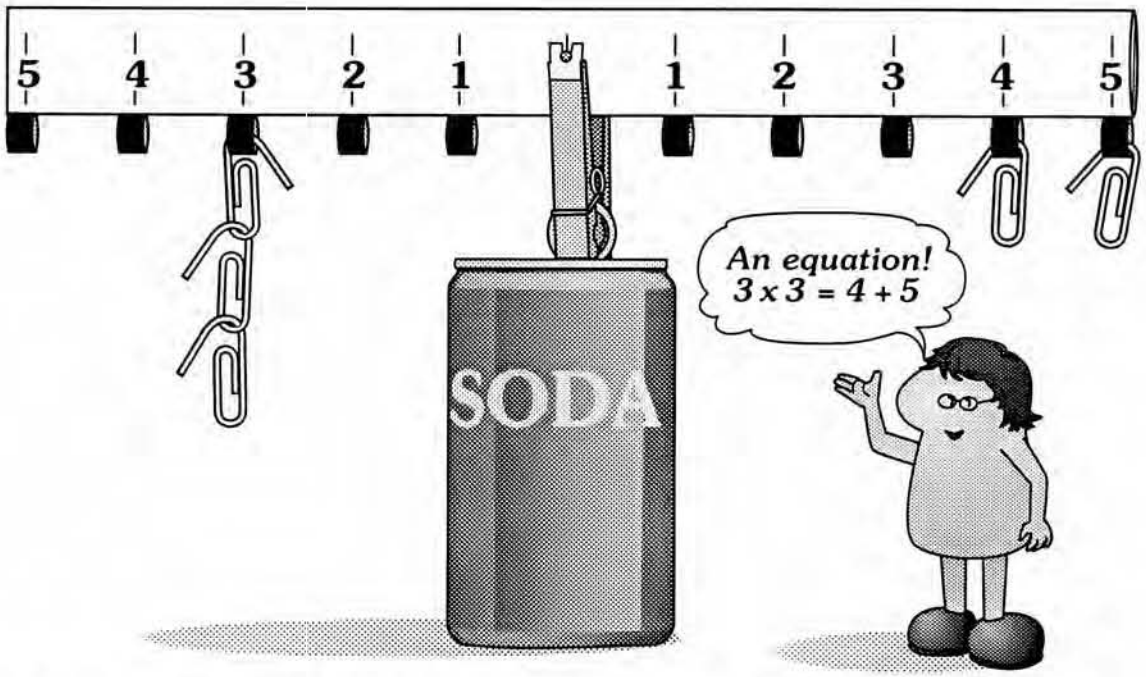
PERFECT BALANCE

Inquiry through
science, math and
technology



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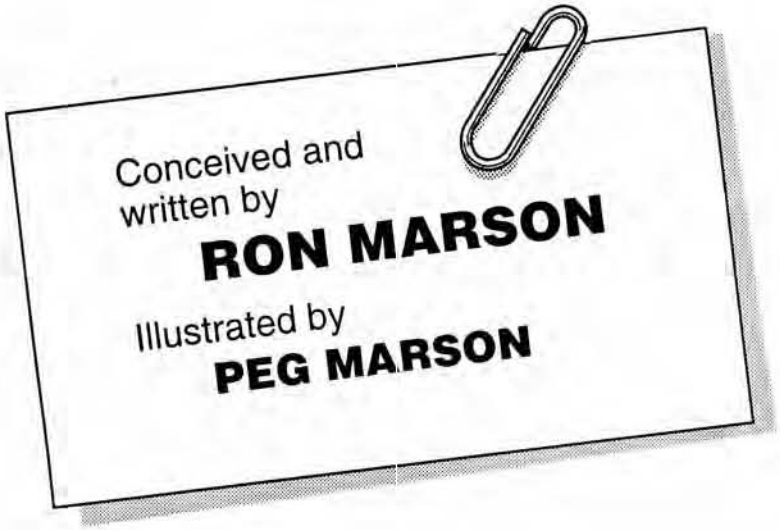

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CONTENTS

PREPARATION AND SUPPORT

ACTIVITIES AND LESSON NOTES

SUPPLEMENTARY CUTOUTS

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.

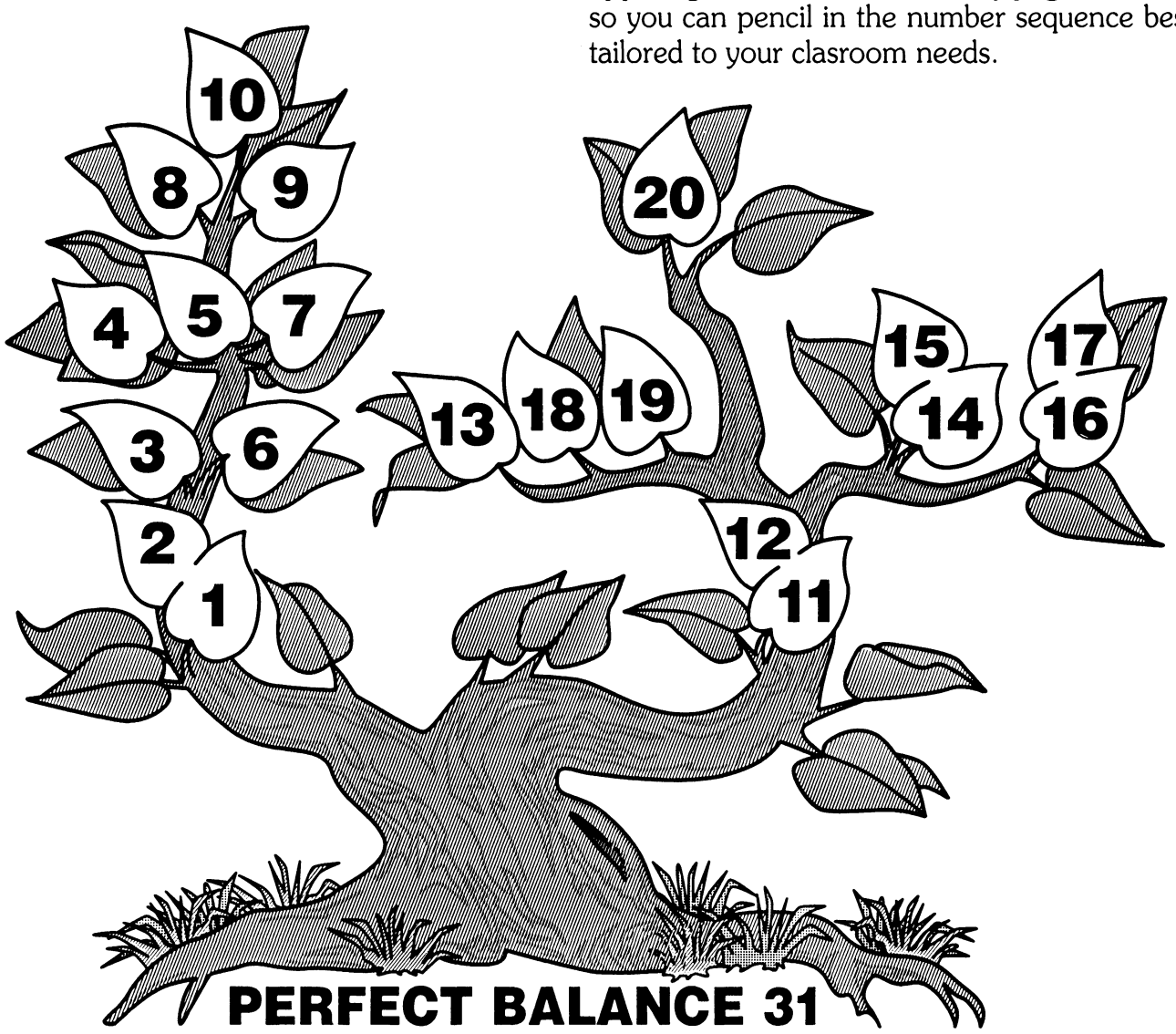
KEY: *special in-a-box materials* (substituted materials) general on-the-shelf materials *optional materials

$Q_1/Q_2/Q_3$	
1/15/15	scissors
1 roll	clear tape
1 roll	masking tape
1/15/15	spring-action clothespins
various	("pincushion" material: small styrofoam cups, foam "packing peanuts," corrugated cardboard, corks or clothespins – see teaching notes 10)
1 pkg	straight pins, 1 inch or 2.5 cm – choose steel pins if you plan to teach TOPS magnetism units
1/15/15	pop-top soda cans with attached finger tabs (small beverage bottles) – see teaching notes 2, step 3
3/30/30	paper clips, boxes of 100, standard size - only 3 boxes needed if you do Activity 20 as a teacher demonstration – we used Acco #1 paper clips – see teaching note 13
1/15/15	cups sand (gravel, beans, or other ballast material) – see teaching notes 2, step 7
1/1/1	lump modeling clay
1/4/15	index cards, standard 3 x 5 inch
10/40/150	thumbtacks (pushpins) that are heavier than your paper clips
1 pgk each	popcorn, lentils, long-grained rice
1/10/15	calculators
1/4/15	objects to weigh: post-1982 pennies, nickels, notebook paper
various	(other objects to weigh – see teaching notes 14, step 2)
1 bag	pinto beans
1/1/1	bowl (margarine tub or equivalent)

Sequencing Activities

This logic tree shows how all 20 activities tie together. In general, students begin at the tree trunk and work up through the related branches. Lower level activities support higher ones. Leaves that open vertically into higher leaves form logical pairs that belong together. Horizontal activities cover similar concepts that you can teach or skip.

Perfect Balance covers a broad range of content areas. Select those topics below that fit your syllabus, then use this logic tree to create your own scope and sequence. Parentheses in the upper right corner of each activity page are blank so you can pencil in the number sequence best tailored to your clasroom needs.



SCIENCE

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- grams: extension 15

Mass and Density: extensions 14 and 15

Metrics: extension 15

MATH

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- weight and number: 19

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- bar graph distribution: 17
- asymptotic: 20

Statistics: 17

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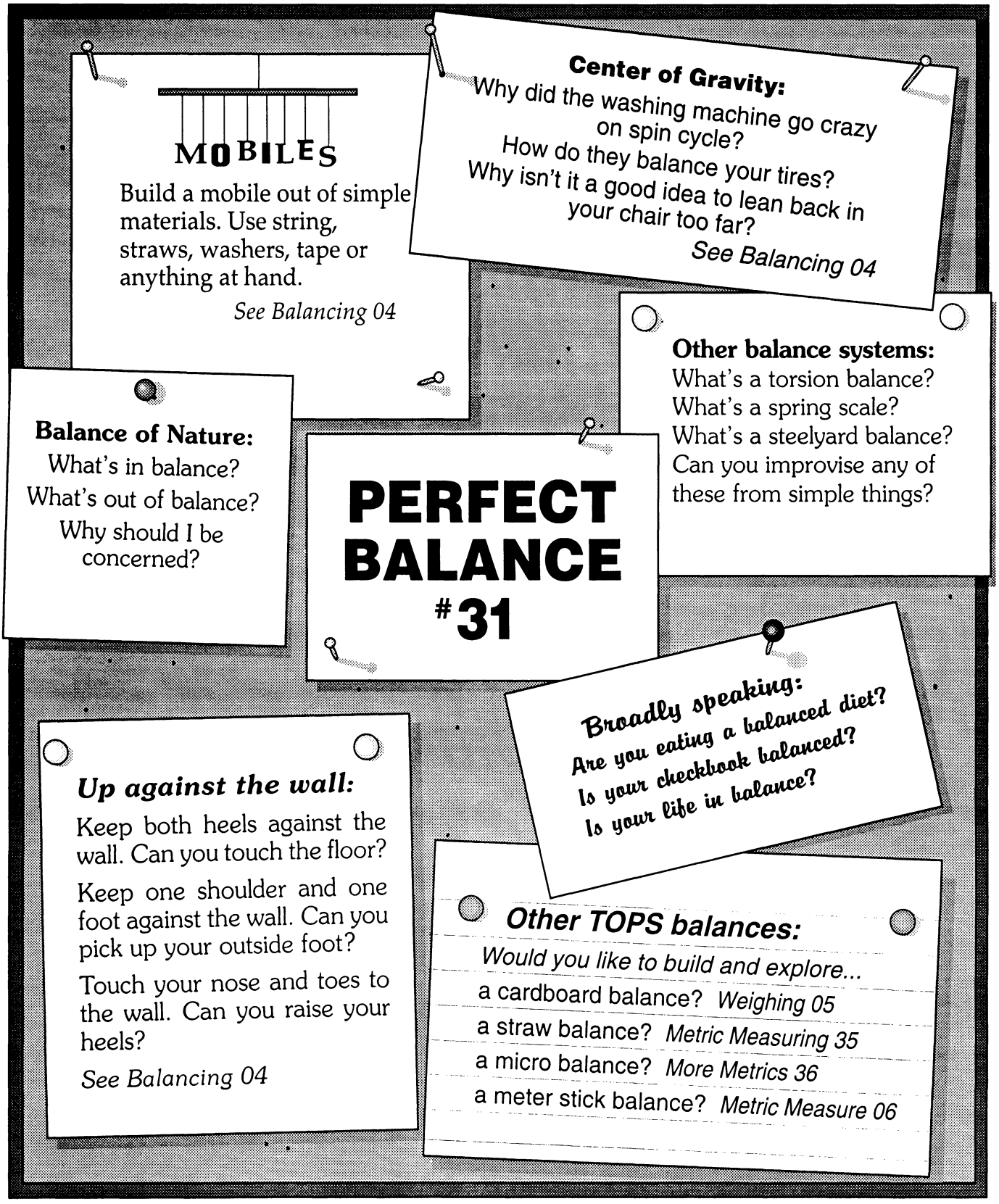
- equal-arm balance: 10, 11

Inventions: extension 16B

Gaining a Whole Perspective

Science is more than facts, more than theories. It is a fascinating and complex fabric of experience, observation, and discovery. Weave in enrichment activities offered as extensions throughout this book. Follow strands of connection with the open-ended ideas below. Do science!



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 a final exam.

activity 1-2

When following directions, which of the following statements can you say is true? Circle one or more.

a. It is important to read carefully.

b. Pictures can help me understand.

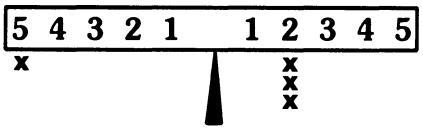
c. I should wait for my teacher to explain everything.

activity 2

Before I use my balance, I should center it. I can do this by adding a little tape to the _____ arm.

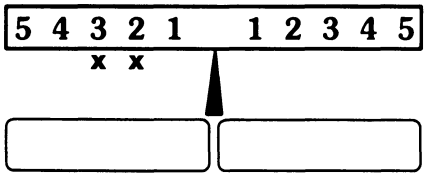
activity 3

Use your math balance (if necessary) to decide if this beam balances:



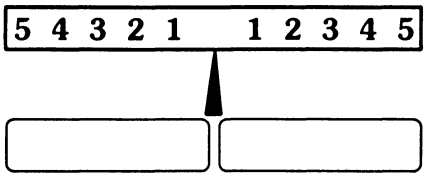
activity 4

Draw two more x's to make this beam balance. Choose your positions so you can write a *different* equation in each box.



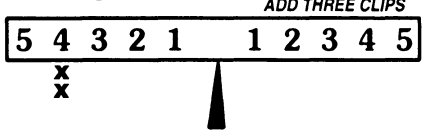
activity 5

Draw x's only under positions 3 and 4 to make this beam balance. Write a multiplication equation in each box.



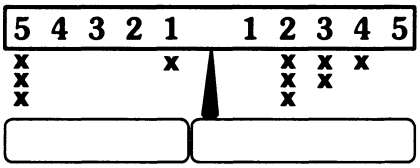
activity 6

Draw 4 different ways to make this beam balance by adding ***3*** paper clips to the right arm:



activity 7

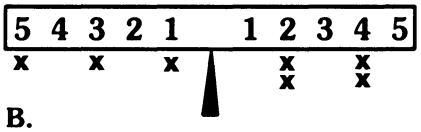
Write an equation in each box. Does this beam balance?



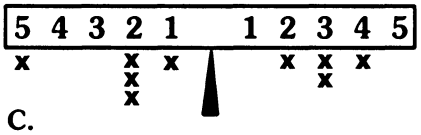
activity 8

Which of these beams balance? Show your math.

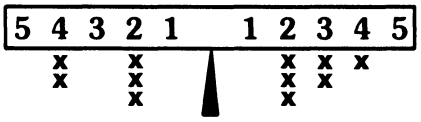
A.



B.



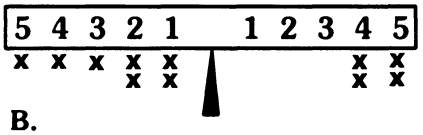
C.



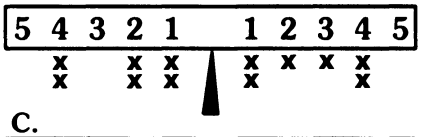
activity 9

Find the beam that tilts ***left***. Show your math.

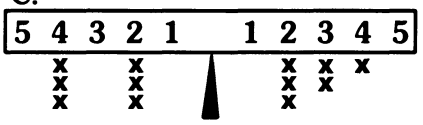
A.



B.

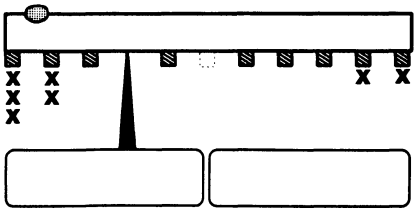


C.



activity 10

Number the tab positions correctly. Then write an equation in each box to show that this unequal-arm beam balances.



activity 13

If ten pennies weigh 62 paper clips, and 10 paper clips weigh 150 staples, how many staples does a penny weigh? Show your units.

activity 14

Teacher prep: Make paper weights of random sizes. Weigh them in paper clips; trim smaller or add tape until equal to an even number of clips. Fold and label them A, B, C....

Weigh 3 different prepared weights to the nearest whole paper clip on your paper beam balance. Label your answers by letter.

activity 15

Teacher prep: Add tape or cut away paper on the weights above. (Reserve a few originals for make-up tests). Circle the letter labels on the altered weights.

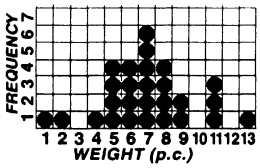
Weigh 3 different prepared weights to the nearest tenth of a paper clip on your balance. Label your answers by letter, and circle the letters.

activity 16

Find the weight of a nickel in paper squares. Use only 28 squares and clay.

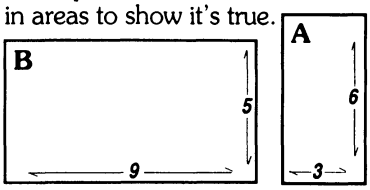
activity 17

Find the ***mode***, the ***median***, and the ***mean*** for this data:



activity 18

Write an equation between A and B. Plug in areas to show it's true.

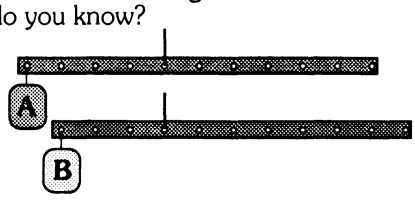


activity 19

How might you find out how much money is in a piggy bank full of dimes without breaking it open?

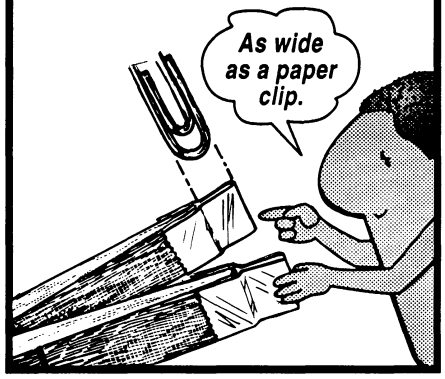
activity 20

Weights A and B hang from identical beams. Which weight is heavier? How do you know?



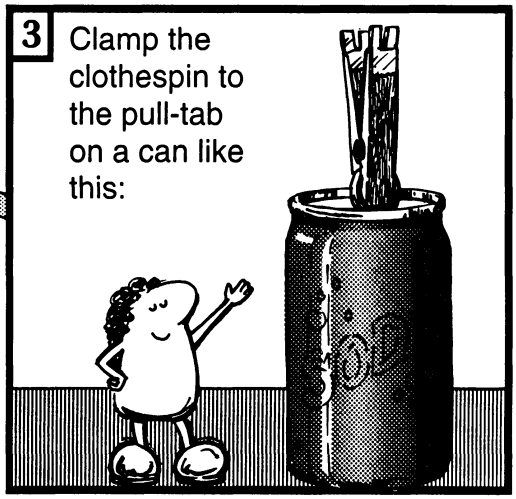
BUILD A MATH BALANCE (2)

1 Fold masking tape over the ends of a clothespin. Pinch the ends flat.

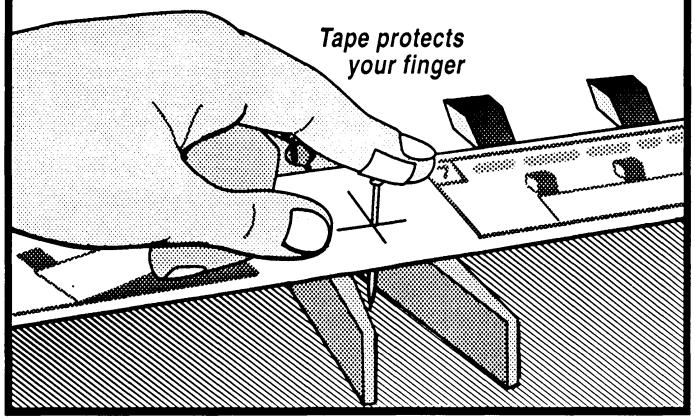


2 Cut out a narrow strip from the center of the tape.

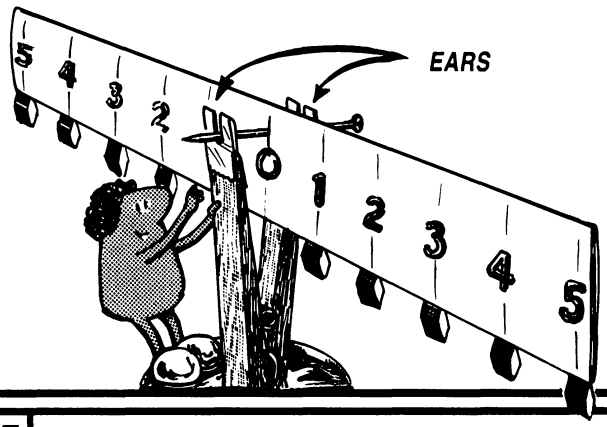
3 Clamp the clothespin to the pull-tab on a can like this:



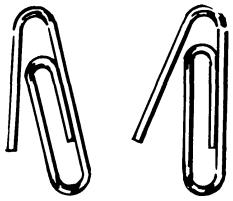
4 Lay your beam over a clothespin. Then push a pin through the exact center of the crossmarks. Leave the pin in.



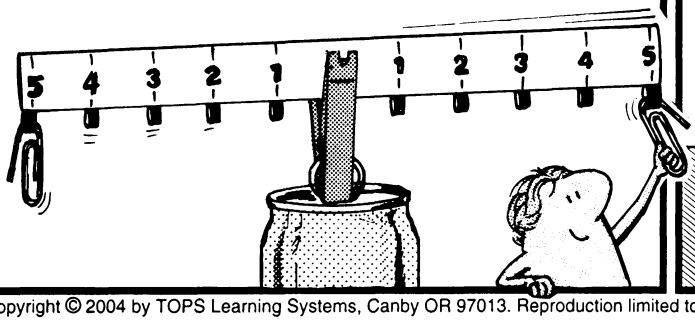
5 Balance your beam on the clothespin clipped on the can. The pin will rest between the "ears."



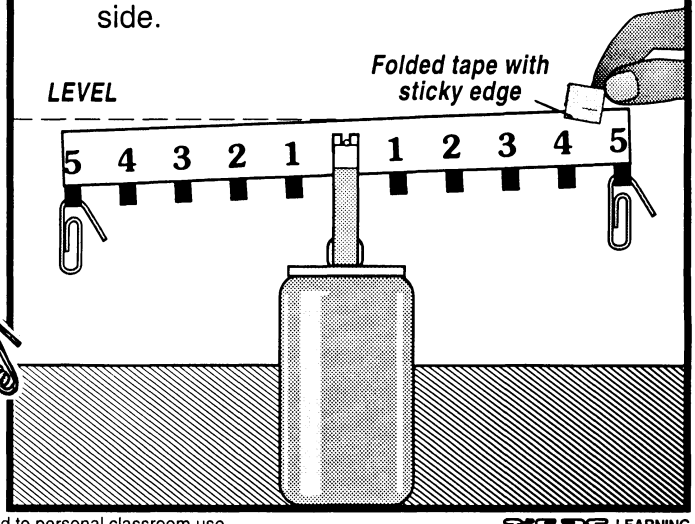
6 Bend out 2 paper clips just a little …



… then hang them from the 2 end loops like this.



7 Make the beam balance level by adding a folded tape tab to the lighter (higher) side.



Objective

To complete assembly of the math balance. To read and follow directions carefully.

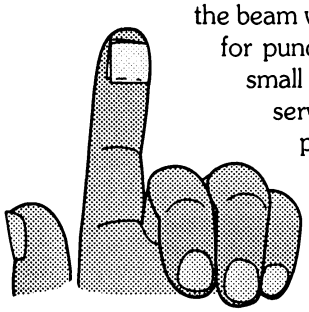
Lesson Notes

1. The tape doesn't need to extend far beyond the clothespin. If the tape "ears" are too long, they are likely to curl and interfere with the free movement of the beam.

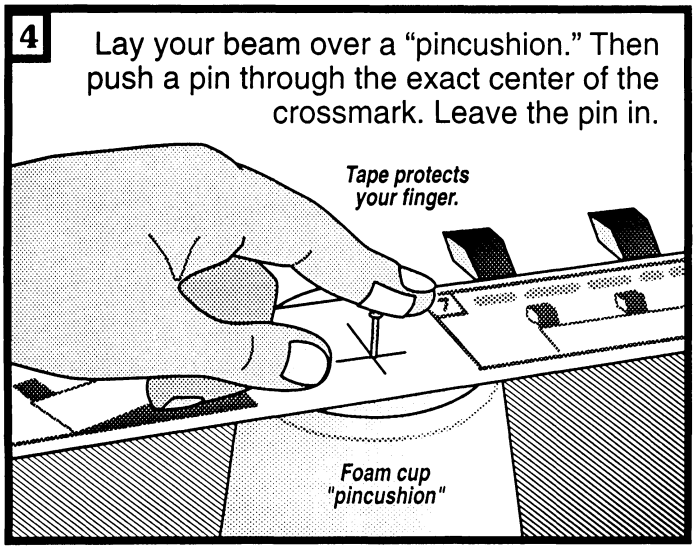
2. If using scissors of poor quality, your students may not be able to cleanly snip away the narrow center strip of tape. In this case, students can scrape it away with the scissors. They should remove it completely so the pivot pin can rest directly on the wood in step 5.

3. Either pop-top cans or small beverage bottles with *narrow* mouths can serve as bases for these balances. If a clothespin doesn't fit a bottle snugly, add tape around the nose of the clothespin.

4. It's important to push the pin through the ***exact*** center of the crossmarks. Some students may need help with this step. Propping the beam across the clothespin (or other "pincushion" surface, as discussed below) allows the pin to penetrate the beam while reducing the potential for punctured fingers. A couple of small squares of tape can further serve as a "thimble" to help protect sensitive fingers from pressure.

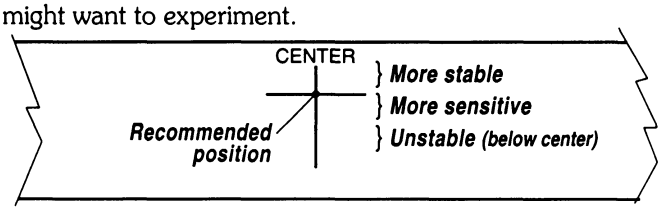


You can choose an alternative "pincushion" approach, which will be used later in these activities, by lightly affixing the following instruction over box 4 before you photocopy a class set. Find a list of quick and easy "pincushions" in the materials list for teaching notes 10.



5. If a student's beam simply can't balance, it's probably upside down. The black tabs must be hanging down.

In general, the beam becomes more stable if the pin is moved higher on the vertical crossmark. This could work better for younger students, or if a lot of motion in the room is stirring up drafts, but readings will not be as precise. Lower pivots will be more sensitive, but become unstable if lower than the beam's center of gravity. This crossmark is a good compromise between stability and sensitivity. Older students might want to experiment.



6-7. You can center the beam without the paper clips, but it comes to rest more slowly, and may drift a bit off its equilibrium position. With ***identical*** paper clips lowering the center of gravity, the beam gains stability and will settle more quickly.

7. A "rider" will be needed to correct inevitable differences in weight between the two arms. A tab of masking tape, folded to leave a narrow sticky edge, is easy to adjust along the higher arm until the balance is just right. If this rider is simply too light to do the job, add more clear tape directly on the lighter arm until nearly balanced.

If the finished system isn't steady enough for younger kids to use easily, you might add some ballast (use sand or gravel) to make the bottle more tip-resistant. Further, you can fold a snippet of tape across the top of the masking tape ears on each side so the beam can't fall off the clothespin.

Evaluation

Is the pivot pin precisely centered? Does the beam swing freely, returning each time to a level position?

Materials

- ☐ The paper beam constructed in activity 1.
- ☐ Masking tape (clear tape may be substituted).
- ☐ Scissors.
- ☐ Two clothespins, or one clothespin and a soft "pincushion" surface such as an overturned styrofoam cup (see the materials for teaching notes 10).
- ☐ A straight pin.
- ☐ A pop-top can or soda bottle, glass or plastic.
- ☐ Paper clips of uniform size and weight. Use a standard size about this big: 
- ☐ Optional ballast material: gravel, sand, beans, etc. See note 3.