 20 W D) 10 W (E) 15 W

$P = IV$ ∴ I = 0.55 A || @ $\frac{1}{2}(0.55)$A, $P = I^2R = 15.2$ W

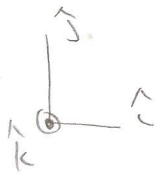
5) As more resistors are added in parallel across a constant voltage source, the power supplied by the source ____.

(A) increases. B) does not change. C) decreases.



Same V across each R

6) An electron moving in the direction of the +x-axis enters a magnetic field. If the electron experiences a magnetic deflection in the −y direction, the direction of the magnetic field in this region points in the direction of the



(A) −z-axis. B) +y-axis. C) −y-axis. D) −x-axis. E) +z-axis.

$\vec{F} = q\vec{v} \times \vec{B}$ For positive charge, B in $+\hat{z}$ gives $\vec{F}$. But this is a negative charge.

7) A horizontal wire carries a current straight toward you. From your point of view, the magnetic field at a point directly below the wire points

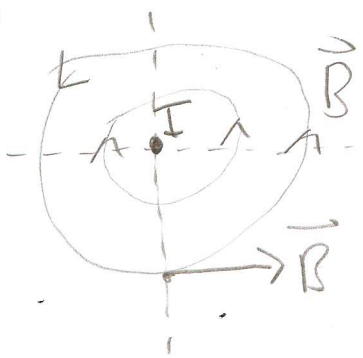
A) vertically upward.

(B) to the right.

C) directly toward you.

D) directly away from you.

E) to the left.



$|\Delta V_{induced}| = \left|\frac{-d\Phi_B}{dt}\right| = A * \frac{dB}{dt} = [60 * \pi(0.06)^2] * 8$

8) A uniform magnetic field is applied perpendicular to the plane of a 60-turn circular coil with a radius of 6.0 cm and a resistance of 0.60 Ω. The magnetic field increases uniformly according to the equation B(t) = 8t . The units are SI. What is the magnitude of the emf induced in the coil?

A) 16 V B) 5.4 V C) 7.2 V D) 12 V E) 9.2 V

9) A circular loop of wire lies in the plane of the paper. An increasing magnetic field points out of the paper. What is the direction of the induced current in the loop?

A) counter-clockwise then clockwise

B) counter-clockwise

C) clockwise

D) clockwise then counter-clockwise

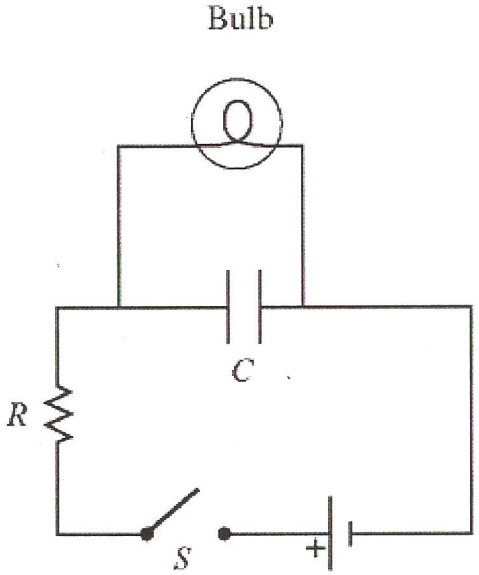
E) There is no current induced in the loop.

Φ_B is increasing out of the page. ∴ Induced current is CW

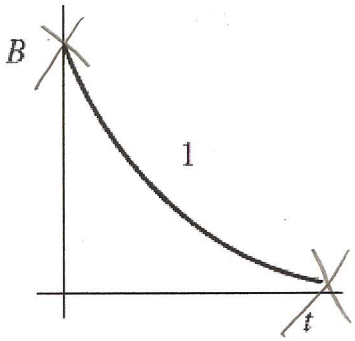
10) A light bulb is connected in the circuit shown in the figure with the switch *S* open and the capacitor uncharged. The battery has no appreciable internal resistance. Which one of the following graphs best describes the brightness *B* of the bulb as a function of time *t* after closing the switch? HINT: The brightness is proportional to the amount of current flowing through the bulb.

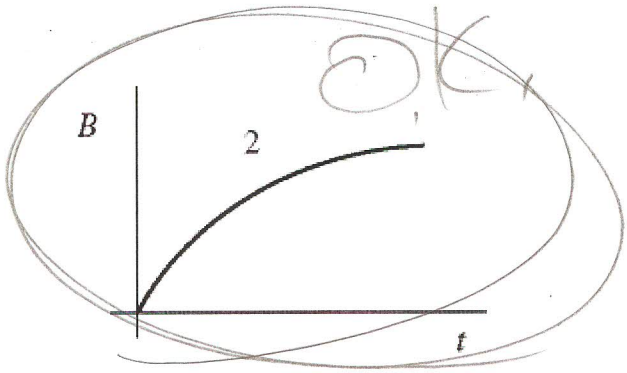
Instant switch closes, C acts like short circuit. ∴ No current through bulb

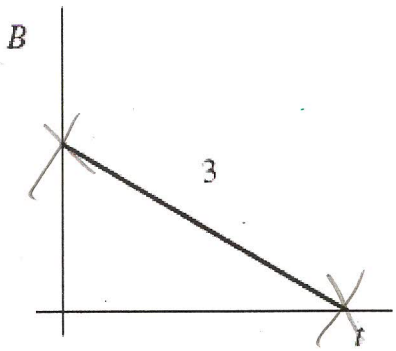
Wait Long time, C Acts like open circuit. ∴ Maximum Current Through bulb.

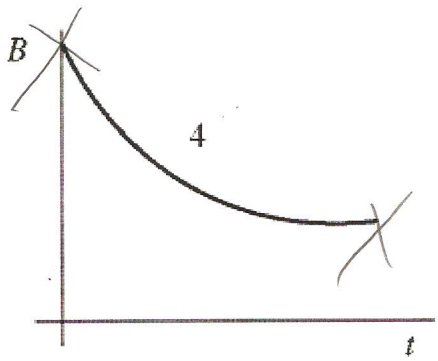


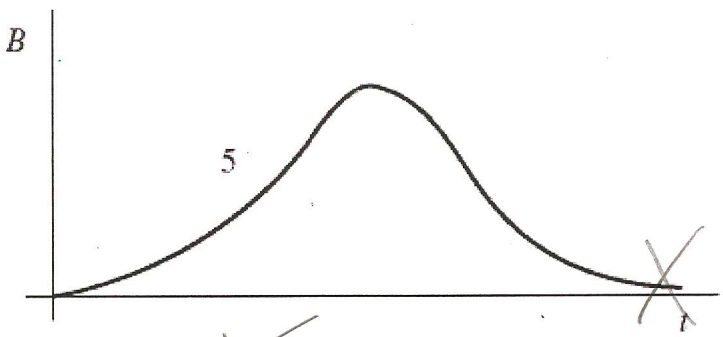
OVER for answer selection









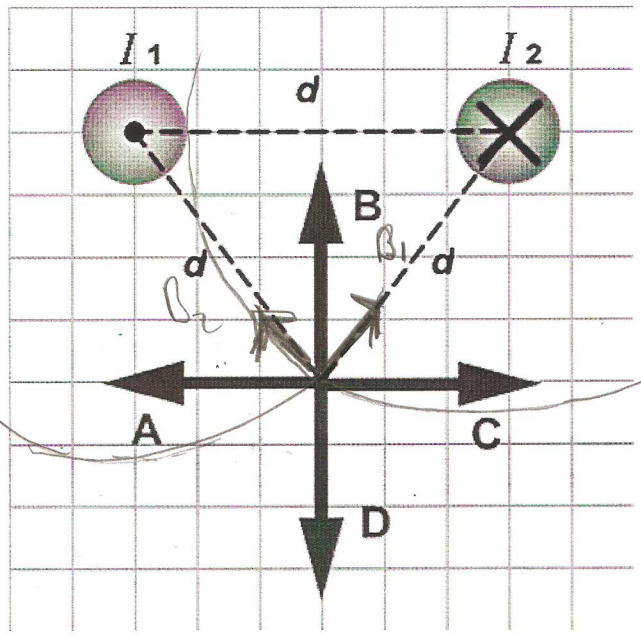


#10)

A) 1 B) 2 C) 3 D) 4 E) 5

OVER

11) 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.

Horizontal components will cancel @ this location.

12) A loop of radius $r = 3.0$ cm is placed parallel to the xy-plane in a uniform magnetic field $\vec{B} = 0.75\ \text{T}\,\hat{k}$. The resistance of the loop is 18 Ω. Starting at $t = 0$, the magnitude of the field decreases uniformly to zero in 0.15 seconds. What is the magnitude of the electric current produced in the loop during that time?

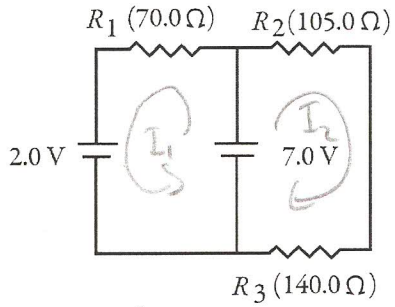
A) 3.9 mA B) 0.79 mA C) 2.1 mA D) 1.7 mA E) 0.20 mA

$\pi(0.03)^2$

$|\Delta V| = \frac{d\Phi_B}{dt} = \frac{\Delta\Phi_B}{\Delta t} = \frac{.75(\text{Area})}{0.15}$

$\therefore I = \frac{\Delta V}{R} = 0.79\times10^{-3}$ A

13) For the circuit shown in the figure, what is the current through resistor R_1?



loop!

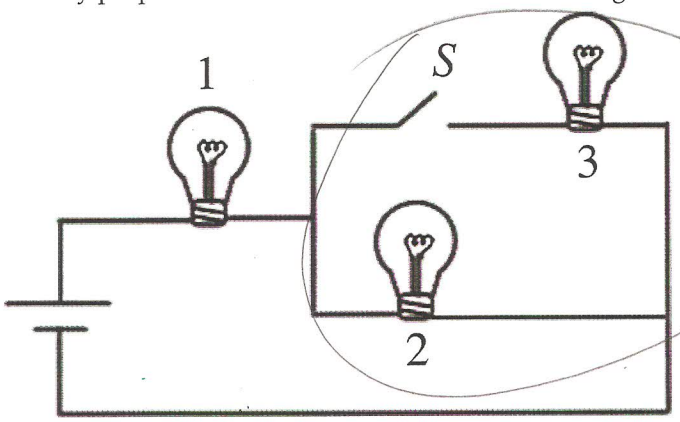
$-2+7-70I_1=0$

$\therefore I_1 = 0.071$ A

Don't need to do any more because we have the requested answer

A) 0.13 A B) 0.071 A C) 0.029 A D) 0.016 A

14) The figure shows three identical lightbulbs connected to a battery having a constant voltage across its terminals. What happens to the brightness of lightbulb 1 when the switch *S* is closed? HINTS: Think of the bulbs as resistors. The brightness is directly proportional to the amount of current flowing through the bulb.



Resistors in parallel

When switch closes, the circuit resistance decreases ∴ Current through ① increases.

A) The brightness remains the same as before the switch is closed.

B) The brightness increases permanently.

C) The brightness decreases permanently.

D) The brightness will decrease momentarily then return to its previous level.

E) The brightness will increase momentarily then return to its previous level.

15) A wire carries a 4.0–A current along the +x–axis through a magnetic field $\vec{B} = (5.0\,\hat{i} + 7.0\,\hat{j})$ T. If the wire experiences a force of 30 N $\hat{k}$ as a result, how long is the wire? HINT: You do not need to expand a determinant by minors.

$I \Rightarrow \hat{i}$, $B \Rightarrow \hat{i}+\hat{j}$, $F \Rightarrow \hat{k}$

$|\vec{B}| = 8.6$, $\theta = 54.46°$

A) 1.1 m B) 1.5 m C) 0.87 m D) 0.63 m

$|\vec{F}| = I\ell|B|\sin\theta$ $\quad \therefore \ell = \frac{F}{IB\sin(\theta)} = 1.07$ meters

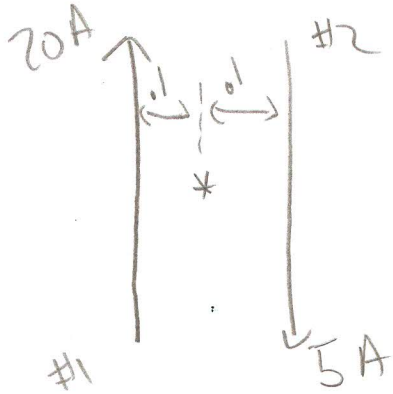
16) A 110–V hair dryer is rated at 1200 W. What current will it draw when operating from a 110–V electrical outlet?

$P = IV$, $\therefore I = \frac{P}{V}$

A) 1.0 A B) 5.0 A C) 11 A D) 90 mA E) 14 A

17) Two long parallel wires carry currents of 20 A and 5.0 A in opposite directions. The wires are separated by 0.20 m. What is the magnitude of the magnetic field midway between the two wires? ($\mu_0 = 4\pi \times 10^{-7}$ T • m/A)

A) 1.0×10^{-5} T B) 2.0×10^{-5} T C) 3.0×10^{-5} T D) 4.0×10^{-5} T E) 5.0×10^{-5} T



$\vec{B}_{\#1} = \frac{\mu_0(20)}{2\pi(0.1)}$ IN

$\vec{B}_{\#2} = \frac{\mu_0(5)}{2\pi(0.1)}$ IN

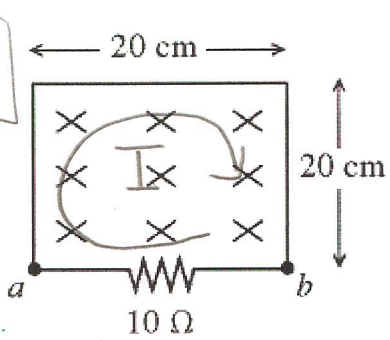
OVER

$\vec{B}_{TOTAL} = 5 \times 10^{-5}$ IN

18) As shown in the figure, a wire and a 10-Ω resistor are used to form a circuit in the shape of a square, 20 cm by 20 cm. A uniform but nonsteady magnetic field is directed into the plane of the circuit. The magnitude of the magnetic field is decreased from 1.50 T to 0.50 T in a time interval of 63 ms. The average induced current and its direction through the resistor, in this time interval, are closest to _____.

$|\Delta V_{induced}| = (.2 * .2) * \left[\frac{1.5 - .5}{63 \times 10^{-3}}\right]$

$I = \frac{\Delta V_{induced}}{R} = 0.063\ A$



Flux ⇒ IN but decreasing

∴ $I_{induced}$ ⇒ CW

A) 95 mA, from *a* to *b*.

B) 63 mA, from *a* to *b*.

C) 63 mA, from *b* to *a*.

D) 38 mA, from *a* to *b*.

E) 38 mA, from *b* to *a*.

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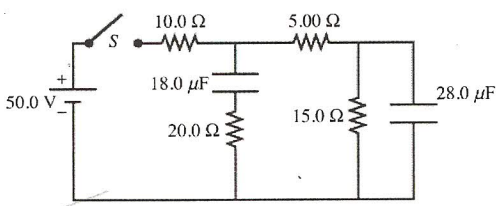
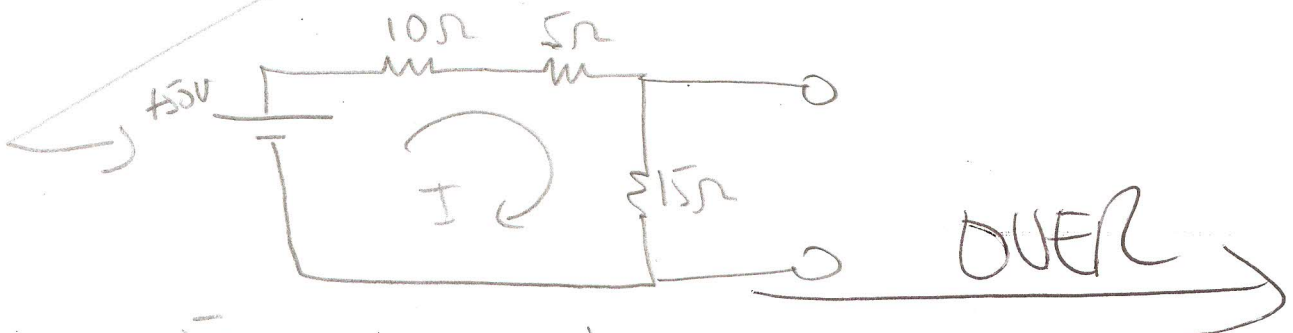
19) For the circuit shown in the figure, the capacitors are all initially uncharged, the connecting leads have no resistance, the battery has no appreciable internal resistance, and the switch *S* is originally open.

Capacitors act like open circuits



After the switch *S* has been closed for a very long time, what is the voltage across the 28.0-μF capacitor?

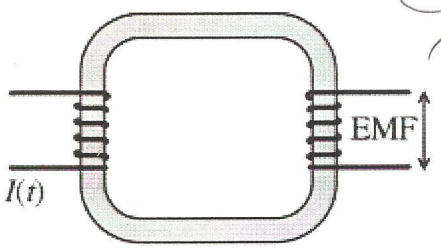
A) 50.0 V B) 25.0 V ✓ C) 37.5 V D) 3.33 V E) 0.00 V

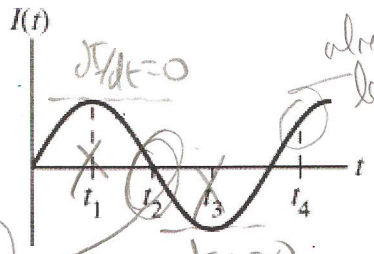


$I = \frac{50}{10+5+15} = 1.67\ A$

ΔV across 28μF capacitor is the same as ΔV across 15Ω resistor: $\Delta V = 1.67(15) = 25$ volts

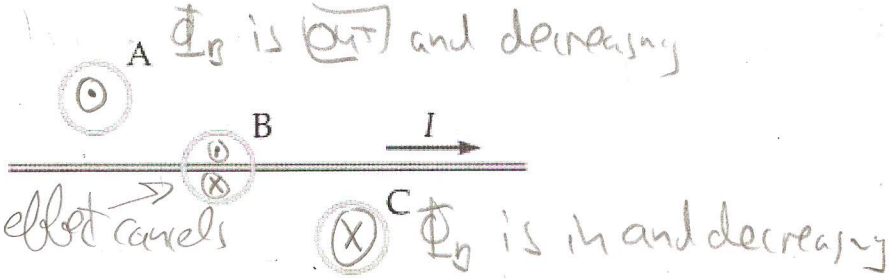
20) An AC current is flowing through the primary of a transformer, and the magnitude of the current as a function of time is shown below. At which moment in time is the induced EMF across the secondary of the transformer a maximum? HINT: Faraday's Law





A) t_1 B) t_2 C) t_3 D) t_4

21) The long straight wire in the figure carries a current I that is decreasing with time at a constant rate. The circular loops A, B, and C all lie in a plane containing the wire. The induced emf in each of the loops A, B, and C is such that



A) loop A has a clockwise emf, loop B has no induced emf, and loop C has a counterclockwise emf.

B) loop A has a counter-clockwise emf, loop B has no induced emf, and loop C has a clockwise emf.

C) no emf is induced in any of the loops.

D) loop A has a counter-clockwise emf, loops B and C have clockwise emfs.

E) a counterclockwise emf is induced in all the loops.

22) A closed loop conductor that forms a circle with a radius of 2.0 m is located in a uniform but changing magnetic field. If the maximum emf induced in the loop is 5.0 V, what is the maximum rate at which the magnetic field strength is changing if the magnetic field is oriented perpendicular to the plane in which the loop lies?

A) 0.080 T/s B) 5.0 T/s C) 2.5 T/s D) 0.40 T/s

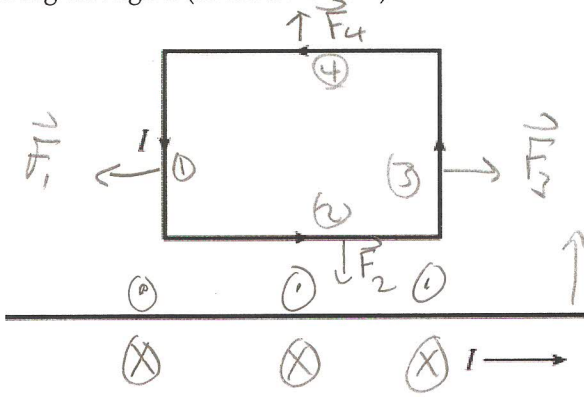
OVER

23) A long straight wire has a constant current flowing to the right. A square ring is situated above the wire, and also has a constant current flowing through it (as shown below). Which of the following statements is true?

$\vec{F} = I\vec{\ell} \times \vec{B}$

$|\vec{F}_1| = |\vec{F}_2|$ Symmetry

$|\vec{F}_4| < |\vec{F}_2|$ because $\vec{B}$ is weaker @ wire ④



$|\vec{B}| = \frac{\mu_0 I}{2\pi r}$

Weaker for large r

A) The net magnetic force on the ring is zero, and the net torque is zero.

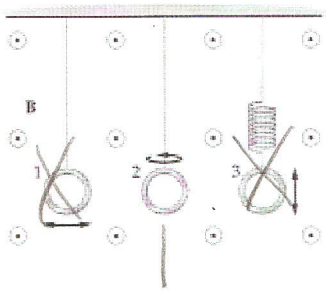
B) The net magnetic force on the ring is upward, and there is also a net torque on the ring.

C) The net magnetic force on the ring is downward, and there is also a net torque on the ring.

D) The net magnetic force on the ring is downward, and the net torque is zero.

E) The net magnetic force on the ring is zero, but there is a net torque on the ring.

24) The three loops of wire shown in the figure are all subject to the same uniform magnetic field $\vec{B}$ that does not vary with time. Loop 1 oscillates back and forth as the bob in a pendulum, loop 2 rotates about a vertical axis, and loop 3 oscillates up and down at the end of a spring. Which loop, or loops, will have an emf induced in them?



$\frac{d\Phi_B}{dt}$

A) loops 2 and 3

B) loops 1 and 2

C) loop 1 only

D) loop 2 only

E) loop 3 only