"A" students work (without solutions manual) ~ 10 problems/night.

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Office Hours W – F 2-3 pm

FITCH Rules

General

G1: Suzuki is Success
G2. Slow me down
G3. Scientific Knowledge is Referential
G4. Watch out for Red Herrings
G5. Chemists are Lazy

Chemistry

C1. It's all about charge
C2. Everybody wants to "be like Mike" (grp.18)
C3. Size Matters
C4. Still Waters Run Deep
C5. Alpha Dogs eat first

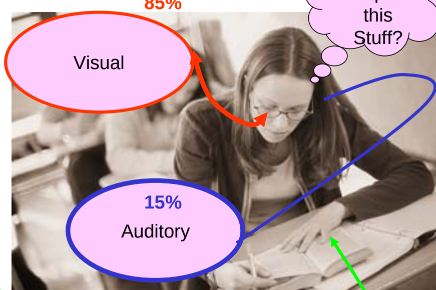
Learning Styles

How do I Acquire this Stuff?

85%
Visual

15%
Auditory

Kinethestic and Tactile



Learning Styles

Intelligences

How do I Org... Re...

Visual/Spatial

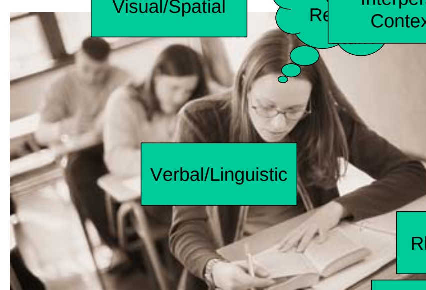
Interpersonal Contextual

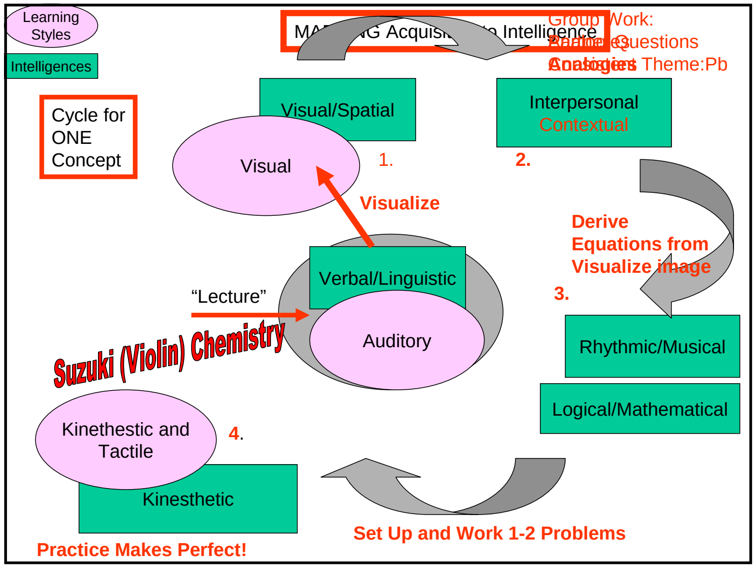
Verbal/Linguistic

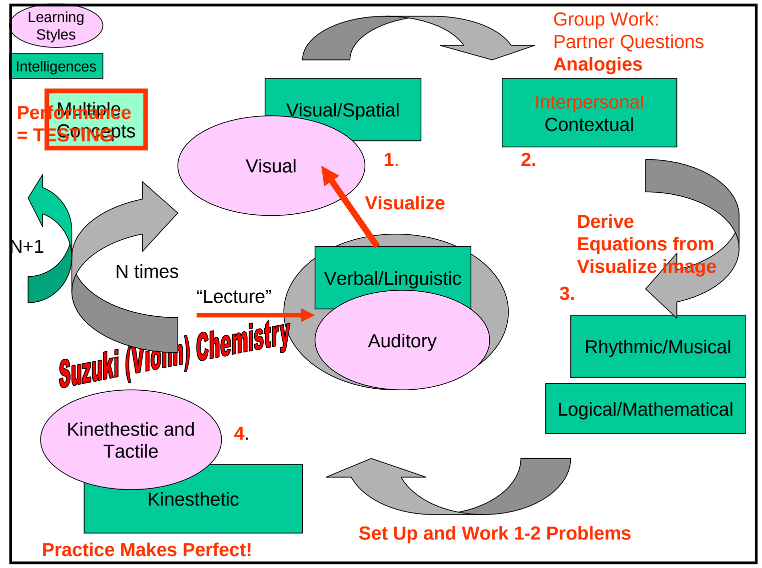
Rhythmic/Musical

Logical/Mathematical

Kinesthetic







1: Suzuki is Success

Suzuki Method of Music Learning

1. Break skills into small parts (fingering pattern; bow crossings; rhythmic clapping)
2. Work on one small skill until it can be accomplished 10 (TEN) times correctly in a row
3. String together small skills into a larger set of tasks
4. Practice concert piece with other students (discussion section; study group)
5. Perform the concert piece.

1: Suzuki is Success

"A" students do every night 10-11 problems successfully

1 Buy a notebook just for problems
2 Assume **all** problems at back of book are relevant, unless otherwise informed.
3 Select problems for which answer is available.
4 Work in notebook for 10 minutes maximum per problem.
5 If unsuccessful circle and move on.
6 Repeat until you have found 10 problems successful OR until 2 hours are spent in gnashing of teeth.
7 Go to Blackboard Discussion site and post problem that gave you the most trouble night before class.
8 At least one problem will be worked as a chalk board problem in lecture.
9 **Remainder of circled problems brought to discussion or office hours.**

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~ 10 problems/night.

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C3. Size Matters

C4. Still Waters Run Deep

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Quiz 1:

What is FITCH RULE #G1?

What is FITCH RULE #G2?

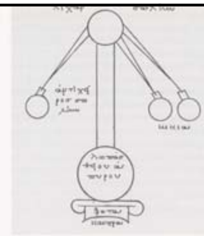
Matter
(Stuff which occupies space or volume)

1. Gas (Variable volume and shape)
2. Liquid (Fixed volume and variable shape)
3. Solid (Fixed volume and fixed shape)

Heterogeneous
Mixed composition

→ Filtration / Distillation →

Pure
fixed composition and properties

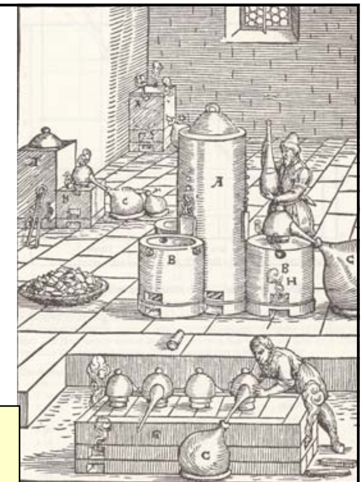


"Marie the Jewess", an alchemist from Alexandria (Egypt) ~ 300 A.D. invented the "bain marie" (double boiler) ~ the first distillation apparatus.

Systematized Distillation experimentation

Abu Musa Jabir ibn Hawan
721-815, born in Tus Khorasan
Died in Kufa (Iraq) chemist, physicist, astronomer
Under house arrest 803-815

Manufacture of nitric acid - mid 1500s - from Agricola's De Re Metallica



Nitric acid distillation by Ercher, ~ 1500s, Germany

(Silver mines)

Matter
(Stuff which occupies space or volume)

1. Gas (Variable volume and shape)
2. Liquid (Fixed volume and variable shape)
3. Solid (Fixed volume and fixed shape)

Heterogeneous
Mixed composition

Filtration
Distillation

Pure
fixed composition and properties

Heterogeneous Mixture
coarse

Homogeneous Mixture
(solutions)

Compounds

Elements
Material Which can't Be broken Down any further

What constitute properties?
How do we measure them?

Properties and Measurements

Property	Unit	Reference State	Time Frame
Length			
	inch	1.man's thumb width	England, before 1300
		2. three grains of barley end to end	England, after 1300
	foot	average man's foot size	
	yard	1. average man's belt length	England, before 1100
		2. length from nose to fingertips of King Henry	England 1200
	rod	a stick long enough to reach from plow to oxen nose tip	
	furlong	length of furrow typically 40 rods	
	hand	unit of measure of a horse from hoof to shoulder	
	mile	1000 double strides of Roman legion	
Volume		Gallon – 8 pounds of wheat	
		Peck – two dry gallons	
		Bushel – 4 pecks	
		10 (wine) gallons = 1 anker	
		18 gallons = 1 rundlet	
		31.5 gallons = 1 barrel	
		42 gallons = 1 tierce	
		63 gallons = 1 hogshead	
		2 tierces = 1 puncheon or 84 gallons	
		1 1/2 puncheons = 1 butt or pipe (or 126 gallons)	
		2 pipes = 1 tun or 252 gallons	

No relationship to length measurements

Roman Scales

Greek Standard wt.

Pre-Columbian Inca (Peru) bone scales

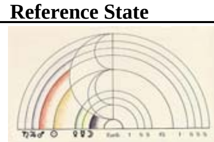
Properties and Measurements

Property	Unit	Reference State	Time Frame
Length			
Volume			
Weight			
	Grain,	equal to the average of grains taken from the middle of the ears of wheat	
	Pound:	7,000 grains constitute the pound avoirdupois.	
	Stone	1. local stone ranged 8-24 pounds 2. standardized: 6.350 kg	England

No Relationship to Length or Volume

Properties and Measurements

Property	Unit	Reference State	Time Frame
Size			
Volume			
Weight			
Color			

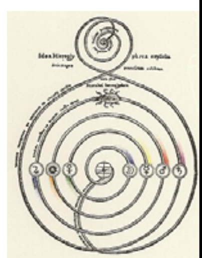


Pythagoras ~550BC

Aristotle 350 BC

Aron sigfrid Forsius 1611

Athanasius Kircher 1646



http://bibliodyssey.blogspot.com/2006/03/history-of-colour-systems.html

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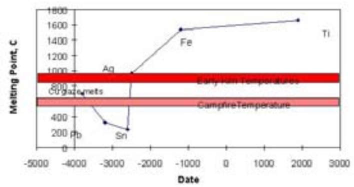
Color in Alchemy: The white rose and the red rose

Properties and Measurements

Property	Unit	Reference State	Time Frame
Size			
Volume			
Weight			
Color			
Temperature			

Greek Physician

1. Glow of the fire
2. **When things melt: wax, sulphur, lead**
3. When water boils



boiling +4

Galen, 170 A.D.

½ boiling water

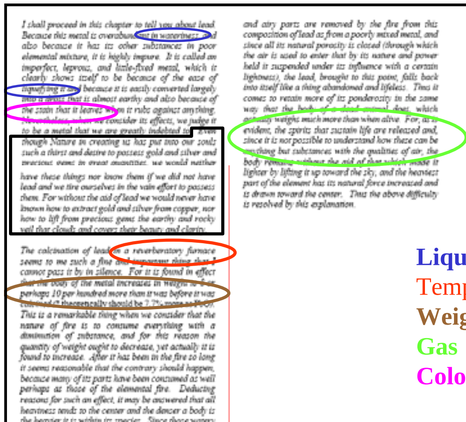
Standard

½ ice

ice -4

What Can We Say/Discover About Matter
Using

Grains
Width of Man's Thumb
Aristotelian colors
Galen's Temperature Scale



I shall proceed in this chapter to tell you about lead. Because this metal is overabundant in wateriness and also because it has its other substances in poor elemental mixture, it is highly impure. It is called an imperfect, leprous, and little-fixed metal, which it clearly shows itself to be because of the ease of liquefying it and because it is easily converted largely into a dross that is almost earthy and also because of the stain that it leaves when it rubs against anything. Nevertheless, when we consider its effects, we judge it to be a metal that we are greatly indebted to. Even though Nature in creating us has put into our souls such a thirst and desire to possess gold and silver and precious gems in great quantities, we would neither have these things nor know them if we did not have lead and we tire ourselves in the vain effort to possess them. For without the aid of lead we would never have known how to extract gold and silver from copper, nor how to lift from precious gems the earthy and rocky veil that clouds and covers their beauty and clarity.

The calcination of lead in a reverberatory furnace seems to me such a fine and important thing that I cannot pass it by in silence. For it is found in effect that the body of the metal increases in weight to 8 or perhaps 10 per hundred more than it was before it was calcined (theoretically should be 7.7% more as PbO). This is a remarkable thing when we consider that the nature of fire is to consume everything with a diminution of substance, and for this reason the quantity of weight ought to decrease, yet actually it is found to increase. After it has been in the fire so long it seems reasonable that the contrary should happen, because many of its parts have been consumed as well perhaps as those of the elemental fire. Deducting reasons for such an effect, it may be answered that all heaviness tends to the center and the denser a body is the heavier it is within its species. Since those watery and airy parts are removed by the fire from this composition of lead as from a poorly mixed metal, and since all its natural porosity is closed (through which the air is used to enter that by its nature and power held it suspended under its influence with a certain lightness), the lead, brought to this point, falls back into itself like a thing abandoned and lifeless. Thus it comes to retain more of its ponderosity in the same way that the body of a dead animal does, which actually weighs much more than when alive. For, as is evident, the spirits that sustain life are released and, since it is not possible to understand how these can be anything but substances with the qualities of air, the body remains without the aid of that which made it lighter by lifting it up toward the sky, and the heaviest part of the element has its natural force increased and is drawn toward the center. Thus the above difficulty is resolved by this explanation.

Biringuccio, ~1520

Liquidity
Temperature
Weight %
Gas
Color

Lack of Adequate reference states
And scales made it difficult to
Discover the elements

Seven pure elements known by the time of the Romans

Lead	Tin	Copper	Mercury	"Iron"	Silver	Gold

Sulfur	**S**	*Sulphurium*	B.C.
Silver	**Ag**	*Argentium*	~3000 B.C.
Copper	**Cu**	*Cuprum* (from the Island of Cyprus)	~3000 B.C.
Gold	**Au**	*Aurum* (shining dawn)	~3000 B.C.
Lead	**Pb**	*Plumbus*	~3000 B.C.
Iron	**Fe**	*Ferrum*	B.C.
Tin	**Sn**	*Stannum*	B.C.
Mercury	**Hg**	*Hydrargyrum* (liquid silver)	Romans
Antimony	Sb	*Anti monos* (not single)	1600s
Tungsten	W	*Tung sten* (Swedish - heavy stone)	Scheele 1781
Potassium	K	Potash (**pot ashes**), *kalium (alkali)*	Davy, 1807
Sodium	Na	*Natrium*	Davy, 1807

8 Elements known to Romans
12 Pure elements known by early 1800s
112 Elements by 1995

Eleven elements here are the only ones whose symbols do not follow their names

FITCH Rules

General
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- **G3. Scientific Knowledge is Referential**
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- **G5.** Chemists are Lazy

Chemistry
- C1. It's all about charge
- C2. Everybody wants to "be like Mike" (grp.18)
- C3. Size Matters
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3. Scientific Knowledge is Referential

Scientific Knowledge is "Referential"

1. Depends upon Measurement tools
2. Tools are agreed upon and uniform
3. **Some STANDARD reference state**
4. Fineness of scale determines Certainty

Properties and Measurements

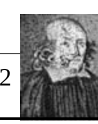
Property	**Unit**	**Reference State**
Size	1 meter (m)	~1/40,000,000 Earth's diameter

Remember this name it has special significance for me

A French astronomer, Abbé Jean Picard, had been the first to measure the length of a degree of longitude and from it compute the size of the Earth, in 1655. This feat in turn was instrumental in the siting of the Paris Observatory: on Midsummer's Day 1667, members of the newly formed Academy of Sciences traced the future building's outline on a plot outside town near the Port Royal abbey, with Picard's meridian exactly bisecting the site north-south.

From there began the task of marking the rest of the meridian throughout France. This work was itself vital to one of the greatest of French inventions: the metric system. The standard meter, derived from the survey of the Paris meridian from Dunkirk to Barcelona, **was defined in 1799 as one ten-millionth of a meridional** quadrant (i.e. from north pole to equator).

SCALAR Units?



1620-1682

Scalar units
In 10s, or 1/10ths

$(10^{x})m$

$x = -n, \ldots -3, -2, -1, 0, 1, 2, 3, \ldots n$

Factor	Prefix	Abbreviation
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

$1cm = 10^{-2} m$

$$1 = \frac{10^{-2} m}{cm}$$

$$1 = \frac{1cm}{10^{-2} m}$$

$$1 = \frac{100cm}{m}$$

Use
As a
X 1
Multiplier
For conversions

All are equivalent statements

Properties and Measurements

Property	Unit	Reference State
Size	m	size of earth
Volume		
	mL = cm³	**m** milli-Liter

$$1cm^3 = (10^{-2} m)^3 = 10^{-6} m^3$$

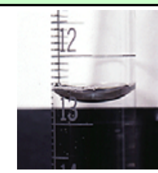
$$1cm^3 \neq 10^{-2} (m)^3 = 10^{-2} m^3$$

$$1cm^3 = 1mL$$

$$1 = \frac{1cm^3}{1mL}$$

OJO!!

This is one of THE most common mistakes in Freshman chemistry.



Properties and Measurements

Property	Unit	Reference State
Size	m	size of earth
Volume	**cm³**	**m**
Weight		
	gram	mass of 1 cm³ water ***

All are inter-related to one Reference state

$$1g = cm^3{}_{water}$$

$$1 = \frac{1g_{water}}{cm^3{}_{water}}$$

$$1 = \frac{1g_{water}}{1mL_{water}}$$

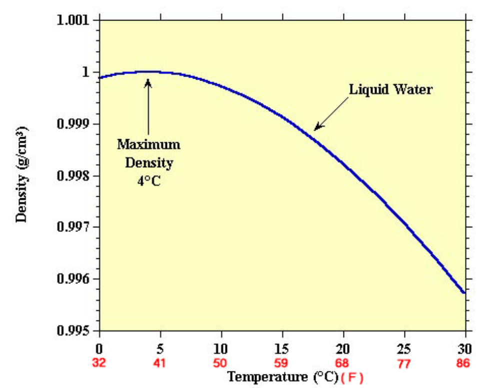
Use
As a
X 1
Multiplier
For conversions

What is the problem
With this reference state?

$$density = d = \frac{mass}{volume} = \frac{m}{V}$$

Changes with temperature

$$d\downarrow \propto \frac{g}{cm^3 \uparrow}$$



Properties and Measurements

Property	Unit	Reference State
Size	m	size of earth
Volume	**cm^3**	**m**
Weight	gram	mass of 1 cm^3 water at specified Temp (and Pressure)

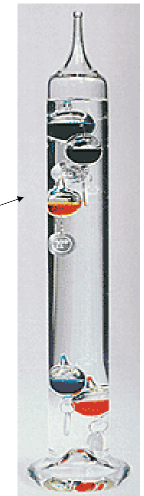
Temperature

Units of Temperature

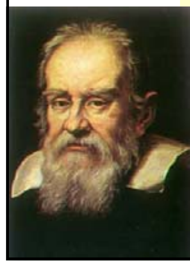
Italian Galileo (1564-1642) Density based

$$density = d = \frac{mass}{volume} = \frac{m}{V}$$

$$d\downarrow \propto \frac{g}{cm^3 \uparrow}$$



Density
Decreases
Calibrated
Float rises



Galileo Galili
1564-1642
Astronomer University of Pisa
Convicted of heresy 1633 by the Inquisition

Units of Temperature

Italian Galileo (1564-1642) Density based

Daniel Fahrenheit 1686-1737
German Glassblower by trade
Chemist by avocation

William Thompson,
1st Lord Kelvin
1824-1907

Irish-Scottish
physicist/mathematician
Telegraph/transAtlantic
cables

Anders Celsius
1701-1744
Swedish Astronomer

The Fahrenheit scale was invented by the German scientist Daniel Gabriel Fahrenheit (1686 Poland - 1736 Dutch Republic). It is fixed by two temperatures: zero degrees Fahrenheit was the temperature of a mix of water, ice, and salt. Ninety degrees Fahrenheit was what people in those days thought was the normal temperature of the human body.

These two fixed points on the Fahrenheit scale were perhaps not the most practical choices, because most people do not spend a lot of time trying to keep water fluid by adding salt to it, and we now know that the temperature that people then thought was the normal temperature of the human body was in fact a few degrees wrong.

The Celsius scale was invented by the Swedish astronomer Anders Celsius (1701-1744, Sweden). It is fixed by two temperatures: zero degrees Celsius is the freezing temperature of water (at a standard sea-level air pressure) and a hundred degrees Celsius is the boiling temperature of water at the same pressure.

The Kelvin scale is named after the British scientist Lord Kelvin, (William Thompson), Baron Kelvin of Largs. It is fixed by one temperature and a temperature difference: zero kelvin (don't say *degree*) is the lowest possible temperature, at which atoms do not move. A one kelvin difference corresponds to a one degree difference Celsius. This scale was invented by scientists for use in physics, because some formulas (those relating pressure of a gas to its temperature, or brightness to temperature, for instance) become easier if you use the zero point of the Kelvin scale.

Units of Temperature

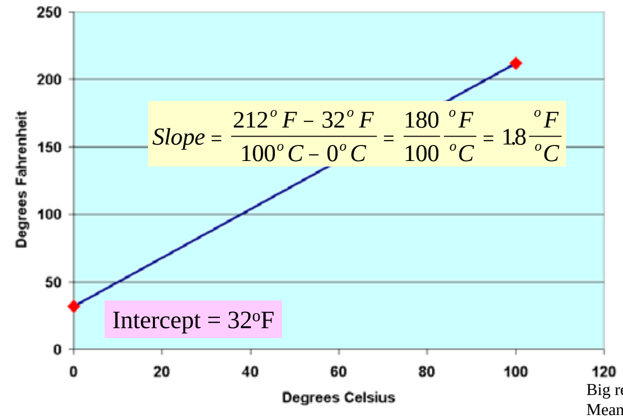
Reference States

	Galen	°F	°C	K
Water Boiling Point, sea level	+4	212°F	100°C	373.15K
Presumed Human Temp		90°F		
½ boiling; ½ freezing water	0			
Water Freezing Point, sea level	-4	32°F	0°C	273.15K
Mixture of Ice, Water, Salt		0°F		
Cessation of atomic motion			-273.15°C	0K

$$T_K = t_{^oC} + 273.15$$

Big red box Means memorize

To relate F and C scales, let's plot the data:



$$Slope = \frac{212^o F - 32^o F}{100^o C - 0^o C} = \frac{180}{100}\frac{^oF}{^oC} = 1.8\frac{^oF}{^oC}$$

Intercept = 32°F

Big red box Means memorize

Equation for a line:

y = (slope)x + intercept

$$t_{^oF} = \left[1.8\frac{^oF}{^oC}\right]t_{^oC} + 32^oF$$

Comment

Learning strategies:

1. Visualize (the graph, or proportionality)
2. Derive the equation
3. Memorize the equation (least successful)
4. Apply the equation several times.
   (Do the homework!)

   See one
   Do one
   Teach one

Room temperature is about 25 °C or 78°F. All motion ceases at 0K.
All motion ceases at what temperature Fahrenheit?

Strategy

1. Convert words to symbols on left hand side of the paper.
2. Mark the unnecessary information as **red herrings.**
3. Random associate with any equations or relationships you can remember. Write those equations down on the left hand side of the paper.
4. Check the equations symbols for various known and unknown symbols required.
5. Choose equation which had unknown with most knowns.
6. Solve.

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What is a "red herring"?

Etymology:

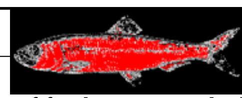
The name of this fallacy comes from the sport of fox hunting in which a dried, smoked herring, which is red in color, is dragged across the trail of the fox to throw the hounds off the scent.

Description of Red Herring

A Red Herring is a fallacy in which an irrelevant topic is presented in order to divert attention from the original issue.

The basic idea is to "win" an argument by leading attention away from the argument and to another topic. This sort of "reasoning" has the following form:

Topic A is under discussion.
Topic B is introduced under the guise of being relevant to topic A when topic B is actually not relevant to topic A).
Topic A is abandoned.



Etymology:

The name of this fallacy comes from the sport of fox hunting in which a dried, smoked herring, which is red in color, is dragged across the trail of ... nt.

WHY DO YOU TORTURE US THIS WAY?

Description of Red Herring

A Red Herring is a fallacy in which an irrelevant topic is pres... The ... away ... "reas... Topi... Topi... topic A (when topic B is actually not relevant to topic A).
Topic A is abandoned.

One current distinction between artificial intelligence and human intelligence is the ability to ignore extraneous information.

When a patient comes to you they will give you all kinds of information, not all of which is relevant.

Strategy

Room temperature is about 25 °C or 78°F. All motion ceases at 0K.
All motion ceases at what temperature Fahrenheit?

1. Convert words to symbols on left hand side of the paper.
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3. Random associate with any equations or relationships you can remember. Write those equations down on the left hand side of the paper.
4. Check the equations symbols for various known and unknown symbols required.

$RT = 25^oC$

$RT \sim 78^oC$

$Known = 0K$

$Unknown = ^oF$

Motion ceases

$T_K = t_{^oC} + 273.15$

$t_{^oF} = \left[1.8\frac{^oF}{^oC}\right]t_{^oC} + 32^oF$

$t_{^oC} = T_K - 273.15$

$t_{^oC} = 0 - 273.15 = -273.15\,^oC$

$t_{^oF} = \left[1.8\frac{^oF}{^oC}\right](-273.15^oC) + 32^oF$

$t_{^oF} = -459.67^oF$

To summarize:

To study matter need:

1. To make observations as to their properties
2. Quantitative measurements help establish the properties
3. Quantitative measurements are based on **Standard systems**

Measure	Symbol	Unit
Length	l	m
Volume	V	cm^3
Mass	m	kg
Temperature	T	°C or °K

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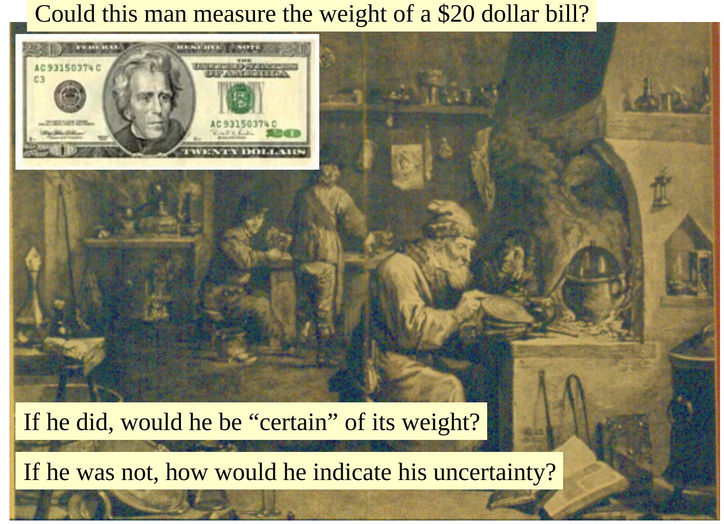
Scientific Knowledge is "Referential"

1. Depends upon Measurement tools
2. Tools are agreed upon and uniform
3. Some STANDARD reference state
4. **Fineness of scale determines Certainty**

Depends upon the instrument or tool of measurement

Could this man measure the weight of a $20 dollar bill?



If he did, would he be "certain" of its weight?

If he was not, how would he indicate his uncertainty?

Uncertainty of $20 dollar bill

Measuring device	Mass
Electronic scale 1	26.0 mg
2	26.3 mg
3	25.8 mg
Average	26.0033mg

Uncertainty was here

How should this be reported?

In addition OR subtraction report to digit where
The measurement becomes variable

Average 26.0

Zero
Is meaningfull

This signifies to all others
That we had variability
In the measurement in the 10^{ths}

Average = 26.0

$26.0mg \neq 26mg$

Would imply that we had
Variability in measuring in the
Ones place

$26.0 \pm 0.1mg \neq 26 \pm 1mg$

Scientific Notation

$26.0 = 2.60x10^1 mg$

$26.0 \neq 2.6x10^1 mg$

(An aside: Andrew Jackson
was lead poisoned a bullet
lodged in his shoulder from
dueling over horse racing)

Old English Method of Stones

What is my weight
In stones?

Me	stones
20$	26.0±0.1 mg
Picard, the dog	56.4 lbs

Add one $20 dollar bill to my
dog and me (I?)

The dog's weight by the
electronic balance at the vet is
56.4 lbs.

How much do the three of us
weigh?

Two parts to this

1. Unit conversions
2. Keeping track of the uncertainty

Rule 1:
Unit conversions are generally ignored in sig figs

Rule 2:
Sig figs in addition/subtractions are related to the decimal place where the greatest uncertainty lies.

Rule 3:
When multiplying or dividing, sig figs are determined by the sig figs in the quantity with the least sig figs

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Me	stone
Picard	56.4 lbs
$20 Dollar bill	26.0 mg
Total	Apples + Oranges+ bananas

Measurement
Stones
Vet electronic
Scientific electronic

Affects "Certainty"

3 sig figs

$$26.0mg\left[\frac{1g}{10^{3}mg}\right]\left[\frac{1lb}{453.6g}\right] = 0.057309lb$$

Exact numbers in the conversion

Do not contribute to the sig figs

"Leading" zeros Are place holders And are usually Not significant

1. Unit conversions
2. Keep Track of Sig Figs

Stone weight?

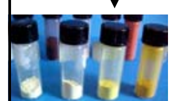
$$\left[\frac{stones}{me}\right]\left[\frac{lb}{stones}\right] = \quad lb$$

1. Unit conversions
2. Keep Track of Sig Figs

Me	lbs
Picard	56.4 lbs
$20 Dollar bill	0.0573 lbs
Total	.4573 lbs
Total	Apples + Apples

PbO w/Sb

PbO



What is our uncertainty?

It lies in the imprecision of my stone weight

This explains why the alchemists were unable to understand the color changes in their transformation of lead to gold:

minute, unmeasureable impurities chemically reacted to give the colors they expected but had not actually controlled for

Matter
(Stuff which occupies space or volume)
1. Gas (Variable volume and shape)
2. Liquid (Fixed volume and variable shape)
3. Solid (Fixed volume and fixed shape)

Heterogeneous
Mixed composition

Filtration
Distillation

Pure
fixed composition and properties

Heterogeneous Mixture
coarse

Homogeneous Mixture
(solutions)

Compounds

Elements
Material Which can Be broken Down any further

Intensive Properties used to identify a substance
(independent of the amount)

Properties and Measurements

Property	Unit	Reference State
Size	m	size of earth
Volume	**cm^3**	**m**
Mass	gram	mass of 1 cm^3 water at specified Temp (and Pressure)

None!
Which of above is an

intensive property?	**extensive properties**
Density Solubility	Size Volume Mass

depend upon the amount of substance present

What could we measure that would be an **intensive property?**

Example To determine the density of ethyl alcohol, a student pipets a 5.00-mL sample into an empty flask weighing 15.246 g. He finds that the mass of the flask + ethyl alcohol = 19.171 g. Calculate the density of ethyl alcohol.

Strategy

1. Convert words to symbols on left hand side of the paper.
2. Mark the unnecessary information as **red herrings.**
3. Random associate with any equations or relationships you can remember. Write those equations down on the left hand side of the paper.
4. Check the equations symbols for various known and unknown symbols required. Choose equation which had unknown with most knowns.
5. Solve.

Example To determine the density of ethyl alcohol, a student pipets a 5.00-mL sample into an empty flask weighing 15.246 g. He finds that the mass of the flask + ethyl alcohol = 19.171 g. Calculate the density of ethyl alcohol.

Ethyl alcohol
student pipets
5.00- mL sample
mass flask = 15.246 g
mass flask + alcohol = 19.171 g
density = ?

$$density = d = \frac{mass}{volume} = \frac{m}{V}$$

$$d = \frac{[mass_{flask+alcohol} - mass_{flask}]}{volume}$$

$$d = \frac{[19.171g - 15.246g]}{5.00mL}$$

$$d = \frac{3.925g}{5.00mL} = 0.785\frac{g}{mL}$$

Sig Figs!

Context for Next Example

The first deforestation of the NE of America was during the colonial period when trees were felled to create an export commodity in
a) shingles
b) oak casks
c) pot ash (remember? Potassium = pot ash, K)

Potassium is very soluble and moves through soils rapidly to ground water.
Trees roots access potassium from deeper in the soil
Tree ashes contain concentrated amounts of potassium

Potassium nitrate was required to create gunpowder.
Calcium nitrate can be obtained from pig urine passing through soil, but calcium nitrate adsorbs water and spoils the nitrate.

Solubility, s

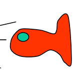
expressed as: g/100g solvent at a given temperature

Example
Taking the solubility of potassium nitrate, KNO_3, to be 246g/100g of water at 100°C and ~~32 g/100 g of water at 20°C~~, calculate:
a) the mass of water required to dissolve one hundred grams of KNO_3 at 100°C
~~b) The amount of KNO_3 that remains in solution when the mixture in (a) is cooled to 20°C~~

100 g KNO_3 = known
x g of water = unknown

$$s_{100^oC} = \frac{246g_{KNO_3}}{100g_{water_{100^oC}}}$$

$$s_{20^oC} = \frac{32g_{KNO_3}}{100g_{water_{100^oC}}}$$



$$s_{100^oC} = \frac{246g_{KNO_3}}{100g_{water_{100^oC}}} = \frac{100g_{KNO_3}}{xg_{water_{100^oC}}}$$

Rearrange so we can solve for unknown x

Flipping Equations

$$\frac{a}{b} = \frac{c}{d} \qquad a = \frac{cb}{d} \qquad ad = cb \qquad d = \frac{cb}{a}$$

$$\frac{d}{c} = \frac{b}{a}$$

$$\frac{a}{b} = \frac{c}{d} \quad \xrightarrow[\text{statements}]{\text{Equivalent}} \quad \frac{d}{c} = \frac{b}{a}$$

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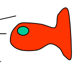

$$s_{100^oC} = \frac{246g_{KNO_3}}{100g_{water_{100^oC}}} = \frac{100g_{KNO_3}}{xg_{water_{100^oC}}}$$

Rearrange so we can solve for unknown x

$$\frac{xg_{water_{100^oC}}}{100g_{KNO_3}} = \frac{100g_{water_{100^oC}}}{246g_{KNO_3}}$$

$$xg_{water_{100^oC}} = \left[\frac{100g_{water_{100^oC}}}{246g_{KNO_3}}\right]100g_{KNO_3} = 40.65041g_{water_{100^oC}}$$

$$xg_{water_{100^oC}} = 40.7g_{water_{100^oC}}$$

Sig Figs!

Example

Taking the solubility of potassium nitrate, KNO_3, to be 246g/100g of water at 100ºC and 32 g/100 g of water at 20ºC, calculate:

a) the mass of water required to dissolve one hundred grams of KNO_3 at 100ºC

b) The amount of KNO_3 that remains in solution when the mixture in (a) is cooled to 20ºC

100 g KNO_3 = known
x g of water at 100ºC= 40.7g

$$s_{100^oC} = \frac{246g_{KNO_3}}{100g_{water_{100^oC}}}$$

$$s_{20^oC} = \frac{32g_{KNO_3}}{100g_{water_{100^oC}}}$$

$$xg_{water_{100^oC}} = 40.7g_{water_{100^oC}}$$

$$s_{20^oC} = \frac{32g_{KNO_3}}{100g_{water_{20^oC}}} = \frac{xg_{KNO_3}}{40.7g_{water_{20^oC}}}$$

$$xg_{KNO_3} = \left[\frac{32g_{KNO_3}}{100g_{water_{100^oC}}}\right]40.7g_{water_{100^oC}} = 13.024gKNO_3$$

$$xg_{KNO_3} = 13.0gKNO_3$$

Name the First Four
Fitch Rules of Chemistry

FITCH Rules

General

G1: Suzuki is Success
G2. Slow me down
G3. Scientific Knowledge is Referential
G4. Watch out for Red Herrings
G5. Chemists are Lazy

Chemistry

C1. It's all about charge
C2. Everybody wants to "be like Mike" (grp.18)
C3. Size Matters
C4. Still Waters Run Deep
C5. Alpha Dogs eat first

"A" students work (without solutions manual) ~ 10 problems/night.

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