Pset1 - KVL Consistency

1 Approach

In approaching this problem the first thing that came to my mind was seeing where Kirchhoff's Voltage Law failed within the smaller four loops.

Calculating the loops counterclockwise comes to:
Upper left loop: - 4V - (-1V) - 2V + 5V = 0V
Upper right loop: 4V - 5V + 2V + 3V = 4V
Bottom right loop: - 2V - (-3V) - 5V + 0V = -4V
Bottom left loop: 2V - 5V + 4V + (-3V) = -2V

2 Analyzing

Seeing that only the upper left loop passes Kirchhoff's Voltage Law and the other ones fail it gives a hint to which voltages shouldn't be changed. If changing any component in the top left loop, then another component in the same loop would also be changed to satisfy the law, meaning the bottom left loop would still be broken. This removes A, C, D, and F from possibly being changed.

Looking at the change of voltages through a signle loop, the two right loops stand out in that they have the same offset. When thinking more about this, it actually means that both circuits can be corrected by changing component G because it is counted in opposite directions when circulating counter clockwise.

With this we can recalculate the upper left and right loops with G as a variable and see that both evaluate to G = -2V:
Upper right loop: 4V - 5V + (G) + 3V = 0V $\rightarrow$ G = -2V
Bottom right loop: - (G) - (-3V) - 5V + 0V = 0V $\rightarrow$ G = -2V

3 Second Change

Now that we've concluded that component G should change to -2V, all that is left is the bottom left loop. Here it's actually possible to change H or K because both of them only affect this loop.

Solving for either we get:

Bottom left loop: 2V - (H) + 4V + (-3V) = 0 $\rightarrow$ H = 3V
Bottom left loop: 2V - 5V + (K) + (-3V) = 0 $\rightarrow$ K = 6V

4 Conclusion

Final conclusion is that G = -2V for the first component change and either H = 3V or K = 6V for the second change.