EXPLORATIONS

Activity 7

Metric Rules

In this activity you will:

♦ Collect data by measuring different linear objects

♦ Develop a strategy to determine the conversion factors needed to convert from one linear measurement to another

♦ Use ratios to compare two different units of measure by division

♦ Explore standards of measure

♦ Investigate significant digits in measurement and in unit analysis

Introduction

The United States is the only major country in the world that does not use the metric system (SI) System International. Is the United States progressing in the conversion from English to metric units? What is the possible impact of going totally metric and how can the power of technology show us the way?

The Problem

In this activity, you will measure length in the English and metric system (SI). You will use your measurements to calculate conversion factors within each system and from one system to the other. Using the lists on the TI-73, you will determine the relationships within each system and between the two systems.

Activity

Collecting Data

1. Measure the lengths and widths of the following items in inches, feet, centimeters and meters: Desk, chalkboard, and textbook.

✎ Record in Table 1 on the student data sheet.

   Find the linear conversion factors in the English system of measure.

2. Set your mode as pictured below by pressing MODE and selecting the needed options.
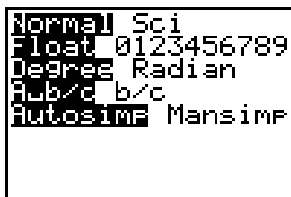
3. Execute the **SetUpEditor** command to set up your lists.

   a. Press 2nd [CATALOG] and then pick the letter **S** from the text editor (press 2nd [TEXT]).

   b. Move your cursor down to the command **SetUpEditor** and press ENTER to select it. Press ENTER to execute it.

   c. Press LIST and enter, in **L1**, the numbers 1 through 6 to represent the respective items measured.
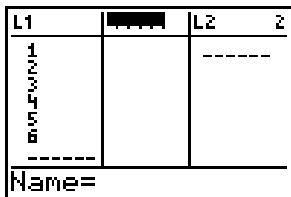
4. Name the list to the right of **L1**, **IN** for inches.

   a. To do this, move to the top of **L2** press 2nd [INS]. Then press 2nd[TEXT], select the letters needed, and select **Done**. Press ENTER to complete the naming of the list.
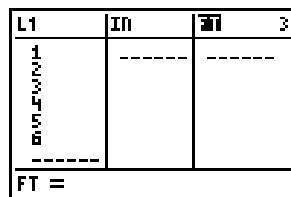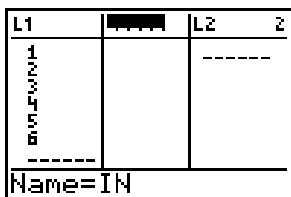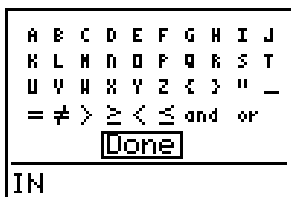
   b. Repeat this process to name another list, **FT**.

    c. Enter the measured items 1 through 6 as elements in the appropriate list from Table 1. Use the fraction and unit keys as explained in the TI-73 manual.

5. Calculate the ratio of inches to feet by dividing the measurements in the **IN** list by the measurements in the **FT** list.

    a. Highlight **L2**, press [2nd] [TEXT], select the quotation marks ("), then select **Done** and press [ENTER].

    b. Press [2nd] [STAT] and select list **IN.**

    c. Press [÷] [2nd] [STAT] and select list **FT.**

    d. Press [ENTER] [2nd] [TEXT] and again select the quotation marks ("), and **Done** when finished. Putting the ratio of inches/feet in quotations will allow the formula to be viewed at the top of the list as a reminder of the ratio.

6. Press [2nd] [QUIT] to move to the Home screen.

    a. To find the mean, press [2nd] [STAT] [▶] [▶] to select **MATH**, then **3:mean(.** Then press [2nd] [STAT] and select **L2** from the **Ls** menu.

    b. Press [)] [ENTER] to calculate the mean of **L2** on the Home screen.

    What is the relationship between the two measurements and this mean? What are the units of this value? This is the approximate conversion factor from feet to inches. What is the exact conversion factor? The units of this value are inches per foot. How do you use this factor to change feet to inches using unit analysis?

$$\frac{5ft}{1} * \frac{12in}{1ft}$$

✎ Answer questions 1 - 3 on the student data sheet.

7. Repeat the process to approximate the conversion factor from inches to feet. Assign the formula **FT/IN** to **L3** as instructed above. Find the mean of **L3**.

✎ Answer questions 4 - 6 on the student data sheet.

What is the relationship between these two units of measure and the mean of the ratio? This is the approximate conversion factor from inches to feet and the unit of measure is feet per inch. How can you find an approximate or exact fraction equivalent to this decimal? How does one change from inches to feet using unit analysis?

$$\frac{78in}{1} * \frac{1ft}{12in}$$

Converting The Data

Find the linear conversion factors in the metric system.

1. Press ⬚LIST⬚ and enter the numbers 1 through 6 to represent the respective items measured in **L4**.

   a. Name the list to the right of **L4**, **CM** for centimeters, and the list to the right of **CM**, **M** for meters.

   b. Enter the measured items 1 through 6 as elements in the appropriate list from Table 1.

2. Find the conversion factor to convert from centimeters to meters.

   a. Highlight **L5** and use the formula **CM/M**. Remember to enclose the formula in quotes so you can view the ratio.

   b. Go to the Home screen to find the mean of **L5**.

✎ Answer questions 7 - 8 on the student data sheet.

3. Repeat the process, dividing lists **M/CM** to establish the conversion factor for changing from centimeters to meters in **L6**.

✎ Answer questions 9 - 10 on the student data sheet.

Find the linear conversion factors from metric to English and vice versa.

4. Go past **L6** to name list **INCM** (inches to centimeter conversion factor).

    a. Highlight **INCM** and use the formula **CM/IN** to determine the factor to change inches to centimeters.

    b. Find the mean of **INCM** List.

✎ Answer questions 11 - 12 on the student data sheet.

5. Go past **INCM** to name list **MFT** (meters to feet conversion factor).

    a. Highlight **MFT** and use the formula **FT/M** to determine the factor to change from inches to centimeters.

    b. Find the mean of **MFT** List.

✎ Answer questions 13 - 14 on the student data sheet.

Analyzing The Data

Compare your calculated conversion factors to the TI-73 conversion factors.

1. Go to a cleared Home screen.

    a. Press ① 2nd [CONVERT] select **1:Length** from the **CONVERSIONS** menu.

    b. Then pick **5:ft** from the **LENGTH** menu and **4:inch**.

c. Press ENTER to see the conversion value. This means "1 foot = 12 inches" or 12 is the conversion factor (factor you multiply by to change feet to inches).

```
1 ft▸inch      12
■
```

2. Repeat the procedure:

a. Press 1 2nd [CONVERT] select **1:Length** from the **CONVERSIONS** menu.

b. In this case reverse the order, picking inches first, then feet.

c. Press ENTER. This means "1 inch = 0.083… feet" or 0.833… is the conversion factor (factor you multiply by to change inches to feet). Compare this value to your calculated factor.

3. Repeat this process to determine the other TI-73 conversion factors.

```
1 inch▸cm    2.54
1 cm▸inch
          .3937007874
1 ft▸m        .3048
1 m▸cm         100
■
```

✎ Answer questions 15 - 16 on the student data sheet.

Use the **Manual-Fit** line to connect the slope of a line to the unit conversion ratio.

4. Set up a scatterplot using the feet as the **x**-coordinate and inches as the **y**-coordinate.

a. Press 2nd Y=, select **Plot 1**, press ENTER.
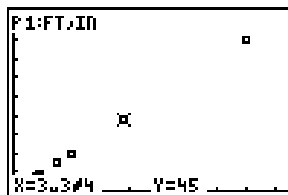
b. Highlight selections as shown below.

```
Plot1 On Off
Type:
Xlist:FT
Ylist:IN
Mark: □ + ·
```

c. Set an appropriate window.

```
WINDOW
 Xmin=0
 Xmax=9.4
 △X=.1
 Xscl=1
 Ymin=0
 Ymax=112.8
 Yscl=12
```

d. Press GRAPH TRACE and discuss the **x** values as the measurement in feet and the **y** values as the measurement in inches.

```
P1:FT,IN              □

              ⊠
         □
        □ □
      ‗□
X=3.3/4        Y=45
```

5. Use the **Manual-Fit** option to position a line through these data points. Set MODE to 0 decimal places so the slope will be a whole number. See the TI-73 manual for information on the **Manual-Fit** function.

```
Ls OPS MATH CALC
1:1-Var Stats
2:2-Var Stats
3:Manual-Fit
4:Med-Med
5:LinReg(ax+b)
6:QuadReg
7:ExpReg
```

```
Manual-Fit Y₁
```

```
12X+0
```

```
Plot1 Plot2 Plot3
\Y₁⊟12X+0
\Y₂=
\Y₃=
\Y₄=
```

✎ Answer questions 17 - 18 on student data sheet.

Activity 7

Metric Rules

Table 1

Item	inches	feet	centimeters	meters
1. length of desk				
2. width of desk				
3. length of chalkboard				
4. width of chalkboard				
5. length of textbook				
6. width of textbook				

1. What was the approximate conversion factor you found to convert feet to inches? _____

2. How did you calculate the conversion factor reported for question 1?

   _____

3. Convert 27.5 feet into inches using this factor. _____

4. What was the approximate conversion factor you found to convert inches to feet? _____ Explain how you calculated this factor._____

   _____

5. Write the exact conversion factor for inches to feet as a fraction and as a decimal _____

6. Convert 65 inches into feet using the exact factor._____

7. What is the conversion factor you found to convert from meters to centimeters?

   _____

   Explain how you calculated this factor.

   _____

8. Convert 2.78 meters into centimeters _____

9. What is the conversion factor you found to convert from centimeters to meters?_____

Explain how you calculated this factor._____

10. Convert 879 centimeters into meters.

_____

11. What is the conversion factor you found to convert from inches to centimeters? _____

Explain how you calculated this factor._____

12. Convert 65 inches into centimeters. _____

13. What is the conversion factor you found to convert from meters to feet?

_____

Explain how you calculated this. _____

_____

14. Change 100 meters to feet._____

15. Write a few sentences about how your conversion factors compared to the TI-73 conversion factor.

_____

_____

_____

_____

_____

_____

16. Summarize measuring and converting within the English system and Metric system (SI).

_____

_____

_____

17. What is the unit conversion ratio you would use to convert measurements from feet to inches? _____

18. Describe any similarities you notice between this ratio and the mathematical expression generated from the manual fit line?

_____

Teacher Notes

Math Strands: Geometry and Measurement

Data collection through the measurement of different linear objects. Developing a strategy to determine the conversion factors needed to convert from one linear measurement to another. Comparing two different units of measure by division using ratios.

Science Strands: Data Collection

Standards of measure, along with significant digits, will be investigated in measurement and in unit analysis.

Classroom Management and Safety

Students should be careful in the use of measurement devices, watching for errors in reading the rulers and in recording the data. A recorder and reader should be assigned positions in lab teams. A discussion of what is meant by the required measurements is important to standardization of results.

The Set Up

♦ Students should be somewhat familiar with the use of a ruler and the systems of measurement of length (in particular, centimeters and meters and inches and feet).

♦ The CBR™ or the CBL™ with the motion probe could be used to collect the measures. Use the **GAUGE** mode on the TI-73, or the multimeter mode on the CBL.

♦ The numbers in **L1** are to be associated with the measures, such as 1: length of desk, 2: width of desk, and so forth, as demonstrated on the student data sheet.

♦ Watch for the use of significant digits in reporting values from the measuring devices and from calculations. Use the MODE option to set the number of digits reported to be appropriate for the situation. Students may use the CBR to get measures in feet and meters.

♦ Students are more likely to find the exact conversion factor of 100. In fact if all elements in **L5** are 100, ask the students if it is necessary to find the mean.

♦ Naming lists and the **Manual-Fit** options are explained in the TI-73 Manual.

Student Data Collection and Analysis Sheet – Key

Table 1 values will vary depending on the size of object measured. Look for significant digits and the approximate variations in magnitudes (that is, the meters are 100 ∗ the centimeters).

1. 12

2. Divide the inches by the feet measures.

3. 27.5 feet * the factor from question one. Approximately 330 inches.

4. 0.08; Divide the feet by the inch measures.

5. 1/12; 0.83333333333…

6. Convert 65 inches * 1/12 = 5.41666666…feet

7. 100; Divide the centimeter measures by the meter measures.

8. 2.78 meters = 278 centimeters

9. 0.01; Divide the meter measures by the centimeter measures.

10. 879 centimeters = 8.79 meters

11. 2.54; Divide the centimeter measures by the inch measures.

12. 65 inches = 165.1 centimeters

13. 3.3; Divide the feet measures by the meter measures.

14. 100 meters = 328 feet

15. Variations, but the numbers should be close.

16. Variations, but the ease of the powers of 10 should be revealed.

17. 12 inches/1 foot

18. The slope is the conversion factor.