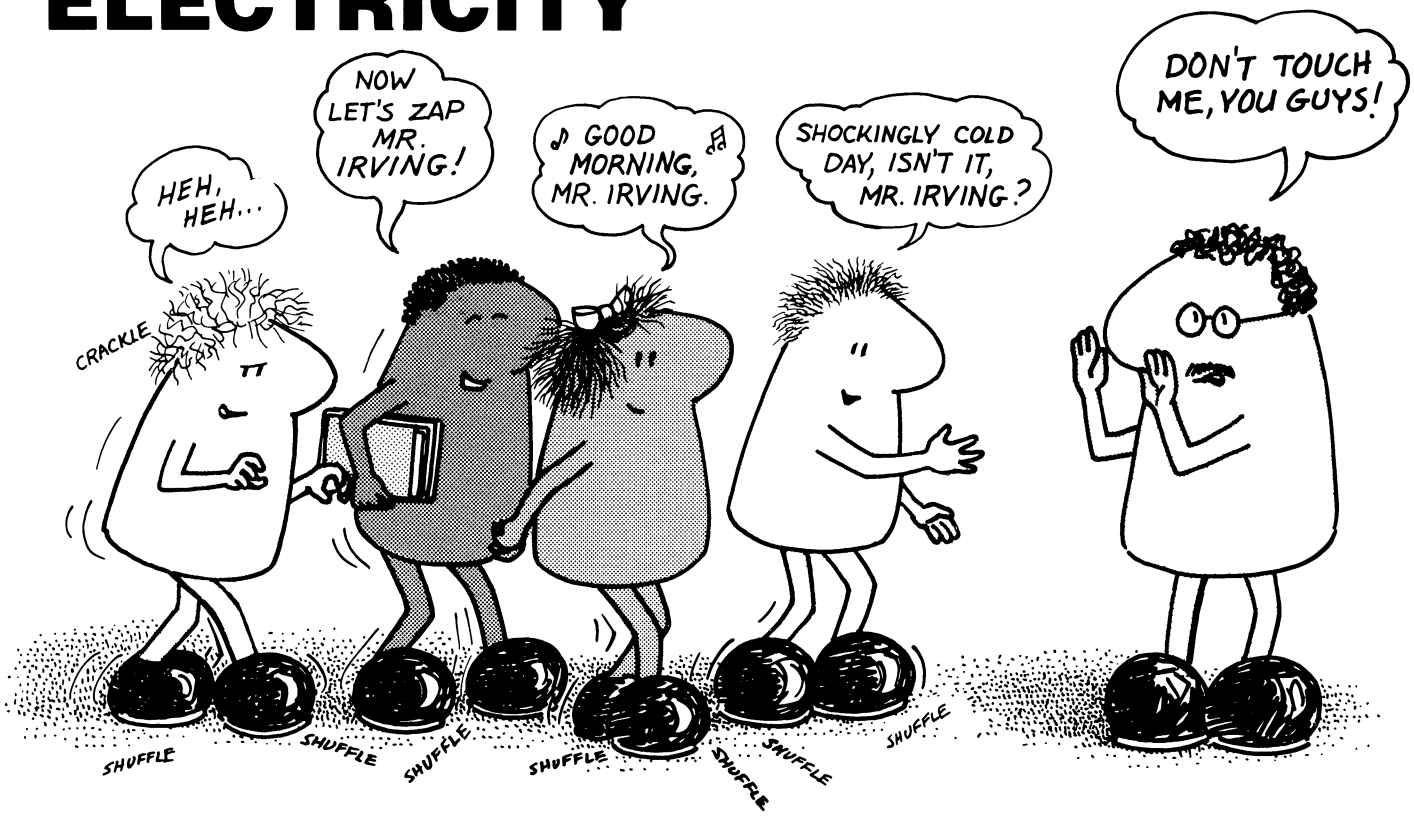
ELECTRICITY



TASK CARD SERIES

Conceived and written by
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TOPS LEARNING SYSTEMS

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CONTENTS

INTRODUCTION

TEACHING NOTES

REPRODUCIBLE STUDENT TASK CARDS

Gathering Materials

Listed below is everything you'll need to teach this module. You already have many of these items. The rest are available from your supermarket, drugstore and hardware store. Laboratory supplies may be ordered through a science supply catalog. Hobby stores also carry basic science equipment.

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

special in-a-box materials:	general on-the-shelf 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 the next time you teach this module.	Normal type suggests that these materials are common. 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.
(substituted materials):	*optional materials:
A parentheses following any item suggests a ready substitute. These alternatives may work just as well as the original, perhaps better. 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 the extra trip, 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 student activity under the heading "Extensions." Materials for these optional experiments are listed neither here nor in the teaching notes. Read the extension itself to find out what new materials, if any, are required.

Needed 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

1/1/1	spool thread
2/30/30	*squares of 10 x 10 cm silk cloth*
1/5/5	rolls masking tape
1/15/15	pairs of scissors
2/30/30	styrofoam cups (blocks of polystyrene)
3/30/30	*size-D dry cells*
10/100/100	*meters bare copper wire, 24 gauge or thinner*
1/6/6	pliers with wire cutting jaws
10/120/130	pennies
2/30/30	*0.27 amp, 2.33 volt light bulbs - see notes 3*
2/30/30	straight plastic straws
10/200/200	medium or heavy duty rubber bands
1/1/1	box steel straight pins
1/5/15/	tin cans
1/15/15	*galvanized nails, about 7 cm or 2 1/2 inches*
1/2/2	rolls aluminum foil
1/3/6	paper punches
5/120/120	clothespins
1/4/4	boxes paper clips
1/15/15	metric rulers
1/15/15	plastic produce bags
1/4/8	meter sticks
3/60/60	*meters (or more) insulated 32 gauge wrapping wire — see notes 19*
2/30/30	baby food jars
1/15/15	ceramic magnets, 1 x 3/4 x 1/8 inch — see notes 19
1/1/1	box steel wool; fine-grade, unsoaped
2/30/30	index cards
1/1/1	*box — a source of corrugated cardboard
.1/2/2	*liters 5% hydrochloric acid
1/15/15	*100 mL beakers (baby food jars)
1/10/15	small test tubes
.1/2/2	liters saturated baking soda solution
1/5/5	box matches
2/30/30	paper towels
1/5/15	*plates or petri dishes
1/1/1	bottle 3% hydrogen peroxide dispensed in smaller dropping bottles
6/30/90	*split-shot lead fishing sinkers*
.1/2/2	liters saturated salt water solution
1/5/15	*capacitors rated .1 farad or greater - see teaching notes 32*
.1/2/2	cups of oil-based clay
2/10/30	*100 Ω resistors rated at 1/4 or 1/2 watt*
1/5/15	*commercial galvanometers — used in activities 32, 35 and 36*
1/1/1	bottle vinegar
1/5/15	washers

Sequencing Task Cards

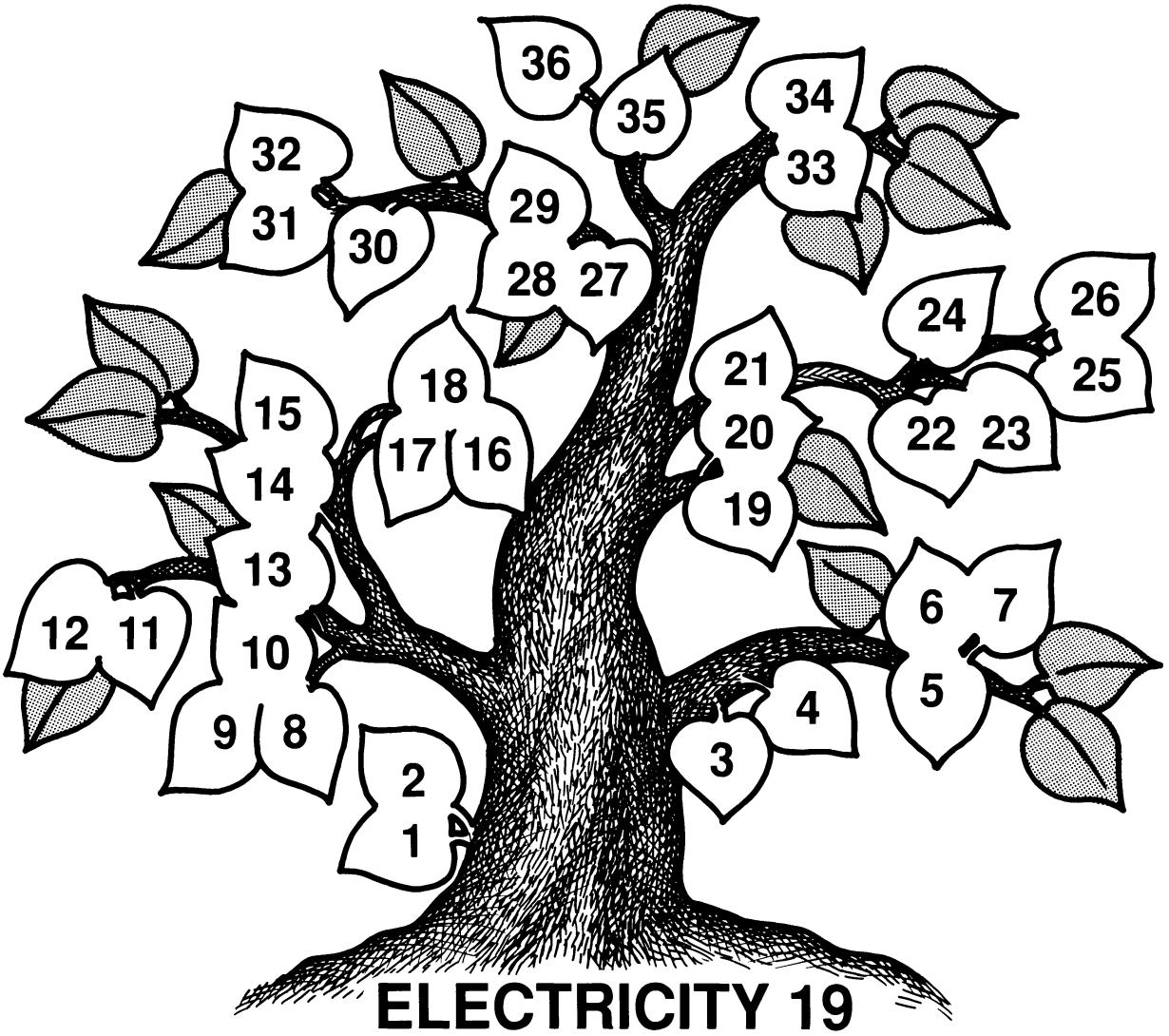
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

At the teacher's discretion, certain activities can be omitted or sequences changed to meet specific class needs. The only activities that must be completed in sequence are indicated by leaves that open *vertically* into the ones above them. In these cases the lower activity is a prerequisite to the upper.

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

On the other hand, if students complete all the activities at a certain horizontal concept level, then experience difficulty at the next higher level, you might go back down the logic tree to have students repeat specific key activities for greater reinforcement.

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 task card allow you total flexibility. They are left blank so you can pencil in sequence numbers of your own choosing.



ELECTRICITY 19

Review / Test Questions

Photocopy the questions below. On a separate sheet of blank paper, cut and paste those boxes you want to use as test questions. Include questions of your own design, as well. Crowd all these questions onto a single page for students to answer on another paper, 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 review in preparation for the final exam.

tasks 1-2

Rubbing a balloon against your shirt sleeve removes electrons from the sleeve and transfers them to the balloon. How is each object now charged, and how will they now interact?

tasks 1-2

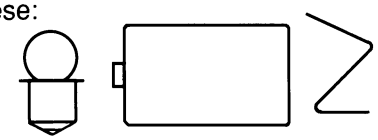
a. Why does clothing cling together when taken from an automatic dryer?
b. A scarf removed from the same dryer tends to puff out rather than hang limp. Explain.

tasks 2-3

How does a dry cell manage to push electrons through a wire?

task 3

a. Diagram how to light 1 bulb with 1 dry cell and 1 wire. Use drawings like these:



b. Draw a similar diagram showing how to light 2 bulbs with 1 dry cell and 1 wire.

tasks 3-4

Design an experiment to prove that liquid mercury is a conductor of electricity.

task 4

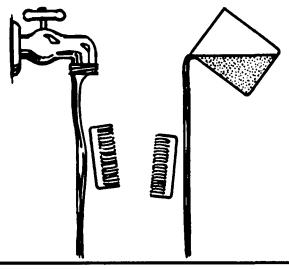
Is the black ceramic material on a bulb, separating its collar from its end contact point, an insulator or conductor? Explain how you know.

tasks 5-7

A negatively charged balloon is brought close to a tiny ball of neutral aluminum foil resting on a table. Predict how these will interact, giving reasons for your answer.

task 6

A stream of water will bend near a charged comb, but a stream of oil is hardly attracted at all. How might molecules of oil be different from molecules of water?



tasks 8-10

Suppose that you wire together 2 cells, a switch and a bulb into a simple circuit. Then you find that the bulb fails to light when you close the switch.
a. What might be wrong with the bulb holder?
b. What might be wrong with the cells?
c. What might be wrong with the switch? How could you use a single piece of wire to test if the switch was really at fault?

tasks 11-12

How would you use a syringe filled with water connected to a tube to show the relationship between...
a. current and voltage?
b. current and resistance?

task 12

A dry cell operating at 1.3 volts lights a bulb with a resistance of 6.5 ohms. How much current flows through the bulb?

tasks 13-15

Diagram the following circuits. Use appropriate symbols to represent the bulbs, cells, wires and switches.
a. A bulb, dry cell and switch wired in series.
b. Two cells in parallel wired to two bulbs in parallel.
c. Two cells in series wired to three bulbs in parallel, with a switch wired in series to each bulb.

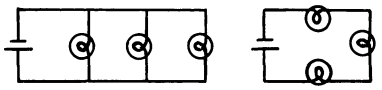
task 14

Why do electricians wire houses in parallel rather than in series?

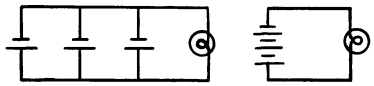
task 15

Compare each pair of circuits. Decide if the left or the right gives more light.

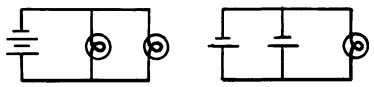
a.



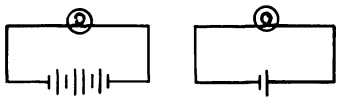
b.



c.



d.



task 16

Diagram a circuit with a double-throw switch that lights just one of two bulbs, but not both at the same time.

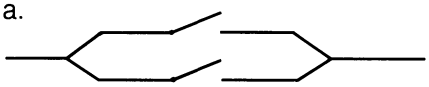
task 17

Diagram how you would wire a stairway switch to independently turn the light on or off at both the top and bottom of a stairway.

task 18

Name each switch configuration. Then match each to its most appropriate function defined below.

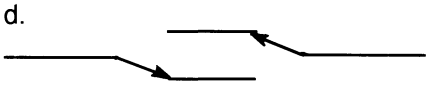
a.



b.

c.

d.



w. Electronically unlocks a high security prison door.
x. Fully controls a yard light from the garage or the house.
y. Smoke detector alarm switches activate a common warning buzzer.
z. Transfers power from a main line to an emergency backup.

task 19

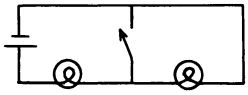
You are given an old dry cell, insulated wire and a compass. Using only these materials, tell how to determine whether the dry cell is dead or alive.

tasks 20, 30

A certain dry cell has terminals with no identifying marks to distinguish positive from negative. How would you use your galvanometer and another normal dry cell to identify the polarity of these terminals?

tasks 21-22

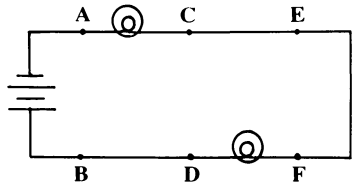
What happens as you flip the switch? Explain.



Review / Test Questions (continued)

tasks 21-22

Which lights will short out if you stretch a wire...
a. across AB?
b. across CD?
c. across EF?



tasks 23, 34

Explain how to connect two or more 10 Ω resistors together to equal each resistance. Show your math.
a. 20 Ω.
b. 30 Ω.
c. 5 Ω.
d. 15 Ω.
e. 2 Ω.

task 24

Explain how fuses protect electrical components in a car against damage. Why is it important to use fuses with the correct ampere rating?

task 25

The leaves of an electroscope separate when charged, then slowly come together. Explain why this happens.

task 25

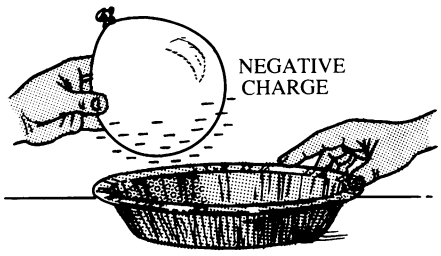
Appliances and tools are often grounded with a third prong. How does this guard against electric shock?

task 26

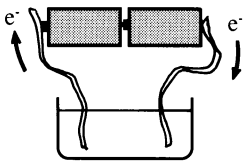
The leaves on an electroscope are spread apart. How could you determine whether they are charged positive or negative?

task 26

A pie plate is grounded in the presence of a negatively charged balloon. How is it now charged? Explain.



task 27



Foil ribbons are connected to 2 dry cells and put into a beaker of weak hydrochloric acid. What gas forms on the right ribbon? The left ribbon? Explain.

task 28

Describe how to capture the gas given off by an Alka-Seltzer tablet dissolving in water.

task 27-29

a. Describe this chemical reaction in words: $HCl \rightarrow H^+ + Cl^-$.
b. Balance this anode reaction:
$Cl^- \rightarrow Cl_2\uparrow + e^-$.
c. Write a balanced reaction to show the electrolysis of hydrogen ions to hydrogen gas at the cathode.

task 29

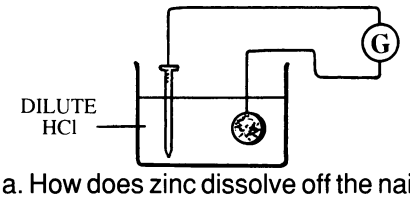
Write a balanced chemical equation for the electrolysis of water.

tasks 28-29

Why does an explosion occur when hydrogen and oxygen are ignited? Where did this energy come from?

task 30

A galvanized zinc nail and a copper penny are wired to a galvanometer and placed in a solution of dilute hydrochloric acid. The galvanometer needle deflects, registering current.



a. How does zinc dissolve off the nail?
b. Why do bubbles form on the penny?
c. Which way do electrons drift through this circuit?

task 30

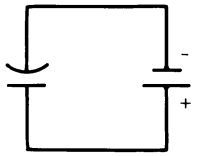
Using only a penny, an iron washer, and a piece of paper towel soaked in dilute acid, describe how you might make electricity flow through a galvanometer.

task 31

Suppose you want to recharge your car battery. Would you connect it in series or in opposition to your charger? Explain.

task 32

a. A dry cell charges a capacitor in a simple circuit. Which side of the capacitor is positive and which side is negative? Explain.



b. Diagram how to use a double-throw switch so it will charge the capacitor and then discharge the stored energy into a flash bulb.

tasks 33-34

If 20 mA of current deflects the tip of a galvanometer needle through an arc of 3 mm, how far will the same needle be deflected by 100 mA of current?

tasks 33-34

How would you convert a galvanometer into a sensitive ammeter?

tasks 32, 35

Discuss the transformation of energy in each device:
a. A hand cranked generator.
b. A storage battery.
c. An electric motor.
d. A capacitor.
e. A flash bulb.

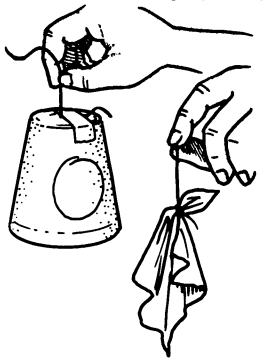
task 36

How is the distance between a cell's negative and positive terminal related to...
a. its internal resistance?
b. its current output?

Task Objective (TO) understand electrostatic attraction between objects as a transfer of electrons.

TRANSFERRING ELECTRONS ○

Electricity ( )



1. Tie thread to a 10 x 10 cm patch of silk; tape thread to the bottom of a styrofoam cup.
2. Draw a target circle on the cup. Rub it hard and vigorously with the silk cloth. (This removes electrons from the silk and adds them to the styrofoam.)
3. Hold each object by its thread. Bring one near the other.
   a. Write your observations.
   b. What is the charge on each material? (Remember that electrons are negative.)
4. A charged surface is neutralized (equalized) by touching it or breathing water vapor on it.
   a. Experiment by charging, then neutralizing your silk-styrofoam system. How can you tell this really happens?
   b. How do electrons move so that each charged object is neutralized?
   (Save your silk and styrofoam.)

Answers / Notes

3a. The silk cloth and styrofoam cup are mutually attracted.
3b. Electrons are removed from the silk, so it is positive. Electrons are added to the styrofoam, so it is negative.

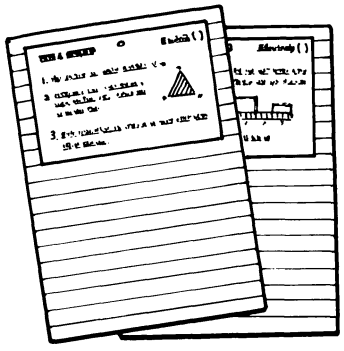
4a. When charged, the cloth and cup cling together. When they are neutralized, there is little or no mutual attraction.
4b. Electrons transfer *from* the negative sytrofoam cup *to* your hands or water vapor. Just the opposite happens with the positive silk cloth: electrons transfer *from* your hands or water vapor to the cloth.

Materials

- ☐ Thread.
- ☐ A 10 cm x 10 cm square of silk.
- ☐ Masking tape.
- ☐ Scissors.
- ☐ A cup or other object made from styrofoam (polystyrene).

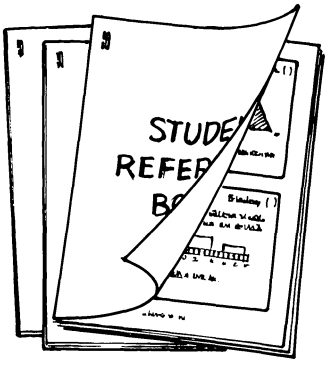
Task Cards Options

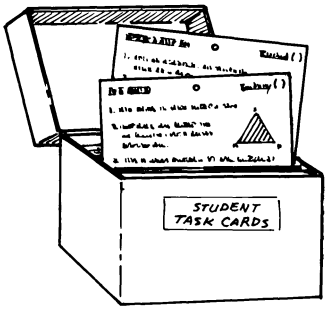
Here are 3 management options to consider before you photocopy:



1. Consumable Worksheets: Copy 1 complete set of task card pages. Cut out each card and fix it to a separate sheet of boldly lined paper. Duplicate a class set of each worksheet master you have made, 1 per student. Direct students to follow the task card instructions at the top of each page, then respond to questions in the lined space underneath.

2. Nonconsumable Reference Booklets: Copy and collate the 2-up task card pages in sequence. Make perhaps half as many sets as the students who will use them. Staple each set in the upper left corner, both front and back to prevent the outside pages from working loose. Tell students that these task card booklets are for reference only. They should use them as they would any textbook, responding to questions on their own papers, returning them unmarked and in good shape at the end of the module.

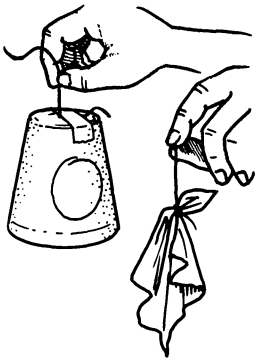




3. Nonconsumable Task Cards: Copy several sets of task card pages. Laminate them, if you wish, for extra durability, then cut out each card to display in your room. You might pin cards to bulletin boards; or punch out the holes and hang them from wall hooks (you can fashion hooks from paper clips and tape these to the wall); or fix cards to cereal boxes with paper fasteners, 4 to a box; or keep cards on designated reference tables. The important thing is to provide enough task card reference points about your classroom to avoid a jam of too many students at any one location. Two or 3 task card sets should accommodate everyone, since different students will use different cards at different times.

TRANSFERRING ELECTRONS ○

Electricity ( )



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   b. What is the charge on each material? (Remember that electrons are negative.)
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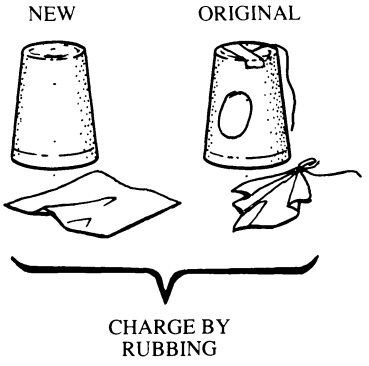
   a. Experiment by charging, then neutralizing your silk-styrofoam system. How can you tell this really happens?
   b. How do electrons move so that each charged object is neutralized?
   (Save your silk and styrofoam.)

LIKE / UNLIKE CHARGES ○

Electricity ( )



1. Get another styrofoam cup and silk patch to use with your original pair tied to threads.
2. Charge each system, then describe these interactions.
   a. Hold *cup* by thread, then bring *cloth* near.
   b. Hold *cup* by thread, then bring *cup* near.
   c. Hold *cloth* by thread, then bring *cup* near.
   d. Hold *cloth* by thread, then bring *cloth* near.
3. Summarize your findings into a general rule.
4. Examine the labeling on a dry cell.
   a. Which end produces electrons? Which end has a deficit? Explain.
   b. *Predict* what will happen if you connected the ends (terminals) with a wire. Use your results from step 3 to support your answer.
   c. Test your prediction, but for no longer than 5 seconds. (This *short circuit* rapidly drains the cell of energy.) What did you observe?