



$$r = 14\Omega, v_1 = 6V, v_2 = 12V$$

- What is the value of $i_1 r_1 - i_2 r_2$? (Hint: you don't need to solve for i_1 and i_2 to answer this. $|i_1 r_1|$ is the voltage drop across the left resistor (why?). Remember Kirchoff's laws.)
- What is the value of $i_1 + i_2 + i_3$? (Hint: Look at the point at the bottom-middle, and think about how those currents interact there. Make sure you think about the sign of each current.)
- What is the value of i_2 ? (Hint: Use the two equations from the previous two problems. Are those two enough equations to solve it?)

Main idea: Basic application of Kirchoff's laws.

Student process: The student is probably aware that it is a Kirchoff's law problem. A student might try to solve for the three currents first. If successful, then the question is answered (along with the next two). If not, then the hint will tell them that they don't need to solve, and (hopefully) get them thinking more qualitatively.

I'm hoping for the same process in problem 2, with the student realizing that he probably doesn't need to solve for the currents in this case either.

The final problem gets to the algebra. The hint tells the student to write down those equations. He notices that two equations are not enough for three variables, and then looks for another equation. (I've observed many students flipping through their book when they need an equation; hopefully the first problem will guide them.)

Why this is an improvement: I essentially thought the problem was too hard numerically. All I've done is to make it easier by adding more

guidance. I'm hoping to teach the (meta-)message that a typical process is to look at a problem to try to extract relationships (in the form of equations), *then* do math to get to the answer. That is, separate the two steps. The most common error is going to be with signs, so I've narrowed down possible errors to one equation and algebra, rather than three equations and algebra. This may facilitate guess-and-check behavior with respect to signs. It's a tough trade-off; I'd like to see how many tries students need for the original.