Answer Key

1. A
2. C
3. E
4. C
5. A
6. D
7. D

Comment for Question 5

Grab the loop and determine the direction of magnetic field in the center of the loop.

The big loop creat magnetic field directed out of page.

Inner loop creat the magnetic field directed into the page. When you apply the formula and find $B_1$ and $B_2$, you have to subtract these two number.

Comment for Question 6

When you apply first right hand rule, you have to remember that direction for velocity is the same as on diagram only when it is positively charges particle. When you deal with negatively charged particle you have to take opposite direction for the velocity.

Comment for Question 7

Before using the right hand rule, chose correct direction of the current. Current flows from plus (long line on battery) toward minus (short line of battery)
Problem # 8 (solution)

Summing the voltages clockwise around the left and right loops gives the following two equations:

1. left loop: \( V_b - i_1 R_1 - i_2 R_2 = 0 \)

2. right loop: \( -V_b + i_2 R_2 - i_3 R_3 = 0 \)

Summing the currents in the top node we get:

\( i_1 - i_2 - i_3 = 0 \) or \( i_3 = i_1 - i_2 \)

We can plug this value for \( i_3 \) into equation 2 above to get:

2. \( V_b = i_2 R_2 - (i_1 - i_2)R_3 \)

Multiplying Eq. (1) by \( R_3 \), multiplying Eq. (2) by \( R_1 \), then adding the equations yields:

Which rearranged yields

Once \( i_2 \) is known, Eq. (1) can be used to get \( i_1 \), and \( i_3 \) can be found as the difference \( i_1 - i_2 \).

\( i_2 = 0.554 \) amps, \( i_1 = .369 \) amps, \( i_3 = -.185 \) amps

\[ i_1 = i_2 + i_3 \]

\[ V_b - i_1 R_1 - i_2 R_2 = 0 \]

\[ V_b + i_3 R_3 - i_2 R_2 = 0 \]

Problem # 9 (solution)

at junction a : \( I_1 = I_2 + I_3 \)

Picking a starting point as the bottom left corner, and moving clockwise around the loop gives:

\[ +\varepsilon_1 - I_1 R_1 - I_3 R_4 - \varepsilon_3 - I_1 R_2 = 0 \]

The inner loop on the right side can be used to get the second loop equation. Starting in the bottom right corner and going counter-clockwise gives:

\[ +\varepsilon_2 + I_2 R_3 - I_3 R_4 - \varepsilon_3 = 0 \]

\[ I_1 = I_2 + I_3 \quad \text{(equation 1)} \]

\[ +9 - 6I_1 - I_3 - 2 - 4I_1 = 0 \quad \Rightarrow 10I_1 + I_3 = 17 \quad \text{(equation 2)} \]

\[ +6 + 4I_2 - I_3 - 2 = 0 \quad \Rightarrow 4I_2 - I_3 = -4 \quad \text{(equation 3)} \]
The simplest way to solve this is to look at which variable shows up in both loop equations (equations 2 and 3), solve for that variable in equation 1, and substitute it in equations 2 and 3.

Rearranging equation 1 gives:

\[ I_2 = I_1 - I_2 \]

Substituting this into equation 2 gives:

\[ 10I_1 + (I_1 - I_2) = 17 \quad \text{so} \quad 11I_1 - I_2 = 17 \quad \text{(equation 4)} \]

Making the same substitution into equation 3 gives:

\[ 4I_2 - (I_1 - I_2) = -4 \quad \text{so} \quad -I_1 + 5I_2 = -4 \quad \text{(equation 5)} \]

This set of two equations in two unknowns can be reduced to one equation in one unknown by multiplying equation 4 by 5 (the number 5, not equation 5!) and adding the result to equation 5.

\[ \begin{align*}
5 \times \text{equation 4:} & \quad 55I_1 - 5I_2 = 85 \\
+ \text{equation 5:} & \quad -I_1 + 5I_2 = -4
\end{align*} \]

\[ 54I_1 = 81 \quad \text{so} \quad I_1 = 1.5 \, \text{A} \]

Substituting this into equation 5 gives:

\[ I_2 = \left( -4 + 1.5 \right) / 5 = -0.5 \, \text{A} \]

The negative sign means that the current is 0.5 A in the direction opposite to that shown on the diagram. Solving for the current in the middle branch from equation 1 gives:

\[ I_3 = 1.5 - (-0.5) = 2.0 \, \text{A} \]

\[ \begin{align*}
5 \times \text{equation 4:} & \quad 55I_1 - 5I_2 = 85 \\
+ \text{equation 5:} & \quad -I_1 + 5I_2 = -4
\end{align*} \]

\[ 54I_1 = 81 \quad \text{so} \quad I_1 = 1.5 \, \text{A} \]

**Problem #10**  Answer is out *(Use first right hand rule.)*

**Problem #10**  Answer is 100N *(Use formula that allows you to calculate the force on moving charge particle in magnetic field)*