Chem 106

Chemistry for Non-science Majors

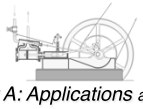
http://chemconnections.org/general/chem106/106%20Intro.1A%202016f.htm

Dr. Ron Rusay

CONNECTIONS: Chemistry ⇆ STEM ⇆ Applications

STEAM

S Science
T Technology
E Engineering
M Mathematics



< A: Applications and Architecture/ Arts

CONNECTIONS

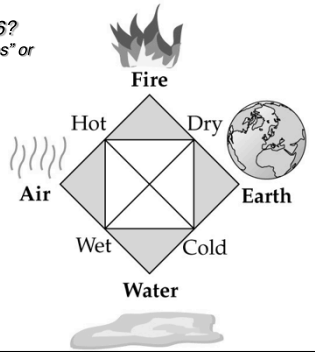
Chemistry, STEM & Applications (STEAM)

Why CHEM 106? (Select one or more.)

A. *Required lab science course needed to meet my higher education goals. I have to take it.*
B. *Chemistry is very easy to me and I need the 4 credit A to boost my GPA.*
C. *Rate_em.com said that it is better to take chemistry than geology, astronomy or oceanography.*
D. *I am very interested in science and chemistry.*
E. *I'm not sure.*

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

In CHEM 106?
"Arts & Sciences" or "Arts versus Sciences"….
Justice Breyer



In CHEM 106?
"Arts & Sciences" or "Arts versus Sciences"….
Justice Breyer

"Because science, told as a story, can intrigue and inform the non-scientific minds among us, it has the potential to bridge the two cultures into which civilization is split—the sciences and the humanities. For educators, stories are an exciting way to draw young minds into the scientific culture."

E. O. Wilson

What is the stuff around us? How do things work?
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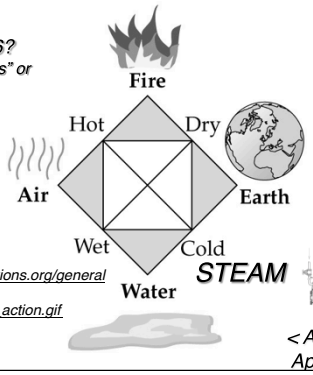
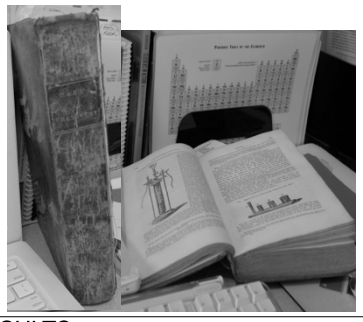
In CHEM 106?
"Arts & Sciences" or "Arts versus Sciences" ….
Justice Breyer



http://chemconnections.org/general/chem106/Steam_engine_in_action.gif

STEAM

< A: Arts and Applications



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

CHEM 106: 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*

Knowledge

How is it acquired?
Hearing (Viewing) , Seeing (Reading), Doing

Which works best?
It depends on our individual traits & skills

How can these be discovered?
Various surveys can be used.

Your first assignment (Metacognition):
Complete a Learning Style Survey.
Apply the results.

Click Image

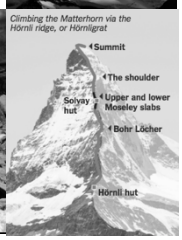
Studying Chemistry & STEAM
Similar to learning to climb an ALP?

Inter-RELATING knowledge:
Past ⇆ Present ⇆ Future

- *A APPRECIATING the Past*
- *L LIVING in the Present*
- *P PREPARING for the Future*

Opportunities & Risks

- *A ACCESSIBLE*
- *L LEARNING*
- *P PROCESSES*



Context: *Digitized Society/Industry 4.0*

Goal: *Evaluate whether a Participating Crowd (YOU) Learned to work together or not (and how much)… emojis?*

Oxford Dictionaries Word of the Year 2015 is...

That's right – for the first time ever, the Oxford Dictionaries Word of the Year is a pictograph: 😂, officially called the 'Face with Tears of Joy' emoji, though you may know it by other names. There were other strong contenders from a range of fields, outlined below, but 😂 was chosen as the 'word' that best reflected the ethos, mood, and preoccupations of 2015.

How well do you know your emojis? Take our quiz.

Why was this chosen?

Emojis (the plural can be either emoji or emojis) have been around since the late 1990s, but 2015 saw their use, and use of the word emoji, increase hugely.

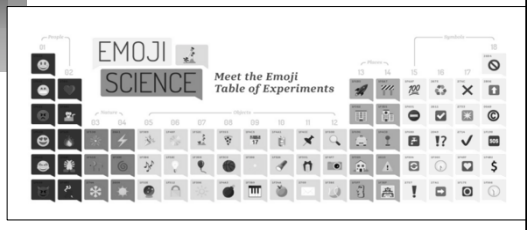
Context: *Digitized Society/Industry 4.0*

Goal: *Change the WORLD!*

Bill Nye, "The Science Guy"

Change the WORLD!

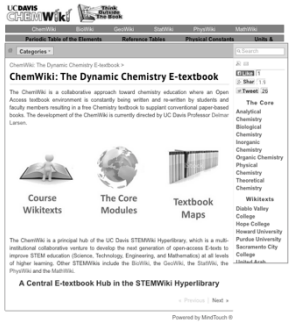
http://emojiscience.com/



Chem 106 Homepage & Wikis

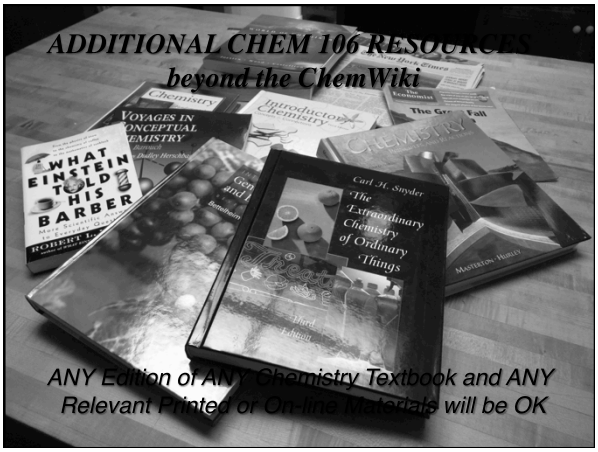
http://chemconnections.org/general/chem106
http://chemwiki.ucdavis.edu/

ChemWiki: a RESOURCE & STEM Hub



*A "**wiki**" is a website that uses software which allows users to access, create and edit any number of interlinked Web pages. "Wiki" is a Hawaiian word for "quick".*

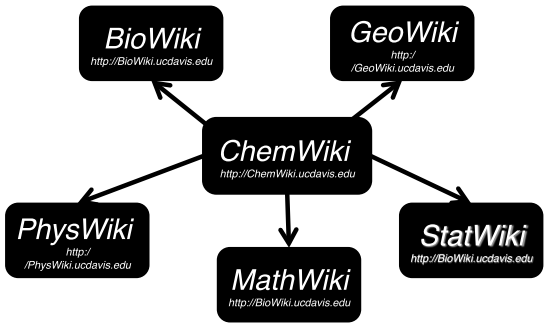
ADDITIONAL CHEM 106 RESOURCES beyond the ChemWiki



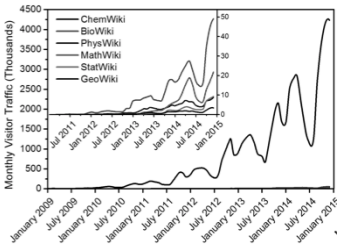
ANY Edition of ANY Chemistry Textbook and ANY Relevant Printed or On-line Materials will be OK

Interconnected Hyperlibrary Resources

"STEMwikis"



ChemWiki / STEM Wikis



Monthly visitor traffic profiles for the ChemWiki (black curve) and five other STEMWikis (inset) since 1/1/2008.

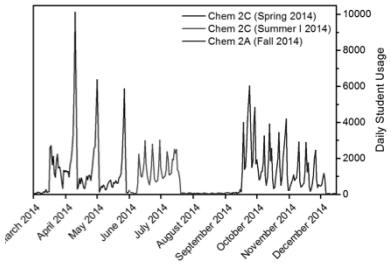
- *Up to 8 million page views per month. (Wikipedia's top 500 chemistry articles totaled 13.2 million in October, 2015)*
- *~35 weeks of reading per day*
- *An estimated $900,000 in student savings with ChemWiki textbooks in 2015*

Research & Evaluation

***(2014)** Comparison of students using ChemWiki materials versus a conventional textbook (Petrucci et. al.) in classes at UCD over three quarters (N> 1,000): Analyses indicate that students using the ChemWiki performed equally as well as students in the Petrucci et al. control course, limiting the covariates in the model*

Independent Evaluation team: iAMSTEM Hub (http://iamstem.ucdavis.edu/about-iamstem/)

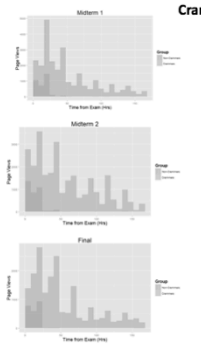
ChemWiki Usage



Daily traffic for student usage of Wikitexts for the ChemWiki pilot. Spikes originate from students "cramming" before exams and quizzes.

Cramming does not work for most students.

How does "cramming" affect exam performance?



Crammer Definition: 75% of pageviews 24 hours before the exam

Exam 1

Group	# students	Avg Score	StDev
Cram	68	68.0	20.1
Non	323	77.9	18.7

Exam 2

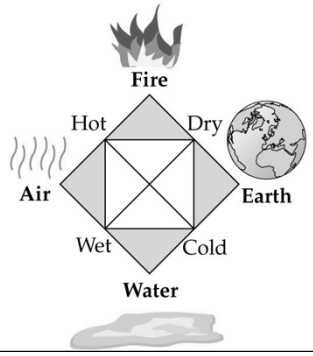
Group	# students	Avg Score	StDev
Cram	65	86.3	14.4
Non	331	90.1	13.1

Final

Group	# students	Avg Score	StDev
Cram	58	128.1	26.1
Non	282	131.5	21.7

Note: Criteria also excludes those with pageviews<10

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?

Observations: Perception

STEAM relies on observations.

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

Observations: Perception

STEAM relies on observations: SEEING

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

Seeing & Visibility

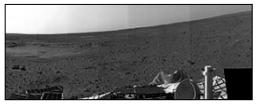
TED (Technology/Education/Design) Talk

https://www.youtube.com/watch?v=8EUy_82IChY
~9 minutes

Awareness & "Change Blindness"

https://www.youtube.com/watch?v=VkrrVozZR2c
~4 minutes

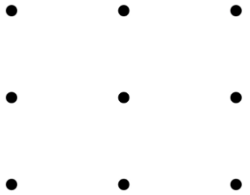
What might this be?



http://mars.nasa.gov/
Why is this important?
Would you colonize Mars?
200,000 people applied!... for a one-way trip?

Problem Solving

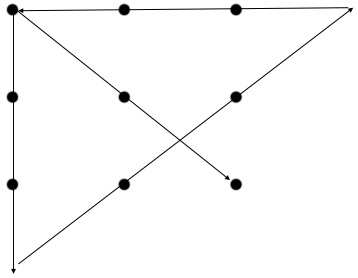
Connect all of the dots with four straight lines without taking a pen or pencil from the surface and passing through each point only once.



Problem Solving

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.

Start

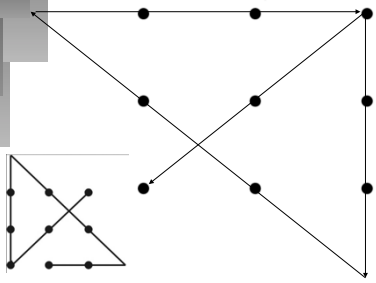


Problem Solving

Can there be more than one solution for the same problem?

Of Course!

Start



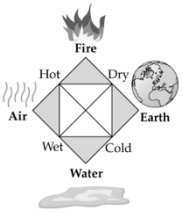
Problem Solving

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.

Click for the answer

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



Aristarchus
~ 270 B.C.E.

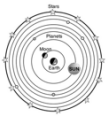
Does the sun "rise" in the east?

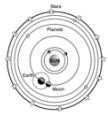
Two plausible possibilities.

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

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

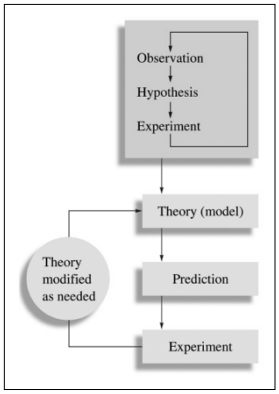
Cleanthes & Stoics
~ 270 B.C.E.





The Scientific Method

- STEAM is 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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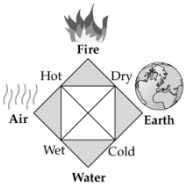
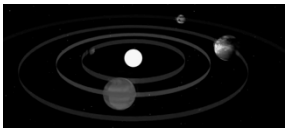




https://www.youtube.com/watch?v=4yzraWw8mrc

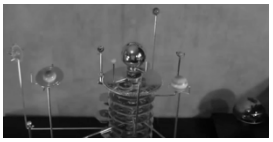
Does the sun "rise" in the east?

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

Helio-centric
Sometime after 1512.

Does the earth rotate clockwise or counter -clockwise?

Question

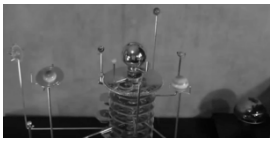


https://www.youtube.com/watch?v=HnASxhZyuIU

Does the sun rise in the east and does the earth rotate clockwise or counter -clockwise?

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

Question



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Helio-centric
Sometime after 1512.

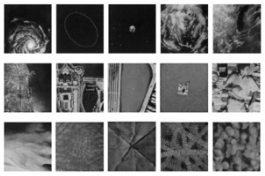
Some Possible Steps in the Scientific Method

- *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/

Question

Measurements & Relative Scale

- *Macroscopic vs. Microscopic*
- *Charles & Ray Eames*
- *TRUE (A) / FALSE (B)*

Macroscopic stuff is visible to the naked eye. Microscopic objects require magnification.

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

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Question

Measurements & Relative Scale

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Powers of Ten: Scale

10^n (n: exponent; 10: base number)

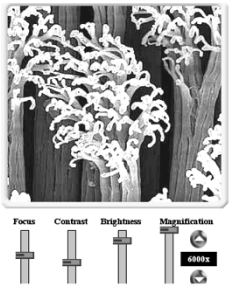
Powers of 10

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

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

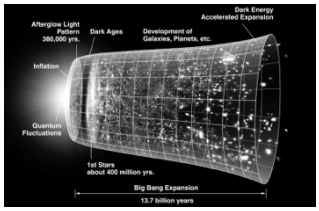
Science 345, 1448 (2014)

Biomimetics and evolution

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

Macroscopic

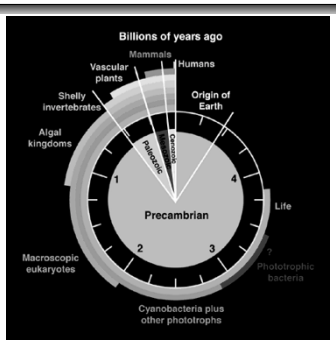
http://www.space.com/24309-shape-of-the-universe.html



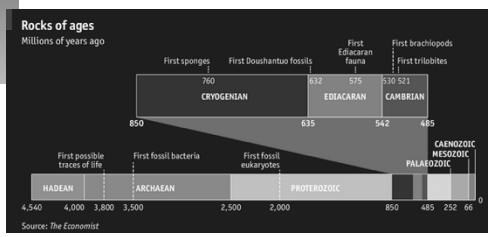
How does the age of the universe compare to the age of the earth? $\frac{13{,}700{,}000{,}000 \text{ years}}{4{,}540{,}000{,}000 \text{ years}} = 3 \text{ x}$

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

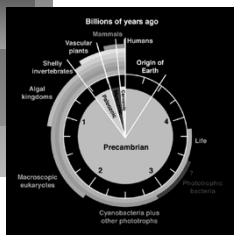
Simple Graphic Comparisons



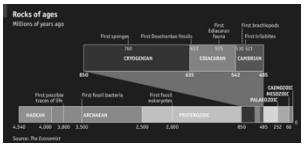
Simple Graphic Comparisons



Simple Graphic Comparison(s)



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

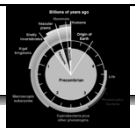


How does our lifespan compare to the age of the earth?

$\frac{4{,}540{,}000{,}000 \text{ years}}{80 \text{ years}} = 56{,}750{,}000\text{x}$

1/56,750,000 = 0.0000000176

QUESTION



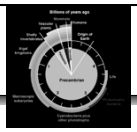
The earth is 4.54 billion years old and assume that our average lifespan will be 80 years. If the total age of the earth is represented by the face of a clock, how much time will 80 years be represented on the clock?

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

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

E) 15,200,000,000 seconds

Answer



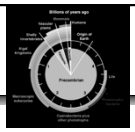
Assume that the earth is 4.54 billion years old and that your average lifespan will be 80 years. If the total age of the earth is represented by the face of a clock, how much time will 80 years be represented on the clock?

$$\frac{80 \text{ years}}{4{,}540{,}000 \text{ years}} = \frac{? \text{ hrs}}{12 \text{ hrs}}$$

$$\frac{80 \text{ years} \times 12 \text{ hrs}}{4{,}540{,}000 \text{ years}} = ? \text{ hrs}$$

$$= 0.000000211 \text{ hrs} \rightarrow ? \text{ sec}$$

Answer



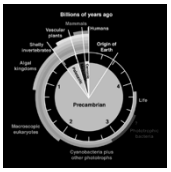
Assume that the earth is 4.54 billion years old and that your average lifespan will be 80 years. If the total age of the earth is represented by the face of a clock, how much time will 80 years be represented on the clock?

A) 0.001520 seconds (1520 microseconds)
B) 0.00076 seconds (0.76 milliseconds)
C) 0.0008 seconds (8 x 10^{-4} seconds)
D) 7,600,000 seconds (7.6 megaseconds)
E) 15,200,000,000 seconds (15.2 gigaseconds)

0.000000211 hr x 60 min/hr x 60 sec/min = ? sec

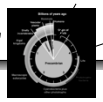
Scale & Relative Sizes

- *Macroscopic vs. Microscopic*



How would you compare the age of Confucius (Master Kong, 孔夫子) born 551 BC, if he were alive today, to the age of the earth?…How would the age of mankind compare to the age of all living things?.. ..the age of industrialized mankind to the age of mankind?

Scale & Relative Sizes



- Macroscopic vs. Microscopic

How would you compare the age of Confucius (Master Kong, 孔夫子) born 551 BC, if he were alive today (551 yrs + 2016 yrs = 2567 yrs), to the age of the earth?…

$$\frac{4{,}540{,}000{,}000 \text{ years}}{2567 \text{ years}} = 1{,}768{,}000 \text{ x}$$

1/1,768,000 = 0.000000566

How would the age of mankind compare to the age of all living things?.. ..

$$\frac{3{,}800{,}000{,}000 \text{ years}}{200{,}000 \text{ years}} = 19{,}000 \text{ x}$$

the age of industrialized mankind to the age of mankind?

$$\frac{200{,}000 \text{ years}}{200 \text{ years}} = 1{,}000 \text{ x}$$

Modern Science & Chemistry

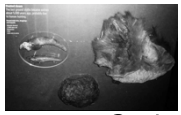
SCIENCE

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

38,000 yrs / 20 yrs = 1900 x

- LENGTH:
  - Use lines to represent the respective ages that can be easily drawn on the classroom's blackboard.
  - Let 1 inch equal some period of time: 1 yr, 5 yr, 10yr, 100yr, 1000yr. (Select an appropriate one.)
  - 38,000 year old (dung) vs. 20 year old student

Representations of Measurements

An example of a relative comparison using length to represent time

- *TIME: LENGTH; 38,000 year old (dung) vs. 20 year old student*
  - *1 in= 1 yr: dung = 38,000 in (> 1/2 mile) - student = 20 in*
  - *1 in= 5 yr: dung = 7,600 in (> 2 football fields) - student = 4 in*
  - *1 in= 10 yr: dung = 3,800 in (> 100 yds) - student = 2 in*
  - *1 in= 100 yr: dung = 380 in (31.6 feet) - student = 0.2 in*
  - *1 in= 1000 yr: dung = 38 in (3.16 feet) - student = 0.02 in*

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.

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

A. Age of the earth	B	85 years *or H?*
B. Average lifespan of a woman in US	C	195,000,000 years
C. Extinction of BIG dinosaurs (Years ago)	E	58 years *or H?*
D. Alchemy (Years ago)	I	13,700,000,000 yrs.
E. Average lifespan of a man in Russia	F	2500 yrs.
F. Ancient science (Years ago)	L	3,800,000,000 yrs.
G. Age of chemistry	K	400 yrs.
H. Dr. R's age	G	200-300 yrs.
I. Age of the universe	D	1000 yrs.
J. Extinction of LITTLE dinosaurs (Years ago)	A	4,540,000,000 yrs.
K. Age of Modern Science	H?	None of the choices
L. First life on earth	J	65,000,000 yrs.