Math-in-CTE Lesson Plan Template

Lesson Title: Scale		Lesson #4
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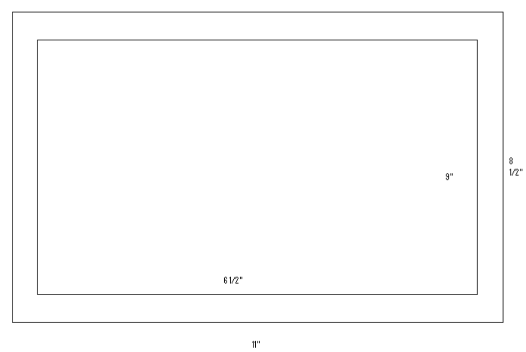
Occupational Area: Engineering/Drafting		
CTE Concept(s): Scale		
Math Concepts: scale, measurement, fractions, mixed numbers, improper fractions, reducing, multiplying and dividing fractions, ratios, proportions, conversion.		
Lesson Objective	Students will be able to understand the use of scale to represent larger or smaller objects in a usable and repeatable format.	
Supplies Needed:	Ruler (Scale), Paper, Pencil, white board/chalk board.	

THE "7 ELEMENTS"	TEACHER NOTES (and answer key)
1. Introduce the CTE lesson.	
When an engineer sets out to design a large object, how will he or she record their design?	On paper or using cad software.
When a paper representation is necessary or desirable, the designer encounters a problem when dealing with very large or very small objects, what do you think that this is?	When drawn on paper at full size, small objects will not be visible, and it will be difficult to accurately draw. Large objects will be too large to fit on the paper when drawn at full size.
In order to make things clear, engineers, architects, designers and draftsmen use a *Scale.* Scale is a method to represent objects with an accurate drawing in a different size. When an Architect draws a house, he wants to accurately represent everything he is drawing as it will be built in the real world. To do this, he or she mathematically converts the measurements they are using to draw with to make their representation fit on the paper that they are using. This is the reason that the scale used to draw a skyscraper on a piece of paper is going to be different than the scale used to draw a small house on the same sheet of paper. If the same scale were used, and the skyscraper filled the paper, the house would be too small to see on its' piece of paper.	
The method for doing the conversion is relatively simple, and this is what we are going to cover today.	

2. Assess students' math awareness as it relates to the CTE lesson. **Fractions** and **ratios** are comparisons of two numbers, or specify the portion of a whole. These are also methods of representing the **scale** of a drawing; they can show the relationship of the item as drawn to its real world size. **Q:** How would you write the relationship between 1 part of 10? **Q:** If I wanted to say that something was ten times smaller than the original, how could I write it?	Remind Students that the scale of a drawing is always shown on the drawing to avoid confusion. **Fractions** – i.e. ¼ **Ratio** – i.e. 1:4 **A:** 1/10 or 1:10 **A:** 1/10 or 1:10
3. Work through the math example *embedded* in the CTE lesson. When an architect establishes the largest dimensions of an object that they want to draw, they can then decide on the scale to use based on the paper they will be drawing it on. If a designer wants to represent a 24' foot line on an 8 ½" x 11" sheet of paper, they will need to scale it down. Since 24' feet is the largest dimension they will be drawing, they will draw it on the longer side (axis) of the paper (11"). **Q:** If they decide to leave a 1" margin all the way around the paper, how much space will they have to draw in? We have now established that we have 9" to draw a 24' object. To find an acceptable scale, we need to establish a relationship between the two. By using 9": 24' as a scale, our 24' line in real life will be exactly 9" on paper. Ex: Convert 24 feet into inches: (1' = 12") 24 * 12 = 288" Actual scale: 9/288 reduces to 1/32	Visual Aid:  **A:** 6 ½ " x 9" 9" : 24' Note: **Numerator** is in **inches**. **Denominator** is in **feet**.

Q:
How will we figure out how long a line to draw to represent 6'? You will notice that in our original computation, the numerator was inches and the denominator was in feet. We need to convert them to the same unit. We will convert them both to inches.

A: (1' = 12")
We need to multiply the full size of the object we wish to represent by the ratio we have already established. To do this, we need to make sure that the <u>units are common</u>.

6 x 12 = 72"

Q:

How will you convert 24' into inches?

A: (1' = 12") Multiply by 12.

Explanation / Notation 1:

24 x 12 = 288"

Explanation / Notation 2:

$$24' \left(\frac{12''}{1'} \right) = 288''$$

Notice how the units cancel each other out and you end up with the desired result.

Q:

Find the length of our 6' as it applies to the scale that we are using 1/32:

Answer:

Explanation / Notation 1:

convert 6' feet to inches

6 x 12 = 72"

then multiply the result by our scale and reduce:

72 x 1/32 = 72 / 32 = 2 ¼ "

Explanation / Notation 2:

(shows long division)

convert 6' feet to inches

$$6' \left(\frac{12''}{1'} \right) = 72''$$

then multiply the result by our scale:

$$72' \left(\frac{1''}{32'} \right) = \frac{72'}{32'}$$

Simplify improper fraction with long division:

	$= 32\overline{)\,72''} = 32\overset{2''}{\overline{)\,72''}} = 32\overset{2''}{\overline{)\,\begin{array}{r}72''\\ -64''\end{array}}}$, $= 32\overset{2''}{\overline{)\,\begin{array}{r}72''\\ -64''\\ \hline =8''\end{array}}} = 2\frac{8}{32}'' = 2\frac{1}{4}''$
4. Work through *related, contextual* math-in-CTE examples. .**Q:** What happens when our scale is not base 2? If we end up with a scale of 1/53 instead of 1/32 in the previous example, how long would the 6' line be? How would you draw a line that is 1 19/53" long? You can't do that accurately using a ruler, so you will have to find a scale that is smaller than the scale you have established (while staying as close as possible) and uses a base 2 number for the denominator (hopefully 16 or less so that a standard ruler is usable), in order to accurately draw the line. The simplest method is to compare the value of our fraction versus that of the marks on a ruler. 1/64 is base 2, while being smaller than the maximum scale we established. It will allow us to accurately draw our lines. 6' will be scaled down to 1 1/8". Our 24' line will become 4 ½".	**A:** 6 x 12 = 72" 72 * 1/53 = 72/53 = 1 19/53" --- 1/53 vs. 1/64 6' = 72 inches 72" at 1/64 scale= 72 * 1/64 = 1 1/8" after reduction 24' = 288" 288*1/64 = 288/64" = 4 ½" after reduction
5. Work through *traditional math* examples. Use several **fractions**, and then **reduce** them. **(Review of previous lesson)** Give students a set of **fractions**, and ask them which ones could be valid **USS fractional measurements** (only the ones with valid **denominators**, and that are properly **reduced**)	Ex: Simplify the following **proper fractions**: 10/20 (1/2), 6/10 (3/5) , 10 / 100 (1/10), 2 / 6 (1/3) , 4/12 (1/3) ,4/16 (1/4), 4/30 (2/15) 16 / 50 (8/25), 16/32 (1/2), 3 / 9 (1/3). Ex: Which ones could be valid **USS fractional measurements?** 12/8 , ½ , 3/17, 15/8, 15/16, 1/8, 1/6, ¼

(Review of previous lesson) Give them **improper fractions**, and have them make them into proper **mixed numbers**. i.e. 17/16 is incorrect it should be 1 1/16 **(Review of previous lesson)**	--- Ex: Simplify the following **improper fraction**: $\frac{72''}{32}$ show them how to **divide** the **numerator** by the **denominator** $= 32\overline{)\,72''} = 32\overset{2''}{\overline{)\,72''}} = 32\overset{2''}{\overline{)\,\begin{array}{r}72''\\-64''\end{array}}},$ $= 32\overset{2''}{\overline{)\,\begin{array}{r}72''\\-64''\\=8''\end{array}}} = 2\frac{8}{32}'' = 2\frac{1}{4}''$ Additional examples: 5/2 (2 ½), 7/4 (1 ¾) , 15/2 (7 ½), 75/ 16 (4 11/16), 30/16 (1 7/8), 24/16 (1 ½), 50/4 (12 ½)
Give them **mixed numbers**, and have them use the math cycle in order to convert into **improper fractions.** **(Review of previous lesson)**	--- Ex: Simplify the following **mixed numbers**. Write $8\frac{2}{3}$ which is a **mixed number** into an **improper fraction**.(Hint: use the math cycle) 3*8 = 24 ; 24 + 2 = 26 = 26/3 ---
Give them some **fractions** to **add** and **subtract.** Point out that adding and subtracting fractions are very similar. **(Review of previous lesson)**	Ex: To add fractions with a **common denominator**, you simply add the two numerators and keep the same denominator. **1 / 3 + 1 / 3 = (1 + 1) / 3 = 2 / 3** Ex: When adding fractions with **different** denominators, we do **all** the steps. **1 / 2 + 1 / 3 = 3 / 6 + 2 / 6 = (3 + 2) / 6 = 5 / 6** http://www.helpwithfractions.com/index.html --- Ex: Here's the Rule for multiplying fractions...

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Give them some fractions to multiply.
(New concept to this lesson)

Give them some fractions to divide
Use Keep Change Flip (KCF) method.
Keep the first fraction, change the sign, flip the last fraction, and multiply straight across, reduce if necessary.
(New concept to this lesson)
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Multiply the numerators.
Multiply the denominators.
Simplify or reduce the resulting fraction, if possible.

2 / 3 X 4 / 5 = (2 X 4) / (3 X 5) = 8 / 15
Additional examples:
4/7 x 1/3 = 4/21; 3/7 x 1/8 = 3/56 ;
1/2 x 3/5 x 3/7 = 9/70

Ex: Here's the Rule for division… to divide fractions, convert the division process to a multiplication process by using the following steps.

Change the "÷" sign to "x" and invert the fraction to the right of the sign.
Multiply the numerators.
Multiply the denominators.
Re-write your answer in its simplified or reduced form, if needed

Once you complete Step #1 for dividing fractions, the problem actually changes from division to multiplication.
1 / 2 ÷ 1 / 3 = 1 / 2 x 3 / 1
1 / 2 x 3 / 1 = 3 / 2
Simplified Answer is 1 ½
Additional examples:
4/7 ÷ 1/3 = 12/7; 3/7 ÷ 1/8 = 24/7 ;
1/2 ÷ 3/5 ÷ 3/7 = 5/6 ÷ 3/7 = 35/18

Ex: A jet aircraft can fly 2,500 miles in 4 hours. How far can it fly in one hour?
Answer: 625 mi
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Give them some **ratios** and **proportions** to solve: **(New concept to this lesson)** Write each ratio in another form: 21 to 3 -> 21:3 or $\frac{21}{3}$ 3 to 5 -> $\frac{3}{5}$ or 3:5 9:2 -> 9 to 2 or $\frac{9}{2}$ $\frac{7}{12}$ -> 7 to 12 or 7:12 Give some equal ratios for each. 5:15 1:3 or 10:30 or 20:60 6 to 4 3 to 2 or 12 to 8 or 30 to 20 Write these as a ratio: an inch to a foot 1:12 (because a foot has 12 inches) an ounce to a pound 1:16 (because a pound has 16 ounces)	Ex: Do $\frac{6}{8}$ and $\frac{36}{48}$ form a proportion? Yes, because $6 \times 48 = 8 \times 36$. Find whether each of the following statements is a proportion: $\frac{2}{3} = \frac{6}{9}$ Use cross products to verify: 2 x 9 = 3 x 6 18 = 18 Yes, its a proportion. 10:5 = 40:20 Use cross products to verify: 10 x 20 = 5 x 40 200 = 200 Yes, its a proportion. $\frac{4}{3} \neq \frac{20}{18}$ Use cross products to verify: 4 x 18 = 3 x 20 72 = 60 No, not a proportion. What value of n will make this a proportion? $\frac{6}{15} = \frac{n}{25}$ 15 x n = 6 x 25 15 x n = 150 n = 150÷15 n = 10
6. Students demonstrate their understanding.	Scale Worksheet
7. Formal assessment. **Have the students demonstrate a knowledge of the vocabulary, and that they can measure a set of lines/objects. Use either the prepared worksheets, or, give them rulers and an assortment of objects to measure, and have them record their results.**	See attached assessment. Assessment

Rubric for Critiquing Math-Enhanced Lesson Plans

Lesson Title:	Lesson #
Author(s):	

Please check the appropriate boxes in the rubric below. Use comment box to make suggestions/recommendations.

ELEMENTS	COMPLETE	NEEDS IMPROVEMENT	COMMENTS
1. Introduce the CTE Lesson.	□ Specific objectives of CTE lesson are explicit. □ Detailed script is provided for introducing lesson to students as a CTE lesson. □ The pulled-out math concept in embedded in the CTE lesson is clearly identified. □ Script is provided to point out the math in the CTE lesson.	□ Lesson objectives are unclear or not evident. □ Little or no script is provided for introducing lesson to students. □ Math concept embedded in the CTE lesson is not pulled-out or made clear. □ Script is not provided to point out the math in the CTE lesson.	
2. Assess students' math awareness as it relates to the CTE lesson.	□ Lesson contains learning activities and/or well developed questions that assess <u>all</u> students' awareness of the embedded math concept. □ Math vocabulary and supporting instructional aids are provided to begin bridging of math to CTE.	□ Script has short list of phrases; no learning activities or questions that support assessment of all students' awareness of the embedded math concept. □ Math vocabulary and/or instructional aids are not provided.	
3. Work through the math example ***embedded*** in the CTE lesson.	□ Script provides specific steps/processes for working through the embedded math example. □ CTE and math vocabulary are explicitly bridged in the script, supported with instructional strategies and aids.	□ Steps/processes for working through the embedded math example are incomplete or missing. □ Little bridging of CTE and math vocabulary is scripted; few or no strategies and aids are provided to relate the CTE to math.	

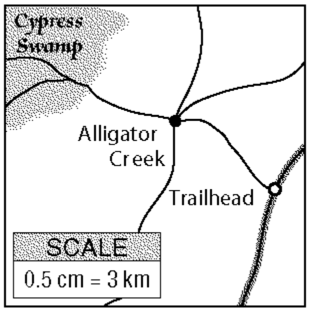
4. Work through the *related, contextual* examples.	□ Lesson provides a work-through of similar examples, using the same embedded math concept in examples from the same occupational area. □ Example problems are at varying levels of difficulty, from basic to advanced. □ Script continues to bridge the CTE and math vocabulary, supported with instructional strategies and/or aids.	□ Few or no additional examples of the embedded concept are provided. □ Examples do not reflect varying levels of difficulty. □ Little or no bridging of CTE and math vocabulary is evident in the script or supported with instructional strategies and/or aids.	
5. Work through *traditional math* examples.	□ A variety of examples are scripted to illustrate the math concept as it is presented in traditional math tests. □ Examples move from basic to advanced. □ Script continues to bridge the CTE and math vocabulary, supported with instructional strategies and/or aids.	□ Few or no math problems illustrate the math concept as it is presented in standardized tests. □ Examples do not reflect varying levels of difficulty. □ Little or no bridging of CTE and math vocabulary is evident in the script or supported with instructional strategies and/or aids.	
6. Students demonstrate understanding.	□ Lesson provides learning activities, projects, etc., that give students opportunities to demonstrate what they have learned. □ Lesson ties math examples back to the CTE content; lesson ends on the CTE topic.	□ No learning activities, projects, etc., provide students with opportunities to demonstrate what they have learned. □ Lesson fails to tie the math back to CTE or end on the CTE topic.	
7. Formal assessment.	□ Lesson provides questions/problems that will be included in formal assessments (tests, projects, etc.) in the CTE unit/ course.	□ Example questions/problems are not provided for use in formal assessments in the CTE unit/course.	

Name ________________________ Date __________________ Period ___________

Scale Assessment

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Bryan and two of his friends plan to use the map of a wildlife preserve to hike from the trailhead to Alligator Creek. After they reach Alligator Creek, they will camp for two days and then hike out of the preserve the same way they hiked in. If the distance from the trailhead to Alligator Creek is about 1.5 centimeters on the map, what is the approximate actual distance Bryan and his friends will hike altogether?



a. 2.25 kilometers
b. 4.5 kilometers
c. 9 kilometers
d. 18 kilometers

____ 2. The scale on a road atlas is $\frac{3}{4}$ inch = 5 miles. If the distance between Fort Lauderdale and Miami is about 27 miles, what is the approximate driving distance on the map in inches?

a. 3 inches
b. 4 inches
c. $6\frac{1}{4}$ inches
d. 9 inches

____ 3. Marcello bought a replica of a swamp monster on a trip to a movie studio. The tag on the replica states that the scale is $\frac{1}{2}$ inch to $\frac{3}{4}$ feet. If the tag is accurate and the replica stands 5 inches high, what was the height in feet of the swamp monster used in the movie?

a. $7\frac{1}{2}$ feet
b. 9 feet
c. $15\frac{5}{8}$ feet
d. $18\frac{3}{4}$ feet

____ 4. An illustrator for a science text draws insects to scale. One of the insects she drew is a green peach aphid. This type of aphid has an adult body that is 2 millimeters long. If the illustrator uses a scale of 2.5 centimeters = 0.5 millimeter to draw the insects, what is the length in centimeters of the aphid in the drawing?

a. 1.25 centimeters
b. 2.5 centimeters
c. 5 centimeters
d. 10 centimeters

____ 5. Solve for d. (Use cross multiplication)

$$\frac{9}{d} = \frac{27}{39}$$

a. 24
b. 13
c. 2
d. 2.8

Short Answer
Maria drew a series of squares. Use the figures to answer the question.

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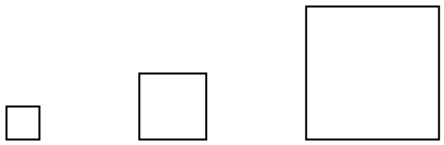
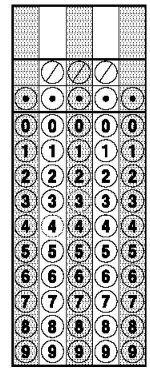


Figure A Figure B Figure C

6.

If the sides of Figure C are 4 times as long as those of Figure A, how many times greater is the **area** of Figure C than the **area** of Figure A?

Remember that the area of a square is: $A = L \times W$



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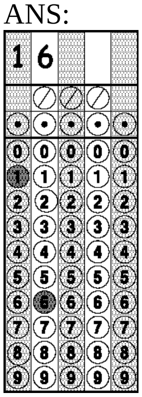
Scale Assessment
Answer Section

MULTIPLE CHOICE

1. ANS: D STO: MA.B.1.3.4
2. ANS: B STO: MA.B.1.3.4
3. ANS: A STO: MA.B.1.3.4
4. ANS: D STO: MA.B.1.3.4
5. ANS: B STO: MA.B.1.3.3

SHORT ANSWER

6. ANS:



STO: MA.B.1.3.3

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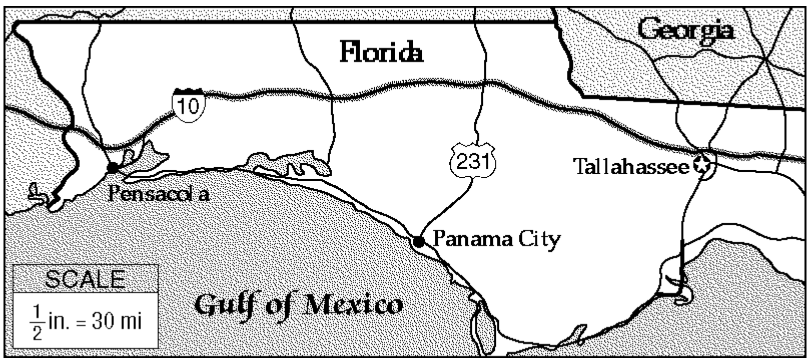
Scale Worksheet

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. A rectangular tract of land measures 6 miles by 2 miles. If the length and width of the tract are increased by a factor of 5, how will the perimeter of the tract change?

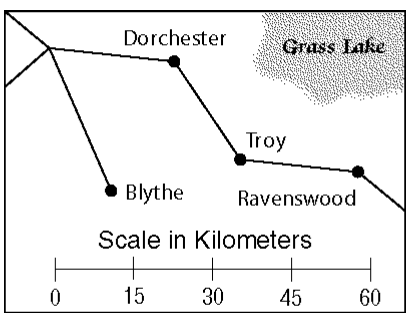
a. The perimeter will remain the same.
b. The perimeter will be 5 times as long.
c. The perimeter will be 10 times as long.
d. The perimeter will be 25 times as long.

____ 2. The Culberson family will drive Interstate 10 from Pensacola to Tallahassee for a family reunion. The distance on the map between the two cities is about $3\frac{1}{4}$ inches. Based on the map scale, what is the approximate driving distance in miles between Pensacola and Tallahassee?



a. 48.75 miles
b. 97.5 miles
c. 195 miles
d. 390 miles

____ 3. Based on the map scale, what is the approximate driving distance between Dorchester and Ravenswood?



a. 20 kilometers
b. 30 kilometers
c. 45 kilometers
d. 50 kilometers

____ 4. Joaquin must draw a scale drawing of a painting for an art assignment. The painting he chose measures 26 inches by 52 inches. If Joaquin's scale drawing is $5\frac{1}{5}$ inches by $10\frac{2}{5}$ inches, which scale did he use?

a. 1 inch = $\frac{1}{5}$ inch
b. 1 inch = 5 inches
c. $\frac{1}{5}$ inch = 5 inches
d. 5 inches = 1 inch

____ 5. Use the formula, Area = length × width, to find the area of the rectangle shown.

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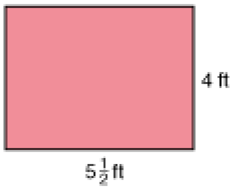


a. $9\frac{1}{2}$ square feet

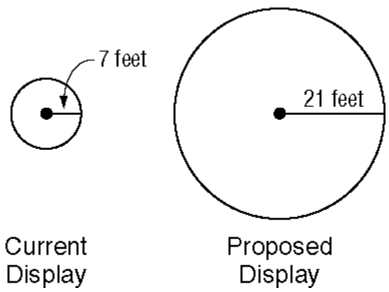
c. $20\frac{1}{2}$ square feet

b. 22 square feet

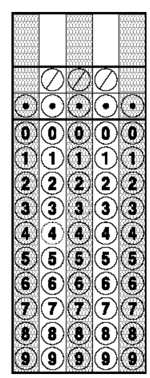
d. 16 square feet

Short Answer

The head gardener at a botanical garden wants to increase the size of a circular display of bird-of-paradise plants. Use the figure to answer the question.



6. Chiavo, the head gardener, uses a flexible rubber border that he places around the edge of the display. The length of the border for the proposed display will be how many times as great as the length of the border for the current display?



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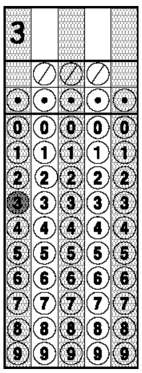
Scale Worksheet
Answer Section

MULTIPLE CHOICE

1.	ANS: B	STO:	MA.B.1.3.3
2.	ANS: C	STO:	MA.B.1.3.4
3.	ANS: C	STO:	MA.B.1.3.4
4.	ANS: B	STO:	MA.B.1.3.4
5.	ANS: B	STO:	MA.B.1.3.3

SHORT ANSWER

6. ANS:



STO: MA.B.1.3.3