SLATE Demonstration Curricula
Contextualizing Mathematics, Engineering, and Manufacturing Education
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Strategic Linking of Academic and Technical Education (SLATE)

Contextualizing Mathematics, Engineering, and Manufacturing Education

How Do You Measure Up?

Prepared by Placer-Nevada Mathematics, Engineering, and Manufacturing Education Contextualized Learning Council
This project was supported by a grant from The James Irvine Foundation.
Contextualizing Mathematics, Engineering, and Manufacturing Education

How Do You Measure Up?

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Preface

In 2011, the James Irvine Foundation generously committed to funding two years of SLATE with the following objectives:

1. Establish English and mathematics cross-discipline, intersegmental faculty councils called Contextualized Learning Councils (CLCs) to create teaching materials and methodologies that provide context and links to real-world applications;

2. Develop, publish, and disseminate eight contextualized curricular units, four English and four mathematics, connected to technical education and other academic disciplines; and

3. Develop a model of faculty professional development.

To achieve the objectives, CLCs were established across California in early 2011. In addition to English and mathematics, the disciplines represented were bio-science, business, environmental science, industrial technologies, mechatronics/manufacturing and product design, public health, public safety, social science, and statistics. Each of the councils had its own personality and motivations, and the curriculum reflects that. The contextualized learning councils were:

- Contra Costa English, Mathematics, and Environmental Science
- Los Angeles English and Social Science
- Placer-Nevada English and Public Safety
- Placer-Nevada Mathematics, Engineering, and Manufacturing
- San Bernardino West English and Environmental Science
- San Francisco Mathematics and Public Health
- Santa Barbara English, Journalism, and Media Arts
- Santa Barbara Mathematics and Automotive
- Shasta English and Small Business
- Shasta Mathematics and Industrial Technology

Each of the councils has its own personality and motivations, and the curriculum reflects that.
In addition to creating field-test ready curricula through an interdisciplinary and linked approach to improve student learning, SLATE improved professional learning for faculty via the same strategy. The SLATE curriculum design process, involving regional faculty members working across disciplines and segments, proved to be a powerful form of professional development. Participants had the advantage of long-term, ongoing support in a venue where they gained in-depth content knowledge informed by a cross-discipline.

The teaching strategies developed through SLATE will be extremely valuable as SLATE high school faculty prepare students with 21st century skills that meet the rigor and relevance demanded by the Common Core State Standards. At the same time, their postsecondary partners have a better understanding of these new standards: what they mean in terms of high school students’ preparation and what adjustments colleges may need to make regarding aligning curricula, programs, and services to ensure students’ continued progress.

Overall, the game-changing cross-disciplinary curriculum and assessments SLATE participants developed have moved them to the forefront of educational leadership. As evidence grows regarding the link between quality professional development and improved student achievement—and school reform—SLATE stands out as an exemplar of how dialog and reflection in a learning community of colleagues turn into achievement in the classroom.

Sandra Scott, Project Director
COUNCIL BACKGROUND

The Placer-Nevada Mathematics, Engineering, and Manufacturing Contextualized Learning Council (CLC) was located in northern California in the foothills of the Sierra Nevada mountains. The council’s participants represented high school and Sierra College mathematics and technical education faculty. The council’s strengths came from positive and mutually respectful relationships and appreciation for what each participant brought to the table. Two career pathways—engineering and design, as well as manufacturing and product development—were chosen because the instructors in those pathways indicated an eagerness to work with their general education counterparts.

This measurement lesson is a response to employer advisory committee input to technical education programs regarding job applicants’ inability to read a ruler, accurately measure, or convert numbers between the metric and U.S. customary measurement systems. While it may seem surprising that job applicants don’t know how to read a ruler, CLC faculty members have observed that many students come into technical education classes not knowing what the lines and marks on a ruler mean.

CLC members wanted to provide a lesson in which students in middle school through community college could practice measuring the properties of two- and three-dimensional shapes, as well as the properties of weight and time, to solve problems while experiencing the importance of accurate measurement.

Council Participants

Virginia Horowitz, SLATE Regional Coordinator
Maile Barron, Sierra Community College
Debbie DeBacco Weddle, Roseville Joint Union High School District
Steve Dicus, Roseville Joint Union High School District
Patty Fauble, CLC Co-Chair, Roseville Joint Union High School District
Mike Fischer, Placer Regional Occupation Program
Dan Frank, Rocklin Unified School District
Valaine Hoffman, Sierra Community College
Steve Hunter, Sierra Community College (Emeritus)
Ardella Koester, Placer Union High School District
Katie Lucero, Sierra Community College
John Montgomery, Roseville Joint Union High School District
Sandy Morse, Placer Union High School District
Kathleen Patterson, Rocklin Unified School District
Christine Poulsen, Placer County Office of Education
Jerry Rieger, Roseville Joint Union High School District
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Lesson

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INTRODUCTION

Grade Level:
middle school, high school, and community college technical education

Time:
This lesson will take approximately one or two 50- to 55-minute class periods to teach, depending upon how much time students need to accomplish the tasks correctly and whether they are assigned the more challenging optional lesson extensions.

Instructional Materials:
- graph paper
- tools for measuring:
  - ruler
  - yardstick, meterstick
  - tape measure
  - stopwatch (or stopwatch app. on a cell phone)
  - small food scale
  - personal weight scale
  - trundle wheel (borrow from P.E. dept. or create; see Google “how to make trundle wheel”)
- objects to measure, e.g.:
  - pencil, pen, textbook, box, desk, picture frame
  - pendulum, hourglass (to measure timeframes of minutes, hours)
  - water bottle, calculator, cantaloupe, textbook
  - odd-shaped, relatively large object such as a chair (to measure weight)
  - piece of paper, a circular plate, a yield sign (to measure area)
  - brick, box, cylindrical item such as an oatmeal container (to measure volume)
  - architectural features such as hallways and rooms (to measure distance), and windows and doors (to measure height/width)
  - calendars (to measure timeframes of days, months, years)
- Handout 1 (Measurement Scoring Rubric), Handout 2 (Units of Measurement and Linear Graphing), and Handout 3 (Units of Measurement and Conversion Factors)

Required Technology:
- calculator
- optional: access to online mapping program (to find distance from home to school)

Cross-Disciplines:
mathematics and the industry pathways of engineering and design and of manufacturing and product development
Unit Overview
Solving many problems arising in everyday life requires applying mathematics. Basic number sense is a fundamental aspect of mathematics education. In this lesson, basic number sense is reinforced as students rotate among stations, measuring different objects with various tools to gather and report data in both the metric and English measurement systems. Students
• use the conversion factor for inches to centimeters through graphing;
• complete projects that require accuracy and precision of measurement, and use a variety of notations as well as ratios and proportions; and
• graph results and create a conversion chart.

This lesson is appropriate in the 7th through 9th grades, a Pre-Algebra or Algebra I class, and/or industrial technology courses such as construction, welding, or drafting. In this lesson, students
• strengthen, deepen, and apply number sense;
• strengthen their conceptual understanding and application of fractions and decimals by measuring objects with a variety of tools;
• convert various units of measurement;
• distinguish between accuracy and precision in measuring;
• collect, analyze, and model data for graphing;
• understand how to organize and structure work individually and in teams for effective performance and the obtainment of goals; and
• apply appropriate problem-solving strategies and critical-thinking skills to work-related issues/tasks.

Essential and Topical Questions
Essential Question:
When measuring, how accurate do you need to be?

This essential question is at the core of measurement skills in the Common Core State Standards (CCSS). In the CCSS, the term “precise” is used in place of “accurate.” In industry, however, “accurate” and “precise” have different meanings. (See sidebar, page 14, for further explanation and clarification.) Have students discuss and respond to the essential question throughout the unit, as appropriate, and note how their answers change, or don’t change, over time, based on their experiences and new knowledge and skills.

Topical Questions:
• Why is it important to measure?
• What are some measurement tools?
• What situations can you describe in which accuracy is very important?

Use these topical questions with your students before, during, and/or after learning experiences, as appropriate and useful, to stimulate discussion and help students use evidence to justify and explain their answers. As students understand that answering these open-ended questions leads to asking more questions, help them make meaning and draw connections between their new knowledge, skills, and understandings.
Learning Objectives
Students will demonstrate a foundational understanding of fractions, decimals, and units of measure through the use of a variety of tools to
• accurately measure an assortment of objects and quantities;
• convert between measurement systems; and
• apply number sense to determine if measurements and conversions are reasonable.

Prior Knowledge/Prerequisite Skills
Students need to know how to apply basic mathematical operations with fractions and whole numbers.

Standards
Common Core State Standards for Mathematics for California Public Schools K–12*

Standards for Mathematical Practice:
SMP 4. Model with mathematics.
SMP 5. Use appropriate tools strategically.
SMP 6. Attend to precision.

K–8 Standards
Mathematics, Grade 8:
8.EE 5. Graph proportional relationships, interpreting the unit rate as a slope of the graph (focus of this unit). Compare two different proportional relationships represented in different ways.

Higher Mathematics Standards
Higher Mathematics Courses, Traditional Pathway
Algebra I:
N-Q 1. Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently and in formulas; choose and interpret the scale and the origin in graphs and data displays.
N-Q 2. Define appropriate quantities for the purpose of descriptive modeling.
N-Q 3. Choose the level of accuracy appropriate to limitations on measurement when reporting quantities.
A-SSE 1. Interpret expressions that represent a quantity in terms of its context.

California Career Technical Education Model Curriculum Standards—Grades 7–12*

**Engineering and Design Industry Sector, Foundation Standards (Academics); 1.1 Mathematics**

**Specific Applications of Mathematical Reasoning Standards (Grade 7):**

2.3. Estimate unknown quantities graphically and solve for them by using logical reasoning and arithmetic and algebraic techniques.

2.7. Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

**Problem Solving and Critical Thinking:**

5.1. Apply appropriate problem-solving strategies and critical thinking skills to work-related issues and tasks.

**Leadership and Teamwork:**

9.3. Understand how to organize and structure work individually and in teams for effective performance and the attainment of goals.

**Manufacturing and Product Development Industry Sector, Foundation Standards (Academics); 1.1 Mathematics**

**Specific Applications of Number Sense Standards (Grade 7):**

1.3. Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.

**Specific Applications of Mathematical Reasoning Standards (Grade 7):**

2.8. Make precise calculations and check the validity of the results from the context of the problem.

**Specific Applications of Geometry Standards (Grades 8–12):**

8.0. Students know, derive, and solve problems involving the perimeter, circumference, area, volume, lateral area, and surface area of common geometric figures.

**Assessments**

- accurate measurement of objects using different measurement tools
- conversion between metric and English measurement systems using measurement data
- discussion of different scenarios where the level of accuracy and precision varies
- completed worksheets and graphs
- participation in class discussions

**Lesson**

**Introduction**

As a pre-assessment, have students measure three common items at their desks (such as a book, their desktop, a piece of paper, etc.) in both centimeters and inches. Have students compare answers and, if necessary, reteach/review correct use of measurement tools.

Engage students in a discussion about the construction of a new gym and/or athletic field. Many topics can be discussed under this example, such as measuring using different systems of measurement, desired level of accuracy, and the difference between precision and accuracy (see sidebar below).

For example, begin the discussion as follows:

- ABC Junior High is building a new gym. The principal measured the existing basketball court and said that it was 74 by 42. The athletic director measured the same court and said it was 22.6 by 12.8. Why might these measurements vary so drastically? Is someone correct and someone incorrect?
- How important is the accuracy of their measurements? (If students don’t generate a discussion about the fact that rounding 6 inches to the nearest foot is or is not appropriate in this situation, lead the discussion in this direction.)
- The standard dimensions for a junior high basketball court are 74 ft. by 42 ft. Suppose that in a certain school district, one school has a court that is 70 ft. by 40 ft. Ask:
  - How might this affect the basketball teams that play in this district?
  - Why might all of the schools in this district convert their courts to be 70 ft. by 40 ft.? Would this “even the playing field” for all the teams?
  - What problems arise with changing all the courts to substandard measurements? (This discussion will give students a chance to consider the difference between precision and accuracy.)

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**Accuracy vs. Precision**

As defined globally in industry, the degree of accuracy in a measurement reflects how close to the actual or true value the measurement is. “A surveyor strives for both accuracy and precision. Many people use the terms ‘accuracy’ and ‘precision’ interchangeably. However, for those in the surveying profession (as well as other technical and scientific fields), these words have different meanings. To surveyors, ‘accuracy’ refers to how closely a measurement or observation comes to measuring a true value, since measurements and observations are always subject to error. ‘Precision’ refers to how closely repeated measurements or observations come to duplicating measured or observed values.”

By this definition, the word “precision” is referring to “accuracy” in the Common Core State Standards SMP 6: Attend to precision.

Next, organize the classroom into 12 stations, providing each station with the appropriate measurement tools for the items at that station. Have students move through the stations and measure each object, deciding on the most appropriate ways for them to measure each.

The following are suggestions for objects to place at each station. Any object that requires the appropriate unit of measurement can be used:

**Stations 1–3:**
Measure length and height in inches and centimeters using a ruler, yardstick, meterstick, and/or tape measure. (This data will be used later to derive the metric conversion factor.):
- Station 1: pencil, pen
- Station 2: textbook, box, desk
- Station 3: piece of paper, picture frame

**Station 4:**
Measure time in seconds with a stopwatch; students can use the standard stopwatch on a cell phone:
- swing of a pendulum
- time to empty one side of an hourglass

**Stations 5–7:**
Measure weight in pounds or ounces using appropriately sized scales:
- Station 5: water bottle, calculator
- Station 6: cantaloupe, textbook
- Station 7: an odd-shaped object, such as a chair (requires that students must reason through the process of weighing themselves with and without the object and then subtracting the two measurements)

**Station 8:**
Measure distance in meters or yards using a trundle wheel:
- length of hallway, distance from classroom to office

**Station 9:**
Measure size in feet or meters using a yardstick, meterstick, and/or tape measure:
- height of door, length of classroom
**Station 10:**
Measure lengths and widths using rulers to calculate area in square inches or square centimeters:
- desktop, piece of paper (rectangle or square area is $\text{height} \times \text{width}$), circular plate (circle area is $\pi r^2$)*, cardboard yield sign (triangle area $= \frac{1}{2} \times \text{base} \times \text{height}$)

**Station 11:**
Measure length, width, height, or diameter using rulers or tape measures to calculate volume in cubic inches or cubic centimeters:
- box or brick ($\text{height} \times \text{width} \times \text{length}$), cylindrical object (a cylinder with radius $[r \text{ units}]$ and height $[h \text{ units}]$ has a volume of $V \ [\text{cubic units}]$, $V = \pi r^2 h$) such as an oatmeal container

**Station 12:**
Measure time to determine the following quantities (specify the following: 365 days per year, 30 days per month):
1. How many hours have you been alive?
2. How many months will you have spent in a high school math class by the time you graduate?
3. The homecoming dance is on [date]. How many minutes do you have left to find a date?

**Activity 1**
Pass out Handout 1, Measurement Scoring Rubric, so that students know what they will be graded on for this activity. Students rotate through the stations measuring and recording data on Handout 2, Units of Measurement and Linear Graphing.

**Activity 2**
Students use the data collected from Stations 1, 2, and 3 to make a t-chart and associated graph to identify the relationship between the U.S. customary and metric systems of measurement on Handout 2.

Students are asked questions at the end of the handout to help them recognize the linear pattern that should arise on their graph. This relationship is critical to the understanding of a linear function. If students have not measured accurately and/or their graphs are not linear in shape, the activity should be paused until all groups have accurate measurements, t-charts, and linear graphs. This could be accomplished by the use of a “swap meet” (trade one or two group members per group, mixing students who have accurate information with those who do not) or by the use of “traveling experts.” (If the majority of the class does not have accurate data, the few who did measure accurately could be dispersed among the groups to explain to the others how to measure and/or graph accurately.)

* $\pi = 3.14.$
Activity 3
Discuss the concept of rate of change and how it is connected to the slope of a line.

a. Lead the class in a discussion of slope. Slope is the vertical change divided by the horizontal change (or rise/run) of a straight line. Slope is also called gradient, incline, or pitch. When building a house, the roof’s pitch has to be calculated.

The formula for slope is expressed as:
Change in $y$ at two points on a graph divided by change in $x$ at two points on a graph,

or $\frac{y_2 - y_1}{x_2 - x_1}$.

For example, if two points on the $y$-axis are 1 and 4, the change on the $y$-axis (vertical) is 3. If two points on the $x$-axis are 2 and 8, the change on the $x$-axis (horizontal) is 6.

Therefore, $3/6$ is the slope. Reduced, it becomes $1/2$ (see fig. 1).

Figure 1. Slope based on rate of change.
b. Lead a class discussion regarding the data and the two questions on Handout 2 about the linear pattern formed on their graphs. The students should be instructed to draw the line of best fit, if they have not done so already, on their graphs. A line of best fit is defined as a line on a graph showing the general direction that a group of points is heading (see fig. 2).

![Figure 2. Line of best fit given data points (in blue).](image)

c. As a class, discuss and answer the questions at the end of Handout 2.

d. To conclude this part of the lesson, ask the students for the actual conversion factor between inches and centimeters (1 in. ≈ 2.54 cm.) and have each student group determine the accuracy of their conversion factor. At this point, revisit the discussion of accuracy from earlier in the lesson and extend the accuracy discussion to percent accuracy, etc. Check for understanding by having students hold up their graphs for the teacher to read and respond to.

Pocket Questions
(Questions that a teacher could ask as leading questions, lesson extensions, or if students are having difficulty.)

- When you plot your data, is there a pattern?
- Are there points that don’t seem to fit the rest of the data? What could cause that and what might be done to fix it?
Close

Using problems from Handout 2, Units of Measurement and Conversion Factors, have the students extend what they have learned about linear conversion factors to determine the conversion factor between miles to kilometers.

Extending the Lesson

Travel, architecture, construction, engineering, automated manufacturing, medicine, technology, and product design and development all involve measurement and precision/accuracy. Students could research this topic and add additional information.
Handouts

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## Measurement Scoring Rubric

### Activity 1

Measure objects in both metric and English systems of measurement and perform conversions between the two systems. The following rubric will be used to assess your work.

<table>
<thead>
<tr>
<th>ASSESSMENT</th>
<th>MEASURE USING APPROPRIATE TOOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceeds Standard</td>
<td><strong>Students independently</strong> determine and use the appropriate tools to accurately measure given objects. They accurately record data and determine appropriate rounding. Students graph and compare their English and metric measurements to determine a conversion factor. Students discern errors and take appropriate steps to correct them.</td>
</tr>
<tr>
<td>Meets Standard</td>
<td><strong>With limited guidance</strong>, students use the appropriate tools to accurately measure given objects. They accurately record data and determine appropriate rounding. Students graph and compare their English and metric measurements to determine a conversion factor. Students correct errors and take appropriate steps to correct them.</td>
</tr>
<tr>
<td>Approaches Standard</td>
<td><strong>With significant guidance</strong>, given objects of various sizes, students use appropriate tools to accurately measure the objects in the English and metric systems. Students record data.</td>
</tr>
<tr>
<td>Below Standard</td>
<td><strong>Even with significant guidance</strong>, student's measurements do not meet accuracy requirements.</td>
</tr>
</tbody>
</table>

2013, www.iebcnow.org
Name: _____________________________

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### UNIT S OF MEASUREMENT AND LINEAR GRAPHING

**Activity 1**

As you walk around to the 12 stations, record your measurement data on this worksheet. Measure as accurately as possible; you will be using this data to derive formulas and answer questions.

<table>
<thead>
<tr>
<th>STATION #</th>
<th>NAME/SKETCH</th>
<th>INCHES</th>
<th>CENTIMETERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station 1</td>
<td>Object 1:</td>
<td>Length:</td>
<td>Length:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Height:</td>
<td>Height:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Length:</td>
<td>Length:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Height:</td>
<td>Height:</td>
</tr>
<tr>
<td>Station 2</td>
<td>Object 1:</td>
<td>Length:</td>
<td>Length:</td>
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<td>Height:</td>
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<td>Object 2:</td>
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<td>Height:</td>
<td>Height:</td>
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<tr>
<td>STATION #</td>
<td>NAME/SKETCH</td>
<td>INCHES</td>
<td>CENTIMETERS</td>
</tr>
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<td>-------------</td>
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<td>-------------</td>
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<tr>
<td>Station 3</td>
<td>Object 1:</td>
<td>Length:</td>
<td>Length:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Height:</td>
<td>Height:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Length:</td>
<td>Length:</td>
</tr>
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<td></td>
<td></td>
<td>Height:</td>
<td>Height:</td>
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</table>

<table>
<thead>
<tr>
<th>STATION #</th>
<th>NAME</th>
<th>MEASUREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station 4</td>
<td>Object 1:</td>
<td>Time:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Time:</td>
</tr>
<tr>
<td>Station 5</td>
<td>Object 1:</td>
<td>Weight:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Weight:</td>
</tr>
<tr>
<td>Station 6</td>
<td>Object 1:</td>
<td>Weight:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Weight:</td>
</tr>
<tr>
<td>Station 7</td>
<td>Object 1:</td>
<td>Weight:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Weight:</td>
</tr>
<tr>
<td>Station 8</td>
<td>Object 1:</td>
<td>Distance:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Distance:</td>
</tr>
<tr>
<td>Station 9</td>
<td>Object 1:</td>
<td>Size:</td>
</tr>
<tr>
<td></td>
<td>Object 2:</td>
<td>Size:</td>
</tr>
<tr>
<td>STATION #</td>
<td>NAME</td>
<td>MEASUREMENT</td>
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<tr>
<td>-----------</td>
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</tr>
<tr>
<td>Station 10</td>
<td>Object 1:</td>
<td>Area:</td>
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<tr>
<td></td>
<td>Dimensions:</td>
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<tr>
<td></td>
<td>Calculations:</td>
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<td>Object 2:</td>
<td>Area:</td>
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<td></td>
<td>Dimensions:</td>
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<td></td>
<td>Calculations:</td>
<td></td>
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<tr>
<td>Station 11</td>
<td>Object 1:</td>
<td>Volume:</td>
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<td>Dimensions:</td>
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<td></td>
<td>Object 2:</td>
<td>Volume:</td>
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<td>Dimensions:</td>
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<td>Calculations:</td>
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<tr>
<td>STATION #</td>
<td>NAME</td>
<td>MEASUREMENT</td>
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</tr>
<tr>
<td>Station 12</td>
<td>Question 1: Conversions and Calculations:</td>
<td>Solution:</td>
</tr>
<tr>
<td></td>
<td>Question 2: Conversions and Calculations:</td>
<td>Solution:</td>
</tr>
<tr>
<td></td>
<td>Question 3: Conversions and Calculations:</td>
<td>Solution:</td>
</tr>
</tbody>
</table>

1. Take the data from stations 1, 2, and 3 and fill in the following table (t-chart) of ordered pairs where \( x = \) length in inches and \( y = \) length in centimeters for each object. Then plot the six ordered pairs from the t-chart on a separate sheet of graph paper. Be sure to label each axis with the correct units.

<table>
<thead>
<tr>
<th>Object</th>
<th>( x = ) length in in.</th>
<th>( y = ) length in cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>
2. Describe the trend that occurs with the plotted points on the graph and determine the conversion factor between inches and centimeters.

3. How accurate is the conversion factor you found as a group? How do you know?

Actual Conversion Factor: ______ in. = ______ cm.

4. Describe how you could use the graph to determine the length in centimeters of an object that is 50 inches long.
3. Using the following table, plot the ordered pairs on a separate sheet of graph paper and determine the conversion factor between miles and kilometers.

<table>
<thead>
<tr>
<th>x = KILOMETERS (KM.)</th>
<th>y = MILES (MI.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 km.</td>
<td>3.106855 mi.</td>
</tr>
<tr>
<td>16.1 km.</td>
<td>10.00407 mi.</td>
</tr>
<tr>
<td>3.5 km.</td>
<td>2.174799 mi.</td>
</tr>
<tr>
<td>12.88 km.</td>
<td>8.003258 mi.</td>
</tr>
</tbody>
</table>

Conversion factor: _____ mi. = ________ km.
4. The distance from your house to the school is _____ miles. What is the distance in kilometers? _____ km.

5. The advised speed limit on German autobahns is 130 km./hour. What is the equivalent speed limit in miles/hour?

6. (Optional) If you can consistently average a 7-minute mile, how many minutes and seconds will it take you to run a 10k?
Handout 1: N/A
Handout 2: Answer key not provided. Answers will vary.
Handout 3: Units of Measurement and Conversion Factors .......................................................... 32
**Answer Key**

**Contextualizing Mathematics, Engineering, and Manufacturing Education**

**Units of Measurement and Conversion Factors**

**Conversion Factor:** \(\text{1 in.} = \frac{2.54}{\text{cm.}}\)

1. If the distance from here to the nearest exit is 4,191 centimeters, what is the distance in feet and inches? (Note: There are 12 inches per foot.)

\[
4191 \text{ cm.} \div 2.54 = 1650 \text{ in.}, \\
1650 \div 12 = 137.5 \text{ ft. or 137 ft., 6 in.}
\]

2. (Optional) If you walk at a rate of 4 feet/second, how many centimeters will you travel in one minute?

\[
1 \text{ minute} = 60 \text{ seconds}, \\
4 \text{ ft./sec.} \times 60 \text{ secs.} = 240 \text{ ft.}, \\
240 \text{ ft.} \times 12 \text{ in./ft.} = 2880 \text{ in.}, \\
2880 \text{ in.} = 7351.2 \text{ cm.}
\]

3. Using the following table, plot the ordered pairs on a separate sheet of graph paper and determine the conversion factor between miles and kilometers.

<table>
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</tr>
</tbody>
</table>

**Conversion factor:** \(\text{1 mi.} = \frac{1.60934}{\text{km.}}\)
4. The distance from your house to the school is ______ miles. What is the distance in kilometers? ______ km.

Answers will vary.

5. The advised speed limit on German autobahns is 130 km./hour. What is the equivalent speed limit in miles/hour?

1 km. = .621371 mi.,
130 km. × .621371 = 80.7783 mph.

6. (Optional) If you can consistently average a 7-minute mile, how many minutes and seconds will it take you to run a 10k?

10k = 6.21371 miles,
7 mins./mi. × 6 mi. = 42 minutes,
7 mins./mi. × 60 secs. = 420 secs./mi.,
.21371 mi. × 420 secs. = 89.7582 secs. = 1 minute, 29.7582 seconds,
Answer: 43 minutes, 29.8 seconds.

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