TOPS LEARNING SYSTEMS

MAGNETISM 33

20 structured activities
using simple things

FOR GRADES 3–8

ACTIVITY SHEET SERIES

MAGNETISM

**with paper clips,
magnets,
pins
and simple things**

SCIENCE WITH SIMPLE THINGS SERIES

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Gathering Materials

Listed below is everything you'll need to teach this module. Buy what you don't already have from your local supermarket, drugstore or hardware store. Ask students to bring recycled materials from home.

Keep this classification key in mind as you review what's needed.

general on-the-shelf materials:	*special in-a-box materials:*
Normal type suggests that these materials are used often. Keep these basics on shelves or in drawers that are readily accessible to your students. The next TOPS module you teach will likely utilize many of these same materials.	Italic type suggests that these materials are unusual. Keep these specialty items in a separate box. After you finish teaching this module, label the box for storage and put it away, ready to use again.
(substituted materials):	***optional materials:**
Parentheses enclosing any item suggests a ready substitute. These alternatives may work just as well as the original. Don't be afraid to improvise, to make do with what you have.	An asterisk sets these items apart. They are nice to have, but you can easily live without them. They are probably not worth an extra trip to the store, unless you are gathering other materials as well.

Everything is listed in order of first use. Start gathering at the top of this list and work down. Ask students to bring recycled items from home. The Teaching Notes may occasionally suggest additional *Extensions*. Materials for these optional experiments are listed neither here nor under *Materials*. Read the extension itself to determine what new items, if any, are required.

Quantities depend on how many students you have, how you organize them into activity groups, and how you teach. Decide which of these 3 estimates best applies to you, then adjust quantities up or down as necessary:

$Q_1/Q_2/Q_3$

- **Single Student:** Enough for 1 student to do all the experiments.
- **Individualized Approach:** Enough for 30 students informally working in pairs, all self-paced.
- **Traditional Approach:** Enough for 30 students, organized into pairs, all doing the same lesson.

KEY: *special in-a-box materials* — general on-the-shelf materials — (substituted materials) — *optional materials

$Q_1/Q_2/Q_3$

2/60/60	ceramic magnets – see notes 1
1 box	paper clips
1 box	steel straight pins, 1 inch
1 roll	aluminum foil
8/40/120	pennies
1 spool	thread
1 roll	masking tape
1 roll	clear tape
1/10/15	pairs of scissors
1/1/3	paper punch tools
1/10/15	styrofoam cups, small size
2/20/30	3x5 inch index cards
2/30/30	*plastic cups or equivalent – see notes 5*
1/1/1	black permanent marker
1/15/15	6½ cm (2½ inch) iron nails
5/75/75	*feet copper or aluminum wire, about 24 gauge, no thicker than 22 gauge, with soft easily stripped insulation.*
1/15/15	size D dry cells
9/36/135	iron washers
2/20/30	wooden clothespins
1 package	clay
1/5/15	jars or equivalent – see notes 18
2/10/30	rubber bands
8/40/120	*cm thin bare copper or aluminum wire, about 30 or 32 gauge – see note 19*
1/3/8	manila folders (pressed cardboard)
2/12/30	clothes hangers (stiff flat rulers or equivalent)
1 package	uncooked rice grains
1 box	staples

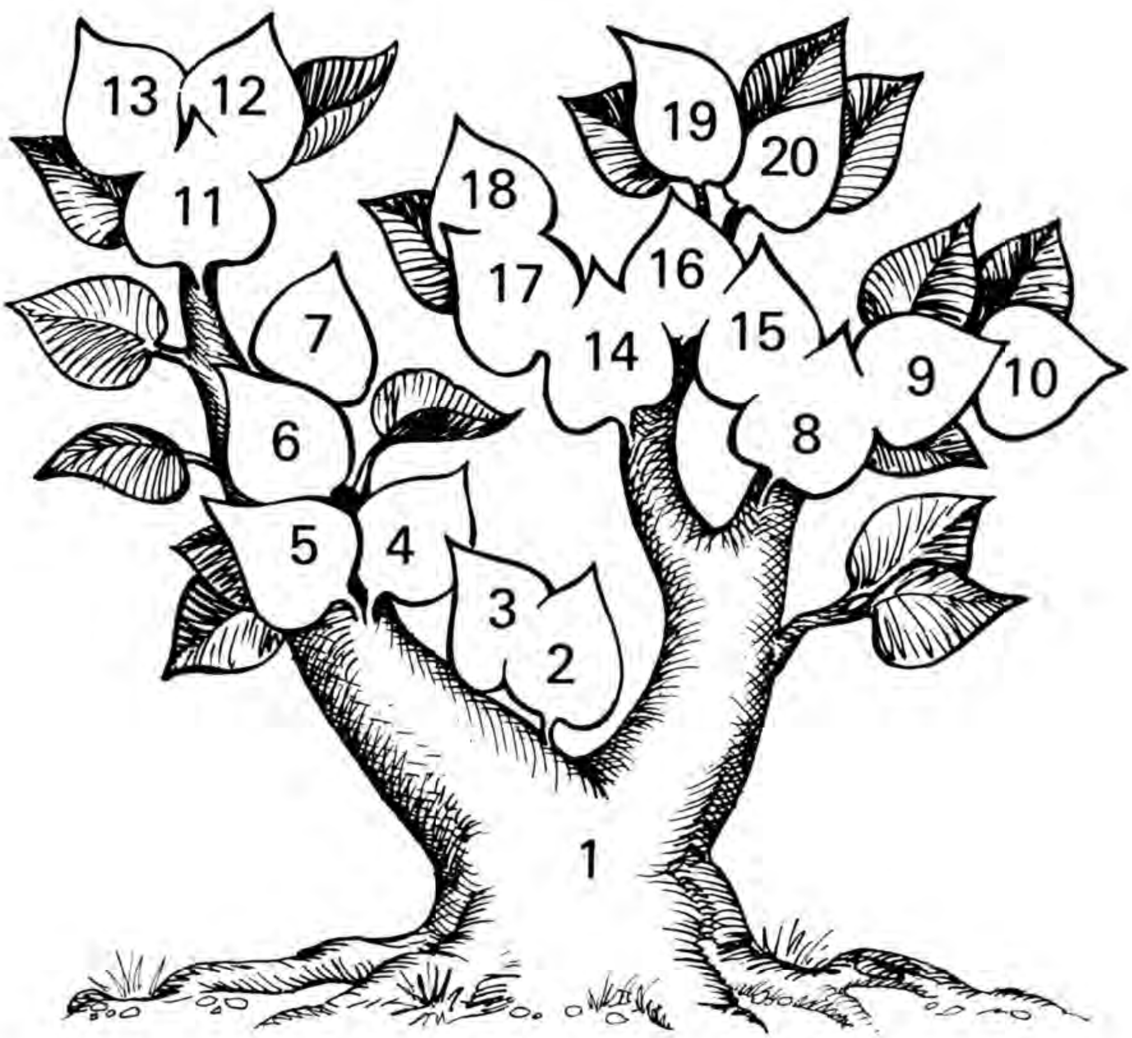
Sequencing Activities

This logic tree shows how all the activities in this book tie together. In general, students begin at the trunk of the tree and work up through the related branches. Lower level activities support the ones above.

You may, at your discretion, omit certain activities or change their sequence to meet specific class needs. However, when leaves open vertically into each other, those below logically precede those above, and should not be omitted.

When possible, students should complete the activities in the same sequence as numbered. If time is short, however, or certain students need to catch up, you can use this logic tree to identify concept-related horizontal activities. Some of these might be omitted, since they serve to reinforce learned concepts rather than introduce new ones.

For whatever reason, when you wish to make sequence changes, you'll find this logic tree a valuable reference. Parentheses in the upper right corner of each activity page allow you total flexibility. They are blank so you can pencil in sequence numbers of your own choosing.



Gaining a Whole Perspective

Science is an interconnected fabric of ideas woven into broad and harmonious patterns. Use extension ideas in the teaching notes plus the outline presented below to help your students grasp the big ideas — to appreciate the fabric of science as a unified whole.

Write a story about the **discovery of lodestone**. Tell how you think this discovery led to the invention of the compass. Be creative.

Related TOPS modules that provide additional hands-on experience using simple materials include:

- 19 Electricity
- 20 Magnetism
- 32 Electricity

Find the **magnetic variation** (declination) for your area. Where else on earth is this variation the same as where you live? Copy an **isogonic map** of the world.

MAGNETISM 33

How did sailors navigate before the invention of the compass? What **forms of navigation** do they use today in ships of iron and steel? Write a report.

Students who show special aptitude or unusual interest in magnetism might wish to investigate these **career possibilities**:

- physicist
- geophysicist
- surveyor
- electrical engineer
- ceramic engineer

What role do magnets play in producing electricity? Read about **generators** and write a report.

Use a pair of compasses and a protractor to **box the compass**. Include at least 16 directions in your coordinate system. Let north be 0° and east be 90°.

Review / Test Questions

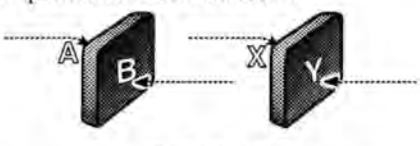
Photocopy these test questions. Cut out those you wish to use, and tape them onto white paper. Include questions of your own design, as well. Crowd them all onto a single page for students to answer on their own papers, or leave space for student responses after each question, as you wish. Duplicate a class set, and your custom-made test is ready to use. Use leftover questions as a class review in preparation for the final exam.

activity 1

The owner of a metal shop wishes to recycle the copper and iron shavings that are swept from the floor each day. How should she separate this mixture of metals?

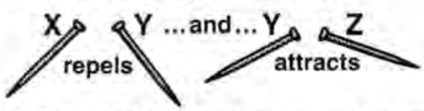
activity 2

Name each pole (***N*** or ***S***) on the lines provided: pole **B** attracts pole **Y**. When magnet **XY** hangs from a thread, pole **Y** points to Earth's north.

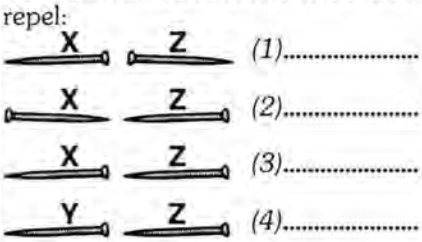


activity 3

Three pins, **X**, **Y** and **Z**, are magnetized to attract and repel like these:



a. Given this information, write whether these pin combinations also attract or repel:

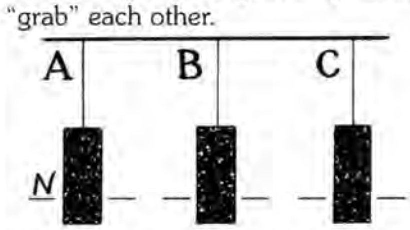


(Hint: You might begin by labeling the ends of all pins with circles and squares.)

b. If the **X** pinhead points ***south***...
the **Y** pinhead must point ....
the **Z** pinhead must point ....

activity 4

Three magnets hang so they almost "grab" each other.

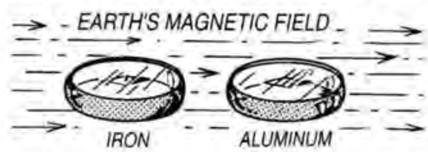


a. One pole is marked north (***N***). Label the other 5 poles.

b. Could you turn magnet **C** by turning magnet **A**? Explain.

activity 5

A compass needle is a tiny magnet that lines up with the earth's magnetic field to give directions. As a compass maker, would you make your compass cases from iron or aluminum? Explain.



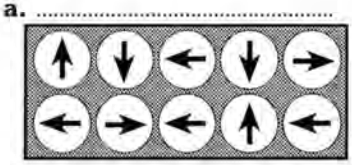
activity 6

What does this graph tell you about a magnet?

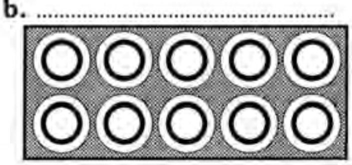
activity 7

The arrows represent atoms with magnetic poles. The circles represent atoms without poles. Identify each bar as a strong magnet, weak magnet, demagnetized material, or nonmagnetic material.

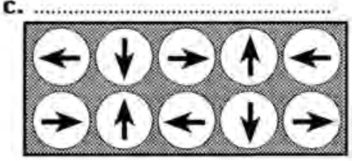
a. ....



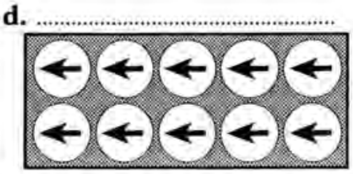
b. ....



c. ....



d. ....

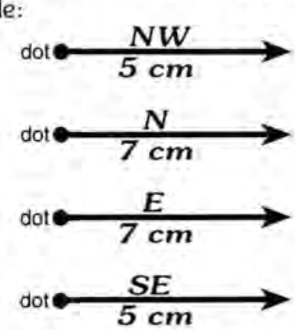


activity 8

On a backpacking trip, you accidently step on your compass. All you can save is the needle. Using only items you are likely to have with you or find around you, how could you fashion a new compass from the old needle?

activity 9

Make a small dot in the center of a clean sheet of paper, then tape the paper to your table. Use your ruler and hairline compass to solve this letter puzzle:

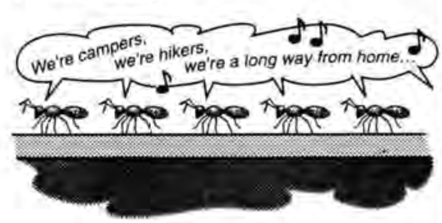


activity 10

Imagine that ants are walking in a straight line along the top edge of your blackboard from right to left.

a. Use your compass to find their direction of travel.

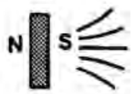
b. Tell how you did this.



Review / Test Questions, continued

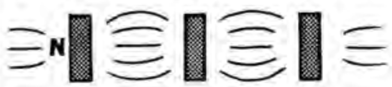
activity 11

Finish this picture. Use long smooth lines to represent the lines of force in the magnetic field.



activity 12

Label the other 5 poles not shown.



activity 13

Finish this picture. Draw lines of force to show the shape of the interacting magnetic fields.

activity 14

Junk yard cranes use giant electromagnets to pick up old car bodies.

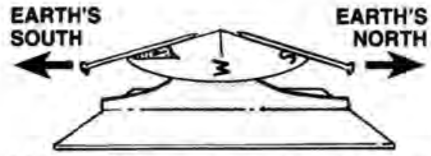
a. If you pulled this electromagnet apart, what would you expect to find inside?

b. As a crane operator, how would you pick up a car body and let it down again?

c. Would this crane work if you used a giant permanent magnet in place of an electromagnet? Why?

activity 15

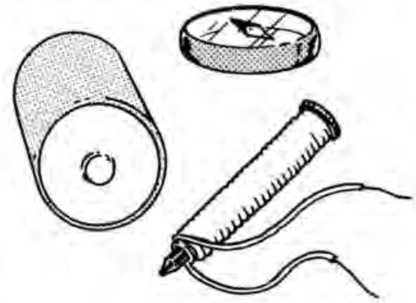
This hat-pins compass points backwards.



How would you remagnetize the pins so they point correctly?

activity 16

Tell how you would put together a compass, a dry cell and an electromagnet to make the compass needle spin like a motor. Draw a diagram.



activity 17

Which invention came first, the electromagnet or the telegraph? Explain your reasoning.

activity 18

The hammer rings the bell by moving rapidly back and forth.

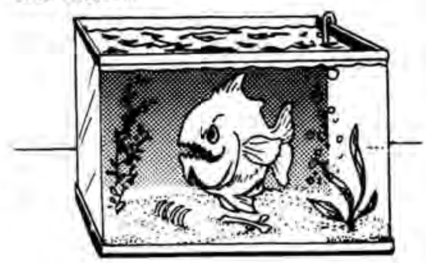
How might an electromagnet and a spring work together to make the hammer move?

activity 19

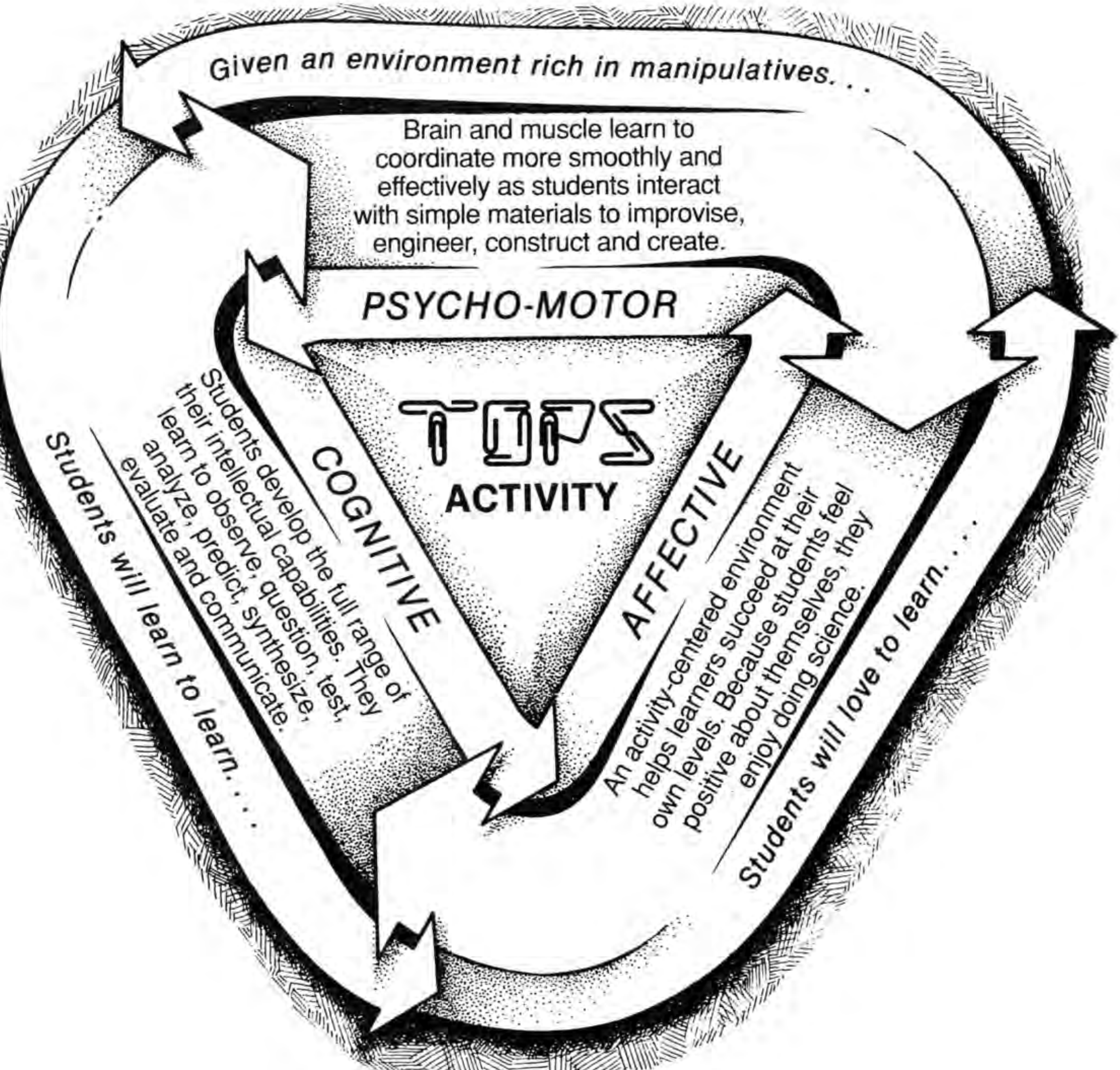
Will your on-off motor work without permanent magnets underneath the loop? Explain.

activity 20

Given a paper towel and two strong magnets, how could you wipe the algae off the inside of a piranha tank without putting your hands in the dangerous waters?



Long-Range Objectives



ACTIVITIES AND LESSON NOTES 1-20

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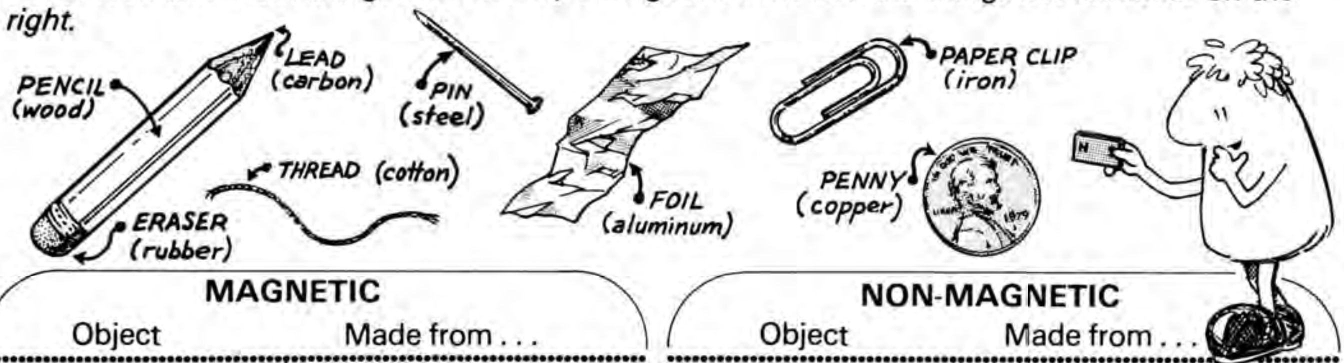
IS IT MAGNETIC?

1 Fill in each table. List things *attracted* by a magnet on the *left* and things *not attracted* on the *right.*



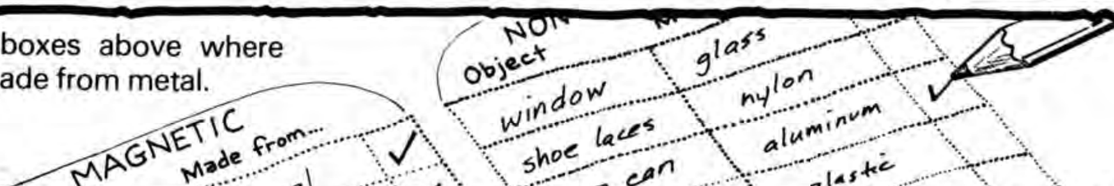
MAGNETIC

Object	Made from . . .	

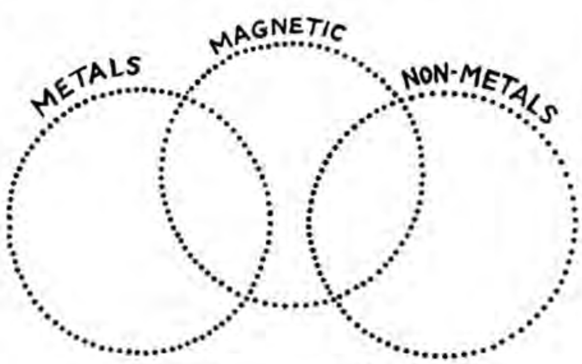
NON-MAGNETIC

Object	Made from . . .	

2 Check those boxes above where the object is made from metal.



3 Write the correct number in the correct space.



1 Cotton	**5 Steel**
2 Copper	**6 Aluminum**
3 Rubber	**7 Carbon**
4 Paper	**8 Iron**

4 Circle true or false. Then give a reason for your answer.

T F All metals are magnetic.

T F Some non-metals are magnetic.

T F Some metals are magnetic.

Objective

To recognize that only a few metals, like iron and steel, are magnetic, while most other metals and nonmetals are not.

Lesson Notes

To successfully teach this module you ***must*** have the right kind of magnets. Fortunately, the rectangular ceramic magnets you need are easy to get. You probably already have a few holding messages to your refrigerator door.

Buy ceramic magnets from science supply outlets, or electronics stores like Radio Shack, or from our TOPS catalog. These come in a variety of shapes and sizes. Some may have a hole in the center, others may be solid. A size about as large as the face of a postage stamp, or even a bit smaller, will work just fine.

ACTUAL SIZES:

Large traditional bar magnets or small circular ring magnets are ***not*** good substitutes.

Because these little magnets are relatively inexpensive, buy a bunch – at least 2 per student plus replacement extras – enough to accommodate your largest class. You can get by with less, of course, as few as 2 per activity group. But this will severely restrict individual involvement in the excitement of discovery learning.

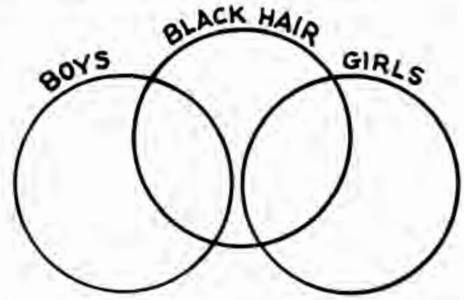
1-2. Be prepared for lots of questions: What is it? How do you spell it? What's it made from? In general, any magnetic object found in your classroom will probably contain ***iron***. Nickel and cobalt are the only other magnetic elements, but these are rare, and almost never found in concentrations large enough to be attracted to magnets.

Your students will also find magnetic things made from ***steel***. Steel is an alloy of iron. It is usually mixed with carbon (sometimes with other metals) to improve strength and hardness. Iron is seldom encountered alone as a chemically pure element.

Whether you say a paper clip is made from iron or steel is a question of semantics: how much carbon should iron have before you call it steel? One way to decide is to consider the metal's hardness. Greater amounts of carbon are alloyed with iron to produce harder steel. A relatively soft ***iron*** paper clip might be distinguished from a hardened ***steel*** pin on this basis. But this distinction is of little consequence; allow your students to interchange the terms iron and steel as they please.

Other questions that may arise: A tin can is magnetic not because it is made from tin. Rather, it is made from tin-plated iron (or steel). ***Ceramic*** magnets are magnetic not because they are made from a special sort of clay. They are made from iron oxide. Nickel as an element is magnetic, although the U.S. nickel coin (a 25% nickel, 75% copper alloy) shows no visible attraction to a magnet. Canadian nickels, however, are magnetic.

3. For classes that are unfamiliar with the logic of sets, draw these Venn diagrams, on your blackboard.



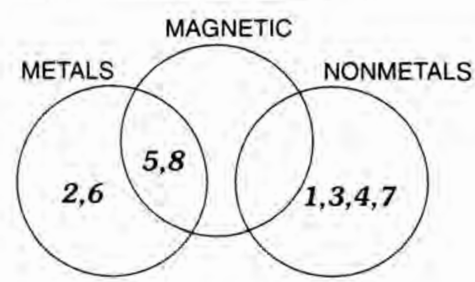
Have each student identify his or her position within the proper section of the proper circle. Where would you place a black wig? (In the center of the middle circle.) Where would you put a white wig? (Outside all three circles.) Where would you park a gray Studebaker?

Answers

1-2. Typical answers:

MAGNETIC Object:	Made from:	**NONMAGNETIC** Object:	Made from:
pin	steel ✔	pencil	wood
paper clip	iron ✔	eraser	rubber
nail	iron ✔	pencil lead	carbon (graphite)
scissors	steel ✔	thread	cotton
staple	iron ✔	foil	aluminum ✔
coat hanger	iron ✔	penny	copper ✔

3.



3. Ⓕ Copper and aluminum are metals, but nonmagnetic.
Ⓕ All nonmetals tested were nonmagnetic.
Ⓣ Iron and steel are examples of magnetic materials.

Materials

☐ Ceramic magnets. All activities in this module are specifically designed for small rectangular permanent magnets, often called ceramic magnets or sandwich magnets. (See opening paragraphs in the teaching notes above.) Purchase these on your local economy or order direct from TOPS. We will ship the quantity you specify and bill you our current catalog price plus shipping.

☐ A collection of objects to test for magnetic attraction. Be sure to include thread, aluminum foil and copper pennies; also paper clips, steel pins and other objects made from iron and steel.

Who are those TOPS folks, anyway?

Ronald Jay Marson graduated from Seattle Pacific University with a B.S. in Chemistry, and from Harvard University with an M.A.T. in Science Education. For three years he taught science and math, and supervised student teaching in Ghana, West Africa, as a Peace Corps volunteer. That's where idealism bumped into reality.

With ingenuity and wit, Ron made do with limited resources, using recyclables and local materials to teach his classes. Returning home, he refined his "science with simple things" approach while teaching at a boarding school in Utah.

Ron's rich and varied experience as an educator, his facility as an explainer of complex concepts, and his respect for the curiosity and native intelligence of children, all come together in his books.

As founder of TOPS Learning Systems, a non-profit educational corporation, Ron has provided quality education based on resources available to everyone. His goal as an educator is to nurture a love of learning as new generations become their own best teachers.

Ron stays refreshed running, backpacking, and engaging friends in deep and searching conversation.

Ron uses the humble paper clip in original hands-on activities. Peg illustrates all their creative manifestations. They met when he was looking for an artist to draw his paper-clip logo, and were soon linked for life. The Marsons planted a 17-acre forest to replace the trees used in their books.

Peg Nazari Marson was working as a free-lance artist and graphic designer when she met Ron in 1981. In her character-building, starving-artist years, she worked as a printer's assistant, apple packer, bank teller, telephone operator, legal secretary, teacher's aide, sign designer and woodworker. One of her all-time favorite jobs was tutoring at-risk high school students in language arts, math and science. She often incorporated diagrams and drawings to help her students understand connections and concepts. Illustrating TOPS lessons was a natural culmination of her work history.

When she's not busy drawing peoplets for TOPS, Peg works on her own art, and has had successful solo gallery exhibits. She paints and draws in a variety of subjects, media and styles, but especially loves colored pencil and watercolor. Learning to do her illustrations on a computer screen – using a mouse instead of a pen – was an ultimately satisfying challenge.

Peg rounds out her life growing flowers organically and struggling to keep weeds at bay in the lush Willamette Valley. She delights in spending time with her grown daughter, Leah, and awesome grandson Griffin.