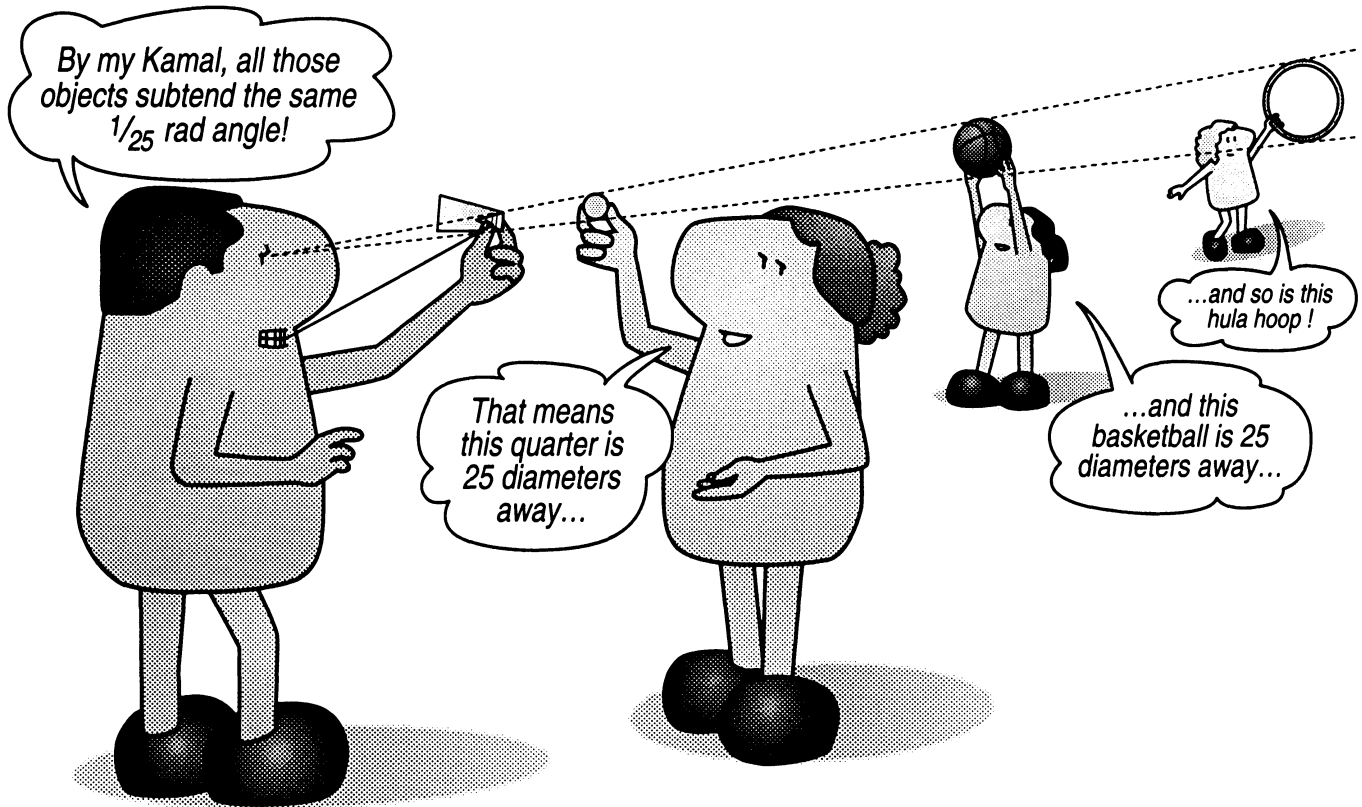


PI in the SKY



SCIENCE WITH SIMPLE THINGS SERIES



WHAT CAN YOU COPY?

Dear Educator,

Please honor our copyright restrictions. We offer liberal options and guidelines below with the intention of balancing your needs with ours. When you buy these labs and use them for your own teaching, you sustain our work. If you “loan” or circulate copies to others without compensating TOPS, you squeeze us financially, and make it harder for our small non-profit to survive. Our well-being rests in your hands. Please help us keep our low-cost, creative lessons available to students everywhere. Thank you!

PURCHASE, ROYALTY and LICENSE OPTIONS

TEACHERS, HOMESCHOOLERS, LIBRARIES:

We do all we can to keep our prices low. Like any business, we have ongoing expenses to meet. We trust our users to observe the terms of our copyright restrictions. While we prefer that all users purchase their own TOPS labs, we accept that real-life situations sometimes call for flexibility.

Reselling, trading, or loaning our materials is prohibited unless one or both parties contribute an Honor System Royalty as fair compensation for value received. We suggest the following amounts – let your conscience be your guide.

HONOR SYSTEM ROYALTIES: If making copies from a library, or sharing copies with colleagues, please calculate their value at 50 cents per lesson, or 25 cents for homeschoolers. This contribution may be made at our website or by mail (addresses at the bottom of this page). Any additional tax-deductible contributions to make our ongoing work possible will be accepted gratefully and used well.

Please follow through promptly on your good intentions. Stay legal, and do the right thing.

SCHOOLS, DISTRICTS, and HOMESCHOOL CO-OPS:

PURCHASE Option: Order a book in quantities equal to the number of target classrooms or homes, and receive quantity discounts. If you order 5 books or downloads, for example, then you have unrestricted use of this curriculum for any 5 classrooms or families per year for the life of your institution or co-op.

2-9 copies of any title: 90% of current catalog price + shipping.

10+ copies of any title: 80% of current catalog price + shipping.

ROYALTY/LICENSE Option: Purchase just one book or download *plus* photocopy or printing rights for a designated number of classrooms or families. If you pay for 5 additional Licenses, for example, then you have purchased reproduction rights for an entire book or download edition for any 6 classrooms or families per year for the life of your institution or co-op.

1-9 Licenses: 70% of current catalog price per designated classroom or home.

10+ Licenses: 60% of current catalog price per designated classroom or home.

WORKSHOPS and TEACHER TRAINING PROGRAMS:

We are grateful to all of you who spread the word about TOPS. Please limit copies to only those lessons you will be using, and collect all copyrighted materials afterward. No take-home copies, please. Copies of copies are strictly prohibited.

Ask us for a **free shipment** of as many of our **TOPS IDEAS Catalogs** as you need to support your efforts. Every catalog is a rich, attractive resource magazine packed with free sample teaching ideas.

Electronic edition 2011. Copyright ©2005 by TOPS Learning Systems. All rights reserved. This material is created/printed/transmitted in the United States of America. No part of this program may be used, reproduced, or transmitted in any manner whatsoever without written permission from the publisher, **except as explicitly stated above and below.**

The **original owner** of this book or digital download is permitted to make multiple copies of all **student materials** for personal teaching use, provided all reproductions bear copyright notice. A purchasing school or homeschool co-op may assign **one** purchased book or digital download to **one** teacher, classroom, family, or study group **per year**. Reproduction of student materials from libraries is permitted if the user compensates TOPS as outlined above. Reproduction of any copyrighted materials for commercial sale is prohibited.

For licensing, honor system royalty payments, or catalog requests, contact: **www.TOPScience.org**; or **TOPS Learning Systems, 10970 S Mulino Rd, Canby OR 97013**; or inquire at **tops@canby.com**

ISBN 978-0-941008-45-7

PI in the SKY

Introduction

Why teach TOPS?	4
Welcome	5
Standards	5
Getting Ready	6
Overview	7
Photocopies	8

PAGE NUMBERS:
Student Lab/Teaching Notes

A Pi is a Constant

Scope & Sequence	9
Student Labs	10-11
Student Tools	12-13
Teaching Notes	14-18

A1: What's pi, anyway?	10/14
A2: Chop circumferences into equal arc-lengths.	10/15
A3: Approximate pi using a paper plate and string.	10/16
A4: Make a pi graph.	11/17
A5: Calculate Earth distances.	11/18
TOOLS: Millimeter Beads / Pi Graph	12-13

B Radians & Degrees

Scope & Sequence	19
Student Labs	20-23
Student Tools	24-25
Teaching Notes	26-32

B1: So what's a radian?	20/26
B2: Inscribe an equilateral triangle.	20/27
B3: And what's a pi radian?	21/28
B4: Divide Circle Y into radian wedges.	21/29
B5: Calibrate a protractor.	22/30
B6: No protractors allowed!	22/31
B7: Calibrate Circle Z in degrees and radians.	23/32
TOOLS: Snowman / Protractor	24-25

C Counting Diameters

Scope & Sequence	33
Student Labs	34-37
Student Tools	38-40
Teaching Notes	41-48

C1: Make a coin-diameter ruler.	34/41
C2: Observe from the plane of your table top.	34/42
C3: Arrange coins to have the same apparent size.	35/43
C4: Explore angular size relationships among coins.	35/44
C5: Make a ruler from paper plates.	36/45
C6: Does a Moon Ruler correctly scale the real thing?	36/46
C7: Gaze at a paper plate moon.	37/47
C8: Test your Moon Ruler on family and friends.	37/48
TOOLS: Coin Ruler / Moon Ruler / Dime Ruler	38-40

D Visual Acuity

Scope & Sequence	49
Student Labs	50-51
Student Tools	52
Teaching Notes	53-56

D1: Test your visual acuity with a 1 mm dot.	50/53
D2: Test your visual acuity with other dot diameters.	50/54
D3: Compare your eyesight with GLAST & Hubble.	51/55
D4: Can you see a dime at 100 meters?	51/56
TOOL: Millimeter Dots	52

E Tie your Kamal

Scope & Sequence	57
Student Labs	58-61
Student Tools	62-63
Teaching Notes	64-70

E1: Make a paper Kamal and try it out.	58/64
E2: Learn to ride your Kamal.	58/65
E3: What's your apparent shoe size?	59/66
E4: Knowing HEIGHT, estimate distance.	59/67
E5: Knowing DISTANCE, estimate height.	60/68
E6: Lay out the inner solar system plus Jupiter.	60/69
E7: Do other planets have larger moon-rises?	61/70
TOOLS: Kamal Triangle / Planets To Scale	62-63

F Look from Here and There

Scope & Sequence	71
Student Labs	72-74
Teaching Notes	75-80

F1: Estimate diameter from a distance.	72/75
F2: Measure something tall three ways.	72/76
F3: What's parallax, and how can we measure it?	73/77
F4: Step aside and look again.	73/78
F5: How far to nearby stars?	74/79
F6: I beg your parsec...	74/80

Getting Ready

- Decide which parts of this book you want to teach, then budget appropriate class time. See Overview on page 7 to understand various options for science and math classes. There are rich possibilities for independent study and extra credit for students who are motivated to do additional, or superlative, work.
- Photocopy relevant student materials as per guidelines on page 8. For your convenience, copying instructions are also summarized at the top of each page.
- Gather these simple materials. Here is a master list of everything you'll need to teach ALL the lessons. Consult the "materials box" at the bottom of each Student Lab for a list of items specific to each activity.

Frequent Use	Occasional Or Single Use	
<ul style="list-style-type: none"> ✓ ruled notebook paper ✓ pencils with good erasers ✓ calculators (scientific calculators optional) ✓ paper plates (generic, 9-inch diameter) ✓ scissors ✓ string ✓ masking tape ✓ clear tape ✓ meter sticks ✓ index cards 	<ul style="list-style-type: none"> ✓ metric ruler ✓ drawing compass ✓ thread ✓ straight pins ✓ size-D battery ✓ straw ✓ hand lenses ✓ coins (U.S. pennies, nickels, quarters) ✓ clay ✓ dark construction paper (black, dark blue) 	<ul style="list-style-type: none"> ✓ standard hole punch ✓ corrugated cardboard ✓ current calendar with moon phases ✓ small jars or cans ✓ box or grocery bag (to carry stuff) ✓ packaging tape ✓ broom ✓ clip board (for recording observations outside) ✓ mirror (optional)

Organize a way to track assignments. It may be a good idea to keep student work on file in class. If you lack file space, substitute an empty copy paper box and brick. File folders and notebooks both make suitable assignment organizers. Students will feel a sense of accomplishment as their completed papers accumulate into an impressive portfolio. Since all assignments stay together, reference and review are easy. Ask students to tape a sheet of notebook paper inside the front covers of their folders or notebooks. Track individual progress by listing and initialing lesson numbers as they are completed.

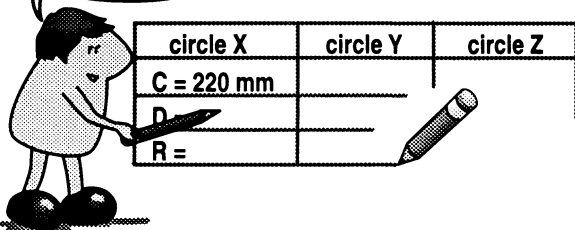
Communicate your grading expectations. We recommend that you grade on individual effort, attitude and overall achievement:

- ✓ **Effort:** How many labs and how much written work has the student completed? Of what quality?
- ✓ **Attitude:** Has the student worked to capacity, or wasted time? What evidence of personal initiative and responsibility?
- ✓ **Achievement:** Assign tasks or ask questions that assess how well students have mastered key concepts.

A1: What's pi, anyway?

1. Get the **Millimeter Beads** supplement.
2. Count “beads” to find the circumference (C), diameter (D) and radius (R) for each big circle **X, Y** and **Z**. Record these measures (in mm) on your own notebook paper.

Each “bead” measures 1 mm across...



3. Calculate the ratio C/D for each circle, rounded to two decimal places.

circles X, Y, and Z:

$$\frac{C}{D} = ?$$

4. Pi is a constant. It is the same for all circles large and small. Describe pi (or π)...
 - a. in terms of C and D.
 - b. in terms of C and R.

concept: A1 A2 A3 A4 A5

materials: Millimeter Beads, calculator, your notebook paper (always).

© 2005 by TOPS Learning Systems.
Contact: www.topscience.org

notes & vocabulary

π Pi is the number of times the diameter of a circle fits around the circumference.

$\pi = 3.1416...$

INTRODUCTION

Orient younger students to the Millimeter Beads page. If each “bead” is one mm across...

- What is the radius of circle X? *35 mm* Its diameter? *twice that*
 What is the arc length of quarter circle Z? *165 mm* Its circumference? *four times that*

LESSON NOTES

Bold numbers in these Lesson Notes and Model Answers always correspond to steps in the Student Labs above.

2. If you have provided non-consumable reference copies of these labs, remind students to keep them clean for other students' use. They should always answer on their own notebook paper, not on the photocopies.

3. Rounding to 2 decimal places means keeping 3 significant figures: 3.14.

Notice that this activity presents fractions in two forms: C/D and $\frac{C}{D}$. On many pages throughout this book, the form we use is prompted by space limitations. Encourage students to write fractions as numerator over denominator when solving equations.

MODEL ANSWERS

2-3. Circle X	Circle Y	Circle Z
C = 220 mm	C = 440 mm	C = 660 mm
D = 70 mm	D = 140 mm	D = 210 mm
R = 35 mm	R = 70 mm	R = 105 mm
C/D = 220 mm / 70 mm = 3.14	C/D = 440 mm / 140 mm = 3.14	C/D = 660 mm / 210 mm = 3.14

4. Students might describe π in their own words, or in terms of a mathematical formula, or both:

- 4a. Pi is the ratio of a circle's circumference divided by its diameter. ($\pi = C/D$)
 4b. Pi is the ratio of a circle's circumference divided by twice its radius. ($\pi = C/2R$).

Point out that all of these inputs (listed in order of increasing accuracy), approximate π : 3.14, 22/7, 3.1416, π key on a scientific calculator. Answers will differ slightly, of course, depending on which value for this non-repeating decimal you enter into your calculator.

TEST FOR UNDERSTANDING

A circle measures 7 mm at its widest and 22 mm around.

- a. What is its diameter? *7 mm*
- b. What is its radius? *3.5 mm*
- c. What is its circumference? *22 mm*
- d. What's pi? $\pi = C/D = 22/7 = 3.14 = C/2R$

ABOUT MATERIALS

Notebook paper is always required, and assumed in all later activities. It goes without saying that a sharp pencil and good eraser are always essential tools.

Scientific calculators are wonderful, but basic four-operation calculators work just fine in all student labs. Input “3.14” or “3.1416” for calculators with no π key.