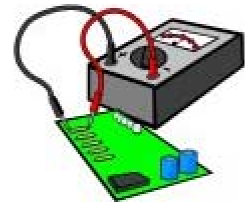
The Path of Resistance

part 5



1 If we did not have electrical energy, our lives would be very dark. For instance, when we turn on our light switch at home, we automatically expect our light to shine brightly. Occasionally, a light bulb will burn out, and we will be left with darkness. However, did you know that there are other situations where the flow of electrical energy can be interrupted as it travels from the power source to the receiver of that power? Did you also know that almost any material can conduct electricity under the right conditions?

2 A material's conductivity is based on how easily electrical energy can pass through it. Metals, such as copper, are considered to be the best conductors of electricity. I know; you are thinking of symphony and orchestra conductors. Actually, electrical conductors are like train conductors. A train conductor helps to ease the traffic flow of passengers as they board the train. Objects, such as metal, are conductors of electrical energy because they allow the electricity to flow easily through them. Most electrical wiring is made of copper since it is inexpensive to mine and mass produce.

3 If you have taken a peek inside a radio or MP3 player recently, you may have thought that the wires were made entirely of rubber. However, copper or metal wires need insulation to maintain the strength of the electrical energy as it travels through the wire. Insulators like rubber are poor conductors of electricity because the electrical energy cannot easily flow through these materials. Glass, plastic, cloth, and other non-metallic materials are also poor conductors of electricity. Electrical wires may be covered in plastic and cloth in addition to rubber. Electricians even wear rubber gloves when they are working with electrical wires.

4 Although insulators are poor conductors of electricity, under the right conditions they can conduct electricity. If you give any object enough voltage, which is the force or push behind the flow of electrical energy, then that object will conduct electricity. Some insulators, when wet, can increase in conductivity. If you add dissolved minerals to pure or distilled water which is a poor conductor, the chemical property of the water would change, and it would become a better conductor. This is the reason you should turn off appliances like your toaster oven when your hands are dry; human skin is a better conductor when wet. It is also not a sound idea to have that radio nearby while you are

taking a long leisurely bath.

5 Now that we have settled the mystery of conductors and insulators, let's discuss situations where the flow of electricity may be interrupted. Resistance slows down the flow of electrons is as it travels along the passageway of the wire. For example, longer electrical wires pose a greater amount of resistance to electricity than shorter wires. This is because the electricity has farther to travel. Another version of this type of resistance is caused by a rheostat. A rheostat or dimmer switch increases or decreases the length of the electrical wire which results in the increase or decrease of the wire's resistance. You can make a simple dimmer switch with a few components. With an insulated wire, attach a small light bulb to a D cell battery. On the other end of the battery attach another insulated wire. Tape each end of a 7 centimetre piece of graphite to a table. Simultaneously touch the bulb base and the wire end opposite it next to each other on the graphite. The bulb should light. As you move the bulb along the graphite away from the wire, the light should dim.

6 The width or diameter of a wire can also affect the flow of electrical current. Think about when you walk through a door on your way to lunch at school. What would happen if you and your classmates tried to get through the door at the same time? Besides the chaos that would occur, you and your classmates would get stuck trying to pass through the door. As a result, very few of you would make it through the door because the passageway would become smaller, and you and your classmates would be late for lunch. This is similar to what happens with electrical wires. When the wire is thick in diameter, the electricity has a broad or wide passageway to travel through without being restricted. When the diameter of the wire is narrow or thin, the flow of electricity is slowed down due to more friction. When there is more friction, heat is produced causing the wire to overheat.

7 Sometimes for safety purposes resistors are used to control the amount of electrical energy that flows through the wires. These types of resistors are called fuses and circuit breakers. Both types contain metal strips or metal ribbons fused together. When the wire that is attached to the fuse or circuit breaker overheats, the metal strip or ribbon melts and opens the circuit which stops the flow of electricity. It is important to replace a melted fuse or circuit breaker because it is an important safety feature in your home. Modern cars also have fuses that are attached to electrical circuits that control power windows, air conditioners, lights, and radios.

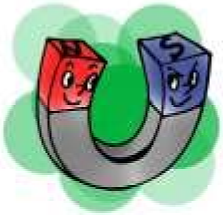
8 There are occasions when electricity is prevented from flowing

through a resistor. A short circuit is a path that allows most of the electricity in a circuit to flow around or away from the device in the circuit. An example of this would be placing long extension cords under heavily traveled rugs. Since the area is heavily traveled, the rubber insulation covering the electrical wire would eventually wear away. Once the rubber wears away, the two bare wires that are left over will touch and cause a short circuit. Not only will the appliance that is attached to the extension cord not work, but you may also create the potential for a hazardous situation like a fire. .

9 So as you are turning on your bedroom light and thinking about how easily electricity flows, remember sometimes that an electrical wire is its own "path of resistance."

The Path of Resistance

1. What is the main theme of this article? (A) Why there are certain safety features in homes that stop electrical flow (B) How electricity flows through different types of materials (C) Why electricity doesn't flow through insulators (D) How electrical flow can be increased and decreased	2. What two types of resistors are used as safety features in houses? (A) Circuit Breakers (B) Fuses (C) Insulators (D) Rheostats
3. Describe the characteristics of electrical wires that would cause resistance to electricity. ____________________ ____________________	4. A more common name for a rheostat is: (A) A dimmer switch (B) A fuse (C) An insulator (D) A conductor
5. Pure or distilled water becomes a better insulator when its chemical properties are changed by: (A) Adding dissolved minerals (B) Adding dissolved conductors (C) Adding dissolved nonmetals (D) Adding dissolved plants	6. Short circuits are caused by: (A) The dimming of lights in a room (B) The overheating of wires that are attached to fuses (C) The conductivity of metals (D) The erosion of rubber insulation resulting in the touching of bare wires
7. The materials that are considered to be poor conductors are: (A) Copper, aluminum, cloth (B) Rubber, plastic, glass (C) Metal, cotton, glass (D) Plastic, cloth, tin	8. You have a melted fuse in the fuse box in your basement. You do not have time to go to the store to purchase a new fuse, so your friend suggests using a copper penny. Is your friend's suggestion a good idea? Why or Why Not? ____________________ ____________________



Magnetism part 6

1 Magnetism is the force by which objects are attracted to other objects or repelled by other objects. Magnets have two opposite ends, called poles. The north pole of one magnet will repel, or push away, the north pole of another magnet. The same thing will happen with two south poles. However, the north pole of one magnet will attract, or pull toward itself, the south pole of another magnet. Just like people say about some boyfriends and girlfriends, "opposites attract."

2 Magnets get their name from Magnesia, a place in Asia where lodestones were found in ancient times. Lodestones were the first known magnets. They are rocks containing iron that have become permanently magnetized. We call permanent iron magnets like these ferromagnetic (ferro- is a prefix that means "iron").

3 Most iron is not permanently magnetic, but it can be made into a temporary magnet. The reason this is possible has to do with the electrons that make up the iron atoms. When the electrons are lined up just right, the piece of iron becomes a temporary magnet.

4 Magnetism involves electrons and electricity. This is a complicated topic. Scientists in this field study things like physics, electromagnetic theory, and quantum mechanics. All of these topics depend on advanced mathematics, so if you want to really get into magnetism someday, keep doing your math homework.

5 Electricity is often used to make one type of magnet, called an electromagnet. Electromagnets are made from copper wire coiled around a core. Iron placed inside the core makes the magnet stronger. When an electric current is sent through the coiled wire, the wire becomes magnetized. When the current stops, the magnetism stops too. Huge electromagnets are used to pick up scrap iron in a junkyard. After the scrap metal is moved to its new location it can be dropped by turning off the electromagnet.

6 Electromagnets have many practical uses. They are used in relays and switches. Electromagnets can generate current in a motor or generator. They are also used in computer disc drives, tape drives, speakers, and power door locks. MRI machines in hospitals use magnetism to make a picture of the inside of your body.

7 Permanent iron magnets have practical uses too. Maybe your mom uses a magnet to hang up your report cards on the refrigerator door. Can you find a door latch that uses a magnet to hold the door closed?

8 Magnets are fun to experiment with. Small iron magnets come in several shapes. There are bar magnets, horseshoe magnets, and donut shaped magnets. With a collection of several small magnets you can do a lot of experimenting. Before you begin, you might also want to collect some small metal objects such as paper clips and coins. With some iron filings and a compass you can do even more experiments. If you want to try electromagnets, you'll need copper wire, an iron nail, a battery or two, and your parents' or teacher's permission.

9 Do an experiment to see which materials a magnet will pick up. Try to prove that "opposites attract." Try to use the compass to find which is the north end of a magnet. Use the iron filings to demonstrate a magnetic field. Try to make an electromagnet. See how the number of coils of wire affects the number of paper clips an electromagnet will pick up. Then if you're ready for something really tricky, experiment with levitation -- see if you can use your magnets to make something float in thin air.

Magnetism

1. The first magnets were called (A) Poles (B) Electromagnets (C) Compasses (D) Lodestones	2. If you want to learn more about magnets, the best subjects to study would be (A) Math and economics (B) Science and art (C) Science and math (D) Civics and history
3. Copper wire, an iron nail, and a battery can be used to make (A) An electromagnet (B) A lodestone (C) A permanent magnet (D) A compass	4. The word magnet comes from (A) The title of an experiment (B) The name of a place (C) The name of a scientist (D) An Italian word
5. Permanent magnets are called "ferromagnetic" because (A) They use electricity (B) They are old (C) They have two poles (D) They are made of iron	6. A good title for this story might be (A) The Magnetic North Pole (B) An Introduction to Magnets (C) Electromagnets (D) Three Magnet Experiments
7. What does the word "levitation" mean? (A) Experiment (B) North Pole (C) Magnetism (D) Floating	8. Describe one experiment that you would like to try with magnets. ____________________ ____________________ ____________________

Magic Fields and Poles

part 7

1 When you hear the word "field", you may think of baseball, corn, or soccer. However, there are also invisible fields called magnetic fields. A magnetic field is the space around a magnet where the force of the magnet can be felt. This field of force is the reason magnets can attract steel and iron objects without touching them. Although you cannot actually see this field of force, you can tell it exists based on how iron and steel objects react to a magnet from a distance. For example, if you place a small paper clip near a magnet, it will start to move toward the magnet almost like "magic".

2 Magnets come in different shapes and sizes. Common shapes are bars, letters (v and u), horseshoes, and cylinders. The field of force for all magnets surrounds the entire magnet and is strongest at the poles or ends of the magnet. Magnets that are shaped like U'S, V'S, or Horseshoes are more powerful than other types of simple magnets. Since these magnets are bent, two poles are used to attract objects instead of one pole like a bar magnet. How do we know where the field of force ends? Well, the field of force around a magnet goes on for an infinite distance or beyond where the human eye can see. So, for our study we could say that a magnet's field of force ends when we are no longer able to see it attract objects like a paper clip. Now for a little magic!

3 Put a paper clip in the palm of your hand. Now try holding a strong magnet against the back of your hand. What do you think will happen? Well, if you said the paper clip will move, you were right. Magnetic fields of force can go through many types of materials, like your hand, without losing their power of attraction. Those materials and your hand are "transparent'' to the magnetic field's lines of force. When an object is transparent, you can see through that object. Well, for a magnet, this means that its power of attraction can go through your hand and attract an iron or steel object within its field of force. Now you understand why people can wear magnetic earrings on their earlobes. Plumbers also use this knowledge about transparency and magnetic fields to help them locate iron pipes in closed walls. Iron and steel, however, are opaque to a magnetic field's lines of force. You are not able to see through opaque objects. Therefore when a magnet touches iron or steel, the force passes to the inside of the objects and

back into the magnet causing an attraction.

4 Remember the poles of magnets that were mentioned earlier? Well, the ends are usually labelled with an "S" for south and an "N" for north. If you were to take two magnets and place a north end together with a south end, they would attract each other. Opposite poles (north-south or south-north) attract each other. If you place two magnets with the same or like poles together (north-north or south-south), they would repel or move away from each other. So even within a magnet's field of force, there are certain laws of attraction.

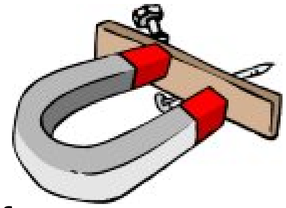
5 Try experimenting on your own with magnets. Test different objects to see if they are transparent or opaque to the magnet's lines of force. Explore to see how far you can place an iron or steel object from a magnet before it cannot be pulled to the magnet. But be careful! When you drop a magnet, it loses some of its power to attract objects. The more you drop a magnet, the less magic you will be able to see.

Magic Fields and Poles

1. Like or similar poles on two different magnets will attract to each other. (A) False (B) True	2. A magnet's field of force stops at the poles of the magnet. (A) False (B) True
3. A magnetic field is__________ (A) Where Detroit Tigers play the World Series (B) The area where the North and South Poles are located (C) Where crops are grown during the fall (D) The space around a magnet where the force of the magnet can be felt	4. Explain why a horseshoe magnet may be more powerful than a bar magnet. ______________________________ ______________________________ ______________________________
5. Describe a situation where it would be better to use certain types of magnets to attract different types of objects. Give examples. ______________________________ ______________________________ ______________________________	6. A material is transparent to a magnetic field's lines of force when ___________ (A) The magnet attracts an object on the other side of the material (B) The magnet repels the object on the other side of the material (C) The magnet attracts the material instead of the object (D) None of the above
7. If you drop a magnet, it will ___________ (A) Decrease its power of attraction (B) Increase its power of attraction (C) Not change the power of attraction of the magnet (D) Attract to the first object near it on the floor	8. Iron and steel are ___________ (A) Transparent to a magnetic field's lines of force (B) Allergic to a magnetic field's lines of force (C) Opaque to a magnetic field's lines of force (D) None of the above

Fields of Attraction and Poles

part 8



1 The fields are alive with the spark of attraction! We have all heard the saying "opposites attract," but how far away can they be before they attract? The answer lies in magnetic fields of force. A magnetic field of force is the invisible area around a magnet where the force of the magnet can be felt. This field of force allows the magnet to attract steel and iron objects without touching them. This invisible field can be inferred based upon how steel and iron objects react to the magnet from a distance. For example, if you place a paper clip on a table near a magnet, the paper clip will be drawn into the field of force, therefore moving towards the magnet. Attraction from a distance has occurred.

2 Magnets come in a variety of shapes and sizes. Common shapes are bars, letters (u and v), horseshoes, and cylinders. The field of force, which is strongest at the poles or ends of the magnet, surrounds the entire magnet. Magnets that are shaped like u's, v's, and horseshoes are more powerful than other types of simple magnets. As you may have guessed, when you have two poles to attract objects instead of one pole, the magnet's pull is much stronger. How do we locate the boundaries of a magnet's field of force? Well, the field of force around the magnet goes on for an infinite distance beyond where the human eye can see. So for our investigation purposes, we can say the magnet's field of force ends when we are no longer able to see its effect on steel and iron objects, such as a paper clip.

3 We know that the field of force surrounds a magnet, but does that field travel through other materials to attract objects? What do you think would happen if you put a paper clip in the palm of your hand and held a strong magnet against the back of your hand? Well, if you said the paper clip would move, you would be right. Magnetic fields of force can go through many types of materials, like your hand, without losing its power of attraction. Those materials and your hand are "transparent'' to the magnetic field's lines of force. This means that the magnet's power of attraction can go through your hand and attract an iron or steel object within its field of force. Now you understand why people can wear magnetic earrings on their earlobes. Plumbers also use this scientific principle to help them locate iron pipes in closed walls. Iron and steel, however, are opaque to a magnetic field's lines of force. When a magnet touches an iron or steel object, the force passes to the inside of the object and back into the magnet causing an

attraction.

4 As you read earlier, the ends of magnets are referred to as poles. The poles of a magnet are usually labelled with an "S" for south and an "N" for north. If you were to suspend or hang a magnet near another magnet, the similar or like poles (north-north or south-south) would repel or move away from each other. The opposite poles of the two magnets (north- south or south-north) would attract to each other. We could apply this same scientific principle to help understand the magnetic poles of the earth.

5 Scientists believe the earth is one giant magnet. If you were to suspend a magnet from a string in North America, the north end of the magnet would point to the north magnetic pole. If you did the same experiment in South America, the south end of the magnet would point toward the south magnetic pole. (Both experiments would work provided that there was no interference from nearby metal objects or deposits.) Why does this occur? One theory is that several parts of the interior portions of the earth rotate at different speeds. The friction that occurs from this rotation causes electric particles to be stripped from atoms. As a result, electric currents are produced and magnetic fields are created. Magnetic poles are different from geographic poles. Since the core or centre of the earth is believed to be made of nickel-iron, scientists think we have one huge electromagnet buried inside the earth.

6 Remember the magnetic field's lines of force we talked about earlier? Well, the lines of force for the earth's magnetic fields run north and south extending into space and circling back down to concentrate at the north and south magnetic poles. Imagine if you sprinkled iron filings on a white sheet of paper and placed that paper over a bar magnet. You would see the iron filings looping from one pole of the magnet to the other with the majority of the filings located at both poles. This is how the magnetic lines of force would appear around earth if you could see them.

7 We have our magnet swinging in North America, and it is pointing to the north magnetic pole. This freely swinging magnet lines itself up so that it is parallel to the earth's lines of force. The lines of force end at the magnetic poles, so the magnet would point to the north magnetic pole in North America. However, magnetic poles should not be confused with geographic poles. The north geographic and magnetic poles are about 1,000 miles (1,600 kilometres) apart, and the south geographic and magnetic poles are 1,500 miles (2,400 kilometres) apart. The location of the north magnetic pole is the upper

Hudson Bay region of Canada, and the south magnetic pole is near Wilkes Land, Antarctica. In terms of compasses, they do not point true north, but they instead point to the magnetic north pole. These poles are constantly shifting, so navigation charts must be changed periodically. Remember, magnetic poles are invisible; geographic poles are not.

8 Now that we have talked about swinging magnets, you are probably saying, "I thought like poles repelled each other and opposite poles attracted each other?" Well, this is still true. The reason for the confusion with our swinging magnet is due to history. People used magnets and compasses for a long time before they understood how they worked. Early scientists referred to the end of the magnet which points to the north as the North Pole. However, the more accurate term for that end of the magnet would be the north-seeking pole, and its opposite end would be the south-seeking pole.

9 Try experimenting with the "laws of attraction." See if you can find ways to explore the earth's magnetic fields of force by designing a homemade needle compass. Who knows? You may be able to use it to journey to the centre of the earth.

Fields of Attraction and Poles

1. A magnet's field of force allows steel and iron objects to be repelled from a distance. (A) False (B) True	2. The earth's magnetic poles are located in different areas close to its geographic poles. (A) False (B) True
3. A material is transparent to a magnetic field's lines of force when _______ (A) An object can be repelled by a magnet through the material (B) An object can attract the material instead of the magnet (C) An object can be attracted by a magnet through the material (D) None of the above	4. Describe a situation which it would be better to use certain types of magnets to attract different types of objects. Give examples. ______________________________ ______________________________ ______________________________