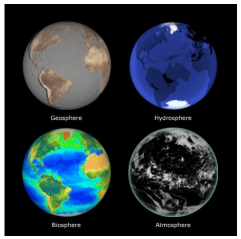
Earth: A System of Spheres

Earth Science

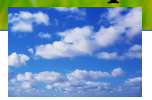
What is Earth Science?

- **Earth Science** - the branch of science dealing with the **physical constitution of the Earth** and its various branches or **SPHERES**.



Earth's 4 Spheres

Atmosphere (air that envelopes Earth)



Biosphere (all life)

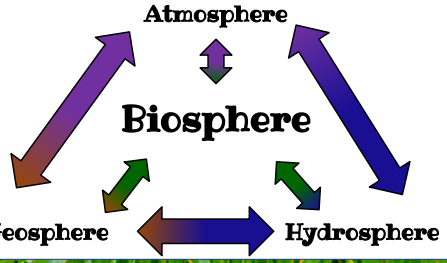
Geosphere (soil, rocks, and minerals)

Hydrosphere (water)

Studying the Spheres

- Atmosphere
  - Weather: meteorology
  - Climate: climatology
- Biosphere
  - Cells: cellular biology
  - Mammals:mammology
- Geosphere
  - Rocks: geology
  - Earthquakes: seismology
- Hydrosphere
  - Lakes: limnology
  - Oceans: oceanography

Sphere Interaction



Sphere Interaction

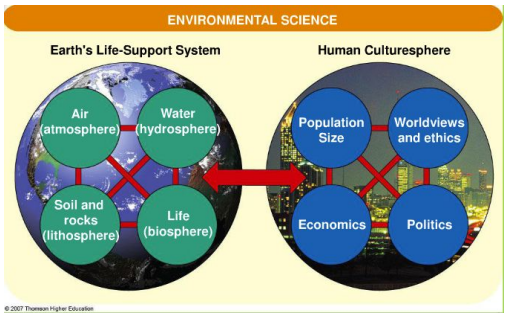
- The 4 spheres constantly change each other.

Hurricanes (atmosphere) sweep across the oceans (hydrosphere) and onto the land (geosphere), damaging the dwellings of people (biosphere). Furthermore, the land (geosphere) causes the hurricanes (atmosphere) to weaken and dissipate.

Humans (biosphere) drill wells into the ground (geosphere) to pump out petroleum. It is then used as fuel for cars which can pollute the air (atmosphere) which animals (biosphere) breathe.

What is Environmental Science?

- **Environmental Science** - **interdisciplinary study of human relationships with other organisms & the nonliving physical environment**



What is the study of Env. Science ?

Environmental Science tries to establish principles and **model how the natural world functions** AND THEN uses these principles to **develop solutions to environmental problems** caused by humans **(ANTHROPOGENIC)**.

What is a System?

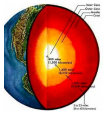
- A **model of interacting parts** that **includes time** as a variable
- Are **either closed or open**
  - **Closed system:** energy enters and leaves but matter does not
  - **Open system:** both matter and energy enter and leave
- **Matter is what matters!**

Planetary System

Earth is a closed system.

The Earth system has two sources of energy (heat):

- **Solar Radiation** (the sun)
- **Geothermic Radiation** (from nuclear reactions occurring in Earth's core)

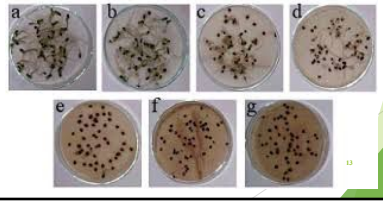


Because Earth is a closed system, the resources will eventually run out.

SO HOW DO WE STUDY EARTH SCIENCE?

EXPERIMENTAL DESIGN USING THE SCIENTIFIC METHOD

- Science answers questions with experiments.



Define the Problem

- **Begin by asking a question about your topic**
- **Represented by a problem statement**

- What is a good question for an experiment?
- One that is **testable**.
- Question about the possible relationship between manipulated and responding variables.

Now we need a hypothesis to guide our investigation.

- What is a hypothesis?
- **No, It is NOT an educated guess!**
- Prediction of possible specific relationship between the cause (IV) and responding effect (DV) that provides a testable answer to the problem.
- Your best thinking about how the change you make might affect another factor.
  Tentative or trial solution to the question
  An if …… then …… statement.

Variables

Variables are things that change.

- The independent variable is the variable that is purposely changed. It is the manipulated variable.
- The dependent variable changes in response to the independent variable. It is the responding variable or what is measured.
- Be sure to operationally define each variable.

Constants in an Experiment

- What are constants in an experiment?
- Factors that are kept the same and not allowed to change

The Control in an Experiment

- What is a control?
- The part of the experiment that serves as the standard of comparison.
- Why is a control necessary?
- It is the unchanged part of the experiment that detects the effects of hidden variables.

Materials and Procedures

- A description of what you will use for your experiment, and how you will do it.
- **Be sure to include:**
- Levels of the Independent Variable
- Repeated Trials
- Drawing of Apparatus

Levels of the Independent Variable

How many different levels of the independent variable should we test?

3 ? 5? 10? The more the better?

Repeated Trials

- What are repeated trials?
- The number of times that a level of the independent variable is tested.
- Why are repeated trials necessary?
- They reduce the possibility of chance errors affecting the results.

Qualitative Observations and Results vs. Quantitative Observations & Results

- What are qualitative observations?
- They are what you perceive that occurred during the course of your experiment. They are identification of trends in the data.
- What are quantitative observations?
- Numbers in the form of raw data displayed in data tables and graphs

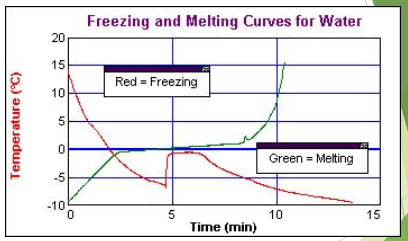
Sample Data Table

Title: The Effect of the independent variable on the dependent variable

Column for independent variable	Column for dependent variable			Column for derived quantity
Label - with units if necessary	Label - with units if necessary - multiple trials included			Label - with units if necessary. Example = average of trials
	1	2	3	
0	0	1	0	0
1	3	5	4	4
2	6	4	7	6
3	7	6	8	7
4	9	9	8	9

Constructing a Graph

What is the purpose of a graph?



Graphs communicate in pictorial form the data collected in an experiment

Graphs

Title: The Effect of the independent variable on the dependent variable

Dependent Variable – include units and an appropriate scale

Independent Variable – include units and an appropriate scale

Bar vs. Line Graphs - Which Should I Use?

The type of graph to use depends on the type of data collected.

Two kinds of data: **Discrete** & **Continuous**

Discrete data are categorical like days of the week, color, and brand of battery. Intervals between the data have no meaning.

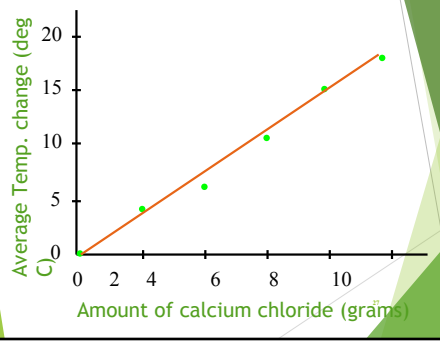
USE A BAR GRAPH

Continuous data are associated with measurements involving a standard scale. Measurements should be able to show a trend or relationship. Intervals between data have meaning.

USE A LINE GRAPH

Constructing a Line Graph:

DRAW A LINE-OF-BEST-FIT



Analysis and Interpretation of Results

This is where you describe in words what is illustrated by your data as shown in your table and graph.

You also describe the meaning of the results.

Possible Experimental Errors

What factors in your materials or procedure might have had an impact on your results?

Conclusion

Why or why not your results supported or did not support the hypothesis.

Hypotheses are never "wrong". They are either supported or not supported.

Include reasons for the hypothesis to be supported or unsupported.

Recommendations for Further Experimentation

What are some practical applications of your results?

What other questions that could be tested arise from your results?