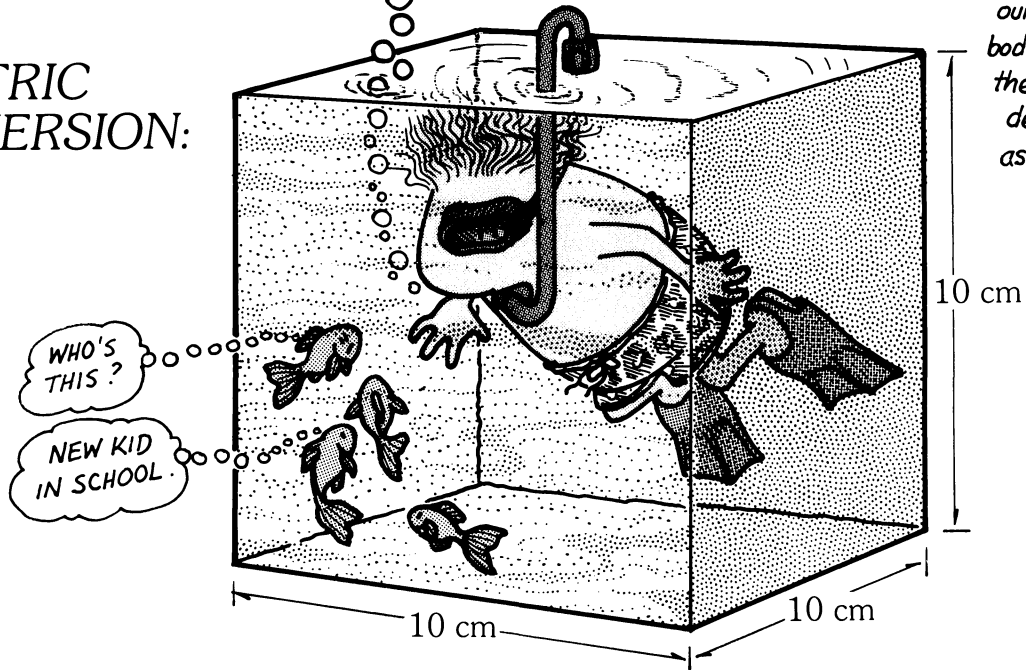


# METRIC MEASURE

This 10 x 10 x 10 cm cube of water holds a 1,000 cm<sup>3</sup> volume, which equals 1,000 ml (1 liter), and has a mass of 1 kg.\*

\* Assuming our little bodies have the same density as water.

METRIC IMMERSION:



TASK CARD SERIES

Conceived and written by

**Ron Marson**

Illustrated by

**Peg Marson**

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# CONTENTS



## INTRODUCTION

- A. A TOPS Model for Effective Science Teaching
- C. Getting Ready
- D. Gathering Materials
- E. Sequencing Task Cards
- F. Long Range Objectives
- G. Review / Test Questions



## TEACHING NOTES

### CORE CURRICULUM

1. Decimal Ladder (1)
2. Decimal Ladder (2)
3. Decimal Ladder (3)
4. Length, Area, Volume...
5. Millions and Billions
6. Our Small Speck
7. Sizing Up a Cylinder
8. Liquid Volume
9. Liter Buckets
10. Pouring Grams
11. Mass x Distance
12. Kilos and Pounds
13. Build a Microbalance
14. Millimasses

### ENRICHMENT CURRICULUM

15. Pass the Rice
16. Mass Estimate
17. Volume Estimate
18. Area Estimate
19. How Can This Be?
20. Ton of Water



## REPRODUCIBLE STUDENT TASK CARDS

Task Cards 1-20

Supplementary Pages —Centimeter Grid  
Centimeter Ruler  
Grid with Inscribed Circle  
Grid with Millimeter Squares

# 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:

<p><i>special in-a-box materials:</i></p> <p>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.</p>	<p>general on-the-shelf materials:</p> <p>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.</p>
<p>(substituted materials):</p> <p>Parentheses enclosing 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.</p>	<p>*optional materials:</p> <p>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.</p>

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<sub>1</sub> / Q<sub>2</sub> / Q<sub>3</sub>

**Single Student:** Enough for 1 student to do all the experiments.

**Individualized Approach:** Enough for 30 students informally working in 10 lab groups, all self-paced.

**Traditional Approach:** Enough for 30 students, organized into 10 lab groups, all doing the same lesson.

KEY:		<i>special in-a-box materials</i> (substituted materials)	general on-the-shelf materials *optional materials
Q <sub>1</sub> / Q <sub>2</sub> / Q <sub>3</sub>			
1/10/10	*calculators	3/30/30	straight straws
1/10/10	scissors	1/10/10	paper clips
1/5/10	rolls cellophane tape	1/10/10	test tubes
4/40/40	meters kite string	1/10/10	<i>tall beverage bottles — quart or 2 liter size</i>
1/10/10	meter sticks	1/10/10	plastic produce bags
1/10/10	pinches table salt	1/10/10	plastic sandwich bags (produce bags)
1/4/10	hand lenses	1/10/10	<i>liters gravel or sand</i>
1/10/10	straight pins	1/5/10	1 pound bag of long-grained white rice — see notes 12
1/10/10	empty cans – see notes 7	1/10/10	clothespins
1/10/10	eyedroppers	1/1/1	spool thread
1/5/10	rolls masking tape	1/10/10	paper cups
1/10/10	10 ml graduated cylinders	1/10/10	<i>bills, US or Canadian, \$1 or higher</i>
1/1/1	source of water	1/10/10	baby food jars with lids
1/10/10	100 ml graduated cylinders	1/1/1	roll paper towels
1/4/10	*pie tins or plates	1/5/10	index cards
2/20/20	<i>half-gallon milk cartons</i>	1/10/10	<i>full sheets of newspaper</i>
1/2/5	paper punches		

# Sequencing Task Cards

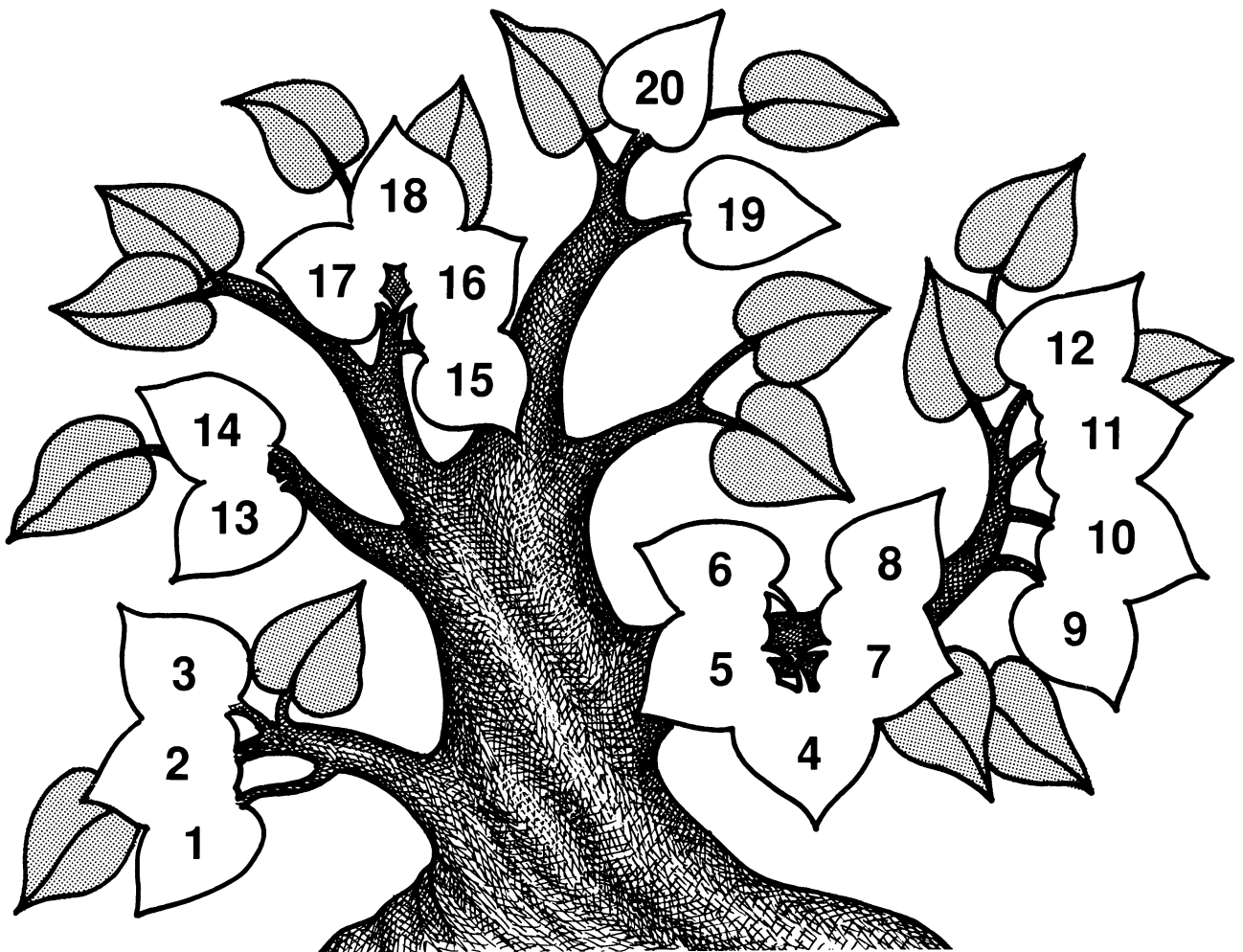
This logic tree shows how all the task cards in this module tie together. In general, students begin at the trunk of the tree and work up through the related branches. As the diagram suggests, the way to upper level activities leads up from lower level activities.

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.

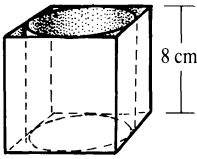
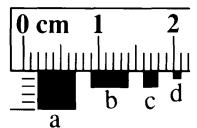
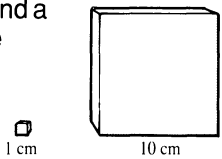

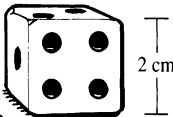
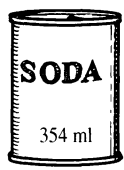
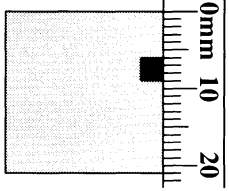

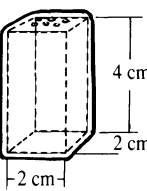
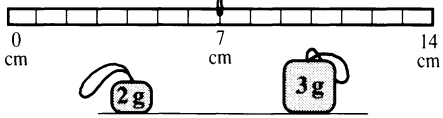
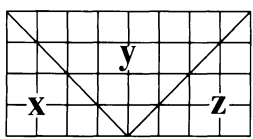
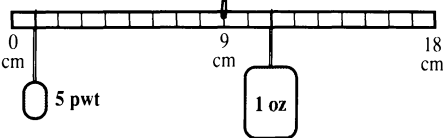
For whatever reason, when you wish to make sequence changes, you'll find this logic tree a valuable reference. Parentheses in the upper right corner of each task card allow you total flexibility. They are left blank so you can pencil in sequence numbers of your own choosing.



**METRIC MEASURE 06**

# 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.

<p><b>task 1-3 A</b> How many million are in a billion?</p>	<p><b>task 7-8</b> An open cube measuring 8 cm on a side holds an inside cylinder of equal height and diameter.</p>  <p>a. What is the volume of the cube? b. What is volume of the cylinder? c. How many ml of water could you expect to pour into just one of the four corners?</p>	<p><b>task 13-14 A</b> A 10 by 10 cm square of black paper has a mass of 1 gram. Which of these boxes, made from the same paper, has a mass of 1 mg? Show your work.</p> 
<p><b>task 1-3 B</b> Define 10 metric units that derive from the meter, giving the value of each one. One of these, for example, is: 1 hectometer = 100 meters.</p>	<p><b>task 7-10</b> Imagine a small water cube measuring 1 cm on a side, and a large water cube measuring 10 cm on a side.</p>  <p>a. What is the dry volume of each? b. What is the liquid volume of each? c. What is the mass of each?</p>	<p><b>task 13-14 B</b> Metriclip Corporation manufactures the "classic paper clip" with a mass of 1 gram. How would you use this clip to develop a system of paper masses capable of measuring small objects within a range of 1,000 mg to 10 mg?</p>
<p><b>task 1-3 C</b> Order these measures from largest to smallest:</p> <p style="text-align: center;">LARGEST ↑ ↓ SMALLEST</p> <p>1,000,000 millimeter 1,000 micrometer 1 centimeter .001 kilometer</p>	<p><b>task 10, 15</b> You want to determine the capacity of a perfume bottle in milliliters, but have no graduated cylinder. Explain how to do it with a gram balance.</p>	<p><b>task 15-16</b> An average-sized raisin weighs about 250 mg. Estimate the number of raisins that fill this box.</p> 
<p><b>task 1-3 D</b> Supply the missing number.</p> <p>1 cm = ? mm      1 mm = ? cm 1 kg = ? g        1 m = ? km 1 g = ? mg        1 ml = ? l 1 s = ? ns        1 b = ? gb</p>	<p><b>task 4-6 A</b></p> <p>a. How many m in 1 km? b. How many m<sup>2</sup> in 1 km<sup>2</sup>? c. How many m<sup>3</sup> in 1 km<sup>3</sup>?</p>	<p><b>task 17</b> About 45 grains of rice fill a cubic centimeter. Estimate how many grains of rice would fill a liter.</p>
<p><b>task 4-6 B</b></p> <p>A die measures 2 cm on a side.</p>  <p>a. How many fit along a 10 cm length? c. How many cover a 10 cm square? a. How many fill a 10 cm cube?</p>	<p><b>task 10</b></p> <p>This empty can has a mass of 16 g. How much does it weigh filled with water?</p> 	<p><b>task 18</b></p> <p>Estimate how many small squares will cover the large square.</p> 
<p><b>task 4-6 C</b></p> <p>Table salt is made of tiny cubes that average about .5 mm on a side.</p>  <p>a. How many of these tiny cubes fill a cubic mm? b. How many fill a salt shaker with inside dimensions of 2 cm x 2 cm x 4 cm?</p> 	<p><b>task 10, 12</b></p> <p>At a grocery store you buy a 2 liter bottle of coke and a 5 pound package of flour. Which product weighs more? Explain your reasoning.</p>	<p><b>task 16-18</b></p> <p>An average penny is about 1.5 mm thick. What is the value of a stack of pennies reaching 1 meter high?</p>
<p><b>task 6</b></p> <p>Is our Earth at the center of the universe? Explain.</p>	<p><b>task 11</b></p> <p>A 14 cm beam, calibrated in centimeters, pivots on center at 7 cm. How far from the pivot should you hang 2 g and 3 g masses so they balance level? Give 2 solutions. Show your work.</p> 	<p><b>task 19</b></p> <p>a. Count squares to determine the area of triangle x, y, and z. b. Confirm your answer. Find the area of the larger rectangle.</p> 
<p><b>task 7-9</b></p> <p>A pipe has a cross-sectional opening of 4 cm<sup>2</sup>. What length of pipe will hold a liter of water?</p>	<p><b>task 11-12</b></p> <p>An 18 cm beam, calibrated in centimeters, pivots on center at 9 cm. If 5 pennyweight (pwt) balances 1 ounce (oz) in the positions shown, find the number of pwt in 1 ounce.</p> 	<p><b>task 20</b></p> <p>A faucet drips at the rate of 10 ml/minute. How much time passes before the dripping faucet wastes... a. 1 liter of water? b. 1 metric ton of water?</p>

**Task Objective (TO)** practice using numeral place values as language, powers of ten, and decimal numbers.

### DECIMAL LADDER (1)

1. Write this equation on the middle line of a sheet of notebook paper, to the right of the margin line: **one =  $10^0 = 1$** .

2. Follow this pattern *upward*, writing equations 1 line at a time, until you reach a billion.

3. Start again at “one” and go *down* until you reach a billionth.

4. Think of the lines on notebook paper as rungs on a ladder.

a. These equations are *one* rung apart. Balance them:

(?) ten = hundred

(?) thousand = hundred

(?) hundredth = tenth

(?) one = tenth

b. These equations are *three* rungs apart. Balance them:

(?) ten = ten thousand

(?) hundredth = ten

(?) one = thousandth

(?) thousandth = millionth

c. How do you balance equations between larger and smaller numbers on this decimal ladder? Invent a rule.

**Metric Measure ( )**

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### Answers / Notes

1-3. *Insist on accuracy and neatness in this important exercise. Metric measurement and decimals are two sides of the same conceptual coin.*

- billion =  $10^9 = (10)(10)(10)(10)(10)(10)(10)(10)(10) = 1,000,000,000$
- hundred million =  $10^8 = (10)(10)(10)(10)(10)(10)(10)(10) = 100,000,000$
- ten million =  $10^7 = (10)(10)(10)(10)(10)(10)(10) = 10,000,000$
- million =  $10^6 = (10)(10)(10)(10)(10) = 1,000,000$
- hundred thousand =  $10^5 = (10)(10)(10)(10)(10) = 100,000$
- ten thousand =  $10^4 = (10)(10)(10)(10) = 10,000$
- thousand =  $10^3 = (10)(10)(10) = 1,000$
- hundred =  $10^2 = (10)(10) = 100$
- ten =  $10^1 = (10) = 10$
- one =  $10^0 = 1$
- tenth =  $10^{-1} = 1/10^1 = 1/10 = .1$
- hundredth =  $10^{-2} = 1/10^2 = 1/100 = .01$
- thousandth =  $10^{-3} = 1/10^3 = 1/1,000 = .001$
- ten thousandth =  $10^{-4} = 1/10^4 = 1/10,000 = .0001$
- hundred thousandth =  $10^{-5} = 1/10^5 = 1/100,000 = .00001$
- millionth =  $10^{-6} = 1/10^6 = 1/1,000,000 = .000001$
- ten millionth =  $10^{-7} = 1/10^7 = 1/10,000,000 = .0000001$
- hundred millionth =  $10^{-8} = 1/10^8 = 1/100,000,000 = .00000001$
- billionth =  $10^{-9} = 1/10^9 = 1/1,000,000,000 = .000000001$

- 4a. (10)(ten) = hundred  
 (.1)(thousand) = hundred  
 (10)(hundredth) = tenth  
 (.1)(one) = tenth
- 4b. (1000)(ten) = ten thousand  
 (1000)(hundredth) = ten  
 (.001)(one) = thousandth  
 (.001)(thousandth) = millionth

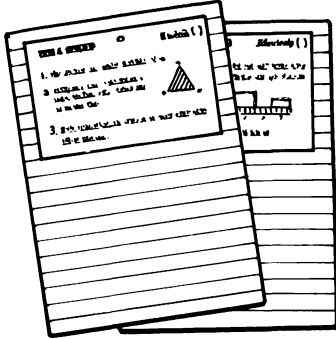
4c. To balance equations between larger and smaller numbers, simply multiply the smaller or divide the larger by a power of 10 equal to the number of rungs that separate them.

### Materials

- Notebook paper.

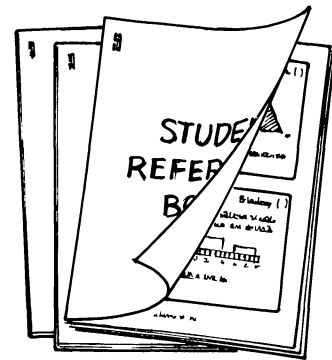
# Task Cards Options

Here are 3 management options to consider before you photocopy:

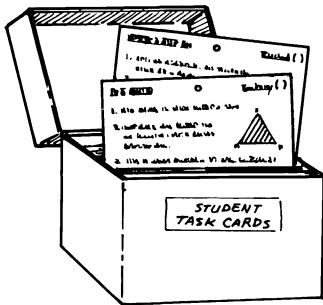


**1. Consumable Worksheets:** Copy 1 complete set of task card pages. Cut out each card and fix it to a separate sheet of boldly lined paper. Duplicate a class set of each worksheet master you have made, 1 per student. Direct students to follow the task card instructions at the top of each page, then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





## DECIMAL LADDER (1)

## Metric Measuring ( )

1. Write this equation on the middle line of a sheet of notebook paper, to the right of the margin line: **one =  $10^0 = 1$** .

2. Follow this pattern *upward*, writing equations 1 line at a time, until you reach a billion.

3. Start again at "one" and go *down* until you reach a billionth.

4. Think of the lines on notebook paper as rungs on a ladder.

ONE RUNG



a. These equations are *one* rung apart. Balance them:

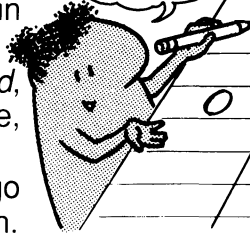
(?) ten = hundred

(?) thousand = hundred

(?) hundredth = tenth

(?) one = tenth

CONTINUE THIS PATTERN...



	<b>1.</b> ↑
thousand	$= 10^3 =$
hundred	$= 10^2 = (10)(10) = 100$
ten	$= 10^1 = (10) = 10$
one	$= 10^0 = 1$
tenth	$= 10^{-1} = 1/10^1 = .1$
hundredth	$= 10^{-2} = 1/10^2 = .01$
	<b>2.</b> ↓

THREE RUNGS



b. These equations are *three* rungs apart. Balance them:

(?) ten = ten thousand

(?) hundredth = ten

(?) one = thousandth

(?) thousandth = millionth

c. How do you balance equations between larger and smaller numbers on this decimal ladder? Invent a rule.

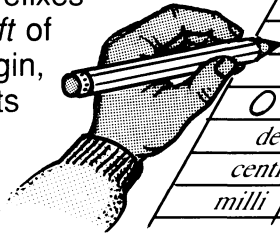
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## DECIMAL LADDER (2)

## Metric Measuring ( )

1. Write these metric prefixes to the *left* of the margin, each in its proper place:



kilo	thousand =
hecto	hundred = $10^2$
deka	ten = $10^1 = (10) = 10$
one	$= 10^0 = 1$
deci	tenth = $10^{-1} = 1/10 = .1$
centi	hundredth = $10^{-2} = 1/100 =$
milli	thousandth = $10^{-3} =$

2. Include these additional prefixes higher and lower on your ladder:

**giga** = billion,  
**mega** = million;  
**micro** = millionth;  
**nano** = billionth.

3. Write the *number* equivalent of a: kiloelephant, millipickle, dekarabbit, decidollar, centidollar, megafish, gigastar, nanopart, hectostudent, micropie.

4. Write the *metric* equivalent of: 100 seconds; .1 bushels; a million volts; .001 ounce;  $10^{-6}$  second; 10 inches;  $10^9$  watts; .01 miles; a billionth gram; 1,000 years.

5. Use your decimal ladder to solve each problem. Explain your reasoning.

- Have you ever run a million millimeters? How far is it?
- Would you rather have a gigacent or a megadollar?
- Can you hold your breath for a kilosecond?
- Have you ever slept a milliyear without waking up?

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