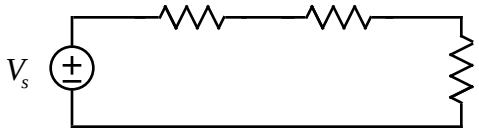
ECE 109 - SERIES AND PARALLEL - INVESTIGATION 10
SERIES RESISTOR CIRCUITS

FALL 2006 **A.P. FELZER**

To do "well" on this investigation you must not only get the right answers but must also do neat, complete and concise writeups that make obvious what each problem is, how you're solving the problem and what your answer is. You also need to include drawings of all circuits as well as appropriate graphs and tables.

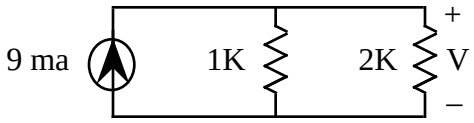
In the last Investigation we saw how to analyze parallel resistor circuits with voltage sources as well as current sources like the following

where we used KCL and Ohm's Law to find the voltages and currents. The objective of this Investigation is to make use of Kirchhoff's Laws to analyze *series circuits* like the following

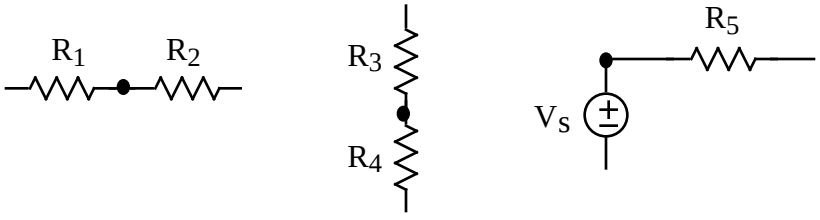


Do **not** use anything you may know about equivalent resistance to solve **any** of the problems in this Investigation. Be sure to take a look at the **Computer Demos** on Series Resistor Circuits.

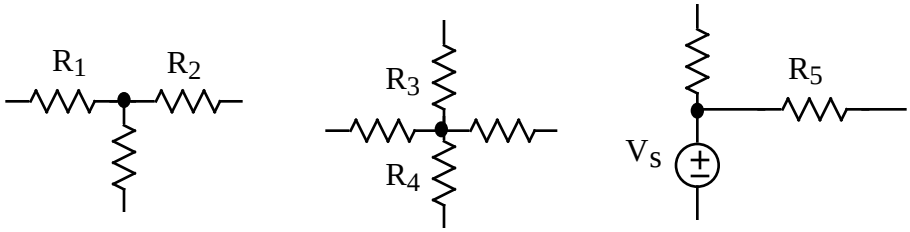
1. We begin with a review problem. Find V in the following circuit



2. Given that R_1 and R_2, R_3 and R_4, and V_S and R_5 **are** connected in **series** in the following circuits



but are **not** connected in series in these circuits

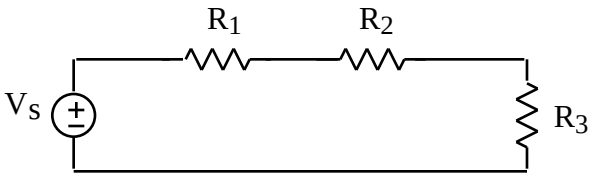


Come up with a definition in terms of nodes and what's connected to them that a person who

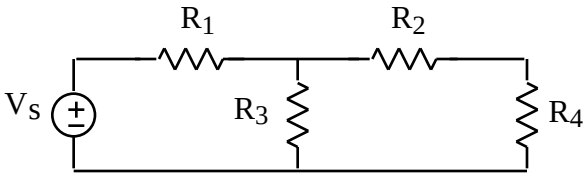
knows **nothing** about voltage or current can use to determine if two circuit elements are in series. **Memorize** this result.

3. Identify which pairs of circuit elements in the following circuits are in series - remember that voltage sources are circuit elements. Use your definition from Problem (2) to justify your answers

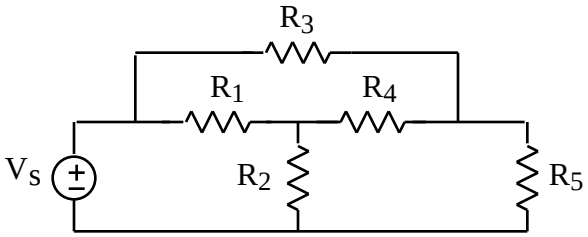
a.



b.



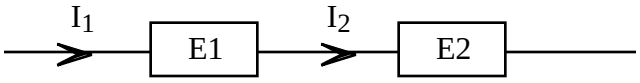
c.



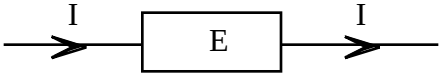
4. Explain why resistors R_1 and R_3 are not in series in circuit (b) of Problem (3)

5. What would you expect we mean when we say a circuit is a **series circuit**. Draw one. Then draw a circuit that is not a series circuit.

6. How would you expect the currents flowing through series circuit elements as follows

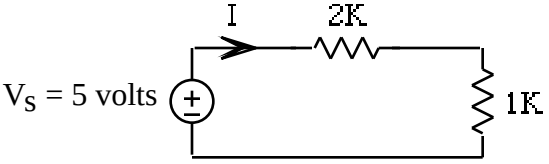


to be related. How do you know. Hint - make use of our previous observation that at any time the current entering a circuit element E is equal to the current leaving it as indicated in



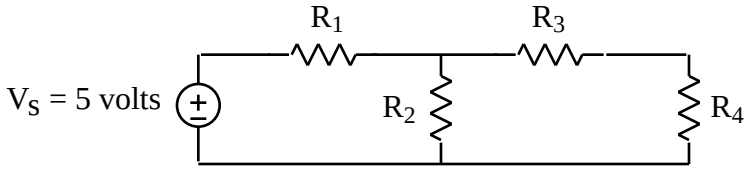
Memorize this result forever

7. Which resistor has the larger voltage across it in the following circuit. How can you tell

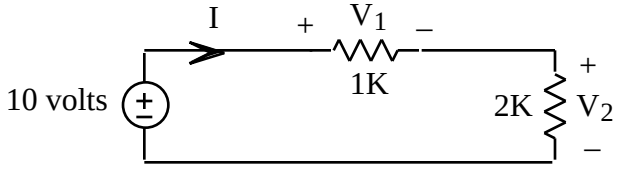


8. What's the minimum information you need to know in the following circuit in order to be able

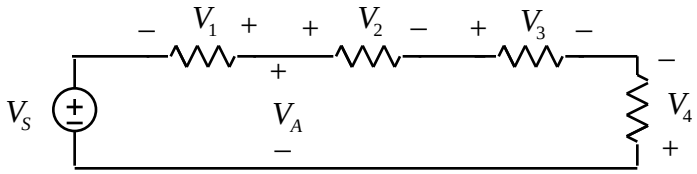
to determine whether R_3 or R_4 has the larger voltage across it. How do you know



9. See if you can come up with a scheme for calculating the current I in the following series circuit. Justify each step. Remember that you can't use anything you may know about equivalent resistance. Hint - start by writing the KVL equation around the loop and then make use of Ohm's Law to express the resistor voltages in terms of their common current I. **Memorize** your scheme for analyzing series circuits



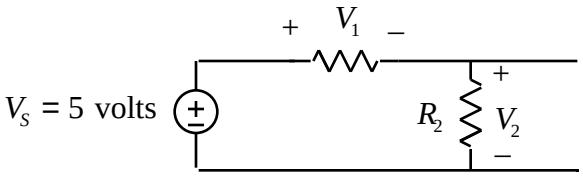
10. Given the following circuit



with $V_S = 10$ volts, $V_2 = 4$ volts, $V_3 = -2$ volts, $V_4 = -4$ volts

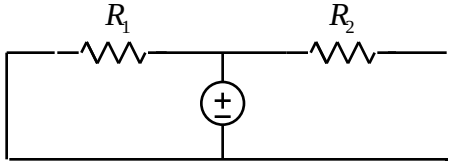
a. Find V_1
b. Find V_A

11. Suppose we connect a wire across R_2 in the following series circuit (we *short* R_2 out)

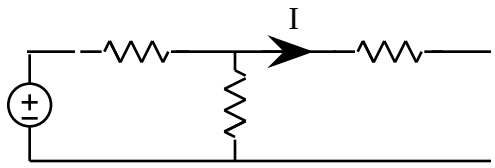


a. Will connecting the wire across R_2 cause V_2 to go up, down or stay the same. Explain
b. Will connecting the wire across R_2 cause V_1 to go up, down or stay the same. Explain

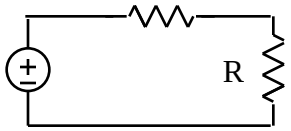
12. Are R_1 and R_2 in the following circuit in series or in parallel. Explain



13. Find I in the following circuit. Note that we call this an *open circuit*

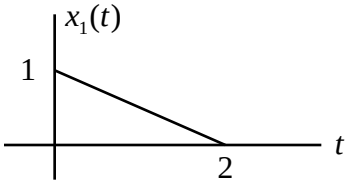


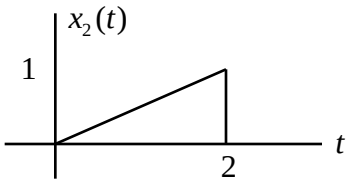
14. Redraw the following circuit



a. If $R = 0$
b. If $R = \infty$

15. Math Review - Given the following graphs for $x_1(t)$ and $x_2(t)$





a. Sketch $y_1(t) = x_1(t) - x_2(t)$
b. Sketch $y_2(t) = x_1(t) - 2x_2(t)$