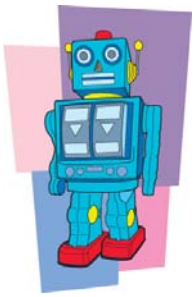
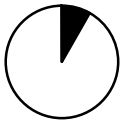
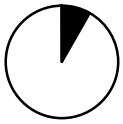
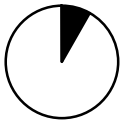


Slide Rules

Students will learn about the history of slide rules, how they work, and then make their own.

TECHNOLOGY TOPICS	PROCESS SKILLS	GRADE LEVELS
History Development Over Time Processes	Safely Using Tools Measuring Visualising Solutions Using Symbols Logical Thinking	4-12

TIME REQUIRED

Advance Preparation	Set Up	Activity	Clean Up
			
5 minutes	**5 minutes**	**20 minutes**	**5 minutes**

SUPPLIES

- rulers (2 per student)
- Copies of Master A, “Slide Rule” (1 per student)
- scissors (1 per student)
- masking tape
- 2 transparent rulers, or 2 metersticks
- one copy of Master B, pictures of Oughtred, Napier and NASA “computers”
- one overhead transparency with Master A copied on it.

ADVANCE PREPARATION

- Make photocopies of Master A - (1 copy per student)
- Copy Master A onto an overhead transparency, and cut the transparency in half vertically.

SET UP

- Distribute one copy of Master A and a pair of scissors to each student.

INTRODUCING THE ACTIVITY

Multiplication is a shortcut for adding. Slide rules are a shortcut for doing multiplication.

400 years ago, two people figured out some neat tricks about multiplication, and invented a calculator called a slide rule that people would use for more than 300 years.

CLASSROOM ACTIVITY

Before introducing the multiplication (logarithmic) slide rules, show how 2 rulers can make an adding slide rule. An adding slide rule works just like a multiplication slide rule. Adding slide rules are not practical, but demonstrate how to use a slide rule in a simple way.

Demonstrate an adding slide rule using two transparent rulers on an overhead projector, or 2 metersticks. (Hint: for students to follow along, have them work in pairs with 2 rulers. Use masking tape to hide the marks for inches. Have students work with the centimeter scale.)

To add using an adding slide rule, place two rulers together on top of each other. Line up 0 (the additive identity) on the top ruler with the first number you want to add on the bottom ruler. Find the second number you want to add on the top ruler. The sum is on the bottom ruler, directly below the second number. See the **student addition procedure** for an example of adding 2 + 3.

From this we see how slide rules function. Adding slide rules use a simple scale. To multiply, you need a logarithmic scale. John Napier (NAY-peer) discovered logarithms. Logarithms have to do with powers of numbers, multiplying the same number by itself over and over.

The powers of 2 are the numbers you get if you multiply 2 by itself over and over. 2, 4, 8, 16, 32, 64, 128…

We use these numbers to make a logarithmic scale. If the distance between each power is the same, you have a logarithmic scale. That is, the distance between 1 and 2 on a logarithmic scale is the same as the distance between 2 and 4, 4 and 8, 8 and 16, and so on. The logarithmic scale has this relationship for all power series. The distance between 1 and 3 is the same as the distance between 3 and 9, 9 and 27, 27 and 81. The distance between 1 and 5 is the same as the distance between 5 and 25, and 25 and 125.

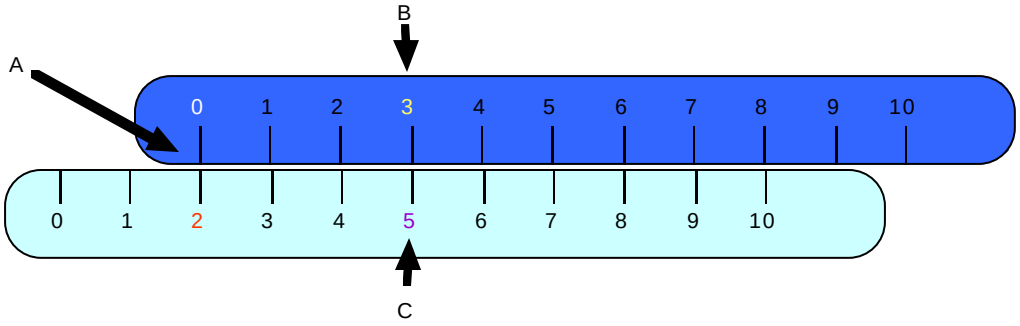
William Oughtred (OTT-red) invented the slide rule, which is two logarithmic scales put next to each other. If you put 1 (the multiplicative identity) of one scale against any number on the other scale, you can see all the multiples of that number down the scales.

The students will make and use a multiplication slide rule. Have the students cut Master A in half along the vertical line in the middle. (The cut does not need to be very straight!) Using the copy made on transparency paper and an overhead projector, show the students how to multiply using the slide rule. The **student multiplication procedure** is an example of multiplying 3 times 2:

Each student follows the directions below.

Student Addition Procedure:

A. Line up 0 on the top scale with 2 on the bottom scale.	2
B. Find the 3 on the top scale.	+3
C. The 3 on the top scale is lined up with 5 on the bottom scale, showing that 2 + 3 = 5.	=5

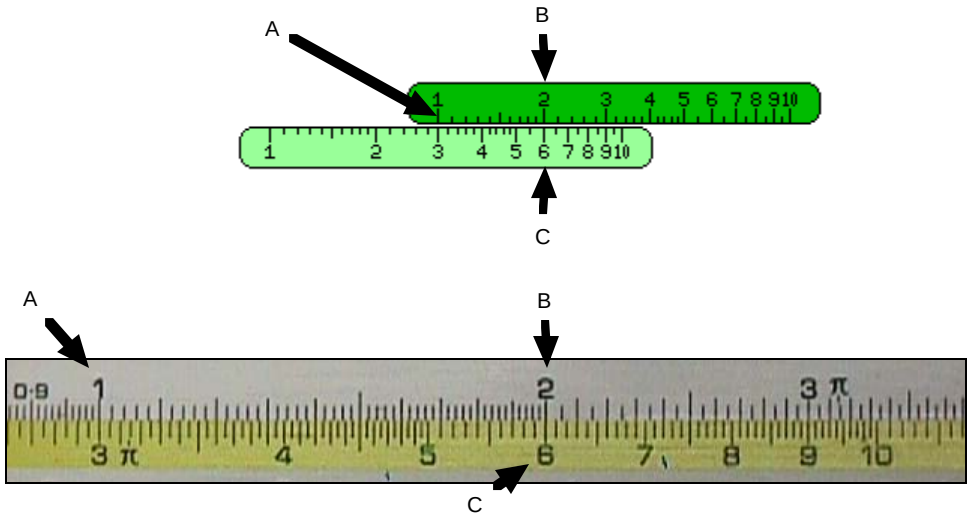


You can see all addition formulas with the number 2. 2 + 4 = 6, 2 + 8 = 10, etc.

Student Multiplication Procedure

Multiply 3 times 2:

A. Line up the 1 on the dark scale with 3 on the light scale.	3
B. Find the 2 on the dark scale.	x2
C. Read off 6 on the light scale.	=6



See the 3 times table. 3 times 3 is 9, 3 times 4 is 12, etc. To multiply another number, line up 1 with that number.

CLASS DISCUSSION

Ask for student observations. There is no correct answer. Let students guide the discussion and present their hypotheses before discussing explanations.

The slide rule was invented to multiply in the 17th century. How do you multiply large numbers?
Calculators.

When do you think calculators were invented?
The first calculator that (barely) fit on a desk was invented in 1968, and cost $2000. For reference, people first walked on the moon in 1969. Most of the scientists who worked on the moon missions used slide rules, not calculators.

To calculate the motion of the moon and the planets, scientists used "computers". But before electronic computers, a "computer" was a woman who sat at a desk and did calculations with a slide rule. They were almost all women. The photo on Master C of these computers can be found at:
http://www.dfrc.nasa.gov/gallery/photo/People/HTML/E49-0212.html

OPTIONAL EXTENSIONS

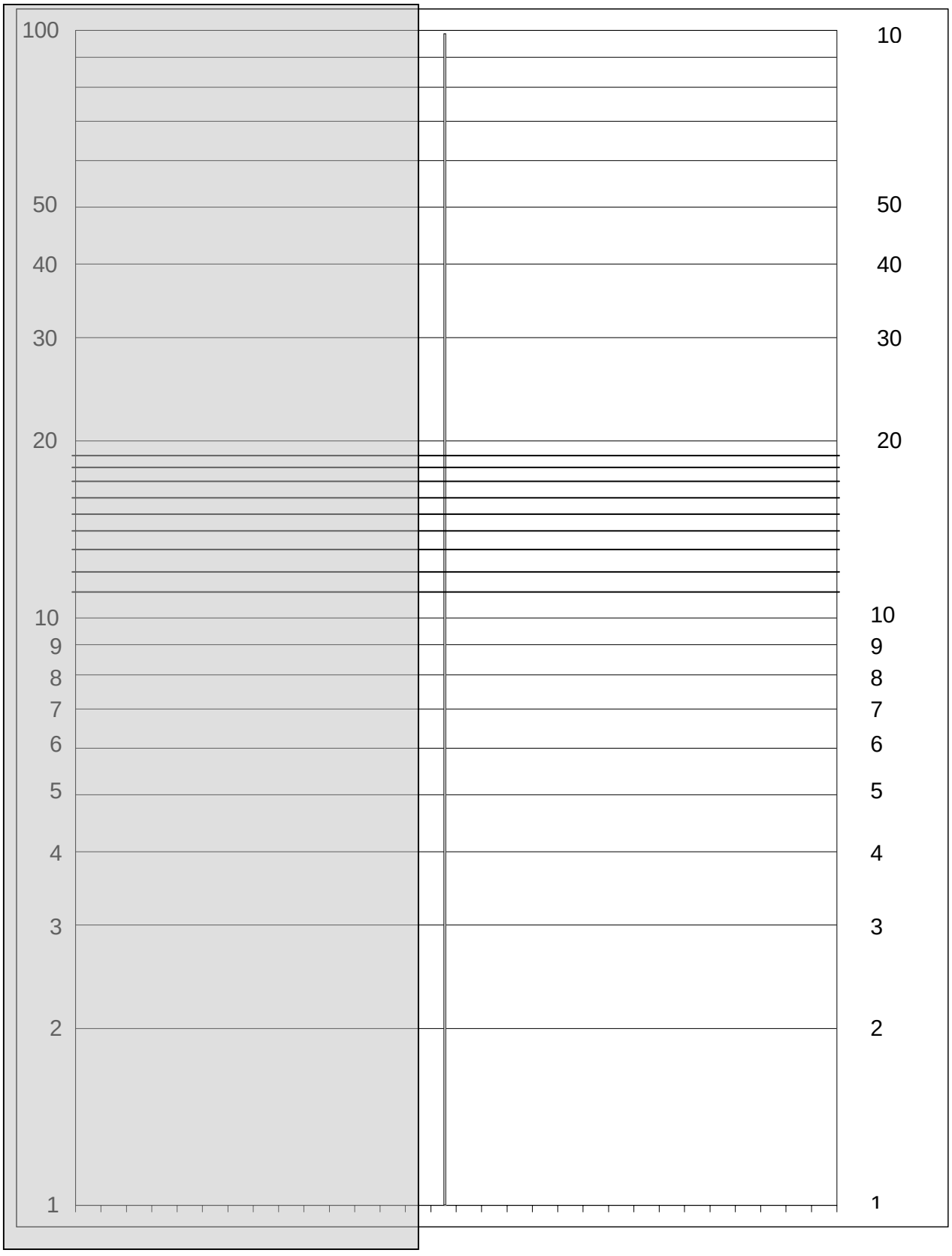
You can show the students how to read square roots or to square a number with a slide rule. Multiplying uses two copies of the same scale; squaring requires two different scales. Master C provides a crude version of these two scales.

Students can make a more precise, useful slide rule. Instructions and printable templates can be found at:
http://www.sphere.bc.ca/test/build.html

You can show students how a circular slide rule works. A printable template can be found at:
http://solar.physics.montana.edu/kankel/math/csr.html

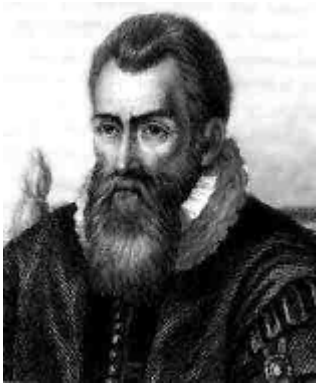
CROSS-CURRICULAR CONNECTIONS

MATH	Explore more details about roots, powers and logarithms. Show how you can have log-10, log-2, and explain the natural log.
LANGUAGE ARTS	Have students write a story about a NASA computer's job, imagining what it felt like to do math all day.
SPACE SCIENCE	Study more about the Apollo missions. Learn what the astronauts did on the moon. Watch the movie "Apollo 13", and watch for engineers using slide rules.
SOCIAL STUDIES	Study large social changes like the replacement of the slide rule by calculators. Examples include the effect of the automobile, the printing press, or vaccines on society. Discuss the question of "crutch vs. tool". Is a calculator better because you can do the math faster? Or is it bad because you don't really understand what you're doing? What would you do if your calculator broke? What happens at the grocery store if the cash registers are broken?



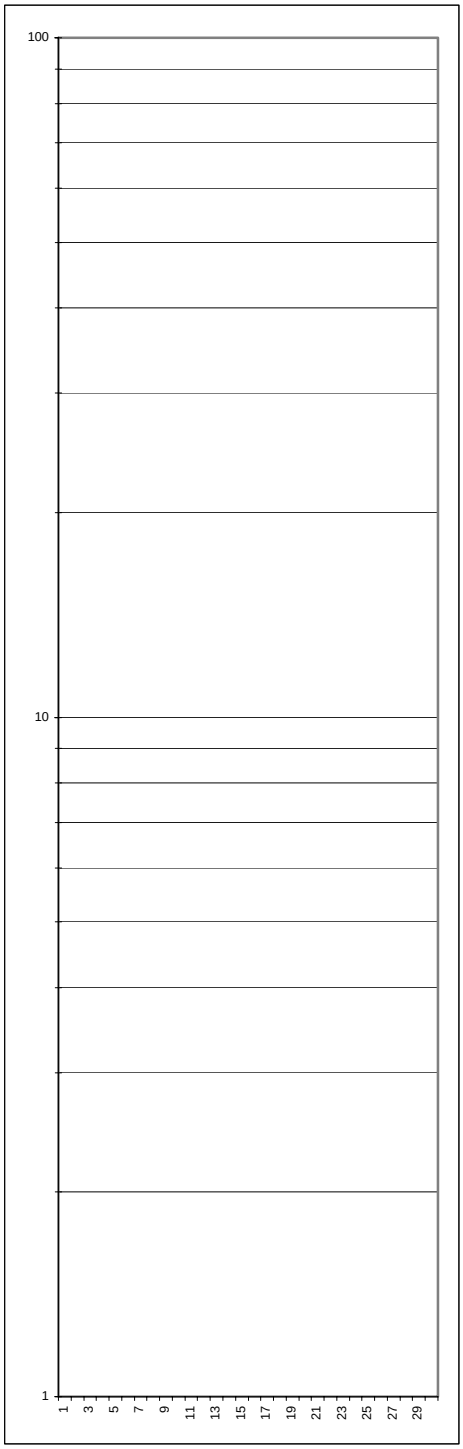
Dryden Flight Research Center E49-0212 Photographed 11/15/49
Dryden personnel with snowman. NASA photo

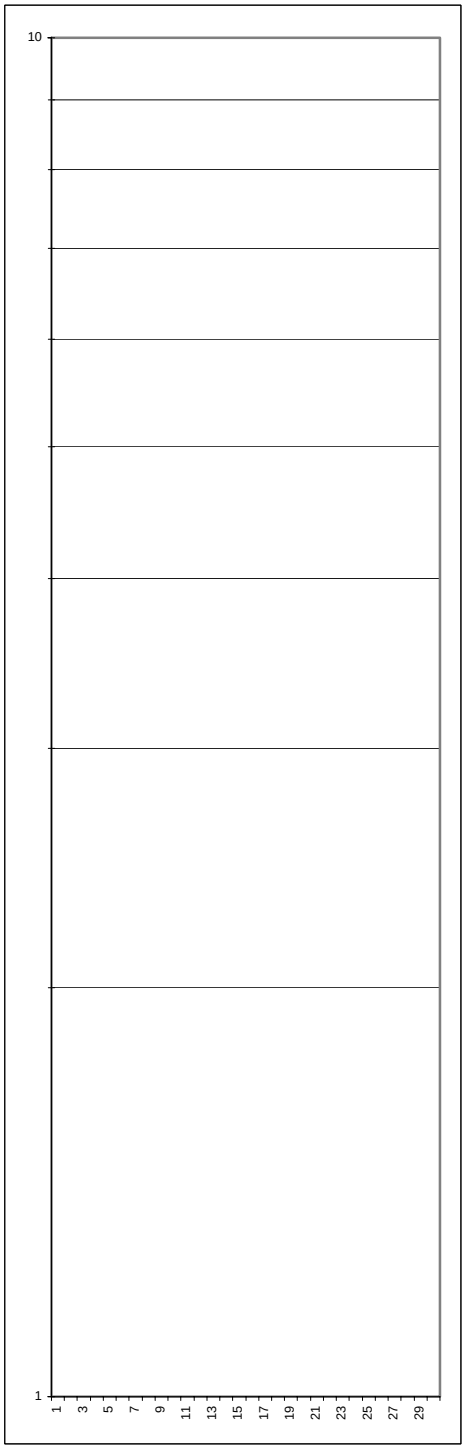
Women computers who worked for NASA



John Napier
Invented logarithms

William Oughtred
Invented the Slide Rule





Optional Extension: Rules to take square roots