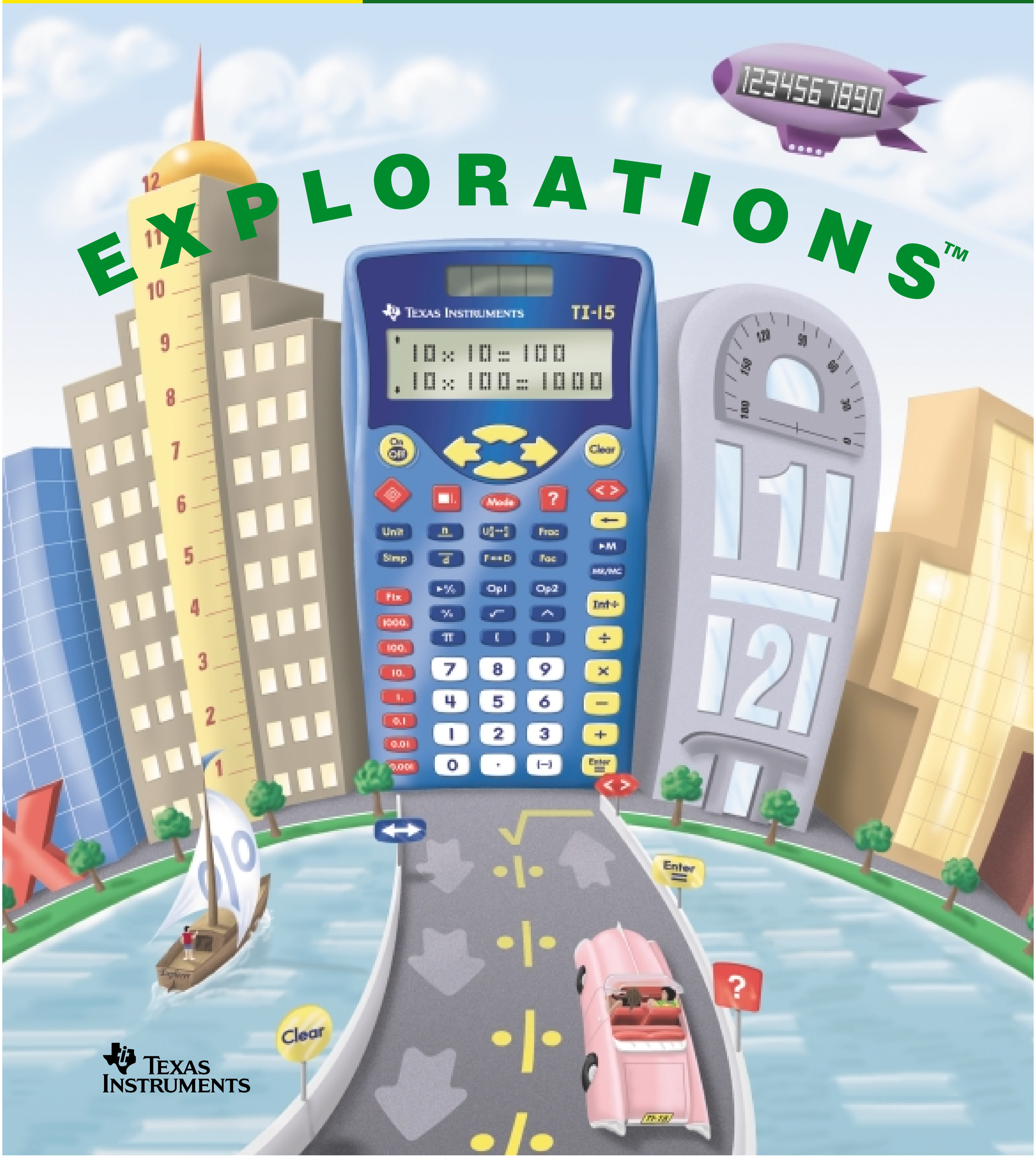
TI-15

A World of Mathematics: Activities for Grades 4, 5, and 6 Using the TI-15

George M. Christ



TEXAS INSTRUMENTS

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A World of Mathematics:
Activities for Grades 4, 5, and 6 Using the TI-15

SI Metric Version

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Texas Instruments Incorporated
7800 Banner Drive, M/S 3918
Dallas, TX 75251

Attention: Manager, Business Services

Printed in the United States of America.

ISBN: 1-886309-29-9
15/ESB/1L1/1A

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Contents

Preface

This book uses the calculator as a problem-solving tool. In each activity, the basic problem could be solved without the calculator; however, the mathematics involved makes the calculator the appropriate tool to use.

To prepare your students for the four-step problem-solving process in all of the activities, use *Activity 1: Problem-Solving Steps* first. By following the steps in this lesson, you will provide your students with a model to follow as they solve the other problems.

Each activity begins with a lesson plan for the teacher and continues with three sections for students**: The Problem Page**, **Things to Consider**, and **Using the Calculator**. The problems are all meant to be solved by a cooperative group. Each student then writes an individual explanation of the solution to the problem.

The **Lesson Plan** lists the concepts and skills for both the mathematics content and the related content area and the materials needed. The remaining sections take you step-by-step through the lesson itself. The *Overview* looks at the mathematics involved in the problem. The *Focus* provides a way to introduce the topic to the students. In *Presenting the Problem*, you will find steps to help guide your students through the problem. After the students have completed the problem, you should use the *Evaluating the Results* section to determine how much the students learned in this activity.

The **Problem Page** presents the problem to the students as well as all of the information they need to solve the problem. Students are also given a description of the final group product, and questions to answer individually after the problem has been solved.

For students who need a more direct approach, use the **Things to Consider** section. The group can use this information to help work through the four-step problem-solving process. This approach may be helpful if students have not had much experience with cooperative groups or creative problem solving.

To help students learn how to use the calculator to solve these problems, **Using the Calculator** pages are provided. On these pages, students will explore specific keystroke sequences as simpler problems are solved. By exploring the features of the TI-15 in these structured problems, students will gain the knowledge and skills they need to use the calculator to solve the problems.

— *George M. Christ*

About the Author

GEORGE M. CHRIST, Ed.D., is a mathematics consultant at Texas Region 10 Education Service Center in Richardson, Texas. He has taught at the elementary, secondary, and university levels. His primary interest is in teacher education, particularly helping teachers connect mathematics problem solving to other content areas. At the university, he received grants that supported graduate-level teacher education and the development of instructional materials for elementary mathematics teachers. Since joining the Region 10 ESC staff he has developed mathematics activities that are used in the eight counties of Region 10 and throughout Texas and the United States. In addition to developing and presenting mathematics activities, he is a church musician and published composer.

Concepts covered

Activity	Problem-Solving	Addition	Multiplication	Division	Geometry/Measurement	Ratio	Percent	Fractions	Science	Social Sciences	Language Arts	Fine Arts
Activity 1 Problem Solving Steps	X								X			
Activity 2 Lifting a Lion	X		X	X	X	X			X			
Activity 3 How Salty Is It?	X		X	X	X				X			
Activity 4 Coast to Coast	X		X	X	X	X				X	X	
Activity 5 Football Scores	X	X	X								X	
Activity 6 Overdue Fines	X		X								X	
Activity 7 Hat Trick	X		X	X	X			X		X		
Activity 8 Reforestation	X		X	X	X			X	X	X		
Activity 9 Silenced Songbird	X		X	X	X				X	X		
Activity 10 Water, Water	X		X	X			X		X	X		
Activity 11 Recycled Sounds	X		X	X	X				X			X
Activity 12 Tints and Shades	X					X	X	X				X
Activity 13 Yards of Tin	X		X	X	X	X						X

EXPLORATIONS

Activity 1

Problem-Solving Steps

Concepts/Skills

- Problem-solving

Materials

- TI-15 calculators
- Problem cards
- Problem-solving steps
- Problem-solving strategies card

Overview

Students will work in groups to learn the four steps of problem solving: understanding the problem, making a plan, carrying out the plan, and evaluating the results. This initial activity helps students develop the skills necessary to solve the other problems in the book.

Focus

Discuss with the students how they solve problems. For example:

- *How do you decide what to wear to school in the morning?*
- *Do you consider the weather, your favorite colors, what is clean and in the closet? Or do you use some other information to decide what to wear?*

After the discussion, explain to them that they are going to work together to solve some problems.

Presenting the Problem

1. Have the students work in groups of four. Each group of four needs one Problem Card and one set of Problem-Solving Steps. Each student in the group should have one of the four *Problem-Solving Steps* pages.
2. Students work through the pages in order: *Understanding the Problem*, *Making a Plan*, *Carrying Out the Plan*, and *Evaluating the Plan*. Each person should read his or her page before the group begins. The words in ***bold italics*** are instructions to the reader. The words in the boxes are to be read to the group and some action taken. Each person needs to follow the steps on his or her page and record group responses as required.
3. After all groups are finished, they should report back to the whole class about their problem and how they solved it.

Evaluating the Results

After the presentations have been made, have the students compare the steps taken to solve each problem. Did each group use all of the steps to solve their problem?

Student Activity

Name ______________________

Date ______________________

Activity 1

Problem-Solving Steps

Understanding the Problem

1. ***Read the problem aloud to your group. Then read what is in this box. Write any answers your group gives you in the box.***

Think about what the problem is asking. Is there extra information in the problem we don't need? Cross out any information we don't need. Remember, not all problems have extra information.

2. ***Now read what is in this box. Write any words that no one knows. Ask for help with those words.***

Does everyone understand all of the words? We all have to know all of the terms in the problem.

3. ***Read the problem aloud to the group again. Then read what is in the box. Write the group's answer in the box.***

We need to write the problem in our own words.

4. ***Read the next box to your group. Write an ending to the sentence.***

Finish this sentence: The question we have to answer is…

5. ***Read this to your group.***

Now we know what the problem is about. Next we will make a plan to solve it. Good work!

Making a Plan

1. ***Read this to the group. Write any answers in the box.***

Look at the list of strategies on the Strategies Card. Which strategies might help us solve this problem?

2. ***Read this to the group. Write any answers in the box.***

Sometimes you need to do something besides one of the strategies. Is there another way to solve the problem? Describe what you think will work.

3. ***Next, read this to the group. You may need to write the steps on another piece of paper.***

Sometimes a list of steps is helpful, such as first we add these numbers, then we divide by this number. What steps should we follow to solve this problem?

4. ***After you have written the list, read this to the group. Write their answers in the box or on another piece of paper.***

Look at the information we have. Do we need other information to solve this problem? Let's list any other information we might need. Where will we get the information?

5. ***Read this to the group last.***

Now we can pat ourselves on the back! Good job! Next, we will work to solve the problem.

Carrying Out the Plan

1. ***Read the problem aloud to the group. Then read the rewritten version of the problem. Next, read the steps the group decided to follow. Finally, read what is in this box.***

> Each of us needs to follow the steps to solve the problem. We will work alone for the first five minutes. Then everyone can work together.

2. ***Everyone needs to have a copy of the problem and all of the information. Check the clock. After five minutes, let everyone discuss what they are doing. Continue working until your group has reached a solution.***
3. ***Next, read this to the group.***

> Does each person have the solution written? You need to know what your answer is and how you got it.

4. ***Finally, read this to the group.***

> We are now three-fourths of the way through the problem-solving process. Way to go! Our next step is to evaluate our answers.

Evaluating the Results

1. ***Read this first. Write the group's comments in the box.***

Some problems have more than one right answer. Other problems have only one right answer. What kind of problem do we have?

2. ***Next, have each person share the answer to the problem.***

Now tell us your answer and how you got it.

3. ***Read this next. Write the groups' comments in the box.***

Do all of the answers make sense? If someone's answer is different from yours, explain how you got your answer. Listen to the other people as they tell how they got their answers. Are all of the answers possible? Is only one of them correct? How do we know?

4. ***Read this next.***

We need to share what we did with the rest of the class. How should we make our presentation?

Each of these problems should be written on separate cards. Each group receives one problem card.

Earth is approximately 150 000 000 kilometres from the sun. The light from the Sun travels at 300 000 kilometres per second.

How long does it take light from the Sun to reach Earth?

Earth is approximately 150 000 000 kilometres from the Sun. Saturn is 10 times as far from the sun as Earth. Light travels at 300 000 kilometres per second.

How long does it take light from the Sun to reach Saturn?

Earth is approximately 150 000 000 kilometres from the Sun. Jupiter is 5 times as far from the sun as Earth. Light travels at 300 000 kilometres per second.

How long does it take light from the Sun to reach Jupiter?

Earth is approximately 150 000 000 kilometres from the Sun. Pluto is 40 times as far from the Sun as Earth. Light travels at 300 000 kilometres per second.

How long does it take light from the Sun to reach Pluto?

Problem-Solving Strategies

Act It Out

Draw a Picture

Guess and Check

Look for a Pattern

Make a Chart or Table

Make an Organized List

Solve a Simpler Problem

Use Logical Reasoning

Work Backwards

EXPLORATIONS

Activity 2

Lifting a Lion

Concepts/Skills

- Multiplication
- Division
- Ratio
- Measurement
- Problem-solving
- Work
- Force
- Energy
- Simple machines

Materials

- TI-15 calculators
- *How Do You Lift a Lion?* by Robert E. Wells, Christy Grant (Editor), Albert Whitman & Co.; ISBN 0807534218
- Ruler
- Meter stick or thin but not pliable board with meter stick attached with tape
- 3 Pencils taped together in a triangular prism shape or other object for fulcrum
- Small toy lion (or other small bean-bag type animal)
- Balance
- Stacking gram masses, or balls of clay or washers weighing about 1 – 5 grams each
- Paper, pencils

Overview

Students will work in cooperative groups to solve a real-world problem presented by the book: *How Do You Lift A Lion?* Using a toy lion and a lever, students will discover how much work is needed to raise the toy lion. They will use proportions to determine the force needed to lift a real lion.

Focus

Read the first section of the book *How Do You Lift A Lion?* by Robert E. Wells to the students. Discuss with the students the parts of a lever shown in the book. Demonstrate making a lever by using a 30-cm ruler with a pencil as a fulcrum. (Note: Do not use the meter stick for the demonstration since doing so will reveal part of the solution.) Place a 5-gram mass (load) at one end of the ruler. Place the pencil (fulcrum) at the 15-cm mark. Have students guess how much weight it will take to lift the five grams. Place masses on the other end of the ruler until the 5-gram mass is lifted. Move the pencil to another location closer to the 5-gram mass. Have students predict how much weight it will take to lift the 5-gram mass. Place masses on the other end of the ruler until the 5-gram mass is lifted. Repeat the process with the fulcrum in two other locations. Write the information in a chart and have the students look for patterns.

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and paraphrase the problem. Make sure the students are clear on what the problem asks.
2. Discuss with students the information on *The Problem* page. Make sure they understand how to create a lever with the meter stick or board and pencils. Remind them of the procedures used in the focus to lift the 5-gram mass.
3. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
4. The presentation should include the mathematics used to predict how much weight it would take to lift the real lion.

Evaluating the Results

1. After the presentations are made, have students examine the various solutions presented.
   - ♦ *How are the presentations similar?*
   - ♦ *How are the presentations different?*
2. Ask them to compare the numbers used.
   - ♦ *Did all groups use the same numbers?*
   - ♦ *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - ♦ *Did each group answer the question?*
   - ♦ *Do the numbers used make sense?*
   - ♦ *Did all of the groups consider all of the variables?*
4. Ask them to evaluate how each group used the calculator to solve the problem.
5. Ask them to extend their thinking.
   - ♦ *How does the weight of the load impact the amount of force needed to lift it with a lever?*

Student Activity

Name ____________________

Date ____________________

Activity 2

Lifting a Lion

The Problem: How much effort will it take to lift a lion with a lever?

Lifting a real lion would be a difficult and dangerous task. So you are going to lift a small toy lion instead. You will use a meter stick as the lever and 3 pencils as the fulcrum. Using the information you gather, your team will predict how much work it will take to lift a real lion.

The Facts

- The position of the fulcrum makes a difference in how much effort it takes to lift an object.
- Effort can be measured in terms of mass, such as grams.
- Proportions can help compare different things, such as comparing a toy lion to a real lion.
- An average full-grown adult lion weighs between 120 and 230 kg.
- An average full-grown adult lion is between 2.5 and 3 metres in length.

The Task

1. Your team will create a chart showing the following information:
   - The amount of work it takes to lift the toy lion with the fulcrum 50 cm from the toy lion
   - The amount of work it takes to lift the toy lion with the fulcrum 25 cm from the toy lion
   - The amount of work it takes to lift the toy lion with the fulcrum 75 cm from the toy lion
   - The predicted amount of work it will take to lift a real lion using a 100 foot lever with the fulcrum 10 m, 15 m, and 20 m from the lion

2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:

   - ♦ How did you measure the amount of work it took to lift the toy lion? Did the position of the fulcrum make a difference? Why do you suppose that happened?
   - ♦ How did you calculate the amount of work it would take to lift a real lion? How did knowing the mass of the toy lion help you in your calculations?
   - ♦ If you were going to lift a real lion, where would you place the fulcrum? Why?

Things to Consider

Understanding the Problem

Read *The Problem* page, and then answer these questions.

- ♦ How much mass did your teacher lift with the 30-cm lever?
- ♦ How much mass was used to lift the load?
- ♦ What difference did the placement of the fulcrum make?

Making a Plan

Before you make your plan, answer these questions.

- ♦ How will you keep the masses on the lever?
- ♦ How will you keep the toy lion on the lever?
- ♦ How will you use the information from the toy lion to answer the questions about the real lion?
- ♦ The mass for the real lion is a range. What number will you use when you calculate the amount of force needed to lift the lion?

Carrying Out the Plan

Before you begin planning your presentation, answer these questions.

- ♦ What does your presentation have to include? Do you have all of the necessary information? What other calculations do you need to make?
- ♦ How will you display your information? What type of chart could you make to display the information? What calculations are needed to make your predictions for the real lion?

Evaluating the Solution

- ♦ Did you answer the question? How do you know?
- ♦ Does your answer make sense? If you move the fulcrum away from the load, does it take more or less effort to lift the lion? Did this happen with all of the different loads?
- ♦ Did everyone in the group write an explanation?

Using the Calculator

Name ____________________

Date ____________________

Lifting a Lion: Using proportions

Miss Kleid is helping plan the refreshments for Field Day. She wanted to know everyone's favorite ice cream flavor so she could order enough ice cream. She surveyed her class. Out of her class of 22 students, 10 students preferred chocolate ice cream, 8 preferred vanilla, and 4 preferred strawberry. Miss Kleid knows there are 531 students at school. How can she predict how many ice cream cups in each flavor she needs?

1. Miss Kleid decides she needs to know the fractional part of her class that likes each flavor. Since there are 22 students in her class, $^{10}/_{22}$ like chocolate, $^{8}/_{22}$ like vanilla, and $^{4}/_{22}$ like strawberry. She decides to simplify the fractions.

Press:	**The display shows:**
10 [n] 22 [d] [Simp] [Enter]	

How does the result help Miss Kleid?

2. Miss Kleid decides that simplifying the fractions doesn't help at all. She needs to know what $^{10}/_{22}$ of 531 students is. Next she tries this:

Press:	**The display shows:**
10 [n] 22 [d] [×] 531 [Enter]	

Does this answer make sense for the number of people in the school who like chocolate ice cream? How do you know? What should Miss Kleid do about the fraction part? What would happen if she simplified the mixed number?

Press:	The display shows:
[Simp] [Enter]	

Does the simplified fraction help?

3. Try the other two fractions and multiply them by 531 to predict the number of students who will prefer vanilla or strawberry ice cream. Do you have fractional parts? What should Miss Kleid do with the fractions to make sure there is enough ice cream for everyone?

EXPLORATIONS

Activity 3

How Salty Is It?

Concepts/Skills

- Multiplication
- Division
- Measurement
- Problem-solving skills

Materials

- TI-15 calculators
- Chart paper
- Marker
- Three 20-litre aquariums
- Sea salt
- Warm water
- Various objects to float

Overview

Students will work in cooperative groups to solve a real-world problem involving salt water. Each group will determine the amount of sea salt needed to turn an aquarium into a simulated salt-water environment. An extension to the mathematics activity is to perform a "sink or float" experiment with the three examples of salt water.

Focus

Ask students to explain the term *salt water*. Have them discuss the possibility of different bodies of salt water having different amounts of salt in the water. Use a map to locate various salt water bodies including the oceans, Mono Lake, the Great Salt Lake, the Dead Sea, and so forth.

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and paraphrase the problem. Make sure the students are clear on what the problem asks.

2. *The Problem* page gives the students the necessary information to solve the problem. Have the students make a plan and carry it out. Help them evaluate their solution before they begin making their chart to show their results.
3. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
4. Have the students post their charts showing the amount of salt required to make each kind of salt water.
5. As a class, compare the results of each group's calculations. Come to consensus about how the salt water should be created. Using the three aquariums, have students prepare the salt water. Once the salt water has been made, have the groups use the three aquariums to conduct a sink or float experiment.

Evaluating the Results

1. After the charts are posted and the experiment completed, have students examine the various solutions presented. Ask the students:
   - *How are the charts similar?*
   - *How are the charts different?*
2. Ask them to compare the numbers used.
   - *Did all groups use the same numbers?*
   - *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - *Did each group answer the question?*
   - *Do the numbers used make sense?*
   - *Did all of the groups consider all of the variables?*
4. Ask them to determine how each group used the calculators.
   - *Did all of the groups use the calculators in the same way?*
5. Ask them to extend their thinking.
   - *What would happen if more salt were added to the Great Salt Lake aquarium?*
   - *What objects do you think would float?*
   - *How could you find out?*

Student Activity

Name ______________________

Date ______________________

Activity 3

How Salty Is It?

The Problem: How much sea salt will it take to create aquarium versions of an ocean, Mono Lake, and Great Salt Lake?

Your team has been asked to create three kinds of salt water: an ocean, Mono Lake, and Great Salt Lake. These three kinds of salt water will be used for a sink or float experiment.

The Facts

- About three-fourths of the world is covered with water. Some of the water is fresh water, but most of it is salt water.
- Not all salt water is the same. Some contains more dissolved chemicals than others.
- The dissolved chemicals are not exactly the same as table salt or sea salt (used in salt-water aquariums). For this experiment, you will use sea salt to simulate the level of dissolved chemicals.
- The ocean has about 24 grams of salt in each litre of water.
- Mono Lake in northern California has about 81 grams of salt in each litre of water.
- The Great Salt Lake's salt content changes. At its saltiest, the Great Salt Lake has about 120 grams of salt in each litre of water.
- Sea salt dissolves more easily in warm water.

The Task

1. Your team will create a chart showing the following information:
   - The amount of salt it will take to make the water in a 20-litre aquarium as salty as the ocean
   - The amount of salt it will take to make the water in a 20-litre aquarium as salty as Mono Lake
   - The amount of salt it will take to make the water in a 20-litre aquarium as salty as the Great Salt Lake
2. After the three aquariums have been set up by the class, you will try floating various objects in the three types of salt water. Add to your first chart the following information:

- A list of items that sink in fresh water but float in ocean water
- A list of items that sink in ocean water but float in Mono Lake water
- A list of items that sink in Mono Lake water but float in Great Salt Lake water
- Lists of items that stay suspended (neither float on the top or sink to the bottom) in each kind of water

3. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:
   - How did you calculate the amount of salt per kind of water? Do your calculations make sense? Did each kind of water use different amounts of salt?
   - Did you find items that sank in one kind of water and floated in another? Why do you suppose that happened?
   - If you wanted to make a 80-litre aquarium as salty as ocean water, what would you do?

Things to Consider

Understanding the Problem

Read the *How Salty Is It? Problem Page,* and then answer these questions.

- How much salt does it take to make a litre of ocean water? A litre of Mono Lake water? A litre of Great Salt Lake water? How do you know?

Making a Plan

Before you make your plan, answer these questions.

- How do you know if an object sinks, floats, or is suspended in water?
- How do you make salt water?

Carrying Out the Plan

Before you begin your chart, answer these questions.

- What does your chart have to show? Do you have all of the necessary information? What other calculations do you need to make?
- How will you display your information on the chart? What additional information will you show on your chart? How many different objects did you use for the experiment? Did you find objects that would float, sink, or suspend in each kind of water? What other information do you know that might make your chart more informative?
- How can you make your chart clear and understandable to the class? Are the letters large enough? Are the colors dark? Is it easy to read?

Evaluating the Solution

- Did you answer the question? How do you know?
- Does your answer make sense? Did size make a difference in whether an object floated or sank? Why do you think that happened?
- Did everyone in the group write an explanation?

Name ______________________

Date ______________________

Using the Calculator

How Salty Is It?: Converting volumes

1. In health class, you learn that people should drink eight 8 oz. glasses of water a day. Your mother buys water in 1-liter bottles. You know that 1 liter = 33.8 ounces. How many 1-liter bottles do you need to drink to have your eight glasses?

Press:	The display shows:
8 [×] 8 [Enter]	

This gives you the number of ounces you need to drink each day.

Press:	The display shows:
64 [÷] 33.8 [Enter]	

This tells you how many 1-liter bottles you need to drink.

How many bottles would your mother need to buy so that you have enough water to drink?

2. You are making punch for a class party. The recipe calls for 1 gallon (128 ounces) of ginger ale. When you go to the store, you find that ginger ale comes in 2-liter bottles. How many 2-liter bottles do you need?

Press:	The display shows:
128 [÷] 33.8 [Enter]	

What is the answer? How many bottles do you need to buy? Remember, you calculated how many liters are in 1 gallon and the ginger ale comes in 2-liter bottles.

3. You are helping your dad paint the outside of your house. The paint sprayer holds one liter of paint. The paint comes in 5 gallon cans. How many times can you fill the sprayer from one can of paint?

Press:	**The display shows:**
5 [×] 128 [Enter]	

This gives you the number of ounces in 5 gallons.

Without clearing the calculator:

Press:	**The display shows:**
[÷] 33.8 [Enter]	

What does this number tell you? How do you know?

EXPLORATIONS

Activity 4

Coast to Coast with Alice

Concepts/Skills

- Multiplication
- Division
- Ratio
- Measurement
- Problem-solving

Materials

- TI-15 calculators
- *Coast to Coast with Alice* by Patricia Rusch Hyatt, Carolrhoda Books, Inc., 1995, ISBN 1-57505-074-9
- United States road maps
- Paper, pencils

Overview

Students will work in cooperative groups to solve a real-world problem comparing automobile travel in the early 1900's and travel today. Each group's final product will include a marked map, a graphic showing the results of the group investigation, an oral presentation about the group's solution to the problem, and individual written explanations about the processes used by the group to reach a solution.

Focus

Read the book *Coast to Coast with Alice* by Patricia Rusch Hyatt to the students. Show the map at the end of the book. Discuss with the students the use of scale to calculate actual distances from a map. (Note: the map in the book does not contain a scale. Students will need a United States road map with a scale to solve the problem.)

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and paraphrase the problem. Make sure the students are clear on what the problem asks.

2. Discuss the information on *The Problem* page with the students. For ease of calculations and comparisons, have the students use an 8-hour day for traveling. If desired, students could include other modes of travel for comparison purposes. If other comparisons are to be made, students should research the average speed for buses, trains, or planes. Students could also investigate the routes taken by these other modes of travel. Have students answer the questions:
   - *Could you follow Alice's route exactly by these other modes of travel? Why?*
3. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
4. In the presentation, students should show the marked map and any graphics they created to solve the problem.

Evaluating the Results

1. After the presentations are made, have students examine the various solutions presented.
   - *How are the presentations similar?*
   - *How are the presentations different?*
2. Ask students to compare the numbers used.
   - *Did all groups use the same numbers?*
   - *Why do you think this is so?*
3. Ask students to determine the reasonableness of the results.
   - *Did each group answer the question?*
   - *Do the numbers used make sense?*
   - *Did all of the groups consider all of the variables?*
4. Ask students to compare how they used the calculator. As different uses are described, ask students to analyze the results for reasonableness.
5. Ask students to extend their thinking. If you wanted to follow Alice's route, which mode of travel would be the best?

Additional Information

Another book, *Alice Ramsey's Grand Adventure* by Don Brown (Houghton Mifflin Company, Boston, 1997, ISBN: 0-395-70127-9) also presents this story.

Student Activity

Name ____________________

Date ____________________

Activity 4

Coast to Coast with Alice

The Problem: How long would Alice Ramsey's trip take today?

Your friend's eccentric great-aunt was born in 1909, the year Alice Ramsey took her trip. She wants to follow Alice Ramsey's route from New York City to San Francisco but she doesn't have 59 days for travel. Your team needs to determine how long the trip would take today, using a current model automobile.

The Facts

- Alice Ramsey drove a 1909 Maxwell touring car to make the trip.
- Alice made the trip with her friend Hermine and her sisters-in-law Nettie and Margaret.
- They visited 31 cities on the trip, starting with New York City and ending in San Francisco.
- The trip took 59 days.
- The Maxwell car that Alice drove could travel at a maximum of 40 miles per hour.
- For this problem, assume that Alice and her friends drove about 8 hours each day.
- Many US highways now have a speed limit of 70 miles per hour.
- Because of stops for food and rest, most drivers average 55 miles per hour on road trips.

The Task

1. Your team will create a display showing the following information:
   - The actual route Alice Ramsey followed, marked on a highway map
   - The mileage for each portion of her trip (city-to-city mileage)
   - The total mileage for the trip
   - The average speed Alice traveled on each portion of her trip
   - The average speed for her entire trip
   - The amount of time it would take to drive the same trip today

2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:

   - How did you calculate the mileage for Alice's trip?
   - How did you calculate the average speed for the trip?
   - Compare the trip in 1909 to the same trip taken today. Calculate how much faster the trip would be today. Explain why you believe your answer is correct.

Things to Consider

Understanding the Problem

Read the *Coast to Coast Problem* page, and then answer these questions.

- How many days did Alice and her friends take to travel from New York City to San Francisco?
- About how many hours of driving did the trip take? How do you know?
- How many miles did Alice and her friends travel? How do you know?
- Do you think Alice drove at the maximum speed for the whole trip? Why do you think so?

Making a Plan

Before you make your plan, answer these questions.

- If you followed Alice's route today, would it be about the same distance? How do you know?
- Would you travel at the same speed that Alice did? How do you know?
- Would you drive about the same number of hours each day that Alice drove? How do you know?

Carrying Out the Plan

Before you begin planning your presentation, answer these questions.

- What does your presentation have to include? Do you have all of the necessary information? What other calculations do you need to make?
- How will you display your information? How could you use the map to show each day's travel in 1909 and today? What other ways could you show the information?
- If your group decided to include other travel modes, how will you include them in your presentation?

Evaluating the Solution

- Did you answer the question? How do you know?
- Does your answer make sense? If you travel faster, will it take more or less time to complete the trip? How do you know?
- Did everyone in the group write an explanation?

Name ______________________

Date ______________________

Using the Calculator

Coast to Coast with Alice: Using stored operations with a constant

Solve this problem with the calculator.

1. Ms. Harris, the principal, is going to give each student in the fifth grade 4 new pencils. She has asked the secretary, Mr. Gonzales, to put the pencils in bundles for each teacher. There are six sections of fifth grade. The number of students in the sections are 22, 25, 24, 27, 23, and 26. How many pencils will go in each bundle?

   Since the number of pencils to be given is constant, you can use the stored operations with a constant function on the calculator.

Press:	The display shows:
[Op1] [×] 4 [Op1] (This stores "multiply by four".)	
22 [Op1]	
25 [Op1]	
24 [Op1]	
27 [Op1]	
23 [Op1]	
26 [Op1]	

Note: To clear Op1, press [Mode] ◄ ◄ [Enter].

2. Little Emily Beth has trouble keeping up with her father when they go for a walk. She has to take 3 steps for each step her father takes. On Monday, Emily Beth took 234 steps on their walk together. On Tuesday, she took 300 steps. On Wednesday, she took 186 steps. On Thursday, she took 459 steps. How many steps did her father take on each day?

   Again, there is a constant involved. This time, division will be used to divide Emily Beth's steps into groups of 3.

Press:	The display shows:
[Op1] [÷] 3 [Op1] (The constant of "divide by three" is stored.)	
234 [Op1]	

   Continue with the rest of the data.

EXPLORATIONS

Activity 5

Football Scores

Concepts/Skills

- Addition
- Multiplication
- Problem-solving

Materials

- TI-15 calculators
- *Miss Nelson Has a Field Day* by Harry Allard and James Marshall, Houghton Mifflin, Boston, 1985, ISBN 0-395-36690-9
- Sports section of a newspaper showing football scores
- Chart paper
- Paper, pencils

Overview

Students will work in cooperative groups to determine the possible combinations of score events to reach a specific score in a football game.

Focus

Read *Miss Nelson Has a Field Day* to the students. Discuss football scores with the students. Present scores from various football games: professional, college, high school, or other scores of interest to the students. Compare the scores of those games with the score from the game in the book. Have students discuss the similarities and differences between all of these scores.

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and paraphrase the problem. Make sure the students are clear on what the problem asks.
2. Discuss with students the information on *The Problem* page. There are numerous combinations that lead to 77 points. Have the students find as many as possible.

3. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
4. Have the teams present their information. Create a class chart showing all of the different ways the different teams solved the problem.

Evaluating the Results

1. After the presentations are made, have students examine the various solutions presented.
   - *How are the presentations similar?*
   - *How are the presentations different?*
2. Ask them to compare the numbers used.
   - *Did all groups use the same numbers?*
   - *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - *Did each group answer the question?*
   - *Do the numbers used make sense?*
   - *Did all of the groups consider all of the variables?*
4. Have them consider the class chart.
   - *Do we have all of the possible combinations?*
   - *How do we know?*
   - *How could we organize the chart to help us see if all combinations have been included?*
5. Ask the class to share the ways they used the calculator and the results they got.

Student Activity

Name ______________________

Date ______________________

Activity 5

Football Scores

The Problem: How could the game score be 77 to 4?

The football team from Horace B. Smedley School won the game 77 to 4. How is this possible? Your team needs to show the different ways a team could score 77 points in a football game.

Action	Points
Touchdown	6
Extra point (only after a touchdown)	1
Two point conversion (only after a touchdown)	2
Field goal	3
Safety	2

The Task

1. Your team will create a poster showing the ways the [Smedley School] team could have earned 77 points.

2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:

   - How did your team decide on the ways the team could have earned 77 points? Do you think you found all of the ways? Why do you think so?

   - What did your team put on its poster? Were there other ways the information could have been displayed? Which way did you like the best? Why?

   - Do you think it is realistic for a team to earn so many points? Why do you think so?

Things to Consider

Understanding the Problem

Read the *Football Scores Problem* page, and then answer these questions.

- What are all of the possible ways a team can score in a football game?
- What are the point values for each of these ways?
- What combinations of point values are actually possible? Can a team score an extra point without making a touchdown first?

Making a Plan

Before you make your plan, answer these questions.

- What is the highest point value a team can earn? Could the team have reached 77 points with just that point value?
- What are the other point values? Could a team reach 77 points with any one of those point values alone?
- Is it realistic that a team would make all their points using only one point value?
- What combination of point values could be used to reach 77 points?

Carrying Out the Plan

Before you begin planning your presentation, answer these questions.

- What does your presentation have to include? Do you have all of the necessary information? What other calculations do you need to make?
- What information needs to be displayed? How will you display your information? What other ways could you show the information?

Evaluating the Solution

- Did you answer the question? How do you know?
- Does your answer make sense? Did all of your combinations total 77 points? Did your combinations follow the rules of football?
- Did everyone in the group write an explanation?
- Did you notice any patterns? How did the patterns help you?
- How did you know when you had found all of the ways to earn 77 points?

Using the Calculator

Name ______________________

Date ______________________

Football Scores: Using parentheses

Consider this problem:

1. Michelle bought school supplies. She bought 5 notebooks at 29 cents each, 6 packages of paper at 58 cents each, and 3 packages of pens at 79 cents each. How much money did she spend?

Press:	The display shows:
[·] 29 [+] [·] 29 [+] [·] 29 [+] [·] 29 [+] [·] 29 [+] [·] 58 [+] [·] 58 [+] [·] 58 [+] [·] 58 [+] [·] 58 [+] [·] 58 [+] [·] 79 [+] [·] 79 [+] [·] 79 [Enter]	

Using parentheses can keep all of the calculations in order and simplify the number of keystrokes used.

Now try this:

Press:	The display shows:
[(] [·] 29 [×] 5 [)] [+] [(] [·] 58 [×] 6 [)] [+] [(] [·] 79 [×] 3 [)] [Enter]	

Was it the same as the first one? Why do you suppose that happened?

2. Roberto was helping his mother at the garage sale. His mother told him he could keep the money from all of the items he sold. Roberto sold 13 items at 5 cents each, 21 items at 10 cents each, and 9 items at 15 cents each. How much money did he get to keep?

Press:	The display shows:
[(] 13 [×] [·] 05 [)] [+] [(] 21 [×] [·] 10 [)] [+] [(] 9 [×] [·] 15 [)] [Enter]	

3. Hildegarde went to the school book fair. She bought 23 books. She bought 9 books at 25 cents each, 10 books at 75 cents each, and 4 books at $1.29 each. How much did Hildegarde spend?

   Write the keystrokes you will use to solve this problem.

   Use a different set of keystrokes to solve the problem. Did you get the same answer? Why do you suppose that happened?

EXPLORATIONS

Activity 6

Overdue Fines

Concepts/Skills

- Multiplication
- Problem-solving

Materials

- TI-15 calculators
- "Overdues" from *A Light in the Attic* by Shel Silverstein; HarperCollins, Publishers, New York; ISBN 0-06-025673-7
- Chart paper
- Markers
- Paper, pencils

Overview

Students will work in cooperative groups to solve a real-world problem: comparing overdue fines at different libraries.

Focus

Read to the students the poem "Overdues" by Shel Silverstein. Discuss overdue fines with them and how they are calculated per day. Ask the students:

- *If the library only charged a penny a day, how much do you suppose the fine will be?*
- *How can you find out?*

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution
2. Have the students read *The Problem* page and paraphrase the problem. Make sure the students are clear on what the problem asks.
3. Discuss with students the information on *The Problem* page. Make sure they understand the information on the chart. Help them determine how they can find the same information about their own library.

4. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
5. In the presentation, students should show a completed display. The display should include a graph with all appropriate labels.

Evaluating the Results

1. After the presentations are made, have students examine the various solutions presented.
   - ♦ *How are the presentations similar?*
   - ♦ *How are the presentations different?*
2. Ask them to compare the numbers used.
   - ♦ *Did all groups use the same numbers?*
   - ♦ *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - ♦ *Did each group answer the question?*
   - ♦ *Do the numbers used make sense?*
   - ♦ *Did all of the groups consider all of the variables?*

Additional Information

The web sites for the libraries used are as follows:

Boston Public Library	www.bpl.org
Boulder Public Library	bcn.boulder.co.us/library/bpl/home.html
Calgary Public Library	public-library.calgary.ab.ca
Pelham Public Library	www.pelham-nh.com/library
Seattle Public Library	www.spl.lib.wa.us

Student Activity

Name ______________________

Date ______________________

Activity 6

Overdue Fines

The Problem: How much would the overdue fine be in different cities?

What if a librarian really charged the narrator of the poem for his overdue book? How much would the fine be?

The Facts

- Overdue book fines start the day after a book is due.
- Fines are different from library to library.
- The amount of time a book can be kept also changes from library to library.
- Some libraries have a maximum fine that can be charged for an overdue book.
- The following chart lists some facts about overdue fines at different libraries.

Library	Length of check out	Overdue fines	Maximum fine
Boston Public Library Massachusetts, US	21 days	$.05 per day for adult books $.02 per day for children's books	No maximum
Boulder Public Library Colorado, US	2 weeks	$.10 per day No fines on children's materials	No maximum
Calgary Public Library, Alberta, Canada	3 weeks	$.30 per day adult books $.15 per day young adult books $.05 per day children's books	No maximum
Pelham Public Library, New Hampshire, US	2 weeks	$.10 per day	$5.00
Seattle Public Library Washington, US	3 weeks	$.10 per day	$4.00
Your Library	???	???	???

The Task

1. Your team will create a poster showing the following information:
   - The number of days the book was overdue
   - A chart showing the information from each of the libraries including your own
   - A graph showing the amount of the overdue fine at each of the libraries on the chart
2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:
   - How did your group calculate the number of days the book is overdue? How do you know the answer is accurate?
   - Were the fines at the libraries the same or different? Why do you suppose that is true?
   - What kind of graph did your team create? Could another graph have been used? How do you know?

Things to Consider

Understanding the Problem

Read the *Overdue Fines Problem* page, and then answer these questions.

- How many days are there in a year? How many days in a leap year? How often do leap years occur?
- When a fine is listed as "per day," does that include the days the library is closed? Why do you think so?
- What is a maximum fine?

Making a Plan

Before you make your plan, answer these questions.

- Could two different libraries charge the same fine for Uncle Henry's book? Why do you think so?
- How does a librarian calculate an overdue fine?
- How many days will it take to reach the "maximum fine" at those libraries that have it?

Carrying Out the Plan

Before you begin planning your presentation, answer these questions.

- What does your presentation have to include? Do you have all of the necessary information? What other calculations do you need to make?
- How will you make your graph? What kinds of graphs would help show the answer to the question? What information will the graph show?
- What other information needs to be displayed?

Evaluating the Solution

- Did you answer the question? How do you know?
- Does your answer make sense? If a library does not have a maximum fine, will the fine be more or less than at a library with a maximum fine?
- If two libraries charge different fines per day, will the total fine be different?
- Did everyone on the team write an explanation?

Name ______________________

Date ______________________

Using the Calculator

Overdue Fines: Basic operations

Use the calculator to solve the following problems.

1. Bill, Roland, and Refugio all save baseball cards. Bill has 73 cards, Roland has 125 cards, and Refugio has 209 cards. How many cards do they have together?

Press:	The display shows:
73 [+] 125 [+] 209 [Enter]	

How do you know your answer is correct?

2. Alicia has 182 baseball cards. She gives 39 cards to Refugio. How many cards does she have now?

Press:	The display shows:
182 [−] 39 [Enter]	

How do you know your answer is correct?

3. Danyel's Explorer troop is going on a camp out. They are taking 17 tents. Each tent needs 9 stakes. How many stakes should Danyel pack?

Press:	The display shows:
17 [×] 9 [Enter]	

How do you know your answer is correct?

4. Tommy is packing teddy bears for the Handy Dandy Toy Company. He has 235 teddy bears to pack. Each box holds 8 teddy bears. How many full boxes will he have when he is finished packing? Will he have any teddy bears left over? How do you know?

Press:	The display shows:
235 [Int÷] 8 [Enter]	

How many full boxes does that make? What happens to the remainder?

Press:	The display shows:
235 [÷] 8 [Enter]	

How is this different from using the [Int÷] key? Which answer is easier to use for this problem? Why do you think so?

EXPLORATIONS

Activity 7

Hat Trick

Concepts/Skills

- Multiplication
- Division
- Fractions
- Measurement
- Money
- Problem-solving
- Prerequisite: understanding of π, circumference, and diameter

Materials

- TI-15 calculators
- Paper, pencils
- Poster paper for visual display
- Chart-sized grid paper (optional for visual display)
- Markers
- Overhead projector or chalkboard

Overview

Students will work in cooperative groups to solve a real-world economics problem. Each group's final product will be a visual and oral presentation to a fictional hat company. Each individual will write an explanation about the processes that the group used to solve the problem.

Focus

Using a show of hands, ask the students the following questions:

- *How many of you like chocolate ice cream?*
- *If you had a choice between chocolate ice cream and strawberry ice cream, how many would choose chocolate ice cream? How many would choose strawberry?*
- *If you had a choice between chocolate ice cream, strawberry ice cream, and cookies and cream ice cream, which one would you choose?*

Calculate the percentage of students who preferred chocolate ice cream in each survey. Discuss with the students the differences in the data from the three surveys.

Ask the following questions:

- *If the cafeteria manager used the results from our survey, what kind of ice cream should he or she buy?*
- *Do you suppose other classes would have similar or different results if they did the same survey? Would the results be the same from two different classes, such as a first-grade class and a sixth-grade class?*

Discuss with the students how surveys often use a sample of people rather than asking all of the people involved. Decisions are often based on the results of a sample.

Presenting the Problem

1. Have the students read the *Hat Trick Problem* page. Have them discuss how the three surveys on ice cream could help them set up the surveys they need to create.
2. Review the four steps of the problem-solving process:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution
3. Discuss with the students the parameters of the final product. Suggest that they consider their visual product as a way to sell their group's ideas to the Top Knot Hat Company board of directors. The teacher will serve as the chairman of the board for the final presentations.
4. If groups have difficulty starting, use the *Things to Consider* page. This page provides guiding questions to help students complete the problem-solving steps.
5. Have students present their ideas and visual display to the class and the chairman of the board.

Evaluating the Results

1. Write the specifications of the project on the board or overhead, using the *Hat Trick Problem* page for the specifications. Have the students in the class evaluate each presentation and visual display for each part of the specifications.
2. After all of the presentations are complete, ask the students to compare the numbers used.
   - *Did all groups use the same numbers?*
   - *Why do you think this is so?*

3. Ask students to determine the reasonableness of the results.
   - *Did each group answer the question?*
   - *Did each group meet all of the parameters?*
4. Ask students to describe all of the ways they used the calculator during the project.
   - *When the calculator was used in different ways, how did the results compare?*
   - *How did the groups analyze the results for reasonableness?*
5. Ask them to extend their thinking.
   - *What other kinds of hats could the Top Knot Hat Company make?*

Student Activity

Name ____________________

Date ____________________

Activity 7

Hat Trick

The Problem: What kind of sports team hats should the Top Knot Hat Company manufacture? How many of each kind should they make?

The marketing department of the Top Knot Hat Company has hired your team to gather information about students in your grade. They need to know favorite colors, typical hat sizes, and favorite sports teams so they can manufacture hats that will be good sellers.

The Facts

- You can use a survey to find information about a group of people.
- Some surveys do not ask every person in a group. They ask a sample of people. Your class can be the sample of students in your grade.
- Hat size is the diameter of a person's head to the nearest $^1/_8$". The diameter of a head can be found by measuring the circumference and dividing by π (3.14 or $^{22}/_7$).
- Even in Canada, most companies use hat sizes that are measured in inches. See the Tilley web site for information. **http://www.boatshow.com/MARINEMARKET/TILLEY/HatSizeChart1.html**

The Task

1. Your team will create a visual display showing:
    - The results of your survey showing favorite colors, typical hat sizes, and favorite sports teams by percent
    - Any other results you think are important to the Top Knot Hat Company
    - Your team's recommendations to the Top Knot Hat Company about the number of hats they should make in each size, color, and logo
2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:
    - What surveys did your team make?
    - What steps did your team follow to compute the numbers needed for your final report? Did the steps give reasonable answers? How do you know?
    - What recommendations did your team make to the Top Knot Hat Company? Did the recommendations make sense? How do you know?

Things to Consider

Understanding the Problem

Read the *Hat Trick Problem* page and then answer these questions.

- Why does the Top Knot Hat Company want to know the favorite colors, the typical hat size, and the favorite sports teams for your grade?
- How can your team go about finding out that information?
- What is a sample?

Making a Plan

- What questions will be on your survey? Who will take the survey?
- How will you find out hat sizes? How many people do you need to measure to find out the right hat sizes for your grade?
- Your recommendations need to be specific. How will you decide how many of each kind of hat the company should make?
- How will you present your survey results?

Carrying Out the Plan

Before you begin your visual display, answer these questions:

- What does your visual display need to show? Do you have all of the necessary information? What other calculations do you need to make?
- How will you display your information? If you are trying to convince the board of directors to follow your team's advice, how can your display help? What other information might be helpful?

Evaluating the Solution

- Did you answer the questions on the *Hat Trick Problem* page? How do you know?
- Does your answer make sense? How did your team use the results of the surveys?
- Do the calculations for the hat sizes make sense? The hat size times 3 should be about the same as the circumference of the head.
- Did everyone in the group write an explanation?

Using the Calculator

Name ____________________

Date ____________________

Hat Trick: Using π

The Greek letter pi (π) is used to represent the numerical relationship between the circumference of a circle and its diameter. If you know either the circumference or the diameter, you can use π to find the other. For example, if you know the diameter of a circle, you can multiply it by π and find the circumference. If you know the circumference, how can you find the diameter?

Try these problems with the calculator:

1. Hai is in charge of a taste test for several different soft drinks. He needs to cover the cans with paper so no one knows which soft drink is in each can. He knows each can has a diameter of about 7 cm. He needs to know the circumference in order to cut the paper.

Press:	The display shows:
7 [×] [π] [Enter]	
[F↔D] to change the display to a number	

If the can is 15 cm high, what size rectangle does Hai need to cut to cover the cans?

2. Delbert is in charge of the Basketball Throw at the school carnival. He is going to use small basketballs for the event. He needs to find a ring the right size for the basketball hoop. Unfortunately, the rings are sold by diameter size. He knows the small basketball has a circumference of 36 cm. What size ring should he buy?

Press:	The display shows:
36 [÷] [π] [Enter]	

Do you need to use the [F↔D] key? If the number is the diameter of the basketball, what size ring should Delbert buy?

Sometimes it is helpful to use the fractional equivalent of π.

For the next problem, use 22/7 as π.

3. The On-Time Clock Company needs to buy boxes for their clocks. The Deluxe Model Clock has a circumference of 62 cm. The square boxes come in the following sizes: 18 cm, 19 cm, 20 cm, 21 cm, and 22 cm. The clock needs to fit snugly in the box for shipping. Which box would be the best for the clock?

Press:	The display shows:
62 [÷] 22 [n] 7 [d] [Enter]	

Does the display show a mixed number? Is it in simplest terms? How can you tell?

(When the answer is in simplest terms, it has a denominator of 11.)

How will you decide which box to use? How would your answer be different if you used the [π] key?

EXPLORATIONS

Activity 8

Reforestation

Concepts/Skills

- Multiplication
- Division
- Fractions
- Measurement
- Money
- Problem-solving

Materials

- TI-15 calculators
- Paper, pencils
- Poster paper for visual display
- Chart-sized grid paper (optional for visual display)
- Markers
- Overhead projector or chalkboard

Overview

Students will work in cooperative groups to solve a real-world environmental problem. Each group's final product will be a visual and oral presentation of the cost of reforestation. Each individual will write an explanation about the processes that the group used to solve the problem.

Focus

Present the students with a problem such as:

- *I know there are about 25 students in each classroom in our school. How can I estimate how many students are in the school?*

Have the students discuss various ways of solving the problem. Have them determine what other information would be needed to solve the problem (the number of rooms with students).

Presenting the Problem

1. Have the students read the *Reforestation Problem* page. Have them discuss how this problem is like the classroom problem they solved in the focus.

2. Review the four steps of the problem-solving process:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution
3. Discuss with the students the parameters of the final product. Suggest that they consider their visual product as a way to sell their group's ideas to Mr. Miller. The teacher will serve as "Mr. Miller" for the final presentations.
4. Groups who have difficulties starting may use the *Things to Consider* page. This page provides guiding questions to help students complete the problem-solving steps.
5. Have students present their ideas and visual display to the class and "Mr. Miller."

Evaluating the Results

1. Write the parameters of the project on the board or overhead. (See *Reforestation Problem* page, *The Task* for the parameters.) Have the students in the class evaluate each presentation and visual display for each parameter.
2. After all of the presentations are complete, ask the students to compare the numbers used.
   - ♦ *Did all groups use the same numbers?*
   - ♦ *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - ♦ *Did each group answer the question?*
   - ♦ *Did each group meet all of the parameters?*
4. Ask them to extend their thinking.
   - ♦ *How could you decrease the cost of reforestation?*
5. Ask students to describe how they used the calculator to solve the problem.

Student Activity

Name ______________________

Date ______________________

Activity 8

Reforestation

The Problem: How much will it cost to reforest 25 square kilometres of forest?

Mr. Miller is looking for a company to reforest his lands. Your company is preparing a bid for him. He currently owns 25 square kilometres of forest land that have about 600 trees per hectare. Requirements for reforestation state that there will be 1000 trees per hectare 5 years after reforestation has occurred. He wants to know how many seedlings you will plant, how many seedlings should be alive at the end of 1 year, 3 years, and 5 years, and how much the planting will cost.

The Facts

- In most reforestation projects, $^{3}/_{4}$ of the seedlings planted are still growing at the end of one year, $^{2}/_{3}$ of the seedlings are still growing at the end of three years, and $^{3}/_{5}$ of the seedlings are still growing at the end of five years.
- After planting, seedling density is usually 3 to 4 trees per 36 square metres.
- 10 000 m^2 = 1 hectare
- 1 km^2= 100 ha
- 1 seedling = 25¢
- Cost to plant 1 seedling = 13¢

The Task

1. Your team will create a visual display showing the following information:
   - The number of trees currently on Mr. Miller's 25 hectares
   - The number of seedlings to be planted
   - The estimated number of seedlings alive after 1 year, 3 years, and 5 years
   - The cost of the seedlings to be planted
   - The cost of planting the seedling
   - The total cost of reforestation

2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:

   - What steps did your group follow to compute the numbers? Did the steps give a reasonable answer? How do you know?
   - How did your group decide on your solution? How do you know your solution makes sense?
   - How did your group use the calculator? How did using the calculator help your group solve the problem?

Things to Consider

Understanding the Problem

Read the *Reforestation Problem* page then answer these questions.

- How many hectares are in one square kilometre? If Mr. Miller has 600 trees per hectare, how many trees does he have in one square kilometre? How do you know?
- If 100 seedlings are planted, how many will be alive after one year? Three years? Five years? How do you know?
- To make sure there are 1000 trees on one hectare after five years, how many seedling need to be planted on that hectare?

Making a Plan

- How many seedlings need to be planted per hectare to have 1000 trees per hectare after five years?
- How many hectares does Mr. Miller have?
- How many seedlings need to be planted in all?
- How much will those seedlings cost?
- How much will it cost to plant those seedlings?
- What will be the total cost of reforestation?
- About how many seedlings will be alive after one year? Three years? Five years?

Carrying Out the Plan

Before you begin your visual display, answer these questions.

- What does your visual display need to show? Do you have all of the necessary information? What other calculations do you need to make?
- How will you display your information? If you are trying to convince Mr. Miller to select your group for the reforestation project, how can your display help convince him? What other information might be helpful?

Evaluating the Solution

- Did you answer the question on the Reforestation Problem Page? How do you know?
- Does your answer make sense? Did your group plant enough seedlings to meet the required number of trees at the end of five years? How do you know?
- Does the calculated cost for reforestation make sense? Is the number of dollars less than the number of seedlings planted? (Remember: it costs less than $1.00 to plant a seedling.)
- Did everyone in the group write an explanation?

Name ____________________

Date ____________________

Using the Calculator

Reforestation: Multiplying decimals

Use the calculator to solve this problem:

1. Hildegarde's mother bought 3 cans of peaches at 89¢ a can. How much did the peaches cost?

Press:	The display shows:
[.] 89 [×] 3 [Enter]	

Does the answer make sense? How do you know?

2. Stefan's mother bought 5 cans of green beans at 49¢ a can, 2 boxes of facial tissues at $1.17 each, and 3 candy bars at 38¢ each. How much did she spend?

Press:	The display shows:
[.] 49 [×] 5 [+] 1 [.] 17 [×] 2 [+] [.] 38 [×] 3 [Enter]	

Does it make sense? Does the calculator multiply or add first? How do you know? How could you use parentheses to make the problem easier to read? Do the parentheses change the answer? How do you know?

3. Anna Maria is having a garage sale. She sold 27 paperback books at 5¢ each. How much did she make on the paperback books?

Press:	The display shows:
[.] 05 [×] 27 [Enter]	

Why do you need to enter a zero before the five? What would happen if you entered [.] 5 [×] 27 [Enter] ? How are the two answers alike? Which answer is more reasonable? How do you know?

EXPLORATIONS

Activity 9

Silenced Songbirds

Concepts/Skills

- Multiplication
- Division
- Measurement
- Problem-solving

Materials

- TI-15 calculators
- Paper, pencils
- Rulers
- Map pencils

Overview

Groups of students will calculate the probable number of Golden-Cheeked Warblers in a specified area of Kerr County, Texas. Each group's final product will include a marked map, a map legend, and explanation paragraphs from each group member.

Background Information

In order to make this problem work mathematically, some adjustments were made in the information presented. All of the basic information is correct: the Golden-cheeked Warbler is a songbird on the endangered species list, the bird nests in the Hill Country of Texas, and each pair requires about 2 hectares of nesting area. The section of Kerr County was chosen for ease of calculation: the fractional area suitable for the birds was selected for mathematical reasons.

Focus

Have the students calculate the area of the classroom. Have them calculate how much area per person the classroom contains. Have them estimate the area per person in their home or apartment. For example, if there are 60 square metres in your classroom and 20 students, there are 3 square metres per person. If the house is 100 square metres and there are 5 people in the house, there are 20 square metres per person.

Presenting the Problem

1. Discuss the concept "endangered species" with the students. What makes a species "endangered?"
2. Discuss a definition of songbird with the students: "a bird, especially of the suborder Oscines of passerines, with a melodious song or call." (From *The American Heritage High School Dictionary,* 1993.) The Golden-cheeked Warbler is a songbird on the endangered species list.
3. Have the students read the *Silenced Songbird Problem* page. Have them discuss how much area a pair of Golden-cheeked Warblers needs. Discuss with the students the various reasons a pair of birds would need so much space.
4. Have each group make a plan to solve the problem. The plan should include ways of finding the numbers they need to solve the problem, drawing a conclusion from that information, and creating the required map.
5. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students solve the problem.

Evaluating the Results

1. After the maps are completed, have groups share what they did. Ask:
   - ♦ *How are the maps similar?*
   - ♦ *How are they different?*
2. Ask the students to compare the maps.
   - ♦ *How can we be certain all of the maps show the needed information?*
   - ♦ *Are all of the legends the same?*
   - ♦ *Did all groups mark the same area of the map?*
   - ♦ *Why do you suppose this is so?*
3. Discuss with the students the numerical answers each group found. Ask them to determine the reasonableness of the results.
   - ♦ *How are the numerical answers alike?*
   - ♦ *How are they different?*
   - ♦ *Is it reasonable for different groups to have different answers?*
   - ♦ *Why do you think so?*
4. Discuss how the calculator was used to solve the problem.
   - ♦ *Did all groups use the calculator in the same way?*
   - ♦ *Why do you think that happened?*

Student Activity

Name ______________________

Date ______________________

Activity 9

Silenced Songbirds

The Problem: How many Golden-cheeked Warblers can live in the part of Kerr County shown on the map?

The Golden-cheeked Warbler is an endangered species found in Texas. In fact, this bird will build its nest only in the Hill Country of Texas. The Hill Country Bird Club wants to estimate how many Golden-cheeked Warblers live in the Kerrville area. They have selected a rectangular area of Kerr County for their survey.

The Facts

- 1 km^2 = 100 ha
- The Hill Country Bird Club estimates that only ¼ of the area on the map is suitable for the warblers.
- Each pair of warblers needs about 2 ha of land.
- 1 ha = 10 000 m^2

The Task

1. Your group will answer the question by marking a map and creating a map legend to show the following:
   - Marked areas showing where the Golden-cheeked Warbler might live
   - The number of square kms in the marked and unmarked areas on the map
   - The number of ha in the marked and unmarked areas on the map
   - The number of Golden-cheeked Warblers that might live in the marked areas
2. Each person will write a paragraph describing the map. This paragraph should answer the following questions:
   - What steps did the group follow to solve the problem at the top of this page? How did the group calculate the number of Golden-cheeked Warblers?
   - Is the group's answer reasonable? How do you know?
   - Bonus Question: Texas Parks and Wildlife rangers estimate that there are about 10,000 pairs of Golden-cheeked Warblers left. How many total ha do these birds need? How many total square kms do these birds need? Solve the problem and explain your solution.

Things to Consider

Understanding the Problem

Read the *Silenced Songbird Problem* page, and then answer these questions.

- How many Golden-cheeked Warblers live in a 2-ha area?
- How many hectares are in a square km?
- How many Golden-cheeked Warblers can live in a square km? How do you know?

Making a Plan

Before you make your plan, answer these questions.

- How many square kms are shown on the map? How do you know?
- How many square kms on the map could have Golden-cheeked Warblers? How do you know?
- How many Golden-cheeked Warblers could live in that many square kms? How do you know?

Carrying Out the Plan

Before you begin your map, answer these questions.

- What is the difference between a km and a square km?
- How can you show square kms on your map?
- How can you mark the areas that could have Golden-cheeked Warblers?
- What information needs to be in your map legend? How will you show that information on the map?

Evaluating the Solution

- Did you answer the question on the *Silenced Songbird Problem* page? How do you know?
- Does your answer make sense? If each pair of warblers needs 2 ha, are there more warblers or more hectares? How do you know?
- Does your paragraph explain the information shown on the map?

Using the Calculator

Name ______________________

Date ______________________

Silenced Songbirds: Solving problems involving area

Solve the following problem with the calculator:

1. Henry is covering a table top with ceramic tiles. The table is 2 ½ metres long and 1 ¼ metres wide. What is the area of the tabletop?

Press:	The display shows:
2 [Unit] 1 [n] 2 [d] [×] 1 [Unit] 1 [n] 4 [d] [Enter]	

Does the answer make sense?

Draw the tabletop on 1-cm grid paper. Let 1 cm = 1 metre.

2. Henry has another problem. The tiles he wants to use are 2 cm square. How many tiles does Henry need to cover the same tabletop?

Calculate the number of tiles in 1 square metre.

Press:	The display shows:
100 [÷] 2 [Enter]	

This gives the number of tiles on one side of the square metre since 100 cm = 1 metre. Now multiply the answer by itself to get the number of tiles in one square metre.

Press:	The display shows:
50 [×] 50 [Enter]	

This answer is the number of 2-cm square tiles in one square metre.

Multiply this answer by the number of square metres in the tabletop (the answer to the first problem).

Press:	The display shows:
2500 [×] 3 [Unit] 1 [n] 8 [d] [Enter]	

Is the answer in mixed number form? Note: The [U n/d ↔ n/d] key changes the display between mixed number form and improper fraction form.

Is the answer in simplest terms? Note: The [Simp] key simplifies the fraction. You may need to simplify more than once. If the display shows $\frac{N}{D} \rightarrow \frac{n}{d}$, you can simplify the fraction further.

Henry can only buy whole tiles. How many tiles does Henry need to buy to complete the tabletop?

1 Mile

2 KM

EXPLORATIONS

Activity 10

Water, Water

Concepts/Skills

- Multiplication
- Division
- Percent
- Ecology
- Problem-solving
- Prerequisite: median

Materials

- TI-15 calculators
- Paper, pencils
- Markers

Overview

Students will work in cooperative groups to solve a real-world problem involving water consumption. Each group's final product will be a chart showing the results of the group investigation, an oral presentation about the group's solution to the problem, and individual written explanations about the processes used by the group to reach a solution.

Focus

Discuss the use and need of water with the students. Have them make estimates/guesses as to the average amount of water one person uses each day. Have them make lists of the ways individuals use water: drinking, bathing, toilet flushing, washing clothes, watering yards, swimming pools, and so forth. Additional information on water consumption can be found at
http://www.glu.org/publications/fate%20report/fate_c2.htm
http://www.greenontario.org/strategy/water.html
http://clarkpud.com/tips.htm.

Background Information

In order to make this problem work mathematically, some adjustments were made in the information presented. Data about the Grimshaw Aquifer was obtained from **http://www.agr.ca/pfra/water/grimrpt2.htm**. Since this activity is based on questions created for an activity about the Edwards Aquifer in Texas, some equivalent data that was not available for the Grimshaw Aquifer was extrapolated from the data provided at **http://www.edwardsaquifer.net** (used in the original activity).

Data from **http://www.agr.ca/pfra/water/grimrpt2.htm** used with permission of Prairie Farm Rehabilitation Administration, Agriculture & Agri-Food Canada.

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and paraphrase the problem. Make sure the students are clear on what the problem asks.
2. *The Problem* page gives the students the necessary information to solve the problem. Have the students make a plan and carry it out. Help them evaluate their solution before they begin making their chart to show their results.
3. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
4. Have the students post their charts and present their plan to the rest of the students.

Evaluating the Results

1. After the charts are posted, have students examine the various solutions presented. Ask:
   - ♦ *How are the charts similar?*
   - ♦ *How are the charts different?*
2. Ask them to compare the numbers used.
   - ♦ *Did all groups use the same numbers?*
   - ♦ *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - ♦ *Did each group answer the question?*
   - ♦ *Do the numbers used make sense?*
   - ♦ *Did all of the groups consider all of the variables?*
4. Ask them to consider how the calculator was used.
   - ♦ *Did all of the groups use the calculator in the same way?*
5. Ask them to extend their thinking.
   - ♦ *What would happen if the discharge of the Edwards aquifer decreased?*
   - ♦ *Would all of the towns survive?*

Extension

The problem calls for using the median discharge of the Grimshaw Aquifer in determining the water consumption of a new town. Students could also calculate the mean discharge and compare the numbers. A discussion about the similarities and differences between two measures could occur.

Additional Information

Additional information about the Grimshaw Aquifer can be found at this web site: **http://www.agr.ca/pfra/water/grimrpt2.htm**.

Student Activity

Name ____________________

Date ____________________

Activity 10

Water, Water

The Problem: How much water will a new town use?

Your team has been asked to decide if the Grimshaw Aquifer can be used as the water source for a new town in northern Alberta, Canada. This town will have a beginning population of 5000 people. Each year, 5000 more people will live in the town until the population reaches 25 000 people. Your problem is to decide if there will be enough water from the aquifer for the town.

The Facts

- An aquifer is an underground water source. The Grimshaw Aquifer is in northern Alberta.
- In Canada, each family of four uses about 1300 litres of water a day.
- Large quantities of water are measured in cubic metres. One m^3 of water is about 1 000 litres.
- The discharge of the Grimshaw Aquifer includes springs, artesian wells, and water pumped from the aquifer. The amount of discharge changes each year. The chart below shows the annual discharge for the years 1983 – 1997.

Estimated annual discharge for the Grimshaw Aquifer (in cubic metres)

Year	Discharge	Year	Discharge	Year	Discharge
1983	96 570 000	1988	121 996 592	1993	133 663 849
1984	94 182 925	1989	102 832 788	1994	109 269 895
1985	114 862 132	1990	97 897 672	1995	102 054 970
1986	109 605 161	1991	106 024 520	1996	94 625 476
1987	123 646 101	1992	151 576 053	1997	91 822 652

Source: *Proposed Community Focused Management Strategy for the Grimshaw Gravels Aquifer: Technical Report*. 1998. Prairie Farm Rehabilitation Administration, Agriculture & Agri-Food Canada. Used with permission.

- About 30% of the discharge of the Grimshaw Aquifer is used by municipalities, such as the new town, and the other 70% includes springflow, water for irrigation, and water for manufacturing plants.

- One other municipality uses the Grimshaw Aquifer. Peace River, a city of about 6500 people, uses the Grimshaw Aquifer as its primary water source.

The Task

1. Your team will create a chart showing the following information:
   - The number of people in the town each year
   - The amount of water they will use each year
   - The median discharge of the Grimshaw Aquifer in cubic metres
   - The percentage of the median discharge the town will use each year
2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:
   - How did you calculate the amount of water per person?
   - How did you calculate the amount of water the town will use each year?
   - How did you decide if there was enough water for the town?

Things to Consider

Understanding the Problem

Read the *Water, Water Problem* page, and then answer these questions.

- How much water does a family of four use each day? How much water does one person use each day? How much water does one person use in a year? How do you know?
- How many litres of water are in one cubic metre? How many people can live for a day on that number of litres? How do you know?

Making a Plan

Before you make your plan, answer these questions.

- What is an estimate of the median discharge of the Grimshaw Aquifer?
- What percentage of the water was used by municipalities?
- How many cubic metres of water were used by municipalities based on the median discharge?
- How many people could live on that much water for a year?
- How much water does Peace River need for its population for a year?
- What percent of the water for municipalities does Peace River use?
- How much water will the people in your town need each year?

Carrying Out the Plan

Before you begin your chart, answer these questions.

- What does your chart have to show? Do you have all of the necessary information? What other calculations do you need to make?
- What kind of chart would best represent this information?
- How will you display your information on the chart? What additional information will you show on your chart? Have you considered including the discharge of the Grimshaw Aquifer, the amount of water one person uses in a year, or the amount of water Peace River uses each year? What other information do you know that might make your chart more informative?
- How can you make your chart clear and understandable to the class? Are the letters large enough? Are the colors dark? Is it easy to read?

Evaluating the Solution

- Did you answer the question? How do you know?
- Does your answer make sense? Is your population smaller than Peace River? Is the amount of water you plan to use less than the amount used by Peace River?
- Did everyone in the group write an explanation?

Using the Calculator

Name ____________________

Date ____________________

Water, Water: Rounding with the Fix keys

Try this problem with the calculator:

1. Harold went to the store to buy clothes. He bought a pair of jeans for $23, a pair of pants for $31, a shirt for $14, and a sweater for $26. About how much did Harold spend?

Press:	The display shows:
[Fix] [10.] 23 [+] 31 [+] 14 [+] 26 [Enter]	

This gives the answer rounded to the nearest 10.

Press:	The display shows:
[Fix] [100.] 23 [+] 31 [+] 14 [+] 26 [Enter]	
[Fix] [·]	

The exact answer is now in the display.

How are the two rounded answers alike? How are they different? When you use [Fix] [10.], to what place is the answer rounded? When you use [Fix] [100.], to what place is the answer rounded? If you were going shopping, which answer would be more helpful?

2. In our school district, there are 4 elementary schools, 2 middle schools, and 1 high school. The enrollments at the elementary schools are 529, 476, 603, and 411. The enrollments at the middle schools are 496 and 541. The enrollment at the high school is 723. About how many students are in the school district?

Press:	The display shows:
[Fix] [100.] 529 [+] 476 [+] 603 [+] 411 [+] 496 [+] 541 [+] 723 [Enter]	

How is the answer rounded?

Now calculate the answer to the nearest 10. What keys do you need to use for this calculation?

Now calculate the answer to the nearest 1000. What keys do you need to use for this calculation?

What is the exact answer to the problem? What keys do you need to use to find this answer?

3. The Dallas Stars and the Buffalo Sabres played in the 1999 Stanley Cup finals. They played 6 games. The attendance at each game was as follows:

Game	Attendance
Game 1	17,001
Game 2	17,001
Game 3	18,595
Game 4	18,595
Game 5	17,001
Game 6	18,595

About how many people attended the six games, rounded to the nearest 1000?

What is the exact answer to the problem? When would you need an exact answer? When would a rounded answer be more helpful?

EXPLORATIONS

Activity 11

Recycled Sounds

Concepts/Skills

- Multiplication
- Division
- Measurement
- Problem-solving

Materials

- TI-15 calculators
- Empty 1-litre bottles (8 per group)
- Empty 2-litre bottles (2 bottles for focus activity)
- Water
- Funnels
- Rulers (metric and customary)
- Metric measuring cups or graduated cylinders

Overview

Students will work in cooperative groups to solve a real-world problem creating a musical instrument from empty 1-litre bottles. The groups will use fractional equivalents to tune the bottles.

Focus

Fill one 2-litre bottle half full with water. Blow across the mouth of the bottle to make a sound. Take an empty 2-litre bottle. Blow across the mouth of the bottle to make a sound. Discuss the two different pitches: the empty bottle will have a lower pitch than the half-full bottle. (Note: students may confuse high and low pitches with loud and soft sounds. Help them understand the difference.)

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and restate the problem in their own words. Make sure the students are clear on what the problem asks.

2. Discuss with students the information on *The Problem*. The chart shows the volume of water needed to created the pitches. Note: The shape of the one-litre bottle makes a difference in the pitch. Adjustments may need to be made to have the bottles in tune. For most students, the level of accuracy in the chart will allow them to recognize the eight pitches of the scale.
3. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
4. Allow the teams time to practice the selected song. Each student in the team should have two bottles (assuming teams of four) that should not be shared with anyone else.

Evaluating the Results

1. After the presentations are made, have students examine the various solutions presented. Ask:
   - ♦ *How are the presentations similar?*
   - ♦ *How are the presentations different?*
2. Ask them to compare the numbers used.
   - ♦ *Did all groups use the same numbers?*
   - ♦ *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - ♦ *Did each group answer the question?*
   - ♦ *Do the numbers used make sense?*
   - ♦ *Did all of the groups consider all of the variables?*
4. Ask groups to analyze the variety of ways students used the calculator to solve the problem.

Student Activity

Name ______________________

Date ______________________

Activity 11

Recycled Sounds

The Problem: How can an eight-note scale be made with 1-litre bottles?

The Facts

- Sounds can be created in a variety of ways. Glass litre bottles can make sounds by striking them with a mallet. Plastic litre bottles can make sounds by blowing across the top of the bottle.
- Filling the bottles with different amounts of water can make different pitches.
- The chart below can help you decide how much water you need to use to fill each bottle to make each pitch by blowing across the opening.

To make this pitch:	Fill the bottle with this much water:
1	Empty
2	$^{11}/_{50}$ litre
3	$^{30}/_{73}$ litre
4	$^{12}/_{25}$ litre
5	$^{10}/_{17}$ litre
6	$^{39}/_{55}$ litre
7	$^{24}/_{31}$ litre
8	$^{13}/_{16}$ litre

The Task

1. Your team will create a set of eight tuned bottles. Each bottle will be a different pitch. Your team will then perform a melody on the tuned bottles.
2. Your team will also create a chart showing:
   - The amount of water in each bottle
   - How the amounts were calculated

3. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:
   - ♦ How did your team calculate the amount of water in each bottle?
   - ♦ Did all of the teams use the same method for calculating the amount of water? Why do you suppose that happened?
   - ♦ How is the amount of water in the bottle related to the pitch you hear? Why do you suppose that is true?

Recycled Sounds Song Page

Play each numbered bottle in order. The vertical lines divide the music into groups of 3 or 4 beats. The horizontal lines indicate a note that should sound longer.

On Top Of Old Smokey

1 | 1 3 5 | 8 - - | 6 - 6 | 4 5 6 | 5 - - | - - 1 | 1 3 5 | 5 - - | 2 - 3 | 4 3 2 | 1 - -

Twinkle, Twinkle, Little Star

1 1 5 5 | 6 6 5 - | 4 4 3 3 | 2 2 1 - | 5 5 4 4 | 3 3 2 - | 5 5 4 4 | 3 3 2 - |
1 1 5 5 | 6 6 5 - | 4 4 3 3 | 2 2 1 -

Joy to the World (simplified version)

8 - 7 6 | 5 - - 4 | 3 - 2 - | 1 - - 5 | 6 - - 6 | 7 - - 7 | 8 - - 8 | 8 7 6 5 | 5 4 3 8 |

8 7 6 5 | 5 4 3 3 | 3 3 3 4 | 5 - 4 3 | 2 2 2 3 | 4 - 3 2 | 1 8 - 6 | 5 4 3 4 | 3 - 2 - |1 - - -

Row, Row, Row Your Boat

1 - - 1- - | 1 - 2 3 - - | 3 - 2 3 - 4 | 5 - - - - - | 8 8 8 5 5 5 | 3 3 3 1 1 1 |
5 - 4 3 - 2 | 1 - - - - -

A Tisket A Tasket

5 | 5 - 3 6 | 5 - 3 4 | 5 5 3 6 | 5 - 3 3 | 4 4 2 2 | 4 4 2 2 | 5 4 3 2 | 3 - 1 -

Things to Consider

Understanding the Problem

Read the *Recycled Sounds Problem* page, and then answer these questions.

- ♦ How many bottles do you need to use? How many different pitches do you need to have?
- ♦ How will you change the pitch?

Making a Plan

Before you make your plan, answer these questions.

- ♦ What measurements can you use? What tools will you need to make these measurements?
- ♦ How will you calculate the amount of water needed? Does the measurement chosen make a difference in your calculations? Why do you think so?

Carrying Out the Plan

Before you begin planning your presentation, answer these questions.

- ♦ What does your presentation have to include? Do you have all of the necessary information? What other calculations do you need to make? Which song will you play?
- ♦ What information needs to be displayed? How will you display your information? What other ways could you show the information?

Evaluating the Solution

- ♦ Did you answer the question? How do you know?
- ♦ Does your answer make sense? Was your group able to perform the song?
- ♦ Did everyone in the group write an explanation?

Name ______________________

Date ______________________

Using the Calculator

Recycled Sounds: Multiplying fractions

What happens to a number when you multiply it by a fraction?

Try this:

1. Multiply 12 times $^1/_2$.

Press:	The display shows:
12 [×] 1 [n] 2 [d] [Enter]	

Now try this:

2. Multiply 12 times $^1/_3$.

Press:	The display shows:
12 [×] 1 [n] 3 [d] [Enter]	

Try one more:

3. Multiply 12 times $^1/_6$.

Press:	The display shows:
12 [×] 1 [n] 6 [d] [Enter]	

A conjecture is a mathematical hypothesis. Write a conjecture about what happens when you multiply by a unit fraction (a fraction with 1 in the numerator). Test your conjecture by trying several more examples.

What do you suppose would happen if you multiplied a number by a fraction other than a unit fraction?

4. Multiply 12 times $^{3}/_{4}$.

Press:	The display shows:
12 [×] 3 [n] 4 [d] [Enter]	

5. Multiply 12 times $^{3}/_{5}$.

Press:	The display shows:
12 [×] 3 [n] 5 [d] [Enter]	

6. Multiply 12 times $^{4}/_{5}$.

Press:	The display shows:
12 [×] 4 [n] 5 [d] [Enter]	

Write a conjecture about what happens when you multiply by a fraction. Test your conjecture by trying several more examples.

EXPLORATIONS

Activity 12

Tints and Shades

Concepts/Skills

- Fractions
- Percentages
- Ratios
- Problem-solving

Materials

For each group of 4 students:

- TI-15 calculators
- Four 120 mL cans of water-base paint (white, black, red, and one other color)
- 15 small paper cups for mixing paint
- 4 medicine syringes showing cubic centimeters or millilitres (one for each color of paint)
- 15 small paint brushes
- White construction paper
- Newspapers (for covering desks)
- Container of water (for washing syringes and brushes)

For the teacher:

- Red, yellow, blue transparency film
- Overhead projector

Overview

Students will work in cooperative groups to solve a problem involving mixing paint colors. Color charts will be used to help students determine the fractional parts and percentages of colors used to create tints and shades.

Background information

- A color chart of tints or shades shows a succession of color samples. A tint color chart shows an increasing amount of color added to white paint. A shade color chart shows an increasing amount of black added to a color. To solve the problem, groups of students will create either a tint chart or a shade chart. To prepare them for this experience, all student groups will create samples of tints and shades using red, white, and black paint. The chart showing the measurements to be used is included on the *Tints and Shades Problem* page.

- To help the students measure the paint accurately, use infant medicine syringes. (These syringes can be found in most grocery and drug stores.) To fill the syringe, push the plunger all the way in, place the open end of the syringe in the paint, and pull the plunger out to the desired amount. Place the syringe in the mixing cup. Push the plunger in and the paint squirts into the cup.

Focus

- Discuss how different colors of paint are made with the students. Use color transparencies on the overhead to “mix” red and yellow, yellow and blue, and blue and red. Discuss the different colors that are made using the transparencies.
- Show the students a color chart from a paint store. Select a chart that shows gradual changes in one color. Have the students make conjectures about how each color could have been made. Record the conjectures.

Presenting the Problem

1. To prepare the students for the problem, have groups of students create a sample color chart using the chart on the *Tints and Shades Problem* page. Help them fill the medicine syringes with an accurate measure of each color. Each color must have its own syringe. Have them mix each color thoroughly in the small cups. Have each student use the brush to paint a small circle (about 2 cm in diameter) of each color. Each shade or tint should have its own brush.
2. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read the *Tints and Shades Problem* page and paraphrase the problem. Make sure the students understand the difference between shade and tint. The problem requires 12 tints or shades while the charts only show 6 tints or shades. Have the students discuss ways to create additional tints or shades.

   The problem requires 12 tints or shades while the charts only show 6 tints or shades. Have the students discuss ways to create additional tints or shades.
3. Have each group plan a process to solve the problem from the *Tints and Shades Problem* page. If students have difficulty, have them use the *Things to Consider* page to guide them.

Evaluating the Results

1. When the groups have completed the task, have them present their results. If all of the groups followed the pattern for mixing colors shown on the chart, the results should be very similar. If students chose a more random approach to the problem, the calculated amounts could be quite different and still correct. Allow groups time to check the calculations on all charts.
2. Discuss questions like:
   - *Did everyone attack the problem in the same way?*
   - *How do you know?*
   - *Did any group have similar results to your results?*
   - *Why do you think that happened?*
3. Have the students find a group whose results were similar to their own.
   - *Why do you suppose your results were similar?*
   - *Did any group have similar numbers but not the same colors?*
   - *Why do you suppose this happened?*
4. Ask students to analyze different ways they used the calculator to solve the problem.

Student Activity

Name ______________________

Date ______________________

Activity 12

Tints and Shades

The Problem: How can a particular shade or tint be made when mixing large quantities of paint?

A paint company has asked your team to create a sample color chart to be used for manufacturing paint. You may choose to create either shades or tints. Your team must determine the amount of each color needed to make one batch of each shade or tint you create.

The Facts

- Adding small amounts of black to a color creates shades
- Adding small amounts of color to white creates tints
- A millilitre is equivalent to a cubic centimeter

A color chart shows progressive changes in the shade or tint of a color. Use the chart below to make a color chart of tints and shades of red.

Tints of Red						
White	5 cc	5 cc	5 cc	5 cc	5 cc	5 cc
Red	0 cc	1 cc	2 cc	3 cc	4 cc	5 cc

Shades of Red						
Red	5 cc	5 cc	5 cc	5 cc	5 cc	5 cc
Black	0 cc	1 cc	2 cc	3 cc	4 cc	5 cc

The paint company mixes paint in a large vat. The vat holds 960 litres of paint. One batch of paint equals 960 litres.

The Task

1. Your team will choose to make either tints or shades. Your team will create a chart showing the following information:
   - Samples of at least 12 different tints or shades of one color
   - The measured amount of each color of paint for each tint or shade
   - The fractional amount of each color of paint for each tint or shade

- The percentage of each color of paint for each tint or shade
- The number of litres needed of each color of paint to make a batch of each tint or shade

2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:
    - How did you determine the fractional parts of each tint or shade?
    - How did you calculate the percentage of each color of paint for each tint or shade?
    - How did you calculate the amount of each color needed to make one batch of paint?
    - How do you know that the batch of paint will match your sample of paint?

Things to Consider

Understanding the Problem

Read the *Tints and Shades Problem* page, and then answer these questions.

- ♦ What paints do you mix to make a tint? When making a color chart of a tint, what color should be first? What do you do next to make another tint? If you want to keep samples of each tint, what should you do?
- ♦ What paints do you mix to make a shade? When making a color chart of shades, what color should be first? What do you do next to make another shade? If you want to keep samples of each shade, what should you do?
- ♦ Look at the mixing chart for tints. If you wanted to make 5 litres of one of the tints, what would you do? How do you know?

Making a Plan

Before you make your plan, answer these questions.

- ♦ Look at the mixing chart for tints. For the first tint, 5 cc of white was used and 0 cc of red. How much paint was used in all? What fractional part of that amount was white? What fractional part was red? How do you know? Look at the second tint. How much paint was used in all? What fractional part of the paint was white? What fractional part was red? How do you know?
- ♦ If you know the fractional part, how can you calculate the percentage? Calculate the percentages for the first two tints from the chart *on Tints and Shades Problem* page.
- ♦ Your color chart needs to show how to make a large quantity of paint. How can the fractions and percentages help you figure how much of each color you will need? How do you know?

Carrying Out the Plan

Before you begin your chart, answer these questions.

- ♦ What does your chart need to show? Do you have all of the necessary information? What other calculations do you need to make?
- ♦ How will you display your information on the chart? Where will your color samples go? What kind of chart could display the rest of the information? What additional information will you show on your chart? What other information do you know that might make your chart more informative?
- ♦ How can you make your chart clear and understandable to the class? Are the letters large enough? Is it easy to read?

Evaluating the Solution

- Did you answer the question on the *Tints and Shades Problem* page? How do you know?
- Does your answer make sense? Is the total amount of paint used for each batch the same? Should it be? How do you know?
- Did everyone in the group write an explanation?
- How did you use the calculator in your investigation? Did anyone use it in a different way? How did your results compare?

Using the Calculator

Name ____________________

Date ____________________

Tints and Shades: Converting fractions to percents

Try this problem with the calculator:

1. Mr. Garcia's class has 23 students. Fourteen of the students are boys and nine of the students are girls. What fraction of the class are boys? What percentage of the class are boys? What fraction of the class are girls? What percentage of the class are girls?

   The total number of students is the denominator of the fraction. The number of boys (or girls) is the numerator.

Press:	The display shows:
14 [n] 23 [d] [Enter]	

This is the fraction of the class that is boys.

Press:	The display shows:
[F↔D]	

This is the decimal equivalent of the fraction.

Press:	The display shows:
[▸%] [Enter]	

This is the percentage of boys in Mr. Garcia's class.

Press:	The display shows:
9 [n] 23 [d] [Enter]	

This is the fraction of the class that is girls.

Press:	The display shows:
[F↔D]	

This is the decimal equivalent of the fraction.

Press:	The display shows:
[▶%] [Enter]	

This is the percentage of girls in Mr. Garcia's class.

2. On last week's mathematics test, Tabitha got 38 of the 43 problems correct. What percentage of the test did she complete correctly?

   Another way to find percent is to divide the numerator (the number correct) by the denominator (total number of questions). What number would be the numerator? What number would be the denominator?

Press:	The display shows:
38 [÷] 43 [Enter]	

This gives the decimal equivalent of the fraction. To change the decimal fraction to a percent, multiply the decimal fraction by 100.

Press:	The display shows:
[×] 100 [Enter]	

This gives the percentage of the test Tabitha got correct. Note: Use the [Fix] [0.01] to round to the nearest hundredths place.

EXPLORATIONS

Activity 13

Metres of Tin

Concepts/Skills

- Multiplication
- Division
- Ratio
- Measurement
- Geometry
- Problem-solving

Materials

- TI-15 calculators
- Drawing of the Lay Family Concert Organ
- Rulers

Overview

Students will work in cooperative groups to solve a problem involving surface area of cylinders. They will use data collected from a real-world example, the Lay Family Concert Organ in the McDermott Concert Hall in the Meyerson Symphony Center in, Dallas, Texas. The drawing used for the activity is an actual scale drawing produced by C.B. Fisk Inc., the builder of the instrument.

Focus

- Have the students take a cardboard cylinder, such as a toilet paper roll, and draw a line along its height. Have them cut the cylinder along this line and spread the cylinder out, making a rectangle.
- Have the students brainstorm ways the surface area of the cylinder could be calculated. Help the students relate the surface area of the cylinder to the area of a rectangle.
- Have them determine how they could measure the two dimensions needed (height and circumference). Discuss how circumference and diameter are related with the students.

Presenting the Problem

1. Review the four steps of problem solving with the students:
   - understanding the problem
   - making a plan
   - carrying out the plan
   - evaluating the solution

   Have the students read *The Problem* page and paraphrase the problem.

2. Discuss the information on the problem page. Help the students relate the toilet paper roll problem to solving the problem of finding the surface area of the pipes. Help them identify the cylindrical part of the pipes. The students will be finding the surface area of open cylinders.
3. The scale for the drawing is not given. The students have to determine the scale using the measurement of the left-hand pipe.
4. If groups have difficulty with the problem, use the *Things to Consider* page. This page provides guiding questions to help the students complete the problem-solving steps.
5. Have the students post their charts and present their results to the rest of the students.

Evaluating the Results

1. After the presentations are made, have students examine the various solutions presented. Ask:
   - ♦ *How are the presentations similar?*
   - ♦ *How are the presentations different?*
2. Ask them to compare the numbers used.
   - ♦ *Did all groups use the same numbers?*
   - ♦ *Why do you think this is so?*
3. Ask them to determine the reasonableness of the results.
   - ♦ *Did each group answer the question?*
   - ♦ *Do the numbers used make sense?*
4. Ask students to analyze the different ways groups used the calculator to solve the problem.
   - ♦ *How did the results differ, if at all?*
5. Ask them to extend their thinking.
   - ♦ *If one square metre of tin weights 14.678 kg, about how much do these ten pipes weigh?*

Additional Information

Additional information about the Lay Family Concert Organ can be found at these websites:

www.tneorg.com/cbfisk/organs/op100_01.html

www.dallassymphony.com/organ.html

Student Activity

Name ______________________

Date ______________________

Activity 13

Metres of Tin

The Problem: How much tin will it take to make copies of the ten largest pipes of the Lay Family Concert Organ?

Quintadena, the wealthy troll, wanted a wind chime for her patio. She saw the pipes of the Lay Family Concert Organ and thought they would be just the right size. Unfortunately, the Dallas Symphony would not sell her the ten longest pipes. In fact, they didn't want to sell her any pipes at all. She needs your team to measure the pipes so she can have copies of them made.

The Facts

- There are 4,535 pipes in the organ, 70 of which can be seen.
- The longest pipe is over 10 metres tall. The shortest pipe is less than 5 cm tall.
- The pipe on the left side of the drawing plays low F#. The cylindrical part of the pipe is 6.71 m tall.
- The diameter of each pipe is different. The diameter is approximately the width of the pipe as drawn on the diagram.
- Each pipe is made of a cylinder and a cone. The height of the cylindrical part of the pipe determines the pitch of the pipe. The longer the cylinder, the lower the pitch.

The Task

1. Your team will create a chart or graph showing the following information:
   - The height of the cylindrical part of each of the ten longest pipes
   - The diameter of each of the ten longest pipes
   - The circumference of each of the ten longest pipes
   - The surface area of the cylindrical part of each of the ten longest pipes
   - The amount of tin needed to make the cylindrical parts of the ten longest pipes

2. Each person on the team will write an explanation of the team's solution. This explanation will answer these questions:

   - ♦ How did you calculate the height of each pipe?
   - ♦ How did you calculate circumference and surface area of each pipe?
   - ♦ Would the method you chose to calculate the circumference and surface area work for any cylinder? How do you know?
   - ♦ Do your calculations make sense? How do you know?
   - ♦ If tin can be purchased in rolls that are 1 metre wide and 30 metres long, how could you estimate how many rolls it would take to make the pipes for Quintadena's wind chime?

Things to Consider

Understanding the Problem

Read the *Metres of Tin Problem* page, and then answer these questions.

- What do you need to know about each pipe to calculate the surface area?
- What numbers do you already have? What numbers do you still need?

Making a Plan

Before you make your plan, answer these questions.

- How will you find the numbers you need? How does knowing the height of the left pipe help you?
- A scale drawing is like a map. How do you use a map scale to find distances on a map? How can you find out the scale for this drawing? How will the scale for this drawing help you find the height of each pipe?
- What calculations will you need to answer the question?

Carrying Out the Plan

Before you begin planning your presentation, answer these questions.

- What does your presentation have to include? Do you have all of the necessary information? What other calculations do you need to make?
- How will you display your information? How could you use a chart to show the information? How could you use a graph? Which method of sharing your information does your group like the best? Why do you suppose that is true?

Evaluating the Solution

- Did you answer the question? How do you know?
- Does your answer make sense? Did the larger pipes have more surface area or less? How do you know?
- Did everyone in the group write an explanation?

Name ____________________

Date ____________________

Using the Calculator

Metres of Tin: Finding surface area

1. Beverly is working on scenery and props for the school play. She has to paint the exterior of open cylinders and two sizes of cubes. The paint can says that one litre of paint will cover 30 square metres. She has to paint 4 cubes that are 0.6 metres on each side, 4 cubes that are 0.9 metres on each side, and 4 open cylinders that are 0.3 metres in diameter and .9 metres tall. How much paint does she need?

   To solve this problem, you need to know how to calculate surface area. Each face of a cube is a square. There are 6 faces on a cube. If each face is 0.3 square metres, then there are 6 * 0.3 * 0.3 = 0.54 square metres of surface area on a 0.3 m cube. How much surface area is there on each 0.6 m cube?

   To find the area of one face, multiply 0.6 x 0.6.

Press:	The display shows:
0.6 [×] 0.6 [Enter]	

   Since there are six congruent faces on a cube, you can multiply the surface area of one face by 6 to get the surface area for the whole cube.

Press:	The display shows:
0.6 [×] 0.6 [×] 6 [Enter]	

   Try this process again for the 0.9 m cubes.

   Now calculate how much surface area is on 4 cubes of each size.

2. The surface area of a cylinder is a little different. Roll a piece of paper into a tube. This is an open cylinder. To find the area of the cylinder, you need to know the circumference of the circle (which is the same as one edge of the paper) and the height (which is the same as the other edge of the paper). To find the circumference of the circle, multiply the diameter by π.

Press:	The display shows:
0.3 [×] [π] [Enter]	

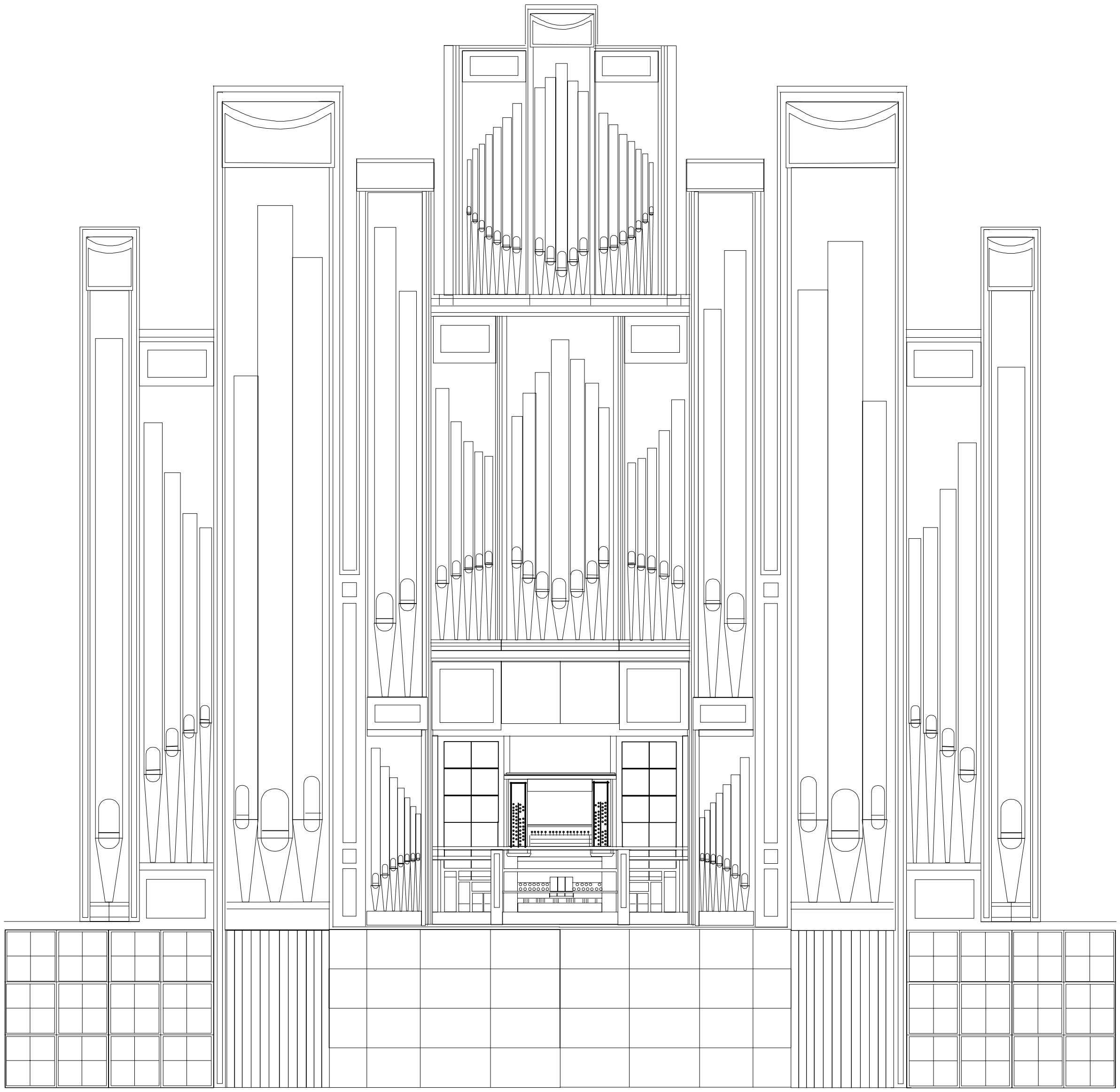
To find the number the calculator used for π, enter [F↔D].

Now multiply the answer times the height of the cylinder.

Press:	The display shows:
[×] 0.9 [Enter]	

The answer is the surface area of one open cylinder in square metres. (Use the [Fix] key to limit the number of decimal places showing.) What is the surface area of four cylinders?

What is the total surface area that needs to be painted? How many litres of paint does Beverly need to complete the scenery for the play?



The Lay Family Concert Organ **C.B. Fisk, Opus 100**

The Dallas Symphony Orchestra

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Gloucester MA 01930

EXPLORATIONS Index