Scientific Notation
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I. Hands-on Connection sheet (3 pages). Read it all first!!

Everybody completes a worksheet.

If there is not room for your answers on this sheet, or if you prefer to write on separate lined paper, or type on the computer, you can attach another sheet.

List all 4 members of your group. Circle your name. Put a star next to your partner.

1. **For your group of 4:** Decide on at least one sentence statement about whether/how the earth has changed. Write this statement here. It is okay if the whole group has the same statement, but yours does not have to agree with the rest of the group.

2. **For your group of 4:** Decide on how the sea floor is spreading. What is the direction of movement? Which geometric transformation do you see? Describe the transformation as completely as possible in words or diagrams.

3. **In partner pairs,** use the internet to find the present day rate of sea floor spreading. Change this rate to meters/year, using scientific units, and write this here. Cite your source (give the web site URL).

4. **In partner pairs,** on separate paper, sketch a map of Pangaea and a map of present-day earth. You may wish to have each partner do one of the maps. Use these maps to find two present-day cities that touched at the time of Pangaea. Mark and name them on both maps. (You can use the plastic "globes" as you wish to help you.) Find two more pairs and mark them also. You will turn these 2 maps in.

5. **In partner pairs,** find the distance between these pairs of cities, in meters, using scientific notation. Write these distances here.

6. **In partner pairs,** create a line graph of separation distance vs. time, using the rate of movement found in question 4 as the slope. Choose the appropriate units for the x and y axes. Notice the time line on the model of sea floor spreading, so that you can choose suitable units. On your graph paper, write an equation that links the time, distance, and rate of spreading. On your graph, put a horizontal line at the appropriate distance for each of your city pairs. You will turn this graph paper in.

7. **In partner pairs,** Where each horizontal distance line meets the slope, you can find the time to reach that distance. Please find that time for each of your city pairs, and write it here. Are all the times about the same? How close are they? What do you think the significant figures are in this case? Please write these answers down here.

In Groups: Be prepared to report out to the class on this time of movement, and how the time compares to the age of the earth.

8. Look up the Ethiopian rift on the internet, and calculate the rate at which the rift is separating, in meters/year. Write this down here. In a sentence, compare this rate with the rate you found in question 3.

9. On your graph, make a new line to represent the new rate that you have found. Based on this new rate, how much time did it take for your cities to separate? Write these down here. Using sentences, compare these times to your original estimates from question 7.

Write these down here. Are they close or very different? How do they compare to the age of the earth? Does this alter your idea of how/if the earth is changing?

II. Useful websites

- http://whc.unesco.org/en/activities/504/ separation rate for the Atlantic
- http://pubs.usgs.gov/gip/dynamic/stripes.html magnetic striping
- http://www.worldatlas.com/aatlas/infopage/howfar.htm distance calculator
- http://www.rochester.edu/news/show.php?id=3486 Ethiopian rift

III. Word Bank/ Key Vocabulary

Continental drift - the earth's continents are moving
Millimeter (mm) - linear measurement in metrics. 1/1000th of a meter.
Oceanic ridges – the mid-Atlantic ridge is a source of additional material
Pangaea – the original continental mass
Plate tectonics –the theory of earth's plates and continental drift
Significant figures – number of digits that represent the accuracy of measurements and assumptions
Sketch – a rough outline drawing to illustrate a point
Transformation – translation, rotation or reflection of an image

IV. Goal of Lesson (70 minutes)

The objective of this lesson is to have students create a linear algebraic model for distance drift between continents, examine how their linear model fits to present data, and use a model to predict events.

Michigan Standards/ GRPS standards:

STANDARD L1: REASONING ABOUT NUMBERS, SYSTEMS, AND QUANTITATIVE SITUATIONS

- L1.1 Number Systems and Number Sense
- L1.2 Representations and Relationships
- A2.1 Definitions, Representations, and Attributes of Functions
- A2.4 Models of Real-World Situations Using Families of Functions
- A3.1 Lines and Linear Functions

V. Materials and Supplies needed for each group of 4 to complete the lesson.

- 2 – floor-spreading models
- 3- computers with internet access
- 4- graph paper, lined paper, rulers and pencils, plastic blow-up globes, internet
- 5- internet
- 6 – graph paper, lined paper, rulers and pencils, internet, calculators
- 7 - graph paper, lined paper, rulers and pencils, calculators

VI. Procedures and Instructions

ENGAGE:

(Show picture of Earth, or a globe)

Has Earth always been the same? What has changed?

Issues of "the same" – related to positions of land mass, size of the earth, composition of the earth and the surface of the earth.

Use (if a student group suggests it) or introduce the idea of plate movement.

Ask students what they would expect to see if the plates were moving. *Issues of moving, what movement means, expansion of the earth*

EXPLORE:

Have students use the model of the sea floor spreading.

Create maps showing drift from the Atlantic split

Students can find on the internet the present speed of sea floor spreading.

Using the internet, find the present-day distance between places that touched in Pangaea.

Encourage students to look for you-tube graphics for Pangaea and for the mid-Atlantic rift.

Use scientific notation to convert units into years and meters.

Create a linear equation (proportion) to model the change of distance with time, and find the rate of change.

Create a graph to show the rate of change, with appropriate choices for x and y axes.

EXPLAIN:

Ask students to report out from groups and give a rough estimate of the length of time that the continents have been drifting apart, with reasons why. Ask why groups may have different answers. Ask whether the answers are very different. Compare the differences with the age of the earth.

Make sure students understand about significant figures and rounding. Report out on units of graphing

Ask students if anybody learned about any other aspects of sea floor spreading.
Talk about having all data fit a model, and about predicting future data from a model.

ELABORATE:

Have students estimate the rate at which the Ethiopian rift has been opening. Use this rate to estimate the time that the continents have been separating. Compare the differences with the age of the earth.
Answers should be in appropriate units, and be rounded to the appropriate level of accuracy.

Assessment Rubric (EVALUATE)

	4=A	3=B	2=C	1=D
Graphic model Pangaea and present-day	Shows Pangaea and rift lines, compares present-day with Pangaea	Shows Pangaea but without rift lines, and shows present-day without being able to compare land	Shows present day map only	No mapping
Distance measurements	Lists cities & countries that are compared, and shows them on the maps. Gives distances and units.	Gives distances and units without specifying cities on the map	Gives general distances estimated from present-day map, but with no specifics.	Distances without units, and without any reference to the map.
speed data	Rate of spread in correct units, with references, showing the conversion to meters/year	Rate of spread in correct units, showing the conversion to meters/year	Rate of spread without correct unit conversion	No information on rate of spread or unit conversion
Equations and graphs	Linear equation relating distance to time, with correct units, and correct graph with units	Linear equation without units. Graph lacks units.	Incorrect linear equation. Graph lacks units.	Incorrect or no equation. No graph, or graph is incorrect.
estimation	Estimation of the spread of the rift, showing work, with correct units	Estimation of the spread of the rift, showing work.	Incorrect application of the equation to time estimates.	No application of the equation to time estimates.
Prediction	Application of equation to the Ethiopian rift data, with a discussion of units, data and accuracy.	Application of equation to the Ethiopian rift data, with a general discussion	No link with the Ethiopian rift data, general discussion	No discussion.

Try to include anchor papers or samples to show students how to earn each grade. Save examples for next group.

Look for common misconceptions so that you may tackle them in the next session with this ground or deal with during the next group.