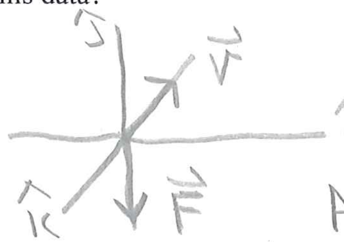
ID: C **Name:** KEY

Exam 2 **29 Questions**

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. A positively charged particle has a velocity in the negative z direction at point P. The magnetic force on the particle at this point is in the negative y direction. Which one of the following statements about the magnetic field at point P can be determined from this data?

a. B_z is positive.
✓ b. B_x is positive.
c. ~~B_y is positive.~~ 0
d. B_x is negative.
e. ~~B_y is negative.~~ 0

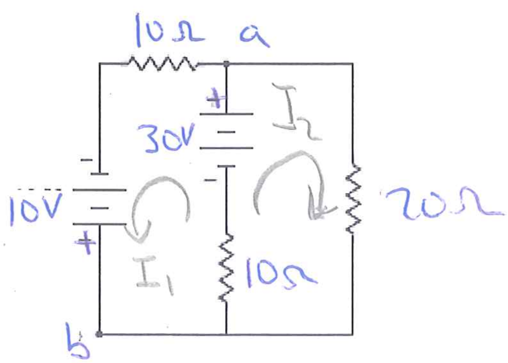


+q

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

As done in class.

____ 2. For the circuit shown below, what is the voltage between the points 'a' and 'b'?



a. 18 V with 'a' at the lower voltage
✓ b. 8.0 V with 'a' at the higher voltage
c. 12 V with 'a' at the higher voltage
d. 18 V with 'a' at the higher voltage
e. 8.0 V with 'a' at the lower voltage

Loop 1

$+30 - 10I_1 + 10 - 10I_1 - 10I_2 = 0$

$-20I_1 - 10I_2 = -40$

(1) $\boxed{2I_1 + I_2 = 4}$

Loop 2

$+30 - 20I_2 - 10I_2 - 10I_1 = 0$

$-10I_1 - 30I_2 = -30$

(2) $\boxed{I_1 + 3I_2 = 3}$

Consider (1) − 2 * (2):

$I_2 - 6I_2 = -2$

$I_2 = \frac{2}{5}$ amps

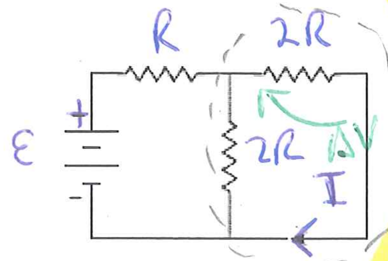
$V_{b \to a} = +I_2(20)$

$= (+\frac{2}{5})(20) = +8$ volts

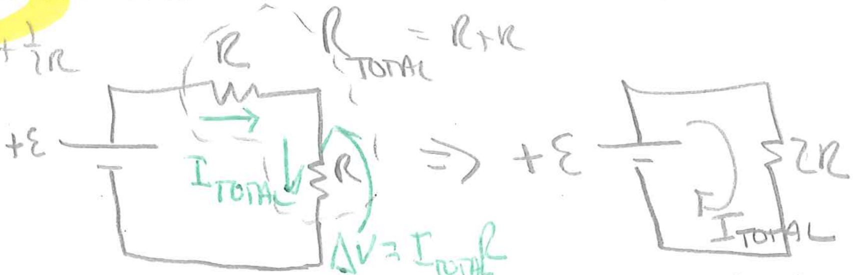
with 'a' @ higher voltage

Could use Kirchhoff $\boxed{\text{OR}}$ equivalent resistance,

____ 3. Determine the voltage, ε, when $I = 0.50$ A and $R = 12\ \Omega$.



$\frac{1}{R_{\parallel}} = \frac{1}{2R} + \frac{1}{2R}$



$\Delta V = I_{TOTAL} R$

$\Delta V = \frac{\varepsilon}{2R}(R)$

$+\varepsilon = I_{TOTAL}(2R)$

⟵ working "backwards" in green ink.

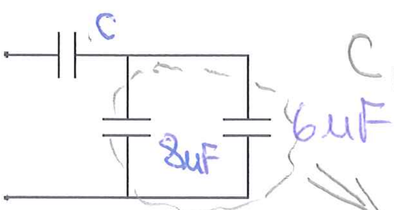
a. 6.0 V
b. 12 V
c. 30 V
d. 15 V
e. 24 V

$\Delta V = I(2R)$

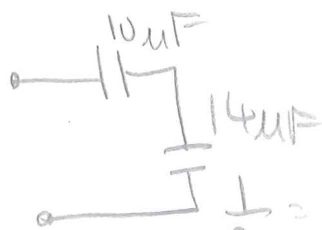
$\frac{\varepsilon}{2R}(R) = 0.5(2R)$

$\therefore \varepsilon = 0.5 * (2R) * 2 = 24$ volts

____ 4. If $C = 10\ \mu$F, what is the equivalent capacitance for the combination shown?



$C_{\parallel} = 8 + 6 = 14\,\mu F$



Analogous to way capacitor problems solved

a. 7.5 μF
b. 5.8 μF
c. 6.5 μF
d. 7.0 μF
e. 13 μF

$\frac{1}{C_{TOT}} = \frac{1}{10} + \frac{1}{14}$

$\therefore C_{TOT} = 5.83\,\mu F$

____ 5. A microwave filter consist of vertical, parallel metal rods which (as we will soon see) absorb microwaves whose electric fields oscillate along the direction of the metal rods. This sets up electric currents which oscillate up and down in the rods. At any one instant, the current in each rod has the same magnitude and direction. Those currents interact so that ________.

$I_1 \uparrow \ \uparrow I_2 \quad \vec{F} = I_2 \vec{l}_2 \times \vec{B}_1$

a. the rods will try to move apart horizontally.
b. the rods will try to shift vertically downwards.
c. the rods will try to shift vertically upwards.
d. the rods will try to move together horizontally.
e. the rods will not be affected because the source of current is not a battery.

As shown and worked in class

____ 6. One reason why we know that magnetic fields are not the same as electric fields is because the force exerted on a charge $+q$ _____________.

$\vec{F} = q\vec{E}$

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

a. is in the same direction in electric and magnetic fields.
b. is in opposite directions in electric and magnetic fields.
c. is parallel to a magnetic field and perpendicular to an electric field.
d. is zero in both if the charge is not moving.
e. is parallel to an electric field and perpendicular to a magnetic field.

____ 7. When a ferromagnetic material that has been magnetized is brought to a temperature greater than the Curie temperature, what happens to its residual magnetism?

a. The residual magnetism disappears. — Mentioned several times in class.
b. The residual magnetism reaches it's highest value.
c. All the magnetic domains causing magnetism become a single domain.
d. Nothing happens to the residual magnetism.
e. The material of the magnet melts causing currents that are magnetic.

____ 8. If 480 coulombs pass through a 4.0-Ω resistor in 10 min, what is the voltage across the resistor?

✓ a. 3.2 V
b. 5.0 V
c. 2.8 V
d. 3.6 V
e. 2.4 V

$I = \frac{\Delta Q}{\Delta t} = \frac{480\ C}{10 \times 60\ \text{seconds}} = 0.8$ amps

$V = IR = 0.8 \times 4 = \underline{3.2 \text{ volts}}$

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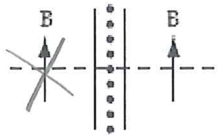
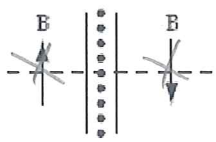
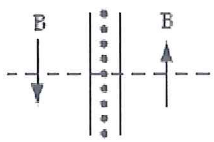
____ 9. A thin infinitely large sheet of current lies in the *y*-*z* plane, as shown in the diagram. The current is coming out of the page. Which diagram below correctly represents the direction of the magnetic field on either side of the sheet?



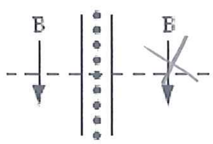
a.



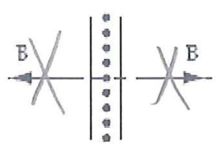
b.



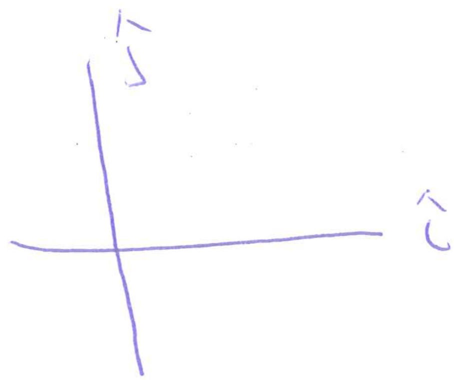
c.



d.

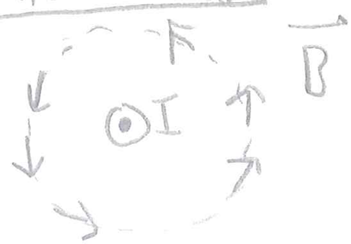


e.



$\hat{k}$ is out of the page

This we know



A bit of imagination w/ the idea of superposition leads us to the correct response.

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____ 10. Gauss's Law states that the net electric flux, $\oint \mathbf{E} \cdot d\mathbf{A}$, through any closed surface is proportional to the charge enclosed: $\oint \mathbf{E} \cdot d\mathbf{A} = \frac{q}{\varepsilon_0}$. The analogous formula for magnetic fields is _______.

Charge enclosed.

a. $\oint \mathbf{B} \cdot d\mathbf{A} = \frac{I}{\mu_0}$.

b. $\oint \mathbf{B} \cdot d\mathbf{A} = -\frac{d\Phi}{dt}$.

c. $\oint \mathbf{B} \cdot d\mathbf{A} = 0$.

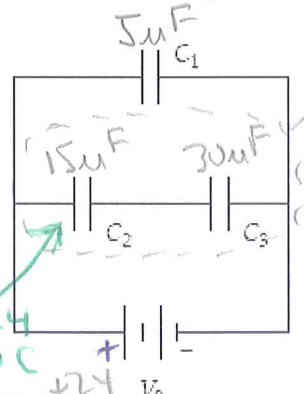
d. $\oint \mathbf{B} \cdot d\mathbf{A} = \frac{q_{mag}}{\varepsilon_0}$.

e. $\oint \mathbf{B} \cdot d\mathbf{A} = \frac{I}{\mu_0 \varepsilon_0}$.

Cannot isolate magnetic charge (N, S)
$\therefore \oint \vec{B} \cdot d\vec{A}$ must be zero.

In your class notes, but you could also come to this conclusion yourself ☺

____ 11. What is the voltage across C_2 when $C_1 = 5.0\ \mu F$, $C_2 = 15\ \mu F$, $C_3 = 30\ \mu F$, and $V_0 = 24$ V?



$\frac{1}{C_{TOTAL}} = \frac{1}{15} + \frac{1}{30}$
$\therefore C_{TOTAL} = 10\mu F$, 5μF,

$C_{TOT} = 10+5 = 15\mu F$

$\Delta V = 24V$, $Q = 10\mu F \Delta V = 2.4 \times 10^{-4} C$

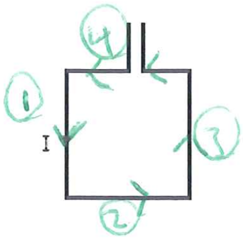
$Q = CV = 3.6 \times 10^{-4} C$

$Q = 2.4 \times 10^{-4} C$
$\therefore \Delta V = \frac{2.4 \times 10^{-4}}{15 \times 10^{-6}}$
$\Delta V = 16$ volts

a. 19 V
b. 24 V
c. 8.0 V
d. 21 V
e. 16 V ✓

Will "work backwards" in green ink (as done in class notes).

____ 12. The magnetic field in a region of space is parallel to the surface of a long flat table. Imagine that this page is lying flat on that table. That places the magnetic field in the plane of this page. When current is present in a wire coil, which is also lying on the table as shown in the figure, the coil tends to rotate so that the left side moves out of the page and the right side moves in to the page. The magnetic field is ______________.

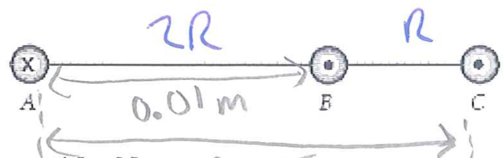


$\vec{F}_{1} = I\,\vec{l}_1 \times \vec{B} \Rightarrow \boxed{OUT}$

$\vec{F}_{3} = I\,\vec{l}_3 \times \vec{B} \Rightarrow \boxed{IN}$

a. in the plane of the page and downwards.
b. in the plane of the page and upwards.
c. in the plane of the page and to the right.
d. in a direction that cannot be determined in this experiment
e. in the plane of the page and to the left.

____ 13. The figure shows a cross section of three parallel wires each carrying a current of 24 A. The currents in wires B and C are out of the paper, while that in wire A is into the paper. If the distance R = 5.0 mm, what is the magnitude of the force on a 4.0-m length of wire A?



$\vec{B}_{@A} = \vec{B}_{B@A} + \vec{B}_{C@A} = \frac{\mu_0(24)}{2\pi(0.01)} \boxed{DOWN} + \frac{\mu_0(24)}{2\pi(0.015)} \boxed{Down}$

$\vec{B}_{@A} = 8\times10^{-4} \boxed{Down}$

a. 15 mN
b. 32 mN
c. 59 mN
d. 77 mN
e. 12 mN

$\vec{F}_A = I\,\vec{l}_A \times \vec{B}_{@A} = 24(4)(8\times10^{-4})\sin(90) = 0.0768 N$
$= 76.8\times10^{-3} N$

____ 14. A small bulb is rated at 7.5 W when operated at 125 V. Its resistance (in ohms) is ________.

$P = \frac{V^2}{R}$ ∴ $R = \frac{V^2}{P}$

$R = 2083\Omega$

a. 940
b. 0.45
c. 17
d. 2 100
e. 7.5

____ 15. On the average, in a ferromagnetic domain permanent atomic magnetic moments(microscopic) are aligned _________ to one another. Hint: ferromagnetic materials, like iron, are use to make permenent magnets.

From class notes.

a. parallel
b. randomly relative
c. perpendicular
d. alternately parallel and antiparallel
e. antiparallel

ID: C

Worked this as an example in Monday's class :)

____ 16. A segment of wire of total length 3.0 m carries a 15-A current and is formed into a semicircle of radius R. Determine the magnitude of the magnetic field at the center of the semicircle. Recall that a small step along the arc, dS, can be written as Rdθ. Also recall that the circumference of a circle is 2πR. Note that the 3 meter wire does **not** form an entire circle. It only forms half a circle.

a. 15 μT
b. 1.0 μT
c. 1.6 μT
d. 4.9 μT ✓
e. 9.8 μT

$d\vec{B} = \frac{\mu_0 I\, d\vec{l} \times \hat{r}}{4\pi r^2}$

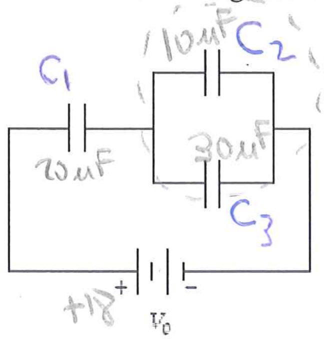
$\vec{B}_{@\,\text{center}} = \frac{\mu_0 I (\pi R)}{4\pi R^2} = \frac{\mu_0 I}{4R}$ $\boxed{\text{IN}}$

$\pi R = 3$

$\therefore R = 3/\pi$

4.93×10^{-6} T $\boxed{\text{IN}}$

____ 17. Determine the charge stored by C_1 when $C_1 = 20\ \mu$F, $C_2 = 10\ \mu$F, $C_3 = 30\ \mu$F, and $V_0 = 18$ V.



C = 40 uF

$\frac{1}{C} = \frac{1}{20} + \frac{1}{40}$

$\therefore C = 13.33\ \mu$F

$Q = 2.4 \times 10^{-4}$ C

a. 0.24 mC ✓
b. 0.50 mC
c. 0.37 mC
d. 0.32 mC
e. 0.40 mC

$Q = CV$
$= 2.4 \times 10^{-4}$ C

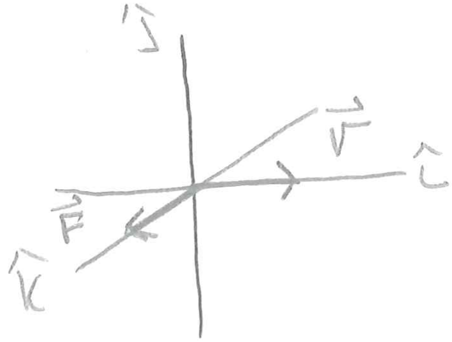
____ 18. An electric heater is constructed by applying 110 V across a wire with a resistance of 5.0 Ω. What is the power rating of the heater?

$P = \frac{V^2}{R} = 2420$ watts

a. 60 kW
b. 2.0 kW
c. 1.5 kW
d. 2.4 kW ✓
e. 1.7 kW

____ 19. An electron moving in the positive x direction experiences a magnetic force in the positive z direction. If $B_x = 0$, what is the direction of the magnetic field? HINT: Draw a picture. Recall that an electron has a negative charge. Also make sure that you are using a right handed x,y,z coordinate system (which is the convention).

a. ~~negative x direction~~
b. negative y direction ✓
c. ~~negative z direction~~
d. ~~positive z direction~~
e. ~~positive y direction~~



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

Negative

ID: C

____ 20. A long straight wire carries a current of 40 A in the +y direction. In that region of space, there is also an external magnetic field in the +y direction whose magnitude is 30-μT. What is the magnitude of the total magnetic field at a point that is 20 cm from the wire?

a. 40 μT
b. 36 μT
c. 50 μT ✓
d. 10 μT
e. 70 μT

40A

$* \vec{B} = \vec{B}_{wire} + \vec{B}_{external} = \frac{\mu_0 I}{2\pi(0.2)}(-\hat{k}) + 30\times10^{-6}\hat{j}$

$\vec{B} = -4\times10^{-5}\hat{k} + 30\times10^{-6}\hat{j}$ || So $|\vec{B}| = 5\times10^{-5}$ T

____ 21. A 2.0-m wire carries a current of 15 A directed along the positive *x* axis in a region where the magnetic field is uniform and given by $B = (30\hat{\mathbf{i}} - 40\hat{\mathbf{j}})$ mT. What is the resulting magnetic force on the wire? NOTE: The magnetic field is given in unist of millitesla.

a. $(-1.5\,\hat{\mathbf{k}})$ N
b. $(+1.2\,\hat{\mathbf{k}})$ N
c. $(+1.5\,\hat{\mathbf{k}})$ N
d. $(+0.90\,\hat{\mathbf{k}})$ N
e. $(-1.2\,\hat{\mathbf{k}})$ N ✓

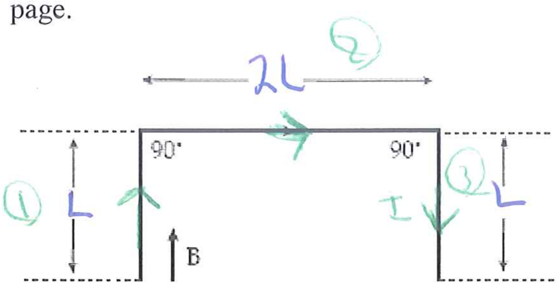
$|\vec{B}| = 50\times10^{-3}$ T

$\theta = \tan^{-1}\left(\frac{40}{30}\right) = 53.13°$

$\vec{F} = I\vec{\ell}\times\vec{B} = 15(2)(50\times10^{-3}) * \sin(53.13)$

Rt. hand rule $\longrightarrow (-\hat{k})$

____ 22. A straight wire is bent into the shape shown. Determine the total magnetic force on the wire when the current *I* travels in the direction shown in the magnetic field $\vec{\mathbf{B}}$. NOTE: The current is in the +y direction on the left part of the wire, the +x direction crossing along the horizontal part of the wire, and the -y direction on the right part of the wire. At all locations, the magnetic field is in the +y direction. The +z direction is out of the page.



$\vec{F}_1 = ILB\sin(0) = 0$

$\vec{F}_3 = ILB\sin(180) = 0$

$\vec{F}_2 = I(2L)(B)\sin(90)$

OUT $(+\hat{k})$

a. 4*IBL* in the –*z* direction
b. 2*IBL* in the +*z* direction ✓
c. 2*IBL* in the –*z* direction
d. 4*IBL* in the +*z* direction
e. zero

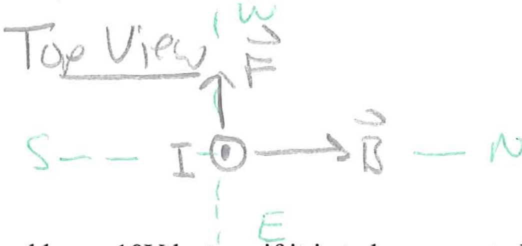
____ 23. The algebraic sum of the voltages around any closed circuit loop in a circuit is _______.

a. maximum if there are no sources of emf in the loop.
b. maximum.
c. equal to the sum of the currents in the branches of the loop.
d. zero. —— Kirchhoff's Voltage Law
e. zero only if there are no sources of emf in the loop.

ID: C

I ↑ → $\vec{B}$ $\vec{F} = I\ell B \sin(90)$ $\boxed{IN}$ $= 0.3$ newtons (IN)

____ 24. An unusual lightning strike has a vertical portion with a positive current of +400 A upwards. The Earth's magnetic field at that location is parallel to the ground and has a magnitude of 30 μT. If the Earth's magnetic field is pointing north, the force exerted by the Earth's magnetic field on the 25 m-long current is ____.



a. 0.012 N, East.
b. 0.
c. 0.012 N, West.
d. 300 N, East.
e. 0.30 N, West. ✓

____ 25. What maximum power can be delivered by an 18V battery if it is to be connected to both a 6.0-Ω resistor and a 9.0-Ω resistor? HINT: The two resistors are configured so that the current in the circuit is a maximum.

⇒ minimum resistance ⇒ parallel

a. 80 W
b. 54 W
c. 22 W
d. 71 W
e. 90 W ✓

R_{TOTAL} +18

$\frac{1}{R_{TOTAL}} = \frac{1}{6} + \frac{1}{9}$ $\therefore R_{TOTAL} = 3.6\,\Omega$ $\| P = \frac{V^2}{R_{TOTAL}} = 90$ watts

____ 26. Equal charges, one at rest, the other having a velocity of 10^4 m/s, are released in a uniform magnetic field. Which charge has the largest force exerted on it by the magnetic field?

→ F is ZERO

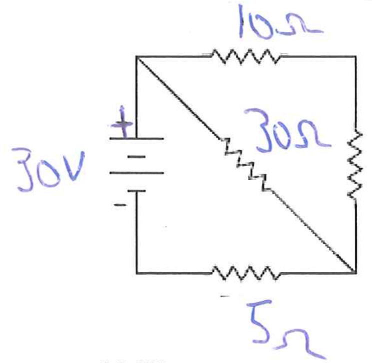
$\vec{F} = q\vec{v} \times \vec{B}$

a. The charge that is moving if its velocity makes an angle of 45° with the direction of the magnetic field when it is released.
b. The charge that is moving, if its velocity is parallel to the magnetic field direction when it is released. → $\vec{F} = 0$
c. The charge that is at rest. $F = 0$
d. All the charges above experience equal forces when released in the same magnetic field.
e. The charge that is moving if its velocity is perpendicular to the magnetic field direction when it is released.

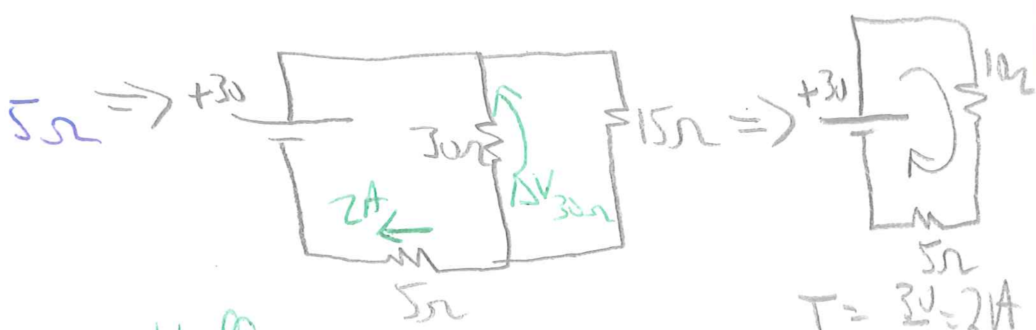
Best Answer

$|\vec{F}| = |q||\vec{v}||\vec{B}|\sin(90)$

____ 27. What is the power delivered to the 30-Ω resistor?



'Short' way:



$I = \frac{30}{15} = 2A$

a. 20 W
b. 60 W
c. 27 W
d. 30 W
e. 13 W ✓

Kirchhoff

$+30 - \Delta V_{30\Omega} - 2(5) = 0$

$\Delta V_{30\Omega} = 20$ Volts

$P_{30\Omega} = \frac{\Delta V_{30\Omega}^2}{30\Omega} = 13.3$ watts

____ 28. A conducting rod with a square cross section (3.0 cm × 3.0 cm) carries a current of 60 A that is uniformly distributed across the cross section. What is the magnitude of the (line) integral $\oint \mathbf{B} \cdot d\mathbf{s}$ around a square path (1.5 cm × 1.5 cm) if the path is centered on the center of the rod and lies in a plane perpendicular to the axis of the rod?

a. 19 μT · m
b. 57 μT · m
c. 38 μT · m
d. 75 μT · m
e. 14 μT · m

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

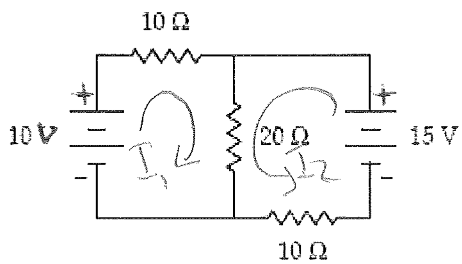
$\frac{I_{enclosed}}{I_{total}} = \frac{\text{Area enclosed}}{\text{Area total}}$

∴ $I_{enclosed} = \frac{2.25}{9}(60) = 15\,A$

$\mu_0 I = 1.884\times10^{-5}$

____ 29. What is the magnitude of the current in the 20-Ω resistor? NOTE: Trust the algebra.

Worked something similar in class on Monday ☺



a. 0.75 A
b. 0.00 A
c. 0.50 A
d. 0.25 A
e. 1.00 A

Loop #1

$+10 - 10I_1 - 20I_1 - 20I_2 = 0$

$-30I_1 - 20I_2 = -10$

① $\boxed{3I_1 + 2I_2 = 1}$

Loop #2

$+15 - 20I_2 - 20I_1 - 10I_2 = 0$

$-20I_1 - 30I_2 = -15$

② $\boxed{4I_1 + 6I_2 = 3}$

Consider ② − 3×①:

$4I_1 - 12I_1 + 3 - 3 = 0$

∴ $I_1 = 0$

from ① ⇒ $2I_2 = 1$

∴ $I_2 = 1/2$ Answer