# Newark Charter School
# Units/Lessons

# Mathematics ~ Grade 4

# Newark Charter School Instructional Unit

**Unit Title: Measurement**

**Content Area: Mathematics**

**Grade Level(s): Grade 4**

**Length of Unit: Seven lessons – eight 50 to 60 minute periods**

**Unit Summary:**
This unit is designed to help students obtain a better sense of U.S. customary and metric measurement. It begins with activities that help students gain an understanding of how systems of measurement have come about in order that students see these systems as a human construction. Hands-on activities involving linear measure, weight, and capacity follow. Students are also introduced to elapsed time and given lots of practice with this frequently difficult concept.

**Common Core State Standards:**
CCSS.Math.Content.4.MD.A.1 Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. *For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...*

CCSS.Math.Content.4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems Involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

CCSS.Math.Content.4.MD.A.3 Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.*

CCSS.Math.Content.4.MD.B.4 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. *For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.*

CCSS.Math.Content.4.NF.B.4c Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. *For example, if each person at a party will eat 3/8 of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?*

CCSS.Math.Content.4.OA.A.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.

**Big Ideas:**

**Measuring skills and understandings are an important help in real-world, daily life.**

**Enduring Understandings:**

**There are systems of common, standard measurements that we can use that will transfer across multiple settings and situations and will help us problem solve.**

**Measurements must be precise and carefully done to have value in problem solving.**

**Essential Question(s):**

**What must I remember to make sure I measure precisely and carefully?**
**Does it really matter what standard I use to measure things?**
**What kinds of things need measuring in real-life?**

**Knowledge and Skills:**

**Students will need to know...**

1. Measurement (Kindergarten) Core Knowledge Sequence, p. 18.
2. Measurement (Grade 1) Core Knowledge Sequence, p. 36.
3. Measurement (Grade 2) Core Knowledge Sequence, pages 57-58.
4. Measurement (Grade 3) Core Knowledge Sequence, pages 79-80

**Student will be able to do...**

Concept Objectives

1. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
2. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
3. Students understand the structure and use of systems of measurement; they understand how these systems have come about and see these systems as a human construction.

Content from the Core Knowledge Sequence

1. 4th Grade Mathematics: Measurement (CKS pages 102-103)
    a. Linear measure: estimate and make linear measurements in yards, feet, and inches (to 1/8 in.); and in meters, centimeters, and millimeters.
    b. Weight (mass): estimate and measure weight in pounds and ounces; grams and kilograms.
    c. Capacity (volume): estimate and measure liquid capacity in teaspoons, tablespoons, cups, pints, quarts, gallons; and in milliliters and liters.
    d. Know the following equivalences among U.S. customary units of measurement, and solve problems involving changing units of measurement:

    Linear measure

        1 ft. = 12 in.
        1 yd. = 3 ft. = 36 in.
        1 mi. = 5,280 ft.
        1 mi. = 1,760 yd.

    Weight

        1 lb. = 16 oz.
        1 ton = 2,000 lb.

    Capacity (volume)

1 cup = 8 fl. oz. (fluid ounces)
1 pt. = 2 c.
1 qt. = 2 pt.
1 gal. = 4 qt.

e. Know the following equivalencies among metric units of measurement, and solve problems involving changing units of measurement:

Linear Measurement
1 cm = 10 mm (millimeters)
1 m = 1,000 mm
1 m = 100 cm
1 km = 1,000 m

Mass
1 cg (centigram) = 10 mg (milligrams)
1 g = 1,000 mg
1 g = 100 cg
1 kg = 1,000 g

Capacity (volume)
1 cl (centiliter) = 10 ml (milliliters)
1 liter = 1,000 ml
1 liter = 100 cl

f. Time: solve problems on elapsed time

Skill Objectives
1. Students construct and interpret number meanings through real-world experiences and the use of hands-on materials.
2. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.
3. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.
4. Students make and use direct and indirect measurements to describe and compare real-world phenomena.
5. Students select appropriate units, including metric and U.S. customary ... to measure to the degree of accuracy required to solve a given problem.
6. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time.
7. Students compare and order objects according to measurable attributes.
8. Students demonstrate the process of measuring and explaining the concepts related to units of measurement.
9. Students use the approximate measures of familiar object (for example, the width of your finger...) to develop a sense of measurement.
10. Students select and use the appropriate standard and non-standard units of measurement in problem-solving situations.
11. Use a line plot to represent measurement data collected for comparison and analysis.

## Assessment Evidence

**Performance or Transfer Tasks:**
Real-world measurement skills should carry over from the learning in this unit.
Understanding of the relationship between measurements we use (equivalencies) need to be built and should transfer.

**Rubrics:**

See appendices

**Other Evidence:**
See appendices

**Student Self-Assessment:**
See appendices

## Learning Plan

**Key Learning Events:**

**Lesson One: The Need for Standards in Measurement (one lesson, approximately one hour)**

A. Daily Objectives
1. Concept Objective(s)
   a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
   b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
   c. Students understand the structure and use of systems of measurement; they understand how these systems have come about and see these systems as a human construction.
2. Lesson Content
   a. Linear measure: estimate and make linear measurements in yards, feet, and inches (to 1/8 in.); and in meters, centimeters, and millimeters.
3. Skill Objective(s)
   a. Students construct and interpret number meanings through real-world experiences and the use of hands-on materials.
   b. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.
   c. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.
   d. Students make and use direct and indirect measurements to describe and compare real-world phenomena.
   e. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time...
   f. Students compare and order objects according to measurable attributes.
   g. Students demonstrate the process of measuring and explaining the concepts related to units of measurement.
   h. Students use the approximate measures of familiar object (for example, the width of your finger...) to develop a sense of measurement.
   i. Students select and use the appropriate standard and non-standard units of measurement in problem-solving situations.

B. Materials
1. Appendix A: Measurement Test (one copy per student)
2. Appendix B: Eye Trick (one overhead copy)
3. Appendix C: Nonstandard Measuring Assignment (one copy per group)
4. Appendix J: Balance Scale (one copy per student)
5. Appendix K: Simple Spring Scale (one copy per student)

6. Appendix L: Scale Rubric (one copy per student)
7. Appendix T: Answer Keys (one copy for teacher)

C. Key Vocabulary

1. A **standard** is an accepted measure used as the basis for comparison.
2. **Measurement** is a comparison with a known standard.

D. Procedures/Activities

1. At the beginning of this class or before you begin this unit, give students an optional take-home assignment of making scales. Provide each interested student with copies of Appendix J: Balance Scale, Appendix K: Simple Spring Scale, and Appendix L: Scale Rubric. It is ideal that at least one student make a balance scale and one student makes a simple spring scale, which they will demonstrate, at the beginning of Lesson Four. (Students can earn up to 30 bonus points for making and presenting either a balance scale or a spring scale. Look at Appendix L as a class to see how points will be allocated.)
2. Give your students Appendix A: Measurement Test. Explain to your students that this is a pretest and that their score on this test will not contribute to their grade. Explain that this pretest is to give them and you an idea of what they know and don't know about measurement. Tell them that they should expect a similar test at the end of this unit. At that point, they and you can see how much they learned! Instruct your students write "Pretest" at the top of their papers. After completing this test, go over/supply correct answers and have students mark their own tests and then collect them..
Special Education Accommodation: Delete one of the incorrect selections (a, b, or c) for questions that have at least three answers from this test to narrow choice field.
3. Make arrows at the ends of the segments on Appendix B: Eye Trick in this manner: on one segment make arrows that are pointing outwards as if it were in fact denoting a line; on the other arrow point your arrows in the opposite direction towards the segment as if you were drawing peace symbols at each end of the segment. Project this overhead and ask your students which segment is bigger. Select a student to prove their answer of which segment is bigger. In order to prove test their answer, they will need to measure both segments – either with a ruler or with another object of their choice. Of course, this is an optical illusion. Both lines are exactly the same length. However, this eye trick demonstrates to your students the need for measurement.
4. Form groups of three. Give each group a copy of Appendix C: Nonstandard Measuring Assignment. Discuss the meaning of the word standard with your students by first asking students what they think standard means. If you cannot illicit the answer from students, give the meaning of the word standard. Do the same for the word measurement. Then instruct your groups to come up with one nonstandard unit. For example, for this activity they may decide to use Ben's hand, Mary's math book, or Jamie's pencil. Have the group assign roles: recorder/reporter, measurer, and taskmaster. Please see Appendix C for a description of these roles and explain these roles to your students. Tell students that they will be measuring the three items listed on Appendix C with their nonstandard unit. Pass out paperclips to each group. Allow approximately 10 minutes for students to complete this activity. Have the groups of three come together as a whole class come together to report back to the large group. In addition to having the reporters of each group report the information they gathered on Appendix C, ask questions like the following: Is one group's measurement of the width of a student desk the same as group two's? Is group three's measurement of the length of the paperclip the same as group four's? Is group five's measurement of the height of the door the same as group six's? Lead the group to come up with the idea that there is a need for some sort of standard in measurement. In fact, point out that measurement is a comparison with a known standard.

E. Assessment/Evaluation

1. Appendix A: Measurement Test

**Lesson Two: How Do I Measure Up? (one lesson, approximately one hour)**

A. Daily Objectives

1. Concept Objective(s)
   a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
   b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
   c. Students understand the structure and use of systems of measurement; they understand how these systems have come about and see these systems as a human construction.
2. Lesson Content
   a. Linear measure: estimate and make linear measurements in yards, feet, and inches (to 1/8 in.)
   b. Know the following equivalences among U.S. customary units of measurement, and solve problems involving changing units of measurement:
   Linear measure
      1 ft. = 12 in.
      1 yd. = 3 ft. = 36 in.
      1 mi. = 5,280 ft.
      1 mi. = 1,760 yd.
3. Skill Objective(s)
   a. Students construct and interpret number meanings through real-world experiences and the use of hands-on materials.
   b. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.
   c. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.
   d. Students make and use direct and indirect measurements to describe and compare real-world phenomena.
   e. Students know, use, describe, and estimate measures of length, capacity, weight, [ and] time.
   f. Students compare and order objects according to measurable attributes.
   g. Students demonstrate the process of measuring and explaining the concepts related to units of measurement.
   h. Students use the approximate measures of familiar object (for example, the width of your finger...) to develop a sense of measurement.
   i. Students select and use the appropriate standard and non-standard units of measurement in problem-solving situations.

B. Materials

1. How Tall How Short How Faraway by David A. Adler or Millions to Measure by David M. Schwartz
2. Appendix D: How Do You Measure Up? (one copy per student)

3. Measuring tapes with U.S. customary measurements, i.e. inches (one per student)
4. Appendix F: Measurement Booklet Assignment / Rubric (one copy per student)
5. Appendix E: Measurement Booklet Template, pages one through four (one copy per student of each page)

C. Key Vocabulary

None

D. Procedures/Activities

1. Begin this lesson with a story that discusses a bit of the history of measurement. Two possibilities are: How Tall, How Short, How FarAway by David A. Adler or Millions to Measure by David M. Schwartz. Whatever story you choose, make sure that it includes information on the fact that early people (e.g. the Egyptians, Sumerians, Hebrew, Europeans) used parts of their bodies as measurement units.
2. Give each child a measuring tape and a copy of Appendix D: How Do You Measure Up? Read over this handout together. Also, remind students that they must begin measuring at the zero point on their measuring tape and have them record their measurements on Appendix D. Circulate the room and check that students are measuring accurately while completing Appendix D.
3. After students have completed Appendix D, discuss their results as a class. Ask questions like: Is Joe's cubit the same length as Mary's? (No. Mary is smaller than Joe.) Is an adult's yard the same size as a child's? (Not usually because an adult is larger than a child.) What problems might this create in the market place? In construction? The need for standards In measurement should come out of the class discussion.
4. Give each student copies of Appendix F: Measurement Booklet Assignment / Rubric. As a class, read Appendix F together pointing out the criteria students will be graded on and expectations for the assignment. Then give each student a copy of all four pages of Appendix E. Have students assemble these booklets by cutting on the dotted lines and then stapling their booklet on the top left corner.
5. Have students open their measurement booklets to page one. Point out the abbreviations for the various measurements on this page and inform students that they will need to learn the abbreviations for these terms as well as their equivalencies. Assign page one for homework due the next class period. Inform students that there will be a quiz on these equivalencies the following day.

E. Assessment/Evaluation

1. Appendix F: Measurement Booklet Assignment / Rubric
2.

**Lesson Three: Metric Linear Measurements (one to two lessons, approximately one hour each)**

A. Daily Objectives

1. Concept Objective(s)
   a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
   b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
   c. Students understand the structure and use of systems of measurement; they

understand how these systems have come about and see these systems as a human construction.

2. Lesson Content

a.Linear measure: estimate and make linear measurements in yards, feet, and inches (to 1/8 in.)

b. Weight (mass): estimate and measure weight in pounds and ounces; grams and kilograms.

c. Know the following equivalences among U.S. customary units of measurement, and solve problems involving changing units of measurement:

Linear measure

1 ft. = 12 in.
1 yd. = 3 ft. = 36 in.
1 mi. = 5,280 ft.
1 mi. = 1,760 yd

Weight

1 lb. = 16 oz.
1 ton = 2,000 lb.

Know the following equivalencies among metric units of measurement, and solve problems involving changing units of measurement:

Linear Measurement

1 cm = 10 mm (millimeters)
1 m = 1,000 mm
1 m = 100 cm
1 km = 1,000 m

Mass

1 cg (centigram) = 10 mg (milligrams)
1 g = 1,000 mg
1 g = 100 cg
1 kg = 1,000 g

3. Skill Objective(s)

a. Students construct and interpret number meanings through real-world experiences and the use of hands-on materials.

b. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.

c. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.

d. Students make and use direct and indirect measurements to describe and compare real-world phenomena.

e. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time...

f. Students compare and order objects according to measurable attributes.

g. Students demonstrate the process of measuring and explaining the concepts related to units of measurement.

h. Students use the approximate measures of familiar object (for example, the width of your finger...) to develop a sense of measurement.

i. Students select and use the appropriate standard and non-standard units of measurement in problem-solving situations.

B. Materials

1. Appendix G: U.S. Units of Length Quiz (one copy per student)
2. Appendix H: Ten-Centimeter Rules (one copy for each pair of students)
3. Appendix T: Answer Keys (one copy for teacher)

C. Key Vocabulary

1. A **meter** is the basic unit of length in the metric system.
2. A **millimeter** is a unit of length which is one thousandth of a meter.
3. A **centimeter** is a unit of length which is one hundredth of a meter.
4. A **kilometer** is a unit of length which is one thousand meters.
5. A **gram** is the basic unit of weight in the metric system.
6. A **centigram** is a unit of weight which is one hundredth of a gram.
7. A **milligram** is a unit of weight which is one thousandth of a gram.
8. A **kilogram** is a unit of weight which is 1000 grams.

D. Procedures/Activities

Day One

1. Begin class with the short quiz, Appendix G: U.S. Units of Length Quiz. When all students have completed the quiz, have students self-correct this quiz and discuss any questions students may have.
2. Before class, make enough copies of Appendix H: Ten-Centimeter Rules so that each student has a total of ten copies of the ten-centimeter rule. Instruct students to cut them out and then tape them together to make a 1-meter ruler. Discuss the need to overlap the ends so that the 1 and 10 marks line up precisely. Ask students what might happen if the ends did not overlap in this way. What if they left space after each of the tens? (Their meter rule would be longer than a meter.) Ask students what they know about the relationship between a millimeter, centimeter, meter, and kilometer. If they cannot tell you, urge them to look at the ten-centimeter rules they are about to connect. If students cannot give you this information, go ahead and tell them that 10 mm = 1cm, 100 cm = 1 m, and 1000 m = 1 km. Also, mention the Latin roots in these words (mil means 1000, centi means 100, kilo means 1000). Ask students if they know of other words with these roots. In addition, before beginning the activity, give students the abbreviations for millimeter (mm), centimeter (cm), meter (m), and kilometer (km). Tell students that they will need to know these abbreviations.
3. Pair students and give each pair a copy of Appendix I: Measuring with a Meter Rule. Have students make their metric rule and begin the activities described and the written responses asked for on Appendix I. Circulate the room answering questions and checking for comprehension.

Day Two

4. Begin class with an oral review of U.S. customary and metric units of length.
5. Then have students continue working on Appendix I. When completed, collect Appendix I for a grade.
6. Assign page four of Appendix E: Measurement Booklet Template for class work for student who finish Appendix I quickly.
7. Before the end of class, explain that for the next class we will be looking at mass. Have students open their measurement booklets (Appendix E) to page two. Review that 16 oz equals one pound and have students give examples of some items that would be measured in ounces (canned food) and pounds (people). Ask what would be weighed in tons (an elephant or car). Have students then open their measurement booklets to page five. Review with students these metric measures of mass. Ask what might be weighed in milligrams. (A leaf.) Centigrams? (A pair of earrings.) Gram? (An apple.) Kilogram? (A person, an elephant.) Also, review the Latin roots in these words (mil means 1000, centi means 100, and kilo means 1000) and give students the abbreviations for centigram (cg), milligram (mg), and kilogram (kg). Tell student that they must also know these abbreviations. For homework, have students bring in six objects that they think weigh 1 milligram, 1 gram, 1 kilogram, 1 pound, 1 centigram, and 1 ounce each. In addition, assign pages four, two, and five of Appendix E for homework due in two lessons time.

E. Assessment/Evaluation
1. Appendix G: U.S. Units of Length Quiz
2. Appendix F: Measurement Booklet Assignment / Rubric
3. Appendix I: Measuring with a Meter Rule

**Lesson Four: The Weight of Things (one lesson, approximately one hour)**

A. Daily Objectives
1. Concept Objective(s)
a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
c. Students understand the structure and use of systems of measurement; they understand how these systems have come about and see these systems as a human construction.
2. Lesson Content
a. Weight (mass): estimate and measure weight in pounds and ounces; grams and kilograms.
b. Capacity (volume): estimate and measure liquid capacity in teaspoons, tablespoons, cups, pints, quarts, gallons; and in milliliters and liters.
c. Know the following equivalences among U.S. customary units of measurement, and solve problems involving changing units of measurement:
Weight
1 lb. = 16 oz.
1 ton = 2,000 lb.
Capacity (volume)
1 cup = 8 fl. oz. (fluid ounces)
1 pt. = 2 c.
1 qt. = 2 pt.
1 gal. = 4 qt.
d. Know the following equivalencies among metric units of measurement, and solve problems involving changing units of measurement:
Mass
1 cg (centigram) = 10 mg (milligrams)
1 g = 1,000 mg
1 g = 100 cg
1 kg = 1,000 g
Capacity (volume)
1 cl (centiliter) = 10 ml (milliliters)
1 liter = 1,000 ml
1 liter = 100 cl
3. Skill Objective(s)
a. Students construct and interpret number meanings through real-world experiences and the use of hands-on materials.
b. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions
c. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.

d. Students make and use direct and indirect measurements to describe and compare real-world phenomena.
e. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time...
f. Students compare and order objects according to measurable attributes.
g. Students demonstrate the process of measuring and explaining the concepts related to units of measurement.
h. Students use the approximate measures of familiar object (for example, the width of your finger...) to develop a sense of measurement.
i. Students select and use the appropriate standard and non-standard units of measurement in problem-solving situations.

B. Materials

1. Appendix L: Balance Rubric (one copy per student presenting)
2. A variety of balance and spring scales (ideally a balance and spring scale for every two students)
3. Appendix E: Measurement Booklet (one copy per student)
4. Appendix M: The Weight of Things (one copy per student)

C. Key Vocabulary

1. The **capacity** of a container is the amount of liquid that can be held in the container.
2. Another word for capacity is **volume.**
3. A **liter** is the basic unit of capacity in the **metric system.**
4. A **centiliter** is a unit of capacity which is one hundredth of a liter.
5. A **milliliter** is a unit of capacity which is one thousandth of a liter.

D. Procedures/Activities

1. Before class, set up balance and spring scales. It would be ideal to have a balance and spring scale for every two students. It would also be ideal to have a use of a lab.
2. Have students that opted to make a balance scale or a spring scale present their scales. Use Appendix L: Balance Rubric to award bonus points. In the class discussion of these projects, make sure to ask the class what force in nature makes these scales work. (Earth's gravity attracts objects downwards. The heavier the object, the more it is pulled downward by the force of gravity.)
3. Demonstrate how to properly use any scales that are set up.
4. Give each student a copy of Appendix M: The Weight of Things. Instruct them to record the six items they brought from home in the appropriate cell on the table.
5. Group your students according to the number of scales you have available. For example, if you have five scales, create five groups of students. In groups, have students test the guesses of the weights of their objects and record on Appendix M the actual weight of their objects. If you have both balance and spring scales, make certain each group gets to experiment with both types of scales. Circulate the class making sure students are using the scales properly and checking their guesses.
6. Before the end of class, explain that for the next class we will be looking at capacity, also called volume. Ask students if they know what is capacity or volume. If you cannot illicit a correct response from students, give the definition for both. Have students open their measurement booklets (Appendix E) to page three Review that 1 quart equals 2 pints and have students give examples of things that would measure quarts (large water bottle) and pints (large beverage glass). Also, review that one gallon equals four quarts and have students give examples of things that would measure a gallon (large plastic milk container) and quarts (small milk cartons). Review the other equivalencies on page three with the students. Then have students open their measurement booklets to page six. Read page six together and complete the equivalencies as a class. Then ask what might be measured in liters (soda). Milliliters?

(Medicine.) Centiliters? (May be used when baking; a centiliter is about the volume of a liquid held in a tablespoon.) For homework, have students bring in seven containers that they think will hold the volumes 1 cup, 1 ounce, 1 pint, 1 quart, 1 gallon, 1 centiliter, 1 milliliter, and 1 liter. Also, assign pages three and six of Appendix E for homework. Tell students to pay attention to the equivalencies of these abbreviations as they will need to knowthem. Booklets should be completed by the next lesson.

E. Assessment/Evaluation

1. Appendix L: Balance Rubric
2. Appendix F: Measurement Booklet Assignment / Rubric

**Lesson Five: The Volume of Things (one lesson, approximately one hour)**

A. Daily Objectives

1. Concept Objective(s)

a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.

b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.

c. Students understand the structure and use of systems of measurement; they understand how these systems have come about and see these systems as a human construction.

2. Lesson Content

a. Capacity (volume): estimate and measure liquid capacity in teaspoons, tablespoons, cups, pints, quarts, gallons; and in milliliters and liters.

b. Know the following equivalences among U.S. customary units of measurement, and solve problems involving changing units of measurement:

Capacity (volume)

1 cup = 8 fl. oz. (fluid ounces)
1 pt. = 2 c.
1 qt. = 2 pt.
1 gal. = 4 qt.

c. Know the following equivalencies among metric units of measurement, and solve problems involving changing units of measurement:

Capacity (volume)

1 cl (centiliter) = 10 ml (milliliters)
1 liter = 1,000 ml
1 liter = 100 cl

3. Skill Objective(s)

a. Students construct and interpret number meanings through real-world experiences and the use of hands-on materials. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.

b. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.

c. Students make and use direct and indirect measurements to describe and compare real-world phenomena.

d. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time.

e. Students compare and order objects according to measurable attributes.

f. Students demonstrate the process of measuring and explaining the concepts related

to units of measurement.

B. Materials

1. Buckets (enough for every three students)
2. Measuring cups (enough for every three students)
3. Measuring pints (enough for every three students)
4. Measuring quarts (enough for every three students)
5. Measuring gallons (enough for every three students)
6. Graduated cylinders that will measure centiliters and milliliters (enough for every three students)
7. Measuring liter (enough for every three students)
8. Funnels (enough for every three students)
9. Lab (not necessary, but ideal)
10. Appendix N: The Capacity of Things (one per student)

C. Key Vocabulary

None

D. Procedures/Activities

1. Before class, set up stations for measuring for groups of three students. Each station should have a bucket of water that exceeds 1 gallon, a funnel, measuring cups, measuring pints, measuring quarts, and measuring gallons or one container that will measure all of these volumes. Each student should also have graduated cylinders that will measure centiliters and milliliters or eyedroppers that will do this, and a measuring liter. It would be ideal to have a use of a lab.
2. Demonstrate how to properly use any measuring equipment students will use.
3. Give each student a copy of Appendix N: The Capacity of Things. Instruct them to record the seven items they brought from home in the appropriate cell on the table.
4. Group your students according to the number of stations you have available. Ideally, you will have enough measuring equipment to assemble one station for every three students. In groups, have the students test the guesses of the capacities of their objects and record the actual volumes of their items on Appendix N. Circulate the class making sure students are using the equipment properly and checking their guesses.
5. Before the end of class, inform students that they will be given a quiz on weight and volume and the beginning of the next class.

E. Assessment/Evaluation

1. Appendix O: Weight, Volume, and Metric Lengths Quiz

**Lesson Six: Elapsed Time (one lesson, approximately one hour)**

A. Daily Objectives

1. Concept Objective(s)
    a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
    b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
2. Lesson Content
    a. Linear measure: estimate and make linear measurements in yards, feet, and inches (to 1/8 in.); and in meters, centimeters, and millimeters.

b. Weight (mass): estimate and measure weight in pounds and ounces; grams and kilograms.
c. Capacity (volume): estimate and measure liquid capacity in teaspoons, tablespoons, cups, pints, quarts, gallons; and in milliliters and liters.
d. Know the following equivalences among U.S. customary units of measurement, and solve problems involving changing units of measurement:
Weight
1 lb. = 16 oz.
1 ton = 2,000 lb.
Capacity (volume)
1 cup = 8 fl. oz. (fluid ounces)
1 pt. = 2 c.
1 qt. = 2 pt.
1 gal. = 4 qt.
e. Know the following equivalencies among metric units of measurement, and solve problems involving changing units of measurement:
Linear Measurement
1 cm = 10 mm (millimeters)
1 m = 1,000 mm
1 m = 100 cm
1 km = 1,000 m
Mass
1 cg (centigram) = 10 mg (milligrams)
1 g = 1,000 mg
1 g = 100 cg
1 kg = 1,000 g
Capacity (volume)
1 cl (centiliter) = 10 ml (milliliters)
1 liter = 1,000 ml
1 liter = 100 cl
f.
Time: solve problems on elapsed time

3. Skill Objective(s)
a. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.
b. Students understand and apply the attributes of length, capacity, weight... in problem solving situations.
c. Students make and use direct and indirect measurements to describe and compare real-world phenomena.
d. Students select appropriate units, including metric and U.S. customary to measure to the degree of accuracy required to solve a given problem.
e. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time.
f. Students compare and order objects according to measurable attributes.
g. Students select and use the appropriate standard and non-standard units of measurement in problem-solving situations.

B. Materials
1. Appendix O: Weight, Volume, and Metric Lengths Quiz (one copy per student)
2. Appendix Z: Answer Keys (one copy for teacher)
3. Magnetic or dry erase boards and accompanying pen (one board and pen for each student)
4. Appendix P: Elapsed Time: (one copy per student and one overhead)
5. Clocks with moving hands (one copy per student)

6. Large clock with moving hands (one for teacher)
7. Appendix Q: Elapsed Time Problems and Answers (one copy for teacher)
8. Appendix R: Elapsed Time Homework (one copy per student)

C. Key Vocabulary

1. **Elapsed Time** is the time or difference between the beginning time and an ending time; it can also be thought of as time gone by.

D. Procedures/Activities

1. Give each student a copy of Appendix O: Weight, Volume, and Metric Lengths Quiz. When all students have completed the quiz, have students self-correct their quizzes. Then answer any questions students may have about the quiz. Inform students to hold onto this quiz as a study sheet for the test at the end of this unit on measurement.
2. Collect Appendix F: Measurement Booklet for grading.
3. Ask students if they know what elapsed time means. If you cannot elicit the definition, give it.
4. Give each child a magnetic or dry erase board and accompanying pen. Instruct them to hold up their work and answer on their board when they have completed the problem you are about to give them. Write this problem on an overhead and say it aloud.

*Carl studies from 5:25 to 5:45. How long does he study?*

Of course, the answer is 20 minutes. Have students explain how they got their answer. Some may have simply subtracted 2 from 4. Others may have added up.

5. Now put this problem on the board.

*Carl studies from 3:48 p.m. to 7:05 p.m. How long does he study?*

Again, instruct students to hold up their work and answer on their boards when they have completed the problem. Have students with correct responses explain how they solved the problem. Then, give each student a copy of Appendix P: Elapsed Time. Project an overhead of Appendix P as the class discusses this detailed explanation of how to solve this problem.

6. Give each student a clock with moving hands. (If your school does not have these, you can have students make them. Instructions and a printable template can be found at http://www.enchantedlearning.com/crafts/clocks/clock/index.shtml.) Then write this problem on the overhead:

*How much time elapses from 3:05 pm to 7:45 am?*

Again, instruct students to hold up their work and answer on their boards when they have completed the problem. Have students with correct responses explain how they solved the problem.

7. Have students refer to page two of Appendix P for a detailed explanation of how to solve this problem. Project this explanation on the overhead, discuss with the class, and demonstrate with the large teacher clock how this problem could be solved.
8. For the remainder of the class, have students solve elapsed time problems on their magnetic or dry erase boards. For each problem, have students hold up their work and answer when they have completed the problem. Circulate the class assisting students as needed or pairing struggling students with those who have mastered solving elapsed time problems. Then have students explain how they solved the problem. If students need the clock manipulative, have them use them. Otherwise, they should not use the clock. See Appendix Q for a list of elapsed time problems with answers.
9. Before class is over, give students Appendix R: Elapsed Time Homework which is due the following lesson.

E. Assessment/Evaluation

1. Appendix R: Elapsed Time Homework

**Lesson Seven: Elapsed Time Practice in the Computer Lab (one lesson, approximately one**

**hour)**

A. Daily Objectives:

1. Concept Objective(s)
    a. Students understand how to use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.
    b. Students develop number sense and use numbers and number relationships in problem-solving situation and communicate the reasoning used in solving these problems.
2. Lesson Content
    a. Time: solve problems on elapsed time
3. Skill Objective(s)
    a. Students use number sense, including estimation and mental arithmetic, to determine the reasonableness of solutions.
    b. Students know, use, describe, and estimate measures of length, capacity, weight, [and] time...
    c. Students demonstrate the process of measuring and explaining the concepts related to units of measurement.

B. Materials

1. Computers with online access (one per student)
2. Clocks with moving hands (one per student)
3. Appendix S: Online Elapsed Time Practice
4. Recording sheet from http://www.harcourtschool.com/activity/elab2002/grade_3/018.html (one per student)

C. Key Vocabulary

None

D. Procedures/Activities

1. This lesson is a day of practice with elapsed time in the computer lab. You will need access to a computer lab with online access for every student to carry out this lesson. Before beginning this class, set up a word document with a list of online elapsed time practice links listed on Appendix S: Online Elapsed Time Practice. Have this Appendix uploadedonto the computers in the lab before class. Also, link to http://www.harcourtschool.com/activity/elab2002/grade_3/018.html and make copies of the recording sheet for this activity for each student.
2. In the computer lab at the beginning of class, project Appendix S onto an LCD projector. The list of websites is arranged from easiest to most difficult. Show students how to minimize and to link from one website to another going over the pointers on Appendix S. Also, have clocks with moving hands available for students who want to use them in solving problems.
3. Circulate the class assisting students as needed or pairing struggling students with those who have mastered solving elapsed time problems.
4. Inform students that they will be taking a test on measurement and elapsed time at the beginning of the next lesson. Have measurement booklets ready to return to students so they have them to study from.

E. Assessment/Evaluation

1. Appendix A: Measurement Test

**CULMINATING ACTIVITY**

The culminating activity for this unit is a review and assessment. Before handing out Appendix A: Measurement Test, give the students up to 15 minutes to ask any questions they may have on measurement or elapsed time. (Consider adding a written response to the question – *Why is having and using common standard units of measure important to everyday living?)*

Special Education Accommodation: Delete one of the incorrect selections (a, b, or c) for questions that have at least three answers from this test. After this test is marked, return both copies of this test – the one taken at the beginning of this unit and the one taken at the end - so that students can see their progress.

**Resources:**

A. How Tall How Short How Faraway by David A. Adler, or Millions to Measure by David M. Schwartz, or any other children's story that discusses a bit of the history of measurement (whatever story is chosen, make sure that it includes information on the fact that early people (e.g. the Egyptians, Sumerians, Hebrew, Europeans) used parts of their bodies as measurement units) (Lesson Two)
B. Measuring tapes with U.S. customary units (Lesson Two)
C. A variety of balance and spring scales; it is ideal to have a balance and spring scale for every two students (Lesson Four)
D. Buckets, measuring cups, measuring pints, measuring quarts, measuring gallons, graduated cylinders that will measure centiliters and milliliters, measuring liters, and funnels; it would also be ideal to have use of a science lab for this lesson(Lesson Five)
E. It is ideal to have a class set of magnetic or dry erase boards and accompanying pen for Lesson Six
F. A class set of clocks with moving hands (check with kindergarten and grade 1 teachers); you can opt to have students make them and instructions and a printable template can be found at http://www.enchantedlearning.com/crafts/clocks/clock/index.shtml (Lessons Six and Seven)
G. Computers with online access - laptops or lab setting (Lesson Seven)

**Handouts:**

A. Appendix A: Measurement Test (Lesson One and Lesson Seven)
B. Appendix B: Eye Trick (Lesson One)
C. Appendix C: Nonstandard Measuring Assignment (Lesson One)
D. Appendix D: How Do You Measure Up? (Lesson Two)
E. Appendix E: Measurement Booklet Template (Lesson Two)
F. Appendix F: Measurement Booklet Assignment / Rubric (Lesson Two)
G. Appendix G: U.S. Units of Lengths Quiz (Lesson Three)
H. Appendix H: Ten-centimeter Rules (Lesson Three)
I. Appendix I: Measuring with a Meter Rule (Lesson Three)
J. Appendix J: Balance Scale (Lesson One and Lesson Four)
K. Appendix K: Simple Spring Scale (Lesson One and Lesson Four)
L. Appendix L: Scale Rubric (Lesson One and Lesson Four)
M. Appendix M: The Weight of Things (Lesson Four)
N. Appendix N: The Capacity of Things (Lesson Five)
O. Appendix O: Weight, Volume, and Metric Lengths Quiz (Lesson Six)
P. Appendix P: Elapsed Time (Lesson Six)
Q. Appendix Q: Elapsed Time Problems and Answers (Lesson Six)

R. Appendix R: Elapsed Time Homework (Lesson Six)
S. Appendix S: Online Elapsed Time Practice (Lesson Seven)
T. Appendix T: Answer Keys (Lesson One, Lesson Three, and last lesson)

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P. *The World of Measurement.* [On-line]. Available URL: http://oncampus.richmond.edu/academics/education/projects/webunits/measurement, Date of access: 6/23/2005
Q. Zimmerman, Robert. Do It Yourself Science, 7 December, 1990, Measure like an Egyptian, pages 22-23.


**Differentiation:**
Accommodations suggestions are made within the individual lesson plans.

**Technology Integrations:**
Smart lessons could be prepared from these plans, if the Smart Board technology is available.

**Content Connections:**
Connections should be made around the history and cultures of early peoples and how they first measured things. Note the math-science connections within lesson plans.

**Appendix A**

# Measurement Test

Name:_____ Score: /60

**Please circle the correct response.** *(Each problem is worth 2 points.)*

1. To measure the length of your desk, you would use:
   a. meters
   b. inches
   c. millimeters

2. The length of a car would be measured using:
   a. feet
   b. centimeters
   c. kilometers

3. How many millimeters are in one centimeter?
   a. 1000
   b. 10
   c. 100

4. Which of the following is equal to two feet?
   a. 70 centimeters
   b. 24 inches
   c. 200 millimeters

5. If Jennifer is four feet tall, how many inches tall is she?
   a. 46 inches
   b. 40 inches
   c. 48 inches

6. Bob is ten meters from the grocery store and ten yards from the movie theater. Which is he closer to?
   a. the grocery store
   b. the movie theater
   c. he is the same distance from both

7. Would it take Olivia longer to run a two mile race or a 4000 yard race?
   a. 2 miles
   b. 4,000 yards
   c. they will both take the same amount of time

# Measurement Test

8. To measure the weight of a toothpick, you would most likely use:
   a. milligrams
   b. grams
   c. kilograms

9. To measure the weight of a pumpkin, you would most likely use:
   a. ounces
   b. pounds
   c. tons

10. To measure the weight of a bicycle, you would most likely use:
    a. centigrams
    b. grams
    c. kilograms

11. To measure the weight of a pair of eyeglasses, you would most like use:
    a. milligrams
    b. grams
    c. kilograms

12. To measure the weight of a truck, you would most likely use:
    a. pounds
    b. tons
    c. ounces

13. To measure the weight of a toothbrush, you would most likely use:
    a. centigrams
    b. grams
    c. kilograms

14. To measure the weight of a rabbit, you would most likely use:
    a. milligrams
    b. grams
    c. kilograms

15. How many milligrams are in one kilogram?
    a. 1,000
    b. 100,000
    c. 1,000,000

# Measurement Test

16. How many grams are in 3 kilograms?
    a. 300
    b. 30,000
    c. 3,000

17. How many ounces are in two pounds?
    a. 8
    b. 16
    c. 32

18. Which of the following amounts is equal to the **highest** number of grams?
    a. 2 kilograms
    b. 3,000 milligrams
    c. 1,000 grams

19. How many centigrams are in one gram?
    a. 10,000
    b. 100
    c. 1,000,000

20. To measure the salt in a cookie recipe, you would most likely use:
    a. pints
    b. cups
    c. teaspoons

21. To measure a large bottle of soda, you would most likely use:
    a. cups
    b. liters
    c. gallons

22. To measure a large jug of water, you would most likely use:
    a. cups
    b. pints
    c. gallons

23. How many centiliters are in one liter?
    a. 10,000
    b. 100
    c. 1,000,000

# Measurement Test

24. How many cups are in one gallon?
    a. 4
    b. 8
    c. 16

25. Are there more cups in a quart or quarts in a gallon?
    a. more cups in a quart
    b. more quarts in a gallon
    c. the two are the same

26. Which of the following is equal to 4 liters?
    a. 400 milliliters
    b. 4,000 milliliters
    c. 4 quarts

27. Emily has a tennis lesson at 3:30 on Tuesdays. Would her lesson most likely take place in the a.m. or p.m. hour?
    a. a.m.
    b. p.m.

28. Midnight is considered 12 o'clock:
    a. a.m.
    b. p.m.

29. Joe finished painting his house at 1:00 p.m. It takes 15 hours to dry. At what time will Joe's house be dry?
    a. 3:00 a.m.
    b. 4:00 a.m.
    c. 4:00 p.m.

30. If it is 10:35 a.m., what time was it 6 hours and 30 minutes ago?
    a. 4:05 a.m.
    b. 4:05 p.m.
    c. 4:30 a.m.

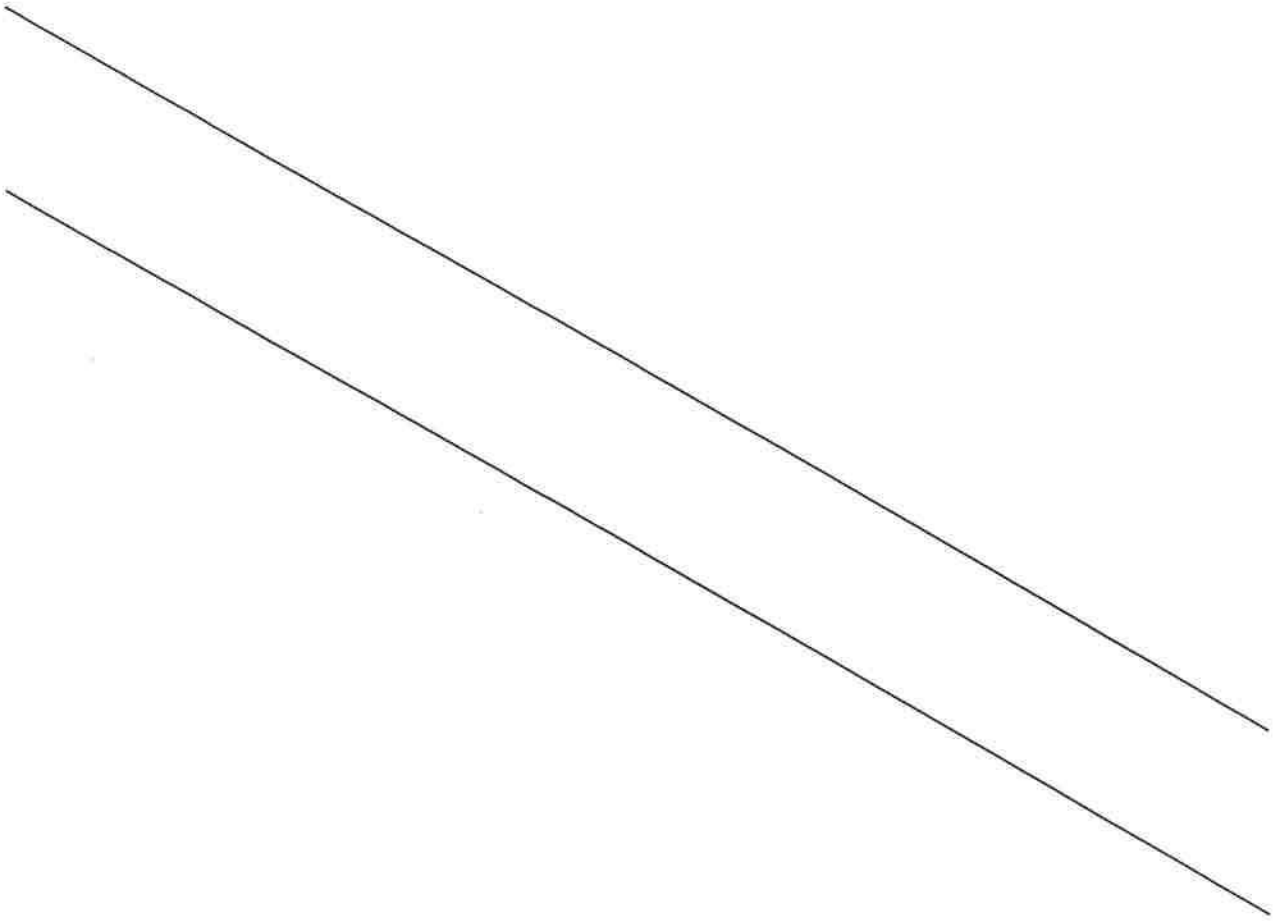
**Adapted From:**

*The World of Measurement.* [On-line]. Available URL: http://oncampus.richmond.edu/academics/education/projects/webunits/measurement, Date of access: 6/23/2005.

**Appendix B**

## Eye Trick

# Which line is bigger?



Appendix C

# Nonstandard Measuring Assignment

Recorder / Reporter: _____
(This person will record the measurements and report to the whole class later.)

Measurer: _____
(This person will do the actual measuring.)

Taskmaster: _____
(This person will assist in the measuring and will keep the group on task in a timely manner.)

Our nonstandard measuring unit: _____

Width of a student desk: _____

Length of a paperclip: _____

Height of the door: _____

Did you have any problems in measuring? Explain.

_____

_____

_____

_____

_____

_____

_____

**Appendix D**

# How Do You Measure Up?

**INCH** Originally, the inch was the length of three barley grains placed end to end. It was also measured as the distance from the tip of the thumb to the first knuckle, or from the first to second knuckle on your index finger.

MY INCH = _____ inches

**CUBIT** The cubit is the measure from the elbow to the middle fingertip. This standard was used by Sumerians (today Kuwait and Iraq), Hebrew (today Israel), and Egyptians. It was used to help build the Egyptian pyramids and is mentioned in the Bible in the building of Noah's arc and King Solomon's temple.

MY CUBIT = _____ inches

**FOOT** Romans used the foot to replace the cubit. They then divided the foot into twelve parts or *uniciae* which is now an inch. The length of a foot is from the longest toe to the heel.

MY FOOT = _____ inches

**YARD** A yard was originally the distance from the tip of the nose to the end of the thumb with the arm outstretched. This measurement was introduced by Henry I and used by cloth merchants during the middle ages.

MY YARD = _____ inches

**HAND** The hand was a measure that included the width of one hand, including the thumb. The term hand is still used today to measure the height of height of horses. Four inches equals one hand.

MY HAND = _____ inches

**FATHOM** Depending on the source, the word fathom comes from the Greek word *faden* which means outstretched arms. Or, it comes from the Anglo-Saxon word for "embrace." It is a term used by sailors and was the length of rope held between two hands with the arms outstretched. Six feet is now a fathom.

MY FATHOM = _____ inches

**PACE** This is the length of a single step. In Roman times, one pace was a double step, and our mile comes from the Latin *mille passum*, meaning 1000 paces.

MY PACE = _____ inches

**Adapted From:**

Tanner, C.E. and M.A.H. Smith, *Measurement.* [On-line]. Available URL: http://asd-www.larc.nasa.gov/edu_act/measure.html, Date of access: 6/24/2005.

# Measurement Booklet Template, page one

# Measurement Booklet

----------cut here----------

## U.S. Customary Units – Length

(page one)

| Equivalencies | Example |
|---|---|
| 1 ft. = _____ in. | |
| 1 yd. = _____ ft. = _____ in. | |
| 1 mi. = _____ ft. | |
| 1 mi. = _____yd. | |

# Measurement Booklet Template, page two

## U.S. Customary Units – Weight

(page two)

| Equivalencies | Example |
|---|---|
| 1 lb. = _____ oz. | |
| 1 ton. = _____ lb. | |

----------cut here----------

## U.S. Customary Units – Capacity (volume)

(page three)

| Equivalencies | Example |
|---|---|
| 1 cup = _____ fl. oz. (fluid ounces) | |
| 1 pt. = _____ c. | |
| 1 qt. = _____ pt. | |
| 1 gal. = _____qt. | |

# Measurement Booklet Template, page three

## Metric - Linear

(page four)

| Equivalencies | Example |
|---|---|
| 1 cm = _____ mm | |
| 1 m = _____ mm | |
| 1 m = _____cm | |
| 1 km = _____m | |

----------cut here----------

## Metric - Mass

(page five)

| Equivalencies | Example |
|---|---|
| 1 cg (centigram) = _____ mg (milligrams) | |
| 1 g = _____ mg | |
| 1 g = _____ cg | |
| 1 kg = _____g | |

# Measurement Booklet Template, page four

## Metric - Capacity (volume)

(page six)

| Equivalencies | Example |
|---|---|
| 1 cl. (centiliter) = _____ mg (milliliters) | |
| 1 liter = _____ ml | |
| 1 liter = _____cl | |

----------cut here----------

Appendix F

# Measurement Booklet Assignment / Rubric

You will be making a "Measurement Booklet" about the U.S. Customary and Metric systems of measurement! First, you will complete the equivalencies. Look in the index in your math book to help you. For each equivalency, you will include at least one example. For example, you may choose to draw a picture of a foot for the equivalency of 1 ft. = 12 in. because a foot is approximately 12 inches long. Or, you may decide to draw a picture of two cups and a picture of a pint-sized container and write "2 cups = 1 pint" underneath your picture for the equivalency 1 pt. = 2 c. You will be completing this booklet in pieces, so keep on schedule as the pieces are assigned. Your booklet will be graded according to the following rubric.

| | 10 | 8 | 7 | 5 |
|---|---|---|---|---|
| **Illustrations** | Nice! You have at least one example per equivalency. | Good! You are missing only two or three illustrations. | You are missing four or five illustrations. | What happened? You are missing more than five illustrations. Please follow directions next time! |
| **Content** | Super! Your equivalencies are all complete and correct! | Good! You have only one to three incomplete or incorrect equivalencies. | You have four to six errors in your equivalencies. | You have more than six errors. |
| **Neatness and Details** | Wonderful! Your booklet was neatly completed. I can tell that you really put a lot of effort into this assignment! | Good! Your booklet was mostly neat, but has a few errors or was not quite complete. | Parts of your booklet were neat and parts were not. | Your booklet was not neat. |

**Total: /30**

**Appendix G**

# U.S. Units of Length Quiz

/12

Name: _____

1. How many 1-foot rulers laid end to end would it take to reach 3 yards?

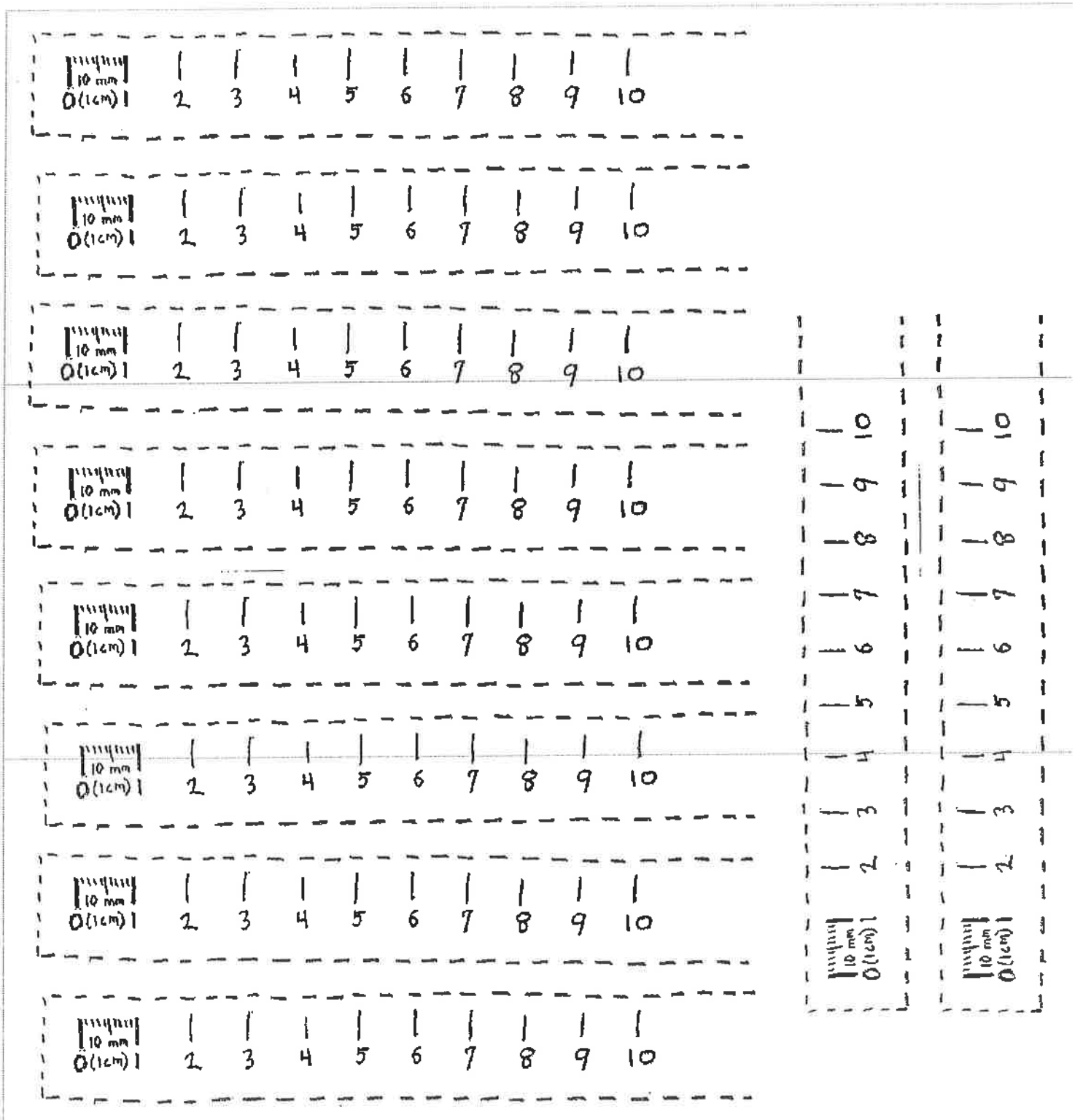
2. A mile is how many feet?

3. One yard is how many inches?

**Adapted From:**
Hake, Stephen and John Saxon. *Math 54,* Oklahoma: Saxon Publishers, Inc., 2001, page 164. 1-56577-034-X.

**Appendix H**

# Ten-centimeter Rules



# Measuring with a Meter Rule, page one

Group Members: _____ /25

_____

After you have assembled your meter rule, please measure the following and complete the chart. Make certain to include units in your measurement. For example: 30 centimeters, 10 millimeters, 1 meter 20 centimeters, etc. (5 points for completeness)

| Body Part | Group Member #1 | Group Member #2 |
|---|---|---|
| Measure the tip of the thumb to the first knuckle. You've estimated how many centimeters are in an inch! | | |
| Measure from the elbow to the middle fingertip. You've estimated how many centimeters are in a cubit! | | |
| Measure from the tip of the nose to the end of the thumb with the arm outstretched. You've estimated how many centimeters are in a yard! | | |
| Measure from the longest toe to the heel. You've estimated how many centimeters are in a foot! | | |
| Measure the width of one hand, including the thumb. You've estimated how many centimeters are in a hand! | | |
| Measure the length of rope held between two hands with the arms outstretched. You've estimated how many centimeters are in a fathom! | | |
| Measure the length of a single step. You've estimated how many centimeters are in a pace! | | |
| Measure the diameter (distance across) a freckle in millimeters. | | |

Now that you have an idea about the metric sizes of various body parts, please complete the following chart by estimating the metric distances of the following. Then, find the actual measures with your metric rule. How close were your estimates? (5 points for completeness)

| Item | Estimate | Actual |
|---|---|---|
| Height of door in meters and centimeters | | |
| Height of desk in centimeters | | |
| Length of pencil in centimeters | | |
| Width of paper clip in millimeters | | |

# Measuring with a Meter Rule, page two

**Fill in the blanks:** (one point each)

10 mm (millimeter) = _____ cm (centimeter)

100 cm = _____ m (meter)

1000 mm = _____ m

**Answer the following:** (two points each)

If each step you take is about a meter, how many kilometers do you walk each day at school?

Could you hit a baseball 100 m? (Hint: The longest homerun ever hit went 193.2 m by Mickey Mantle.)

**Circle the answer that you think is correct:** (two points each)

Length of a pen: 12 m 12 cm 12 mm

Distance walked in two hours: 8 m 8 mm 8 km

Thickness of a toothpick: 1mm 1 cm 1m

Length of paper: 28 mm 28 cm 28 m

**Adapted From:**
Zimmerman, Robert. *Do It Yourself Science,* 7 December, 1990, *Measure like an Egyptian,* pages 22-23.

## Appendix J

# Balance Scale

*Note: Have an adult partner work with you!*

**Materials:**

- Two identical paper cups
- 1 foot long ruler
- Scissors
- Table
- String
- Hole punch
- Sticky tape
- 2 or 3 heavy books
- Coat hanger (one thin enough to bend easily)

**Directions:**

1. Make a loop of string. Slide the loop over the ruler, securing it with tape at the six-inch mark.
2. Punch three holes equally spaced around the rim of each cup.
3. Cut six sixteen inch long strings.
4. Thread one through each hole, tying a knot in the end just below the cup rim. Make the knot big enough that it won't pull through the hole. Or, loop the string and knot it around the rim of the cup.
5. Bring the three strings for one cup together. Knot them together about three inches from the free ends. Then tie a knot right at the ends to form a loop between the two knots. Slide this string loop over the ruler, anchoring it with tape at the one-inch mark. Tie the strings for the other cup the same way, anchoring the loop at the eleven inch mark.
6. Bend the coat hanger hook away from the rest of the hanger at a 90 degree angle. (You will be using the triangular part of the hanger for an anchor that will be placed under books on a table.)
7. Lay the hanger flat on the table with the bent hook sticking over the edge.
8. Stack books on the triangular part of the hangar that is lying flat to hold it in place.
9. Slip the scale's center loop over the hanger's hook.
10. Once it stops swaying, the ruler should hang level and the two cups should be exactly opposite each other. If the cups are not level, adjust the length of the strings. If the ruler is not level, adjust the string loop or the hanger's hook until it is level.
11. Your balance scale is suitable for small and lightweight objects. You may use paperclips as a nonstandard unit of measure to measure various objects. For example, how many paper clips does a dime weigh? A nickel? A tea bag? A button? You can also use your balance to compare the mass of objects. Which is heaviest? A cap from a 2-liter soft drink bottle or a button?
12. Experiment with your balance. Be prepared to explain how you made your balance to the class, demonstrate how to use it, and discuss what it can actually measure.

**Adapted From:**

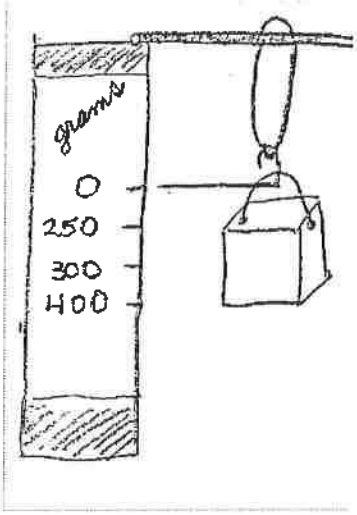
Markle, Sandra. *Measuring Up!*, New York: Simon and Schuster Publishing, 1995, pages 22-23. 0-689-31904-5.

**Appendix K**

# Simple Spring Scale

**Materials:**

- large paper clip
- large and thick rubber band
- string
- empty milk carton
- pencil or small rod
- small weight (a coin or nut will do)
- several 250 g weights




**Directions:**

1. Punch a hole on opposite sides of your milk carton. Then feed a string through these holes leaving several inches of slack. You are creating a kind of hanging basket.
2. Unbend the paper clip to form a hook and a pointer. Hang your basket on the hook. The pointer should point in a horizontal direction to the floor.
3. Thread a thick rubber band onto the bent paper clip. Loop a pencil or small rod through the rubber band. Place the pencil across two desks and put a small weight inside.
4. Tape some paper to the side of one of the desks so that the paper clip pointer rests near the top of the paper. Mark this position with a *0*.
5. Then place a 250 g weight into your scale. Mark this position on the paper with *250 g*. Place another 250 g weight into your scale and mark the paper with a line and *500 g*. Do this until about 1000 grams.
6. Now place other objects into your scale. The weight of the object will make the weight stretch by a certain amount depending on how heavy it is. Some suggested objects are: paperclips, a quarter, pencil, and eraser. Because you have drawn a scale, you can figure the weight of any lightweight (up to 1000 g) object! Be prepared to explain how you made your balance to the class and demonstrate how to use it. Also, can you explain what force in nature makes your spring scale work?

**Adapted From:**

Ardley, Neil. *Making Metric Measurements*, New York: Franklin Watts Ltd., 1983, pages 7-8.

Appendix L

# Scale Rubric

| | 10 | 8 | 5 |
|---|---|---|---|
| **Message** | Right On! Your description of how your scale was made and your demonstration of how to use it were clear! | I mostly understood your description and demonstration, but there were one or two areas which were not clear. | Your description was confusing. |
| **Delivery** | Your delivery was awesome! You made eye contact with the class when it was appropriate, you were loud enough to be heard, and you were appropriately enthusiastic! It was obvious that you were well-prepared. Way to go! | Your delivery was good, but one to two of the following elements asked for (eye contact, voice volume, enthusiasm, preparedness) were missing. | Your delivery lacked more than three of the following elements asked for (standing straight up, eye contact, voice volume, enthusiasm, preparedness). |
| **Construction** | Super! Your scale has both been constructed neatly and accurately! It works! | I can tell that you put effort into making your scale, but it is either not constructed very neatly or it doesn't work. | Your scale is not constructed neatly and doesn't work. |

## Total Bonus Points:

Appendix M

# The Weight of Things

| Object | Guessed Weight | Actual Weight |
|---|---|---|
| | 1 milligram | |
| | 1 gram | |
| | 1 kilogram | |
| | 1 pound | |
| | 1 centigram | |
| | 1 ounce | |

**Appendix N**

# The Capacity of Things

| Object | Guessed Volume | Actual Volume |
|---|---|---|
| | 1 cup | |
| | 1 ounce | |
| | 1 pint | |
| | 1 quart | |
| | 1 centiliter | |
| | 1 milliliter | |
| | 1 liter | |

**Appendix O**

## Weight, Volume, and Metric Lengths Quiz

# Please complete the equivalencies.

a.) 1 pound = _____ ounces

b.) 1 ton = _____ pounds

c.) 1 centigram = _____ milligrams

d.) 1 gram = _____ milligrams

e.) 1 gram = _____ centigrams

f.) 1 kilogram = _____ grams

g.) 1 cup = _____ fluid ounces

h.) 1 pints = _____ cups

i.) 1 quart = _____ pints

j.) 1 gallon = _____ quarts

k.) 1 centiliter = _____ milliliters

l.) 1 liter = _____ milliliters

m.) 1 liter = _____ centiliters

# Elapsed Time, page one

**Question:** *Carl studies from 3:48 p.m. to 7:05 p.m. How long does he study?*

**Remember!**
**THE EASIEST WAY TO FIND ELAPSED TIME IS TO ADD,** not subtract.

**Solution 1:**

1. If Carl studies from 3:48 to 7:05, then he studies for 12 minutes from 3:48 to 4:00.
2. He studies 3 hours from 4:00 to 7:00.
3. He studies 5 minutes from 7:00 to 7:05.
4. Total = 12 minutes + 3 hours + 5 minutes = 3 hours and 17 minutes.

The problem is kind of like making change. Add up.

**Solution 2:**
*You may choose to borrow, but be careful!*

In a typical subtraction problem like $\begin{array}{r} 45 \\ -\ 17 \end{array}$ we can't subtract 7 from 5, so we

borrow from the next column over. We end up with $\begin{array}{r} 3\ 15 \\ -\ 1\ 7 \\ \hline 1\ 8. \end{array}$

We can do this because the digit in the tens' column is worth 10 ones'. Or, we traded one 10 for ten 1's.

But, subtraction of time is tricky. A 1 in the rightmost column is worth 1 minute. A one in the second column from the right is worth 10 minutes. A 1 in the third column from the right is NOT WORTH 100 MINUTES. It's worth 60 minutes. So, borrowing looks like this:

$\begin{array}{r} 7:05 \\ -3:48 \end{array}$ ⇨ $\begin{array}{r} 6:65 \\ -\ 3:48 \\ \hline 3:17 \end{array}$

# **Moral of Story:** Keep Track of What You're Borrowing!

**Adapted From:**
Doctor Ian, *Elapsed Time and the Grouping Factor.* [On-line]. Available URL: http://mathforum.org/library/drmath/view/62400.html, Date of access: 6/28/2005.

# Elapsed Time, page two

**Question:** *How much time elapses from 7:45 am to 3:05 pm?*

**Solution:**

Think about this problem using a clock and then moving the clock ahead hour by hour. When you can't move ahead a full hour, start by moving in 15, 5, or 1-minute intervals, and then add the hours as they go by.

7:45 am + **1 hour** = 8:45 am
8:45 am +**1 hour** = 9:45 am
9:45 am + **1 hour** = 10:45 am
10:45 am + **1 hour** = 11:45 am
11:45 am + **1 hour** = 12:45 **pm**
12:45 pm + **1 hour** = 1:45 pm
1:45 pm + **1 hour** = 2:45 pm
2:45 pm + **15 minutes** = 3:00 pm
3:00 pm + **5 minutes** = 3:05 pm

1 hour + 1 hour + 1 hour + 1 hour + 1 hour + 1 hour + 1 hour = 7 hours
15 minutes + 5 minutes = 20 minutes

*7 hours 20 minutes have gone by!*

**Adapted From:**
*Elapsed Time.* [On-line]. Available URL: http://www.shodor.org/interactive/activities/clock3/what.html, Date of access: 6/28/2005.

**Appendix Q**

# Elapsed Time Problems and Answers

1. It is 1:45 pm. What time will it be in 3 hours and 20 minutes? *5:05 pm*
   *Stress that am or pm must be included for a complete answer when asked for a specific time.*

2. It is 1:15 pm. What time was it 4 hours and 25 minutes ago? *8:50 am*
   *Students will need to first count back the number of minutes. Then they should count back the hours.*

3. It is 1:20 pm. What will be the time 3 hours from now? *4:20 pm*

4. It is 10:15 am. What time will it be 10 minutes from now? *10:25 am*

5. It is 3:25 pm. What time will it be in 6 hours? *9:25 pm*

6. It is 7:15 pm. What time was it 10 hours ago? *9:15 am*

7. It is 9:20 am. What time will it be in 15 minutes? *9:35 am*

8. It is 8:05 pm. What time will it be 3 hours from now? *11:05 pm*

9. It is 9:35 pm. What time will it be 13 hours from now? *10:25 am*

10. It is 2:20 am. What time will it be in 30 minutes? *2:50 am*

11. It is 6:06 am. What time will it be in 12 hours? *6:06 pm*

12. It is 5:35 pm. What time will it be in 2 hours and 25 minutes? *8:00 pm*

13. It is 4:10 pm. What time will it be in 4 and a half hours? *8:40 pm*

14. It is 10:40 am. What time will it be 5 hours and 20 minutes from now? *4:00 pm.*

**Source:**

Hake, Stephen and John Saxon. *Math 54,* Oklahoma: Saxon Publishers, Inc., 2001. 1-56577-034-X.

**Appendix R**

# Elapsed Time Homework

Name: _____ Score: /25

*Show all written work! Make certain to include am and pm in your answers!*

1. It is 9:25 pm. What time will it be 2 hours and 20 minutes from now?

2. It is 4:25 am. What time will it be 2 hours and 35 minutes from now?

3. It is 7:25 am. What time will it be 5 hours and 15 minutes from now?

4. It is 8:17 am. What time will it be 10 minutes from now?

5. It is 8:05 am. What time was it 2 hours ago?

**Source:**
Hake, Stephen and John Saxon. *Math 54,* Oklahoma: Saxon Publishers, Inc., 2001. 1-56577-034-X.

**Appendix S**

# Online Elapsed Time Practice

Please visit these links in the order listed.

1. http://www.harcourtschool.com/activity/elab2002/grade_3/018.html
   *Make certain to use the recording sheet provided by your teacher for this activity.*

2. http://www.oswego.org/testprep/math4/d/elpsedp.cfm

3. http://www.quia.com/jfc/66516.html
   *There are three activities on this website.*

**Begin with the Electronic Flashcards.**
Use the back of your recording sheet from link #1 for scratch work and to record your answers. Then check your answer by clicking the electronic card. If you got the correct answer, remove the card for another card. If you missed the problem, click on *try again later* which will keep the card in the stack, but will then give you another problem to solve.

Next, try **Matching.**

Finally and for a challenge, try the **Concentration** game.

Appendix T

# Answer Keys

## Appendix A: Measurement Test

| | |
|---|---|
| 1-b | 16-c |
| 2-a | 17-b |
| 3-b | 18-a |
| 4-b | 19-b |
| 5-c | 20-c |
| 6-b | 21-b |
| 7-b | 22-c |
| 8-a | 23-b |
| 9-b | 24-c |
| 10-c | 25-c |
| 11-b | 26-b |
| 12-b | 27-b |
| 13-b | 28-a |
| 14-c | 29-b |
| 15-c | 30-a |

## Appendix G: U.S. Units of Length Quiz

1. 9 one-foot rulers
2. 5280 ft.
3. 36 in.

## Appendix I: Measuring with a Meter Rule

Charts: *answers may vary*
Fill in the Blanks: *1; 1; 1*
Answer the following: *answers may vary*
Circle the answer that you think is correct: *12 cm; 8 km; 1 mm; 28 cm*

## Appendix O: Weight, Volume, and Metric Lengths Quiz

a. 16
b. 2000
c. 10
d. 1000
e. 100
f. 1000
g. 8
h. 2
i. 2
j. 4
k. 10
l. 1000
m. 100

## Appendix R: Elapsed Time Homework

1. 11:45 pm
2. 7:00 am
3. 12:40 pm
4. 8:27 am
5. 6:06 am