In this middle school mathematics unit two imaginary characters, Horatio and Portia, decide to make their fortune in Quincy Market (Boston, Massachusetts) running a Bull Market cart. In order to solve the problems that they encounter, they need to learn ratio and proportion, map reading, estimation, area and perimeter, population sampling, problem solving, and the collecting and processing of data. Teacher notes at the beginning of each section indicate the math objectives, materials, and whether the activity is a reinforcement or an extension of a math skill. The unit is divided into seven modules that can be used either independently or sequentially. These are: (1) an introduction to Quincy Market; (2) the use of the ruler; (3) map exploration; (4) ratio and proportion; (5) scale drawing; (6) perimeter and area; and (7) a simulation (in which the students run their business using the Bull Market Game or a computer simulation). Each module consists of two or three class activities and additional activities which can be used as extensions. The unit contains student worksheets, teacher notes, transparency masters, Bull Market Game cards, and a diskette to be used with the computer portion of the "simulation" module. (TW)
A Teacher Invigoration and Curriculum Development Project
sponsored by the
National Science Foundation
and
Harvard Graduate School of Education
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This material is based upon work supported by the National Science Foundation under Grant No. MDR-84-70399.

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Hyooshin Kim and Barbara Neufeld of
Education Matters, Inc.
Acknowledgements

We would like to acknowledge the contributions that several people have made to the development of these materials and to the overall implementation of the project.

For their presentations to the Teacher Fellows and project staff and for their helpful comments on the direction of The Regional Math Network activities, special gratitude is due to:

Stanley Bezuszka  Peter Hilton  Steven Leinwand
Patricia Davidson  Alan Hoffer  Henry Pollak
Carole Greene   Deborah Hughes-Hallett  Judah Schwartz
Michael Guillen  Margaret Kenney  Harold Weymouth

The following individuals have given technical advice and contributed their expertise to various aspects of the project:

Aardvark Systems  Steve Codell  Blythe Olshan  Christopher Unger
Eric Arnold  Lily Lee  Pamela Roth  Scott Wilder
John Chuang  Jeff Loeb  Philip Sadler

Special appreciation to David Li, Boston Public School graduate, class of '86, who facilitated the creation of T-Stop Sales.

The Regional Math Network benefitted greatly from the untiring efforts of the Research Assistants and the MidCareer Math and Science Teacher Training Program Fellows. These individuals included:

John Bookston  Mary Eich  Joy Moser  Joe Patuleia  Randy Starr
Lisa Bonanno  Matt Goggins  Sonya Neithrop  Joel Poholsky  Ted Stein
John Burnette  Randall Hancock  Matt O'Connor  Jeff Sayah  Jearid Waitkus
Tom Czarny  David Masunaga  Eileen O'Sullivan  Scott Smith

A special note of thanks is due to the Production Staff who typed, corrected and retyped the multiple drafts. Their willingness to work toward an improved final copy was impressive.

Steve Codell  Scott Cranton  Robert Hafer  Stuart Klein  Loralyn Thompson
Marianne Connolly  John Domilici  Audrey Handelman  Lisa Oray
Brian Cranton  Charles Gerlach  Ruskin Hunt  Robert Sporn

Particular recognition is given to Michael N. Smith of Laser Designs Corp. of Cambridge for his direction and organization during the final stages of production, and to Randy Hobbs of P&R Publications, who guided the printing process.

Finally, the Regional Math Network gratefully acknowledges the administrators, teachers, students, schools and districts within the region that participated in the development and evaluation of the project materials. Th. Regional Math Network would not have been possible without their cooperation.
FOREWORD

Mathematics is an increasingly important skill for understanding and appreciating the challenges in our society. Yet the learning of these concepts poses difficulties for many students, especially as they reach the junior high/middle school years. At the same time, mathematics teachers are leaving their profession at a rapid rate, tired of using materials that have not been revised to reflect changes in our society and its workforce. Clearly, a need exists to revitalize both the self-esteem and the teaching resources of those who have chosen this profession. The Regional Math Network aims to address these difficulties. The project, funded by the National Science Foundation, is sponsored by the Harvard Graduate School of Education.

The overall goal of the Regional Math Network is to invigorate individual teachers and to enhance the quality of the materials and techniques of those in the mathematics teaching profession. To achieve this goal, the Regional Math Network provided 22 Teacher Fellows from eleven school systems with a structured opportunity to collaborate with local business professionals and university personnel in the development of innovative teaching materials and instructional strategies. The school systems represented in the project include Acton, the Archdiocese of Boston, Boston, Cambridge, Chelmsford, Hingham, Lexington, Somerville, Waltham, and the Carroll, the Tower, and the Buckingham, Brown & Nichols Schools.

The Regional Math Network also seeks to stimulate math teaching in the greater Boston area. Toward that end, the Network sponsors seminars, receptions and meetings for math teachers and other interested professionals and students. The Regional Math Network serves as a model of collaboration on several levels: among different schools in the region, between schools and local businesses, and between these parties and the University, which primarily serves as a facilitator and resource.

A fundamental objective is to produce supplemental materials that are engaging for early adolescents and to improve their interest and ability in problem solving. The Teacher Fellows were organized into four project teams, each with a team leader and graduate research assistants. After conducting a needs and interest assessment within many regional schools and districts, each project team selected a specific context that provided the basis for the consideration of a major mathematical topic traditionally covered in the middle school curriculum. These contexts include an ice cream factory, local sporting events, the solar and space shuttle systems and Quincy Market, a local tourist and commercial area. To better understand the context, teams conferred with members of the local business community and worked with students from Harvard's MidCareer Math & Science Program, former business professionals studying to become mathematics teachers.
Each of these four context areas is linked to specific mathematical topics. While this emphasis does not exclude other related topics, teachers seeking materials on a particular topic may choose to work with a specific unit. The topics of emphasis include:

- Ice Cream - Fractions
- Math/Space Mission - Estimation, Geometry and Relational Concepts
- Quincy Market - Ratio and Proportion
- Sports Shorts - Decimals and Percents

All four of the units include a common emphasis on problem posing and problem solving. Many of the activities are open ended, encouraging students to pose their own problems for solving. Other themes and topics common to all of the units stress skills of estimation, graphing, polling, reading and interpreting charts, calculators and computer application and mental arithmetic. All of the materials stress realistic, mathematical applications that are accessible and motivating to middle school students.

Each of the units contains a variety of teacher and student resources. These include teacher notes and teaching suggestions, student pages, answers, activity cards, transparency masters, manipulative materials and classroom games. Additionally, the Quincy Market unit contains a computer disk suitable for any Apple computer.

These materials were written by teachers for other teachers to use. Hence, the materials and format are designed with a teacher’s needs and constraints in mind. Comments about these materials are welcomed and may be made by writing to Professor Katherine K. Merseth, The Regional Math Network, Harvard Graduate School of Education, Cambridge, MA 02138.
NOTES TO TEACHERS
.ContainsKeyNotes to Teachers

Horatio and Portia, A Mathematical Adventure
Overview of the Units
Activity Grid

Student Pages and Teacher Notes

Introduction to Quincy Market
Ruler
Map Exploration
Ratio and Proportion
Scale Drawing
Perimeter and Area
Simulation

Teacher Resources

Resources and Addresses
City/Town Statistics
Quincy Market Data
Super Challenges
Graph Paper
HORATIO AND PORTIA

A Mathematical Adventure

Introduction

Welcome to the world of Horatio and Portia, two imaginary characters who hear about Quincy Market and decide to make their fortune running a Bull Market cart. They have all sorts of adventures and mis-adventures in the process as they use maps to find out how to get to Quincy Market, take surveys to determine what to sell, and finally, run their cart.

Horatio and Portia constantly need math skills to solve their problems. They learn ratio and proportion, map reading, estimation, area and perimeter, population sampling, problem solving, and the collecting and processing of data.

Students who have used this unit in its pilot form have found it both fun and challenging, and we expect that your students will, too. They will use math because they need it to solve interesting and real problems that spark their imagination.

To make this unit easy to use by teachers who have many demands on their time, we have provided a variety of already prepared or easy to prepare materials. The Teacher Notes at the beginning of each section indicate the math objectives, materials needed, and whether the activity is a reinforcement or extension of a math skill.

We have divided the unit into seven modules. Each can be used independently, but the story line and the mathematical ideas flow best when they are used sequentially. The modules are:

1. Introduction to Quincy Market
2. Ruler
3. Map Explanation
4. Ratio and Proportion
5. Scale Drawing
6. Perimeter and Area
7. Simulation

Each module consists of 2-3 class activities and additional activities which can be used to reinforce or extend the topics presented in class. Every effort has been made to present material in a variety of ways and on a variety of levels. You will find individual, group and class activities. Material is presented concretely, visually, verbally, and numerically.

Teachers who have access to a computer for class use will find that the unit provides excellent opportunities for introducing students to real-life computer applications. The data which Horatio and Portia gather can be organized using a data base. In addition, their cart's inventory and financial reports are perfect for spreadsheet applications. We have included a computer game developed for this project, T-Stop Sales, which simulates the Bull Market cart business. The program will run on any Apple II computer.
OVERVIEW OF THE UNITS

Introduction to Quincy Market: This unit, which introduces the student to Quincy Market, provides a variety of alternatives to the teacher. A field trip (guidelines included), or a poster of Quincy Market which can be colored and displayed to stimulate class discussion can "set the scene".

Students are introduced to Horatio and Portia, who have just found a flyer announcing a sales opportunity at Quincy Market. Students read and study the flyer and accompanying scale drawings to glean facts about the market and to make decisions about potential sales opportunities.

Ruler: Students construct their own rulers and then use Quincy Market Bull Cart information to solve puzzles which require careful measurements. A map of a section of downtown Boston is also included which requires measurement and problem solving.

Map Exploration: Students use maps to explore metropolitan Boston. Students locate their own communities, Quincy Market, and other points of interest. They study scale coordinates, linear measurement, and distance within a circle of specific radius as they discover a wide variety of information about Eastern Massachusetts. The state map extends their map reading skills and knowledge of routes, distances and scale.

Ratio and Proportion: Horatio and Portia have to make important decisions about what to sell, how much to charge, and where to locate their cart. Students help Horatio and Portia to make predictions using actual figures from Quincy Market shops. They take their own survey to determine what they would sell. Teachers with access to a computer may have students record and analyze their information using a data base.

This unit incorporates many mathematical objectives including generating data from text and maps, population sampling, ratio, proportion, survey techniques, data collection and analysis, and problem solving.

Scale Drawing: Students use the scale drawing of Quincy Market to construct a classroom display. They then construct three dimensional models of the Bull Market carts and enlarge pictures of a crow and a grasshopper to include in the display.

In this unit, the students are using their knowledge of ratio and proportion, linear measure, scale drawing, and area and perimeter to solve real problems. Since this is a class project, students must depend upon one another for accuracy.

Perimeter and Area: Horatio and Portia need to know about perimeter and area to solve some of their problems. They develop an intuitive understanding of these topics as they explore Quincy Market. For example, they discover how many carts it would take to surround Quincy Market, how many people can fit into a small area, and project these answers onto larger areas.

In this unit students will use their knowledge of perimeter and area to make projections about Quincy Market.
Simulation: Students finally run their cart!! We have provided two methods of achieving this. In the "Bull Market Game", the class (or small groups) compete to make the greatest profit at the end of the week. The teacher who has access to one or more Apple computers can use the program specifically designed for this unit, "T-Stop Sales". In this program, students try to beat Sloppy Joe, a lazy business person who also runs a tee shirt cart. They can beat him only if they order carefully and price wisely. Both options require problem solving strategies and provide a review of basic math skills.

Students also learn to keep business records either by hand or using a computer spreadsheet application. They complete the project by finishing Portia and Horatio's Story.
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INTRODUCTION TO QUINCY MARKET
GETTING THE FACTS

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<td>Generate data from written materials and maps</td>
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**Before Class:**

- Prepare a bulletin board
  - Select appropriate bulletin board materials from the following introductory pages
    (Note: A large poster of Quincy Market is included in your packet)
- Schedule a field trip (optional)
- Make overheads of scale drawings and cast of characters

**During Class:**

1. Introduce the history of Q.M. using "Hometown Boy Makes Good" information sheet.
2. Discuss the present day Q.M. using the scale drawings and "Move Over Mickey Mouse".
3. Introduce the cast of characters (Horatio, Portia, etc.).
   (Note: These characters are essential to the story line in each unit.)

**After Class**

- Ask students to write and solve five interesting math questions based on "Move Over Mickey Mouse."  
  Reinforcement
- Make a poster illustrating an idea from "Hometown Boy Makes Good."
  Reinforcement
Attention

A BUSINESS OPPORTUNITY

RUN YOUR OWN BULL MARKET CART
AT
FANEUIL HALL MARKET PLACE
"FUN, FANTASY, FOOD, AND FROLIC"

Spend a day at Faneuil Hall Market place and find out how the Bull Market carts operate!
QUINCY MARKET FIELD TRIP

A field trip to Quincy Market provides an excellent introduction to this unit. Students not only have an opportunity to "sample the flavor" of Quincy Market, they also have an opportunity to expand their knowledge of Boston history through a trip to Faneuil Hall and to learn how to do some real "data collection" as they gather information about Quincy Market. A trip must be carefully planned, however, so that students gain maximum benefit from it. Some important information to help you plan your trip is included below:

**Best time to visit:** October to May (least crowded)

**Transportation:** Nearest T-Stop is Haymarket. Parking is very limited.

**Cost:** None, other than food and transportation

**Restrooms:** In basement of rotunda, very limited.

**Guided Tours:** None of Quincy Market, but the National Park Service provides guided tours of Faneuil Hall

**Chaperones:** One for every 6 to 10 students if you plan to have students collect data

**Pre-Field Trip Class Preparation:**

- Discuss Quincy Market and Faneuil Hall:
  - Their history (brief outline in appendix)
  - Location (use the T-Aid map)
  - Layout of shops—difference between stall, Bull Market, and store (use diagram)

- Brainstorm about what students should look for:
  - Location and type of food stalls
  - Location and type of Bull Market carts
  - Location of grasshopper (weathervane on Faneuil Hall)
  - Location of bull (weathervane on Quincy Market)
  - Number of salespeople at each stand
  - How weather affects sales
  - How many geometric shapes can students find
  - Which is the best location for a Bull Market cart
  - Which is the most popular cart, food stall
  - How do carts store their supplies

- Assign specific tasks to each group:
  - Make a list of all the food stalls
  - Make a list of all the Bull Market carts
  - Count the number of pieces of pizza sold in 5 minutes (specify which 5 minutes and compare to another 5 minute period at a different time during the day)
  - Count the number of ice cream cones sold in 5 minutes
  - Count the number of people who enter the west door in 5 minutes
  - Estimate the dimensions of Quincy Market

**Follow-Up (homework, projects, etc.)**

- Sketch a model of your favorite cart
- Draw a sketch of Quincy Market with the layout of stalls and carts from your notes
- Write an article on Quincy Market for your school or local newspaper
FANEUIL HALL MARKETPLACE

HOMETOWN BOY MAKES GOOD!
Faneuil Hall was a gift to the city of Boston by Peter Faneuil in 1742 to mark his success and repay his hometown by building a hall for public use.

FIRE DESTROYS FANEUIL HALL!
Faneuil Hall burned down in 1761 and was rebuilt in 1763 with public funds.

THE CRADLE OF LIBERTY!
Faneuil Hall became famous as a meeting place and popular "rostrum." The first rumblings of the American Revolution took place here. Faneuil Hall continues to be a popular, national "rostrum" (have you looked this word up yet?) for many popular and unpopular ideas, causes, and organizations.

-The Hall 'below' became a 'market' for the exchange of goods.

-The Hall 'above' became a 'market' for the exchange of ideas.

GROWING PAINS FOR FANEUIL HALL!
Architect Charles Bullfinch enlarges it in 1806.

A NEW NEXT DOOR NEIGHBOR!
The Quincy Market Building was constructed in 1823. It was designed by architect Alexander Parish.

QUINCY MARKET TAKES NOTHING FOR GRANITE!
The Quincy Market Building is a two story granite market house. It is flanked by two 'harmonious' granite warehouses, one on North Market Street and the other on South Market Street.

...BUT THE WALLS START TUMBLIN' DOWN!
The markets remained in continuous use but by 1950 needed much repair.

REPAIRS, RENEWAL AND REBIRTH!
Redevelopment began in 1973 and was completed in 1978.
Did you know that 12 to 14 million people visit Quincy Market every year! That's more people than visit Disney World! Not only do these people visit Quincy Market—they spend money too!

$\$\$\$\$\$\$\$\$\$\$\$

The average visitor spends $37, including $10 at the Bull Market Carts. The average Bull Market Cart shopper is between 10 and 20 years old. These visitors give an ambitious young businessperson an excellent opportunity to get started.

Who Visits Faneuil Hall Marketplace?

Here are some important figures:

18% work in Boston
18% live within Route 128
7% live in Massachusetts outside Route 128
57% live outside New England

What Do People Eat?

Here are some statistics: (approximate)

Pizzeria Regina sells 600 pizzas a day
The Taco Maker sells 400 tacos and 250 burritos a day
Boston Brownies sells 1000 brownies each day
Introducing

The
Miscalculations
of
Horatio and Portia

THE CAST OF CHARACTERS

HORATIO

What's He Like?

A curious 13 year old--sometimes disorganized, sometimes illogical, sometimes impulsive, and sometimes...........

Favorite Expression:

"Oops! I miscalculated again!"

PORTIA

What's She Like?

A curious 13 year old--sometimes organized, sometimes logical, often methodical, and often...............

Favorite Expression:

"It's perfectly obvious!"
THE GRASSHOPPER

What's He Like?

He's the symbol of Faneuil Hall Market place and sits high atop Faneuil Hall on the weathervane. He's always 'happy-go-lucky'.

Favorite Expression:

"I never measure! I just count my hops!"

THE CROW

What's He Like?

Very logical--all the time!

Favorite Expression:

"The best way to get there is to fly in a straight line."

THE BULL

What's He Like?

He is the strong and proud symbol found atop the Quincy Market Building. He lends his name to the Bull Market pushcarts.
FOLLOW THE RULER

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading a Ruler</td>
<td>Rulers</td>
</tr>
<tr>
<td>Estimation Skills</td>
<td>Tape measure (optional)</td>
</tr>
</tbody>
</table>

During Class:

1. Using "Portia's Complaint" do the following: (overhead may be used to verify answers)
   a. Introduce the ruler and discuss the divisions of an inch into 1/2, 1/4, 1/8, 1/16 inch segments.
   b. Compare the divisions of an inch on the different rulers.
   c. Ask students to mark various measurements on the rulers (e.g., find 2 1/2 and place an "A" there)

2. Have students estimate (do not allow rulers) and record their estimates on "Classroom Trivia" and/or "How do you Measure Up?"

3. Measure objects previously estimated and complete "Classroom Trivia" or "How do you Measure Up?" (Decide on appropriate degree of accuracy)

After Class

"Code to Portia"                             Reinforcement
Research the history of linear measurements and origins of specific units of measurement (e.g., inch, foot, yard)  Extension
PORTIA: I was absent when you taught rulers. It's not my fault!
<table>
<thead>
<tr>
<th>OBJECT</th>
<th>ESTIMATION</th>
<th>ACTUAL MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of your desk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of your desk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of file cabinet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of room</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of door</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of your book</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickness of desk top</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diameter of clock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Now think of your own</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Less than 1&quot;)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Less than 1')</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Less than 1 yard)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**HOW DO YOU MEASURE UP?**

<table>
<thead>
<tr>
<th>Object</th>
<th>Estimation</th>
<th>Actual Measurement (to nearest inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arm span</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hand span</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Little finger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width across palm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of thumb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of smile</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longest hair on your head</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Some interesting measurements!
- Distance from nose to end of extended arm is approx. 36" (adult).
- Span of hand is approx. 7 inches. Sheet of paper is 8 1/2" X 11".
- Pens are approx. 6" long.

Now use the back of your paper to write 5 ratios comparing the lengths of various parts of your body.
To help Portia with her ruler skills, Horatio has left her a secret message which she must decode by reading these rulers.

1. I will meet you at

   1 1/2, 3/4, 5, 2 1/4, 2 7/8, 3 3/8, 4 1/4, 5 5/8, 1 7/8, 1 1/4, 2 5/8, 1/2

2. around

   2 1/2, 4, 1 1/4, 3/8, 3 1/2, 5 1/4, 1 1/8, 5/8

3. We should plan to meet at

   1 3/8, 3 3/8, 2 5/8, 5 3/4, 1 7/8, 5 3/4, 1/4, 6/8, 5/8, 4 7/8, 3 1/4, 2 3/4

4. Do you want pepperoni, mushroom, onion pepper, or

   3 1/2, 2 1/4, 4/8, 5 1/4, 4, 1 5/8, 2 7/8, 3 5/8, 4 1/2
## WHERE'S MY CART?

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading a Ruler</td>
<td>Rulers</td>
</tr>
<tr>
<td>Estimating Skills</td>
<td></td>
</tr>
</tbody>
</table>

### During Class:

Use "The Name Game" and/or "The Match Game" to reinforce skills.

### After Class

"Take the Bull by the Horns" Extension
<table>
<thead>
<tr>
<th>THE MATCH GAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEART STOP</td>
</tr>
<tr>
<td>BEAR WARES</td>
</tr>
<tr>
<td>STRAWBERRY PATCH</td>
</tr>
<tr>
<td>T-STOPS</td>
</tr>
<tr>
<td>DOUBLE SCOOP</td>
</tr>
<tr>
<td>FLOWER POWER</td>
</tr>
<tr>
<td>BALLOONS A-FLOAT</td>
</tr>
<tr>
<td>COOKIE JAR</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THE NAME GAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>END OF THE RAINBOW</td>
</tr>
<tr>
<td>SWEET-TOOTH</td>
</tr>
<tr>
<td>PIECE OF PIZZA</td>
</tr>
<tr>
<td>POT OF GOLD</td>
</tr>
<tr>
<td>BUTTON BOUTIQUE</td>
</tr>
<tr>
<td>BOOK WORM</td>
</tr>
<tr>
<td>POWDER PUFF</td>
</tr>
<tr>
<td>COUNTRY CUPBOARD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TAKE THE BULL BY THE HORN</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRAIN ENGINE</td>
</tr>
<tr>
<td>LUCKY DIP</td>
</tr>
<tr>
<td>LETTERS</td>
</tr>
<tr>
<td>SAILBOAT</td>
</tr>
<tr>
<td>PIANO</td>
</tr>
</tbody>
</table>
THE MATCH GAME

GRASSHOPPER:
You know, I'm the symbol of Faneuil Hall Marketplace.
Well, I'm the symbol of logic and common sense.
And I know how to match all the carts with their symbols.
How can you do that?
I learned how to measure! I'll show you how!

CROW:

HORATIO:

GRASSHOPPER:

HORATIO:

Directions: Find each cart by measuring from dot to dot. Cut out the stickers from the sticker sheet for Bull Market Lessons and paste on each cart correctly.
1. From A to the Cookie Jar cart is 4 2/4".
2. From C to the Bear Wares cart is 2 3/4".
3. The Strawberry Patch is 2 1/4" from the Cookie Jar.
4. The T-Stops cart is 3 1/4" from C.
5. Heart Stop is 2 2/4" away from The Strawberry Patch.
6. The Double Scoop is 6 3/4" from D.
7. The Flower Power cart is 3 1/4" from T-Stops.
8. 9 2/4" from Bear Wares is Balloons-A-Float.
THE NAME GAME

HORATIO: I'm not sure where all the carts are in the Bull Market.

PORTIA: It's perfectly obvious to me where they are!

CROW: O.K. then, Portia, where's The Country Cupboard?

PORTIA: Well, it's, uh, um..., over there, near the, uh, um, or I think maybe it's near the ...

CROW: I think there's a way we can measure and figure out where they are!

Directions: Find each Cart by measuring from dot to dot. Cut out the stickers from the sticker sheet for Bull Market Lessons and paste on each cart correctly.

1. From A to the Sweet Tooth is 7 1/2".
2. Piece of Pizza cart is 3 1/2" from End of the Rainbow.
3. 2 1/2" from B is the Pot of Gold jewelry cart.
4. The Button Boutique is 5 1/2" from Pot of Gold.
5. The distance from Button Boutique to Book Worm is 9 1/2".
6. The Powder Puff is 2" from Book Worm.
7. The Country Cupboard is 6 1/2" from cart G.
8. End of the Rainbow is 5 1/4" from Sweet Tooth.
TAKE THE BULL BY THE HORN

DIRECTIONS:

1. Name each cart. Use the "Take the Bull by the Horns" sheet. Put an appropriate symbol in each cart (or create your own). Save this as an answer sheet.

2. Write a set of directions for the points similar to the Bull Market Cart lessons.

PUZZLES BY ______________________________ (YOUR NAME)

DIRECTIONS:

1. From point A to ______________________ measures ________.
2. _______  ____________________ ________
3. _______  ____________________ ________
4. _______  ____________________ ________
5. _______  ____________________ ________
6. _______  ____________________ ________
7. _______  ____________________ ________
8. _______  ____________________ ________
9. _______  ____________________ ________
10. _______  ____________________ ________
11. _______  ____________________ ________
12. _______  ____________________ ________

Are you an expert game creator? Give your directions and a blank Bull Market Cart sheet to a classmate to solve.
Take the Bull by the Horns.
LINE UP

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measuring to nearest 1/8&quot;</td>
<td>Rulers</td>
</tr>
<tr>
<td></td>
<td>Adding Machine Tape or masking tape (1 yd. for every 2-3 students.)</td>
</tr>
<tr>
<td></td>
<td>Length cards, cut a sufficient number for all groups and put each set in a container.</td>
</tr>
</tbody>
</table>

During Class:

Arrange class into groups of two or three students. Students take turns drawing a length card and marking off the lengths indicated on their tape. First group to complete the length of their tape wins. Groups check each other's work.

Example:

First student chooses 3/4" and marks that length on tape. Next student chooses 1/2" so must mark 1 1/4" on the tape.

![Ruler Diagram]

After Class

"As the Grasshopper Hops" Extension
### LENGTH CARDS

<table>
<thead>
<tr>
<th>7/8&quot;</th>
<th>1 3/4&quot;</th>
<th>3 7/8&quot;</th>
<th>5&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8&quot;</td>
<td>1 1/4&quot;</td>
<td>3 3/4&quot;</td>
<td>4 7/8&quot;</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>1 1/2&quot;</td>
<td>3 1/2&quot;</td>
<td>2 5/8&quot;</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>4&quot;</td>
<td>2 7/8&quot;</td>
<td>4 1/2&quot;</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>3&quot;</td>
<td>2 3/8&quot;</td>
<td>3 3/8&quot;</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>2&quot;</td>
<td>2 1/8&quot;</td>
<td>4 5/8&quot;</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>.1&quot;</td>
<td>2 1/2&quot;</td>
<td>4 3/4&quot;</td>
</tr>
</tbody>
</table>
AS THE GRASSHOPPER HOPS

Use the Boston Back Bay Map.
Measure all map lengths of streets to the nearest 1/4".
YOU MUST TRAVEL ONLY ON THE STREETS.

1. Measure the map length of Marlborough Street. ____________ (Note Marlborough Street runs from Massachusetts Avenue to Arlington Street.)

2. Measure the map length of Gloucester Street. ____________

3. Find the shortest distance from the corner of Fairfield Street and Beacon Street to the corner of Dartmouth Street and Newbury Street. ____________

Using different streets, find another route to reach the same destination. Record the distance and explain your route. ____________

4. Traveling from the corner of Boylston Street and Hereford Street to the corner of Exeter Street and Newbury Street, how many different routes can you find? ____________

5. How many inches will the grasshopper travel on this map route:

   Begin at the corner of Massachusetts Avenue and Beacon St.
   Hop down Beacon St. and turn right on Hereford St.,
   Hop down Hereford St. and turn left on Newbury St.,
   Hop down Newbury St. and turn left on Dartmouth St.,
   Hop down Dartmouth St. and turn right on Marlborough St.,
   Hop to Berkeley St.

   ____________

If 1 inch = 1/8 mile, approximately how many miles would the grasshopper have traveled if he took the real trip? ____________

6. If a three inch grasshopper can hop approximately twenty times his length, how many hops will it take him to cover the route in question five? This is tough! ____________
7. Find the spot:

Begin at the corner of Arlington St. and Newbury St. and go
1 1/2" down Newbury St.
Turn right and go 2 3/4".
Turn left and go 3 1/4".
Turn left and go 3 3/4".
Turn right and go 1 1/2"

Use street names to tell where you would be at the end of the trip.

Approximately how many miles would this trip be if 1" = 1/8 mile?
To help Ponta with her ruler skills, Horatio has left her a secret message that needs decoding by reading these rulers.

1. Ian met you at 9
2. Around noon
3. We should plan to meet at 1
4. Do you want pepperoni, mushroom, or pepperoni?

Directions: Find each card by measuring from dot to dot. Cut out the stickers from the sticker sheet for Bull Market Lessons and place each card correctly.

1. From A to the Sweet Tooth is 7 1/2".
2. Piece of Pizza card is 9 1/2" from End of the Rainbow.
3. 2 1/2" from B is the Pet of Gold jewelry cart.
4. The Butter Boutique is 5 1/2" from Pet of Gold.
5. The distance from Butter Boutique to Book Worm is 9 1/2".
6. The Powder Puff is 2" from Book Worm.
7. The Country Cupboard is 8 1/2" from card C.
8. End of the Rainbow is 5 1/4" from Sweet Tooth.

THE NAME GAME

HORATIO: I'm not sure where all the cats are in the Bull Market.
PORTIA: It's perfectly obvious to me where they are.
CROW: O.K., then, Portia, where's The Country Cupboard?
PORTIA: Well, it's uh, um... over there, near the, uh, um, or I think maybe it's near the...
CROW: I think there's a way we can measure and find out where they are!

THE MATCH GAME

GRASSHOPPER: You know, I'm the symbol of Forcall Half Kneeling.
CROW: Well, I'm the symbol of logic and common sense.
HORATIO: And I know how to match all the cats with their symbols.
GRASSHOPPER: How can you do that?
HORATIO: I learned how to measure! I'll show you how!

Directions: Find each card by measuring from dot to dot. Cut out the stickers from the sticker sheet for Bull Market Lessons and place each cat correctly.

1. From A to the Cookie Jar cat is 4 3/4".
2. From C to the Bear Whimsy cat is 2 3/4".
3. The Strawberry Patch is 2 1/4" from the Cookie Jar.
4. The T-Wing cat is 2 1/4" from C.
5. Heart Step is 2 1/4" away from The Strawberry Patch.
6. The Double Scoop is 8 3/4" from D.
7. The Flower Power cat is 5 1/4" from T-Steps.
8. 5 3/4" from Bear Whimsy is Balcony-A-Poind.

Note: The diagram on the right shows the ruler measurements for the cards.
Use the Boston Back Bay Map.

1. Measure the map length of Marlborough Street. \[7 \frac{3}{4}\]" (Note Marlborough Street runs from Massachusetts Avenue to Arlington Street.)

2. Measure the map length of Gloucester Street. \[5\]"

3. Find the shortest distance from the corner of Fairfield Street and Beacon Street to the corner of Dartmouth Street and Newbury Street.

4. Travelling from the corner of Boylston Street and Hereford Street to the corner of Exeter Street and Newbury Street, how many different routes can you find? Explain all of the shortest routes.

5. How many inches will the grasshopper travel on this map route:
   - Begin at the corner of Massachusetts Avenue and Beacon St.
   - Hop down Beacon St. and turn right on Hereford St.
   - Hop down Hereford St. and turn left on Newbury St.
   - Hop down Newbury St. and turn left on Dartmouth St.
   - Hop down Dartmouth St. and turn right on Marlborough St.
   - Hop to Berkeley St.

   \[12 \frac{1}{2}\]"

   If 1 inch = 1/8 mile, approximately how many miles would the grasshopper have traveled if he took the real trip?

   \[1 \frac{3}{4}\] miles

6. If a three-inch grasshopper can hop approximately twenty times his length, how many hops will it take him to cover the route in question five?

   This is tough! \[15 \frac{3}{4}\] hops

7. Find the spot:
   - Begin at the corner of Arlington St. and Newbury St. and go
     - 1 1/2" down Newbury St.
     - Turn right and go 2 3/4".
     - Turn left and go 3 1/4".
     - Turn right and go 1 1/2"

   Use street names to tell where you would be at the end of the trip.

   The corner of Hereford St. and Boylston St.

   Approximately how many miles would this trip be if 1" = 1/8 mile?

   \[1 \frac{3}{4}\] miles
A PARTIAL MAP OF
BOSTON
MASSACHUSETTS

CAMBRIDGE
MEMORIAL DRIVE
CHARLES RIVER BASIN

MAP EXPLORATION

Regional Math Network • Harvard Graduate School of Education • Harvard University
MAP EXPLORATION

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate System, Scales, Ratio and Proportion</td>
<td>Boston and Vicinity Map</td>
</tr>
<tr>
<td>Distances within a Specific Circle</td>
<td>Review map and coordinates</td>
</tr>
<tr>
<td></td>
<td>before class</td>
</tr>
</tbody>
</table>

**During class:**

1. Introduce the Boston and Vicinity Map.
   a. Arrange students in groups and let them examine the map for 5 minutes. Discuss and list some of the pertinent information.
   b. Locate Quincy Market and your town. Discuss possible routes between them.

2. Discuss coordinates.

3. Play a game "I'm thinking of a town." (Student says "I'm thinking of a town in G-4.") Other students must identify that town (same idea as 20 questions). Questions must be ones requiring only a "yes" or "no" answer.

**After Class**

Partial Map of Boston

Have students generate questions about this map or write your own questions on the board. (e.g. Give the coordinates for Fenway Park or what town is found in A10?)
A PARTIAL MAP OF BOSTON
MASSACHUSETTS
BOSTON AND VICINITY

Topic/Objective
Scales - Ratio and Proportion
Distances within a specific radius

Materials
Boston and and Vicinity Map
Rulers, String, Compass, or
Circle transparencies
(masters included)

During class:

1. Calculate distances using scale measure.
   Have the student:
   a. Give the scale measure of the map (1" = 2 miles).
   b. Measure approximate mileage between two towns by measuring from the first
      letter of one to the first letter of the other. Explain that we have chosen this
      method because it is well defined, but the method can be misleading. Is it really
      only one mile from Belmont to Arlington—should we measure from center of town
      to center of town? Can we tell the center of town from this map? Can anyone
      think of another accurate method?

   1. Newton to Chelsea (9 miles)
   2. Brookline to Medford (7 1/2 miles)
   3. Lexington to Bedford (4 miles)
   4. Boston to Newton (8 miles)
   5. Holliston to Wellesley (10 1/2 miles)
   6. Dedham to Hingham (14 miles)
   7. Acton to Natick (15 1/2 miles)
   8. Peabody to Revere (9 miles)
   *9. Your town to other towns.
   *10. Your town to Quincy Market.

2. Determine distance using a radius and make a chart. (optional)
   Review the meaning of the term radius and teach students how to determine towns
   within a specific circle using transparencies, string, or compass.
   Have the student:
   a. List the towns within a 5 mile radius of Winchester and record.
      (Lexington, Arlington, Belmont, Medford, Malden, Melrose, Stoneham, Woburn,
      Burlington)
   b. List the towns within a 6 mile radius of Watertown and record.
      (Arlington, Medford, Somerville, Cambridge, Brookline, Newton, Waltham,
      Belmont)
   c. List those towns that are in both sets. (Arlington, Belmont, Medford)

After Class
"Routes from Boston" Extension

The Regional Math Network • Harvard Graduate School of Education • Harvard University
6" Circle Transparency
1. How many miles is it from Boston to Cambridge to Watertown to Newton? _______

2. How many miles is it from Boston to Cambridge to Brookline to Newton? _______

3. How much further is it from Boston to Newton if you go through Somerville than if you take the most direct route? ________________

4. Make a list of 2 different routes you can take from Boston to Framingham if you can't pass through the same city/town twice? Show the cities in order, using the first letter of each city name. Reminder: Use BO for Boston and BR for Brookline.

   Example: ROUTE                      TOTAL NUMBER OF MILES
   BO-C-W-N-F                        20

   Now find two other routes from Boston to Framingham.
   ____________________________________   ______________________
   ____________________________________   ______________________

5. What is the shortest route from Boston to Framingham?
   ____________________   How many miles? ________________

6. How many miles is the longest route from Boston to Framingham if you can't pass through the same town/city twice? ________________

7. Find a route which leaves Boston and visits every town/city just once and ends back in Boston.
   ________________________________

   How many miles is it? ________________

   Is there more than one route? _______
WHERE DOES THE CROW LAND?

**Topic/Objective**
- Scale
- Linear Measure

**Materials**
- Massachusetts map
- Push pins or thumbtacks
- 1 set of Crow cards

**During class:**

1. Arrange students in groups of 4-5. Give each group a map. Note that now students will measure from the centers of towns, not from first letters of names.

2. Give each group the same crow card. The group decides using the map where the push pin should be placed.

3. Choose a group at random to place the push pin on the bulletin board map. That group assigns a member to go to the bulletin board.

4. The other groups verify that the push pin has been correctly placed. If the pin was incorrectly placed, another group may try. Points should be awarded for correct placement and subtracted for incorrect placement.

**After Class**

- Have students write their own crow cards to add to the deck
- Have students develop a system for noting which push pin matches each crow card.
WHERE DOES THE CROW LAND?

<table>
<thead>
<tr>
<th>#1</th>
<th>#2</th>
<th>#3</th>
</tr>
</thead>
<tbody>
<tr>
<td>The crow starts in Boston and flies 18 miles towards Lowell. Where does he land?</td>
<td>The crow starts in Lawrence and flies 21 miles toward Gloucester. Where does he land?</td>
<td>The crow starts in Chicopee and flies 33 miles toward Fitchburg. Where does he land?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>#4</th>
<th>#5</th>
<th>#6</th>
</tr>
</thead>
<tbody>
<tr>
<td>The crow starts in Northampton and flies 19.5 miles toward Fitchburg. Where does he land?</td>
<td>The crow starts in Chelmsford and flies 16.5 miles toward Needham. Where does he land?</td>
<td>The crow starts in Fall River and flies 43.5 miles toward Worcester. Where does he land?</td>
</tr>
</tbody>
</table>
**WHERE DOES THE CROW LAND?**

<table>
<thead>
<tr>
<th>#7</th>
<th>#8</th>
<th>#9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>The crow starts in Arlington and flies 19.5 miles toward Lunenburg. Where does he land?</strong></td>
<td><strong>The crow starts in Pittsfield and flies 51 miles toward Worcester. Where does he land?</strong></td>
<td><strong>The crow starts in Belmont and flies 45 miles toward Bourne. Where does he land?</strong></td>
</tr>
<tr>
<td>#10</td>
<td>#11</td>
<td>#12</td>
</tr>
<tr>
<td><strong>The crow starts in New Bedford and flies 10.5 miles toward Nantucket State Forest. Where does he land?</strong></td>
<td><strong>The crow starts in Beverly and flies 26 miles toward Provincetown. Where does he land?</strong></td>
<td><strong>The crow starts in Lawrence and flies 4.5 miles toward Melrose. Where does he land?</strong></td>
</tr>
</tbody>
</table>
**WHERE DOES THE CROW LAND?**

<table>
<thead>
<tr>
<th># 13</th>
<th># 14</th>
<th># 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>The crow starts in Cambridge and flies 9 miles toward Sudbury. Where does he land?</td>
<td>The crow starts in Palmer and flies 16.5 miles toward Stockbridge. Where does he land?</td>
<td>The crow starts in Pittsfield and flies 60 miles towards Fitchburg. Where does he land?</td>
</tr>
<tr>
<td># 16</td>
<td># 17</td>
<td># 18</td>
</tr>
<tr>
<td>The crow starts in Foxborough and flies 60 miles toward Amherst. Where does he land?</td>
<td>The crow starts in Holden and flies 6 miles toward Hudson. Where does he land?</td>
<td>The crow starts in Newburyport and flies 12 miles toward Peabody. Where does he land?</td>
</tr>
</tbody>
</table>
### WHERE DOES THE CROW LAND?

<table>
<thead>
<tr>
<th># 19</th>
<th># 20</th>
<th># 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>The crow starts in Bridgewater and flies 42 miles toward Amesbury. Where does he land?</td>
<td>The crow starts in Westfield and flies 60 miles toward Groton. Where does he land?</td>
<td>The crow starts in Boston and flies 103 miles toward Pittsfield. Where does he land?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># 22</th>
<th># 23</th>
<th># 24</th>
</tr>
</thead>
<tbody>
<tr>
<td>The crow starts in Framingham and flies 19.5 miles toward Brockton. Where does he land?</td>
<td>The crow starts in Palmer and flies 22.5 miles toward Ashburnham. Where does he land?</td>
<td>The crow starts in Lynn and flies 12 miles toward Gloucester. Where does he land?</td>
</tr>
</tbody>
</table>
1. How many miles is it from Boston to Cambridge to Watertown to Newton? 9 miles

2. How many miles is it from Boston to Cambridge to Brookline to Newton? 11 miles

3. How much farther is it from Boston to Newton if you go through Somerville than if you take the most direct route? 2 miles

4. Make a list of 2 different routes you can take from Boston to Framingham if you can't pass through the same city/town twice. Show the cities in order, using the first letter of each city name. Reminder: Use BO for Boston and BR for Brookline.

Example: ROUTE TOTAL NUMBER OF MILES
BO-C-W-N-F 20
Now find two other routes from Boston to Framingham.
BO-G-W-N-F 26 miles
BO-G-M-D-F 36 miles

5. What is the shortest route from Boston to Framingham? BO-C-W-N-F
6. How many miles is the longest route from Boston to Framingham if you can't pass through the same city/town twice? 36 miles

7. Find a route which leaves Boston and visits every town/city just once and ends back in Boston. BO-G-A-N-D-F-N-R-W-C-S-BD

How many miles is it? 69 miles
Is there more than one route? Yes
RATIO AND PROPORTION
Your Ratios

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>Total school population by grade and sex. See Appendix for other useful statistics.</td>
</tr>
</tbody>
</table>

**During Class:**

1. Introduce the concept of a ratio as a comparison of two quantities using the "Your Ratios" chart (2 out of 3, 2 to 3, 2:3, 2/3).

   If class size is odd, you may choose to:
   - add yourself
   - add imaginary students
   - use calculators

   For school and town populations, you may choose to use rounded numbers.

2. Reduce ratios of larger numbers, if possible.

   - The ratio of a vote of 140,000 to 200,000 is equivalent to the ratio of a vote of 7 to 10.
   - If 400 out of 1000 people buy ginger ale, this ratio is equivalent to 2 out of 5 people buying ginger ale.

   Simplify some examples from the chart.

3. Change some of these simplified ratios to percents.

**After Class**

"Your Ratios"  Reinforcement

Add your own ratios and complete chart.
<table>
<thead>
<tr>
<th>Your Classroom</th>
<th>Ratio</th>
<th>Simplified Ratio</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys to total students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls to total students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students to desks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue-eyed students to total students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown-eyed students to total students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left-handed students to total students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Our class to total school population</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population of seventh grade to town population</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Think of YOUR OWN RATIOS for the remaining spaces.*

1. 
2. 
3. 
4. 
### PORTIA PREDICTS

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportions</td>
<td>&quot;Your Ratios&quot; completed for last night's homework</td>
</tr>
</tbody>
</table>

#### During Class:

1. Introduce the concept of proportion with examples on the board. A proportion is an equation that states that two ratios are equal.
   - **A. Review from fractions:**
     - **Reducing:** If 4 out of every 8 students will go on a field trip, and 47 students go on a field trip, how many students are there in all?
       
       \[
       \frac{4}{8} = \frac{47}{?}
       \]

       Expanding: If the ratio of boys to girls in your class is 4 to 5 and there are 15 girls in the class, how many boys are there in the class?
       
       \[
       \frac{4}{5} = \frac{?}{15}
       \]

   - **B. Introduce cross multiplication:**
     If I have a ratio of 2 candy bars for every 3 children, and I have 28 students, how many candy bars will I have?
     
     \[
     \frac{2 \text{ candy bars}}{3 \text{ students}} = \frac{? \text{ candy bars}}{28 \text{ students}}
     \]

2. Use "Your Ratios" to generate new examples and in particular to predict statistics for the school.

#### After Class:

- "Portia Predicts" Reinforcement
- Textbook Examples of Cross Multiplication
- or Use QM data in Appendix to generate questions
Portia watched what foods were being sold at Quincy Market. She learned some interesting things. Can you use her research to answer these questions?

Assume: Quincy Market is open 10 hours every day, 7 days a week.*

1. At the Taco Maker Horatio observed that 20 tacos were sold in 30 minutes. At this rate, how many tacos would be sold in ...

| ______ tacos in 1 hour | ______ tacos in 1 1/2 hours |
| ______ tacos in 5 hours | ______ tacos in 1 day |
| ______ tacos in 1 week | ______ tacos in 1 year |

2. Portia was told the Pizzera Regina sells an average of 600 pizzas per day. At this rate, how many pizzas would be sold in ...

| ______ pizzas in 1 hour | ______ pizzas in 5 hours |
| ______ pizzas in 1 week | ______ pizzas in 1 year |

3. Horatio discovered the Boston Brownie sell 5 times as many brownies to adults as to young people, a 5 to 1 ratio. (Warning! This isn't a 1 to 5 ratio)

1) If they sell a total of 180 brownies in 1 hour, how many were sold to adults? _______ to young people? _______

2) How many brownies are sold in one day to adults? _______ to young people? _______

3) How many brownies are sold in one week to adults? _______ to young people? _______

* Actually, Quincy Market is only open 6 hours on Sunday but for this set of predictions assume it is open 10 hours on Sunday.
ONE OF THE CROWD

**Topic/Objective**
- Ratio,
- Proportions, Estimation,
- Prediction

**Materials**

**During Class:**

1. What is the ratio of the number of seventh graders in your home town to the number of visitors to Quincy Market?

   **Example:**
   In one year 14,000,000 people visited Quincy Market. If Cambridge seventh graders were the only visitors that year, how many times would each seventh grader have had to visit Quincy Market?

   The ratio of Cambridge seventh graders to the number of visitors is:

   \[
   \frac{500}{14,000,000} \text{ or } \frac{1}{28,000}
   \]

   Every seventh grader would have had to visit Quincy Market 28,000 times that year.

2. How many times would each seventh grader in Boston have to visit Quincy Market in order to total 14,000,000 visitors?

3. You may choose to generate some other examples from this chart or add statistics about towns not listed.

<table>
<thead>
<tr>
<th>Town</th>
<th>Est. Grade 7 Population (1986)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston</td>
<td>4500</td>
</tr>
<tr>
<td>Cambridge</td>
<td>500</td>
</tr>
<tr>
<td>Hingham</td>
<td>275</td>
</tr>
<tr>
<td>Chelmsford</td>
<td>425</td>
</tr>
<tr>
<td>Lexington</td>
<td>350</td>
</tr>
<tr>
<td>Somerville</td>
<td>450</td>
</tr>
<tr>
<td>Waltham</td>
<td>450</td>
</tr>
<tr>
<td>Lincoln</td>
<td>125</td>
</tr>
<tr>
<td>Marblehead</td>
<td>175</td>
</tr>
<tr>
<td>Acton</td>
<td>300</td>
</tr>
<tr>
<td>Medford</td>
<td>375</td>
</tr>
</tbody>
</table>

**After Class:**

"One of the Crowd"
"The Crowd According to Portia"  

Reinforcement  Extension

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HORATIO: There sure are a lot of people here at Faneuil Hall Marketplace!
CROW: About 14,000,000 people visit every year.
HORATIO: Suppose every seventh grader in my school visited Quincy Market. How many times...
CROW: Poor Horatio. He'll never solve that one. We had better help him!

<table>
<thead>
<tr>
<th>Town</th>
<th>Est. Grade 7 Population 1986</th>
<th>Town</th>
<th>Est. Grade 7 Population 1986</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boston</td>
<td>4500</td>
<td>Waltham</td>
<td>450</td>
</tr>
<tr>
<td>Cambridge</td>
<td>500</td>
<td>Lincoln</td>
<td>125</td>
</tr>
<tr>
<td>Hingham</td>
<td>275</td>
<td>Marblehead</td>
<td>175</td>
</tr>
<tr>
<td>Chelmsford</td>
<td>425</td>
<td>Acton</td>
<td>300</td>
</tr>
<tr>
<td>Lexington</td>
<td>350</td>
<td>Medford</td>
<td>375</td>
</tr>
<tr>
<td>Somerville</td>
<td>450</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Suppose your town decides to take every seventh grader in the town to Quincy Market for the day:

1. How many busses would you need if a school bus can carry 50 students? _________
   What is the ratio of students to busses in your town? _________

2. How many pizzas will you order if every student eats two pieces of pizza on the trip and each pizza has eight slices? _________
   What is the ratio of students to pizzas in your town? _________

3. One of the teachers took a survey on the way home and gathered the following information:
   How many students bought
   - 1/5 of the students bought T-shirts. T-shirts? ______
   - 1/3 of the students bought jewelry. Jewelry? ______
   - 3/4 of the students bought candy. Candy? ______

4. Make up your own ratio questions about a trip to Quincy Market.
THE CROWD ACCORDING TO PORTIA

PORTIA: Boy, it's certainly crowded in here!! I can hardly move.

CROW: Did you know that between twelve and fourteen million people visited Faneuil Hall Marketplace last year?

GRASSHOPPER: No! Come on!! That's more people than visited Disney World last year.

PORTIA: It's perfectly obvious it's a reasonable estimate. In the last 15 seconds, I counted 16 people coming through that door. That's 64 in a minute. Wait a minute!! Where's my calculator?? Sixty-four times...

Did Portia estimate correctly? Check her figures.

(Hint: The market is open every day, 10 hours a day, Monday through Saturday. On Sunday it's open 6 hours)
**SURVEY INTRODUCTION**

<table>
<thead>
<tr>
<th><strong>Topic/Objective</strong></th>
<th><strong>Materials</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey techniques</td>
<td>Overheads of:</td>
</tr>
<tr>
<td>Ratio, proportion</td>
<td>Bull’s Eye View of the Carts</td>
</tr>
<tr>
<td></td>
<td>Portia’s Survey</td>
</tr>
</tbody>
</table>

**During class:**

1. Discuss cart locations and products sold at Quincy Market.  
   Locate selected carts on overhead.  
   Use scale drawing on bulletin board to identify specific locations on overhead  
   (i.e. rotunda, doors, stairs, selected restaurants).

2. (Optional) Use these facts to generate discussion of carts:  
   More than 1,000 different products are sold.  
   Only 1% of the carts do not succeed.  
   Cart rental is $175 to $250 per week.  
   4 to 5 applications for carts are received each week.  
   There is often a one-year waiting period to get a cart.  
   New carts have a two-week probation period.

3. Introduce the idea of a survey using overhead of Portia’s Survey.

4. Take class surveys on: favorite ice cream, favorite pizza, etc.

5. Explain that we use the **ratios** determined in a survey (eg. 10 out of 30 students in the class like chocolate ice cream) to make **predictions** about a larger group using **proportions**. Explain that in some situations proportions give us a good estimate but only if the sample of students has similar tastes to the larger group.

6. Explain that in other situations our predictions are much more accurate (e.g., on a map, if the scale is 1" = 3 miles and the distance from Cambridge to Lexington is 2", we can accurately **predict** that the distance will be 6 miles).

7. Discuss "How Will You Make Your Fortune" with students. Have them complete this for homework.

**After Class**

"How Will You Make Your Fortune"  
Reinforcement

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Key to a Bull's Eye View  
(Bull Market Carts, July 1986)

1. T-shirts                                    "Fanueil Hall"
2. Sun glasses                                "Boston"
3. T-shirts                                    make your own
4. Buttons                                    Christmas ornaments personalized
5. Christmas ornaments                        "Just Dreaming" pillows with sayings or names
6. Just Dreaming                               "Wild clothes" jams, dresses, Hawaiian shirts
7. Earrings                                   "Earrings" pillows, scarfs. etc.
8. T-shirts                                    Top Deck beach chairs
9. "Wild clothes"                             "Harvard", "Boston College"
10. "T-shirts"
11. "Scribbly Things"                         color Boston picture (for young children)
12. "Scribbly Things"                         all kinds of chimes
13. MINI CHIMES                                "Hand Painted" welcome signs, thimbles, trinket boxes, refrigerator magnets
14. "MINI CHIMES"
15. "Personalized name posters"
16. "Sign Maker" made to order
17. "T-shirts"                                 "Boston whale watching"
18. "T-shirts"                                 "Boston whale watching"
19. "Posters and note paper"
20. "T-shirts"                                 "Boston Greeting Cod"
21. "Coke hats" straws attached
22. "Shells, plant hangers, and chimes"
23. "Tales and Tails" stuffed animals
24. "Boston Fans" cups, dishes, bumper stickers
25. "T-shirts"                                 "Boston"
26. "Ceramic chimes" butterfly, rainbow
27. "Truly Boston" visor caps, napkins, commuter mugs
28. "Truly Boston"                            "Boston Lobsters, "I love Boston", Boston Beach Club
29. "Pocket Book" wallets, bags
30. "Jewelry" gold pins, charms
31. "Glass" window sun catchers
32. "Li'l Lefty Shop" bags, cups, playing cards
33. "Dinosaurs" puzzles, school bags, stuffed animals
34. "Rainbow Connection" belts
35. "Mail a Heart" personalize your heart, earrings, pins
36. "Celebration" clown dolls, door wreaths, bagel magnets
37. "Celebration"
38. "Straw bags" pocket books
39. "Music theme" shopping bags, cups, hats, key chains, note paper, aprons
40. "Cat theme" cups, banners, leashes, figurines, address books, placques
41. "Glass" lanterns, floating candles
42. "Wizard Shop" figurines, note paper, crystals
43. "Precious Cargo" t-shirts, cups, bags
44. "Marcus and Me" leather bags, belts
45. "Precious Cargo" t-shirts, cups, bags
46. "Leather bags" pocket book
47. "Cape Cod Porcelin" lamps, vases, dishes
Bull Market Carts (cont)

47. Hand woven items
48. Expressions by Chari
49. Paintings
50. Caligraphy and Quotes
51. Notable Names
52. Bagtime
53. Concord Hand Design
54. Salt Marsh Pottery
55. Ireland
56. Handmade mice
57. Inkidincado
58. American Cup
59. Purple Panache
60. Greater Boston Tea Co.

- dresses, scarves, belts
- umbrellas (with messages or names)
- framed (Boston, etc.)
- plaques with quotes
- visor caps, baby clothes
- quilted bags, ties
- pottery, plant pots
- hand-painted pottery, bells, boxes
- Irish toilet paper, plaques, shirts, hats, etc.
- door decorations and stuffed animals
- rubber stamps
- "American Cup" t-shirts, shorts, visors, mugs
- bags, earrings, scarves, pins
- t-shirts
PORTIA: It seems perfectly obvious to me that no one would want a Horatio T-shirt.

HORATIO: Well, I like it!

PORTIA: I think we should take a survey.

Portia's Survey

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-shirts</td>
<td>60</td>
</tr>
<tr>
<td>Jewelry</td>
<td>6</td>
</tr>
<tr>
<td>School Supplies</td>
<td>2</td>
</tr>
<tr>
<td>Stuffed Animals</td>
<td>9</td>
</tr>
<tr>
<td>Buttons</td>
<td>3</td>
</tr>
</tbody>
</table>

Total Survey 80

"At this rate, I will make a FORTUNE!"
HOW WILL YOU MAKE YOUR FORTUNE?
Why not follow Portia's example.

Pretend you want to open a Bull Market cart at Quincy Market. Before you make your application you must decide what would be a profitable item to sell!

To do this you must:

- Choose 5 items to include in the survey and poll family and friends.
- Conduct your survey among 25 people of various ages.
- Record your information on the chart below.

<table>
<thead>
<tr>
<th>ITEM</th>
<th>TALLY</th>
<th>ITEM TOTAL</th>
<th>PERCENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL

Make up 5 questions using Your Survey results.
Creating a Bar Graph

**Topic/Objective**
Survey techniques
Graphing

**Materials**
Overhead of Portia's Survey
Overhead of Steve's Ice Cream Bar Graph
Large scaled graph paper (included)
Construction paper (optional)

During class:

1. Review the techniques for and value of conducting a survey using Portia's Survey from previous lessons. Encourage students to give other examples.

2. Using the results of Steve's Ice Cream Survey, discuss bar graphs and the advantages of depicting information in graphical form. Guidelines for drawing bar graphs are included on Steve's Ice Cream Bar Graph.

3. Work through one of the bar graphs with students in class using Graph Your Stats.

4. (Optional) Discuss License Application which students complete after completing their bar graph.

After Class

"Tally-Ho!" Reinforcement
"Steve's Ice Cream Survey" Extension
STEVE'S ICE CREAM SURVEY

On a recent Tuesday afternoon Horatio took a 4 minute survey at Steve's Ice Cream Shop.

<table>
<thead>
<tr>
<th>Flavor</th>
<th>Number of Cones Sold</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cookie-O</td>
<td>### ### /</td>
<td>12</td>
</tr>
<tr>
<td>Vanilla</td>
<td>### /</td>
<td></td>
</tr>
<tr>
<td>Oatmeal Raisin</td>
<td>### /</td>
<td></td>
</tr>
<tr>
<td>Maple Walnut</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>Chocolate Ripple</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>Strawberry</td>
<td>/</td>
<td></td>
</tr>
</tbody>
</table>

Total Number of Cones Sold in Four Minutes.

Steve's Ice Cream Bar Graph

Your bar graph must have:

1. Title that tells what graph is about
2. Labels—on side and bottom of your graph that tell the kinds of facts listed and how many
3. Bars—horizontal or vertical, that are of equal width and equally spaced
GRAPH YOUR STATS

Your bar graph must have:

1. Title—that tells what graph is about

2. Labels—on side and bottom of your graph that tell the kinds of facts listed and the quantities of each

3. Bars—horizontal or vertical that are of equal width and equally spaced

Draw a bar graph for each of these tally sheets.

This tally sheet shows pounds of candy sold in one hour at Sweet Tooth in Quincy Market.

<table>
<thead>
<tr>
<th>TALLY SHEET</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gummi Bears</td>
<td>### ### ###</td>
</tr>
<tr>
<td>Licorice</td>
<td>###</td>
</tr>
<tr>
<td>Jelly Bears</td>
<td>### ###</td>
</tr>
<tr>
<td>Sweet Tarts</td>
<td>### //</td>
</tr>
<tr>
<td>M&amp;M's</td>
<td>### ###</td>
</tr>
</tbody>
</table>

This sheet shows the results of a survey on adult size T-shirts sold at a T-shirts cart in Quincy Market in one day.

<table>
<thead>
<tr>
<th>TALLY SHEET</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>###</td>
</tr>
<tr>
<td>Medium</td>
<td>### ###</td>
</tr>
<tr>
<td>Large</td>
<td>### ### ######</td>
</tr>
<tr>
<td>Extra Large</td>
<td>### ### ######</td>
</tr>
</tbody>
</table>
Use the information from your survey to create a bar graph of your information.

1. Check your survey tally and bar graph with your Quincy Market representative.

2. When it is approved, ask for an application for a Bull Market License.

3. Complete the license application carefully!

   Good luck!
APPLICATION FOR BULL MARKET LICENSE

Name

Homeroom number

Class Name

Teacher Name

Items to be merchandised

Reasons for selecting above items

Color scheme

Name of cart

How would the cart add to the festive spirit of the market place?

Other information which might best describe your product and presentation

Signature

Date

Please color in this drawing of a Bull Market cart showing the merchandise you would sell, how it would be displayed, any fixtures to be used (boxes, baskets, etc.) the method of hanging or attaching merchandise, the overall color scheme and type of sign, including the name of your cart.
**STEVE'S ICE CREAM SURVEY**

On a recent Tuesday afternoon Horatio took a 4 minute survey at Steve's Ice Cream Shop.

<table>
<thead>
<tr>
<th>Flavor</th>
<th>Number of Cones Sold</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cookie-O</td>
<td>!!!!!!</td>
<td>12</td>
</tr>
<tr>
<td>Vanilla</td>
<td>!!!</td>
<td></td>
</tr>
<tr>
<td>Oatmeal Raisin</td>
<td>!!!/</td>
<td></td>
</tr>
<tr>
<td>Maple Walnut</td>
<td>!!!</td>
<td></td>
</tr>
<tr>
<td>Chocolate Ripple</td>
<td>!!!</td>
<td></td>
</tr>
<tr>
<td>Strawberry</td>
<td>//</td>
<td></td>
</tr>
</tbody>
</table>

Total Number of Cones Sold in Four Minutes: 12

1. What is the ratio of Cookie-O cones to the total number of cones sold? __________
   What is the ratio of each of the other flavors to Cookie-O? _______________________

2. If Steve sells this many cones in 4 minutes, how many does he sell in an hour?
   In a 10 hour day? __________  In 5 days? __________

3. On a weekend day Steve sells twice as many cones as on a weekday. How many cones does he sell on a Saturday? __________
   On a weekend? (Sat and Sunday) __________
   How many cones will he sell in a whole week? __________

4. If it takes one gallon of ice cream to make 25 cones, how many gallons will Steve need on Tuesday?
   _______________________________________________________________________

5. If an ice cream container holds 3 1/2 gallons, how many containers must Steve order for Tuesday?
   _______________________________________________________________________

6. If you were going to order ice cream for a week, how many gallons would you need? __________
   How many containers would that be? __________

7. How many gallons of each flavor per weekday must Steve order? __________

* If each container has a diameter of 16", how much room does Steve need to store a weekday's supply? __________
PORTIA PREDICTS

Portia watched what foods were being sold at Quincy Market. She learned some interesting things. Can you use her research to answer these questions?

Assume: Quincy Market is open 10 hours every day, 2 days a week.

1. At the Taco Maker Horatio observed that 20 tacos were sold in 30 minutes.
   At this rate, how many tacos would be sold in...
   - 1 hour
   - 5 hours
   - 1 week
   - 1 year

2. Portia was told the Finger Fingers卖 an average of 600 pizzas per day.
   At this rate, how many pizzas would be sold in...
   - 1 day
   - 5 hours
   - 1 week
   - 1 year

3. Horatio discovered the Boston Brownie sells 5 times as many brownies to adults as to young people, a 5 to 1 ratio. (Warning: This isn't a 1 to 5 ratio)
   - If they sell a total of 180 brownies in 1 hour, how many were sold to adults?
   - How many brownies are sold in one week?
   - How many brownies are sold in one year?

4. Horatio recorded the Boston Brownie sells 5 times as many brownies to adults as to young people, a 5 to 1 ratio. (Warning: This isn't a 1 to 5 ratio)
   - If they sell a total of 180 brownies in 1 hour, how many were sold to adults?
   - How many brownies are sold in one week?
   - How many brownies are sold in one year?

* Actually, Quincy Market is only open 6 hours on Sunday but for this set of predictions assume it is open 10 hours on Sunday.

THE CROWD ACCORDING TO PORTIA

PORTIA: Boy, it's certainly crowded in here! I can hardly move.
CROW: Did you know that between twelve and fourteen million people visited Faneuil Hall Marketplace last year?
GRASSHOPPER: Not. Come on! That's more people than visited Disneyland last year.
PORTIA: It's perfectly obvious! It's a reasonable estimate. In the last 15 seconds, I counted 16 people coming through that door. That's 64 in a minute. How many minutes? Where's my calculator? Sixty-four times...

---

STEVE'S ICE CREAM SURVEY

On a recent Tuesday afternoon Horatio took a 4 minute survey at Steve's Ice Cream Shop.

---

ONE OF THE CROWD

HORATIO: There sure are a lot of people here at Faneuil Hall Marketplace!
CROW: About 14,000,000 people visit every year.
HORATIO: Suppose every seventh grader in my school visited Quincy Market. How many times?
CROW: Poor Horatio. He'll never solve that one. We had better help him.

---

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SCALE DRAWING
SCALE DRAWING OF SHOPS

**Topic/Objective**
- Scale drawing
- Linear measure
- Perimeter, area

**Materials**
- Graph paper, rulers
- Scissors, paper
- Direction cards (per store)
- Construction paper, tape
- Graph paper - included in packet (6 blocks per inch)

**Pre-class preparation:**
Review scale drawings of Quincy Market; determine scale appropriate to display area (e.g. if 9' are available, use a 1" = 6' scale); cut up cards and review them; position the outlines of Quincy Market using the dimensions listed below.

**During class:**
1. Use a sample card to show students how to determine the correct scaled dimensions for their shop.
   Example: Cardoos 6' x 24'
   If 1" = 6', the scaled dimensions of Cardoos would be 1" x 4".
2. Each student selects a card and computes the scaled dimensions for that store.
3. Then, each student draws his/her shop on graph paper using correct dimensions. Using the graph paper as a guide, students then transfer this shape onto construction paper. Each shop should be named and may be decorated if there is time.
4. Discuss the floor plan with the students. Plot the location of the sample shop. Each student locates his/her shop and positions it correctly.

**Floor Plan**
Quincy Market Building

![Floor Plan Diagram]

West

East

Regional Math Network • Harvard Graduate School of Education • Harvard University
<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Product</th>
<th>Dimensions</th>
<th>1&quot; = 6' Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coffee Connection</td>
<td>coffee, etc.</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>2</td>
<td>Beverly's Kitchen</td>
<td>quiches &amp; soups</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>3</td>
<td>Kilvert &amp; Forbes</td>
<td>cookies &amp; brownies</td>
<td>[Diagram]</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Paul W. Marks</td>
<td>cheese</td>
<td>24' x 18'</td>
<td>4&quot; x 3&quot;</td>
</tr>
<tr>
<td>5</td>
<td>Aegean Fare</td>
<td>Greek specialties</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>6</td>
<td>Pizzeria Regina</td>
<td>pizza</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>7</td>
<td>Peanut Butter Fantasies</td>
<td>peanut butter</td>
<td>24' x 21'</td>
<td>4&quot; x 3 1/2&quot;</td>
</tr>
<tr>
<td>8</td>
<td>J.P. Aboody</td>
<td>fruit cups &amp; salads</td>
<td>[Diagram]</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Cardoos</td>
<td>candy &amp; nuts</td>
<td>6' x 24'</td>
<td>1&quot; x 4&quot;</td>
</tr>
</tbody>
</table>
## QUINCY MARKET INFORMATION SHEET

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Product</th>
<th>Dimensions</th>
<th>1&quot; = 6' Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Joey's Gelateria</td>
<td>ice cream</td>
<td>9' x 18'</td>
<td>1 1/2&quot; x 3&quot;</td>
</tr>
<tr>
<td>11</td>
<td>Doe, Sullivan &amp; Company</td>
<td>cheese</td>
<td>27' x 9'</td>
<td>4 1/2&quot; x 1 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>24' x 9'</td>
<td>4&quot; x 1 1/2&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9' x 12'</td>
<td>3&quot; x 1&quot;</td>
</tr>
<tr>
<td>12</td>
<td>Jennetta's</td>
<td>subs &amp; Italian specialties</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>13</td>
<td>The Monkey Bar</td>
<td>drinks</td>
<td>24' x 18'</td>
<td>4&quot; x 3&quot;</td>
</tr>
<tr>
<td>14</td>
<td>Ming Tree</td>
<td>Chinese food</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>15</td>
<td>Boston &amp; Maine Fish Co.</td>
<td>seafood</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>16</td>
<td>Great Stuff</td>
<td>salads</td>
<td>24' x 36'</td>
<td>4&quot; x 6&quot;</td>
</tr>
<tr>
<td>17</td>
<td>Boston Beanery</td>
<td>beans</td>
<td>9' x 9'</td>
<td>1 1/2&quot; x 1 1/2&quot;</td>
</tr>
<tr>
<td>18</td>
<td>Freedman's Bakery</td>
<td>bagels &amp; pastries</td>
<td>24' x 48'</td>
<td>4&quot; x 8&quot;</td>
</tr>
</tbody>
</table>
# QUINCY MARKET INFORMATION SHEET

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Product</th>
<th>Dimensions</th>
<th>$1'' = 6'; \text{Scale}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Steve's Ice Cream</td>
<td>ice cream</td>
<td>24' x 24' 40' 24'</td>
<td>6 2/3' 4' 6 2/3' 4'</td>
</tr>
<tr>
<td>20</td>
<td>Julian's Cheesecake</td>
<td>cheesecake</td>
<td>9' x 9'</td>
<td>1 1/2'' x 1 1/2''</td>
</tr>
<tr>
<td>21</td>
<td>M. Berenson</td>
<td>meat</td>
<td>24' x 39' 24' 40'</td>
<td>4'' x 6 1/2''</td>
</tr>
<tr>
<td>22</td>
<td>E.N. West</td>
<td>meat</td>
<td>24' x 18' 24'</td>
<td>4'' x 3''</td>
</tr>
<tr>
<td>23</td>
<td>Aris Barbecue</td>
<td>chicken &amp; ribs</td>
<td>24' x 24' 24' 40'</td>
<td>4'' x 4''</td>
</tr>
<tr>
<td>24</td>
<td>Brown Derby Deli</td>
<td>hot dogs &amp; pastrami</td>
<td>24' x 36' 24' 40'</td>
<td>4'' x 6''</td>
</tr>
<tr>
<td>25</td>
<td>Au Bon Pain</td>
<td>French breads</td>
<td>6' x 36' 36' 36'</td>
<td>1'' x 6'' 1'' x 6'' 4'</td>
</tr>
<tr>
<td>26</td>
<td>North End Bakery</td>
<td>Italian pastries</td>
<td>6' x 18' 6' 36'</td>
<td>1'' x 3''</td>
</tr>
</tbody>
</table>
# QUINCY MARKET INFORMATION SHEET

<table>
<thead>
<tr>
<th>#</th>
<th>Name</th>
<th>Product</th>
<th>Dimensions</th>
<th>1&quot; = 6' Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Aval's Fudge</td>
<td>fudge</td>
<td>6' x 12'</td>
<td>1&quot; x 2'</td>
</tr>
<tr>
<td>28</td>
<td>Taco Maker</td>
<td>Mexican specialties</td>
<td>6' x 18'</td>
<td>1&quot; x 3'</td>
</tr>
<tr>
<td>29</td>
<td>A la Carta</td>
<td>hors d'oeuvres</td>
<td>24' x 24'</td>
<td>4&quot; x 4'</td>
</tr>
<tr>
<td>30</td>
<td>Boston Brownies</td>
<td>brownies</td>
<td>24' x 18'</td>
<td>4&quot; x 3'</td>
</tr>
<tr>
<td>31</td>
<td>The Colombo Yogurt Shop</td>
<td>yogurt</td>
<td>24' x 18'</td>
<td>4&quot; x 3'</td>
</tr>
<tr>
<td>32</td>
<td>Walrus and the Carpenter</td>
<td>clams &amp; oysters</td>
<td>24' x 18'</td>
<td>4&quot; x 3'</td>
</tr>
<tr>
<td>33</td>
<td>Fisherman's Nest</td>
<td>fish &amp; seafood plates</td>
<td>24' x 24'</td>
<td>4&quot; x 4&quot;</td>
</tr>
<tr>
<td>34</td>
<td>Cafe Marion</td>
<td>burgers &amp; salads</td>
<td>24' x 39'</td>
<td>4&quot; x 6 1/2&quot;</td>
</tr>
<tr>
<td>35</td>
<td>Raging Cajun</td>
<td>gumbo &amp; jambalaya</td>
<td>9' x 9'</td>
<td>1 1/2&quot; x 1 1/2&quot;</td>
</tr>
<tr>
<td>36</td>
<td>Carol Ann Bake Shop</td>
<td>Italian pastries</td>
<td>9' x 48'</td>
<td>1 1/2&quot; x 8&quot;</td>
</tr>
</tbody>
</table>

![Diagram of market layout]
<table>
<thead>
<tr>
<th>No.</th>
<th>Shop Name</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>Taco Maker</td>
<td>18' x 24'</td>
</tr>
<tr>
<td>29</td>
<td>A la Carte</td>
<td>24' x 24'</td>
</tr>
<tr>
<td>30</td>
<td>Boston Brownies</td>
<td>24' x 18'</td>
</tr>
<tr>
<td>31</td>
<td>The Columbo Yogurt Shop</td>
<td>24' x 18'</td>
</tr>
<tr>
<td>32</td>
<td>Walrus and the Carpenter</td>
<td>24' x 18'</td>
</tr>
<tr>
<td>33</td>
<td>Fisherman's Net</td>
<td>24' x 24'</td>
</tr>
<tr>
<td>34</td>
<td>Cafe Marion</td>
<td>24' x 39'</td>
</tr>
<tr>
<td>35</td>
<td>Raging Cajun</td>
<td>9' x 9'</td>
</tr>
<tr>
<td>36</td>
<td>Carol Ann Bake Shop</td>
<td></td>
</tr>
</tbody>
</table>

You must figure the missing dimensions.

Quincy Market Floor Plan Assignment Cards • East Wing • To Be Cut For Students
<table>
<thead>
<tr>
<th></th>
<th>The Coffee Connection</th>
<th>Beverley's Kitchen</th>
<th>Kilvert &amp; Forbes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>24' x 24'</td>
<td>24' x 24'</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>6' x 24'</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>42' x 36'</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Paul W. Marks</td>
<td>Aegean Fare</td>
<td>Pizzeria Regina</td>
</tr>
<tr>
<td>5</td>
<td>24' x 18'</td>
<td>24' x 24'</td>
<td>24' x 24'</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Peanut Butter Fantasies</td>
<td>J.P. Aboody</td>
<td>Cardoos</td>
</tr>
<tr>
<td>8</td>
<td>24' x 21'</td>
<td>27' x 10'</td>
<td>6' x 24'</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>24' x 14'</td>
<td></td>
</tr>
</tbody>
</table>

Quincy Market Floor Plan Assignment Cards - West Wing - To Be Cut For Students
<table>
<thead>
<tr>
<th></th>
<th>Joey's Gelateria</th>
<th>Doe, Sullivan &amp; Co.</th>
<th>Jennetta's</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9' x 18'</td>
<td>24' x 24'</td>
<td>24' x 24'</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>The Monkey Bar</td>
<td>Ming Tree</td>
<td>Boston &amp; Maine Fish Co.</td>
</tr>
<tr>
<td>14</td>
<td>24' x 10'</td>
<td>24' x 24'</td>
<td>24' x 24'</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Boston Beanery</td>
<td>Great Stuff</td>
<td>Freedman's Bakery</td>
</tr>
<tr>
<td>18</td>
<td>9' x 9'</td>
<td>24' x 36'</td>
<td>24 x 48'</td>
</tr>
</tbody>
</table>

QUINCY MARKET FLOOR PLAN ASSIGNMENT CARDS • WEST WING • TO BE CUT FOR STUDENTS
<table>
<thead>
<tr>
<th>No.</th>
<th>Business</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Steve's Ice Cream</td>
<td>24' x 48'</td>
</tr>
<tr>
<td>20</td>
<td>Julian's Cheesecake</td>
<td>9' x 9'</td>
</tr>
<tr>
<td>21</td>
<td>M. Berenson</td>
<td>24' x 39'</td>
</tr>
<tr>
<td>22</td>
<td>E.N. West</td>
<td>24' x 18'</td>
</tr>
<tr>
<td>23</td>
<td>Aris Barbeque</td>
<td>24' x 24'</td>
</tr>
<tr>
<td>24</td>
<td>Brown Derby Deli</td>
<td>24' x 36'</td>
</tr>
<tr>
<td>25</td>
<td>Au Bon Pain</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>North End Bakery</td>
<td>6' x 18'</td>
</tr>
<tr>
<td>27</td>
<td>Aval's Fudge</td>
<td>6' x 12'</td>
</tr>
</tbody>
</table>

You must figure the missing dimensions.
QUINCY MARKET • EAST WING

FOR TEACHER USE IN SETTING UP BULLETIN BOARD DISPLAY.
INCH MARKINGS SHOULD BE MADE ON MASKING TAPE OR OTHER GUIDE ON BULLETIN BOARD.

SCALE: 1" = 6'

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THE GRAPH-HOPPER

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale drawing, linear measure</td>
<td>Construction paper</td>
</tr>
<tr>
<td>Ratio, proportion</td>
<td>1/2&quot; and 1&quot; graph paper</td>
</tr>
<tr>
<td>Perimeter, area</td>
<td>(included in unit)</td>
</tr>
<tr>
<td></td>
<td>Rulers</td>
</tr>
</tbody>
</table>

**Pre-class preparation:**
Prepare a sample crow, and grasshopper.

**During class:**

1. Ask students to choose the scale they wish to use (1/2" or 1"). Remind them that their drawings will be used as part of the class display and that a variety of sizes are needed.

2. Distribute graph paper according to scale chosen.

3. Begin a sample crow or grasshopper on the board or overhead with the class. Have students continue work on their own or in small groups. Use the coordinate system to help complete your drawings.

4. Discuss with the class the effect of scale on both the area and perimeter of a design.

**Extensions:**

If your classroom has floor tiles, have students complete one design on the floor using colored chalk.

If a pantograph is available, ask a group of students to learn how to use it and present a class demonstration.

Prepare overhead transparencies from some of the designs. Project them on the wall at different distances and examine the effect on area and perimeter.
THE GRAPH-HOPPER

HORATIO: I'm trying to enlarge drawings of the crow and the grasshopper and it's not working.

PORTIA: Well, it's perfectly obvious to me that you gotta use graph paper.

The crow and grasshopper have been drawn on 1/4" graph paper.

Enlarge the pictures by using 1/2" or 1" graph paper.

Now answer the following questions:

1) What size are the squares on your graph paper? How much larger are your squares than the squares on this page? What is the perimeter of your square? Of the one above? What is the area of your square? Of the one above?

2) What do you think this enlargement will do to the length of the grasshopper or the wing span of the crow? Measure corresponding parts to check your guess.

3) What do you think this enlargement will do to the area of the paper covered by the grasshopper or the crow?

List some other questions you might ask and give their solutions.
# Construction of Bull Market Cart

## Teacher Notes

### Topic/Objective
- Scale drawing
- Linear measure
- Perimeter, Area

### Materials
- Posterboard or oak tag
  - (1 1/3 pieces of 8 1/2 x 11 per cart)
- 1/4" metal fasteners
- Glue, compass, scissors

### Pre-class Preparation:
- Construct sample cart; gather materials (posterboard or oak tag); duplicate cart design on oak tag (optional)

### During Class:
1. **Oak Tag**: If oak tag is used and cart design has been duplicated on oak tag, students will be ready to cut and assemble their carts immediately.
2. **Posterboard**: Instruct students to paste their designs onto the posterboard before cutting and assembling carts.
   (Students may be encouraged to work in pairs so they can assist one another)

### After Class

- Compare the volume of the top tray of the model cart to that of the real cart. What is the ratio of these volumes?
- Choose an item to sell from your cart. Name your cart appropriately and decorate it. You may even stock the cart. Draw all items to scale.
- Construct a full-size cart. The full-size cart is 3' by 6' (use the scale drawing to construct it). Appliance boxes (e.g., refrigerator box) would be useful. Double wheels will give added support. A roof might even be added.
  - (Note: this introduces square and cubic factors)

---

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CONSTRUCT YOUR OWN
BULL MARKET CART

Use the design which your teacher gives you. Follow directions for oak tag or posterboard depending on the material you are using.

OAK TAG: Skip to step 1 below.

POSTERBOARD: Using a ruler and ball point pen, trace the design from the paper onto the posterboard. Press hard. Now go to step 1 below.

1. Carefully cut all pieces along solid lines.

2. Use a compass to construct two circles with diameters of 3" on your plain piece of oak tag. Cut out these circles for cart wheels.

3. Fold carefully on dotted lines. Dots should be on the outside of the fold.

4. Glue AB to AB and CD to CD.

5. Fold in tabs G, H, I and J and glue to form the top of the cart.

6. Insert a small metal fastener into the center of one wheel, then through point F on the cart leg and point F on the brace, and fasten. (Be sure that the brace tab is inside the leg cart with the tab facing down.)

7. Insert another fastener through the center of the other wheel, then through point E on the other leg and finally through point E on the brace.

8. With glue, attach the other leg brace, matching K's and L's.
PERIMETER AND AREA
PERIMETER

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept of perimeter</td>
<td>12.5 feet of yarn knotted at 12 feet, graph paper, 2</td>
</tr>
<tr>
<td></td>
<td>yardsticks, dot paper for all students</td>
</tr>
</tbody>
</table>

During class:

1. Ask four students to hold the yarn and be prepared to create different shapes. Ask two students to check measurements with yardstick. All other students should record figures on dot paper or graph paper. Use scale $1" = 1'$ or $1/4" = 1'$.

2. Ask the students to form the following using the yarn (all of the perimeters will be the same since the length of the yarn never changes):

   - a triangle
   - an equilateral triangle--discuss the meaning of congruence
   - a right triangle--how many different right triangles can be formed? Does one of the right triangles have sides 3, 4, and 5? (remind students that the perimeter is constant)
   - a square
   - a rectangle--how many different rectangles can you form? What is the perimeter of each? What is the area of each? What rectangle appears to have the largest area?
   - What does perimeter mean? If I know the perimeter of a figure, can I always predict the area?

After Class

"I Counted My Hops!"

Use textbook for supplementary problems

Regional Math Network • Harvard Graduate School of Education • Harvard University
Horatio: How far is it around the Quincy Market building?

Grasshopper: I didn't really measure, but I counted my 242 hops. If every grasshopper hop is 60 inches long, what is the perimeter of the Quincy Market Building in feet?

Horatio: I didn't really measure, but I took 24 steps when I walked along the width of the building. If every step Horatio took was 25" long, what was the width of the building in feet?

Using the information from the Grasshopper and Horatio, find the dimensions of the Quincy Market Building.

(Hint: Draw a diagram of a rectangle to help you solve the puzzle.)
HANDS AROUND THE SCHOOL

**Topic/Objective**
Concept of perimeter

**Materials Needed**
Town Map (optional)

**During class:**

1. Ask students to stand around the perimeter of the room (or the lunchroom or gymnasium—wherever there is blank wall space).
   - Can they enclose the entire perimeter?
   - Can they enclose the perimeter with fewer people?
   - Estimate and agree upon the length for which each person is responsible
   - Estimate the largest perimeter that this class could form

2. Can you predict whether all of the students in the school could surround the school building? The gym? The football field? Your town?

3. Did you know that most people are "squares"? ("squares" means that the ratio of their arm spread to their height is close to 1).
   - Check this with:
     - Members of your class
     - Small children
     - Adults

4. Using an enlarged map of your town have students use yarn to measure the perimeter and convert this answer to feet. Calculate the number of people required to surround the town. Could your town's population do this?

5. (Challenge Project) "Hands Across America" tried to create a human chain from New York to Los Angeles. If it is 2825 miles, how many students would be necessary for the chain?

**After Class**

"Quincy Market, We've Got You Surrounded"  Extension
"Portia's Dilemma"  Extension

Regional Math Network • Harvard Graduate School of Education • Harvard University
QUINCY MARKET: WE'VE GOT YOU SURROUNDED!

Fact: The Quincy Market building is 555' long and 50' wide. The average person has an arm spread of 5 feet.

Question: How many visitors would it take to surround Quincy Market?

Fact: Approximately 35,000 people visit Quincy Market every day.

Question: If all of the visitors on Tuesday held hands, how many times would Quincy Market be surrounded?

SPREAD OUT!!

132
Fact: One day Quincy Market had 34,364 visitors. Every visitor had a 5' arm spread. Suppose every visitor was there at the same time, and they all joined hands around the outside of Quincy Market.

Question: What is the largest (in area) rectangle that can be formed that uses every visitor and has dimensions proportional to those of Quincy Market?
AREA: SQUARES AND RECTANGLES

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop concept of area</td>
<td>Use Masking tape to mark 4 square feet and 1 square yard on the floor. Place the tape so that one square is 2 feet on a side and the other is 3 feet on a side</td>
</tr>
</tbody>
</table>

During Class:

1. Ask one student to stand in the 4 square-foot box. Can another student fit? How many can fit? (Rule: Both feet must be on the floor)

2. Have students stand in the square yard box. How many can fit?

3. What is the ratio of the number of students in the 4 square-foot box to the number of students in the square yard box?

   Use these numbers for the following problems and the homework assignment.

4. Have students estimate the number of students who could fit in:
   - the classroom
   - the gym, etc.

5. How many square feet (yards) would hold the entire class?

6. How many square feet (yards) would hold the entire school?

After Class

"How Many Visitors Can Fit in Quincy Market?" Reinforcement
"Bull Market Cart Storage" Extension
Use textbook for supplementary problems
Reinforcement

HOW MANY VISITORS CAN FIT INTO THE QUINCY MARKET BUILDING?

The dimensions of the Quincy Market Building are 50' by 555'. If we assume there are no obstacles in the building, how many people can fit inside the building at one time? First floor only, please! (HINT: Use the results from your class experiment and think about the number of people that fit into a square yard).

Find out about the fire regulations for your town and what limits there are on building capacity. How many people could legally fit into Quincy Market if it were in your town?

Use the results of your class experiment to determine how many people could fit into an elevator 5' x 6'. If the average weight of each person is 130 lbs., how much weight is that elevator carrying?
Bull Market carts are 3' wide and 6' long. If there are 50 carts that must be stored in a room, find the dimensions of the smallest room that will hold all 50 carts. The room should only have one door (which opens out). You decide where that door should be. The carts must be placed so that any cart can get out without moving other carts.

Show the arrangement of the carts in the room.

HINTS: Graph paper might help. You may choose to use the carts you have constructed and start with a smaller number of carts.
SPOT ON THE WHEEL

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumference of a circle</td>
<td>String, Rulers, Calculator,</td>
</tr>
<tr>
<td></td>
<td>Chart on blackboard (optional),</td>
</tr>
<tr>
<td></td>
<td>Tape Measure (optional)</td>
</tr>
</tbody>
</table>

Pre-Class Preparation: Cut-out cardboard circles with diameters of 3", 4", 5", 10", and 12". Put chart below on blackboard.

<table>
<thead>
<tr>
<th>Diameter of Wheel</th>
<th>Measure of Circumference</th>
<th>C/D</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 inches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 inches</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During Class:
1. Explain that the word circumference is used to designate the perimeter of a circle.
2. Ask students to find a diameter (by folding circle in half) and to measure and record the diameter and circumference (using string or rolling circle on a flat surface).
3. Have students make a visual comparison of circumference and its relationship to diameter.
4. Encourage them to verbalize that for any circle the circumference is approximately three times the diameter.
5. Use the chart on the blackboard and a calculator to develop $C/D = 3.14$ and introduce the symbol $\pi$. Stress that 3.14 is an approximation and that the formula $C = \pi D$ may be used to find the circumference of a circle with known diameter.
6. Have students make up several examples using the formula and "Spot on the Wheel" in class. Have students share the examples with each other.

After Class
"Spot on the Wheel"                         Reinforcement
"Pi for Horatio"                             Reinforcement
"How Many Rotations"                         Extension
Use textbook for supplementary examples

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Horatio observes a nick on the edge of the wheel as one of the vendors pushed a bull market cart into position.

HORATIO: I wonder how far the cart moves when the wheel turns exactly once?

PORTIA: It's perfectly obvious to me that we need to measure the circumference of the wheel and compare our measure, in some way, to the diameter of the wheel.

HORATIO: Circumference! What's that?

PORTIA: Circumference is the perimeter of the wheel.

Portia and Horatio did some measurement and put the results on a chart. Complete the chart by finding the indicated measurements and doing the necessary calculations. (HINT: A calculator could make this easier).

Find 5 other circular objects to measure and complete the chart.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>DIAMETER</th>
<th>DISTANCE AROUND OUTSIDE OF CIRCLE (circumference)</th>
<th>Divide circumference by diameter and round answer to nearest hundredth</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHEEL</td>
<td>3 feet</td>
<td>9.5 feet</td>
<td>3.17</td>
</tr>
<tr>
<td>PIZZA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHOCOLATE CHIP COOKIE</td>
<td></td>
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</tbody>
</table>

What do you observe in the last column? What are your conclusions?
# MORE SPOTS ON THE WHEEL

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>DIAMETER</th>
<th>DISTANCE AROUND OUTSIDE OF CIRCLE (CIRCUMFERENCE)</th>
<th>CIRCUMFERENCE DIAMETER ROUND ANSWER TO NEAREST HUNDREDTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHEEL</td>
<td>5 FEET</td>
<td>15.9 FEET</td>
<td>3.18</td>
</tr>
</tbody>
</table>

What do you observe in the last column?

What are your conclusions?
PORTIA: Horatio, it's perfectly obvious to me you don't need to measure the circumference, just multiply the diameter by $\pi$! Apple or blueberry?

HORATIO: Poor Horatio! He still thinks $\pi = \text{apple}$, but you know $\pi = 3.14$ (well, almost!). Find the circumference of the following using the formula $C = \pi d$.

1. A cup with a diameter 4". ______
2. The top rim of a flower pot with diameter 6". ______
3. The bottom rim of a lampshade with diameter 12". What is your answer in inches? ______ In feet? ______
4. A circular rug with diameter 54". What is your answer in inches? ______ In feet? ______ In yards? ______
5. A circular swimming pool with diameter 18'. What is your answer in feet? ______ In yards? ______
6. A button with diameter 1/2". What is your answer in inches? ______
7. A bicycle wheel with radius 13". How many inches have you travelled when the wheel makes one rotation? ______
8. Estimate the diameter of a pipe with circumference 9 1/2". ______

Measure the circumference of 3 circular objects and use the formula $C = \pi d$ to estimate the diameter of these objects.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>CIRCUMFERENCE</th>
<th>DIAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
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<tr>
<td>2.</td>
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<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
HOW MANY ROTATIONS, HORATIO?

HORATIO: I think I'll push this cart around Quincy Market and count the number of times the wheel turns.

CROW: Remember, Horatio, the Quincy Market building is 50 feet wide and 555 feet long.

GRASSHOPPER: An estimation is good enough for me!

PORTIA: Does anybody have a calculator?

Find out how many times the wheel turns when the bull market cart is pushed around the perimeter of the Quincy Market building.

Why might Horatio's answer be different from Portia's?

Are there any accuracy problems here?
A BIG SLICE IN THE LIFE OF HORATIO

**Teacher Notes**

### Topic/Objective

<table>
<thead>
<tr>
<th>Area of circle (estimation)</th>
</tr>
</thead>
</table>

### Materials

- Graph chalkboard
- 1" graph paper (3 pieces per student)
- Compasses
- String (2 feet)

**During Class:**

1. Distribute graph paper and compasses to each student.
2. Brainstorm with students to generate methods for approximating the area of a circle.
3. Have students draw a circle with radius 3" on their graph paper and count the squares. (Approximate partially covered squares.)
4. Repeat same procedure with circles of 1" and 2" radius.
5. Draw circles of radius 4" on chalkboard. Ask students to brainstorm how they would use their graph paper to find the area of this circle. (Hint: students should draw semicircle on graph paper.)
6. Introduce "A Big Slice in the Life of Horatio".
   - Discuss meaning of a 16" pizza. (Hint: radius = 8").
   - Show students how to draw a circle using string. Suggest that students draw their circles on newspaper or a brown paper bag. Have students use their graph paper for estimating area.

**After Class**

"A Big Slice in the Life of Horatio" Reinforcement
A BIG SLICE IN THE LIFE OF HORATIO

HORATIO: I'm starved! I want a large 16" pizza.

PORTIA: That's more than twice the size of the 10" pizza! You'll never finish all that, Horatio!

HORATIO: It's only 6" bigger!

Portia and Horatio are not using the same type of comparison. BOTH ARE RIGHT! Can you explain why?

Construct circles of diameter 10" and 16" and estimate carefully the area of each circle. Bring your circles to class and be prepared to explain your method of estimation.
During Class:

1. Discuss methods used by students to approximate the area in "A Big Slice in the Life of Horatio".

2. Use the parallelogram method to help students visualize the area of a circle.

For a parallelogram:
Area = (base) x (height)
Area = (1/2)Cr
Area = (1/2) (πd) r
Area = (1/2) π (2r) r
Area = πr²

3. Have the students cut the circle into eight equal slices and form a parallelogram. This intuitive approach leads to the actual formula.

4. Use the formula to calculate the area of the 10 and 16 inch pizzas. Compare the results with previous estimations.

5. Have students solve additional examples. Stress the meaning of r².

After Class

Textbook examples using formula Reinforcement
ROOM UNDER THE UMBRELLA

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of Circle</td>
<td>Square yard marked on floor</td>
</tr>
<tr>
<td></td>
<td>36&quot; diameter circle on floor</td>
</tr>
<tr>
<td></td>
<td>(use masking tape to outline shapes on floor)</td>
</tr>
</tbody>
</table>

During Class:

1. Determine how many students can stand in a square yard or in a 36" circle.
2. Have students form groups to solve "Room Under the Umbrella". (Teacher may have to brainstorm or suggest possible approaches, diagram, etc.)
3. Ask students why we used a square yard and a 36" circle in our comparison.

After Class:

"All Wet" Reinforcement
Text book problems using πr² Reinforcement
"Room Under the Umbrella" Extension
ROOM UNDER THE UMBRELLA

Horatio: Even in that crowd of people with umbrellas, I GOT WET!

Crow: Look at the facts, Horatio.

1. How many people can stand in a square yard?

2. How many people can stand under an umbrella that is 36" in diameter?

Use a rectangle 15' by 9' as an example and estimate the number of people that get wet.

Think! What happens if we change the size of the rectangle to 8' by 5' or the diameter of the umbrella to 40"?

Make up some other umbrella problems.
1 COUNTED MY HOPS

Horatio: How far is it around the Quincy Market building?
Grasshopper: I didn't really measure, but I counted my 242 hops.

If every grasshopper hop is 60 inches long, what is the perimeter of the Quincy Market Building in feet?

1210 feet perimeter

Horatio: I didn't really measure, but I took 24 steps when I walked along the width of the building.

If every step Horatio took was 25 inches long, what was the width of the building in feet?

600 inches = 50 feet width

Using the information from the Grasshopper and Horatio, find the dimensions of the Quincy Market Building.

(Hint: Draw a diagram of a rectangle to help you solve the puzzle.)

555 feet \times 50 feet

PORTIA'S DILEMMA

Fact: One day Quincy Market had 34,364 visitors. Every visitor had a 5-foot arm spread. Suppose every visitor was there at the same time, and they all joined hands around the outside of Quincy Market.

Question: What is the largest (in area) rectangle that can be formed that uses every visitor and has dimensions proportional to those of Quincy Market?

length of human wall = 78.910 ft.
width of human wall = 71100 ft.
Area = 559,551,000 sq. ft \times 560,000,000

HOW MANY VISITORS CAN FIT INTO THE QUINCY MARKET BUILDING?

The dimensions of the Quincy Market Building are 50' by 555'. If we assume there are no obstacles in the building, how many people can fit inside the building at one time? First floor only, please! (Hint: Use the results from your class experiment and think about the number of people that fit into a square yard).

3083 sq. yds. \times \frac{people}{60 \text{ yd.}} = \frac{people}{145 \text{ times}}

Find out about the fire regulations for your town and what limits there are on building capacity. How many people could legally fit into Quincy Market if it were in your town?

Use the results of your class experiment to determine how many people could fit into an elevator 5' x 6'. If the average weight of each person is 130 lbs., how much weight is that elevator carrying?

3.3 sq. yds. \times \frac{people}{3083 \text{ sq. yd.}} \times 130 \text{ lbs.} = \frac{lbs.}{109}
PI FOR HORATIO

PORTIA: Horatio, it's perfectly obvious to me you don't need to measure the circumference, just multiply the diameter by xπ.

HORATIO: Apple or blueberry?

Poor Horatio! He still thinks xπ is apple, but you know x = 3.14 (well, almost). Find the circumference of the following using the formula C = πd.

1. A cup with a diameter of 4".
   C = πd = 3.14 * 4" = 12.56"

2. The lip rim of a flower pot with diameter 6".
   C = πd = 3.14 * 6" = 18.84"

3. The bottom rim of a lampshade with diameter 12". What is your answer in inches? 37.70" in feet? 3.14 ft.


5. A circular swimming pool with diameter 18". What is your answer in feet? 56.52" in yards? 18.84 yds.

6. A button with diameter 1/2". What is your answer in inches? 1.57"

7. A bicycle wheel with radius 12". How many inches have you traveled when the wheel makes one rotation? 37.69"

8. Estimate the diameter of a pipe with circumference 9 1/2". 3"

Measure the circumference of 3 circular objects and use the formula C = πd to estimate the diameter of these objects.

<table>
<thead>
<tr>
<th>OBJECT</th>
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<tbody>
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<tr>
<td>3.</td>
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</tr>
</tbody>
</table>

How many rotations, Horatio?

HORATIO: I think I'll push this cart around Quincy Market and count the number of times the wheel turns.

CROW: Remember, Horatio, the Quincy Market building is 50 feet wide and 555 feet long.

GRASSHOPPER: An estimation is good enough for me!

PORTIA: Does anybody have a calculator?

Find out how many times the wheel turns when the bullmarket cart is pushed around the perimeter of the Quincy Market building.

128.5 rotations

Why might Horatio's answer be different from Portia's?

Are there any accuracy problems here?

Variations from the path Horatio takes, ie. how close to the building.

ROOM UNDER THE UMBRELLA

HORATIO: Even in that crowd of people with umbrellas, I got wet!

CROW: Look at the facts, Horatio.

1. How many people can stand in a square yard?

2. How many people can stand under an umbrella that is 35" in diameter?

Use a rectangle 15' by 9' as an example and estimate the number of people that get wet.

15 people get wet assuming 5 people per sq. yd. and 4 people per umbrella.

Think! What happens if we change the size of the rectangle to 8' by 5' or the diameter of the umbrella to 40"?

Make up some other umbrella problems.
Simulation
BUSINESS SIMULATIONS

<table>
<thead>
<tr>
<th>Topic/Objective</th>
<th>Materials Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving</td>
<td>For Bull Market Game</td>
</tr>
<tr>
<td>Percent of a number</td>
<td>Bull Market Cards</td>
</tr>
<tr>
<td></td>
<td>Bull Market Score Sheets</td>
</tr>
<tr>
<td></td>
<td>(6 per student)</td>
</tr>
<tr>
<td></td>
<td>For Computer Simulation</td>
</tr>
<tr>
<td></td>
<td>Any Apple II Computer</td>
</tr>
<tr>
<td></td>
<td>T-Stop Saleogram Disk</td>
</tr>
<tr>
<td></td>
<td>(included in unit)</td>
</tr>
</tbody>
</table>

Before Class:

Decide whether to use the Bull Market Game or the Computer Simulation or both.

The Bull Market Game is a simplified simulation of running a T-Stop cart. Each student maintains his/her own records and performs the calculations as the teacher presents each card. Students may also work in small groups. This activity can be used for two or more class periods.

T-Stop Sales is a computer simulation which will run on any Apple II computer. Students can work in small groups to run a cart and try to beat Sloppy Joe, a lazy but successful business person. This activity also can be used for two or more class periods.
BULL MARKET
GAME

Materials Needed: Green Bull Market cards 5 1/2" x 4 1/4", Bull Market scoresheet

DIRECTIONS: This game is based on the BULL MARKET at Quincy market. The score sheet presents a one week simplified simulation of a T-shirt cart. The game may be used by an entire class, small groups or individually. Since directions on some cards vary, based on the price of T-shirts and the placement of the cart inside or outside, several students could use the same five cards for a week but have different profits.

1. Shuffle the deck of cards and put them face down.

2. Fill in your name on the score sheet and fill in the starting amount. This should be $3,000 at the beginning of WEEK #1 and the profit or loss carried over for any other week. Also, note all carts pay a $20.00 storage fee each week.

3. Choose inside or outside position for your cart for the week and enter the appropriate amount.

4. Order the number of T-shirts to keep the stock at 600. Your price per T-shirt is $4.00.

5. Choose a selling price from $10.00 to $15.00 for the T-shirts for the first day of the week.

6. Take the top card in the pack and write the % (up or down) in the appropriate column. Calculate the number of T-shirts sold based on a normal day of 60 shirts sold.

   e.g., Sales up 10% 60 + 6 60 - 45
   10% of 60 is 6 66 85% of 60 is 45 15

7. Put the number of T-shirts sold for the day in the appropriate blank and calculate the total sales for the day.

8. Choose a price for T-shirts for the next day. Continue the same process for the week.

9. At the end of the week find the total number of shirts sold for the week.

10. Find the total sales for the week.

11. To calculate total profit for the first week subtract the $3,000 you started with from the total sales. Carry this amount to the start of the next week.

NOTE: Don't forget at the beginning of each week to readjust your T-shirt order to keep inventory at 600.
# BULL MARKET SCORESHEET

## WEEK# ________

### NAME ____________________________

### STARTING AMOUNT

(This should be $3,000 for the first week.)

- Inside ($275) or Outside ($150)
  - $ ________________
- Storage ($20.00)
  - $ ________________
- Order _____ T-shirts at $4.00 each
  - $ ________________

### CASH ON HAND

- $ ________________

<table>
<thead>
<tr>
<th></th>
<th>PRICE OF T-SHIRTS</th>
<th>TAKE CARD % UP OR DOWN</th>
<th>T-SHIRTS SOLD</th>
<th>TOTAL SALES FOR DAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUNDAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MONDAY</td>
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<tr>
<td>TUESDAY</td>
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<tr>
<td>WEDNESDAY</td>
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<tr>
<td>THURSDAY</td>
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<tr>
<td>FRIDAY</td>
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<tr>
<td>SATURDAY</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>TOTALS FOR WEEK</td>
<td></td>
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### Balance $ ________________

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Regional Math Network • Harvard Graduate School of Education • Harvard University
**T-Stop Sales** is a computer simulation which will run on any Apple II computer. The program simulates the sale of T-shirts at a Bull Market cart for 1 month. Students run their cart in competition with Sloppy Joe's T-shirts. Sloppy Joe is a lazy businessperson who always orders the same number of T-shirts and never changes his prices.

The goal of the game is to beat Sloppy Joe by ordering and pricing carefully. Students use problem solving strategies and accurate math calculations to win the game.
GRAND FINALE

Finish Horatio and Portia's story.
<table>
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<tr>
<th>MATERIAL</th>
<th>ADDRESS</th>
<th>TELEPHONE NUMBER</th>
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<tr>
<td>T-Aid Map</td>
<td>MBTA Customer Service</td>
<td>617-722-3200</td>
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<tr>
<td></td>
<td>10 Park Plaza</td>
<td></td>
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<tr>
<td></td>
<td>Boston, MA 02116</td>
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<tr>
<td>Official Massachusetts Transportation Map</td>
<td>Public Information Office</td>
<td>617-973-7500</td>
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<td>Mass. Dept. of Public Works</td>
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<td>Teachers' Guide to Faneuil Hall (People and Places)</td>
<td>Boston National Historic Parks</td>
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<td>The American Road</td>
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<td></td>
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<tr>
<td></td>
<td>Dearborn, MI 48121</td>
<td></td>
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<tr>
<td>Brochure on Quincy Market</td>
<td>Faneuil Hall</td>
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<tr>
<td>Town/City</td>
<td>1985 Population</td>
<td>Sq. Miles Land and Water Area</td>
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<tr>
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<tr>
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<td>10.14</td>
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<tr>
<td>Weymouth</td>
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**Steve's Ice Cream**

Most popular flavors:  
1. Cookie-O  
2. Oatmeal Raisin  
3. Vanilla and Chocolate

Least popular:  
1. Nuts  
2. Butter Pecan

The most popular flavors sell at a 5 to 1 ratio to the least popular flavors.

They sell 110 pieces (3 1/2 gallons each) on weekends vs. 60 pieces on weekdays.

**Raging Cajun**

1. Jambalaya  ($4.50 lg., $2.50 sm.)  
2. Gumbo  (least popular)

Jambalaya to Gumbo  60 to 20

**Aris Barbecue**

1. 1/4 pounder cheesburgers to jumbo hotdogs  4 to 1  
2. Fried onion rings to jumbo hot dogs  5 to 1

**Boston Brownies**

Adult preferences:  
German Chocolate  vs.  Butterscotch  
5 to 1  
Boston's Best  4 to 3

Young people:  
M&M Brownies  vs.  Double Deck  
Even

Adult customers outnumber youngsters 5 to 1, and about 1000 brownies are sold per day.

**The Taco Maker**

1. Taco  400 per day  
2. Burrito  250 per day  
3. Tostado  50 per day

Root Beer to Diet Coke  10 to 1
QUINCY MARKET DATA

Cardoos (candy and nuts)

Gummi "bears", "worms", "strawberries", "fish", "shells" vs. Gumballs 3 to 1
vs. Sugar Daddy's 20 to 1
vs. Shoelace Licorice 3 to 1

Pizzeria Regina

Cheese vs. Pepperoni 3 to 1

Whole Pizzas:

Pepperoni to Mushroom 4 to 1
to Anchovy 20 to 1

They sell about 600 pizzas per day.

Ming Tree

#10 Combination Plate vs. #3 (chow mein, fr. rice & chicken fingers) 3 to 1

Appetizers:

1. Teryaki sticks
2. Chicken Wings
3. Shrimp and Egg Rolls (less popular)

Teryaki to Egg Rolls 2 to 1
SUPER CHALLENGES!!

1. How big is 1,000,000? How can you communicate this to someone else?

2. You run a T-shirt cart and must make some decisions concerning staffing, pricing, etc. How can you gain maximum profit?
   - What are the patterns of sales—when are they heavy, light?
   - When does the line of customers require a second salesperson?
   - What should the price of T-shirts be to minimize change and maximize a desirable sounding price?

3. What is the "best" route from your home to Quincy Market? How do you define "best"? (Some ideas: minimum average time, most reasonably consistent time, traffic patterns, etc.)

4. Design a parking garage for Quincy Market.

5. What is the best location for a T-shirt cart in Quincy Market?
   - Should it be inside or outside?
   - How crowded should the area be?
   - What other stands should it be near?
IF SHIRTS ARE $12.50 SALES ARE DOWN 10%

IF SHIRTS ARE MORE THAN $12.50 SALES ARE DOWN 90%

IF SHIRTS ARE LESS THAN $12.50 SALES ARE NORMAL
BUSINESS IS BOOMING!

SALES ARE UP
75% IF YOUR SHIRTS
ARE $10.00

SALES ARE UP
50% IF YOUR SHIRTS
ARE MORE THAN $10.00
WEATHER IS BAD!

Sales are down 50% if you are inside

Sales are down 95% if you are outside
SALES DOWN 10%
SENIOR CITIZEN TRIP

SALES ARE UP 20% IF YOUR SHIRTS ARE LESS THAN $11.00

SALES ARE DOWN 30% IF YOUR SHIRTS ARE $11.00 OR MORE

169
SALES
UP
40%
SALE

IF YOUR SHIRTS ARE $10.00 YOU SELL 20% OF YOUR REMAINING STOCK (ROUND TO THE NEAREST WHOLE NUMBER)

IF YOUR SHIRTS ARE MORE THAN $10.00 YOU SELL 5% OF YOUR REMAINING STOCK
SALES UP 30%
SCHOOLS ON FIELDTRIPS!

SALES ARE UP 10% IF YOUR SHIRTS ARE LESS THAN $13.00

SALES ARE DOWN 80% IF YOUR SHIRTS ARE $13.00 OR MORE
SALES DOWN 50%
NICE
WEATHER
AND MOST PEOPLE
ARE OUTSIDE
SALES ARE UP
15% IF YOU ARE OUTSIDE
SALES ARE DOWN
60% IF YOU ARE INSIDE
SALES DOWN 45%
STORM. NATIONAL DISASTER DECLARED BY GOVERNOR NO SALES TODAY
BUSINESS AS USUAL
SALES DOWN 25%
GREAT WEATHER!

SALES ARE UP 80% IF YOU ARE OUTSIDE

SALES ARE UP 10% IF YOU ARE INSIDE
SPECIAL ORDER
150 Shirts Sold
CONVENTION IN TOWN

SALES ARE UP 100%
SCHOOLS ON FIELDTRIPS!

SALES ARE UP 80% IF YOUR SHIRTS ARE LESS THAN $12.00

SALES ARE UP 30% IF YOUR SHIRTS ARE $12.00 OR MORE
WEATHER IS GREAT!

SALES ARE UP
10% IF YOU ARE INSIDE

SALES ARE UP
25% IF YOU ARE OUTSIDE
STORM TODAY

SALES ARE DOWN
30% IF YOU ARE INSIDE

SALES ARE DOWN
90% IF YOU ARE OUTSIDE
NO SALES

IF YOU ARE OUTSIDE

IF YOU ARE INSIDE
SALES ARE DOWN 70%
SALES UP 25%
SALES DOWN 30%
SALES DOWN 15%
SALES
UP
15%

190
Advertisement Pays Off

Sales Up 5%
SALES UP 20%
NO SALES

IF YOUR SHIRTS ARE $15.00

IF YOUR SHIRTS ARE LESS THAN $15.00 SALES ARE UP 35%
SALES
UP
45%
TOURIST SEASON

ALL SALES ARE UP 25%
SALES DOWN 40%
SALES DOWN 35%
SALES UP 5%
SALES DOWN 20%
Sales up 10%
SALES
ARE UP
33 1/3 %
IF YOU ARE OUTSIDE
SALES
ARE DOWN
66 2/3 %
IF YOU ARE INSIDE

202
SALES UP 50%
CONVENTION IN TOWN

SALES ARE UP 60% IF YOUR SHIRTS ARE LESS THAN $12.00

SALES ARE DOWN 50% IF YOUR SHIRTS ARE $12.00 OR MORE
SALES UP 35%