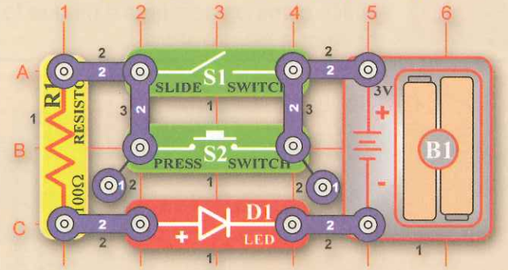
Nearly all electricity produced eventually becomes heat. All currents flowing through resistors produce heat in them. Light from a lamp or TV produces heat in whatever it shines on. All the circuits in a computer produce heat, and most computers have vents to get this heat out.

3-8 Introduction to Logic

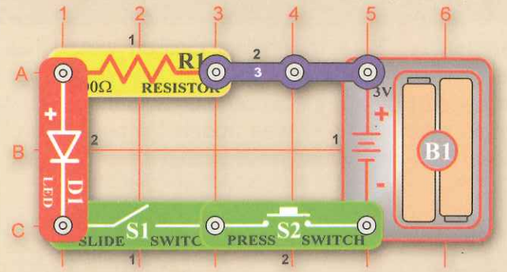
Experiments

Consider this circuit (which is project 47):



If the slide switch OR the press switch is on, the LED lights up. This is called an OR circuit. While this may seem very simple and boring, it represents an important concept in electronics. Two switches like this may be used to turn on a light in your house. You could also have more than two switches and the circuit would function the same way.

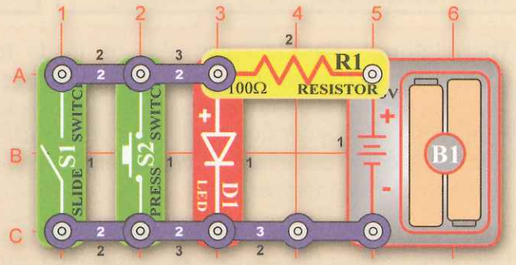
Now consider this circuit (which is project 48):



If the slide switch AND the press switch are on, the LED lights up. This is called an AND circuit. Two switches like this may be used to turn on the same light in your house, the room switch and the master switch in the electrical box.

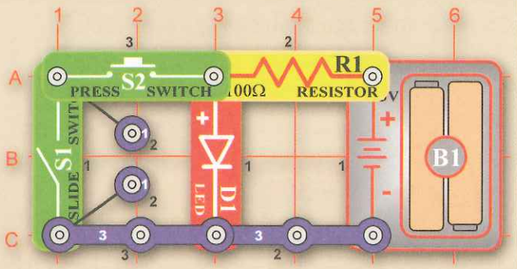
AND and OR circuits are the basic building blocks of today's computers, though transistors are used instead of switches and LEDs. Combinations of AND and OR circuits are used to add and multiply numbers together.

Now consider this circuit (which is project 49):



This circuit is the counter-part to the OR circuit, the LED lights in the opposite combinations of that circuit. Engineers called it a NOR circuit (short for "NOT this OR that").

Now consider this circuit (which is project 50):

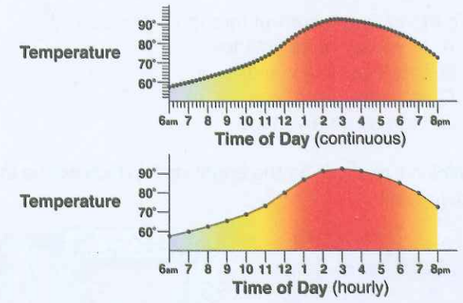


This circuit is the counter-part to the AND circuit, the LED lights in the opposite combinations of that circuit. It is called a NAND circuit (short for "NOT this AND that"). This circuit can also have more or less than two inputs, though when it only has one input it is referred to as a NOT circuit.

OR, AND, NOR, NAND and NOT circuits are all important building blocks in modern computers.

3-9 DIGITAL ELECTRONICS

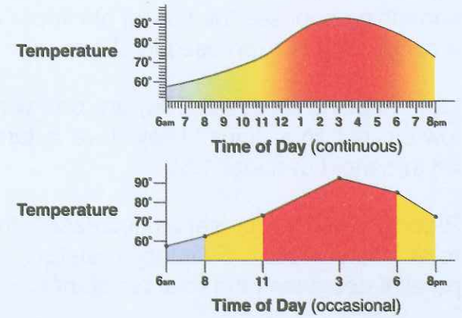
Suppose you wanted to keep a record of how the temperature outside was changing throughout the day. You could use a thermometer to measure it, and watch it continuously or just check it every hour and write it down. Your results might look something like this:



Checking it once an hour gave you a very good record of how the temperature was changing throughout the day, with much less effort than watching it all day long.

Digital electronics uses a series of numbers to represent an electrical signal. If your thermometer was electronic it might increase an output voltage as the temperature increased. It would be hard to store what that voltage was throughout the day, but easy to measure it and store it as a series of numbers. The series of numbers could be converted back into a continuous voltage later.

The accuracy of your digital representation depends on how accurately and how often you measured the original voltage. For example, you could get a better or worse representation of your temperature:



Sometimes it is easier to process information as a digital series of numbers (computers), and sometimes it is easier to use a continuously changing voltage (AM radios). Many products use both methods on the same information but at different times. The disadvantage of digital systems is that they are more complex since they have to store and process all the numbers. The advantages are that IC technology makes it inexpensive to store and process information, and digital systems are more protected from interference.

Computers store numbers in memory using vast arrays of transistors that are switched on or off. The OR, AND, NOR, NAND, and NOT gates are actually made up of transistors. These gates are used to add and multiply large numbers in tiny pieces to form the processing functions in computers.

Quick Quiz

1. Draw a schematic for a circuit using a battery set, an LED, a 50KΩ adjustable resistor, and a 1KΩ resistor. The LED must have adjustable brightness, and must never have less than 1KΩ in series with it.

Summary

Summary of Chapter 3:

1. Resistors are used to limit and control the current in a circuit.

2. Resistance is a measure of how much something opposes the flow of electricity in a circuit, and is expressed in ohms.

3. Light emitting diodes (LEDs) are one-way, low-current light bulbs. They have a turn-on threshold of about 1.5V.

4. Placing resistors in series increases the total resistance. Placing resistors in parallel decreases the total resistance.

5. In a circuit, the current equals the voltage divided by the resistance. This is known as Ohm's Law.

6. Power measures how much energy is moving through a circuit, it equals the voltage multiplied by the current and is expressed in Watts.

7. Materials which have very low resistance are called conductors. Materials which have very high values of resistance and are called insulators.

8. Photoresistors change their resistance when light shines on them.

9. All currents flowing through resistors produce heat in them.

10. OR, AND, NOR, NAND and NOT circuits are basic building blocks of computers.

11. Digital electronics uses numbers to represent an electronic signal. The accuracy of the digital representation depends on how accurately and how often the original signal was measured.

12. Computers store numbers using arrays of transistors that are switched on or off.

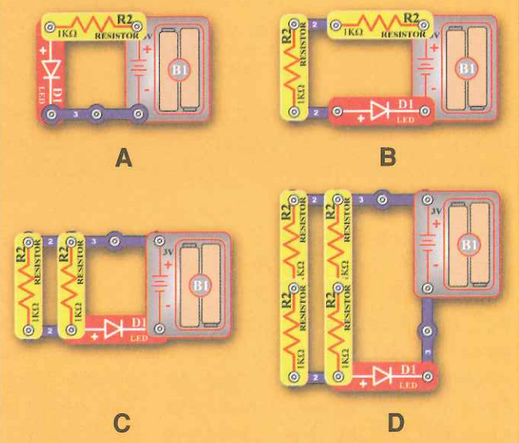
Quiz

Chapter 3 Practice Problems

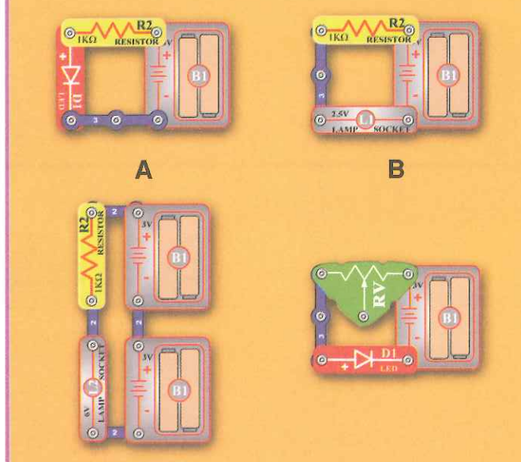
1. The following are characteristics of an LED except:
   A. They block current flow in one direction.
   B. They get brighter as current increases.
   C. They can handle very high currents.
   D. They can emit different colors of light.

2. To increase the current through a circuit, you . . .
   A. Increase the resistance.
   B. Decrease the watts.
   C. Increase the ohms.
   D. Increase the voltage.

3. Which circuit will be the brightest? Which will be the dimmest?



4. Which circuit will be the brightest?

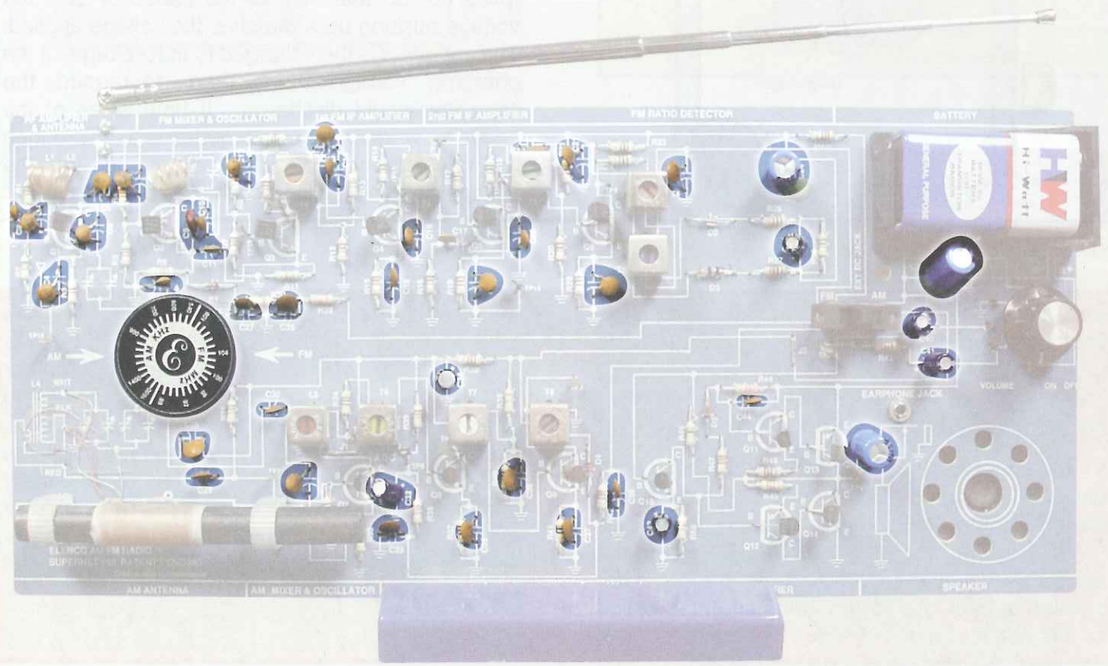


Answers: 1. C, 2. D, 3. C/B, 4. A

CHAPTER 4: CAPACITORS

Learn By Doing®

Capacitors are components, which can store electric charge, an ability that makes them useful in many types of circuits. They can delay changes to a circuit, allowing things to happen slowly or in sequence. They are essential to filtering and tuning circuits, and in many electronic products they are the most common component. As an example of how important capacitors are in electronics, consider a typical AM/FM radio (shown below). It contains 41 capacitors, which are highlighted.



In this chapter you will learn about the different types of capacitors, how they work, and how they are used in circuits. It will be fascinating to see how these simple components make electronics work.