

Water Purification and Mixtures

Unit 14, Chemistry Themed

Some Possible Fishkill Issues

- Cost
 - Loss in revenue to local business, especially tourism (would you visit such a place?)
 - Lasting impact to reputation because of negative publicity
 - Expense of shipping drinking water
 - Investigation costs
 - Clean up cost of dead fish
 - Cost of permanent solution (depends on results of investigation)
- Health
 - Whatever killed the fish, might harm humans too
 - Bacteria from rotting fish may foul water
 - Insects may spread disease from dead fish to humans
- Inconvenience
 - Water used for sanitation and hygiene limited or unavailable
 - Uncertainty as to length of problem

Direct and Indirect Water Use

- Could you see the water that was used?
 - If so, that's direct water use
 - Examples: Washing clothes, drinking, watering the lawn
- Was the water used “behind the scenes”?
 - If so, that's indirect water use
 - Examples: Food (it takes a great deal of water to grow a grape, raise cattle, make a piece of paper, etc.)

How America Uses (fresh) Water.... Depends on where you live!

- Dry, sparsely populated regions use water mostly for agriculture (West)
- Larger populations need a greater portion for power and domestic (household)
- Many different uses of fresh water throughout the world, but some places don't have enough!
- Below is the distribution from your text:

Purpose	Region						
	Nation	East	South	Midwest	West	Alaska	Hawaii
Domestic	12	14	10	12	11	8	14
Irrigation/Livestock/Aquaculture	34	3	20	23	76	68	6
Industrial	4	5	7	5	1	1	2
Mining	1	1	1	2	1	19	0
Thermoelectric-power	49	78	63	58	11	3	78

Earth's Fresh Water Supply

- The earth is covered by 2/3 water, but that doesn't mean that usable water is available
- Water is a very valuable resource for any nation on earth
- Ocean water is salt water (not fresh): 97.2% of all water are in oceans
- Distribution of the 2.8% of earth's fresh water:
 - 2.11% in glaciers and ice caps
 - 0.62% in aquifers (underground, reached by wells)
 - 0.009% in lakes (Hinsdale's water source)
 - 0.001% in the air (water vapor... what gives us "humidity")
 - 0.0001% in rivers

Oil of the 21st century

- Water rights are expected to cause conflicts between nations as the century continues
- Many people rely on wells (aquifers: “groundwater”)
- Wells need to be much deeper than decades ago – run dry eventually
- Hinsdale gets it’s water from lake Michigan (luckily)

Water purification: Lab, Nature & Municipal

Lab

- Decanting including picking off large particles
- Coarse filtration (through gravel)
- Fine filtration (through sand)
- Charcoal adsorption (removes foul taste/odor)

Nature

- Evaporation/precipitation
- Filtration (to aquifers)
 - Slow
 - “hardens” water (Ca, Fe ions, etc.)

Man (municipal)

- Screening (large debris filtration)
- Flocculation: $\text{Al}(\text{OH})_3$ traps suspended particles
- Settling (solids sink)
- Sand filtration
- Disinfection:
 - Chlorination (THM's)
 - Ozone or UV (temporary)

Percent purified water & Distillation

- Foul water lab: Percent purified = $100\% * \text{Purified volume} / \text{Original volume}$
- Distillation
 - Just like we learned in petroleum: Separation based on boiling point
 - Water is heated up to where it boils
 - Salt, etc., have very high BP and don't boil (remain dissolved)
 - Vapor expands and is cooled
 - Pure water is collected
- Produced very pure water, but very Expensive!
- Pure water doesn't conduct electricity (ions dissolve in it do)
- Water purity can be (partially) tested by measure electrical conductivity

Some important water properties

- (Pure) Water doesn't conduct electricity – not an ion!
- Water is a polar molecule
 - Uneven distribution of electrons (electrons crowd around oxygen atom a lot)
 - Strong attractive force between water molecules (hydrogen bonding)
 - Beads up (surface tension)
- Density is 1.00 g/mL
- Liquid water is MORE dense than solid water (ice) – very unusual!

Chemical Formulae (review)

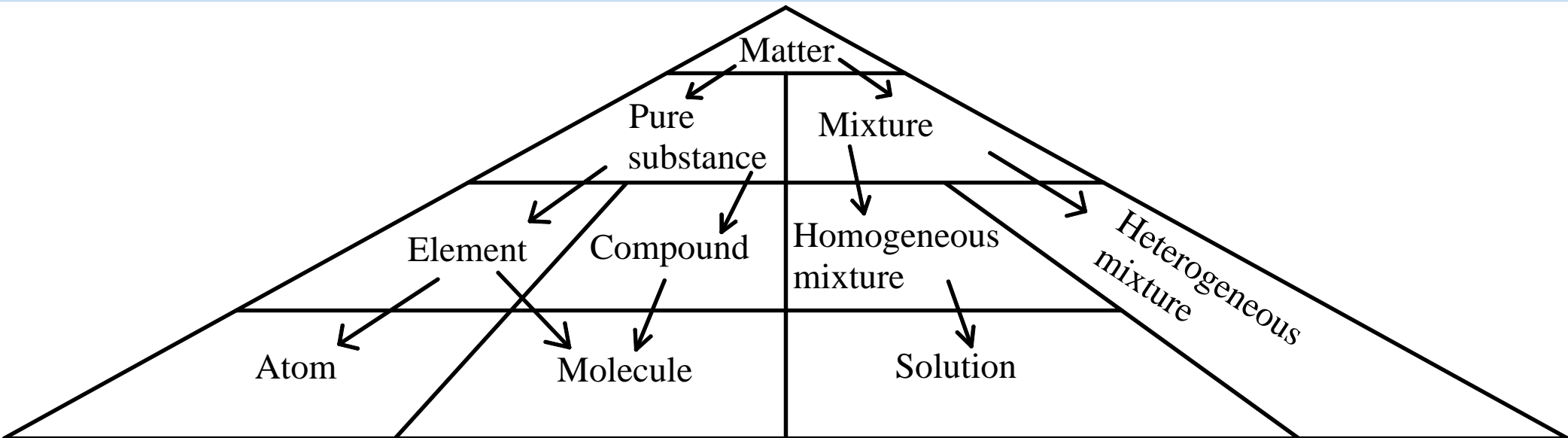
- **Chemical symbol:** Code for an element (ex. N is for nitrogen)
- **Chemical formula:** Representation of a substance using chemical symbols (ex. H₂O)
- **Subscript:** Code in a chemical formula representing how many atoms in a substance (ex. The 2 in H₂O shows there are two hydrogens in a molecule of water; subscripts of 1 are left blank)
- **Chemical reaction:** A process where at least one substance changes chemically
- **Chemical equation:** A recipe for a chemical reaction, ex:
 - $2 \text{C}_2\text{H}_6(\text{g}) + 7 \text{O}_2(\text{g}) \rightarrow 4 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{l})$
- **Reactants:** The original substances (prior to reacting, always left side of equation)
- **Products:** The substances present after a reaction takes place (always right side of equation)

Classifying Matter (organizing matter)

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Classifying Matter (The Matter Pyramid)

- **Matter:** That which has mass and occupies space
- **Atom:** Smallest possible unit of an element with no chemical bonds
- **Chemical bonds:** An attractive force (electrical) binding atoms together
- **Molecule:** Two or more atoms chemically bonded
- **Element:** Matter consisting of only one kind of atom
- **Compound:** A molecule with at least two different kinds of atoms
- **Pure substance:** Possessing a uniform chemical composition (i.e. matter which is not a mixture)
- **Mixture:** Two or more pure substances blended together
- **Homogenous mixture:** A mixture of constant composition (well-mixed)
- **Heterogeneous mixture:** A mixture whose composition varies
- **Solution:** A homogeneous mixture



Classifying Matter - Examples

- Classify the gas in a bottle of pure nitrogen
 - Matter, pure substance, element, molecule
- Classify distilled (pure) water
 - Matter, pure substance, compound, molecule
- Classify tap water
 - Matter, mixture, homogenous mixture, solution
- Classify air (on earth...what you're inhaling now)
 - Matter, mixture, homogenous mixture, solution
- Classify the gas in a bottle of pure helium
 - Matter, pure substance, element, atom
- Classify foul water
 - Matter, mixture, heterogeneous mixture

Molecular Modeling – Some Examples

- **Process:** Use different geometric symbols, hatching, shading, etc. to represent different atoms
- **A:** A mixture - Three molecules, two of them are elements
- **B:** A mixture - Everything is an element composed of atoms and (diatomic) molecules.
- **C:** Pure substance – Element composed of atoms.
- **D:** Pure substance – Compounds, which must be molecules

