Chapter 16
DC Circuits Chapter Review

EQUATIONS:

- $i = \frac{dq}{dt}$ or $i = \frac{\Delta q}{\Delta t}$ [The rate at which charge passes a point in an electrical circuit (i.e., the amount of charge Δq that passes the point per unit time Δt) is defined as the current i through that point.]
- $V_R = i_R R$ [The electrical potential difference V_R across a resistor (also called the voltage difference across the resistor) is ALWAYS equal to the current i_R through the resistor times the size of the resistor R. This is called Ohm's Law.]
- $R_{eq} = R_1 + R_2 + R_3 + \ldots$ [The equivalent resistance R_{eq} of a series combination of resistors equals the sum of the individual resistors in the combination. Note that R_{eq} for a series combination is always bigger than the largest resistor in the combination.]
- $1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 + \ldots$ [The inverse of the equivalent resistance R_{eq} of a parallel combination of resistors equals the sum of the inverse of each of the individual resistors in the combination. Note that R_{eq} for a parallel combination is always smaller than the smallest resistor in the combination.]
- $\sum i_{in\mathbf{to}\ a\ node} = \sum i_{out\ of\ a\ node}$ [Kirchoff's First Law states that the current into a node (i.e., a junction) must equal the current out of the node.]
- $(\sum \Delta V)_{around\ any\ closed\ path} = 0$ [Kirchoff's Second Law states that if you sum the voltage changes around any closed path within a circuit, the sum must equal zero. As the starting and ending points must be the same if the path is truly closed, this seems incipiently obvious. Nevertheless, the approach is powerful.]
- $P = iV$ [As power is defined as the amount of work per unit time being done by some entity, the derived expression for power either dissipated or provided to a circuit by a circuit element is equal to the current through the element times the voltage across the element. This particular expression is ALWAYS used when dealing with the amount of power supplied to a circuit by a power source. In that case, i is the current being drawn from the power supply and V is the voltage across the power supply. Although the expression can be used on resistors, there is another form that is more commonly used. It follows below.]
- $P = i^2R$ [Substituting the Ohm's Law expression $V = iR$ into the derived power expression, we get this relationship. IT IS ONLY GOOD FOR RESISTORS. It states that the power dissipated by a resistor is equal to the square of the current passing through the resistor times the size of the resistor's resistance.]
- $P = V^2/R$ [Rarely used, this is the third way to express the power dissipated by a resistor.]

COMMENTS, HINTS, and THINGS to be aware of:

- A node is a junction where wires meet within an electrical circuit. A branch is a section of circuitry between two nodes. The current in a particular branch will be the same everywhere within the branch.

- The sum of the individual voltage drops or increases between two points must equal the net voltage change between the two points. This sounds dumb, but it can be of use when trying to analyze a circuit quickly (i.e., without writing out Kirchoff's Laws in all of their gory . . . or is that glory?).

- The direction of current flow is defined as the direction positive charges would move in the circuit if positive charges could move in the circuit. This is the reason current flows from the high voltage to the low voltage side of a power supply. Yes, this is weird, but it is the way current was defined in the beginning and the tradition has stuck.

- A series combination of resistors has no junctions between resistors, and each resistor must be attached to a neighbor in only one place. Current is common to resistors in a series combination (i.e., every resistor has the same current through it).

- A parallel combination of resistors will always have junctions between the resistor connections, and each resistor must be attached to every one of its neighbors in two places. Voltage is common to resistors in a parallel combination (i.e., every resistor has the same voltage across it).

- The only things you will ever be asked to determine in a circuit problem are current values. Even when you are trying to determine the reading of a voltmeter across a resistor, you must determine the current through the resistor first, then use $V_R = iR$ to get the voltage. All meters do in a circuit is let you know which currents are being sought . . . that, and to make the circuit appear more confusing than it has to be. So when you find yourself doing a formal Kirchoff's Law problem, REMOVE ALL METERS that may have been placed in the circuit before starting the analysis. There is no reason not to do this.

- There will be times when Kirchoff's Laws could be used to determine a current, but common sense can shorten a five minute problem into a thirty second problem. If, for instance, you see a clever way to, say, sum voltage differences due to resistors (i.e., iR drops) and power supplies (i.e., V_o's) across a known voltage change, use it. Don't be bashful about being creative and bold.

- Power dissipated by a resistor is governed by the current through the resistor (remember, $P = i^2R$). If the current through a resistor goes up, so will the power dissipated by R. If the current through a resistor goes down, so will the power dissipated by R. That means that if you are given a problem in which you are told something about how a resistance changes, then asked what has happened to the power dissipated by the resistor, you have to determine what has happened to the current through the resistor to answer the question.

- When power is dissipated by a resistor, the so-called lost energy is usually converted into heat or light.

- When using Kirchoff's Laws, define a branch current in terms of other currents in the circuit whenever you can. That is, use Kirchoff's First Law to define your currents. Doing so will cut down the number of unknown currents with which you will have to deal, simplifying the problem in the process.