Chem 108

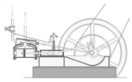
Introductory Chemistry

Dr. Ron Rusay

CONNECTIONS: Chemistry ⇆ STEM ⇆ Applications

STEM

S Science
T Technology
E Engineering
M Mathematics



What is the stuff around us? How do things work?
Ancient Questions: in Greece, China, Arabia, Persia

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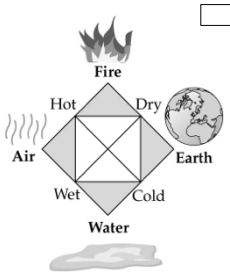
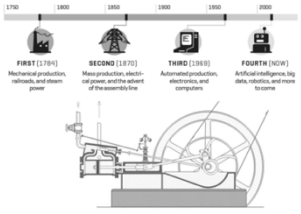
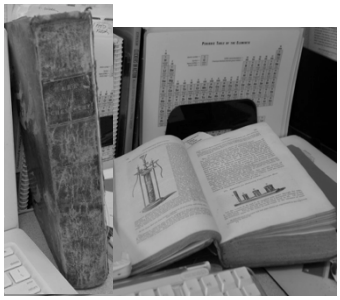


Industrial Revolution Segments 1700-2018



STEM



RESULTS: *Protocols, Explanations, Comparisons, Predictions & Tangible Products: "Ponderables versus Imponderables" (terms used circa 1830)*
Additionally: MANY MANY VOCABULARIES in many languages

CHEM 108: Science, Chemistry, Mathematics, & Questions about the World Around Us

- *College and career success require broad content knowledge and proficiency in reading, writing, language, communications, science and mathematics.*
- *These skills are building blocks necessary for success in addressing complex problems, in life-long learning, and in individual challenges.*

CHEM 108: Science, Chemistry, Mathematics, & Questions about the World Around Us

- *What is Science?…. What is Chemistry?*
  - *VOCABULARY: Key Terms → COMMUNICATING*
- *Comparisons and Conversions :*
  Ratios, Percent, Density, Moles, Masses
- *Mathematics / Arithmetic:*
  Adding, Subtracting, Multiplying, Dividing, Powers of Ten, Scientific Notation
- *Measurement & Units: (metric)*
- *Matter & Energy : Classification & Properties*
- *Periodic Table*

Information & Knowledge

How are they acquired?

Hearing, Seeing (Viewing/Reading), Doing

Which works best for you?

It depends on our individual traits & skills

How can these be discovered?

Various surveys can be used.

Your first assignment ("Metacognition"):

http://chemconnections.org/general/chem108/learning.html

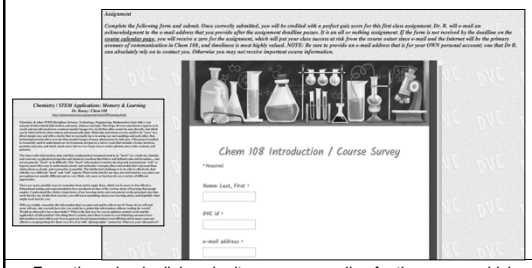
- *Complete Learning Style survey & submit results on-line.*
- *Apply the results.*

Click Image

First Graded Assignment

Chem 108 Survey

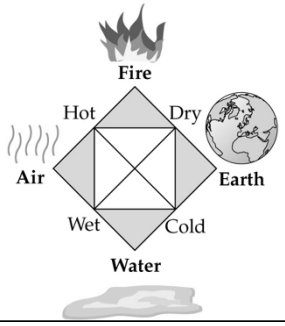
http://chemconnections.org/general/chem108/learning.html



From the calendar link, submit responses on-line for the survey, which will provide your first grade. Pick up hard copy when leaving today if needed.

What is the stuff in the world around us?
How does stuff work?

Ancient Questions: in Greece, China, Egypt & Arabia, Persia



Does the sun "rise" in the east?

Observations: Perception

STEM relies on observations.

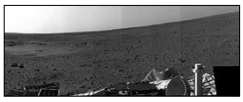
- *Can more than one observation be correct?*
- *What do you see?*

Observations: Perception

STEM relies on observations: SEEING

http://video.pbs.org/video/2365563172/

What might this be?



http://mars.nasa.gov/

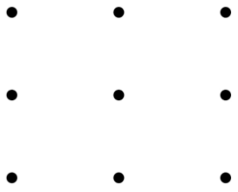
Why is this important?

Would you colonize Mars?

200,000 people have applied!... for a one-way trip?

Problem Solving

Connect all of the dots with four straight lines without taking a pen or pencil from the surface and passing through each point only once.

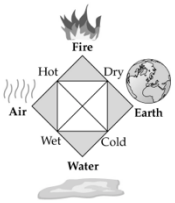


Problem Solving

An arborist is asked to plan an orchard that has 10 trees arranged in 5 rows having 4 trees in each row.

- *Find a pattern that satisfies the plan.*

What is the stuff around us? How do things work?
Ancient Questions:
in Greece, China, Egypt & Arabia, Persia



Does the sun "rise" in the east?

Two plausible possibilities.

(Geo-centric model)
Sun moves around the earth.

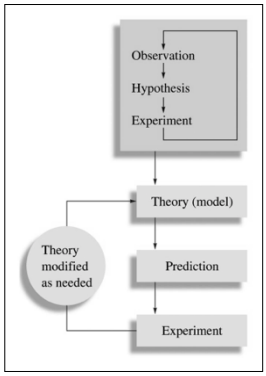
Cleanthes & Stoics ~ 270 B.C.E.

Aristarchus ~ 270 B.C.E.

(Helio-centric model)
Earth rotates and moves around the sun.

The Scientific Method

- *STEM discoveries are driven by observing, asking questions, & making predictions, but where does it end and philosophy & speculation begin?*
- *The Scientific Method is a way to predict outcomes and develop logical theories, but it is not foolproof!*



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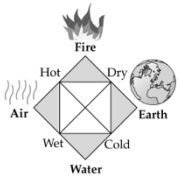
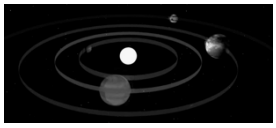


Does the sun "rise" in the east?

Geo-centric
Until the 16th century: Copernicus / Galileo

Helio-centric
Sometime after 1512.

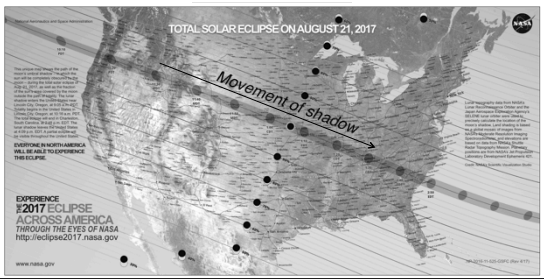
The earth rotates around the sun and on its axis.



https://www.youtube.com/watch?v=4yzraWw8mrc [1:17-]

Solar Eclipse

Maximum ~ 75% of Total @ DVC: 10:15 AM
https://eclipse2017.nasa.gov/



Question

https://www.youtube.com/watch?v=HnASxhZyuIU

Does the sun rise in the east, and does the earth rotate clockwise or counter -clockwise? Provide an explanation for your answer.

A) Yes, Clockwise
B) Yes, Counter-clockwise
C) No, Clockwise
D) No, Counter-clockwise

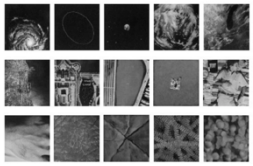
Some Possible Steps in the Scientific Method

- 1. Observations
  - qualitative (generalities)
  - quantitative (numbers)
- 2. Formulating hypotheses
  - possible explanation for the observation
- 3. Gathering information & Performing experiments
  - gather new information to test whether the hypothesis is valid

Observations

Measurements & Relative Scale

- Macroscopic vs. Microscopic
- Charles & Ray Eames / IBM financed video:



http://chemconnections.org/general/movies/Powers Of Ten (Charles & Ray Eames) 1.mp4

https://www.youtube.com/watch?v=0fKBhvDjuy0

Powers of Ten (Images) http://www.wordwizz.com/imagendx.htm

http://www.eamesoffice.com/

Hearing/Viewing: Guiding Questions

Measurements & Relative Scale

http://chemconnections.org/general/chem108/Powers%20of%20Ten-Guide.html

From the calendar links, submit responses on-line; graded weekly.

Powers of Ten: Scale

10^n (exponent; base number)

Powers of 10

Exponential Number	Ordinary Number
$1 \times 10^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10$	1,000,000
$1 \times 10^3 = 10 \times 10 \times 10$	1,000
$1 \times 10^2 = 10 \times 10$	100
$1 \times 10^1 = 10$	10
$1 \times 10^0 = 1$	1
$1 \times 10^{-1} = \frac{1}{10}$	0.1
$1 \times 10^{-2} = \frac{1}{10} \times \frac{1}{10}$	0.01
$1 \times 10^{-3} = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$	0.001
$1 \times 10^{-6} = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$	0.000 001

Scientific Notation

Scientific Notation: A single digit followed by a decimal and a power of ten.

$D . D D \times 10^n$ (power of 10)

Examples: 2,345 mL and 0.002340 g

2,345 mL = 2.345 x 10^3 mL 0.002340 g = 2.340 x 10^{-3} g

Scientific Notation

power of 10

$$D.DD \times 10^{n}$$

Write the following in scientific notation:

0.001520 seconds

15,200,000,000 seconds

Convert the number in scientific notation to a regular number:

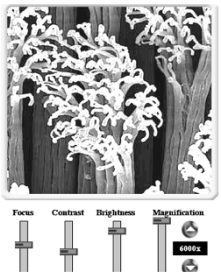
7.6 x 10^{6} seconds

7.6 x 10^{-4} seconds

Microscopic Gecko's Toe and Setae

6,000x (6 x 10^{3})

Magnification using Atomic Force Microscopy (AFM)



Full et. al., Nature (2000)
5,000 setae / mm^2
600x frictional force; 10^{-7} Newtons per seta (0.0000001)

Geim, Nature Materials (2003)
Glue-free Adhesive
100 x 10^{6} hairs/cm^2 (100,000,000)
Yurdumakan, Chem Comm (2005)
200X Gecko's Force

http://micro.magnet.fsu.edu/primer/java/electronmicroscopy/magnify1/index.html

Biomimetics and evolution

https://www.youtube.com/watch?v=9ZJYbcG0Ts0

Science 345, 1448 (2014)

Biomimetics and evolution

http://www.darpa.mil/program/z-man

Microscopic vs. Macroscopic

Relative Scale

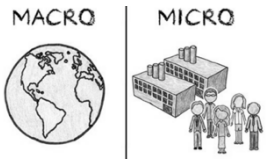
Microscopic materials are very, very small and require magnification to perceive them. Macroscopic stuff is large, and is generally something that is visible to the naked eye.

http://chemconnections.org/general/movies/Powers Of Ten (Charles & Ray Eames) 1.mp4

https://www.youtube.com/watch?v=0fKBhvDjuy0

Microscopic vs. Macroscopic

Relative Sizes



Macroscopic

https://phys.org/news/2015-10-big-universe.html

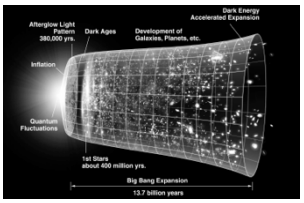
How big is the observable "macroscopic" universe?

So large that light has had barely enough time to travel its distance in 14 billion years.

Macroscopic stuff like the universe is sometimes too large for most of us to really appreciate.

Relative Comparisons

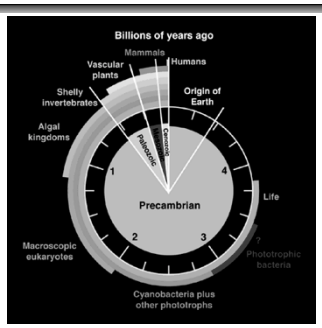
http://www.space.com/24309-shape-of-the-universe.html



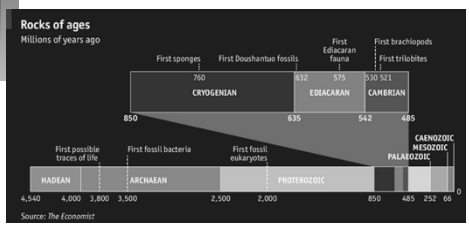
How does the age of the universe compare to the age of the earth? $\frac{13{,}700{,}000{,}000 \text{ years}}{4{,}540{,}000{,}000 \text{ years}} = 3 \times$

The earth is considered to be 4,540,000,000 years old.

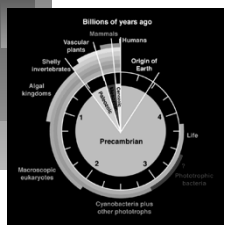
Simple Graphic Comparisons



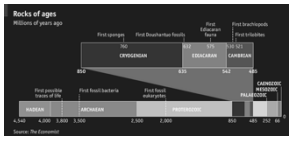
Simple Graphic Comparisons



Simple Graphic Comparison(s)



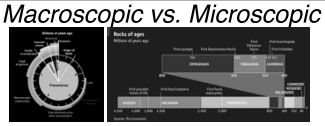
The earth is 4.54 billion years old and some humans' average lifespan is estimated to be ~80 years.



How does the age of the earth compare to a human's lifespan?

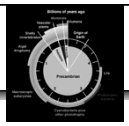
Scale & Relative Sizes

- *Macroscopic vs. Microscopic*



1) *How would you compare the age of the earth to the age of Confucius (Master Kong, 孔夫子) born 551 BCE if he were alive today?*
2) *How would the age of mankind (200,000 years) compare to the age of all living things (??? Years)?*
3) *How would the age of industrialized mankind (200 years) compare to the age of mankind?*

QUESTION



The earth is 4.54 billion years old and assume that our average lifespan will be 80 years. If the total age of the earth is represented by the face of a clock, how much time will 80 years be represented on the clock?

A) 0.001520 seconds ***B) 0.00076 seconds***

C) 0.0008 seconds ***D) 7,600,000 seconds***

E) 15,200,000,000 seconds

Modern Science & Chemistry

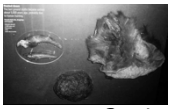
SCIENCE

Ancient Sloth Dung Excites Scientists

- *Would this excite you enough to pursue a career in science & chemistry?*
- *What would be the title of the scientist's PhD thesis and what does dating have to do with it?*

"People called my Ph.D thesis my 'Ph.D feces.'" says Hendrik N. Polnar, an American biologist working at the Max-Planck-Institute for Evolutionary Biology in Munich.

How do we know how old things are ?… like sloth dung



Carbon Dating

Radiocarbon dating allows determining the age of biological artifacts like dung up to about 40,000 years old. This method provides an indirect measurement of age.

- *How do we determine our own age?*
- *Can this work for anyone or any animal that ever lived?*

Representations of Measurements:

An example of a relative comparison using length to represent time

- *TIME: 38,000 year old (dung) vs. 20 year old student*
- *LENGTH:* ***38,000 yrs / 20 yrs = 1900 x***
  - *Using lines to represent the respective ages that can be drawn on the classroom's blackboard; Select a scale:*
  - *1 inch equals: 1 yr, 10 yr, 100yr, 1,000yr, 10,000yr. (Select an appropriate one.)*
  - *38,000 years vs. 20 years*
  - *Which scale is best?*

QUESTION

Which scale is the most practical to graphically represent the age of a 38,000 year artifact vs. a 20 year old student on the same graph on the blackboard?

A) *1 in= 1 yr* ***B)*** *1 in= 10 yr*

C) *1 in= 100 yr* ***D)*** *1 in= 1,000 yr*

E) *1 in= 10,000 yr*

Match the years in the second column with choices from the first column

A. Age of the earth	_____85 years
B. Average lifespan of a woman in US	_____195,000,000 years
C. Extinction of BIG dinosaurs (Years ago)	_____ 58 years
D. Alchemy (Years ago)	_____ 13,700,000,000 yrs.
E. Average lifespan of a man in Russia	_____ 2500 yrs.
F. Ancient science (Years ago)	_____ 3,800,000,000 yrs.
G. Age of chemistry	_____ 400 yrs.
H. Dr. R's age	_____ 200-300 yrs.
I. Age of the universe	_____ 1000 yrs.
J. Extinction of LITTLE dinosaurs (Years ago)	_____ 4,540,000,000 yrs.
K. Age of Modern Science	_____ None of the choices
L. First life on earth	_____ 65,000,000 yrs.