Mathematics, Science, and Technology Education Partnership

IRG Section IV

Exemplary Lessons

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Sample Mathematics Unit Plan

This three-day lesson plan introduces students to metric measurement and conversions of units within the metric system. The plan centers primarily on linear measure. It is intended for grades 5 and/or 6, although the methods of unit conversion are appropriate for higher grades in which measurements of capacity and mass are typically covered. This lesson plan is also appropriate for middle-grade science classes, since measurement in the sciences relies almost exclusively on metric units.

The lesson plan is partitioned into three or more days during which students engage in the following activities:

Day 1. Students are guided to create their own paper meter strips, subdivided into decimeters, centimeters, and millimeters. Students then locate parts of their own bodies that are approximately equal in length to the subdivisions of the meter. They also consider multiples of the meter to develop physical interpretations of the decameter, hectometer, and the kilometer. Their measuring competency is developed as they visit measuring stations located throughout the classroom to make estimations and compare measurements of a variety of objects.

Day 2. Students begin to apply the relationships between the metric prefixes and learn a variety of methods for converting from one metric prefix to another. They first examine their own paper meter strips and the subdivisions of the meter. They discover the mathematical operations (multiplying and dividing by powers of 10) necessary for making these conversions. Next, students are guided to see the direct correlation between the metric prefixes and the place-values of our base-10 numeration system. To help students recall the order of the metric prefixes, a memory device is introduced (e.g., "King Henry drank milk dunking chocolate munchkins"). Finally, students are introduced to a hands-on "magic" device called a Metric Genie. They are shown how this device can be used to easily convert from one prefix to another within the metric system. (This device was originally developed at the Lawrence Hall of Science, Berkeley campus of the University of California.) Students are then shown how the Metric Genie operates and why it works. Specifically, the Genie shifts the decimal places based of multiplying or dividing by powers of 10. With this knowledge, students are encouraged to create their own methodologies (similar to the Metric Genie) for converting between metric prefixes.

Day 3. The last day is devoted to applications of the metric system in situations involving the measurement of length. Specifically, students apply metric measurement in finding distances on maps that have been scaled in metric units. Finally, students are required to complete a project requiring them to create a scale model of the solar system using metric units.

Teacher(s):		Date:
Subject: Mathematics	**Grade(s):** 6	**Time to complete (in periods):** 3-5 40-minute periods
Unit: Measurement	**Lesson Topic/Title:** Metric Measurement of Length and Metric Unit Conversions	
Student population: ☐ Special Education ☐ LEP ☐ LD ☐ G&T **X** Academically Average ☐ Low achieving ☐ Other		

OBJECTIVES of the lesson:
[STATE THE SPECIFIC GOALS OF THIS LESSON. WHAT WILL STUDENTS KNOW OR BE ABLE TO DO BY THE COMPLETION OF THE LESSON?

STUDENTS WILL BE ABLE TO:

- Think in the metric system (SI) by determining personal references in metric units.
- Measure length to the nearest centimeter.
- Convert from one metric unit of length to another unit within the metric system.
- Estimate metric lengths.
- Apply metric measurement in problem-solving situations.

BACKGROUND KNOWLEDGE necessary for students before engaging in this lesson:

STUDENTS MAY NEED TO REVIEW THE FOLLOWING BACKGROUND KNOWLEDGE:

- How to use a ruler with Standard American units.
- Knowledge of decimal place values.
- Knowledge that multiplying numbers by powers of 10 moves the decimal point to the right; dividing numbers by powers of 10 moves the decimal point to the left.
- How to find the perimeter and area of plane figures.
- How to read a map and scaled distances.

PRECONCEPTIONS that may need to be addressed:

STUDENTS MAY HAVE THE FOLLOWING MISCONCEPTIONS:

- Since customary rulers have 16 subdivisions, fractions should be used in all measurements rather than decimals.
- Metric measurements are rarely used. Most people use Standard American measurements, except in the sciences and in sports.

List 1 or 2 of the overarching NEW YORK STATE MATHEMATICS STANDARDS to be addressed in this lesson:	Write out CODES and PERFORMANCE INDICATORS for RELATED MATHEMATICAL CONTENT & PROCESSES addressed in this lesson:
MEASUREMENT STRAND Students will: • determine what can be measured and how, using appropriate methods and formulas; • use units to give meaning to measurements; • understand that all measurement contains	6.CN.1 Understand and make connections and conjectures in their everyday experiences to mathematical ideas. 6.CN.9 Recognize and apply mathematics to other disciplines and areas of interest. 6.CN.2 Explore and explain the relationship between

error and be able to determine its significance; • develop strategies for estimating measurements. NUMBER SENSE AND OPERATIONS STRAND Students will: • understand numbers, multiple ways of representing numbers, relationship among numbers, and number systems; • understand meanings of operations and procedures, and how they relate to one another; • compute accurately and make reasonable estimates.	mathematical ideas. 6.CN.3 Connect and apply mathematical information to solve problems. 6.CN.4 Understand multiple representations and how they are related. 6.CM.3 Organize and accurately label work. 6.CM.4 Share organized mathematical ideas through the manipulation of objects, numerical tables, drawings, pictures, charts, graphs, tables, diagrams, models, and symbols in written and verbal form. 6.CM.11 Decode and comprehend mathematical visuals and symbols to construct meaning. 6.R.5 Use representations to explore problem situations. 6.R.7 Use mathematics to show and understand physical phenomena (e.g., determine the perimeter of a bulletin board). 5.M.3 Measure to the nearest centimeter. 5.M.4 Identify equivalent metric units of length. 5.M.5 Convert measurement within a given system. 5.M.6 Determine the tool and technique to measure with an appropriate level of precision: lengths. 5.M.10 Determine personal references for metric units. 5.M.11 Justify the reasonableness of estimates. 5.N.8 Ordering decimal numerals. 6.N.15 Ordering rational numerals. 6.N.21 Multiple representations of rational numerals.

MAJOR CONCEPTS addressed:	**MAJOR SKILLS addressed:**
• Thinking in the metric system (SI), as well as in the customary (Standard American) measurement system. • Understanding relationships among the metric prefixes. • Measuring length.	• Competence in converting between prefixes within the metric system. • Competence in estimating metric units of length. • Competence in metric measurement of length. • Competence in applying metric measurement in real-world situations. • Competence in interpreting scaled distances on timelines and maps.

APPLICATIONS to Science and/or Technology: [Include 1 or 2]

Scientists use the metric system (SI) for measuring lengths, mass, capacity, and temperature. The metric system is used in technology because it offers more precision in measurements than the Standard American system.

How does this lesson represent BEST PRACTICE?	
X Focuses on important (standards-based) ideas & skills and promotes conceptual understanding X Uses a *variety* of instructional approaches to maintain student engagement (e.g., ☐ lecture, ☐ group work and team work ☐ demonstration ☐ field trips ☐ role play ☐ skits ☐ dramatization). (others) ☐________ ☐ ________ *Please check.* ☐ Encourages guided discovery, inquiry, and design ☐ Engages students in peer and self assessment ☐ Includes key questions to elicit responses that reflect understanding of important content X Promotes procedural fluency ☐ Addresses naïve conceptions ☐ Prompts discourse among students and with teacher	☐ Builds on prior student knowledge ☐ Aligns curriculum, instruction, and assessment Establishes cross-disciplinary connections X Establishes real-world connections for students so that they generalize lesson concepts to MST applications ☐ Prompts higher order thinking (students analyze, compare and contrast, classify…) ☐ Prompts students to generate alternative ideas and strategies ☐ Adjusts instructional methods according to student population and understanding ☐ Procedure includes summary focused on key ideas ☐ Motivates learning during and beyond the lesson

MATERIALS AND RESOURCES Needed (List IT resources and other materials)

Rulers (metric and customary), the attached plain paper strips, paper meter sticks, "metric genies," and daily activity sheets.

INSTRUCTIONAL PLANNING: PROVIDE A COMPLETE SEQUENCE OF *ALL* TEACHING PROCESSESS AND STUDENT ACTIVITIES INVOLVED IN IMPLEMENTING THE LESSON.
This should include *ALL* teacher explanations, examples, questions, and student activities associated with the delivery of the lesson. Nothing should be left to the imagination. *Other teachers should be able to reproduce this exact lesson using this lesson plan.* Indicate (with an asterisk) where embedded formative assessments will occur during the implementation of the lesson. Indicate instructional alternatives that may be employed for differentiating instruction for students with special needs.

Day 1. The lesson focuses on the meter, the basic unit of length in the metric system. Students will create a meter strip, obtain approximations for these lengths on their own body, in the classroom, and on the playground.

Do now: This initial activity will review the process of multiplying and dividing decimal numerals by powers of 10. For example, 0.45 x 10 = 4.5 , 2.3 x 100 = 230. , 74.6 x 1000 = 74600 , and .8 ÷ 10 = .08 , 6.1 ÷100 = .061 , 92 ÷ 1000 = .092 . The teacher will ask: What happens to the decimal point when we multiply by 10? … by 100? … and by 1000? (Ans. The decimal shifts to the right 1 place, …2 places, …and 3 places.) What happens to the decimal place when we divide by 10? …by 100? … and by 1000? (Ans. The decimal shifts to the left 1 place, … 2 places, … and 3 places.) The teacher will state, "These ideas will be used in the lesson for today. I'm glad you remembered about multiplying and dividing by powers of ten."

Motivation: What is a meter? Let's build a meter strip and find out!

- **First, students will be given an introduction to the metric system:**

  A system of measurement called the ***Metric System*** is used in most countries around the world. It is also called the International System of Units (abbreviated **SI** from the French language). This system is based on the decimal (or base 10) numeration system. The place values of the decimal numeration system correspond directly with the subdivisions of the units within the metric system. The metric system has special names for units of length, weight or mass, capacity, and temperature. Scientists like to use the metric system because they frequently work with very large or very small numbers and need a lot of precision in their measurements.

  First, we will focus on the basic unit for length, known as the **meter.** We will examine 7 subdivisions of the meter – 3 larger and 3 smaller than the meter. These subdivisions have special names, similar to our place value names.

- **Students will be guided to create their own meter strip and all of its subdivisions.**

  The teacher will distribute one paper meter strip, marked off in centimeter units, to each student. (These are provided in the attachment, **Day 1: Two Meter Strips.)** For the exact instructional sequence, see the attachment entitled **Day 1: Activity Sheet 1 and Class Notes**. In brief, students will be told the names of these subdivisions in terms of their fractional part of a meter. Students will also create measurement strips that are multiples of 10 meters each; e.g., 10 meters, 100 meters, etc. They will name these lengths in terms of metric units. *Students will locate parts of their body that are equivalent in length to various metric units, thus providing personal references to metric units.

- Students will work in pairs and visit several stations as they complete the attached activity sheet entitled **Day 1: Activity Sheet 2** . *This activity will be used to assess students' measuring competency. After students have measured themselves as requested on Activity Sheet 2, students will report their work on Activity Sheet 2 to the whole class and answer questions from their peers and the teacher.

***Homework:** It is highly probable that students will not be able to complete Activity Sheet 2 before class is over. Completion of the remainder of the sheet will be required for homework.

Day 2. This lesson focuses on conversions between units (of length) within the metric system.

Students will be asked to use the knowledge they have gained through constructing their own meter strips to make metric conversions by multiplying or dividing by 10, 100, or 1000. *They will do these conversions using paper/pencil or calculator computations.

Do Now. Convert each of the following to the indicated metric unit:

3 m = ____cm , 80 cm = _____ dm , 2.5 dm = ____ mm , 709 hm = _____ km

It is anticipated that many students will find this laborious, difficult, and time consuming.

Students may need to be reminded to look at their meter strip to discover the relationship between the prefixes.

Motivation: After about 5 minutes, the teacher will ask the class if they would like to learn about a device that will make metric conversions very easy, if fact, *almost magic*!

- Students will be introduced to a hands-on device called the Metric Genie (created by the Lawrence Hall of Science). The teacher will distribute a Metric Genie to each student (See attachment, **Day 2: Metric Genies for 5 Students**). The Metric Genie is a device that helps students easily locate the decimal point in order to convert between metric units. (Note: The logic underlying this procedure should not be lost. It is important that students realize that the Metric Genie simply multiplies or divides the given metric unit by powers of 10 when shifting the decimal point either to the right or to the left, respectively.)

- Students should be provided a quick review of the base ten place-value system and its relationship to metric prefixes as shown below.

1000 100 10 1 .1 .01 .001

Kilometer = **1000** meters
Hectometer = **100** meters
Decameter = **10** meters
Meter = **1** basic unit of length
Decimeter = **.1** meters
Centimeter = **.01** meters
Millimeter = **.001** meters

The bold letters show the abbreviations for the metric units.

km hm dam M dm cm mm

It is important that students remember the order of these prefixes and units. There is a little saying (mnemonic) that may help students remember.

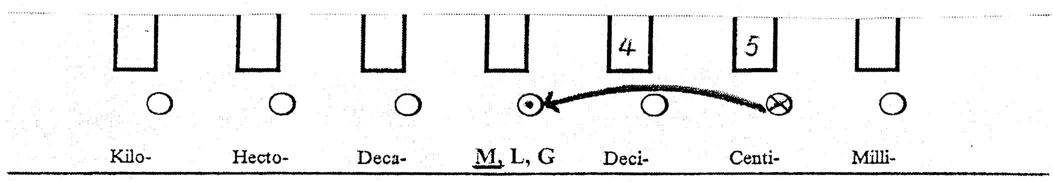
"King Henry drank milk dunking chocolate munchkins."

Students should be encouraged to create your own sentence for remembering the metric prefixes or units.

- **Using the Metric Genie**
  Consider the following conversion: **45 cm = ? m**
  Remind students that if no decimal is shown in a number, it is assumed to be to the right of one's place. Therefore, 45 = 45•

  As shown on the Metric Genie below, we first place the Genie on a clean sheet of paper and enter the given number into the Genie in the open circles and rectangles so that **the decimal point is placed in the circle with the original prefix and the numerals fit into the open rectangles, relative to the location of the decimal**. Next, we find the desired conversion unit (m) and move our decimal point to that new location. Therefore, 45• decimeters is converted to •45 meters. This whole process is indicated below.

Shown on the Genie:



Look at the original entry:

				4	5	
km	hm	dam	M	dm	cm •	mm

Look at the converted entry:

				4	5	
km	hm	dam	M •	dm	cm	mm

Therefore, 45 cm = .45m .

It's like Magic!!!

Of course, this whole process of moving the decimal two places to the left is the same as dividing a number by 100. In this problem, we know that there are 100 centimeters in 1 meter. Therefore, **45 cm** is only **.45 m**. Several other examples of using the Genie should be illustrated at this point. The Genie (template) should be placed on a clean section of the paper prior to beginning each new problem.

- *Students will use their Metric Genies to gain procedural fluency in converting between units within the metric system. A class activity is provided on attachment, **Day 2: Class Activity Sheet, Metric Genie**. The teacher will circulate the classroom, assisting students as necessary and checking on students' progress.
- As soon as students gain proficiency in metric conversions using the Metric Genie, they must create their own memory device for metric conversions. Students should eventually be "weaned from the Genie" (in approximately one week). Students with special needs will be allowed to use the Metric Genie as long as necessary.

***Homework:** See attachment, **Day 2, Homework.**

Day 3. This lesson focuses on applications of metric measurement in situations involving the measurement of length. These include map reading (scaled in metric units) and designing scale models of the solar system.

Motivation: How do we use the metric system in real-world measurement activities?

Students will be divided into groups of 2 or 3 (with varying abilities) to do measurement activities included on the attachment entitled: **Day 3: Activity Sheet , Measuring with a Metric Ruler**.

*For Part I on the Day 3 Activity Sheet, students will need to be reminded (or taught) how to round off numbers and how to measure "to the nearest centimeter." Specifically, if a measurement extends into part of a centimeter, it will be included in the final measurement of the item only if the part is **.5 cm or larger**.

For example, the following measurements have been rounded-off "to the nearest centimeter":
13.6 cm, it will be recorded as 14 cm
12.3 cm, it will be recorded as 12 cm
10.5 cm, it will be recorded as 11 cm

*The teacher will circulate the room, observing students' progress and assisting as needed.

*For Part II on the Day 3 Activity Sheet, students will need to measure distances between cities on the map to the nearest centimeter. Then, in order to convert the scaled distances to their actual distances, students will need to apply the map scale (1 cm = 200 km). This means that each centimeter will be multiplied by 200 km.

For example, the map distances should be converted to their actual distances as follows:

Scaled Distance		Real Distance
3 cm =>	3 * 200 =>	600 km
7 cm =>	7 * 200 =>	1400 km

*Homework: See attachment, **Day 3: Project Homework, Build a Scale Model of the Solar System**

Follow-up activities will introduce students to the metric units of capacity (liters) and mass (grams).

For ready-made quizzes go to:
www.edhelper.com/measurement.html

For practice on the decimal system and metrics, go to:
www.ncwdn.org/decimals/metric.html

For additional lessons go to:
www.nist.gov/public_affairs/kids/metric.html
www.teach-nology.com/teachers/lesson_plans/math/
www.mathforum.org/paths/measurement/e.measlessons.html

ASSESSMENT Methodologies [Embedded Diagnostic, Formative and Summative] planned to demonstrate the degree to which students have mastered the listed NYS Performance Indicators indicated on the prior page. *Attach COMPLETE EXAMPLES of all methods checked below*

X Selected Response: (Circle type(s): Paper/pencil tests; multiple choice; true/false; matching; short answer fill-ins)

☐ Essay: (Circle type(s): Extended written answers; Graphic organizers - KWL or TWK) (*indicate guiding questions, scoring criteria, and sample student responses*)

☐ Constructed Response: (Circle type(s): Multi-steps; Document-based questions) (*indicate guiding questions, scoring criteria, and sample student responses*)

X Performance Assessment: (Circle type(s): Individual; group; product-based; performance-based; artistic; authentic. (I*ndicate guiding questions, scoring criteria, and sample student responses.*)

X Classroom observation (Circle type: Formal; Informal) (*if formal, indicate guiding questions, scoring criteria, and sample student responses*)

☐ Whole class discussion (*indicate guiding questions, scoring criteria, and sample student responses*)

☐ Small group discussions (*indicate guiding question, scoring criteria, and sample student responses*)

☐ Individual student interviews (*indicate interview questions, scoring criteria and student responses*)

☐ Process or Reflective measures: (Circle type: Journals; Logs) (*indicate scoring method; explain development and use of rubrics; provide an example of a finished journal*)

☐ Portfolios (*indicate scoring method; explain development and use of rubrics; provide an example of a finished portfolio*)

X In-class worksheet/written assignment (*explain assignment and/or provide example of student work*)

X Quiz/Test/Exam (*indicate scoring method; provide an example*)

X Others (*describe*): Create a scale Model of the Solar System; Project [Choose one from: Design the largest playground (greatest area) with a given perimeter of 12 decameters <u>or</u> Using the metric system, make a scale model of the middle school (outside measures only)]. See Project Scoring Rubric.

<u>DESCRIPTION OF SUMMATIVE ASSESSMENT</u>: Indicate how students' learning of lesson objectives (stated earlier) was comprehensively assessed. ("Post" assessment.) Include description of assignment and sample items. Attach scoring criteria (checklist or rubrics) used to evaluate the work, and three samples of student work (high, medium, and low).

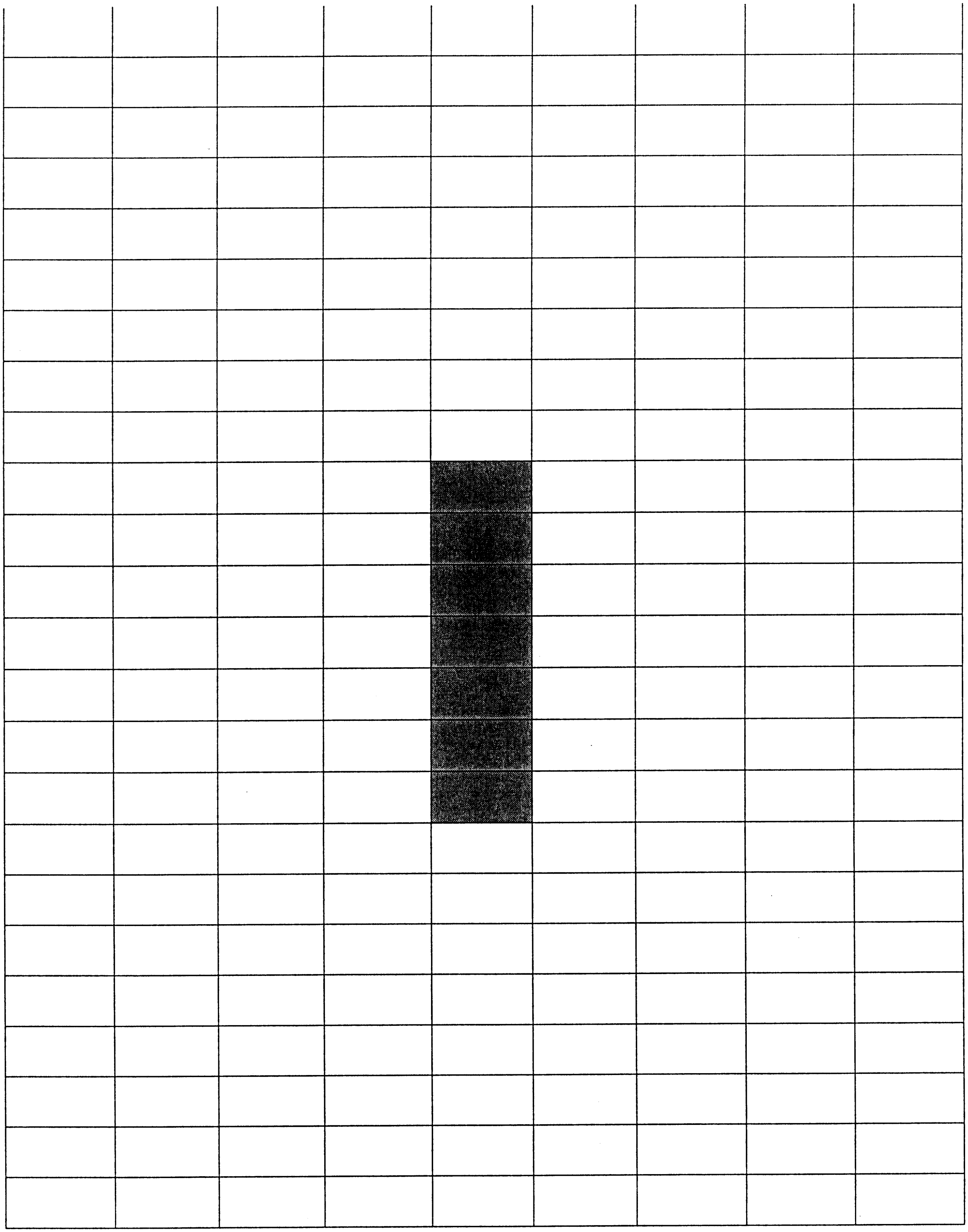
See **Summative Assessment** (Attached). Part I is an in-class test which will be graded for accuracy and completeness.

Part II is a group project. It will be assessed by collecting and grading student work (See attached Rubric for Project Evaluation). The teacher will observe student interaction and evaluate informally the process that students apply in solving the problem.

***<u>AFTER LESSON IMPLEMENTATION,</u>* <u>PROVIDE YOUR REFLECTIONS</u>: Tell the story of what happened in the classroom. Indicate what worked, what you would change for the next implementation, and students' reactions to the lesson. Use additional pages if needed.**

[To be completed after these lessons have been implemented.]

This next page can be used to create meter strips for each student. Each rectangular unit is 1 centimeter <u>wide</u>. Students can cut out strips and tape them together to form one long strip that has a length of 100 cm (or 1 meter). The next page is large enough to create two meter strips.



Day 1

Activity Sheet 1 and Class Notes

Distribute one meter strip (from the given template above) to each student in the class and complete the following activities.

Students should fill in the blanks as they create the metric units.

1. The distance from my ________________ to my ______________ is about 1 meter long. A meter is the standard unit in the metric system for measuring length. Its abbreviation is m. Sometimes it is written as "metre" instead of "meter."

2. Fold your meter strip into 10 equal pieces. One of these units is called a decimeter. Fill in the blanks: ________ decimeters = 1 meter; 1 decimeter = ______ meter (This answer will be a fraction). The width of my________________________ is about 1 decimeter. The abbreviation for decimeter is dm. The prefix *deci-* means one-tenth, which can be written as 1/10 or 0.1

3. Each pre-marked unit on the meter strip is called a centimeter. Count the number of centimeters on the meter strip. Fill in the blanks: ____centimeters = 1 meter; 1 centimeter = _______meter; _______ centimeters = 1 decimeter. The width of my ____________________ is about 1 centimeter. The abbreviation for centimeter is cm. The prefix *centi-* means one-hundredth, which can be written as 1/100 or 0.01.

4. Use a very sharp pencil point to divide one centimeter into 10 equal parts. One of these tiny units is called a millimeter. If you marked off the whole meter into millimeters, how many millimeters would be in the whole meter? Fill in the blanks: ________millimeters = 1 meter; 1 millimeter = _______meter; ____ millimeters = 1 centimeter. The width of my___________________is about 1 millimeter.

The abbreviation for millimeter is mm. The prefix *milli-* means one-thousandth, which can be written as 1/1000 or 0.001.

5. We need 10 student volunteers to come to the front of the room with their meter strips. We will tape these 10 meter strips end-to-end to form one long strip. This long strip is called a decameter. Fill in the blanks: 1 decameter = ___________meters. The abbreviation for decameter is dam. The prefix *deca-* means 10. The length of a decameter is about _________________.

6. Imagine this: Suppose you taped 10 decameters together to make one really long measuring strip. This big strip is called a hectometer. 1 hectometer = __________meters. The abbreviation for hectometer is hm. The prefix *hecto-* means 100.

7. Finally, imagine this: Tape 10 hectometers together. How many meters would you use? _____________ This super long unit is called a kilometer. 1 kilometer = _____________meters. The abbreviation for kilometer is km. The prefix *kilo-* means 1000. One kilometer is a little more than ½ mile (0.6 miles) or the length of 10 football fields!

Day 1

Class Activity Sheet 2

Determining Personal References for units of length in the Metric System (SI)

Materials: blank paper strips, centimeter ruler, meter stick .

The teacher will demonstrate how to use the blank paper strip for measuring. A pencil and the paper strip will be used to mark off the length of the item. Then, the distance of the mark on the paper strip from the (initial) end of the strip will be measured using a centimeter ruler or meter stick.

1. Station 1: Use a meter stick to measure the door: base and height. Determine its perimeter in centimeters and then in decimeters.

   ____

   ____

2. Station 2: Identify the appropriate metric unit to estimate the measure of the following:

   a. Thickness of a dime ______________________________

   b. Thickness of a crayon ___________________________________

   c. length of your teacher's desk ______________________________

   d. Distance from Chicago, IL to Manhattan, NY _________________

3. Use your paper strips to find the following measurements requested in the table below: (Complete for homework if you cannot finish in class.)

MEASUREMENT	LENGTH OR CIRCUMFERENCE
Around the base of my thumb	cm
Around my wrist	cm
Around my neck	cm
Around my waist	cm
Around my head	cm
Arm span	dm
Elbow to wrist	dm

4. There is an old saying that one time around your waist is equal to two times around your neck. Is this true for you? Why or why not?

5. There is another old saying that one time around your neck is equal to two times around your wrist. Is this true for you? Why or why not?

6. There is an ancient belief that a person's height is equal to the distance from the person's longest fingertip on the left hand to the corresponding fingertip on the right hand. Determine your height and arm span measurements at one of the stations your teacher has set up. Is this true for you? Why or why not?

Day 2

Metric Genies for Five Students

Cut out the rectangular and circular regions above each prefix. Place the Genie on a clean section of paper. Enter the decimal point of the given unit in the circle above the given prefix (or unit). Enter the numerals in the rectangular spaces, respective to the given decimal point. Place an x over the original decimal point and then insert a new decimal point in the circle above the prefix to which you are making the conversion. Metric Genies are included below (idea borrowed from the Lawrence Hall of Science, University of California, Berkeley).

Kilo- Hecto- Deca- M, L, G Deci- Centi- Milli-

Kilo- Hecto- Deca- M, L, G Deci- Centi- Milli-

Kilo- Hecto- Deca- M, L, G Deci- Centi- Milli-

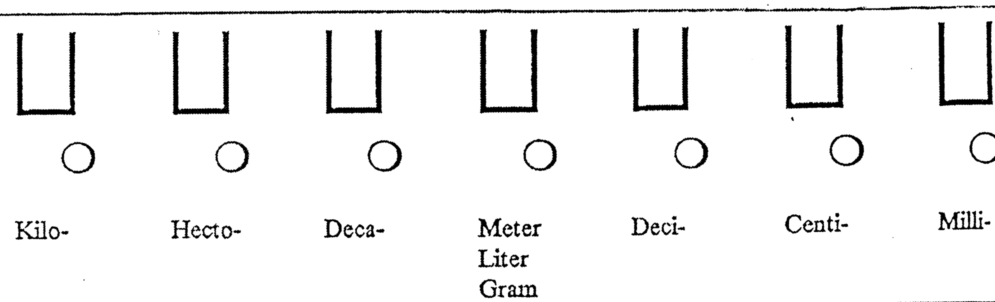
Kilo- Hecto- Deca- M, L, G Deci- Centi- Milli-

Kilo- Hecto- Deca- M, L, G Deci- Centi- Milli-

Day 2

Class Activity Sheet

Metric Genie



Use the Metric Genie to convert to the metric unit indicated:

1. 54 m = ___________ cm
2. 4.5 m = ___________ hm
3. 72 km = ___________ mm
4. 0.36 dm = ___________ m
5. 835 dam = ___________ mm
6. 9.035 dm = ___________ dam
7. 62.4 cm = ___________ dm
8. 90.5 km = ___________ m

Day 2 — Homework

Convert to the indicated unit, using the Metric Genie.

Part I

1. 5 cm = ________ hm

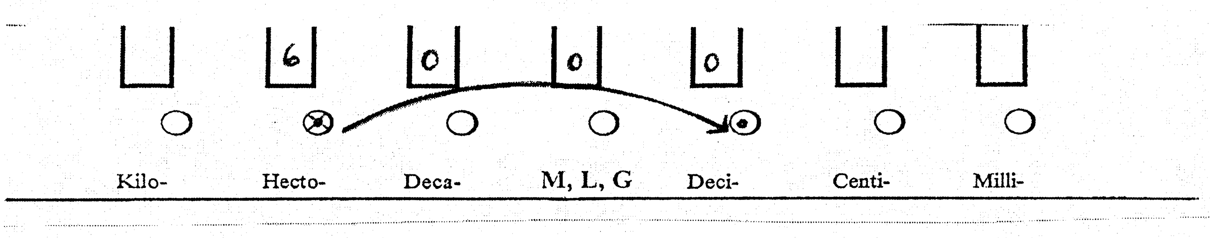
2. 23 mm = ________ km

3. 6 m = ________ dam

4. 67 dam = ________ km

To convert to a smaller unit, you should move the decimal point to the right, like the following example: 6 hm = ? dm

Metric Genie:



Look at the original entry:

km	hm •	dam	M	dm	cm	mm
	6					

Converted entry:

km	hm	dam	M	dm •	cm	mm
	6	0	0	0		

Notice that the empty boxes between the original number and the decimal point are filled-in with zeros.

Therefore, 6 hm = 6000 dm

Part II Determine the following conversions.

1. 82 hm = ______ mm

2. .5 dam = _______cm

3. 1.7 m = _______dm

4. 1.23 km = _______m

Part III

1. 56 km = ____________ mm

2. 1.2 cm = ____________ dam

3. 34.6 mm = ____________ dm

4. 168 m = ____________ hm

5. 0.75 dm = ____________ cm

6. 9 hm = ____________ m

7. 100 mm = ____________ dm

8. 2000 cm = ____________ dam

9. 76.54 m = ____________ mm

10. .4 dm = ____________ km

Part IV

Compare using >, <, or = . [Hint: Convert the measurements to the same unit.]

1. 56 cm O 6 m

2. 7 dam O 6980 mm

Day 3

Activity Sheet

Measuring with a Metric Ruler

Part I

Measure each line segment to the nearest 0.1 centimeter:

1.

2.

3.

4.

5.

6. Which line segments are the closest in length?

7. Which line segments are the furthest apart in length?

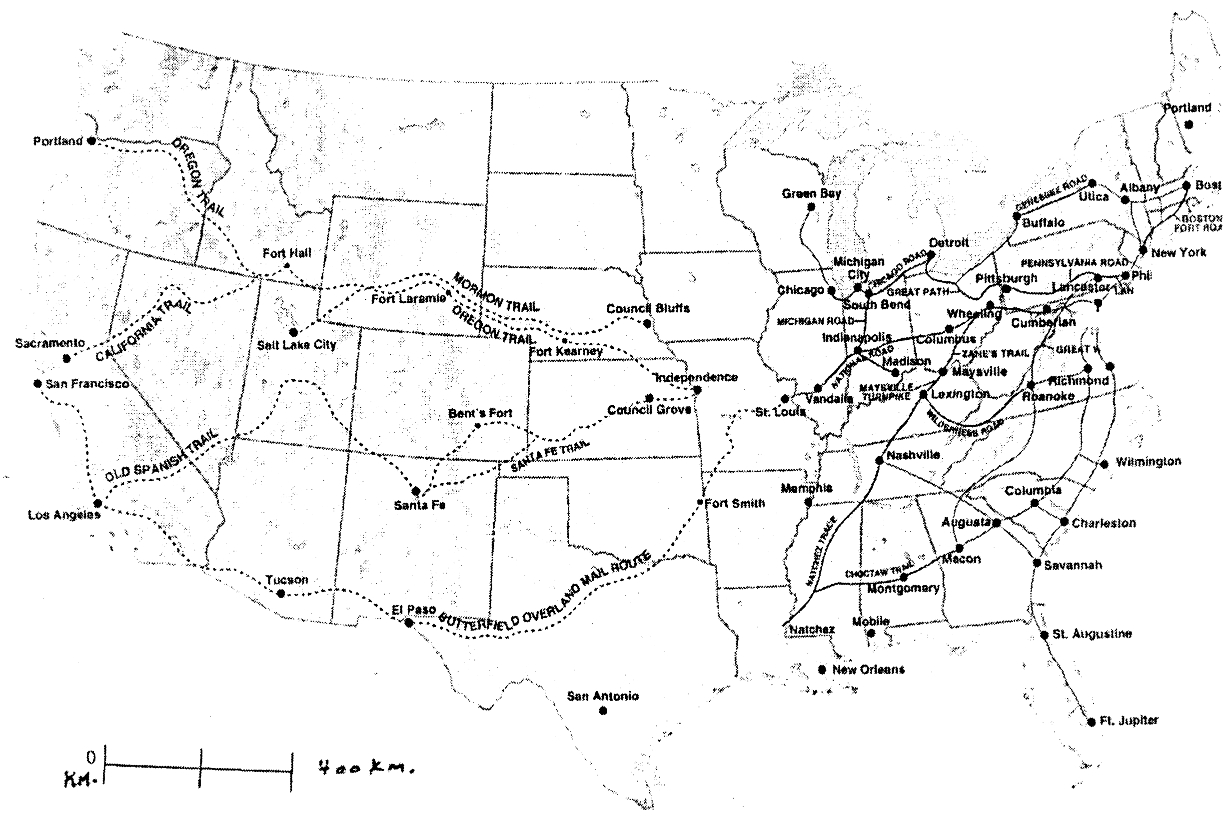
8. Can you measure the lengths of these paper clips? How much longer is the larger paper clip than the smaller paper clip?

Part II

Map Skills: Measuring to the nearest whole centimeter.

Below is a map of the early 1800's. Use your metric ruler to measure the following distances to the nearest whole centimeter. Then, use the scale below to estimate the real distance in kilometers between the cities.

Scale: 1 cm = 200 km.



	Map Distance	Real Distance
1. Santa Fe to Independence	_________ cm	_________ km
2. San Antonio to New Orleans	_________ cm	_________ km
3. Albany to New York	_________ cm	_________ km
4. Tucson to El Paso	_________ cm	_________ km
5. Chicago to Sacramento	_________ cm	_________ km
6. Portland to San Francisco	_________ cm	_________ km

Day 3

Project--Homework

Build a Scale Model of the Solar System

Imagine that you could travel far into space and look back at the Solar System. You would see the planets moving in their orbits, at different distances from the Sun. All of the planets move in the same direction, revolving counterclockwise around the Sun. Are some planets too small to be seen from space? A scale model may help you to visualize the relative size of the planets.

The Size of the Physical Bodies in the Solar System

For this project, consider the radius of each of the physical bodies in the solar system listed in the table below.

THE SOLAR SYSTEM

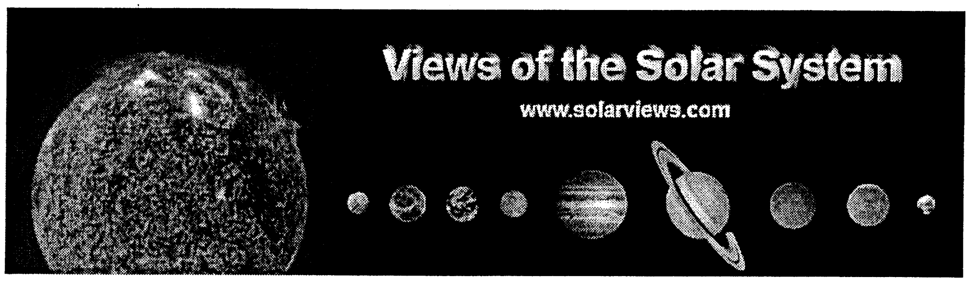
Name	Radius (km)	Rounded to 1000s	Scaled: 1cm = 1000 km
Sun	695000		
Mercury	2439.7		
Venus	6051.8		
Earth	6378.14		
Mars	3397.2		
Jupiter	71492		
Saturn	60268		
Uranus	25559		
Neptune	24746		
Pluto	1137		

Instructions:

- In the third column of the table, round-off each of these values to the nearest thousand.
- In the forth column of the table, record the scaled size of each radius using the scale 1 cm =1000 km. For example, if the radius is 5,000 km , then the scaled size would be 5 cm.
- Create a scale model of each of these physical bodies in the solar system using the procedures below.

- Draw and cutout a circle with the scaled radius for each of these physical bodies in the solar system. On each circle, write the name of the physical body it represents. Also, draw its radius and record its actual value on the radius.
- Color each of these circles with the color of the actual physical body it represents. (Pictures of these bodies can be found on the following web page: http://www.solarviews.com/)

http://www.solarviews.com/



- Connect these circles together with string in their actual order from the sun.
- Describe at least two unique characteristics of the object.
- Put your name on the project and turn it in to your teacher three days after the assignment was given.

Summative Assessment

Part I This section is an in-class test. You have the full period to complete it. Each problem is worth 3 points.

A. Write the correct abbreviation for each metric unit.

1. Kilometer ________
2. Millimeter ________
3. Decimeter ________
4. Hectometer ________
5. Decameter ________
6. Centimeter ________
7. Meter ________

B. Describe a physical approximation for each of the following metric units of length.

1. Kilometer ____
2. Millimeter ____
3. Decimeter ____
4. Hectometer ____
5. Decameter ____
6. Centimeter ____
7. Meter ____

C. Complete these conversions. You may use your Metric Genie.

1. 12000 mm = _______ m
2. 5 cm = _______ mm
3. 104 km = ______ hm
4. 1.6 cm = ________ dm
5. 19.8 m = ______km
6. 250 dam = _____dm
7. 5.6 hm = ________ m
8. .63 dm = _____mm
9. 1.45 cm = _______m

D. Compare using > , < , =

1. 536 cm O 53.6 dm
2. 42 mm O 5 m
3. 3.6 m O 360 cm
4. 5 dm O 508 mm

E. Fill in the blanks:

1. Multiplying a decimal number by 100 shifts the decimal _____ places to the _______.
2. Dividing a decimal number by 1000 shifts the decimal ______ places to the ________.
3. Multiplying a decimal number by 10 shifts the decimal ______places to the ________.

F. The following sentence that helps me remember the order of the metric prefixes is:

G. Explain two reasons for using the metric system in measurements.

H. On a map, if two cities are 4.5 cm apart and the map scale is 1 cm = 200 km, how far are the cities actually apart? Explain.

<u>Part II</u> This part is a project that must be completed with a partner. See the grading rubric below. It is due in three days.

Choose one problem:

1. Design the largest playground (greatest area) with a given perimeter of 12 decameters. You may choose any shape you wish for the playground. Please provide a written description of the procedures you used.
2. Using the metric system, make a scale model drawing of the middle school (outside measurement only). Please provide a written description of the procedures you used and indicate the scale used for interpreting the scale model.

Rubric for Assessment of Projects (1 point = 8.4%)

Dimension	Excellent *4 points*	Good *3 points*	Fair *2 points*	Needs Work *1 point*
Conceptual Understanding of Mathematics Involved	• Excellent use of mathematical concepts/language. • An array of words, tables, and illustrations may be used. • Demonstrates a thorough understanding of the mathematical concepts and/or procedures embodied in the task.	• Good use of mathematical language and concepts but contains some minor errors. • Good conceptual understanding of key concepts shown in multiple ways. • All components are included and meet expectations.	• Demonstrates partial under-standing of mathematical concepts and key terminology. • May show some misunderstanding of underlying mathematical concepts. • Includes many components which meet expectations, but not all.	• Demonstrates only a limited understanding of concepts and/or procedures. • May address some elements of the task correctly but reaches an inadequate solution and/or provides reasoning that is faulty or incomplete. • Reflects a lack of understanding of the underlying math concepts.
Solutions to Problems	• Contains clear, complete explanations • Use mathematically sound procedures/strategies / ALL WORK SHOWN • All problems solved correctly	• Good evidence of strategies used. • Procedures for solving problems are mathematically sound. • May contain an incorrect solution but applies a mathematically appropriate process with valid reasoning in the explanation. • All components included and meet expectations.	• Addresses most aspects using mathematically sound procedures and strategies. • May contain incorrect solutions but applies an appropriate strategy using valid reasoning and an explanation. • May contain correct solutions accompanied by incomplete procedure, reasoning, and/or explanations. • Includes many components which meet expectations, but not all.	• Solutions reflect multiple flaws related to a misunderstanding on how to solve. • Uses inappropriate procedures/strategies. • Work is unclear and difficult to follow. • May contain a correct solution but no work shown.
Written Work and Visual Presentation	• Excellent overall structure and diagrams. • Work connects an array of concepts. • All components include and work goes beyond what is expected. • All explanations are clearly presented. • Work is extremely neat.	• Good overall structure & neat. • Clearly organized work which connects multiple concepts. • Most explanations are clearly presented with few areas of confusion. • All components includes and meet all expectations.	• Most components written adequately. • Diagrams are somewhat ambiguous. • Work is not very neatly presented.	• Poorly written and diagrams are flawed or not included. • Content contains major errors and misunderstanding of terms. • Few components are included with meet expectations. • Not neatly presented.

Keep for future reference

Overview of the Metric (SI) System

National Institute of Standards and Technology

http://www.nist.gov/metric

You Will Need to Know About Metric

(For Your Everyday Life)

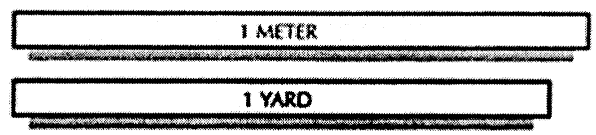
Metric is based on the Decimal system

10

The metric system is simple to learn. For use in your everyday life you will need to know only ten units. You will also need to get used to a few new temperatures. Of course, there are other units which most persons will not need to learn. There are even some metric units with which you are already familiar; those for time and electricity are the same as you use now.

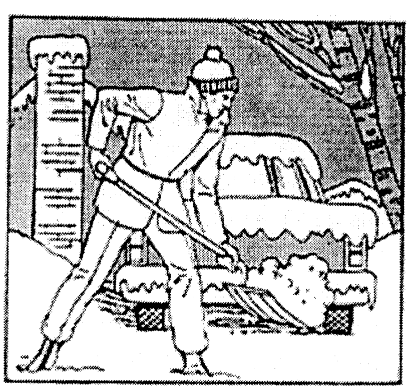
BASIC UNITS

Meter: a little longer than a yard (about 1.1 yards)



Liter: a little larger than a quart (about 1.06 quarts)

Gram: a little more than the weight of the paper clip

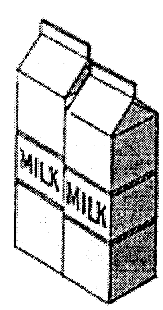


25 Degrees Fahrenheit

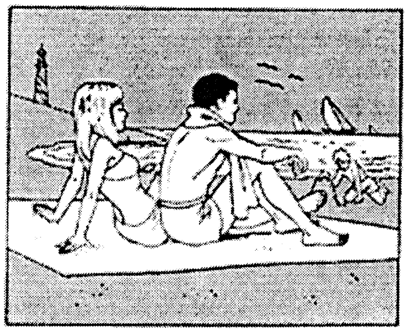
COMMON PREFIXES
(to be used with basic units)
milli: one-thousandth (0.001)
centi:one-hundredth (0.01)
kilo: one-thousand times (1000)

For example:
1000 millimeters = 1 meter
100 centimeters = 1 meter
1000 meters = 1 kilometer

1 LITER



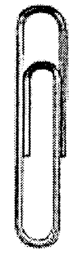
1 QUART

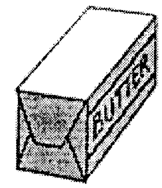


25 Degrees Celsius

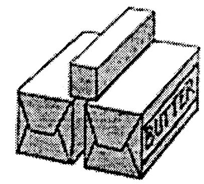
OTHER COMMONLY USED UNITS
millimeter: 0.001 meter - diameter of a paper clip wire
centimeter: 0.01 meter - a little more than the width of a paper clip (about 0.4 inch)
kilometer: 1000 meters - somewhat further than 1/2 mile (about 0.6 miles)
kilogram: 1000 grams - a little more than 2 pounds (about 2.2 pounds)
milliliter: 0.001 liter - five of them make a teaspoon

OTHER USEFUL UNITS
hectare: about 2 1/2 acres
metric ton: about one ton





1 pound



1 Kilogram

Sample Science Unit Plan

This two- to three-day lesson plan introduces eighth grade science students to methods for estimating populations in an ecosystem. Scientific concepts are elucidated by applications of ratios and proportions. This lesson is intended for implementation in a science laboratory setting.

The lesson is partitioned into two extended science laboratory periods, during which students engage in the following activities:

Day 1. Students are introduced to three methods for estimating the size of a population of a given species, namely, the *observation*, *sampling*, and *mark-and-recapture* methods. Each method is considered within a specific context and the merits of each are discussed. Examples of each method are illustrated and computational procedures using ratios, proportions, and percents are explored. Students are given reinforcing class activities and homework associated with these three methods of estimating populations.

Day 2. The method of *mark-and-recapture* is refined on the second day. Students learn that it is better to have more than one sample of a population for estimation purposes. In particular, more samples of a population will produce more reliable estimates of the true population size. For this purpose, the *mark-and-recapture (with repetitions)* method is illustrated. Students then engage in laboratory activities that exemplify this methodology. They are required to write a complete lab report of their findings based on established guidelines.

MSTP Science Lesson Template

Teacher(s):			Date:
Subject: Science/Living Environment	Grade(s): 8	Time to complete (in periods): Two extended science laboratory periods	
Unit: Ecology	Lesson Topic/Title: Estimating Populations		

Student population:
☐ Special Education ☐ LEP ☐ LD ☐ G&T X Academically Average ☐ Low achieving ☐ Other

OBJECTIVES of the lesson:
[State the SPECIFIC Science and Mathematics goals of this lesson. What will students know or be able to do by the completion of the lesson?]

Students will be able to:
1. Estimate population size by acquiring a sample from a sub-region of an ecosystem.
2. Use the **mark-and-recapture** method to estimate the size of a population.
3. Describe factors that may affect population size.

BACKGROUND KNOWLEDGE necessary for students before engaging in this lesson:

Students should understand that a population consists of all of the members of one species living in one area (ecosystem) and that there are many biotic and abiotic factors that affect the size of a given population.

PRECONCEPTIONS that may need to be addressed:

Students may believe that the only way to determine a population's size is to capture and count each individual organism.

List 1 or 2 of the overarching NEW YORK STATE SCIENCE STANDARDS to be addressed in this lesson:	Write out CODES and PERFORMANCE INDICATORS for RELATED SCIENTIFIC CONTENT & PROCESSES addressed in this lesson:
Key idea 6: Plants and animals depend on each other and their physical environment.	6.1: Explain factors that limit growth of individuals and populations. 6.1de: The number of organisms any habitat can support is limited by the available energy, water, oxygen, & minerals and by the ability of ecosystems to recycle the residue of dead organisms through the activities of bacteria and fungi. 6.1f: Living organisms have the capacity to produce populations of unlimited size, but environments and resources are finite. This has profound effects on the interactions among organisms.

MSTP Science Lesson Template

List 1 or 2 of the overarching NEW YORK STATE MATHEMATICS STANDARDS to be addressed in this lesson:	Write out CODES and PERFORMANCE INDICATORS for RELATED MATHEMATICAL CONTENT & PROCESSES addressed in this lesson:
Connections: Apply math to science →	8.CN.9 Recognize and apply mathematics to other disciplines, areas of interest, etc.
Algebra: Ratio & proportion, formulas →	8.PS.10 Use proportionality to model problems.
Statistics & Prob.: Predictions from Data →	7.S.8 Interpret data to provide the basis for predictions.
MAJOR CONCEPTS addressed:	**MAJOR SKILLS addressed:**
Science: Population studies	**Science:** Analyzes results from observations/expressed data.
Mathematics: Ratio & proportion; connections	**Mathematics:** Setting up and solving proportions.

How does understanding the listed math concepts INFORM Science knowledge? (Not just math that is simply *related* to the science, but math that helps students better *understand the science ideas*)

By setting up a proportion and using algebra to calculate an estimate of the size of a species, students will observe relationships between the following: (1) the ratio of the number of animals in a species that has been marked, compared to the entire population and (2) the ratio of the number of recaptured animals in a species having marks, compared to the total number recaptured animals. Such a proportional relationship is frequently used by scientists to estimate the size of a population when it is not possible or practical to actually count each member of a given population.

How does this lesson represent BEST PRACTICE?

- ✓ Focuses on important (standards-based) ideas & skills and promotes conceptual understanding
- ✓ Uses a *variety* of instructional approaches to maintain student engagement (e.g., □ lecture X group work and team work □ demonstration □ field trips □ role play □ skits □ dramatization). X (others) modeling □ __________ *Please check.*
- □ Encourages guided discovery, inquiry, and design
- □ Engages students in peer and self assessment
- ✓ Includes key questions to elicit responses that reflect understanding of important content
- ✓ Promotes procedural fluency
- □ Addresses naïve conceptions
- ✓ Prompts discourse among students and with teacher
- ✓ Builds on prior student knowledge
- ✓ Aligns curriculum, instruction, and assessment
- ✓ Establishes cross-disciplinary connections
- □ Establishes real-world connections for students so that they generalize lesson concepts to MST applications
- □ Prompts higher order thinking (students analyze, compare and contrast, classify…)
- □ Prompts students to generate alternative ideas and strategies
- □ Adjusts instructional methods according to student population and understanding
- □ Procedure includes summary focused on key ideas
- ✓ Motivates learning during and beyond the lesson

MSTP Science Lesson Template

<u>MATERIALS AND RESOURCES</u> needed (including IT resources and other materials)

Estimating population size pre- and post-assessment
Counting turtles lab packet
Hand-held calculators
Model turtle populations (a package with an unknown number of "turtles"; one per 2 students)
Investigating populations report guidelines
Assortment of turtle reference books
Model of a report on an overhead transparency
List of turtle reference websites
Scoring rubric for lab reports
Environmental Science textbook for general populations estimating information

<u>INSTRUCTIONAL PLANNING</u>: PROVIDE A <u>COMPLETE SEQUENCE</u> OF *<u>ALL</u>* TEACHING PROCESSESS AND STUDENT ACTIVITIES INVOLVED IN IMPLEMENTING THE LESSON. This should include *<u>ALL</u>* teacher explanations, examples, questions, and student activities associated with the delivery of the lesson. Nothing should be left to the imagination. *Other teachers should be able to reproduce this exact lesson using this lesson plan.* Indicate (with an asterisk) where embedded formative assessments will occur during the implementation of the lesson. Indicate instructional alternatives that may be employed for differentiating instruction for students with special needs. **BE SPECIFIC ABOUT HOW MATHEMATICAL CONCEPTS ARE INFUSED INTO THIS SCIENCE LESSON* Use additional pages if needed.* See below.

Day 1

1. Administer pre-assessment.
2. Facilitate a class discussion of estimating populations. "If scientists wanted to determine the size of a population, like crickets in a field or cliff swallows in a cliff colony, what techniques could they use?"
   - **Observation**
     - Direct: count them
     - What difficulties may arise when using this method?
       Anticipated answers: The population may be too large to count. The population may be spread out over too large a region of access. The conditions may not allow counting of the whole population.
   - **Sampling**
     - Take a sample from a sub-region of the ecosystem.
     - For example, to estimate the number of tadpoles in a pond count all of the tadpoles in 1 cubic meter of the pond. Suppose you count 150 tadpoles. Use this information to estimate the number of tadpoles in the whole pond of 19,000 cubic meters.
       Estimated population = 150 * 19,000
       = 2,850,000 tadpoles
     - Ask: What sources of error may this method impose?
       Anticipated answers: The tadpoles may not be evenly distributed in the pond.
       A small sample may not be representative of the population.
   - **Mark-and-Recapture**
     Suppose that a lake is stocked with catfish and we wish to estimate the total number of catfish in

the lake. We will take a random sample of 40 catfish from the lake and mark them with tags. Then we will release these fish back into the lake. The next day we will revisit the same lake and take a sample of 80 fish from the lake. Suppose that 2 of these fish have tags. Estimate the "Total population size" of catfish in the lake.

One method to use in this situation is ratio and proportion:

$$\frac{40}{\text{Total population}} = \frac{2}{80} \qquad \textbf{[Ratios of Part to Whole]}$$

$$2\,(\text{Total population}) = (40)(80)$$

$$\text{Total population} = \frac{3200}{2}$$

$$(\text{Estimated})\ \text{Total population} = \mathbf{1600\ \ catfish}$$

However, we could set up the ratio and proportion another way and still arrive at the save answer:

$$\frac{\text{Total population}}{40} = \frac{80}{2} \qquad \textbf{[Ratios of Whole to Part]}$$

$$2\,(\text{Total population}) = (40)(80)$$

$$\text{Total population} = \frac{3200}{2}$$

$$(\text{Estimated})\ \text{Total population} = \mathbf{1600\ \ catfish}$$

<u>Summary of the Mark-and-Recapture method</u>:

In general, an estimate of the population size using the mark-and-recapture method can be found by creating and solving a ratio and proportion problem. When two ratios are equal, we say they are "in proportion." Thus, we call the equation below "a proportion."

[Method 1: Proportion]

$$\frac{\text{Number marked}}{\text{Total population}} = \frac{\text{Number marked in subsequent sample}}{\text{Number recaptured in subsequent sample}} \qquad \textbf{[Ratios of Part to Whole]}$$

OR

[Method 2: Proportion]

$$\frac{\text{Total population}}{\text{Number marked}} = \frac{\text{Number recaptured in subsequent sample}}{\text{Number marked in subsequent sample}} \qquad \textbf{[Ratios of Whole to Part]}$$

- Distribute worksheet for class work. (See attachment). The items not completed in class will be assigned for homework.

Day 2

1. Check homework and answer questions regarding the methods for estimating total population size discussed yesterday.

3. Explain that today we will be discussing ways to improve the accuracy of the mark-and-recapture method for estimating the total population size of a species.

4. For the technique of mark-and-recapture to be valid, scientists must collect samples randomly from the entire population. Explain that samples must be chosen to be representative of the whole region and the whole population. That is what we mean when we say that samples should be "randomly selected."

   For example, if we wanted to use a sample to determine the number of boys in a large room of 100 people, it would not be a random sample if we chose only from the table of 10 people seated near the front of the room. That would not be a "random sample." In fact, all girls may be seated at that particular table. The teacher should facilitate a discussion of ways we might select a more "random sample" of 10 people from that room.

5. To improve the accuracy of the mark-and-recapture method for estimating the size of a population, many samples should be taken. In general, the more samples taken, the more accurate the estimate of the population size. We call this the Mark-and-Recapture Method with Repeated Trials.

   For example, suppose the New York Department of Agriculture wants to estimate the total number of Mallard ducks in Suffolk County during the month of July. To do this, a random sample of 30 Mallard ducks was taken from various regions of Suffolk county and tagged. The ducks were then returned to the regions from which they were taken. For each of the next 5 days, 15 Mallard ducks were captured throughout the county and the number of tagged ducks in the sample was recorded in the chart below. The ducks were always returned to their habitat after they were captured.

Mark-and-Recapture Method with Repeated Trials

Trial number	# captured	# recaptured having a tag
1	15	2
2	15	1
3	15	2
4	15	3
5	15	0
Totals	**75**	**8**

Notice that the total number of ducks captured in the 5 samples was 75 and the total number of recaptured ducks that had been tagged among the recaptured ducks was 8. An estimate of the total population size of Mallard ducks may be found by solving the following proportion. (An equivalent proportion would work as well):

$$\frac{\text{Number marked}}{\text{Total population}} = \frac{\text{Total number marked in subsequent samples}}{\text{Total number recaptured in subsequent samples}}$$ **[Ratios of Part to Whole]**

$$\frac{30}{TotalPopulation} = \frac{8}{75}$$

$$\text{Total population} * 8 = 30*75$$

$$\text{Total population} * 8 = 2250$$

$$\text{Total population} = \frac{2250}{8}$$

$$\text{Total population} = 281.25$$

$$\text{(Estimated) Total population} = 281 \text{ Mallard ducks}$$

6. Distribute lab packets and read the directions with students.
7. Arrange students into pairs.
8. Distribute model turtle populations.
9. Model how to select "turtles" randomly.
10. Invite students to collect data and complete the data table.
11. Remind them to show all work on separate paper, including proportions. Have calculators available for students.
12. While completing the lab packet, encourage students to take at least five samples before they analyze the data.
13. Instruct students to answer the lab questions.
14. Distribute the report guidelines and discuss.
15. Provide students with the following resources to complete their reports:
    - Turtle resource books from the library.
    - Environmental Science text books with population estimation information.
    - List of general turtle information websites.

        1. http://en.wikipedia.org/wiki/Turtle
        2. http://42explore.com/turtle.htm
        3. http://www.unc.edu/~dtkirkpa/stuff/maps.html
        4. http://hsus.org/wildlife/a_closer_look_at_wildlife/turtles_and_tortoises/
        5. http://www.hilozoo.com/animals/AR_p_turtle.htm
        6. http://www.calm.wa.gov.au/science/turtles_general.html

    - Grading rubric for the lab report. [See attachment]

ASSESSMENT Methodologies [Embedded Diagnostic, Formative and Summative] planned to demonstrate the degree to which students have mastered the listed NYS Performance Indicators indicated on the prior page. *Attach COMPLETE EXAMPLES of all methods checked below*

- ✓ Selected Response: (Circle type(s): Paper/pencil tests; multiple choice; true/false; matching; short answer fill-ins)
- ☐ Essay: (Circle type(s): Extended written answers; Graphic organizers – KWL or TWK) (*indicate guiding questions, scoring criteria, and sample student responses*)
- ☐ Constructed Response: (Circle type(s): Multi-steps; Document-based questions) (*indicate guiding questions, scoring criteria, and sample student responses*)
- ✓ Performance Assessment: (Circle type(s): Individual; group; product-based; performance-based; artistic; authentic. (*Indicate guiding questions, scoring criteria, and sample student responses.*)
- ✓ Classroom observation (Circle type: Formal; Informal) (*if formal, indicate guiding questions, scoring criteria, and sample student responses*)
- ✓ Whole class discussion (*indicate guiding questions, scoring criteria, and sample student responses*)
- ☐ Small group discussions (*indicate guiding question, scoring criteria, and sample student responses*)
- ☐ Individual student interviews (*indicate interview questions, scoring criteria and student responses*)
- ☐ Process or Reflective measures: (Circle type: Journals; Logs) (*indicate scoring method; explain development and use of rubrics; provide an example of a finished journal*)
- ☐ Portfolios (*indicate scoring method; explain development and use of rubrics; provide an example of a finished portfolio*)
- ✓ In-class worksheet/written assignment (*explain assignment and/or provide example of student work*)
- ☐ Quiz/Test/Exam (*indicate scoring method; provide an example*)
- ✓ Others (*describe*) **Student lab report, including calculations, and data tables.**

DESCRIPTION OF SUMMATIVE ASSESSMENT: Indicate how students' learning of lesson objectives (stated earlier) was comprehensively assessed. ("Post" assessment.) Include description of assignment and sample items. *Attach scoring criteria (checklist or rubrics) used to evaluate the work, and three samples of student work (high, medium, and low).*
The pre- and post-assessments are the same. The instrument is labeled accordingly and included in the attachments. It is graded for accuracy in terms of mathematical computations and descriptive interpretations.

***AFTER LESSON IMPLEMENTATION*, PROVIDE YOUR REFLECTIONS: Tell the story of what happened in the classroom. Indicate what worked, what you would change for the next implementation, and students' reactions to the lesson. Use additional pages if needed.**

Attach to this lesson template: any and all WORKSHEETS and HANDOUTS, examples of ALL indicated ASSESSMENTS (embedded formative and summative), and SAMPLE STUDENT WORK.

Living Environment
Period _____________

Name____________________

Date ____________________

Estimating Populations Pre-Assessment (and Post-Assessment)

1. A scientist wants an accurate estimate of the number of crickets living in a large field. Describe one technique she could use.

2. A scientist uses a **sampling** technique to estimate the number of frogs living in a 1000 square meter marsh. The scientist carefully counts every frog living in one 10 square meter section of the marsh and then multiplies this count by 100 to estimate the total population.

Describe one source of error in this technique.

Describe one way to improve the accuracy of this technique.

3. A scientist does a **mark-and-recapture** study to estimate the total number of turtles living in a large pond. The scientist randomly catches and marks 20 turtles from the pond and then releases them. A week later, the scientist returns and randomly catches 40 turtles from the population. Four of the turtles have a mark. Estimate how many turtles live in the pond. Show all work.

4. What does "randomly" mean as it is used in problem 3 ?

5. Describe any possible sources of error you see in using the **mark-and-recapture** technique.

<u>Day 1</u>

Class Worksheet and Homework

1. A researcher uses a sampling technique to estimate the number of grasshoppers in a 1500 square meter field. She carefully counts all of the grasshoppers in a 5 square meter section of the field. Estimate the total number of grasshoppers in the field. (Note that this is <u>not</u> the mark-and-recapture method.)

2. Suppose you wish to estimate the number of Monarch butterflies in Florida in the month of May using the <u>mark-and-recapture</u> method. On May 1, a random sample of 200 Monarch butterflies is caught and tagged. On May 20, another random sample of 300 Monarch butterflies is caught and 20 of these have tags. Set up a proportion problem and use it to estimate how many Monarch butterflies are in Florida in the month of May.

Proportion ____

Solve your proportion to estimate the total population size of Monarch butterflies in Florida in the month of May.

Show your work.

[# 3 & 4 below are similar problems requiring solution by proportion.]

3. Jenny's Gift Shop sells candles in a variety of packages. The cost per candle is the same in every package. A package of 8 candles costs $12.96. Write a proportion that can be used to determine the cost of a package of 3 candles.

Proportion____

Solve your proportion to determine the cost of a package of 3 candles.

Show your work.

4. Mike made a skateboard ramp shaped like a triangle. It is 4.5 feet long and 3.0 feet high. He wants to make another ramp that is shaped like a triangle, similar to the first ramp. The new ramp will be 4 feet high. Write a proportion that Mark can use to find the length, x, of the new ramp.

Proportion ____

What is the length, in feet, of the new ramp?

Show your work.

5. Ms. Lahti has an aquarium in her classroom. She has three types of fish: angelfish, goldfish, and guppies. These fish are distributed in the aquarium in a ratio of **4 : 6 : 10**, respectively. Determine the <u>percent</u> of each type of fish in the aquarium. [Hint: 4/20 is the ratio of angelfish to the total number of fish in the aquarium. Therefore, the percentage of angelfish in the aquarium is found by converting 4/20 to a percent.]

Set up three proportion problems and solve them to determine the three per cents requested. Show your work.

Proportion 1: ____

Angelfish %________________________

Proportion 2: ____

Goldfish %________________________

Proportion 3: ____

Guppies %________________________

Day 2

Investigating Populations
Lab Report Guidelines

Your lab report must include each of the following:

1. **Coversheet—Activity title, your names, the date, and optional graphics.**
2. **Statement of the research question—How can the size of a population be estimated?**
3. **Statement of the hypothesis—If a system of marking and recapturing is used, then the size of a population of turtles in a pond can be estimated.**
4. **Introduction—A few paragraphs that give background information about turtles and the mark-and-recapture method with repeated trials of population sampling.**
5. **List of materials used.**
6. **Description of the procedures employed to answer the research question and to evaluate the hypothesis.**
7. **Results—Include the data collected in a table using the format below:**

Mark-and-Recapture Method with Repeated Trials

Trial number	# recaptured	# recaptured having a tag (marked)
1	______	______
2	______	______
3	______	______
4	______	______
5	______	______
Totals	______	______

Show the proportion and its complete solution for estimating the total population size.

8. **Statement of the conclusion—Restate the hypothesis and use the data as evidence that supports the conclusion.**

Procedures for Lab Activity

Biologists often use the mark-and-recapture technique to estimate the size of a population. In this activity, you will receive a container that represents a pond. The container will be filled with identical items that represent the total population of turtles in a pond. You will simulate the mark-and-recapture (with repeated trials) technique to estimate the total number of "turtles" in the pond.

Procedure:

- You and your partner will receive a bag of goldfish, a bowl, and a magic marker.
- Empty the entire bag of goldfish into the bowl. The bowl containing the goldfish represent the total population of "turtles" in a pond.
- Capture and mark an X on 20 of the goldfish. This represents 20 marked "turtles."
- Return the 20 marked "turtles" to the pond.
- Stir the pond to distribute the "turtles" throughout the pond.
- Close your eyes and recapture 15 of the "turtles." Open your eyes and count the number of marked turtles among the 15 that were captured. Record these numbers in the table below. Then, return the 15 turtles to the pond.
-

Mark-and-Recapture Method with Repeated Trials

Trial number	# recaptured	# recaptured having a mark (tagged)
1	15	________
2	15	________
3	15	________
4	15	________
5	15	________
Totals	________	________

- Stir the pond and repeat the previous step four more times until the table is complete. Compute the totals.
- Set up a proportion using **20** as the ***number marked*** and the totals from the table for the ***number recaptured in a subsequent sample*** and the ***number marked in a subsequent sample.*** Substitute these values into the proportion below (or an equivalent proportion):

$$\frac{\text{Number marked}}{\text{Total population}} = \frac{\text{Total number marked in subsequent samples}}{\text{Total number recaptured in subsequent samples}}$$

- Solve the proportion to estimate the total population size of turtles in the pond.
- Count the number of "turtles" in the bowl to determine the accuracy of your estimated population.
- Repeat the experiment, by adding five more trials to your table.
- Recalculate the totals in the expanded table.
- Set up a new proportion using the new totals and calculate a new population estimate.
- Is the new population estimate more closely related to the actual population size?
- What does this tell us about the number of trials that should be taken in the mark-and-recapture technique?

Grading Rubric for Lab Report

Item	Points Possible	Points Earned
Coversheet	6	
Research Question/Hypothesis	8	
Introduction/Background information on turtles	15	
Introduction/Sampling Methods	10	
Materials	6	
Procedure	10	
Results/Data Table	15	
Discussion	15	
Conclusion	15	
Total Points	**100**	

Comments:

Sample Technology Education Design Activity

This five-week activity introduces eighth grade technology education students to a "hybrid" design activity which includes a computer-based design experience (using Google Sketchup to design a bedroom), followed by a physical modeling experience where the participants would construct the model once they optimized the design on screen. The activity requires five weeks of classroom instructional time and its focus would be on embedding eighth grade mathematics (scale, ratio and proportion, geometry) into the bedroom design to assess the efficacy of contextualizing mathematics.

The bedroom design activity reflects "informed design," a design pedagogy developed and validated through several NSF projects conducted by the Hofstra Center for Technological Literacy. Informed design leads students through a series of knowledge and skill builders to inform their knowledge base prior to designing thus enabling students to reach informed design solutions, as opposed to engaging in trial-and-error problem solving where conceptual closure is often not attained.

MSTP Mathematics, Science and Technology Partnership
Funded by
The National Science Foundation

Bedroom Design – Student Worksheets

Class and Period______________________________ **Date:** ______________

List students in Group:

____________________________ ______________________________

____________________________ ______________________________

____________________________ ______________________________

Materials you will need:
- ☐ card stock or index cards
- ☐ colored paper
- ☐ foam board or cardboard
- ☐ markers

State what the design challenge is:

____

____

____

1. Clarify the Design Specifications and Constraints

What are the specifications and constraints the design must meet?

____

____

____

____

2. Research and Investigate

In order to better complete the design challenge, you need to first gather information to help you build a knowledge base. Completing the Knowledge and Skill Builders that follow will enhance your ability to design a cost-effective and functional bedroom.

Knowledge and Skill Builder 1: Geometric Shapes

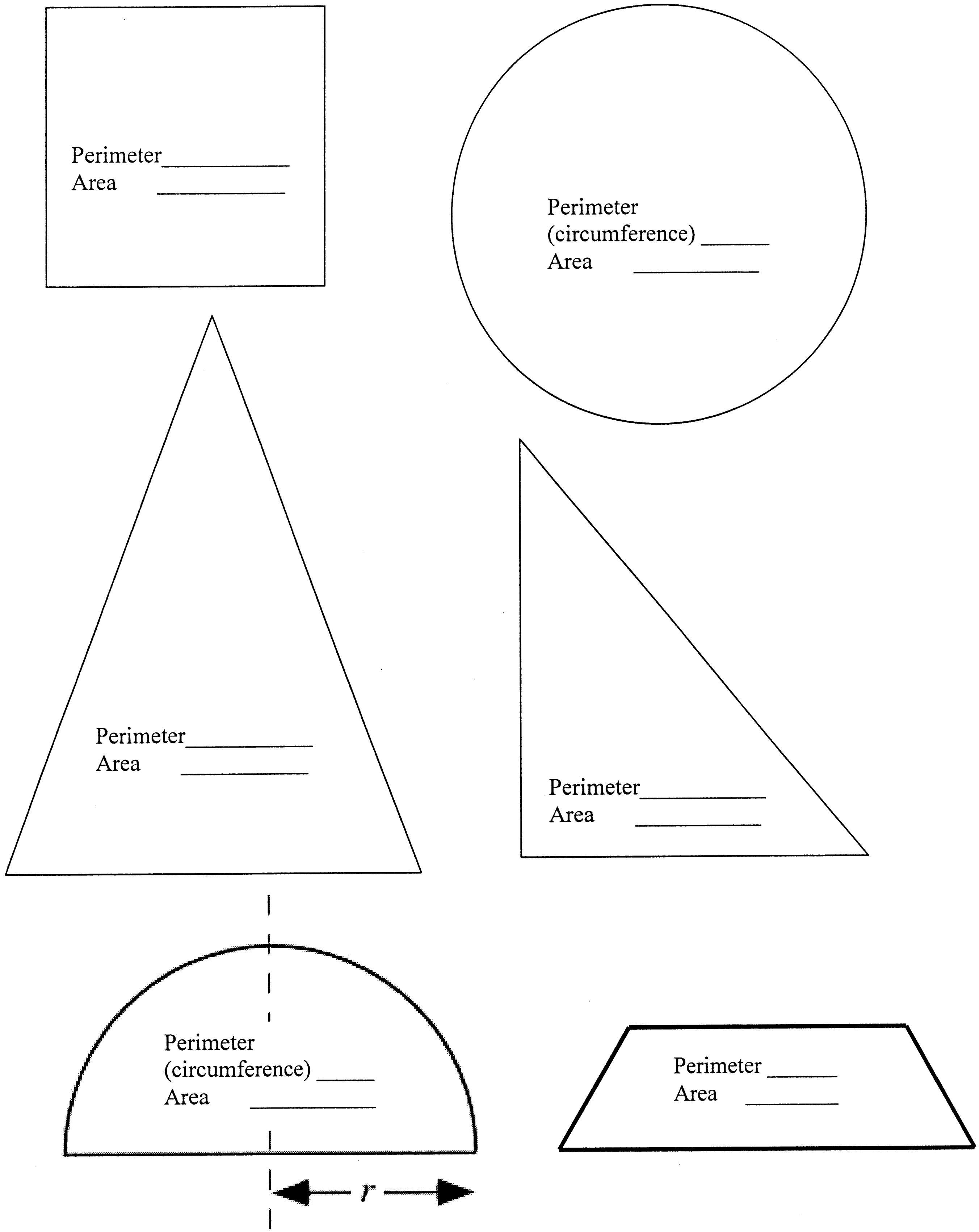
It is important to understand different geometric shapes so you can use them in your design. In this KSB you will draw different geometric shapes and determine their areas and perimeters.

A. Sketch several different rectangles that have an area of 24 square units. Complete the table below and respond to the questions. (Show the whole numbers used for the dimensions).

Length	Width	Area in square units	Perimeter in units

1. How do you know you have found all rectangles meeting the requirements provided?
2. What is the relationship between the dimensions of a rectangle and its area?
3. What is the relationship between the dimensions of a rectangle and its perimeter?
4. Describe the rectangle with an area of 24 square units and the greatest perimeter?
5. Describe the rectangle with an area of 24 square units and the least perimeter?

B. Measure the dimensions of the following shapes, in inches, and determine their perimeters (in inches) and their areas (in square inches). Round dimensions to the nearest half-inch. Formulas [Area = l*w, Area = ½ b*h , area = πr^2 , perimeter = $2\pi r$]



Knowledge and Skill Builder # Using Google Sketch up to create 3D drawings

1 Open Google Sketch up
  a. Click on View>Toolbars>Uncheck getting started
  b. Click on View>Toolbars>Check Large Tool Set (extended toolbar appears on left side)
  c. Discuss the power of Google Sketch up as a design tool
  d. Click on Help>Self Paced Tutorials>Introduction
  e. Walk through all the tabs in the Tutorial
  f. If other self paced tutorials aren't downloaded
    i. Click on Help>Self Paced Tutorials>Get more tutorials
    ii. Use the webpage to download all of the tutorials except the Introduction.
    iii. Go to step g. i.
  g. If other self paced tutorials are downloaded
    i. Open Drawing Part 1 tutorial and follow
    ii. Open Drawing Part 2 tutorial and follow
    iii. Open Drawing Part 3 tutorial and follow
    iv. Open Breaking Edges tutorial and follow
    v. Open Color and Materials tutorial and follow
  h. Discuss the x,y,z axes and how they work in Sketch up
  i. Discuss how 3-dimensional objects have six faces and how they can be viewed independently in Sketch up
  j. Illustrate the views using Camera>standard views> ****
  k. Change the view to Camera>standard views>Top
    i. Discuss how this is the same as a Floor Plan view
  l. Draw a few shapes but use dimensions rather than freehand drawings
    i. Discuss how Sketch up keeps track of dimensions
      1. Discuss the symbols used to represent feet and inches in Sketchup.
    ii. As a group draw a simple shape with dimensions
    iii. Switch the standard view to see how the object looks
    iv. Make the 2D drawing into 3D using the Push/Pull tool
    v. Switch the standard view to see how the object looks
  m. Begin drawing the dimensions of the minimum room size that represents the bedroom
    i. Draw the profile of the walls including standard wall thickness
    ii. Raise the walls to the standard height
  n. Draw a rectangle on any wall according to the size of window desired
  o. Push/Pull the rectangle out to create the window opening
    i. Insert a window from the Component Library according to the planned size
    ii. Make the entire room a component (select all>right-click>make component)
  p. Use the Component library to bring in furniture
    i. Illustrate how to move, resize, and rotate objects

Illustrate how to edit components to add materials

Knowledge and Skill Builder 2. Ratio and Proportion

Scale models help in visualizing what the finished room will look like. Instead of making a full-size drawing, we can use a scale in which 1 inch equals 1 foot. If the full-size dimension is 12 feet, the scaled dimension – the line we draw to represent 12 feet – is 12 inches long.

Whole Class Discussion

a. On separate sheets of paper, make three scale drawings of a room that measures 12 feet by 15 feet. Make one drawing for each ratio: A) ½ in. = 1 ft., B) 1 in. = 1 ft., and C) 2 in. = 1 ft. (Use large sheets of paper for the last 2 drawings or optionally illustrate on a board).

Which scale drawing can provide the most detail? Why?

____

____

____

b. What is 10% of 120 square feet? ________ How might you use this answer to find 20% of 120 square feet? ______________________________________
What is 20% of 120 square feet? __________

Group and Individual Work

1a. Assume that a room you are designing has dimensions of 12 feet by 15 feet. What is the floor area? ________________

1 b. Assume you are designing a trapezoidal room with an altitude of 12 feet and bases of 10 feet and 20 feet. What is the floor area? ____________

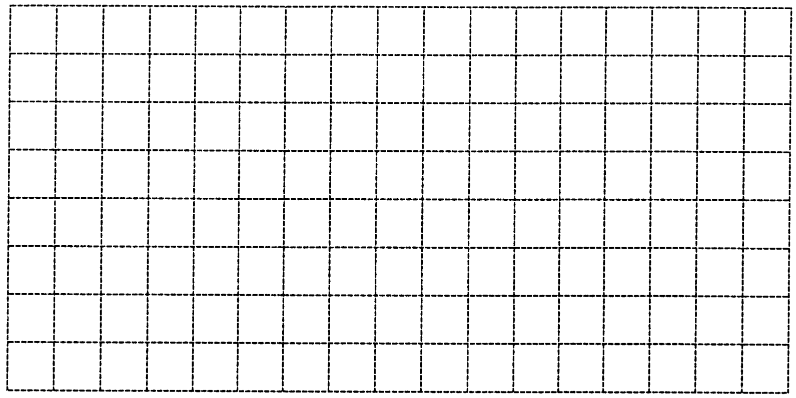
1 c. Assume you are designing a semi-circular room with a diameter of 12 feet 4 inches. What is the floor area? _________

Select one of the above shapes for your room,

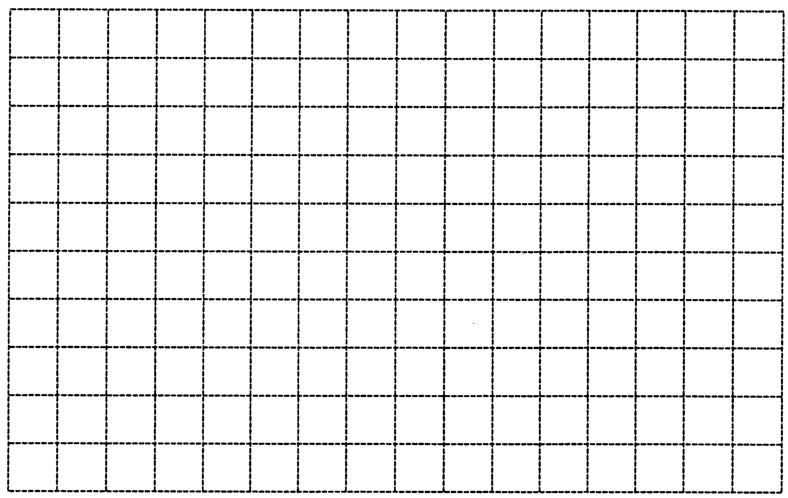
If the window area must be 20% of the floor area, what is the total window area?____________

What could be the dimensions of a square window? ____________________________
Sketch a possible square window on the grid below using a scale of ¼" = one foot.

What could be the logical dimensions of a rectangular window? ___________________________
Sketch a possible rectangular window on the grid below using a scale of ¼" = one foot.

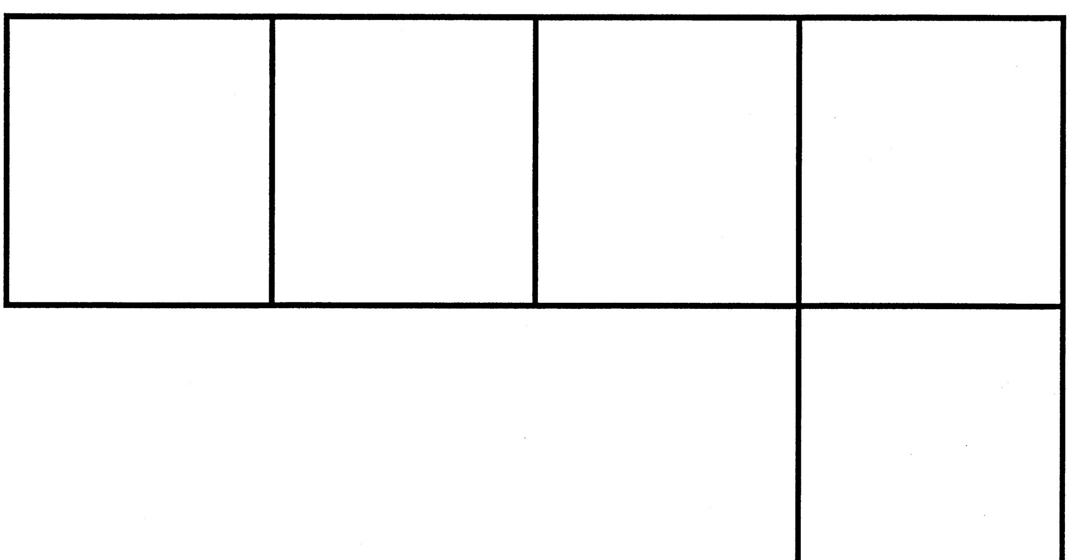


What could be the logical dimensions of a triangular window? ___________________________
Sketch a possible triangular window on the grid below using a scale of ¼" = one foot.



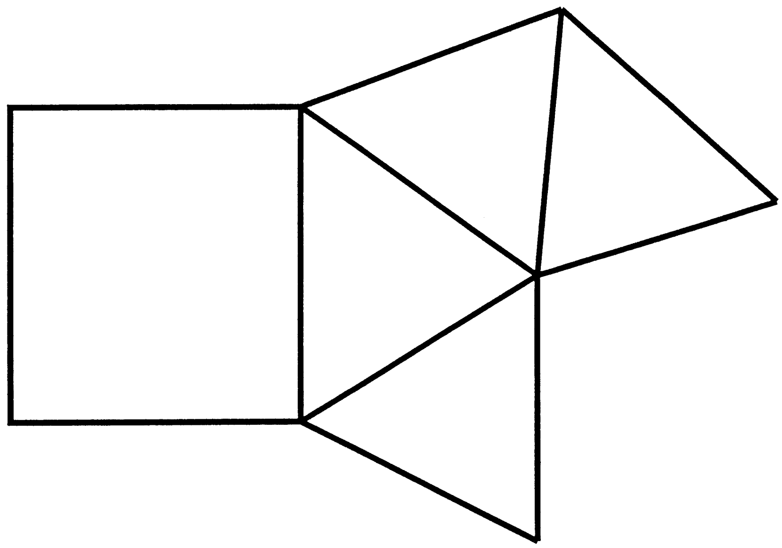
Knowledge and Skill Builder 3. Creating Nets, Folding Nets

a) Draw the following net on a piece of paper and fold it into an open box. Tape the edges.



b) Create your own net and fold it to make a closed box, or cube.

c) Draw the following net on a piece of paper and fold it, taping the edges. What two-dimensional geometric figures form this net? ______________________________



d) Draw the following net on a piece of paper and fold it, taping the edges? What is this solid figure called? ______________________________

Knowledge and Skill Builder 4. Aesthetics

What is the atmosphere you would like to create in your bedroom? Will it be vibrant and alive? Quiet and cozy? The shape and design of your furnishings and the location of windows and skylights can have a great effect. Describe the atmosphere you want. Indicate your preferences for the shape and design of furnishings and the placement of windows.

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____

Choose a color scheme. You can use pleasing color combinations wherever you like.

What color(s) should your room be?______________________________________

What color should the floor be? ____

What color(s) should the furnishings be? _________________________________

Knowledge and Skill Builder 5. Pricing Information

The Excel worksheet can be used for prices in designing your bedroom. However, they may not represent the best prices available. Investigate costs in catalogs or newspaper advertisements and change prices to make your worksheet more accurately reflect real costs.

3. Generate Alternative Designs

Sketch two of your possible alternative solutions to the bedroom design problem. Remember to consider the specifications and constraints. Include a description of what you consider to be each solution's strengths and weaknesses. Use additional sheets of paper if necessary.

4. Choose and Justify the Optimal Solution

Choose your preferred solution. Explain how your solution meets the specifications and constraints. What makes this alternative better?

What tradeoffs if any, did you make in selecting this alternative?

6. Test and Evaluate

Did your design meet the initial specifications and constraints? Indicate the tests you conducted and the experiments you performed to verify this.

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____

Besides the initial specifications, did your particular design include any other specifications, such as the size of the wheels or the specific materials to be used? Describe the testing procedure and explain how the design meets all the specifications.

____

____

____

____

____

____

7. Redesign the Solution

What problems did you encounter that would influence a redesign of your solution? Did you change your original design concept? Why?
If you had to redesign your model, what changes would you recommend in your new design? Explain your reasoning. What additional tradeoffs, in any, would you have to make?

8. Communicate Your Achievements

Describe the plan you will use to present your solution to your class, and show what handouts you will use. (You make include Power Point slides).

Name________________________________ Class__________________ Date ______________

SELF-ASSESSMENT

Use this scoring guide to judge your success.

	Excellent (4)	Good (3)	Adequate (2)	Resubmit (1)
Research and Investigation: I completed all the Knowledge and Skill Builders. I fully answered all the questions asked within them.				
Alternative Designs: I provided at least two sketches with good detail and with all important elements included.				
Optimal Design: I justified the optimal design solution with a detailed explanation as to why it was the best alternative and why it would meet the specifications and constraints.				
Constructing a Prototype: I constructed a prototype based on the optimal solution. I explained changes I made. I included a final sketch of the prototype.				
Testing and Evaluation: I tested and evaluated the final design. The tests were conducted in a reliable and scientific fashion, and I repeated the tests. I explained why the testing was reliable.				
Data Analysis: I constructed data tables based on the testing and used this information to explain the results from testing.				
Meeting Specifications and Constraints: The design worked; it solved the problem and met the specifications and constraints.				
Redesign: I analyzed the results from testing and made sense of them using math, science, and technological knowledge. Based on this, I made recommendations for design improvements.				
Communication: I made a well-organized, clear, written and oral presentation to my class. I discussed each aspect of the design during the presentation.				
Teamwork: Our group worked well together during the entire project. We planned tasks and helped each other, maintaining interest and effort throughout.				
TOTAL POINTS =				