**Circuit Elements:** In the first chapter of the text, we treated all circuit elements as "black boxes" and asserted that they all shared three specific properties (review this if necessary.) All circuits at this level, it was correctly claimed, could be built out of these rather mysterious and anonymous elements. In this section we further investigate the types of ideal basic circuit elements that exist and describe the relationship between the voltage across the terminals and the current that flows through the element, the so-called iv-characteristics.

1) There are two types of <u>independent</u> circuit elements in circuit analysis. Name them, draw their circuit schematics, and sketch their iv-characteristics on the iv-graphs shown below (pay close attention to the axes of the graphs).

   a) Name:
      Circuit schematic:            iv-characterisic graph:

   b) Name:
      Circuit schematic:            iv-characterisic graph:

2) There are four types of <u>dependent</u> or controlled sources. Name them and draw their circuit schematics below.

   a) Name:                                    b) Name:
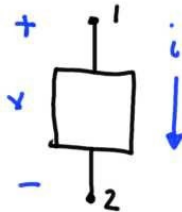      Schematic:                                  Schematic:

c) Name:

   Schematic:

d) Name:

   Schematic:

**Resistors and Ohm's Laws:** There is one circuit element for which the ratio of the voltage to the current is fixed for all values (within reason) called the **resistor**.

1) Given the ideal basic circuit element shown below, how is its resistance defined?



2) Draw the circuit schematic for the **resistor** and the iv-graph. Make sure to label the voltage polarity and the current direction in the schematic.

  Circuit schematic:                              iv-characteristic graph

3) What does the slope of curve on the iv-characteristic graph for a resistor signify? How can you find the resistance value of the resistor on the iv-graph?

4) What is Ohm's law? (This is an equation) What are the units of resistance?

5) Does Ohm's law apply to voltage sources? Why or why not?

6) Does Ohm's Law apply to current sources? Why or why not?

7) What is the difference between and passive and an active circuit element?

8) Depending on the system of interest, the resistance of an element is less of interest that the reciprocal of the resistance called the conductance. What is the definition of conductance? What are the units?

9) It can be shown that three different equations can be used to calculate the power dissipated by a resistor. What are the three equations?

**Definitions and Kirchhoff's Laws:** There are two essential laws, called Kirchhoff's Laws, which are used in circuit analysis. One is called Kirchhoff's Current Law, or KCL for short, and the other is Kirchhoff's Voltage Law, or KVL. In order to do circuit analysis, one must have a thorough understanding of these laws and how they are used, as well as the terminology and conventions with which they are written.

1) What is the definition of a node?

2) What is the definition of a loop?

3) In your own words, state the content of Kirchhoff's Current Law (KCL). Write it in equation form. What sign convention are you using for the currents?

4) In your own words, state the content of Kirchhoff's Voltage Law (KVL). Write it in equation form. What sign convention are you using for the voltages?

**Problems:** Validity of Circuits

For each of the circuits show below, state if the interconnection is valid or invalid. If the circuit is valid, then determine the total power generated by the circuit. If the circuit is invalid, then clearly state the reason why.

a)

10V

5V

2A

b)

1V

2V

3V

5A

c)

2A

1A

5V

10V

3A

d)

30V

10A

100V

20A