Name KEY

20 Questions

SCROLL DOWN

Select the one response that best answers each question.

1) The vecotor **A** = $5\hat{i} + 7\hat{j}$. The vector B = $-8\hat{j}$. If **C** = **A** x **B** , what is the vector **C**?
HINT: You can do this without expanding a determinant.

A) 40 units in the $-\hat{k}$ direction
B) 56 units in the $+\hat{k}$ direction
C) 56 units in the $-\hat{k}$ direction
D) 40 units in the $+\hat{k}$ direction

2) A magnet is placed inside a box. The magnetic flux through the box is _______.

A) positive
B) zero
C) negative
D) more information is needed

3) A region of space contains a uniform, constant magnetic field of 10 .0T in the $+\hat{i}$ direction. If a –5 C charge enters this region with a velocity of 25 m/s in the $-\hat{k}$ direction, what is the initial force that it experiences?

A) 1250 N in the $-\hat{j}$ direction
B) 1250 N in the $+\hat{k}$ direction
C) 1250 N in the $+\hat{j}$ direction
D) 1250 N in the $-\hat{k}$ direction

4) A wire carries a current of 5.0 A along the $\hat{j}$ axis in the $+\hat{j}$ direction. In this region of space, there is also a uniform magnetic field of 10 .0 T in the $+\hat{i}$ direciton. What is the force on a 2.0 m segment of the current carrying wire?

A) 100 N counterclockwise
B) 100 N in the $+\hat{k}$ direction
C) 100 N clockwise
D) 100 N in the $-\hat{k}$ direction

5) Two wires are parallel to the $\hat{j}$ axis and are separated by a distance of 3.0 m. Each carries a current of 10.0 A, but the currents are flowing in opposite directions. What is the magnitude of the magnetic field at a point that is between the wires, exactly 1.5m from each wire?

A) 2.67×10^{-6} T
B) 0 T
C) 1.33×10^{-6} T
D) 1.78×10^{-6} T

6) A wire in the plane of this page carries a 5.0 A current UP. At one instant in time, a 10.0 C charge is in the plane of the page, a perpendicular distance of 5m to the right of the wire, and and travelling IN at a speed of 7.0 m/s. At that instant, what is the magnetic force on the charge?

A) 1.4×10^{-5} N , IN
B) 0 N
C) 350 N , DOWN
D) 1.4×10^{-5} N , RIGHT

7) A wire in the plane of this page carries a 5.0 A current UP. At one instant in time, a 10.0 C charge is in the plane of the page, a perpendicular distance of 5m to the right of the wire, and and travelling RIGHT at a speed of 7.0 m/s. At that instant, what is the magnetic force on the charge?

A) 0 N
B) 350 N, DOWN
C) 1.4×10^{-5} N , UP
D) 1.4×10^{-5} N , DOWN

8) A segment of wire 4.0m in length carries a current along the + $\hat{\mathbf{i}}$ axis from x = 0 to x = 4. The Biot-Savart Law will be used to calculate the magnetic field at the observation point x= 0 , y= a. For that calcualtion, the vector $\hat{\mathbf{r}}$ ___________.

A) never changes its $\hat{\mathbf{i}}$ and $\hat{\mathbf{j}}$ components
B) never has a + $\hat{\mathbf{j}}$ component
C) cannot be defined in terms of $\hat{\mathbf{i}}$ and $\hat{\mathbf{j}}$
D) never has a + $\hat{\mathbf{i}}$ component

9) The direction of the magnetic field, as expressed in the Biot-Savart Law, is given by $\mathbf{dl} \times \hat{\mathbf{r}}$. This cross product gives the direction of the field ________________________.

A) at any point along a line from $\mathbf{dl}$ in the direction of $\hat{\mathbf{r}}$.
B) nowhere, because it defines the direction for integration not the direction of the field.
C) only at the observation point
D) only at the location of $\mathbf{dl}$

10) A region of space has a uniform magnetic field that is in the + $\hat{\mathbf{i}}$ direction. A positive charge enters this region with an initial velocity in the + $\hat{\mathbf{k}}$ direction. We wish to place an electric field in this region of space and choose its magnitude and direction so that the charge experiences no net force. In what direction must that electric field point?

A) it depends on the sign of the charge
B) $-\hat{\mathbf{j}}$
C) $+\hat{\mathbf{j}}$
D) $-\hat{\mathbf{k}}$

11) A coaxial cable has an inner conductor that is surrounded by an insulator. That insulator is covered with a conducting sheath (usually a flexable wire mesh). Current flows in one direction through the inner conductor, through the circuit, then back along the outer conductor. If the diameter of the cable is 5.0 mm and the inner conductor carries a current of 0.25 A, what is the magnetic field a perpendicular distance of 3 cm from the inner conductor?

A) 3.33×10^{-6} T
B) 1.67×10^{-6} T
C) 0 T
D) 1.0×10^{-5} T

12) A region of space has a magnetic field given by $B(x,y,z,t) = xyt\ \hat{\mathbf{i}} - 4zt^2\ \hat{\mathbf{j}} + 8x^2y\ \hat{\mathbf{k}}$. Note that this field is neither uniform nor constant. The units are SI. At time t= 10 s, what is the magnitude of the magnetic flux through a square that is parallel to the y-z plane and has corners at (x,y,z) coordinates of (1,0,0), (1,1,0), (1,1,1), (1,0,1)?

HINT: Draw the picture to visualize the square.

A) 0 T m^2
B) 100 T m^2
C) 10 T m^2
D) 5.0 T m^2

13) A region of space contains a magnetic field given by $\mathbf{B} = -(8t^2 + 4)\,\hat{\mathbf{k}}$. A conducting ring with a resistance of 2.0 Ω enclosing an area of 0.1 m^2 lies in the x–y plane, centered on the origin. You are standing on the z–axis at the location z= 5 looking back toward the origin. At a time of t = 10s, is there a current induced in the ring and, if so, in what direction is it flowing?

A) Yes, counterclockwise B) Yes, clockwise C) No

14) A wire lies along the $\hat{j}$ and carries a current in the + $\hat{j}$ direction. That current is increasing with time. A conducting ring lies in the x–y plane <u>to the right of the wire</u>. You are standing along the + z–axis looking back at the x–y plane. Is there a current induced in the ring and, if so, in what direction is it flowing?

A) Yes, clockwise B) Yes, counterclockwise C) No

15) A wire lies along the $\hat{j}$ and carries a current in the + $\hat{j}$ direction. That current is increasing with time. A conducting ring lies in the x–y plane <u>to the left of the wire</u>. You are standing along the + z–axis looking back at the x–y plane. Is there a current induced in the ring and, if so, in what direction is it flowing?

A) No B) Yes, counterclockwise C) Yes, clockwise

16) Maxwell's contribution to "Maxwell's Equations" ____________________.

A) Maxwell made no contributions, but only collected equations already published in the literature
B) was to say that a changing magnetic flux produced an electric field that began on positive charges and ended on negative charges
C) was to say that a changing magnetic flux produced an electric field that 'circled' on itself.

17) A light wave's electric field is given by the equation $E(z,t) = 400.0 \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{i}}$. The units are SI. In what direction is the wave propagating?

A) in the –z direction B) in the + z direction C) in the –x direction D) in the + x direction

18) A light wave's electric field is given by the equation $\mathbf{E}(z,t) = 400.0 \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{i}}$. The units are SI. At the origin, what is the direciton of the electric field at time t = 0?

A) $+\hat{\mathbf{k}}$ B) $+\hat{\mathbf{i}}$ C) $-\hat{\mathbf{i}}$ D) $-\hat{\mathbf{k}}$

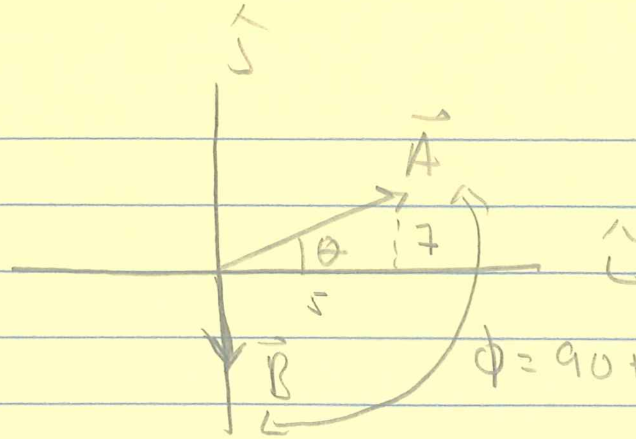
19) A light wave's electric field is given by the equation $E(z,t) = 400.0 \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{i}}$. The units are SI. Which of the following is the corresponding expression for the wave's magnetic field?

A) $\mathbf{B}(z,t) = -\,1.3\text{x}10^{-6} \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{i}}$
B) $\mathbf{B}(z,t) = +\,1.3\text{x}10^{-6} \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{j}}$
C) $\mathbf{B}(z,t) = -\,1.3\text{x}10^{-6} \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{j}}$
D) $\mathbf{B}(z,t) = 400.0 \cos[\,(15.0\text{x}10^6)z + (5\text{x}10^{15})t]\,\hat{\mathbf{j}}$

20) The solar constant is the intensity of sunlight for a unit area , oriented facing the sun, at the top of the Earth's atmosphere. It has a value of 1366 W/m^2. Taking the Earth–Sun distance as 1.5×10^{11} m, what is the total power output of the Sun?

A) 2.05×10^{14} W   B) 9.1×10^{-9} W   C) 3.1×10^{25} W   D) 3.9×10^{26} W

1.) $\vec{A} = 5\hat{i} + 7\hat{j}$
$\vec{B} = -8\hat{j}$



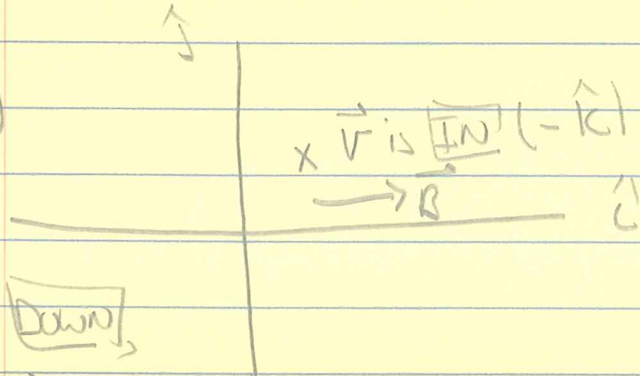
$\theta = \tan^{-1}(\tfrac{7}{5}) = 54.46^\circ$

$\phi = 90 + \theta = 144.46$

$|\vec{C}| = |\vec{A}||\vec{B}|\sin(144.46) = 8.60 * 8 * \sin(144.46) = 39.99$
in $-\hat{k}$ direction.

2.) No magnetic monopoles $\Rightarrow \Phi_B = 0$ through any closed surface (SEE NOTES)

3.)



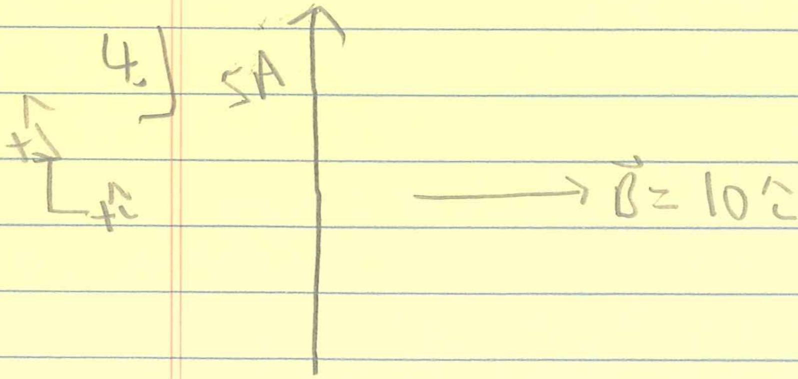
$\vec{B} = 10\hat{i}$

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

$|\vec{F}| = 5 * 25 * 10 * \sin(90)$
$= \underline{1250\ N}$

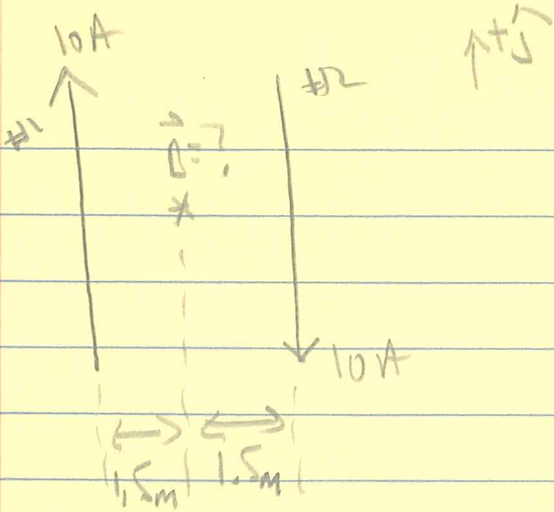
$\vec{v} \times \vec{B}$ is $\boxed{DOWN}$,
so $(-5)\vec{v} \times \vec{B}$ is
$\boxed{UP} \Rightarrow +\hat{j}$

4.)



$\vec{F} = I\vec{l} \times \vec{B} = 5(2)(10)\sin(90)$
$= 100\ N$ $\boxed{IN}$
$-\hat{k}$

5.)

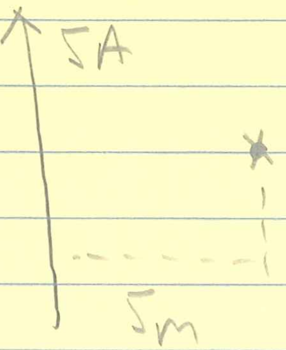


$\vec{B}_{\#1} = \frac{\mu_0 I_1}{2\pi r_1} = 1.33 \times 10^{-6}$ $\boxed{IN}$

$\vec{B}_{\#2} = \frac{\mu_0 I_2}{2\pi r_2} = 1.33 \times 10^{-6}$ $\boxed{IN}$

$\vec{B}_{TOTAL} = 2.67 \times 10^{-6}$ $\boxed{IN}$

6.)



$v = 7\ m/s$ $\boxed{IN}$

$q = 10\ C$

$\vec{B}_{\text{due to } I \text{ @ } q} = \frac{\mu_0 (5)}{2\pi (5)} = 2 \times 10^{-7}\ T$ $\boxed{IN}$

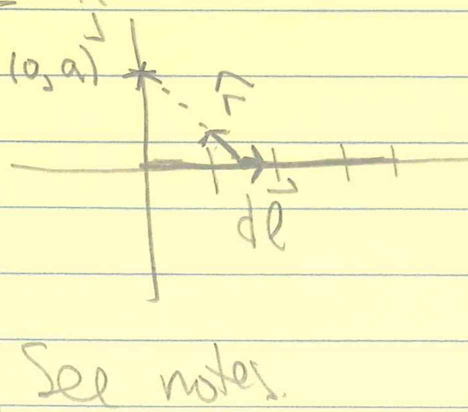
$\vec{F} = q \underbrace{\vec{v} \times \vec{B}}_{\sin(0)} = \underline{\underline{0}}$

7.) *Same but $v = 7\ m/s$ $\boxed{RIGHT}$

$\vec{F} = 10(7)(2 \times 10^{-7}) \sin(90) = 1.4 \times 10^{-5}$ $\boxed{UP}$

$\vec{B} \otimes \rightarrow \vec{v}$

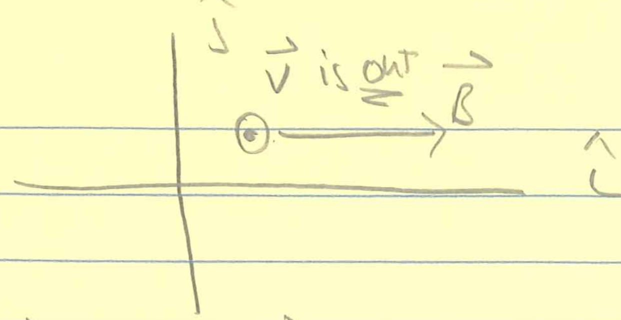
8.)



Along the entire $\int dx$, $\hat{r}$ never has a $+\hat{i}$ component

9.) See notes.

10.)



$\hat{k}$ is $\boxed{\text{out}}$

* You were cautioned in class several times to use right hand coordinate systems ($\hat{k} = \hat{i} \times \hat{j}$)

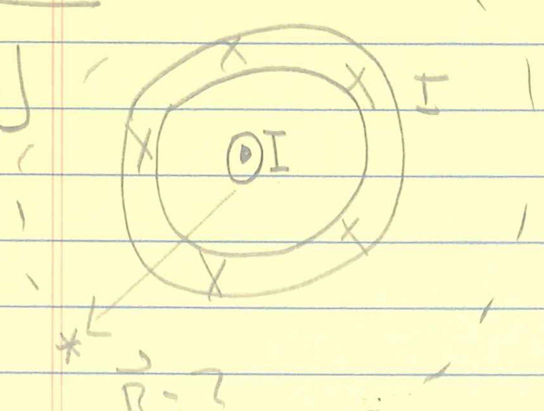
$\vec{F} = q\vec{v} \times \vec{B}$ is $+\hat{j}$

so $\vec{F} = q\vec{E}$ must be $-\hat{j}$

$\therefore$ $\vec{E}$ is in $-\hat{j}$ direction

Does NOT depend on sign of q!

11.)



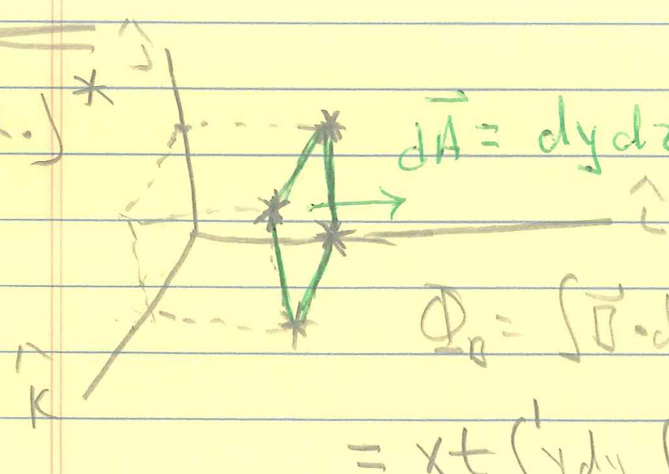
$\oint \vec{B} \cdot d\vec{l} = \mu_0 I_{enclosed}$

0

$\vec{B} = ?$

$\therefore B = 0$ SEE NOTES

12.) *



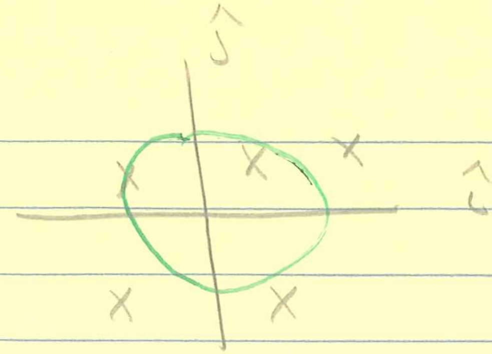
$d\vec{A} = dy\,dz\,\hat{i}$ $\quad x = 1$ *

$\Phi_B = \int \vec{B} \cdot d\vec{A} = \int xyt\,dy\,dz\,\hat{i} \cdot \hat{i}$

$= xt \int_0^1 y\,dy \int_0^1 dz = xt \left(\frac{y^2}{2} \Big|_0^1 \right) = \frac{x t}{2} = \frac{t}{2}$ *

$\therefore$ @ $t = 10\,s$, $\Phi_B = 5\ T \cdot m^2$ 4

13) $\vec{B} = -(8t^2+4)\hat{k}$



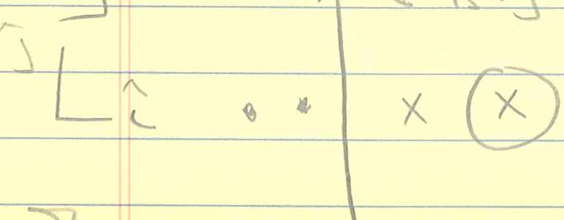
$\uparrow$

$\vec{B}$ is $\boxed{\text{IN}}$

We can see that $\vec{B}$ is into the page and has a magnitude increasing w/ time. ∴ Φ through center is INCREASING, and induced current must be $\boxed{\text{CCW}}$

☺ Can you see other ways this question could have been constructed that would be more interesting?

14)



I is $+\hat{j}$ and INCREASING

$\vec{B}$ is $\boxed{\text{IN}}$ and increasing

∴ Induced current is $\boxed{\text{CCW}}$

15) Ring on left, $\vec{B}$ is $\boxed{\text{OUT}}$ and increasing

∴ Induced current is $\boxed{\text{CW}}$

16) SEE NOTES

17/18/19) $\vec{E}(z,t) = 400 \cos\left[15*10^{6} z + 5*10^{15} t\right] \hat{i}$

17 $\Rightarrow$ travels in the $-z$ direction

18 $\Rightarrow$ $\vec{E}(0,0) = 400\cos(0)\hat{i} = 400\hat{i}$

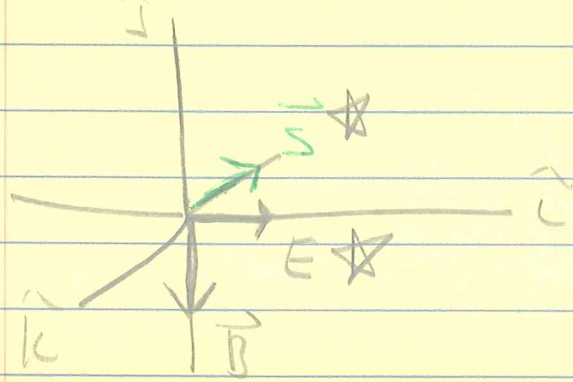
$+\hat{i}$

19 $\Rightarrow$ $c = \frac{E_{max}}{B_{max}}$

$\therefore B_{max} = \frac{E_{max}}{c} = \frac{400}{3*10^{8}} = 1.3*10^{-6}\ T$

$\vec{B}(z,t) = -1.3*10^{-6} \cos\left(15*10^{6} z + 5*10^{15} t\right) \hat{j}$

$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$



20) Power = Intensity * Area = $1366\left(4\pi\left(1.5*10^{11}\right)^{2}\right)$

$= 3.86*10^{26}\ W$