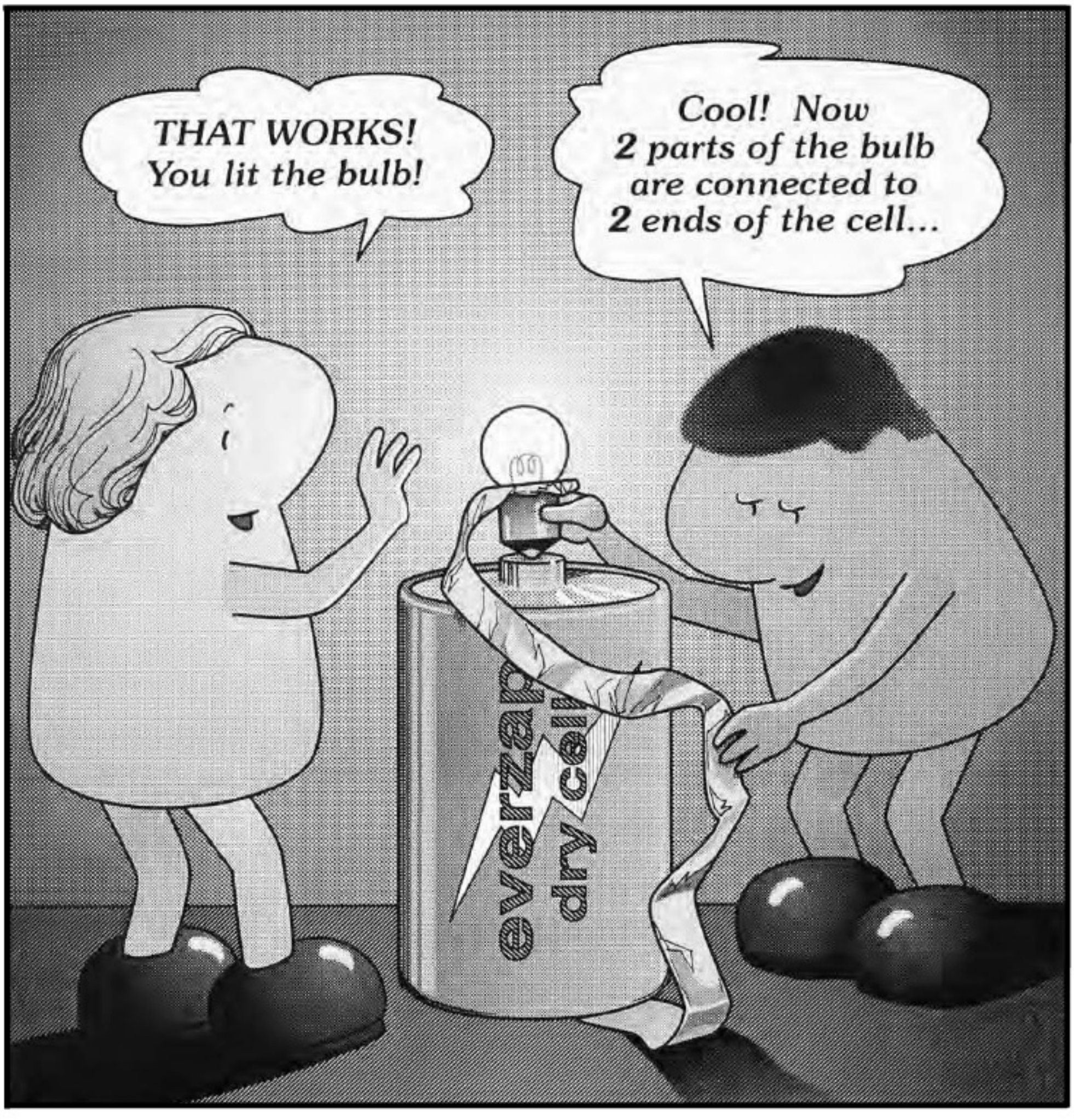
TOPS
LEARNING SYSTEMS

ELECTRICITY 32

20 structured activities
using simple things

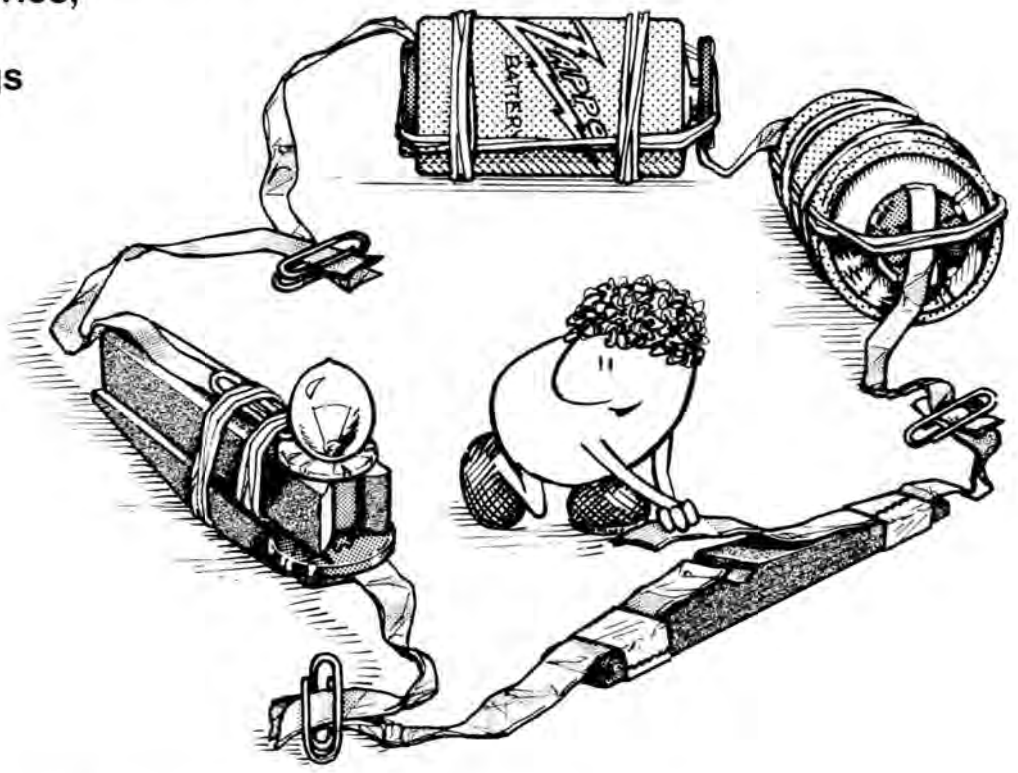
FOR GRADES 3–8



ACTIVITY SHEET SERIES

ELECTRICITY

with bulbs, batteries, foil, clothespins and simple things



SCIENCE WITH SIMPLE THINGS SERIES

Conceived and written by
RON MARSON

Illustrated by
PEG MARSON

TOPS LEARNING SYSTEMS

10970 South Mulino Road
Canby, Oregon 97013
Fax: (503) 266-5200
Website: topscience.org

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ISBN 978-0-941008-53-2

CONTENTS

PREPARATION AND SUPPORT

ACTIVITIES AND LESSON NOTES

SUPPLEMENTARY PAGES

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* (substituted materials) general on-the-shelf materials *optional materials

$Q_1/Q_2/Q_3$	
1 roll	masking tape, 3/4 inch wide – see teaching notes 1 for possible substitutions
1 box	aluminum foil, light duty OK
1 / 15 / 15	pairs of scissors
3 / 30 / 30	dry cells, size D, 1.5 volt
2 / 30 / 30	flashlight bulbs, 4.5 volt, designed for 3 size D dry cells, often marked PR 3. Bulbs with a "collar" (a protruding rim of metal below the bulb) will work better than screw-in kinds. It is important to use bulbs from the same manufacturer with the same resistance rating so they will shine equally bright See Teaching Notes 3 for an economical alternative.
1 box	paper clips
15 / 150 / 150	rubber bands: narrow, medium size are easiest to use
10 / 100 / 150	pennies
5 / 150 / 150	index cards, 3 x 5 inch preferable
1 / 2 / 3	paper punch tools
6 / 110 / 130	wooden spring-action clothespins
1 box	steel wool, unsoaped, fine grade, about as thick as human hair
1 / 10 / 30	straight pins: 1-inch steel pins
3 / 30 / 30	balloons, any size

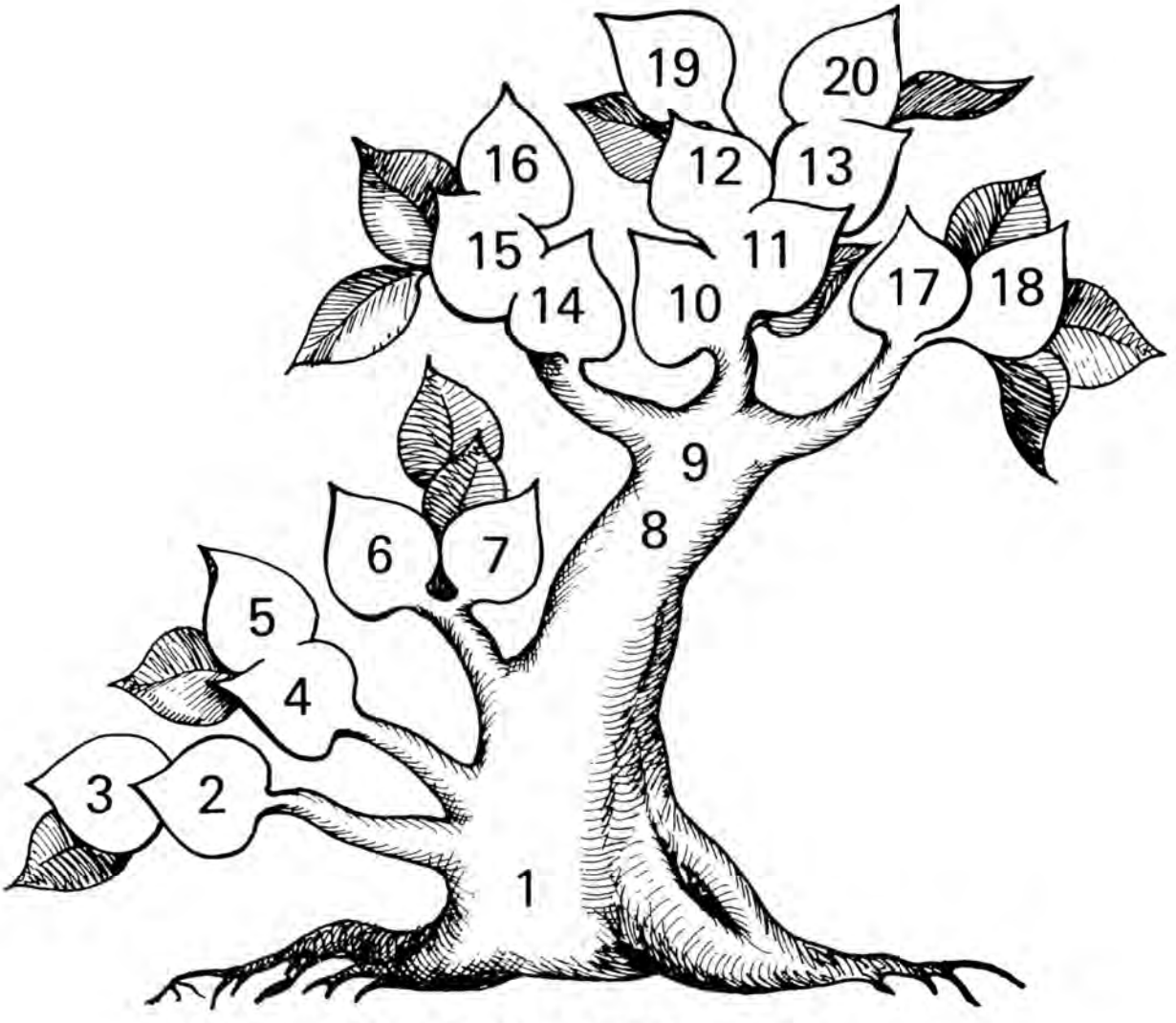
Sequencing Activities

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.

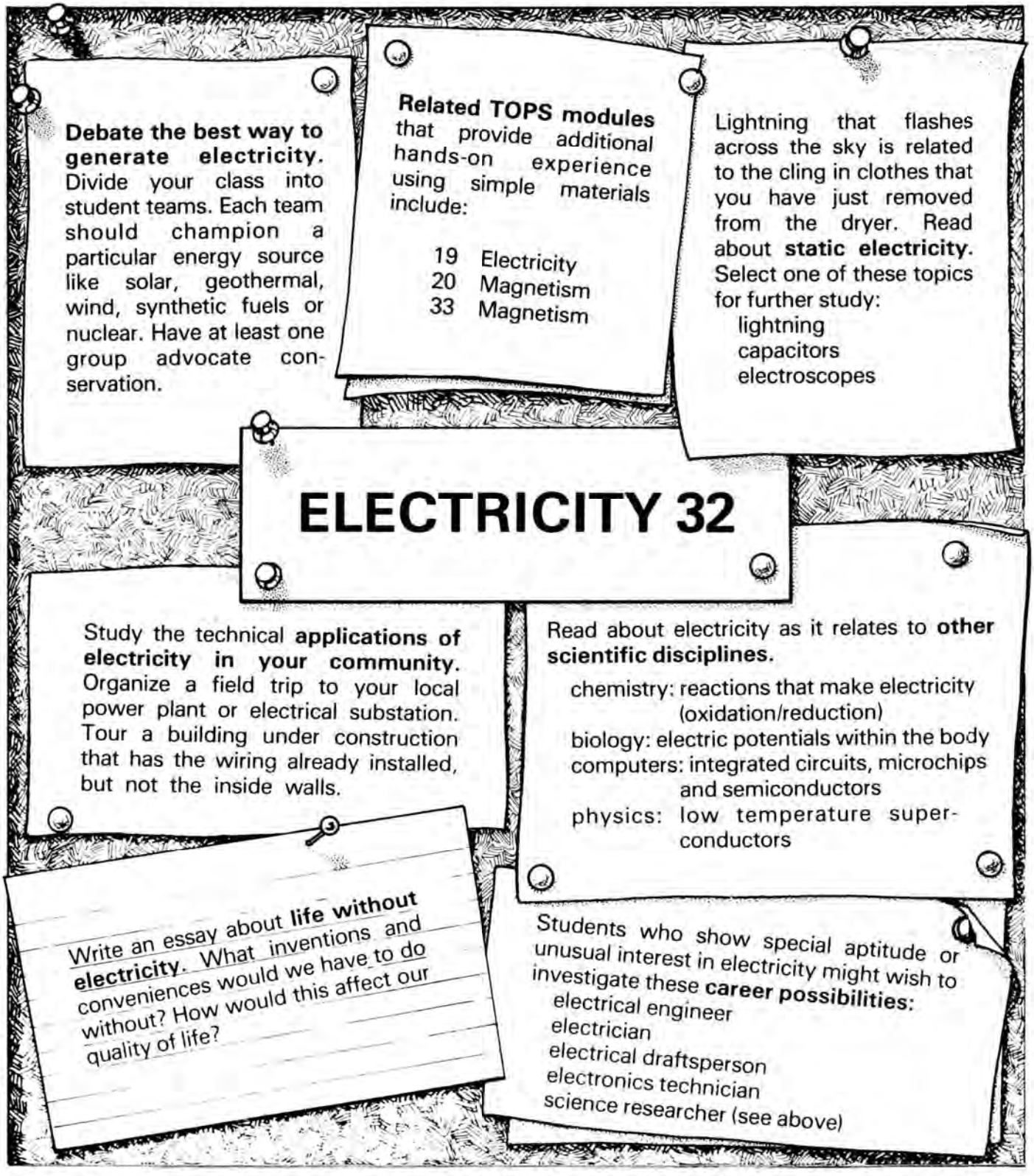
When possible, students should complete the activities in the same sequence as numbered. If time is short, however, or certain students need to catch up, you can use this logic tree to identify concept-related horizontal activities. Some of these might be omitted, since they serve to reinforce learned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



Review / Test Questions

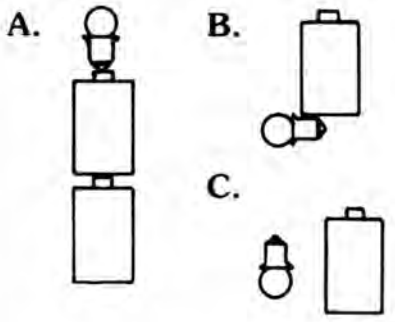
Photocopy these test questions. Cut out those you wish to use, and tape them onto white paper. Include questions of your own design, as well. Crowd them all onto a single page for students to answer on their own papers, or leave space for student responses after each question, as you wish. Duplicate 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

Draw a way to light a bulb with a dry cell. Draw another way that doesn't work.

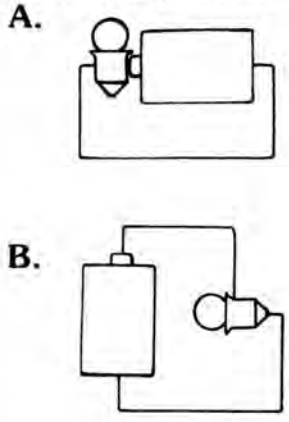
activity 2

Connect bulbs and dry cells with lines to show how to light each bulb.



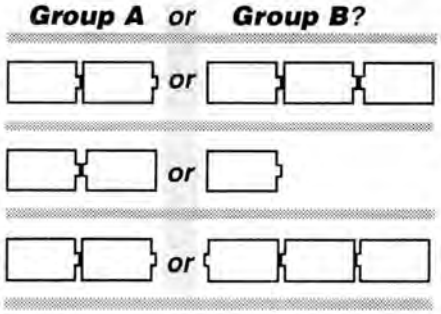
activity 3

Predict if these bulbs will light. Give a reason for each prediction.



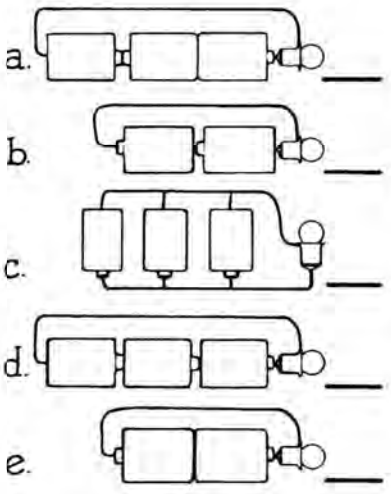
activity 4

Circle one group (A or B) to show which cells make a bulb shine brighter. Do this in all three rows of problems.



activity 5

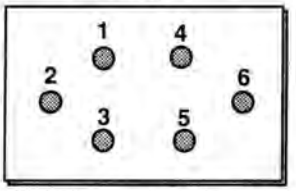
Number these 5 groups of cells by how bright they make the bulb shine. Write ***1*** in the blank next to the brightest, ***2*** for the next brightest, and so on.



activity 6

You have discovered a UFO (unidentified fallen object) in your back yard. You want to find out if it's a conductor or insulator of electricity. Use words and pictures to tell what you would do.

activity 7



a. A bulb lights with holes 1, 4 and holes 4, 5. Therefore the bulb *must* light with hole(s) _____ as well.

b. Hole 1 lights only with 2. Hole 2 therefore *cannot* light with holes _____.

activity 8a

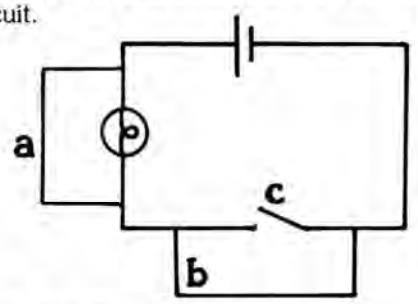
Which end of the dry cell is the positive pole? When you build a circuit, in what direction do the electrons flow?

activity 8b

Why must a circuit contact *both ends* of a dry cell to light the bulb?

activity 9

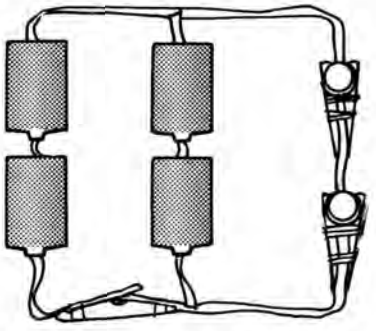
This circuit has a bypass at ***a***, another bypass at ***b***, and an open switch at ***c***. Circle all true sentences about this circuit.



1. The bulb lights if you close ***c***.
2. The bulb lights if you remove ***a***.
3. The bulb lights if you remove ***b***.
4. The bulb lights if you remove ***a*** and ***b***, then close ***c***.

activity 10

Redraw this circuit using the correct symbols. Use arrows to show how electrons flow through the circuit.



activity 11

Diagram this circuit:

1 cell + 1 switch
1 cell + 1 switch } in parallel
2 bulbs in series

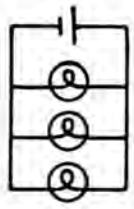
Use arrows to show how electrons should flow through the wire. You may use your electro-squares, if you wish.

Review / Test Questions, continued

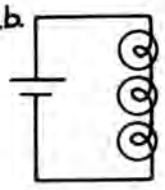
activity 12

Compare each pair of circuits. Circle the one that produces more light.

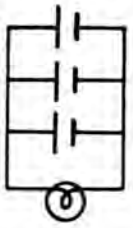
1a.



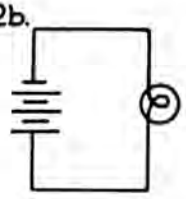
1b.



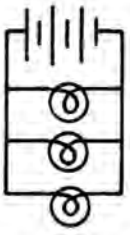
2a.



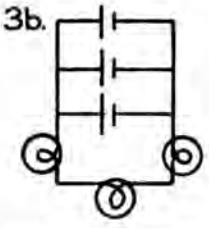
2b.



3a.



3b.

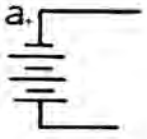


In which pair of circuits is the difference in the amount of light the greatest? Why?

activity 13

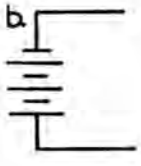
Add 3 bulbs and 3 switches to this circuit so you can turn off each light independently.

a.



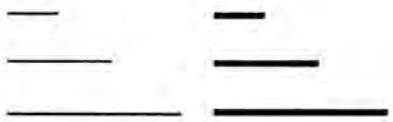
Add 4 bulbs to this circuit so that if you unhook any one bulb, another will go off but the remaining two will stay on.

b.



activity 14

Six copper wires, 3 thin and 3 thick, have different lengths as shown. *Circle* the wire with the greatest resistance. Draw a *box* around the wire with the least resistance.

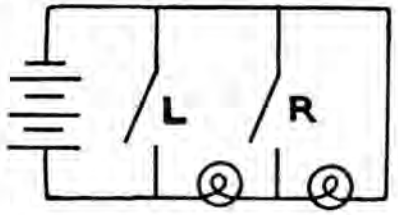


activity 15

To use less copper and thus save money, an electrician installs thinner copper wire in a home than the building code allows. Why is this a dangerous practice?

activity 16

Fill in the blanks with "on" or "off."



To make *both* lights shine, turn L _____ and R _____.

To make *one* light shine, turn L _____ and R _____.

To make *no* lights shine, turn L _____ and R _____.

activity 17

It's a hot summer evening. All the kitchen lights are on and the air conditioner is humming. You put your dinner in the oven and turn on the temperature control. Suddenly everything goes dark. What's wrong? What should you do?

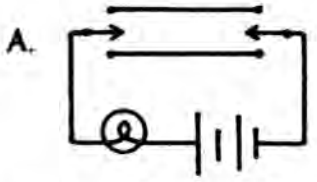
activity 18

Which steel wool fiber is more likely to get hot enough to pop a balloon, a thick strand or a thin strand? Explain.

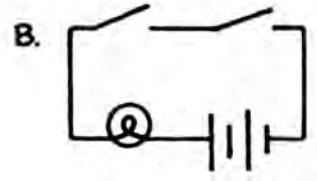
activity 19

Which kind of circuit is best to put at the top and bottom of a stairway, A or B? Explain.

A.



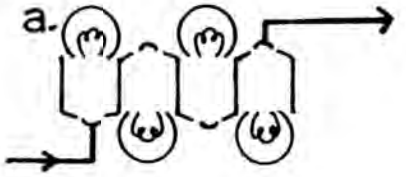
B.



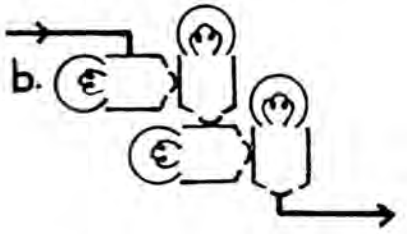
activity 20

Show how electricity flows through each set of bulbs. Indicate which bulbs shine.

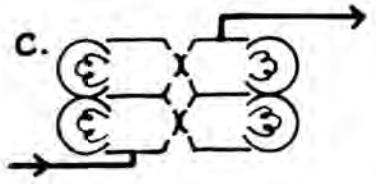
a.



b.

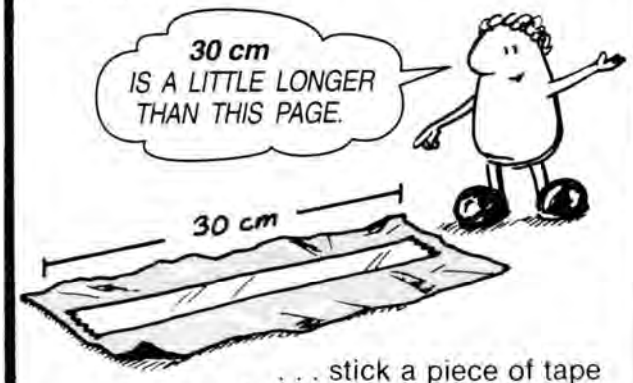


c.



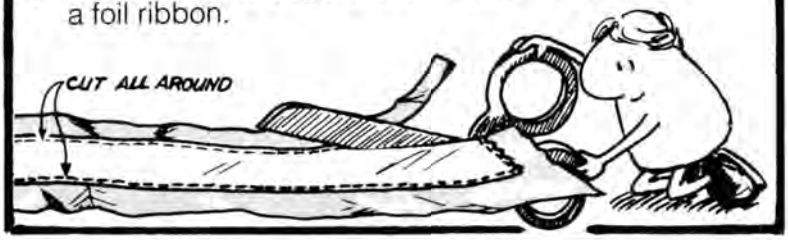
IT WORKS!

1 Make some wire from aluminum foil and tape. To do this . . .



. . . stick a piece of tape about 30 cm long to the *dull* side of a strip of aluminum foil.

2 Cut around the edge of the tape to make a foil ribbon.



3 Fold the ribbon along its length, so the shiny side stays out and the tape is folded inside.

4 Crease the fold along the edge of your table.

5

6 Use this foil ribbon to light a bulb with a dry cell.

7 Using pictures like these, draw how you made the bulb light. Also draw a way you tried that didn't work.

This works:

This doesn't:

8 Tape your name to your dry cell. You will use it during this whole module on Electricity.

CONSERVE ENERGY:
make your dry cell last!

Objective

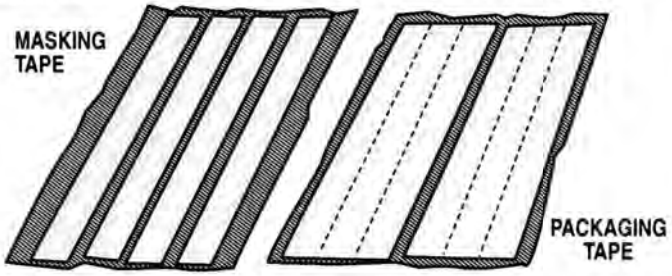
To discover by trial and error how to light a bulb with a dry cell and foil ribbon.

Lesson Notes

The foil conducting ribbons used in these lessons are strong, flexible, tangle-proof, and much easier for young children to use than copper wire. Using paper clips with the ribbons, students make secure connections when they build circuits. A completed circuit that is supposed to turn on, turns on – the first time!

1-2. Some students may cut the foil into strips before they apply the tape. This doesn't work. They'll create a mess and have to start over. If you wish to avoid students handling (or mishandling) strips of sticky tape altogether, you can pretape the foil yourself, and have them simply cut out the strips.

Most any kind of tape will work. We recommend that you use ¾ inch masking tape, which folds into convenient ⅜ inch width conducting strips. Alternatively, apply 2 inch packaging tape to the foil and divide it into 3 separate strips.



3. Aluminum foil conducts electricity, but tape does not. If your students fold the strip with the tape on the outside, they'll end up with a useless strip of non-conducting ribbon. This is less likely to happen if you supply opaque or colored tape; even young children usually guess that the shiny foil side is the "working" part of the ribbon.

But what happens if your students stick clear tape to the foil? They can't see it, so may accidently fold the nonconducting side out. To avoid this, step 1 asks students to apply tape to the *dull* side of the foil, while step 3 directs them to fold the *shiny* side (untaped) to the outside.

6. It may seem surprising that students of high school age, and even adults, don't generally know how to light the bulb. They usually need to do a lot of trial and error investigating. Such exploratory activity is, of course, ideal. Don't be too quick to come to the aid of puzzled students.

Younger students, however, may become frustrated beyond their ability to cope. Help them out by twisting the foil ribbon around the top of the bulb collar (see step 1 of activity 4). With this connection in place, your younger scientists will soon discover the other connections and light the bulb.

Sometimes students complain of being "shocked". Electricity produced by size D cells is totally safe, not strong enough to harm anyone. What they actually feel is the heat generated through the ribbon when it inadvertently connects both poles of the cell. Without a light bulb providing resistance, electron flow is great enough to heat up the ribbon.

Caution students to disconnect these "hot" wires immediately, since they quickly drain the cell of its energy.

ENERGY DRAINING "HOT" WIRE

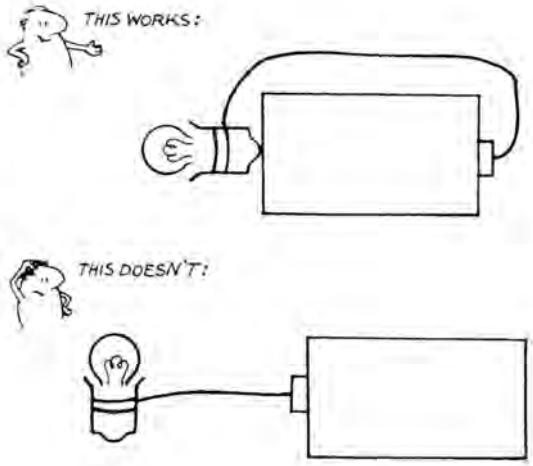
7. There are many different ways to light a bulb with a cell and wire. Your students will discover many of these variations in activities 1-3.

It's conceptually important to clearly indicate how the contact points on the bulb and cell are interconnected. Watch out for drawings where the bulb looks like an undifferentiated blob, the cell like a box, and the foil ribbon like a railroad track. Refer your students to the schematic drawings provided.

8. This step is optional but recommended. If your students understand that they must continue to use their own cells throughout the entire module, they will more readily conserve energy. Remind them again to immediately disconnect energy-draining hot wires.

Answers

7.



Materials

☐ Aluminum foil. Pre-cut rectangles about 30 cm long. See lesson note 1-2.

☐ Masking tape or packaging tape (opaque is desirable. See notes 1-2 and 3.

☐ Scissors.

☐ Size D dry cells (1.5 v), one per student. If fresh, they should last for this entire unit.

☐ Flashlight bulbs, one per student. Use a size designed for 3 dry cells, or 4.5 volts. It may be marked PR 3. It is important to use bulbs from the same manufacturer with the same resistance rating so they will shine equally bright – a requirement for later activities.

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.

TOPS Learning Systems is a nonprofit educational corporation. Our purpose is to create the highest quality, friendliest, hands-on learning activities you'll find anywhere, and to make them available everywhere, cheap!

We offer over 40 books as wonderfully creative as this one, covering a wide range of topics in science, math, and classroom management.

Visit us at **www.TOPScience.org** for a **free sample activity** based on each of our titles.