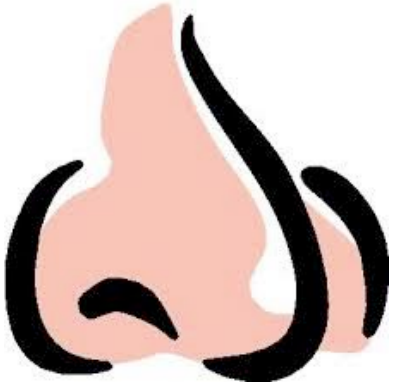
Objective 2

Classify substances as elements, compounds, mixtures.
Relate substance type to properties.
Use properties to identify substances and separate mixtures.

Properties Are Used to Identify Substances

How do you Identify your lab partner?

http://www.clipartpanda.com/categories/eye-clip-art-pictures



http://www.thedailyblarg.com/2011/05/how-not-to-wax-your-husbands-nose-hair.html

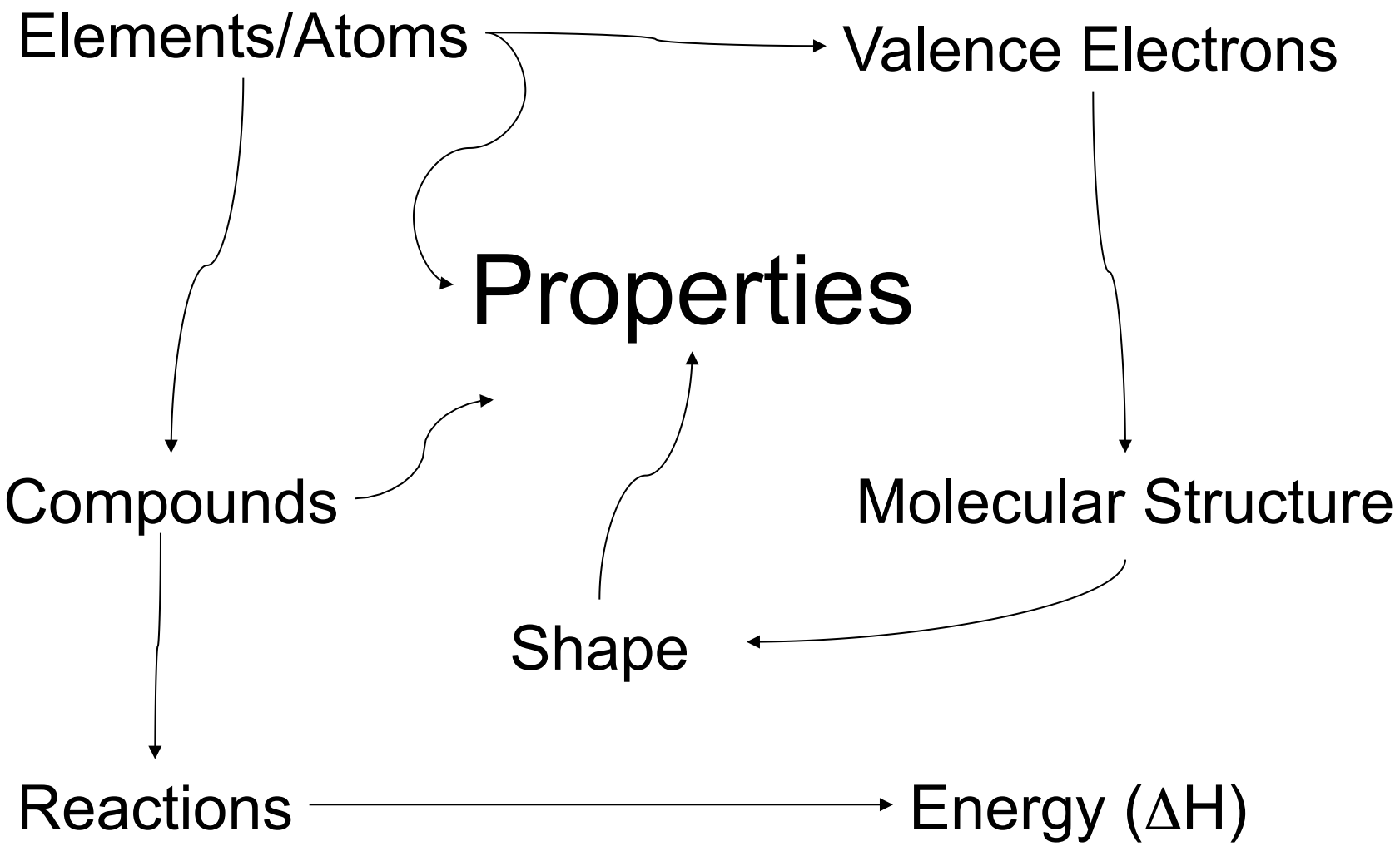
http://www.mycutegraphics.com/graphics/body/arm.html

Properties Are Used to Identify Substances

What is IT?

http://brocktonucc.org/wp-content/uploads/2015/07/female-detective-1.jpg

http://www.exportersindia.com/excelexportimport/white-crystal-salt-chennai-india-95322.htm


Elements/Atoms
Valence Electrons
Properties
Compounds
Molecular Structure
Shape
Reactions
Energy (ΔH)

Properties of Substances are Used to Make Useful Things

Applications

glass

semiconductors

batteries

lasers

alloys

insulators

magnets

conductors

Your iPhone has a lot of elements in it!

https://www.youtube.com/watch?v=66SGcBAs04w&feature=em-subs_digest

http://www.att.com/wireless/iphone/#fbid=xNZPDAbrXQr

Each Cell Phone Contains

40 elements: including Ag (300 mg), Au (30 mg), Pb, and Hg

Au concentration is 50x greater than in an ore in a mine

Only 27 of the 40 elements are economically recoverable.

Only 3% of 1.8 billion phones bought in 2014 are recycled.

We Americans have >200 million old phones "hibernating" at home.

More rare earth metals in electronics in landfills than all known global reserves.

< 1% of rare earth metals are currently recycled.

CEN, 9/1/14, p. 30 "Dialing Back on Cell Phone Waste"

Rare Earth Elements have many important applications:

Lanthanum
Neodymium
Praseodymium
Dysprosium
Terbium
Cerium
Europium

http://cen.acs.org/articles/88/i35/Securing-Supply-Rare-Earths.html

KEY COMPONENT

Clean energy technologies require rare-earth metals and other critical materials

	SOLAR CELLS PHOTOVOLTAIC FILMS	WIND TURBINES	VEHICLES: MAGNETS	VEHICLES: BATTERIES	LIGHTING PHOSPHORS
RARE-EARTH ELEMENTS					
Lanthanum				X	X
Cerium				X	X
Praseodymium		X	X	X	
Neodymium		X	X	X	
Samarium		X	X		
Europium					X
Terbium					X
Dysprosium		X	X		
Yttrium					X
OTHER CRITICAL MATERIALS					
Indium	X				
Gallium	X				
Tellurium	X				
Cobalt				X	
Lithium				X	

SOURCE: Department of Energy

http://cen.acs.org/articles/89/i20/Concern-Grows-Over-Rare-Earths.html

Objective: Use Properties to Classify Substances

What is an atom? Give an example.

What is an element? (An element is identified by the number of protons = **atomic number**.)
Give an example.
How are elements classified?
Name one property of each element type. (See the **Periodic Table**)

What is a molecule? Give an example. (Note: in 2001, only 22% of general public understood the term, "molecule.")

What is the difference between an atom, an electron, and an ion?
(Note: in 2010, only 51% of general public knew electrons are smaller than atoms.)

See "Chemistry Tree" for Substance Classification, Properties

PERIODIC TABLE OF THE ELEMENTS

Which elements are the ***metals***?

1A												3A	4A	5A	6A	7A	8A
1 H 1.008	2A																2 He 4.003
3 Li 6.939	4 Be 9.0122											5 B 10.811	6 C 12.011	7 N 14.007	8 O 15.999	9 F 18.998	10 Ne 20.183
11 Na 22.99	12 Mg 24.312	3B	4B	5B	6B	7B	8B			1B	2B	13 Al 26.982	14 Si 28.086	15 P 30.974	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.9	23 V 50.942	24 Cr 51.996	25 Mn 54.938	26 Fe 55.847	27 Co 58.933	28 Ni 58.71	29 Cu 63.546	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.922	34 Se 78.96	35 Br 79.904	36 Kr 83.8
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc [97]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.4	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.91	56 Ba 137.34	57* La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po 210	85 At 210	86 Rn 222
87 Fr 215	88 Ra 226.03	89** Ac 227.03	104 Rt [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [269]	109 Mt [268]	110 [271]	111 [272]	112 [277]		114 [289]		116 [289]		

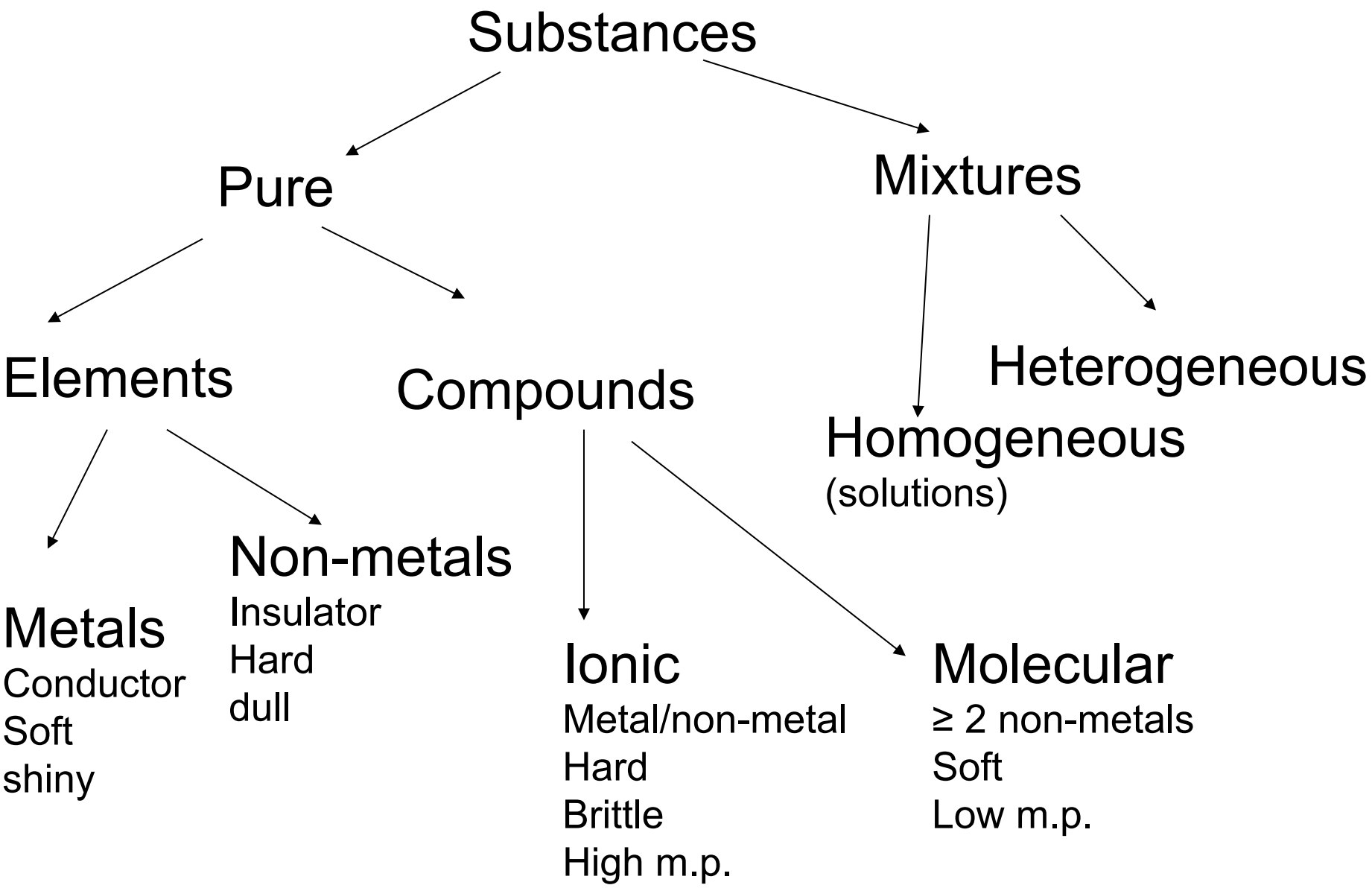
*Lanthanides	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 145	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.92	66 Dy 162.5	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
**Actinides	90 Th 232.04	91 Pa 231	92 U 238.03	93 Np 237.05	94 Pu 239.05	95 Am 241.06	96 Cm 244.06	97 Bk 249.08	98 Cf 252.08	99 Es 252.08	100 Fm 257.1	101 Md 258.1	102 No 259.1	103 Lr 262.11

Gaseous at room temperature
Liquid at room temperature
Gallium melts at 29.78 deg. C.
Synthetic elements
All other elements are solid at room temperature

Which elements are the ***non-metals***?

http://www.csudh.edu/oliver/chemdata/periodic/periodic-1.htm

Chemistry Tree (like a Family Tree)



In What Form Are The Elements In Our Body?
Element or Ion?

Iron is used to make Steel and is essential in our diet.
Where is iron found on earth?
What is the form of iron from this source?

http://blog.khymos.org/tag/shiny/

Some Elements are Essential in your Diet

Mineral	Major Functions	Dietary Sources
Calcium	Bone and tooth development and maintenance. Muscle contraction and nerve transmission.	Milk, cheese, green vegetables, fortified orange juice.
Fluoride	Maintenance of tooth and bone structure.	Fluoride-containing drinking water, tea.
Iron	Major component of hemoglobin Aids in energy utilization.	Organ meats, eggs, enriched flour, dark green vegetables, dried fruit.
Zinc	Essential component of hormones, insulin, and enzymes, wound healing, immune response.	Milk, meat, eggs, liver, seafood, dried beans.
Iodine	Essential part of thyroid hormones, regulation of metabolism.	Iodized salt, seafood.
Magnesium	Enzyme activity, transmission of nerve impulses, protein production.	Whole grains, seafood, green vegetables.
Potassium	Nerve function and body water balance.	Dates, raisins, bananas, grains, legumes, milk, meats.
Phosphorus	Bone growth and maintenance, energy transfer in cells.	Eggs, fish, meat, poultry, grains, cheese, milk.
Selenium	Antioxidant. Immune response.	Seafood, meat, eggs, whole grains.
Sodium	Body water balance.	Salt, soy sauce, tomato juice.

FDA allows 12 claims on food labels linking food components and disease risk (http://pubs.acs.org/cgi-bin/bottomframe.cgi?7748spectab1)

Food/food component	Relationship to disease
Calcium	Prevents osteoporosis
Dietary lipids	Cause cancer
Sodium	Causes hypertension
Dietary saturated fat and cholesterol	Cause coronary heart disease
Fiber-containing grain products, fruits, and vegetables	Prevent cancer
Fruits, vegetables, and grain products that contain fiber, particularly soluble fiber	Prevent coronary heart disease
Fruits and vegetables	Prevent cancer
Folate	Protects against neural tube defects
Dietary sugar alcohols	Protects dental caries
Soluble fiber from certain foods (oats and psyllium husk)	Prevents coronary heart disease
Soy protein	Prevents coronary heart disease
Whole grain foods	Prevents certain kinds of cancer, including lung, colon, esophagus, and stomach

Objective: Identify and distinguish between atoms, molecules, and ions

The FDA recommends a daily intake of sodium of 2300 mg. What is a source of sodium in our diet?

a. Sodium metal b. sugar c. salt d. carbon

What is the form of sodium from this source?

a. element b. molecule c. ion

1 tsp ___ = 2,400 mg sodium
Americans consume an average of 3,440 mg sodium/day.
Biggest source of dietary sodium is bread (7.3%), followed by pizza (6.3%)
C&EN, 9/16/13, p. 12.

One Source of Elements is Cookware!

What are your pots and pans made of?

Aluminum leaches out from aluminum pans into your food, especially acidic foods.
E.g., the amount of aluminum in spaghetti sauce increased from 2.5 to 7.5 milligrams per quart from cooking in an aluminum pan.
Typical person ingests 7-9 mg Al per day
Other sources of Al: antacids, buffered aspirin, baking powder.

Stainless Steel (Fe, C, Ni, Cr, Mo): small amounts of minerals leach out; can be a useful source of Cr and Fe. But Ni may cause allergic reactions.

Iron: E.g., the iron level in the spaghetti sauce from 6 milligrams to more than 700 milligrams per quart of sauce during cooking. Since 10 to 18 milligrams of iron is recommended daily, iron cookware can be a significant source of iron.

http://cen.acs.org/articles/91/i22/Toying-Around-Toxic-Metals.html

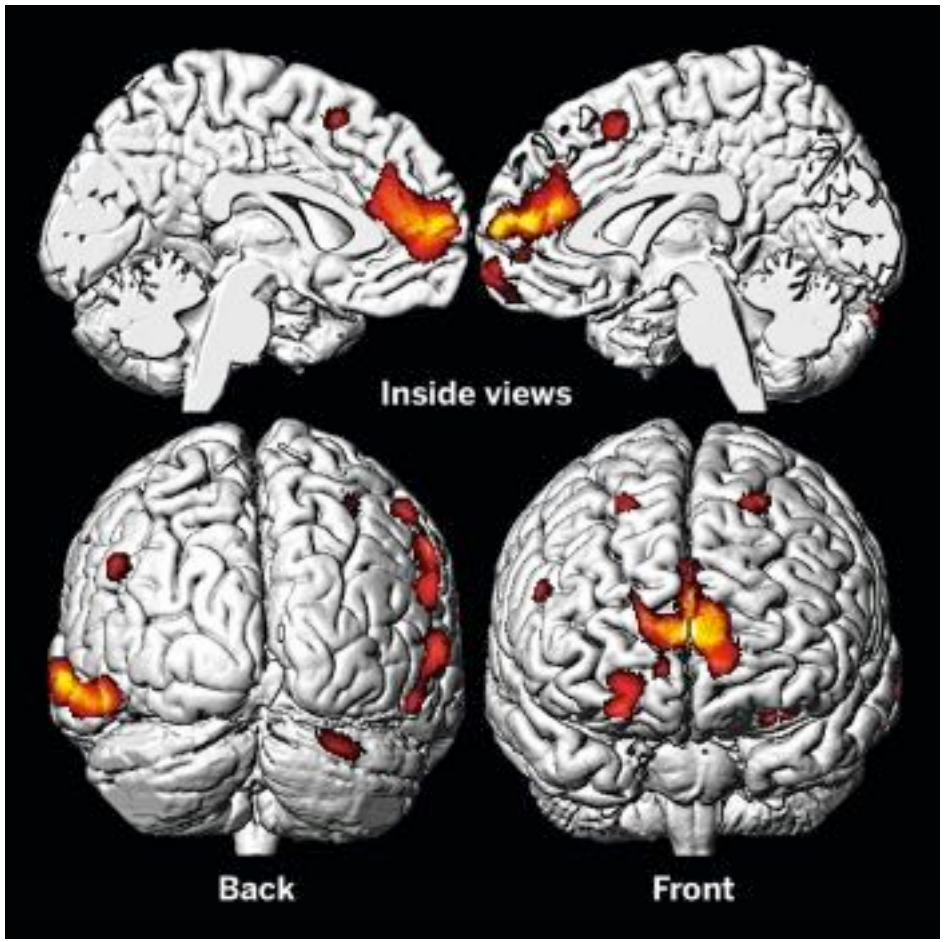
6/3/13, CEN, "Toying Around With Toxic Metals", p. 32

Exposing to harmful metals, such as arsenic, cadmium, chromium, and lead from lip gloss or children's jewelry.

Researchers estimated that *women get more than 20% of their acceptable daily intake* of aluminum, cadmium, and chromium from applying lipstick roughly twice per day.

http://cen.acs.org/articles/92/i5/Crimes-Lead.html

2/3/14, C&EN, p. 27 Lead Exposure May Lead to Criminal Acts



Lead appears to interfere with the dopamine (neurotransmitter) system in our brains. It controls **reward and impulse behavior**, a factor in aggression. Another is the glutamate system, responsible in part for **learning and memory**.

Composite MRI images of about 160 members of the Cincinnati Lead Study show that childhood exposure to lead causes gray matter loss (orange areas), especially in frontal areas of the brain.

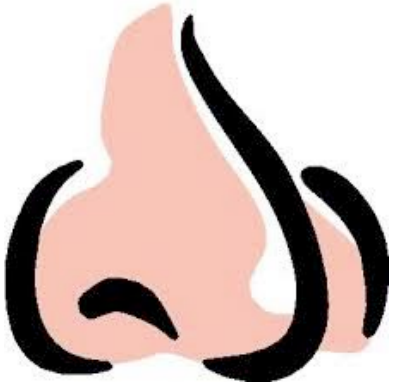
Buffalo Wild Wings Sells ***Mercury***?!

C&EN, 6/2/14, p. 40
(http://cen.acs.org/articles/92/i22/Unexpected-Chemical-Sightings-Debunking-Drinkable.html)

Properties Are Used to Identify Substances

How do you Identify your lab partner?

http://www.clipartpanda.com/categories/eye-clip-art-pictures



http://www.thedailyblarg.com/2011/05/how-not-to-wax-your-husbands-nose-hair.html

http://www.mycutegraphics.com/graphics/body/arm.html

Properties Are Used to Identify Substances

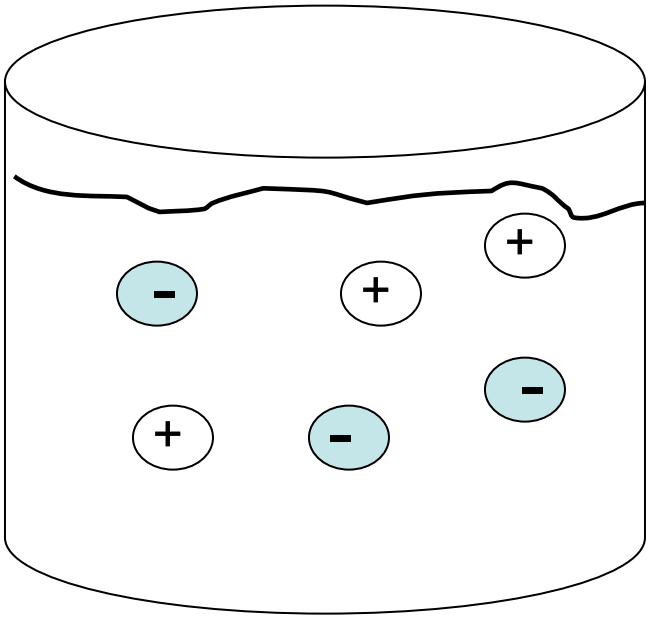
How do you identify a substance?

Color
Density
Melting point
Boiling point
Etc.

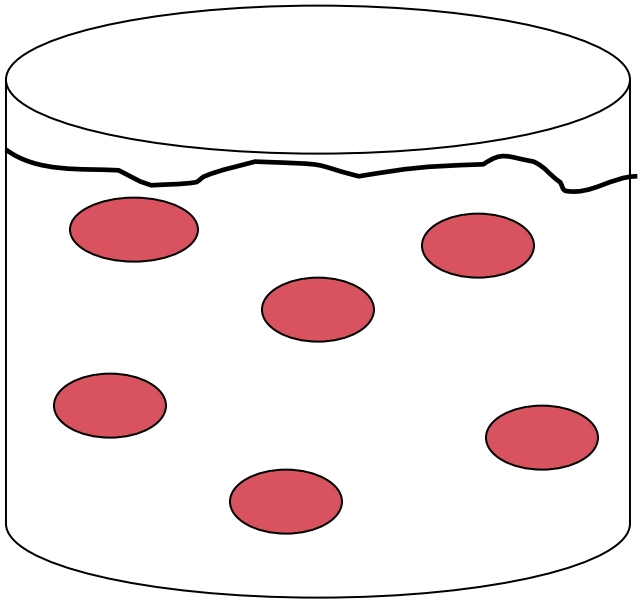
http://www.dreamstime.com/stock-photo-blue-liquid-image14658340

A Compound Dissolves (Soluble) in Water

Which one is an electrolyte solution?



1



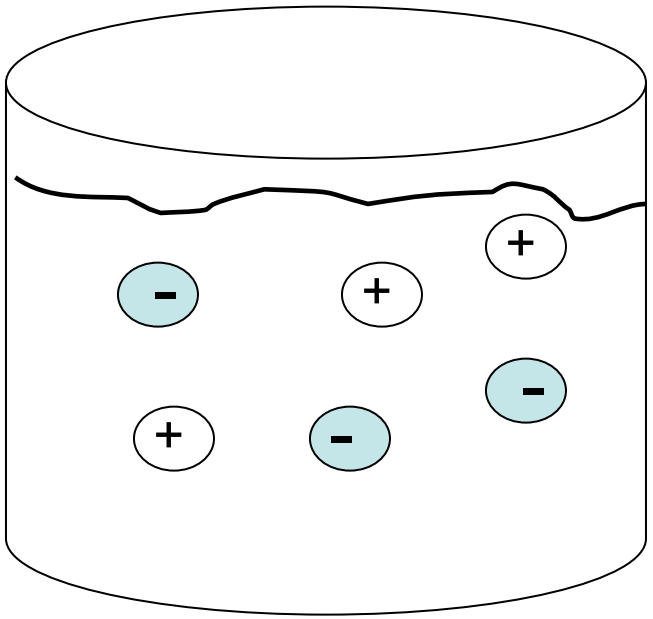
2

What experiment tells you whether you have (1) or (2)?

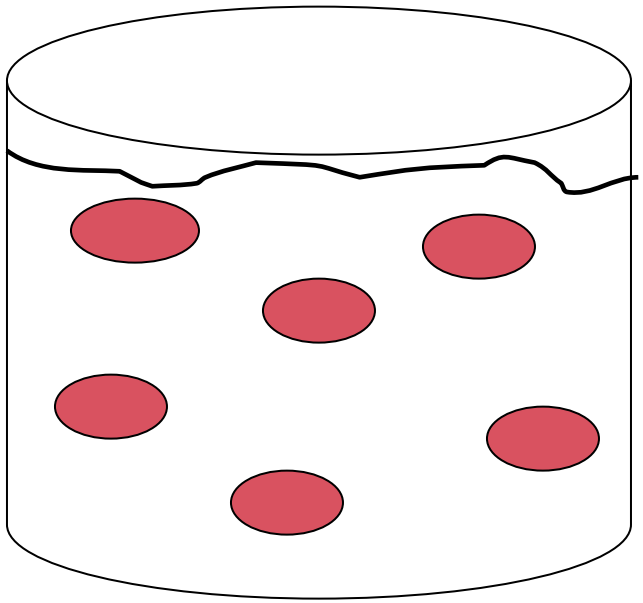
A Compound Dissolves (Soluble) in Water

Which one is a NaCl solution?

Which one is a sugar ($C_{12}H_{22}O_{11}$) solution?



1

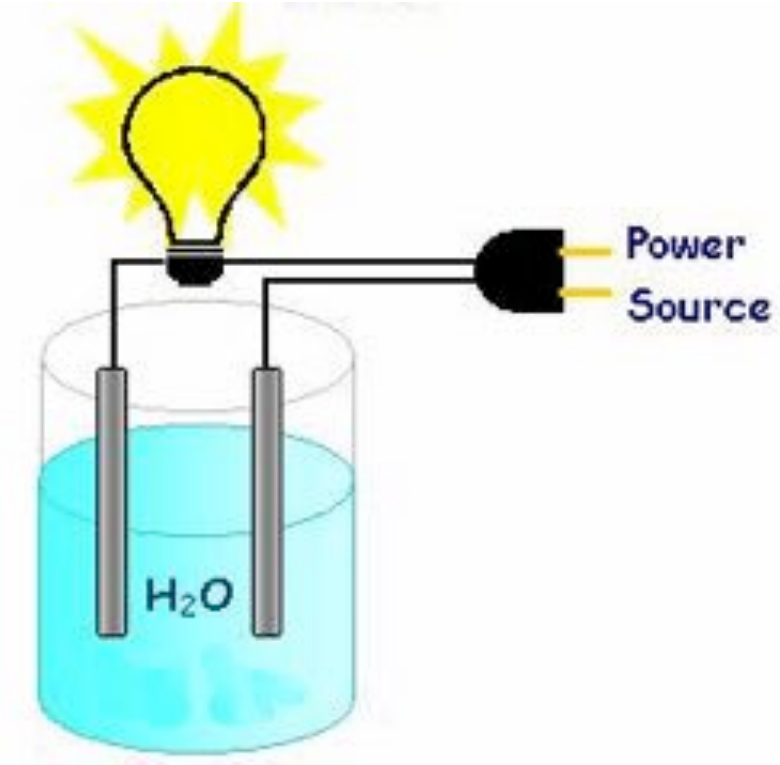


2

What experiment tells you whether you have salt (aq) or sugar (aq)?

Objective: Use Properties to Identify and Distinguish between Atoms, Molecules, and Ions

A white solid is added to a beaker of water. The solid is either **sugar** or **salt**.



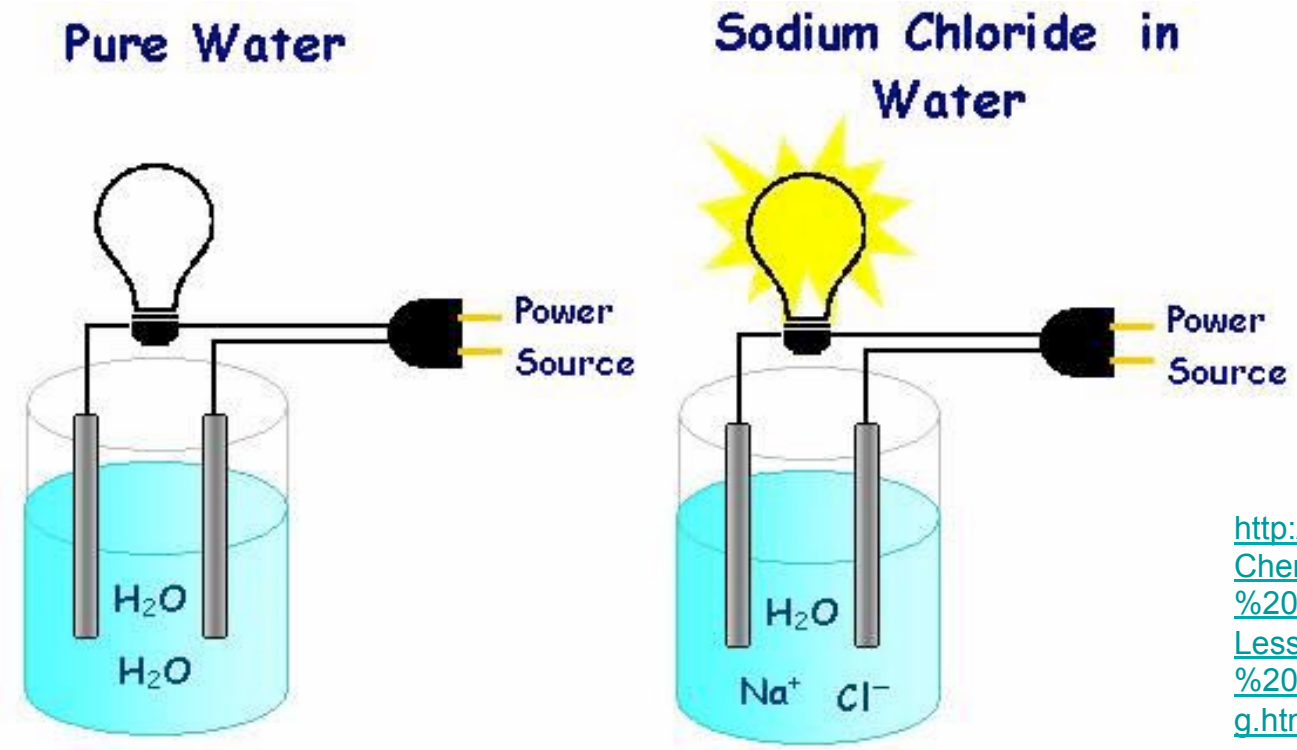
What is the solid?

Sugar

Salt

Salt = sodium chloride = NaCl = Ionic Compound
Sodium ion = Na^+
Chloride ion = Cl^-

NaCl is soluble in water.
Forms electrolyte solution:
Na^+ (aq) + Cl^- (aq).



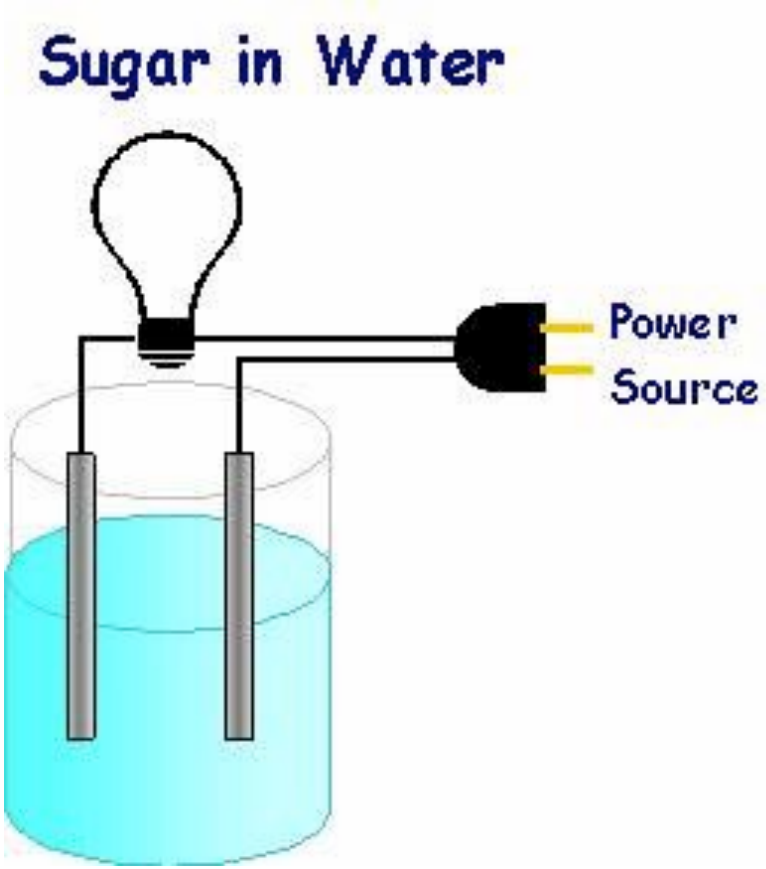
http://theshiksa.com/2012/06/04/salt-friend-or-foe/

http://www.mts.net/~alou/Chemistry%2011/Unit%204%20-%20Solutions%20Lessons/Lesson%202%20-%20The%20Process%20of%20Disolving.htm

Sugar = sucrose = $C_{12}H_{22}O_{11}$ = molecular compound

http://www.theguardian.com/lifeandstyle/2014/jan/13/sugar-how-to-give-up-11-easy-steps

Sugar is soluble in water.
Forms non-electrolyte solution:
$C_{12}H_{22}O_{11}$ (aq) = NO ions



http://www.mts.net/~alou/Chemistry%2011/Unit%204%20-%20Solutions%20Lessons/Lesson%202%20-%20The%20Process%20of%20Disolving.htm

Objective: Use Properties to Identify and Distinguish between Atoms, Molecules, and Ions

Water is added to a beaker containing **sugar** ($C_{12}H_{22}O_{11}$) and **salt** (NaCl).
An electrolyte solution forms.
What ion(s) are in this solution?

a. C^{4+}
b. O^{2-}
c. Na^{+}
d. Na
e. Cl^{2-}
f. Cl^{-}
g. CO_3^{2-}

6 tsp sugar = 100 Cal
Americans consume >355 Cal of added sugar per day.
AHA recommends added daily sugar limit of 100 Cal for women and 150 Cal for men.
C&EN, 9/16/13, p. 12.

You are asked to identify a solid for $$.
You make the following observations:

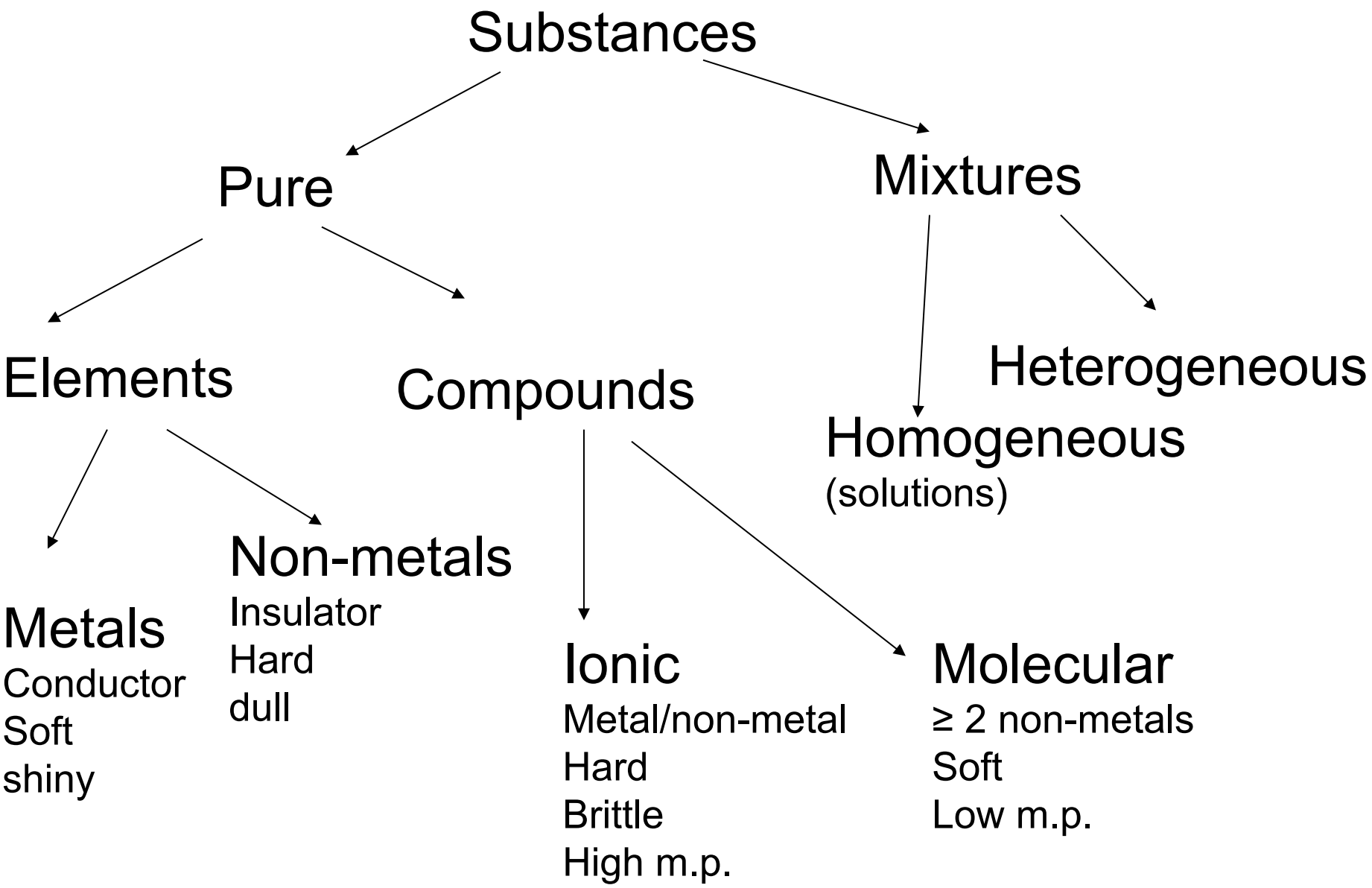
- it is white
- it has a low melting point
- it dissolves in water
- the conductivity is of the solution is low

This solid is a:

a. Metal
b. Non-metal
c. Ionic compound
d. Molecular compound
e. mixture

http://cosmeticsadd.blogspot.com/2012/03/what-is-lauric-acid-used-for.html

Chemistry Tree (like a Family Tree)

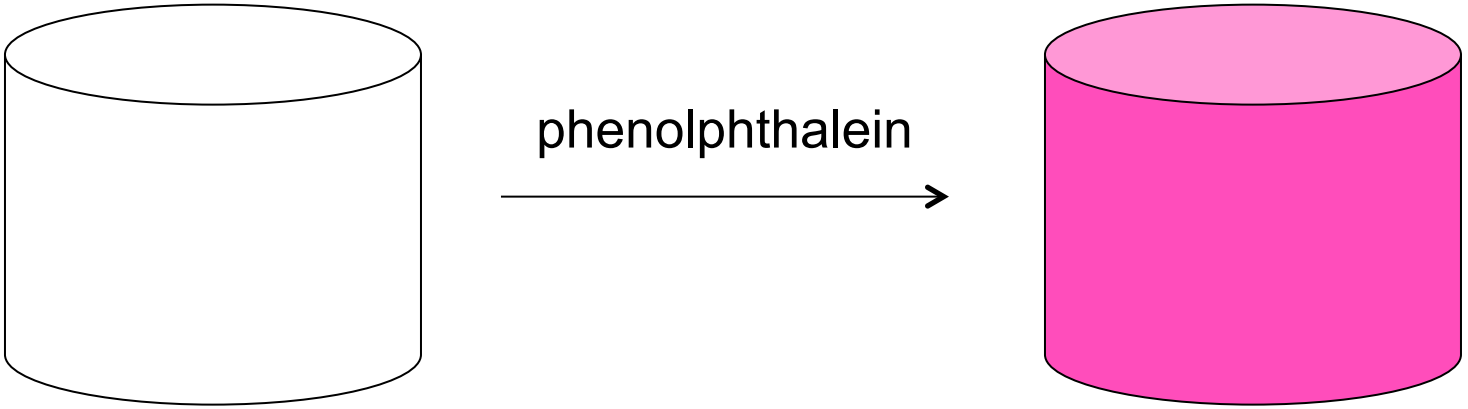


You are given a white solid and told it is either sugar or salt.
You do the following tests:

Test	Observation	Conclusion
i	solid dissolves in water	
ii	conductivity is high	
iii	melting point = 800^{o}C	

What is the solid? Give reasons.

You add 1 drop of phenolphthalein to a colorless solution. The solution turns pink.
The colorless solution is a _____.



Acids and Bases are very common substances

Acids Are Givers; Bases Are Takers

	Acids	Bases
Definition	H^+ donor	H^+ acceptor
Taste	Sour	Bitter
Litmus	Blue --> Red	Red --> Blue
Phenolphthalein	Colorless	Pink
pH	< 7	> 7
Reactivity	With metals	Does NOT react with metals
	With Bases	With Acids

Acids/Bases can donate/accept more than 1 H^+ (polyprotic)

http://happierthanever.com/how-to-solve-problems-with-a-glass-of-water/

What is the pH of water?
What is $[H^+]$ of water?
What is the pOH of water?
What is the $[OH^-]$ of water?
Why is water considered a neutral solution?

Water and Aqueous Solutions Contain H^+ and OH^-

pH is a measure of $[H^+]$

$pH = -\log [H^+]$	$[H^+] = 10^{-pH}$

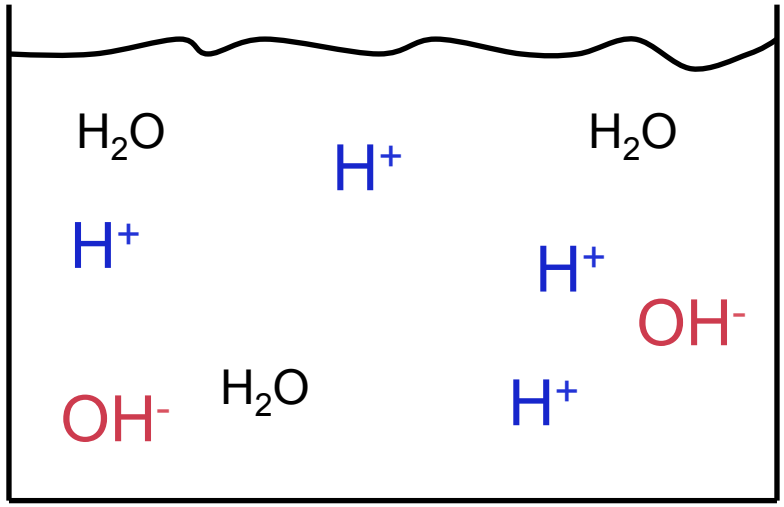
pOH is a measure of $[OH^-]$

$pOH = -\log [OH^-]$	$[OH^-] = 10^{-pOH}$

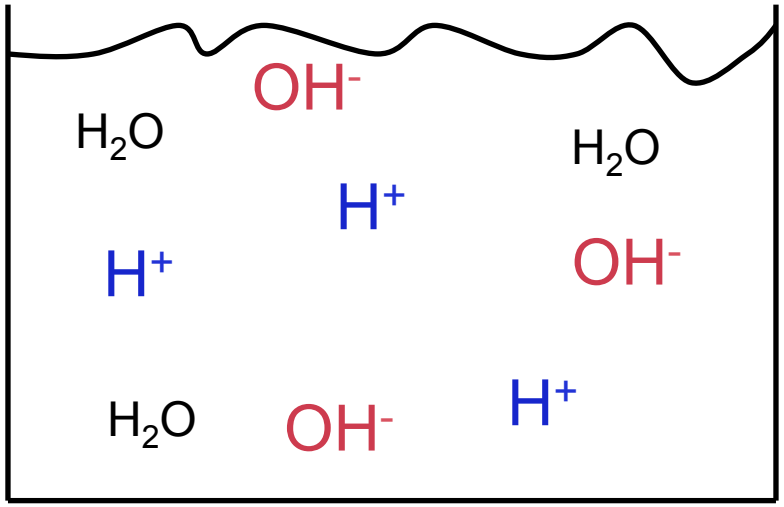
pH and pOH are related:

$pH + pOH = 14$	$[H^+][OH^-] = 1 \times 10^{-14}$

Water and Aqueous Solutions Contain H^+ and OH^-



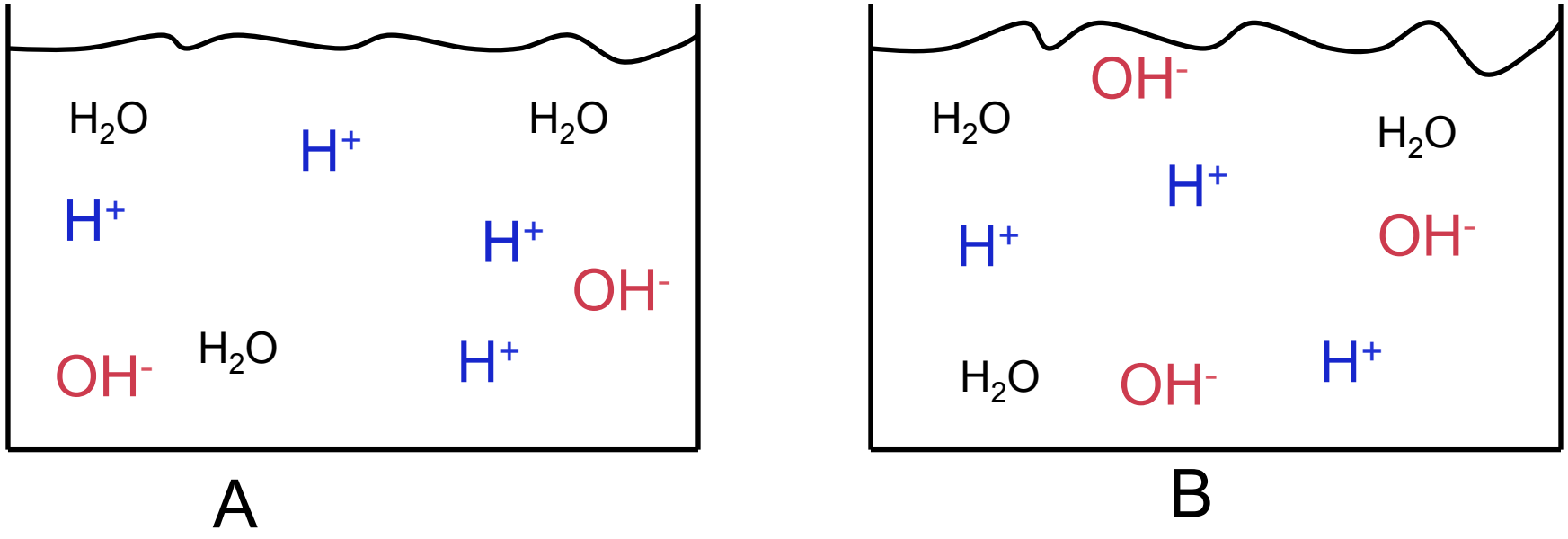
A



B

Which solution is neutral?	A	B	neither
Which solution is an acid?	A	B	neither
Which solution is a base?	A	B	neither

Water and Aqueous Solutions Contain H^+ and OH^-



Which solution has a higher pH?

A B neither

Which solution has a higher pOH?

A B neither

Water and Aqueous Solutions Contain H^+ and OH^-

Water has _____ concentration of H^+ and OH^-

a. higher b. lower c. same

Acids have _____ H^+ than OH^-

a. more b. less c. same

Bases have _____ H^+ than OH^-

a. more b. less c. same

Which Hand (right or left) is the Acid?

http://www.econtech.com/newsletter/february2011/february2011a1.php

Acids Are Givers; Bases Are Takers

Which is the Giver, HA or H_2O?

What is it Giving?

Acids Are Givers; Bases Are Takers

$$HA + H_2O \longrightarrow A^- + H_3O^+$$

A Strong Acid _____ its H^+ compared to a Weak Acid.

a. easily donates

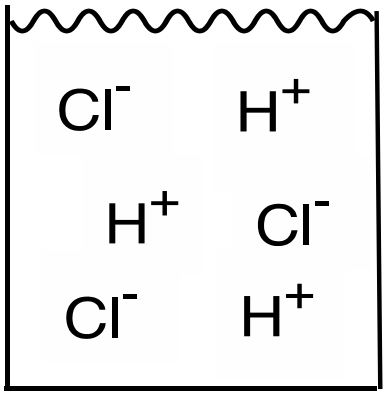
b. holds onto

A Cheapskate is like a ____ acid.

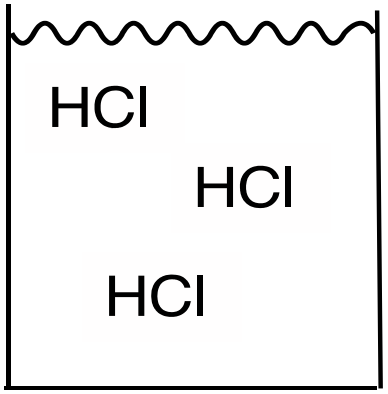
c. strong

d. weak

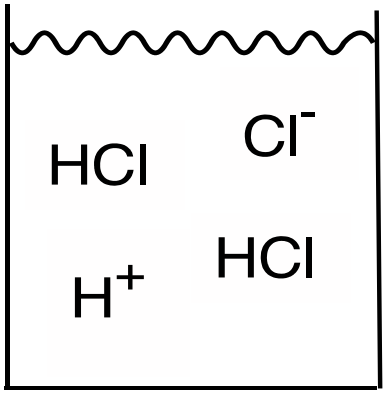
Muriatic acid (HCl) is a common acid used in metal cleaning and the manufacture of chemicals and rubber. Which picture best describes HCl?



A



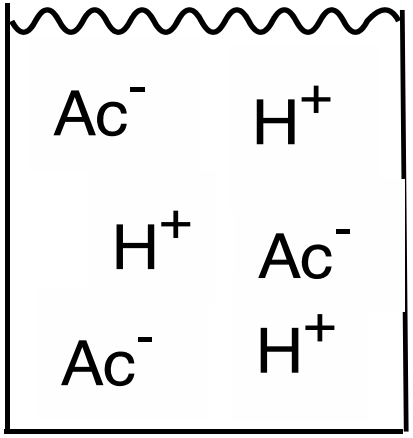
B



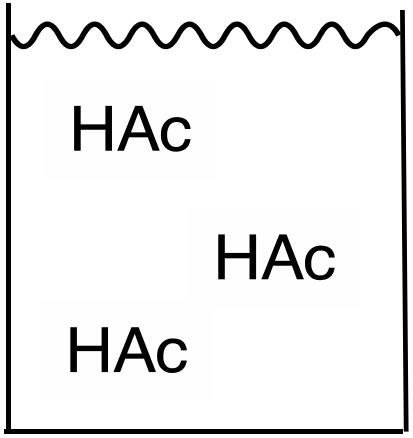
C

What experiment tells you whether you have A, B, or C?

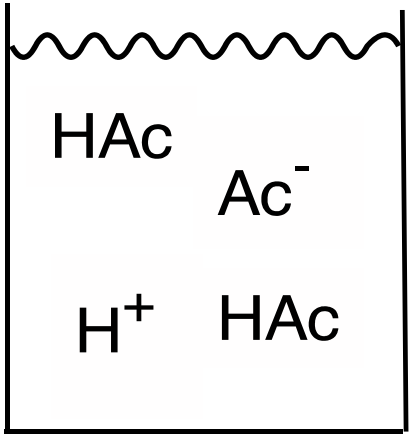
Vinegar contains acetic acid ($HC_2H_3O_2$). Which picture best describes acetic acid?



A



B



C

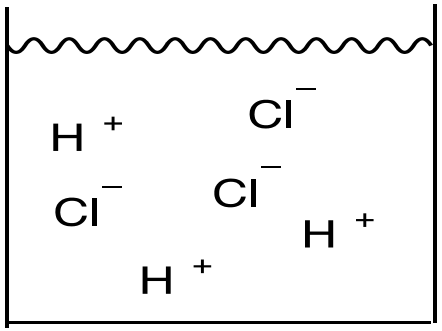
What experiment tells you whether you have A, B, or C?

Acids are Givers; Bases are Takers

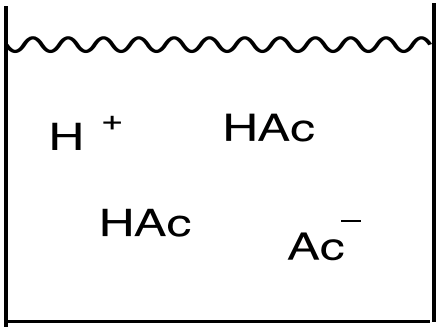
Some Acids are Better Givers (Stronger Acids) than Others

Some Bases are Better Takers (Stronger Bases) than Others

Strong Acid is like a big spender:
easily donates its H^+,
dissociates completely into its ions



Weak Acid is like a cheapskate:
does not easily donate its H+,
dissociates partially into its ions



pH measures $[H^+]$ ==> $pH = -\log [H^+]$ or $[H^+] = 10^{-pH}$

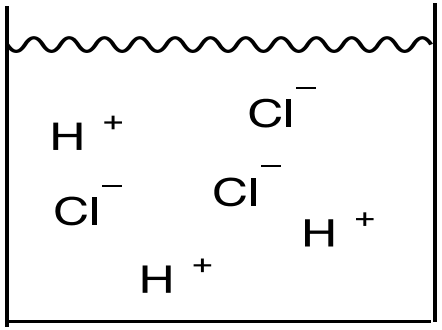
Low pH means high $[H^+]$ (acid)

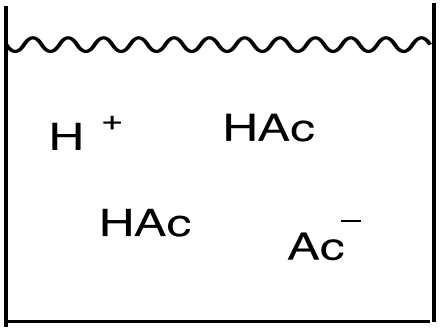
High pH means low $[H^+]$ (base)

Acids and Bases Are Aqueous *Solutions*

Electrolyte solutions have many ions --> _____ conductivity (carry electricity).
Weak or non-electrolyte solutions have few ions --> _____ conductivity.

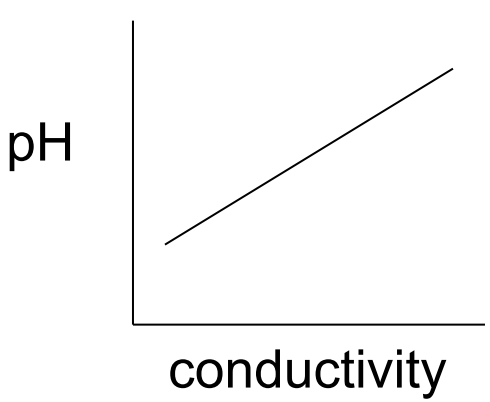
Compare a 0.1 M HCl solution to a 0.1 M $HC_2H_3O_2$ solution.
a. Which solution has the higher conductivity?
b. Which solution has the higher pH? Give reasons.

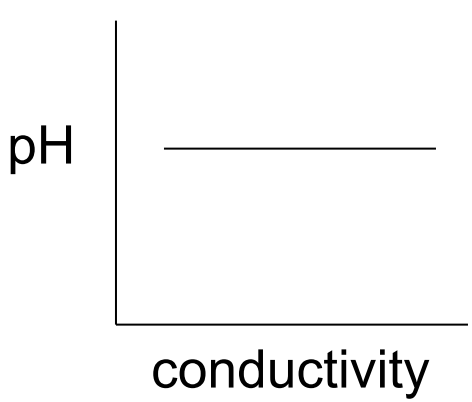


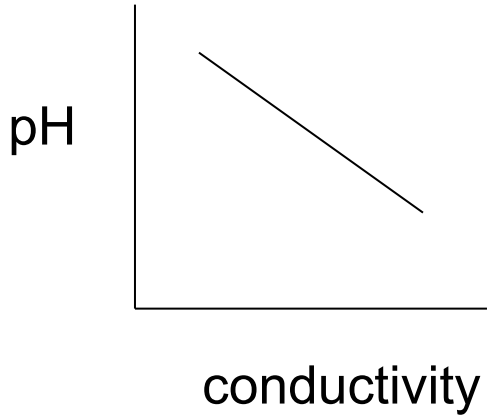


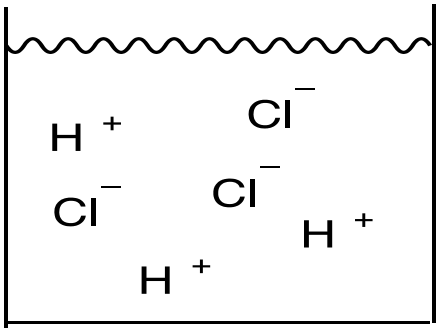
Acids and Bases Are Aqueous *Solutions*

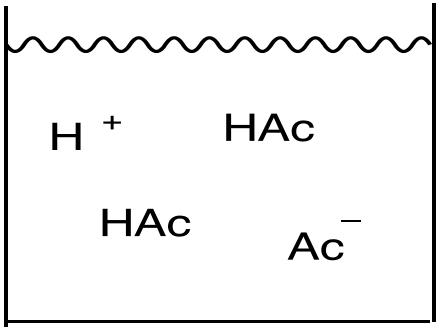
Which graph represents the pH-conductivity relationship of acids?











Strong acid = high conductivity. Weak acid = low conductivity

You are given the same concentration of a strong acid and weak acid. Strong acid has a lower pH than a weak acid.

A **Base** is an anion or anion part of ionic compound.

H_2CO_3 (aq) <==> 2 H^+ (aq) + CO_3^{2-} (aq)

acid conjugate base

Na_2CO_3

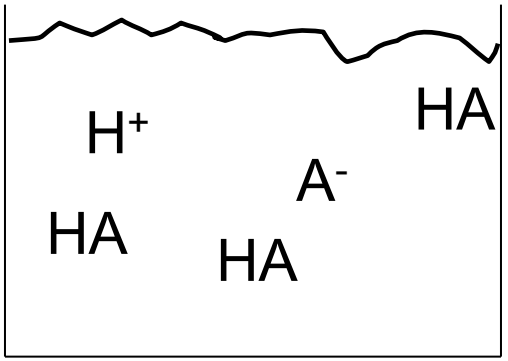
1. Tests on a colorless liquid show a pH of 9, blue litmus stays blue, turns phenophthalein pink, and tastes bitter. It must be:

(i) acid (ii) neutral (iii) base

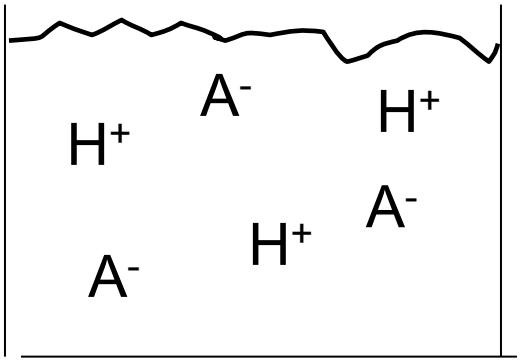
2. Every acid has a conjugate (partner) base. The conjugate base of HCl is:

(iv) H^+ (v) Cl^- (vi) H_2Cl (vii) H_3O^+

3. HA is a strong acid. Which picture represents HA?



(viii)



(ix)

4. Which type of acid has a high conductivity?

(i) strong acid (ii) weak acid

5. You are given the same concentration of a strong acid and weak acid. A strong acid has a _____ pH than a weak acid.

(iii) higher (iv) lower

You are given a colorless liquid.

Test	Observation
Blue litmus	blue
Phenolphthalein	colorless
Conductivity	low

What is the identify this liquid?

a. Strong acid

b. weak acid

c. Water

d. base

(From Exam 1, Fall 2013) You are given 100 ml of a colorless liquid and told it is either 0.25 M sulfuric acid, 0.25 M acetic acid, 0.25 M sodium hydroxide, or 0.25 M sugar (sucrose, $C_{12}H_{22}O_{11}$).

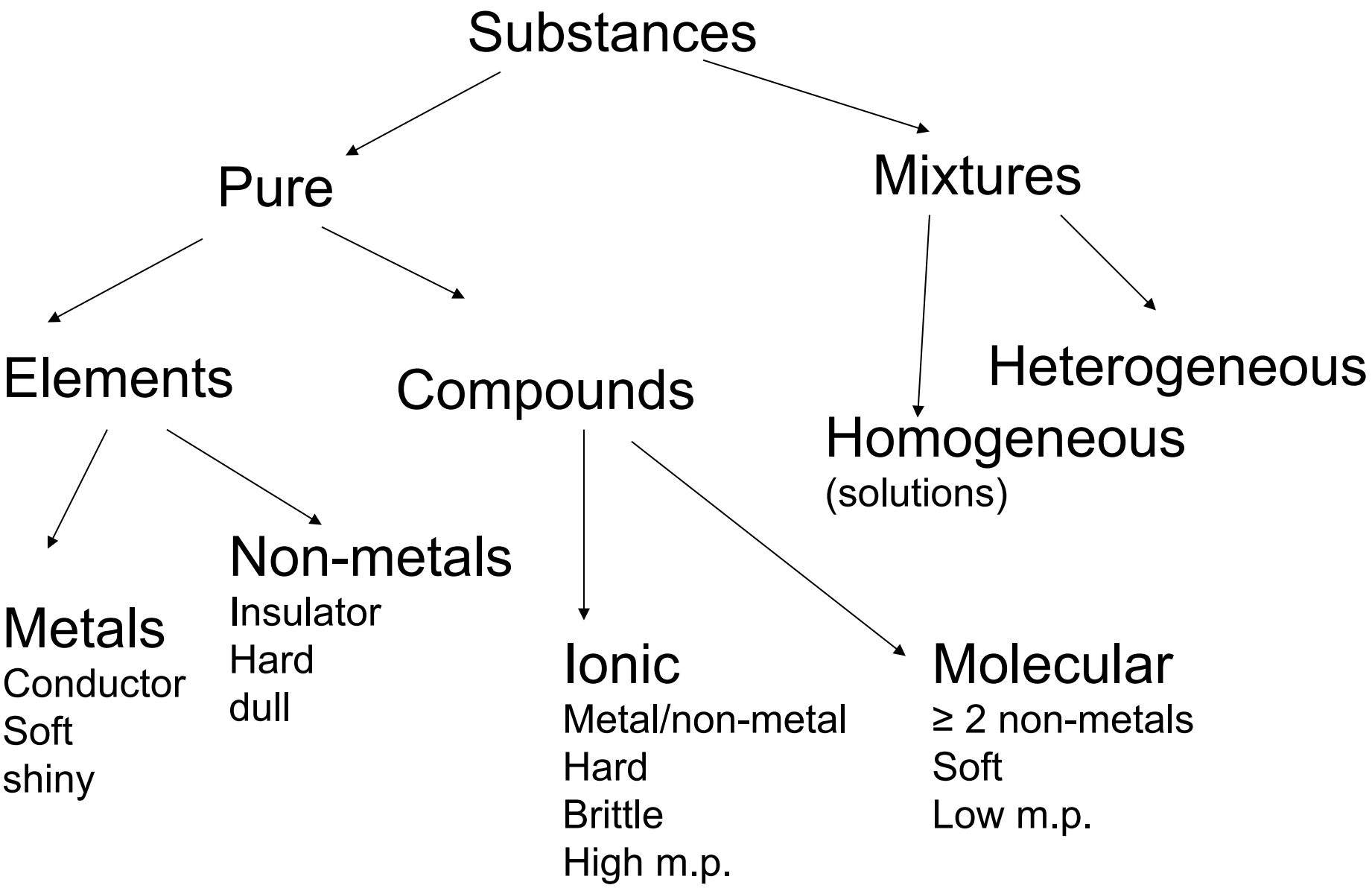
a. Which of the four liquids has the highest pH? Give reasons.

b. You do the tests shown in Table 1. For each test, draw a conclusion and eliminate, if possible, one or more of the liquids.

Test	Observation	Conclusion	Liquid you can eliminate
Red litmus	red		
pH	2.7		
Conductivity	1000 μS/cm		

c. What is the identity of the colorless liquid?

Chemistry Tree (like a Family Tree)



Lab

You are given a mixture of sand and water. How would you separate this mixture?

http://teachers.saschina.org/ahossack/2010/09/20/sand-and-water/

Use a Difference in a Property to Separate A Mixture Into Pure Substances

Separation Method	Mixture Type	Property	Example
Filtration	Solid/liquid	State	Sand/water
Distillation	Liquid/liquid	b.p.	Ethanol/water
Recrystallization	Solid/solid	Solubility	Aspirin and impurities

Describe how you would separate each mixture. What property is used to accomplish this separation?

a. sand/salt mixture

b. salt water mixture

Lab

Bring a soda

How will you separate the sugar from the rest of the soda?

What property will you use to do this separation?

http://en.wikipedia.org/wiki/File:Glass_of_beer_MONGO.jpg

Lab

Your adult beverage needs more spirit. How do you make it more spirited?

Ethanol (C_2H_5OH) Is Made From Sugar

Sugar – fermentation → 13-15% ethanol – distill → 95% ethanol
yeast (anaerobic)

Ethanol:water distillation

An *azeotrope* is a mixture of two or more pure compounds (chemicals) in such a ratio that its composition cannot be changed by simple distillation. This is because when an azeotrope is boiled, the resulting vapor has the same ratio of constituents as the original mixture of liquids. Because composition is unchanged by boiling, azeotropes are also known as constant boiling mixtures.

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

Break azeotrope by adding a material separation agent, e.g., benzene, doing a pressure swing distillation (azeotrope is pressure dependent), or using molecular sieves.

http://auto.howstuffworks.com/make-your-own-ethanol2.htm

Ethanol physiology: http://scifun.chem.wisc.edu/GenChem/Enrichment/Strang.htm

Distillation and oil refining

http://science.howstuffworks.com/oil-refining4.htm

Properties Are Characteristic Features of a Substance

Use properties to ***identify*** a substance

- density
- m.p., b.p.
- color
- solubility

Use a **difference** in one property to ***separate*** a mixture

- density
- m.p., b.p.
- color
- solubility

Silicon is used in the electronics industry. Electronic grade silicon (EGS) must have 99.999999999% purity. EGS is refined from metallurgical grade silicon (MGS) by growing single crystal silicon using the Czochralski method. The main impurities in Si are Fe, Al, Mg, and Ca. The total concentration of elements other than carbon and oxygen must be reduced below 1 part per billion (ppb). Only the electrically inactive elements carbon and oxygen are each allowed to occur in concentrations above 1 ppb.

References: http://serve.me.nus.edu.sg/nanomachining/wafer_preparation.htm
http://people.deas.harvard.edu/~jones/es154/lectures/lecture_2/materials/materials.html
http://www.techfak.uni-kiel.de/matwis/amat/elmat_en/kap_5/backbone/r5_1_2.html

a. What property is used to purify silicon? Look up the numerical value of this property of silicon and the main impurities in silicon.

b. The impure silicon is heated to 1500^{o}C in a crucible. Could aluminum be used for a crucible? Give reasons. If aluminum can't be used, what type of substance could be used as a crucible material? Give reasons.

c. The Czochralski method separates the impurities from Si. A seed crystal of pure Si is dipped into the Si melt and slowly withdrawn. As the seed crystal is pulled away from the melt, a pure Si ingot develops. What happens to the concentration of impurities in the melt as the seed crystal is withdrawn? Can the entire melt be used to make a Si ingot? Give reasons.

d. Why do you think carbon and oxygen are allowed to have higher concentrations than other impurities?

http://cen.acs.org/articles/91/i13/Toward-Sustainable-Electronics.html

4/1/13, CEN, p. 41 “Toward Sustainable Electronics”

RECYCLING ELECTRONICS BY THE NUMBERS

Nearly **400** million electronic gadgets were discarded in the U.S. in 2010, constituting **2.4** million tons of e-waste.

Electronics typically aren’t designed for recycling; only **27%** was collected for recycling.

Up to **80%** of that amount was shipped to developing countries.

SOURCE: Environmental Protection Agency