

**Chapter One: p. 12 The Scientific Method.**  
**Chapter Three: Earth in Space and Solar Energy (all).**  
**(Session 2)**

THE SCIENTIFIC METHOD (Chapter One page 12).

Assume you have observations that require an explanation.

Propose a hypothesis or multiple hypotheses.

Is the hypothesis supported by experimental evidence that is observable by the senses and/or mathematical models? If yes, the hypothesis attains the status of a theory. If not, discard the hypothesis.

A theory should be able to explain and predict outcomes.

What does Stephen Hawkins have to say about the Scientific Process?

Leonardo Da Vinci, 1552-1519, first articulated the process of The Scientific Method.

Galileo Galilei 1564-1642 upset authorities who believed in an Earth Centered Universe, when he reported that he saw moons around Jupiter and Sun Spots with his newly invented telescope.

Famous "Laws":

$$F=ma$$

$$E=mc^2$$

Quantum Mechanics.

The speed of light is how fast?

Paradox of the Twins.

Theory of Everything.

String Theory.

Where did the gold or silver in our teeth come from?

Current accepted age of the universe: 13.7 billion years.

At one time observations with the Hubble Telescope indicated that some stars were older than the universe itself. How was that dilemma resolved?

Composition of the Universe: Heavy Elements: .03%, Neutrinos .3%, Stars: 0.5%, Free Hydrogen and Helium 4%, Dark Matter 25%, Dark Energy 70% (repulsive force).

### EARTH IN SPACE AND SOLAR ENERGY (Chapter Three - all)

Universe: 50-125 billion galaxies.

Milky Way galaxy: 400 billion stars.

### THE SOLAR SYSTEM AND BEYOND

Planets: how many, names, and in which sequence?

Asteroids

Comets

Meteoroid, meteor, meteorite

Dwarf Planets and their diameters: Eris – the reason for the big controversy (1,488 miles), Pluto (1,430 miles), Ceres (950 miles).

Keuper Belt, a disk shaped region beyond Neptune with small ice bodies, the source of comets.

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Oort Cloud

## Solar Direct Energy:

Thermal heat absorption from mirrors. A field of mirrors 91 miles square could provide enough power for all of the US (Newsweek, Nov. 2007).

Photovoltaic cells.

## The Sun and Its Energy:

5500°C - 6100°C

Fusion (how different from fission?)

Sun Spots 1500°C to 2000°C cooler than the rest of the Sun's surface.

Cycles?

Climate impact?

Distance to the Sun?

## Planets

### Terrestrial Planets

Small, close to the Sun, metal and rock

Mercury:

5% of Earth mass.

425°C (800° F) / 1183°C (-297°F).

Rotation 59 days. Any other body with similar rotation?

Venus:

Magellan space craft, 96% CO<sub>2</sub> in atmosphere (rest?)

450°C. Retrograde motion.

The surface of Venus reflects how much of the Sun's energy?

Earth

Mars:

Did the Viking space craft kill the Martians:

Evidence for recent water flows on the surface.

Surface varies from -125°C to +25°C.

## Gas Planets

Jupiter:

Life on Europa, the second of four moons?

Saturn:

Cassini in launched in 1997, 2005 Heugens probe  
to the surface of Titan.

Uranus:

Retrogade motion.

Neptune

Detection of extra solar planets:

A star's light 'blinks'

Doppler shift in the star's light.

To date over 200 planets have been detected in more than 170 solar systems.

What are the chances of Extra Terrestrial Life in the Milky Way Galaxy?

**DRAKES EQUATION:**  $N = R^* fp ne fl fi fc L$

$R^*$  = mean rate of star formation in the Milky Way , our local galaxy  
(10 / year)

$fp$  = The fraction of those stars which form planetary systems (one half of those stars)

$ne$  = the number of planets in those systems which are ecologically suitable for life forms to evolve (two).

$fl$  = the number of those planets on which life forms actually form (one).

$fi$  = the number of those which evolve to an intelligent form (0.01).

$fc$  = the number of advanced intelligent life forms which develop the capacity of interstellar radio communication (0.01).

$L$  = the life expectancy of those technically advanced civilizations  
(10\*\* to 1000\*\*\* years)

\*\* 1961 estimate during the "Cold War"      \*\*\* Carl Segan      (4)

## THE EARTH - SUN SYSTEM

### Electromagnetic Radiation

- 41% visible light energy.
- 9% shorter wavelengths.
- 50% longer wavelengths.

Study Figure 3.10

### Solar Constant

- 2 calories / cm<sup>2</sup>
- 1370 watts / m<sup>2</sup>

Rotation on Earth's axis every 24 hours.

Angular Velocity: 360° per 24 hours.  
15° / hour

### Linear Velocity:

- Pole: 0 mph.
- Equator: 1038 mph.
- Where is the best place to launch a rocket?
- Why is there a rocket launching facility on Kodiak Island?

### Circle of Illumination:

Boundary between day and night.

Revolution. Change in distance to the Sun causes the Earth to receive a varying amount of sunlight, amounting to 3.5%.

- Perihelion January 3 at 147 million km.
- Aphelion July 4 at 152 million km.

Earth Rotations per year 365 ¼.

### Plane of the Ecliptic

- @ 23.5° to Earth's Equator (angle of inclination).
- Axis maintains Parallelism.

Over time the tilt of the Earth's axis changes, as does the eccentricity of the Earth's orbit, bringing us in and out of ice ages. (5)

## SUN ANGLE, DURATION AND INSOLATION

Insolation - Incoming Solar Radiation. Local conditions depend upon:  
Local angle of the Sun, length of daylight, and cloud cover.

The Sun warms the Earth during the day. What happens at night?

Seasons:

Summer Solstice: June 21  
Autum Equinox: Sept 22  
Winter Solstice: Dec 21  
Spring Equinox: March 21 (Vernal Equinox)

Reference Locations:

Arctic  
Antarctic  
Tropic of Cancer  
Tropic of Capricorn

Understand how Erastosthenes figured out how big the Earth is ( before the Earth became “flat” during the “Dark Ages“).

Lines on Earth delineating the Sun’s rays:

Arctic and Antarctic Circles at latitudes: \_\_\_\_\_ and \_\_\_\_\_.

Tropic of Cancer and Capricorn at latitudes: \_\_\_\_\_ and \_\_\_\_\_.

Analemma: a diagram showing where and when the Sun is directly Overhead on any particular day of the year.

Zenith: at noon, where the Sun is most directly overhead.

