Final ***integrated*** **project / lesson plan** (teams-Due: Thursday, August 12th)

Submit as hard copy AND electronically through ANGEL

Names: **Kim Meek, Sean Metz**
Grade level(s)/Subject taught: **11th grade Algebra II, 9th grade Earth Science**
Objectives: **Science: Simulate Eratosthenes measurements and calculations he used to discover the circumference of the Earth.** **Math: Use the context of Eratosthenes discovery of the circumference of the Earth to teach the idea of radians and the equation arc length = radius * theta.**

Describe the *integrated* Mathematical - Science Concepts or "key ideas" that modeling will be used to teach: (e.g. Students use mathematical modeling/ multiple representation to provide a means of presenting, interpreting, communicating, and connecting mathematical information and relationships and… Organisms maintain a dynamic equilibrium that sustains life).

Mathematical - Science Concepts to be integrated:

Students use learning technologies (Geometer's Sketch pad) to facilitate solving a problem. Specifically, they use two models. One that shows a visual representation of Eratosthenes process and a test his equation for all values of theta.

Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and recognize the historical development of ideas in science. For example, the students will understand how Eratosthenes made his measurements and calculated the circumference of the Earth, which is quite accurate. The historical implications are that he was the first or most well-known man to accurately (to within 100 miles) calculate the distance around the equator.

Students understand the relationships and common themes that connect mathematics, science and technology. Math and technology are tools that can be used together to gain insight about science related topics. Mathematical thinking and algorithms are needed to "power" the technology that can visually model the real-world environment.

For your ***integrated*** **project / lesson plan)** lesson (team effort), describe how you plan on using a desired modeling software package(s) with your students AND how you might integrate or weave together the two (or more…) math and science concepts into one or more lessons. You might describe what a visitor might see walking into your classroom during this lesson. You might also describe the role of the student during the entire lesson and your role as the teacher. Please try to be specific as possible. Also, construct a tentative rubric that you might use with your students.
** see example page 5.

Prompts:

1. How will you assess the prior knowledge of the student?
2. How will you begin the lesson?
3. What are the teacher and students doing every 5-10 minutes? (Teacher Actions and Student Actions
4. Describe your thinking of how the concepts will be integrated.
5. How will you assess the learning for the lesson?
6. How will the chosen software/tool(s) be integrated into our teaching as per rubrics in this packet? (i.e. you may want to discuss a problem or describe how you might use the chosen modeling package in your plan. How does the model/tool help the concept(s) to be taught)?

*Using _**Geometers Sketch Pad**__ I plan on having my students…*
(software / modeling tool)

This lesson will involve an 11th grade Algebra class as well as a 9th grade Earth Science class. The students will use their prior knowledge of the Earth Science concepts of Eratosthenes as well as the equation used to solve for percent deviation. This project will be executed during the spring months (March or April) and will require all of the students to make measurements at the same time of day (solar noon). This lab would actually be treated as an in school field trip for both the 11th and 9th grade students.

(9th Grade Earth Science)

As the lab begins there will be questions on the overhead for the students to solve to make sure they can use the percent deviation formula.
In this lesson the students will observe two models *(Figure 1,2*) that were created using Geometers Sketch Pad. The models will demonstrate how the Sun's rays create angles on the surface of the Earth that can be measured. The measurements can be plugged into a formula that will be used to calculate the circumference of the Earth.
During a prior lesson the Earth science students will be asked to find the actual latitude and longitude coordinates that will be needed to make the calculations. The class will also be asked to find the exact time when the Sun will be the highest point of the sky at our particular coordinates.

After the students understand the proper the steps taken to solve for the circumference of the Earth using the measurement of a shadow, the students will see the web site that stores their data. The website for the Noon day project contains links for the students to look at other student measurements from different location around the world.
http://njnie.dl.stevens-tech.edu/noonday/
As a group we will register for this project in late August.

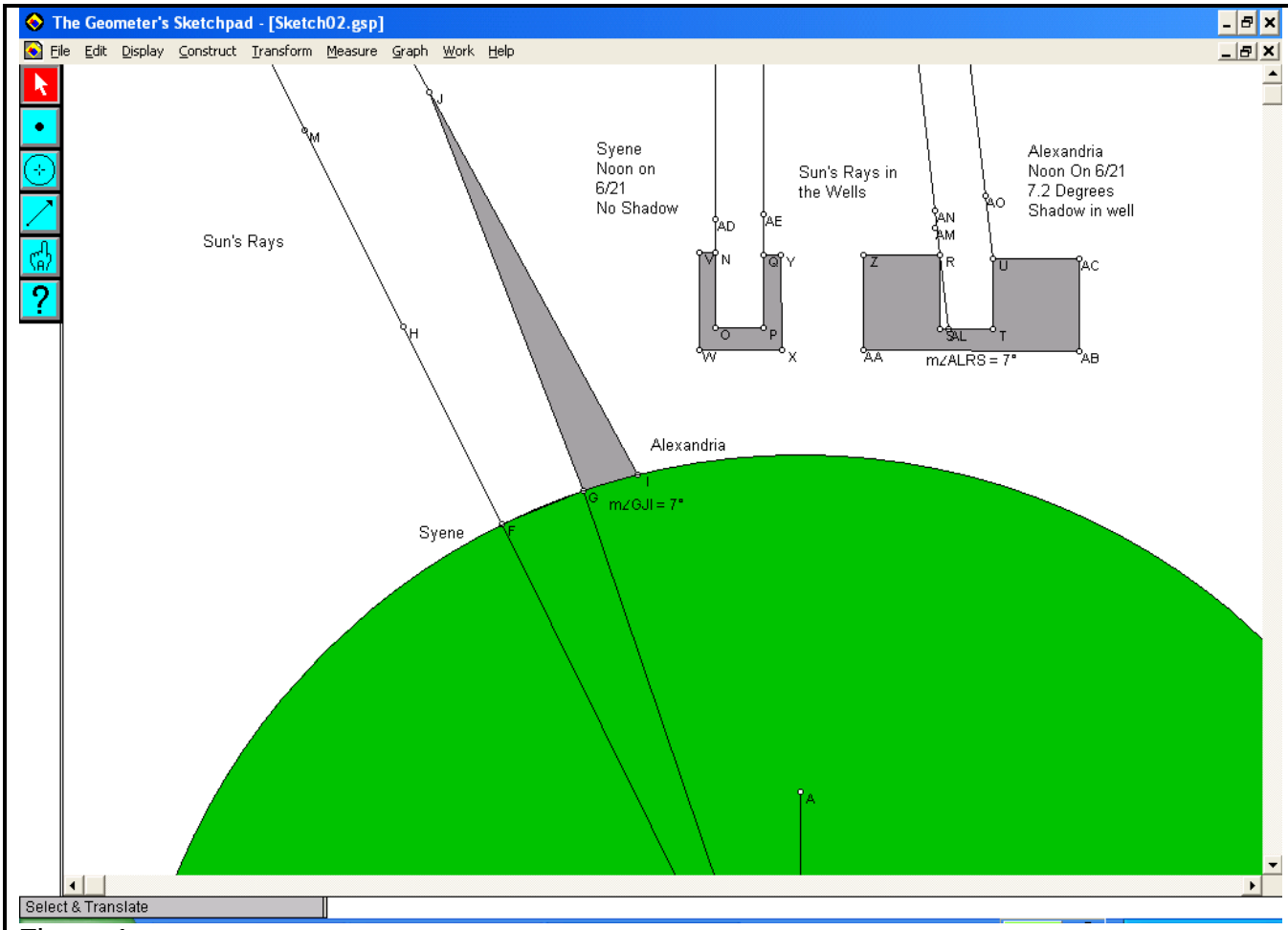


Figure 1

After The students have seen the website they will precede to the tennis courts to begin making measurements of the angles that the Sun's rays they create using the meter sticks. After the data has been collected the students will move back inside the classroom. The data will be calculated to find the angles by the 11th grade math students and then entered into the spreadsheets and loaded to the website.
A post lesson will require the students of the 9th grade Earth Science class to actually calculate the percent deviation for the measurement that they created during this lab.

11th GRADE MATH ALGEBRA II

The juniors explore Eratosthenes in more detail than when they were freshman. They use trigonometric functions, ratio and proportions, and circle geometry to calculate the circumference. This reviews their prior understanding and provides a practical context to apply mathematical concepts to help students in their own school. Then we use this situation

to extend student's knowledge to include the equation arc length = interior angle * radius, which aligns with the curriculum.

Initially, I ask the students if they remember studying Eratosthenes in 9th grade and we talk about it for 5 minutes. At this time, I show the students the two GSP models that demonstrate his discovery (Figure 1 and Figure 2). I describe how the 9th graders this year took actual measurements and participated in the world-wide Noon Day project, and that we were going to help them compute the circumference given the length of the meter stick, the length of the shadow and the distance between two cities. I give the students the data and let them work in groups to solve for the circumference of the Earth. I want to see how much the students can remember and apply from their past experiences, so I let them struggle without giving much direction. Then depending on how they do, I either give them some clues or discuss their solutions. To help I display the model of Figure 2 to give the students a visual. I also direct them to the websites for Eratosthenes. They are also responsible for putting their calculations into an excel worksheet to return to the science department.

The next day we continue discussion about this problem only we relate it to ratio and proportion. Specifically, the students see that the fraction of the angles equals the fraction of the arc length to the circumference. This class should be held in a computer lab with GSP capabilities so the students can work in groups on the model Sean and I created Figure 3. The purpose of this experiment is for the students to discover the relationship s = r * theta and that this is a generalized form of C = pi * d, and that it is derived from Eratosthenes formula. The model then shows them that this relationship works for all values of theta and for all sizes of circles. This fits into the curriculum when we cover the concept of radians.

The students demonstrate their knowledge by presenting another real-world application of this concept and how it applies. The students can choose from any practical situation that involves radian measure as a fraction of the circle. They are graded on how well they work throughout the few days prior to the project and during, their applicability of the concept and their presentation.

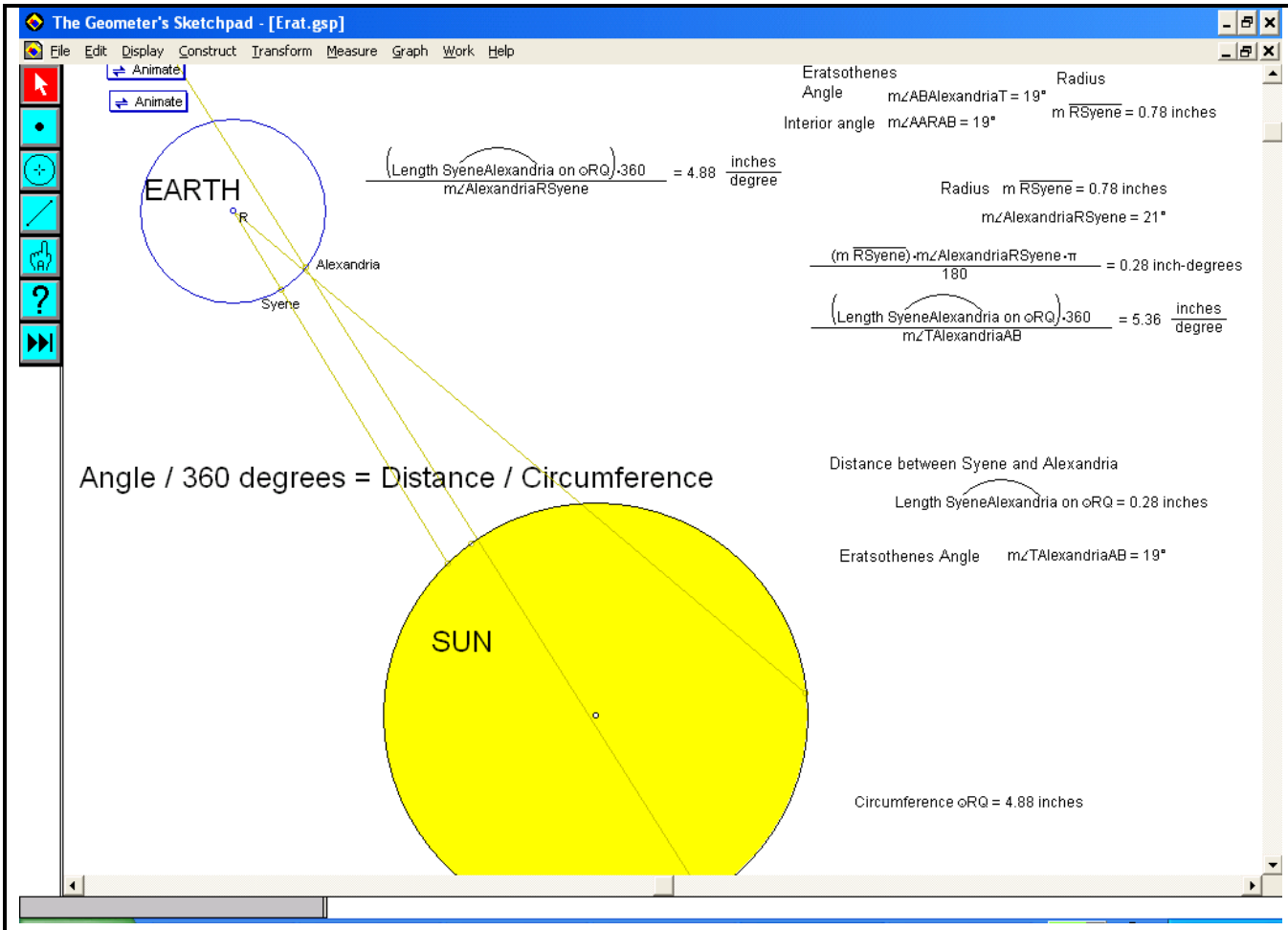
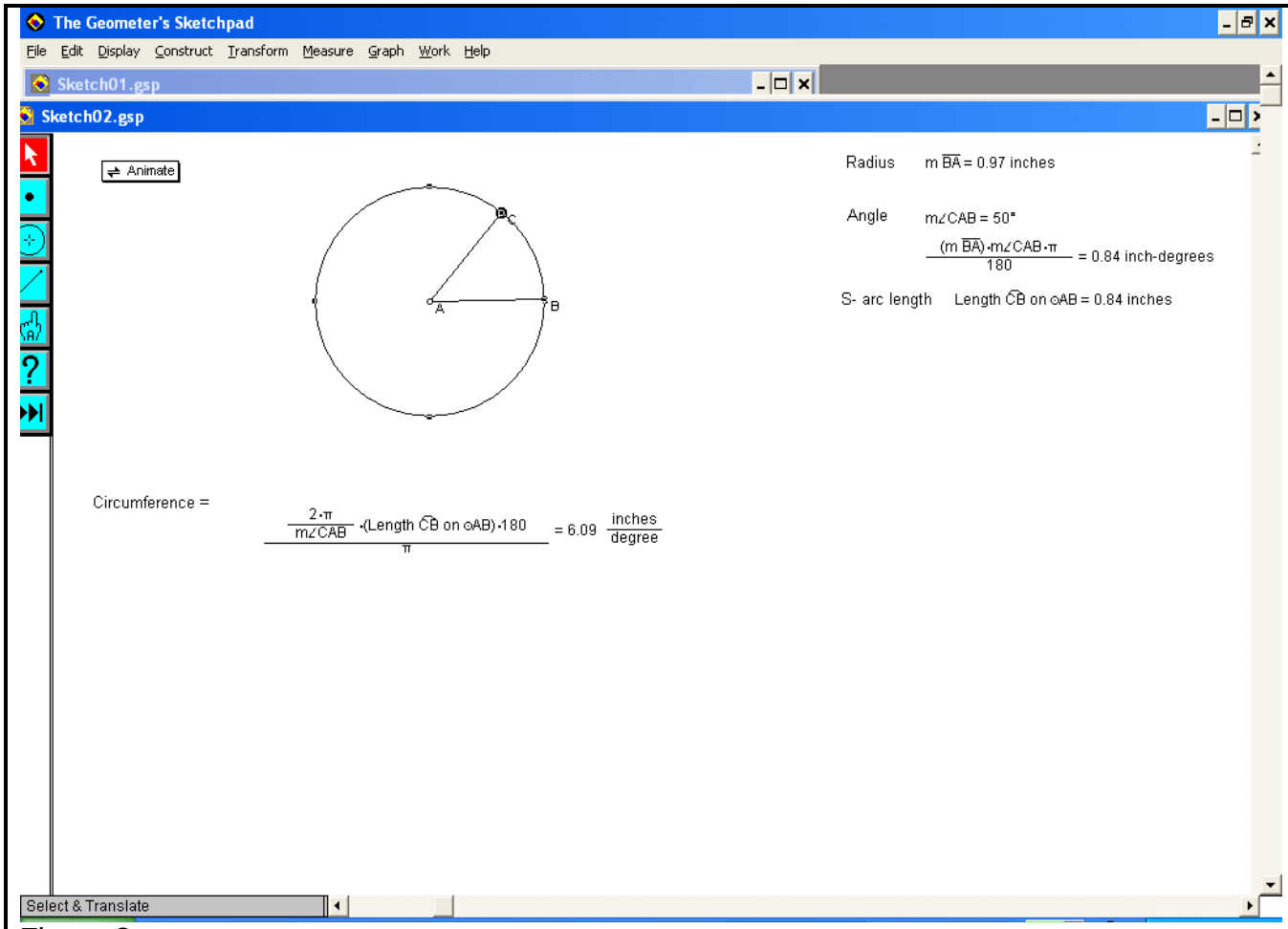

The Geometer's Sketchpad - [Erat.gsp]
File Edit Display Construct Transform Measure Graph Work Help
Animate
Animate
EARTH
R
Alexandria
Syene
SUN
Eratsothenes Angle m∠ABAlexandriaT = 19°
Interior angle m∠ARAB = 19°
Radius m RSyene = 0.78 inches
(Length SyeneAlexandria on ⊙RQ)·360 / m∠AlexandriaRSyene = 4.88 inches/degree
Radius m RSyene = 0.78 inches
m∠AlexandriaRSyene = 21°
(m RSyene)·m∠AlexandriaRSyene·π / 180 = 0.28 inch-degrees
(Length SyeneAlexandria on ⊙RQ)·360 / m∠TAlexandriaAB = 5.36 inches/degree
Angle / 360 degrees = Distance / Circumference
Distance between Syene and Alexandria
Length SyeneAlexandria on ⊙RQ = 0.28 inches
Eratsothenes Angle m∠TAlexandriaAB = 19°
Circumference ⊙RQ = 4.88 inches

Figure 2


The Geometer's Sketchpad
File Edit Display Construct Transform Measure Graph Work Help
Sketch01.gsp
Sketch02.gsp
Animate
C
A
B
Radius m BA = 0.97 inches
Angle m∠CAB = 50°
(m BA)·m∠CAB·π / 180 = 0.84 inch-degrees
S- arc length Length CB on ⊙AB = 0.84 inches
Circumference = 2·π / m∠CAB ·(Length CB on ⊙AB)·180 / π = 6.09 inches / degree
Select & Translate
Figure 3

Rubric for the 9th grade Earth Science Class

This will be graded as a lab fir the Earth Science class, and the lab will be worth a total of **ten** of points.

The first **five** points will be given on the lab for the actual measurements made and participation during the lab. Also the students will need to find the Latitude and longitude coordinates of Brighton High School. The students will also find the precise time when the Sun will be at solar noon.

First 5 Points

1.) Groups work together to make measurements
2.) Find Latitude, and Longitude
3.) Find the Solar noon
4.) Making the calculation of circumference of the Earth
5.) Calculating the percent deviation of their own personal calculation

The last **five** points will be given to the students that complete a lab write up, following completion of the lab.

Questions the lab write-up will need to address.(Last 5 points)

1.) What procedure did you take to find the measurements, and then calculate the circumference?
2.) Using the percent deviation formula, how close were you measurements?
3.) What is one possible reason your calculation was not precise?
4.) What could you do next time to make the calculations more precise?
5.) What is one reason Eratosthenes calculation was not exact?

MATH RUBRIC:

CRITERIA	5	3	1
How did our group work together?	All members participated Independently researched and solved problem	There were a few problems in the group, we needed guidance and help solving the problem	We needed a lot of guidance and our group did not share the work evenly among members
How well does our real-world application fit the radian concept?	The concept can solve a relevant real-world problem	The concept is related to a real-world topic, but does not solve anything practical	The concept and topic are not related or there is a major misunderstanding
How well did we present?	All members spoke Visuals large and easy to read, audible, timely	The main idea was presented clearly but not all members contributed, hard to hear, or ran over time limit.	Only one or two people spoke, could not hear, could not see visual, or no visual

Teacher determines time limit based on time constraints and student input.