Introduction and Chapter 1 : About Science

Chapter 1: About Science

- Scientific Measurements
- Mathematics—The Language of Science
- Scientific Methods
- The Scientific Attitude
- Science and Technology
- Physics - The Basic Science

What is Science?

Science is the body of knowledge that describes the order within nature, and the causes of that order.

Began long time ago, when people noticed regularities and relationships in nature.
-weather patterns , beginning of rainy season
-Star patterns in the night sky

Scientific Measurements

- Measurement is foundation of the scientific method.

  If its not measurable it isn't science.
- How much you know about something is often related to how well you can measure it.

- Making careful quantitative measurements are important.

- The measurement accuracy is also fundamental to the to the scientific method.

Scientific Measurements

- Measurements represent some physical quantity. For example, 9.4 seconds represents a time. The quantity has a number (9.4) and a unit (seconds).

- The number tells you the amount and the unit tells you the thing that you are talking about. **Both the number and the unit** are required to specify a measured quantity.

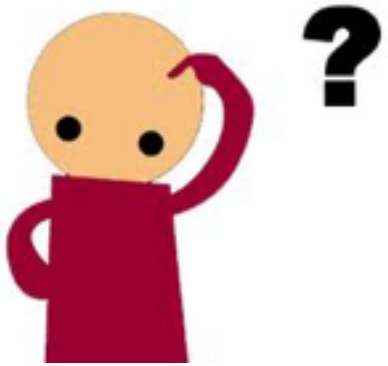
- Leaving *either* out makes your answer wrong!!!

Scientific Measurements

- In 3rd century, scientists made fairly accurate measurements of the size of earth, moon and sun, as well as distances between them.

- How did they do that without computers and calculators?

Trigonometry !!!

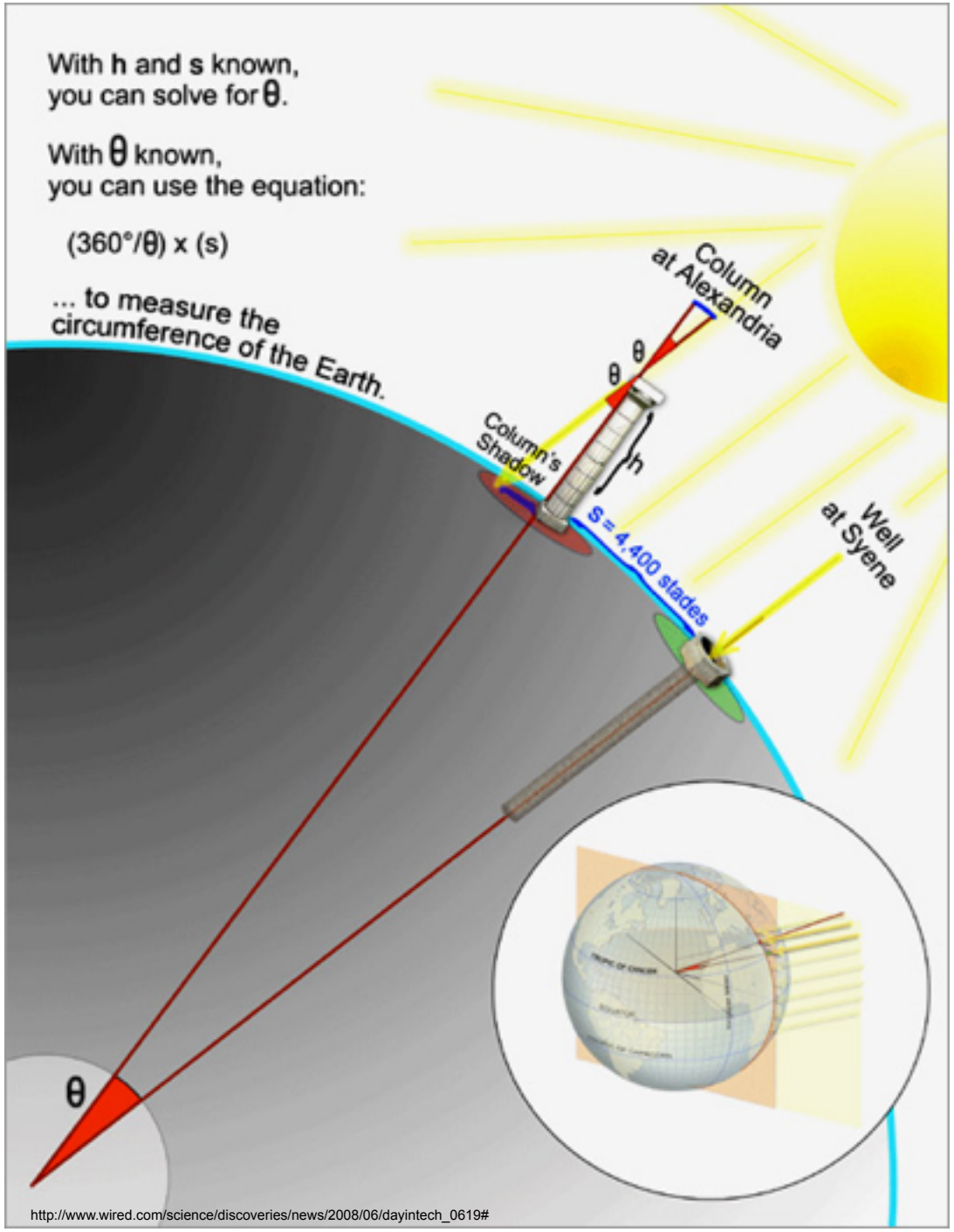


How did Eratosthenes measure the size of earth?

First measured by Eratosthenes about 235 BC.

He learned: the Sun is highest in the sky at noon On June 22, and it is directly overhead the city Syene.

http://en.wikipedia.org/wiki/Eratosthenes



7.2/360 =1/50

Circumference of the earth is 50 times the distance from Alexandria to Syene.

Distance from Alexandria to Syene = 800 km

Circumference of the earth
= 50 x 800 km
= 40,000 km

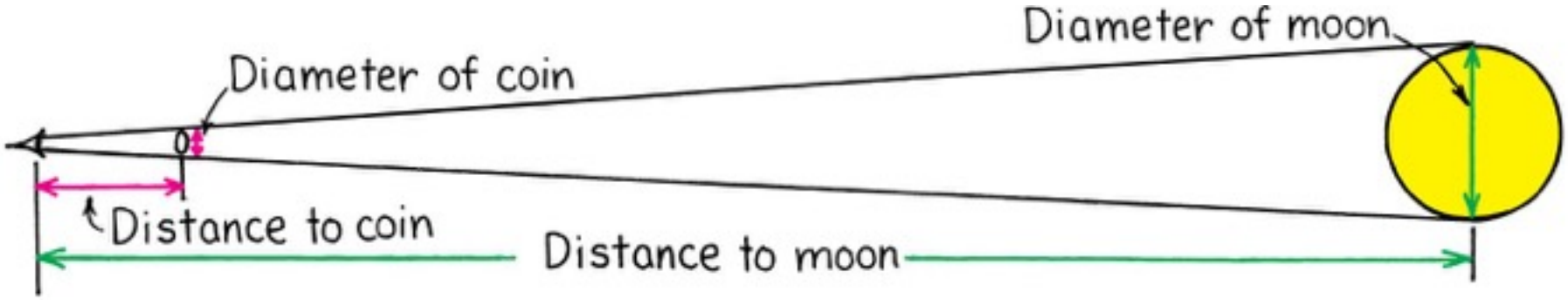
How accurate do you think the angle and distance measurements were?

How accurate do you think the angle and distance measurements were?

An uncertainty of 0.1 degree would be an accuracy of 0.1/7.2 or about 14%.
The circumference is 40,075 km at the equator and 40,008 km around the poles.

So, the accuracy is 0.02% to 0.2% !!!

Distance to the Moon



$$\frac{\text{Coin diameter}}{\text{Coin distance}} = \frac{\text{Moon diameter}}{\text{Moon distance}} = \frac{1}{110}$$

With Aristarchus's measurement of the Moon's diameter (see page 3), we can calculate the distance to the Moon.

Mathematics

Mathematics is the language of science.

When ideas are expressed in mathematical terms, they are unambiguous.

Provide compact expressions of relationships between concepts.

Scientific Methods

1) Recognize a question or a puzzle (ex: unexplained fact)

2) Make an educated guess – Hypothesis.

3) Predict consequences of the hypothesis.

4) Perform experiment(s), measurements and calculations to test the hypothesis.

5) Formulate the simplest rule that organizes hypothesis, prediction, and results.

The Scientific Attitude

The scientific attitude is one of inquiry, integrity
And humility,- i.e., a willingness to admit error.

If evidence contradicts a hypothesis, a law or a principle, then it must be changed or abandoned.

The Scientific Attitude

The Greek philosopher Aristotle claimed that an object falls at a speed proportional to its weight. Nearly 2000 years this idea was accepted until Galileo showed that heavy & light objects dropped from the Leaning Tower of Pisa fell at nearly equal speeds.

Scientists must accept their experimental findings even when they would like them to be different.

Scientific Theory

In everyday speech, a theory is no different from a hypothesis – a supposition that has not been verified. This is inaccurate !!!

A scientific theory

* Is a general rule that organizes facts, hypothesis, measurements or and observations.
* Evolves or undergoes change.
* Must be changed when proven incomplete or wrong.

Facts

- Agreed upon observations by competent observers.
- Measurements that are repeatable.
- May be revised by further detailed observations or data (measurements) with different equipment or under different conditions.

Scientific Hypothesis

If there is no test for its possible wrongness,
then the hypothesis is NOT scientific.

Predicts facts and in the ideal case predicts other observations that can be measured.

Falsifiable or can be disproved (proven is not enough)

Consider Charles Darwin's hypothesis that life forms from simpler to more complex forms.

Is this a scientific hypothesis?

- Consider Charles Darwin's hypothesis that life forms from simpler to more complex forms.

Is this a scientific hypothesis?

YES. Because this could be proved wrong if paleontologists discovered that more complex forms of life appeared *before* simpler forms of life.
Less complex life forms are found to precede their more complex forms which support the claim.

Consider the hypothesis:

“Intelligent life exists on other planets somewhere in the universe”

Is this a scientific hypothesis?

Intelligent life exists on other planets somewhere in the universe”

Is this a scientific hypothesis?

NO.
Though it can be proven correct by a single finding of intelligent life elsewhere in the universe, there is no way to prove it wrong, if no intelligent life is ever found.
If we searched the far away in the universe of many years & found no life, it would not prove that it doesn’t exist ‘around the next corner’.

Check Point

- Which of these is a scientific hypothesis?

a. Atoms are the smallest particles of matter that exist.

b. Space is permeated with an essence that is undetectable.

c. Albert Einstein was the greatest physicist of the 20^{th} century.

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a. **Atoms are the smallest particles of matter that exist.**
b. Space is permeated with an essence that is undetectable.
c. Albert Einstein was the greatest physicist of the 20th century.

Only a is scientific because there is a test for falseness. The statement is not only capable of being wrong, but in fact has been proved wrong.

Scientific Theory

- General rule that organizes facts, hypothesis, measurements or and observations.
- Evolve or undergo change.
- Must be changed when proven incomplete or wrong.

Principle or Law

- Theory that has been proven useful through many measurements or observation.
- Useful for a large number of conditions, predictions or observations

Science and Technology

- Science is concerned with gathering knowledge and organizing it.

- Technology is applied science, used by engineers and technologists for practical purposes.

Physics - The Basic Science

Science -> life sciences & physical sciences

Life sciences: biology, zoology, botany

Physical sciences: geology, astronomy, chemistry, physics

Physics is the basic science. It is about the nature of basic things such as motion, forces, energy, matter, heat, sound, light & the structure of atoms.

An understanding of science begins with an understanding of physics.

Homework

- Read Chapter 1 in detail
- Do Exercises: 3, 9 (explain your answer)
- Read Chapter 2

- Homework due: May 21