AREA 2

THE EARTH MODEL

AREA TIME EMPHASIS	TOPIC	TITLE	TIME
20 DAYS	III	Measuring the Earth	10 days
	IV	Earth Motions	10 days

What Is Our Model of the Earth?

TOPIC ABSTRACT

Time Emphasis: 10 days

Major Behavioral Objectives

At the completion of this topic, the student should be able to:

A. Develop models to illustrate the earth's size and shape and the extent of the earth's spheres.

B. Determine a method for locating a point on the earth's surface, measure the physical properties at this point, and develop models of some of the fields that exist at that point.

Approach

Students will very likely have preconceived ideas concerning earth dimensions and relative scale. Care should be taken to place the magnitude of the various dimensions in proper perspective. This topic should be developed from a "how-do-we-know-it" approach employing a questioning, analytic technique.

The measurement of a physical characteristic at many points should be used to develop the field concept. The field can then be used to infer the characteristics of points that have not been measured.

Students should be provided with enough experience with fields so that the concept can be easily applied in later topics.

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TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
A. Earth dimensions		
A-1 Shape	**A-1 *How can the earth's shape be determined?***	**III-A-1**
A-1.1 Evidence	A-1.11 Observations of the altitude of Polaris measured as a function of latitudinal distance leads to an interpretation of the earth's shape.	PIO-1, 2, 3, 4, 5; CCO-11, 12
	A-1.12 Other evidences that indicate the earth's shape include: a. photographs of the earth from space b. gravimetric measurements	PIO-1, 2, 3, 4, 5; CCO-11, 12
A-2 Size	**A-2 *How can the earth's size be determined?***	**III-A-2**
A-2.1 Measurement techniques	A-2.11 The dimensions of the earth can be determined from observations of the earth from space.	PIO-1, 5; CCO-11
	A-2.12 The circumference of the earth can be determined from observations of the sun's altitude measured at the same time in two different locations.	A-2.12 An actual determination of the circumference of the earth can be made by measuring the sun's

		position and exchanging the data with another school. PIO-1, 2, 3, 4, 5; CCO-11, 12
	A-2.13 The earth's diameter, volume, and surface area can be calculated once the circumference is known.	PIO-1, 5; CCO-11
A-2.2 Measurement determination	A-2.21 The earth's circumference through the poles is less than the measurement along the equator.	PIO-1, 2, 3, 4, 5; CCO-11
	A-2.22 The earth is nearly spherical, being only slightly oblate.	A-2.22 The objective in this understanding is to put the earth's shape in proper perspective regarding scale. The "out of roundness" should not be overemphasized. Otherwise, students may develop an exaggerated mental model of the earth's shape. PIO-1, 3; CCO-11, 12
A-3 Extent of the atmosphere, hydrosphere, and lithosphere	***A-3 What is the extent of the atmosphere, hydrosphere, and lithosphere?***	**III-A-3**
A-3.1 Atmosphere	A-3.11 Nearly all of the atmosphere is confined to a thin shell surrounding the earth. However, the atmosphere extends several hundred kilometers into space.	A-3.11 The objective in this understanding is to put the extent of the atmosphere in proper perspective regarding scale. PIO-1, 3; CCO-7, 11
	A-3.12 The atmosphere is stratified, with each layer possessing distinct characteristics.	PIO-5; CCO-7, 9, 11
A-3.2 Hydrosphere	A-3.21 The majority of the earth's surface is covered with water that is largely confined to a relatively thin film.	PIO-1, 3; CCO-7, 11
A-3.3 Lithosphere	A-3.31 The rock near the earth's surface forms a continuous solid shell around the earth.	A-3.31 Relate to topic XII. PIO-1, 3; CCO-7, 11
B. Positions on the earth		
B-1 Position determination	***B-1 How can a position on the earth's surface be determined?***	**III-B-1**
B-1.1 Coordinate systems	B-1.11 A coordinate system of imaginary lines, an earth grid, can be developed to determine a position on the earth's surface.	B-1.11 The students should become aware that many reference systems can be used to determine positions on the earth. PIO-2, 3, 5
	B-1.12 The latitude-longitude system is based on celestial observations.	PIO-2, 3, 5; CCO-11

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
B-2 Position description	**B-2 *How can the characteristics of a position be measured and described?***	**III-B-2**
B-2.1 Vector-scalar properties	B-2.11 The physical characteristics of a point may be either vector or scalar quantities.	PIO-3, 5
B-2.2 Fields	B-2.21 A field is a region of space which contains a measurable quantity at every point.	PIO-3, 5
	B-2.22 Isolines are models representing field characteristics in two dimensions.	PIO-3, 5
	B-2.23 Iso-surfaces are models representing field characteristics in three dimensions (e.g., contour map or magnetic field)	PIO-3, 5
	B-2.24 The characteristics of a field frequently change with the passage of time.	B-2.24 A field should be studied in which change can be noted. Do not create the impression that fields are static or unchanging. PIO-2, 3, 5; CCO-1, 7, 10, 11
	B-2.25 Gradients within the field express the degree of change of the field quantity from place to place.	PIO-5; CCO-7

QUESTIONS:

(B-2.21) 1. What is a field?

2. What field quantity does a contour map represent?

(B-2.22) 3. Explain how field characteristics can be shown in two dimensions.

(B-2.23) 4. Explain how field characteristics can be shown in three dimensions.

(B-2.24) 5. Would a field represented by contour lines be likely to undergo change with the passage of time?

6. What information is necessary to make an accurate contour map?

(B-2.25) 7. How does a contour map show areas of steep gradient? low gradient?

8. What characteristic shape does a valley have on a contour map? Explain how you could determine the direction of stream flow from a contour map.

III-B-2b: CONTOUR MAPPING

QUESTION:

How can the characteristics of a position be measured and described?

INTRODUCTION:

Maps are models. The kind of maps most often used by earth scientists are called contour or topographic maps. In this investigation, you will work with and make contour maps to determine how they portray the physical environment and to learn some of their advantages and lisadvantages.

OBJECTIVES:

When you finish this investigation you should be able to:

1. match actual landforms and photographs of landforms with their map projections.

2. describe the properties of contour lines, and given some field data, determine whether it is scalar or vector.

3. given a topographic map, estimate the elevation at any given point.

4. given a topographic map, indicate the areas of highest and lowest elevation, and the areas of maximum and minimum gradient.

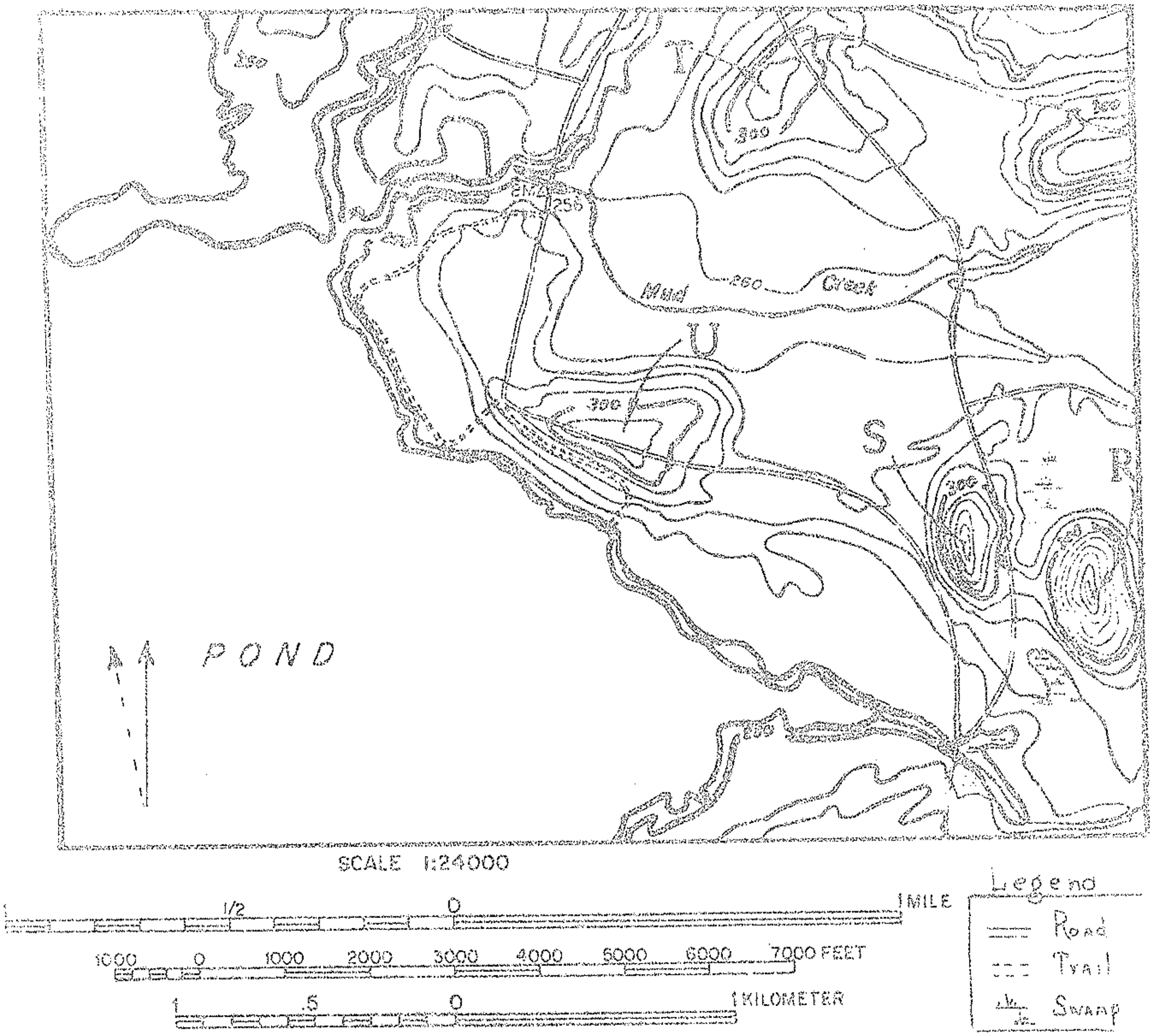
METHOD:

1. Place the landform model in the plastic shoebox. Mark the side of the box with equal divisions (1 centimeter is an appropriate division). Pour water into the box until the water level is at the first division mark. With the grease pencil, trace the interface between the water and the model. Repeat this until the water level is above the top of the model.

2. Pour out the water and put the top on the shoebox. Place a plastic sheet over the cover and trace onto the sheet the lines you just drew on the landform model. These lines on the sheet are called contour lines, the completed sheet is a contour map of the landform model.

3. Complete the topographic map exercise on the supplementary sheet.

SUPPLEMENTARY SHEET
CONTOUR MAP EXERCISE



1. How far would you have to walk, in miles, if you followed the trail from where it leaves the highway, just below the BM 256 marker, to the point where it again joins the highway?

2. Which of the lettered hills has the highest elevation? What is it?

3. In what general direction does Mud Creek flow?

4. Which side of hill "T" has the least gradient?

5. What is the approximate elevation of the water in North Pond?

What Are the Motions of the Earth?

TOPIC ABSTRACT

Time Emphasis: 10 days

Major Behavioral Objectives

At the completion of this topic, the student should be able to:

A. Collect data on the motions of objects in the sky.
B. Draw inferences about earth motions from evidence such as the Coriolis effect and the Foucault pendulum.
C. Draw inferences from celestial and terrestrial observations relating frames of reference for time and earth motion.
D. Analyze models of the solar system using locally obtained data to synthesize a simple model, and evaluate the model for its applicability.

Approach

Topic IV continues the development of a general model of the planet earth by the examination of terrestrial, lunar, and planetary observations. These observations should be used to construct a model for earth motions.

The geocentric and heliocentric models should be introduced and the observations used to support or refute these models.

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TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
Celestial observations		
A-1 Motions of objects in the sky	**A-1 What observations can be made of celestial objects?**	**IV-A-1**
A-1.1 Star paths	A-1.11 The apparent daily motion of stars is a circular path.	PIO-5; CCO-4, 6, 8
	A-1.12 The daily rate of motion of stars is constant.	PIO-5; CCO-6, 8
A-1.2 Planetary motions	A-1.21 The movement of planets through the star field is not uniform.	PIO-5; CCO-4, 6, 8
	A-1.22 The apparent diameter of each planet varies in a cyclic manner.	PIO-5; CCO-5, 6, 8
	A-1.23 The observation of planets indicates that many rotate.	PIO-5; CCO-4, 6, 8
A-1.3 Satellite motion	A-1.31 The moon's motion creates a cycle of phases.	PIO-5; CCO-4, 5, 6, 8
	A-1.32 The moon's apparent diameter varies in a cyclic manner.	PIO-5; CCO-4, 5, 6, 8
A-1.4 Sun motion	A-1.41 The sun's apparent daily path through the sky is an arc.	PIO-5; CCO-4, 6, 8
	A-1.42 The sun's apparent path varies with the seasons.	CCO-5, 6, 8

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
	A-1.43 The high noon position is never directly overhead farther north than 23½° N. latitude.	CCO-5, 6, 8
	A-1.44 The points of sunrise and sunset vary with the seasons.	CCO-5, 6, 8
	A-1.45 The length of day varies with the seasons.	CCO-5, 6, 8
	A-1.46 The apparent solar diameter varies in a cyclic manner during the year.	PIO-5; CCO-4, 5, 6, 8
B. Terrestrial observations		
B-1 Motion at the earth's surface	***B-1 What terrestrial evidence suggests earth motions?***	**IV-B-1**
B-1.1 Foucault pendulum	B-1.11 The plane of vibration of a freely swinging pendulum appears to change direction in a manner that is predictable.	PIO-5; CCO-6, 9
B-1.2 Coriolis effect	B-1.12 The path of a fluid at the surface of the earth appears to undergo a predictable horizontal deflection.	PIO-5; CCO-6, 9
C. Time		
C-1 Frames of reference for time	***C-1 How are frames of reference determined for time?***	**IV-C-1**
C-1.1 Earth motions	C-1.11 The frames of reference for time are based upon the motions of the earth.	CCO-5, 6
	C-1.12 Mean time differs from apparent solar time by an amount which varies with the seasons.	CCO-5, 6
D. Solar system models		
D-1 Geocentric and heliocentric models	***D-1 What models explain the observations of celestial and terrestrial motions?***	**IV-D-1**
D-1.1 Geocentric model	D-1.11 The apparent motions of celestial objects are explained by a geocentric model.	PIO-3, 4; CCO-5, 11, 12
	D-1.12 The apparent terrestrial motions of objects are not explained by a geocentric model.	PIO-3, 4; CCO-11
D-1.2 Heliocentric model	D-1.21 The apparent motions of celestial objects are explained by a heliocentric model.	PIO-3; CCO-6, 12
	D-1.22 The apparent terrestrial motions of objects are explained by a heliocentric model.	PIO-3; CCO-6, 12
	D-1.23 Compared to the geocentric model, the heliocentric model of celestial motion is less complex.	PIO-3, 4; CCO-5, 6, 8

TOPIC OUTLINE	MAJOR UNDERSTANDINGS	INFORMATION TO TEACHERS
D-2 Simple celestial model	***D-2 What simple celestial model can be synthesized from observations?***	**IV-D-2**
D-2.1 Geometry of orbits	D-2.11 The earth's orbit around the sun is an ellipse with the sun at one of the foci.	PIO-3; CCO-3, 5, 6, 12
	D-2.12 The orbits of the other planets also describe ellipses with the sun at a focus.	PIO-3; CCO-5, 6, 12
	D-2.13 The areas swept out by an imaginary line connecting the sun and a planet are equal for equal intervals of time.	PIO-3; CCO-5, 8
	D-2.14 The period of any given planet is related to the mean radius of its orbit. $[T^2 \alpha \bar{R}^3]$	PIC-3; CCO-5, 8
D-2.2 Force and energy transformations	D-2.21 The gravitational force between objects is attractive.	PIO-3; CCO-2, 6, 9
	D-2.22 The gravitational force is proportional to the product of the masses of the objects and inversely proportional to the distance between their centers squared. $\left[F \alpha \frac{M_1 M_2}{R^2}\right]$	
	D-2.23 A cyclic energy transformation between kinetic and potential energy takes place as the earth moves, resulting in a change in the earth's speed.	PIO-3; CCO-1, 2, 3, 4, 5, 6, 8
	D-2.24 The length of the day varies because of the change in speed of the earth in its orbit.	CCO-5, 6, 9