EVERYDAY CHEMISTRY

WCSU: DIGAETANO

**One day, Albert Einstein wrote on a chalkboard:**

9 x 1 = 9

9 x 2 = 18

9 x 3 = 27

9 x 4 = 36

9 x 5 = 45

9 x 6 = 54

9 x 7 = 63

9 x 8 = 72

9 x 9 = 81

**9 x 10 = 91**

**Chaos ensued as the students realized that Einstein had made a mistake**, as the correct answer for 9 x 10 is 90 (not 91). His students were a bit brutal and began ridiculing the great scientist. Einstein waited for the class to settle down, before speaking to them.

He said, Despite the fact that I analyzed 9 problems correctly, no one congratulated me. But when I made one mistake everyone started laughing. This suggests that even though a person is successful, Society will notice that person’s slightest mistake. So, don’t let criticism destroy your dreams. The only person who never makes a mistake is someone who does nothing.

Note: According to <https://www.aap.com.au/factcheck/story-about-einsteins-maths-mistake-doesnt-add-up/>, (AAP Factcheck), this episode never happened to Einstein. So, what’s the point? Well, I think there are two points:

1) Check your statements. (Notice I did not say “facts” … They are not facts, until proven). Then re-check your

statements. Provide support, proof, a source!

2) I like it! I believe we do not stress the positive sufficiently. In education, I feel, we tend to focus upon error. I will

emphasize both accuracy and error as foci. I need to do so! In large part, it’s my job. I will tell you where I feel you

have gone wrong – but I will also strive to point out where you have it correct - where you are growing - where you are

achieving. **This is school, not paradise. You do not need to be perfect to be here. Quite the contrary.**

NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ EVERYDAY CHEM: **UNIT 1 (P1)** MATTER & ENERGY

The whole of science is nothing more than the refinement of everyday thinking.

(Albert Einstein)



Check Out: The Human Element commercial: (oldest version), from DOW Chemical

[**http://www.youtube.com/watch?v=i3byt7xMSCA**](http://www.youtube.com/watch?v=i3byt7xMSCA)

and: Cognitive Ease: [**https://www.youtube.com/watch?v=cebFWOlx848**](https://www.youtube.com/watch?v=cebFWOlx848)

I) Chemistry is the ***central science***. V**ery little** research, technological development and/or

implementation occurs without chemistry. Where there is matter or energy involved, there is chemistry.

So, **chemistry is a science. But, what is science?**

A) The English term: *science* comes from the Latin word, **scientia**

B) What does the Latin word, (Scientia or, Science) mean? \*Knowledge

1) \* Knowledge ≠ Information

C) science is concerned with \*prediction & explanation (knowledge)

of phenomena, ***using*** information. If we can't use something to help predict of to explain an

issue, then it is just data. \*Information ≠ Knowledge. Science is a process of Knowledge



***The telephone book is full of facts but it doesn't contain a single idea***

(Mortimer Adler)

II) Now, specifically, what is chemistry**?** At its very heart, chemistry is about transforming matter.

Chemistry is the study of:

A) matter: its ***composition, structure, and properties (essentially, chemicals).***

B) the ***reactions***  matter undergoes (types of reactions, bonding, kinetics)

C) the ***energy*** associated with the reactions of matter. (We will look at chemical (potential) energy,

as well as light, infrared and heat (the transfer of energy)

**Historians, Linguists, Artists & Harry Potter fans:** The word Chemistry is from the Greek chemeia**.** The word was used to designate the art of metal working. It translates as the word, *black* - used possibly due to the black soil of the Nile Valley, known asChemi. (<http://hilltop.bradley.edu/~rbg/Origin.html>) The chemical arts originated in Egypt. The Arabs added the prefix, “al” , and in time, *alchemy* was the name given to the chemical arts up through the Renaissance. (<https://www.ncbi.nlm.nih.gov/pubmed/3064584>) As alchemical arts morphed & disappeared, with the onset of controlled experimentation, math and theory, the field of alchemy became known as ***chemistry****.* (As a side note, there were a few alchemists right up through the 1920s, even here in the USA...)



For a listing of paper ideas/topics/possibilities… check out <http://www.chemistryexplained.com/index.html>

**Consider This:**

You can see less than 1% of the electromagnetic spectrum and hear less than 1% of the acoustic spectrum. As you read this, you are traveling at 220 km/sec across the galaxy. Ninety percent **(90%)** of the cells in your body carry their own microbial DNA and are not “you”. The atoms in your body are 99.99999999999% empty space and **none of the atoms currently** in your body are the ones you were born with, but the vast number of these atom **originated in the belly of a star**. In many ways, you are as old as the universe – as the matter of ancient stars is found in you. Human beings have 46 chromosomes, **2 fewer** chromosomes than the common potato. The existence of the rainbow depends in part on the conical photoreceptors in your eyes; to animals without cones the rainbow does not exist. Hence, you don’t just look at a rainbow, **you create it**. This is rather amazing, especially considering that all the beautiful colors you see represent less than 1% of the electromagnetic spectrum.

**Know This:** Our ancestry is extraterrestrial. **We are children of the stars** – **We are each the universe, expressing itself as human, for a time.** We can learn about & explain and make prediction about all the above. We are each, frankly, spectacular!

III) **There are two huge divisions in chemistry** seen as being closely

associated with physics

Reaction Chemistry Nuclear Chemistry

(our course: inorganic & organic chemistry)

deals with changes\* in the electron deals with changes in the \* nucleus

cloud(s) of the reacting species of the atom (e.g. changes in the number

and / or and energy of protons and neutrons)

the accompanying changes

in the phase of matter Often, there is a conversion between

Matter ↔ Energy

Matter, Energy and Charge are conserved and

**reaction chemistry is really all about the**

**activity (sharing/losing/gaining) of electrons!!!**

Okay ... Wait a minute ... Matter, Energy What do these words mean?

Well, you can know what something ***is*** by what it ***isn't*** . And, in "reaction chemistry" matter and energy

are treated as being relatively different. The two terms can blend when we study nuclear chemistry, but

we're not there yet. So, for now, we will differentiate between what we mean by the term, matter, then

you will know more about it, and how to identify what is meant by energy!

**Try This:** **What do you think?** Consider the following terms. Put a “Y” for yes, next to the example(s) of

matter. Work with a neighbor if you wish.

1) helium 2) charcoal 3) sound 4) heat 5) temperature 6) water

7) air 8) light 9) sand 10) blood 11) motion 12) TV show/signal

IV) j0290876Thus, what is matter? \*anything which possess mass and volume

Or better …. \*anything you can use to fill a balloon and keep in the balloon for a

period of time.

A) Essentially, *energy* is the ability to create a change or to do work (we will spend a good deal of

time on this a bit later. However, you now know the examples of energy from the prior list,

because you know about matter, and you know what something *is, by what it is NOT*!

1) But for now, let’s just take a quick look at an everyday application: Muscle Contraction

![Diagram

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAMyNgAAkpIAAgAAAAMyNgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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<https://ib.bioninja.com.au/higher-level/topic-11-animal-physiology/112-movement/muscle-contraction.html>

And now the understanding of ***matter*** and thus energy .... brings us back to the terms: mass, volume, and weight

B) **Big Idea #1:**  Law of the Conservation of Matter, Energy (& Charge):

🌢Matter and energy cannot be created nor destroyed by *ordinary chemical means,*

🌢BUT, energy can be converted into various forms of energy and/or transferred.

So, assuming nothing gets in and nothing gets out of the reaction chamber, the mass of the

chemicals that react must equal the mass of the chemicals produced. The energy-content

of the whole system is also constant ... but the forms of energy may change (chemical energy

may change to light and/or some form of kinetic energy)

Cut to the Chase: Matter, Energy and Charge (meaning electrons and protons are conserved in

reaction chemistry (not necessarily, nuclear chemistry). Essentially, the number

of grams of matter reacted must equal the number of grams produced. Or, the

number of chemical species you put in of any element as a reactant, is the same

number you get, as a product.

e.g.) 2 Na + Cl2 🡪 2 NaCl

46 grams 70 grams 116 grams

**Think about this metaphor**: **You can't clean something without something else getting dirty**....

or **You can only get out, what you put in**  ... It's that straight forward....

Here is a very unscientific means of trying to understand the conservation of matter, and what we mean

by the term, chemical reactions. **Chemical reactions rearrange the atoms, but reactions do not**

**change the type or number of the atoms.**

DORMITORY →\* DIRTY ROOM

ELEVEN PLUS TWO →\* TWELVE PLUS ONE

SNOOZE ALARMS →\* ALAS NO MORE ZS

ASTRONOMER →\* MOON STARER

The interpretation per the LCME, that you can only get out, what you put in, connects to our Alchemy Lab

C) LCME was first articulated, by Antoine Laurent Lavoisier (and his wife, Marie-Anne) .

[A person and person sitting at a table

Description automatically generated with low confidence](http://www.bc.edu/bc_org/avp/cas/his/CoreArt/art/resourcesb/dav_lavois.jpg)In a **closed system,** the mass of the reacted contents equals the mass of the

contents of the system after the reaction is completed.

This power couple carefully massed the reactants (ingredients) and the

products (results) of what we now call chemical reactions. They showed that

while the matter may change its state (e.g., solid reactants produced gaseous

products), the total mass of the matter (products) in the reaction chamber, is

the same at the end as the mass of the matter (reactants) at the beginning of

the experiment. Much later, this idea was expanded to incorporate energy.

David's *Portrait of Monsieur Lavoisier and His Wife*

<http://www.bc.edu/bc_org/avp/cas/his/CoreArt/art/neocl_dav_lavois.html>

1) N.B: The LCME is best applied to issues of **reaction chemistry**, and does not apply at all

times to nuclear reactions, under all circumstances. There are nuclear reactions in which

mass is converted to energy, & vice versa. (e.g. Via nuclear fusion, the Sun, releases energy

as matter is converted to energy (400 million, million, million, million watts of energy/minute

are released by the sun.) *Wonders of the Solar System: Empire of the Sun with Professor Brian Cox [Note: 1 watt = 59.9 joule/minute]*

2) We are going to explore what are sometimes called: the **Dimensions of Matter**.

e.g.) Mass, Weight, Volume, Density, Pressure

Try This!

1) Given the balanced equation representing a reaction for the formation of water: 2 H2 + O2 → 2 H2O

What is the total mass of water formed when 8 grams of hydrogen (H2) react completely with 64 grams of

oxygen (O2)? (Hint: Apply the LCME)

(1) 18 grams (2) 36 grams (3) 56 grams (4) 72 grams

|  |  |
| --- | --- |
| Component | Mass  (grams/serving) |
| 1 scoop Chocolate Ice Cream | 72.3 |
| 1 scoop Vanilla Ice Cream | 71.5 |
| Hot Fudge | 37.0 |
| Banana | 122.0 |
| Whipped Cream | 2.1 |
| Cherry | 6.7 |

2) Use the table of mass to complete this questions

Provide the math set up you would use to calculate the mass of a hot fudge banana split sundae made with 2 scoops of vanilla ice cream, 1 scoop of chocolate ice cream, 3 servings of hot fudge, 1 banana, 2 servings of whipped cream and two cherries. The arithmetic answer is provided …just show how you might calculate it.

Math Set Up:

\*2(71.5 grams) + 1(72.3 grams) + 3(37.0 grams) + 1(122.0 grams) + 2(2.1 grams) + 2(6.7 grams)

ans: 465.9 grams

V) What are chemicals? Essentially, a “chemical” is matter classified as a substance (any element or

compound), OR any mixture of substances.

A) Substances

1) Substances are homogeneous (pure, uniform throughout) chemicals, in which samples

are made of only 1 specific element **or** 1 specific compound, in the **solid, liquid or gas**

**phase**.

2) Ideally, substances are unvarying in their physical characteristics … Hence, a substance is

expected to have a single (constant) melting point, one normal boiling point, a constant

density (at specific temperatures and pressures) …All substances are homogeneous.

3) There are 2 different categories of **substances**

a) Elements: a sample of matter (a chemical) in which all of the atoms in the sample,

have the same atomic number. The matter on the periodic table …

i) recognition skill: \* only one type of capital letter in the symbol, and

a true (s), (l) or (g)

ii) Elements cannot be decomposed into any simpler substance.

N.B. The atoms of an element can be “smashed” into protons neutrons and electrons …

but these are subatomic particles …not substances…. (Ah, vocabulary!)

Metaphor: Think of an element, like a single letter of the American alphabet.

iii) There are four large categories of elements:

* metals
* nonmetals
* metalloids
* noble gases (often lumped in with the nonmetals)

b) Compounds: an uncharged sample of matter (a chemical) made of \* 2 or more

different elements that have been combined via chemical bonds, in a

definite proportion.

i) recognition skill: \* 2 or more different capital letters with (s), (l), (g)

ii) Compounds have a definite proportion between the components. This ratio

is represented by the subscripts. These subscripts cannot be changed for the

specific compound.

iii) Compounds are formed by \* when different chemical species bond

iv) a bond is a manifestation of potential energy which may exist between species

when electrons of one species are attracted to the positive nucleus of a second

species.

v) Compounds can be chemically decomposed into simpler compounds or back

to their elements.

CdCO3(s) → CdO(s) + CO2(g) or 2 H2O → 2 H2(g) + O2(g)

Metaphor: Think of a compound as a unified group of letters, forming a word. Change a letter of

Diagram

Description automatically generated the word or the number of a letter, you change the word. Thus, if you were to change

any one of the elements or the number of a specific element of a compound, you change it to a different compound!

<https://www.chemistryjokes.com/jokes/can-i-take-your-drink-order/>

vi) There are at least 2 large categories of compounds:

* Inorganic Compounds (These tend to lack C – H bond and/or

lack carbon altogether.

* + The chemical species of inorganic compounds may be “held together” by \*ionic bonds or covalent bonds – or both!
  + Inorganic compounds may be described with the terms; \* ionic compounds or molecular compounds
  + It is estimated that there are approximately 600,000

inorganic compounds

* + examples:
* Organic Compounds (These are compounds of carbon, with the exceptions of CO2, CO, cyanides (KCN), carbonates and hydrogen carbonates (Na2CO3, NaHCO3)
* Organic Compounds ***tend to have*** C – H bonds
* It is estimated that there are 16 million to 20 million organic compounds

4) Intro to Organic Compounds

a) So many compounds with a carbon backbone exist because

i) carbon atoms can undergo a process called \*catenation, in which carbon atoms

make strong covalent bonds (share electrons) to other carbon atoms.

ii) carbon atoms make four covalent bonds (that’s a lot of bonds for 1 atom), so

is a good deal of room for variation and building out.

iii) carbon makes strong/stable bonds with atoms of other elements as well.

b) The simplest class or category of organic compounds are called:\* hydrocarbons. They

are made of ONLY carbon and hydrogen atoms.

c) Organic compounds can contain just about any of the nonmetals, such as; oxygen,

sulfur, nitrogen, phosphorus, fluorine, and some organic compounds, even contain

certain metals!

Many different classes of organic compounds, containing atoms other than just

carbon and hydrogen, are listed on the following pages. These class or type of

compounds contain, \*functional groups: which are atoms that give special chemical

properties to the compound.

d) Organic compounds undergo a host of chemical reactions. One of the more common

chemical reactions is \* combustion

i) in the reaction of \*combustion, there must be a fuel (the organic compound)

and oxygen. Oxygen is flammable, but it is not, itself combusted …there is a

difference.

**Some classes of organic compounds with functional groups**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Class | Description | Examples of molecular or condensed formula | a Example / Structure | b Example / Structure |
| Alcohol  (Mono-  hydroxy) | R-OH  1 (O-H) group bonded to a carbon. Soluble in water (polar molecule) | a C3H7OH  b C4H9OH | a1-propanol  H H H  | | |  H—C—C—C—O-H  | | |  H H H | b 2-butanol  H H H H  | | | |  H—C—C—C—C—H  | | | |  H OH H H |
| Alcohol  (Glycol or Dihydroxy) | 2 O-H groups (or OH groups ) bonded to carbon. Soluble in water (polar molecule) | a C2H4(OH)2  b C3H6(OH)2 | a1,2-ethanediol (ethylene glycol)  H H  | |  H—C—C—H  | |  OH OH | b1,2-propanediol (propylene glycol)  H H H  | | |  H—C—C—C—H  | | |  H O-H O-H |
| Ester | O  ||  R—O—C—R'  The product of an alcohol & organic acid reaction. | a CH3OOCCH3  b C2H5OOCC2H5 | a methyl ethanoate  H O H  | || |  H—C—O—C—C—H  | |  H H | b ethyl propanoate  H H O H H  | | || | |  H—C— C—O—C—C—C—H  | | | |  H H H H |
| Ketone | O  ||  R— C—R**'**  A **carbonyl group** on an "interior" or non-terminal carbon | a C3H6O  b C6H12O | a 2-propanone (acetone)  H O H  | || |  H—C—C—C—H  | |  H H | b 3-hexanone  H H H O H H  | | | || | |  H—C—C—C—C—C—C—H  | | | | |  H H H H H |
| Carboxylic  Acid  (the most common form of organic acid) | O  ||  R—C—O-H  A **carboxyl**  **group** (COOH) bonded to a carbon. Soluble in water | a CH3COOH  b C2H5COOH | a ethanoic acid (acetic acid)  H O  | ||  H—C—C—O—H  |  H | b propanoic acid    H H O  | | ||  H—C—C—C—O—H  | |  H H |
| Amine  (simple) | R⎯N⎯H  |  H  An organic derivative of NH3 (at least one H is replaced with an organic group. A weak base (B-L) | a C3H7NH2  b C6H5NH2 | a 1-propanamine (1-propylamine)  H H H  | | |  H⎯C⎯C⎯C⎯N⎯H  | | | |  H H H H | b aniline    ••  N⎯H  |  H |
| Halide  (Halocarbon) | R-X  Halogen(s) substituted onto a hydrocarbon, by removing hydrogen(s) | a C3H7Br  b C3H6F2 | a1-bromopropane    **Br** H H  | | |  H—C—C—C—H  | | |  H H H | b1,2-difluoropropane  H H **F**  | | |  H—C—C—C—H  | | |  H **F**  H |

B) Mixture: \*a physical combination of at least 2 different substances, in varying proportions,

in which the component substances generally keep their physical characteristics.

1) Properties of Mixtures

a) The composition may be varied. When mixtures are made, there are **NO NEW**

**bonds made**. The components of the mixture tend to maintain their own

chemical attributes.

i) The physical characteristics of a mixture depend upon the components and

their concentrations.

e.g. alloys, colligative properties (last laboratory exercise)

b) Mixtures are not *true* solids liquids or gases. Many are dissolved in water, and are

called aqueous solutions. An aqueous solution often has\* (aq). e.g. NaCl(aq)

It simply means a second chemical is completely dissolved in water

c) Mixtures may be homogeneous (uniform in look) or heterogeneous (multiple visuals)

d) The components of a mixture can be separated from each other, via physical means,

such as filtration, chromatography, evaporation, distillation etc… NO CHEMICAL

BONDS ARE BROKEN AS WE SEPARATE A MIXTURE!

e.g. When we boil saltwater: Energy + H2O(ℓ) 🡪 H2O(g) we do not break the

bonds between H and O, but molecules of water and salt are separated.

Three of the Phases of Water

A picture containing diagram

Description automatically generated

<https://www.bartleby.com/questions-and-answers/ice-liquid-water-water-vapor-increased-freedom-with-respect-to-translation-molecules-spread-out-esse/5ddcfbec-8b36-411a-a579-9c3393c2f7dc>

Notice that as phase changes (as in boiling), the atoms of water (the hydrogen and oxygen) are all

still attached to each other. The only changes are in the distance between the molecules of water.

Now, when boiling saltwater, the molecules of water are separated and the dissolved material (the

salt) is left behind, for the most part. In boiling, water molecules are NOT ripped apart!



 **GIMME A METAPHOR!!**

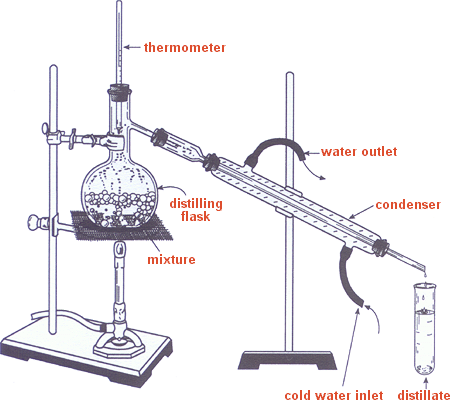
Think of a tossed salad when thinking about a

mixture. A tossed salad has multiple components

just physically placed next to each other. The

proportions can vary. The components can be

physically separated from each other.

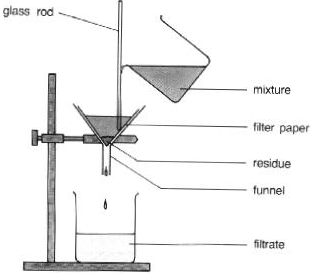


2) Physical Separation Techniques

Distillation: Separates different **liquids** from each

other based upon different \* **boiling points**

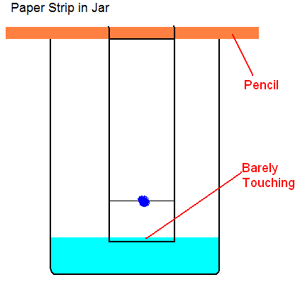
http://tinyurl.com/288ouok



Filtration: Separates dissolved species from \* un-dissolved (insoluble)

species. Filters (carbon or paper) are used generally. Think of a coffee maker

<http://tinyurl.com/2375j6a>



 Chromatography: Separates substances from each other based on

**solubility** in a common solvent. Some solutes

are attracted to the substrate and others are

attracted to the solvent.

<http://tinyurl.com/24sb6kd>

Precipitation: Crystallizes (makes an INsoluble solid) from chemicals reacting in solution or

or in the gaseous phase.

Evaporation/Boiling: Dissolved solids are left behind as a liquid solvent vaporizes.

These videos offer some “everyday” applications of mixtures.

Check out: Separation of saltwater <https://www.youtube.com/watch?v=riEbNXcmLrQ>



[This Photo](http://babylonica.deviantart.com/art/Check-Mark-and-Box-106646881) by Unknown Author is licensed under [CC BY](https://creativecommons.org/licenses/by/3.0/)

Separation of sand and water: <https://www.youtube.com/watch?v=rmc4ez71VwM>

Separation of alcohol and water: <https://www.youtube.com/watch?v=I5wuMGNsdHk>

Covid Vaccine: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/different-vaccines/overview-COVID-19-vaccines.html>

Alice Ball: <https://www.youtube.com/watch?v=dymJcBkGlbs>

3) Acidic solutions and Base (alkaline) solutions are examples of special aqueous solutions or

aqueous mixtures.

4) Arrhenius Acids (1 of 3 different definitions of acids – named for Svante Arrhenius)

a) Arrhenius Theory of Acids: An acid in the Arrhenius sense is any compound which

donates a H+ specifically to a water molecule, turning H2O into H3O+

i) applies only to aqueous solutions (acids dissolved in water).

b) In general, an Arrhenius acid \*increases the concentration of H3O+ in a solution.

c) Arrhenius acids are fairly easy to recognize by formula, as the acidic hydrogen is

often the first element of the formula:

HCl(aq), HNO3(aq), HF(aq), H2SO4(aq) or in the case of

carboxylic acids, there is a functional group -COOH, and the last H is often the

acidic (donated) hydrogen.

HCOOH(aq) (formic acid),

CH3COOH(aq) (acetic/ethanoic acid),

C6H8O7(aq) or CH2COOH-C(OH)COOH-CH2COOH (citric acid),

d) There are strong acids and weak acids.

5) Arrhenius Theory of Bases: Arrhenius bases tend to increase the concentration of

hydroxide polyatomic ion (OH-1) when added to water.

a) Arrhenius bases produce alkaline solutions (pH values greater than 7)

Arrhenius bases are pretty much exclusively inorganic compounds with a metal

species bonded to the OH-1

Recall you can find the metalson the periodic table.

NaOH

KOH

Ca(OH)2)

b) Carbon bonded to OH is an alcohol (not a base)

c) We use bases to make soap!

6) Acids and bases \*neutralize each other to produce water and some form of a salt

a) A salt is merely a compound made from a metal and nonmetal, produced via

a neutralization reaction.

b) Not all salts are edible. Some are downright dangerous.

7) Application: Distillation of Oil: The physical separation of the mixture, petroleum,

into its constituent compounds and elements.

Note: Distillation is a different process from that of cracking.

A solid reference: <http://science.howstuffworks.com/environmental/energy/oil-refining4.htm>

a) Petroleum: A fossil fuel (like coal and natural gas) Petroleum is mixture of hundreds

of various hydrocarbons (molecules of only hydrogen and carbon) of varying sizes,

masses, properties.

i) \*It is not made from dead dinosaurs!

The process of making petroleum began 100 million years BEFORE the

dinosaurs even appeared! It is made from the **anoxic conversion** of the

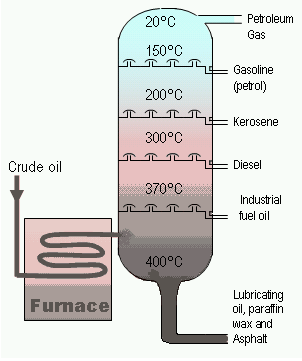
remains of sea algae/diatoms (well before the dinosaurs)

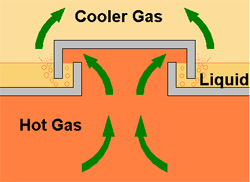
b) The petroleum mixture is heated to high temperatures to encourage the evaporation

of the components.

The Distillation Tower works by **becoming progressively cooler from the base to the top.** All the hydrocarbon fractions start off in gas form, as they have been heated to that point. The gases then rise up the tower.

The gas mixture then encounters a barrier through which there are only openings into the bubble caps.



 The gas mixture is then forced to go through a liquid before continuing upwards. The liquid in the first tray is

at a cool enough temperature to get the heaviest gas fractions to condense into liquid form, while the lighter fractions stay gaseous.

This process continues until only the very lightest fractions, those

of 1 to 4 Carbon atoms, at the top of the tower.

http://www.green- planet-solar-energy.com/fractional-distillation-of-crude-oil.html

Note: A new 5.6 billion dollar refining facility is being built in Cushing, OK

A fairly standard visualization of a fractional distillation column

<http://www.chemistrydaily.com/chemistry/Oil_refinery>

8) A look at oil & everything chemistry provides us from the mixture known as

one 42-gallon barrel♦ of petroleum.

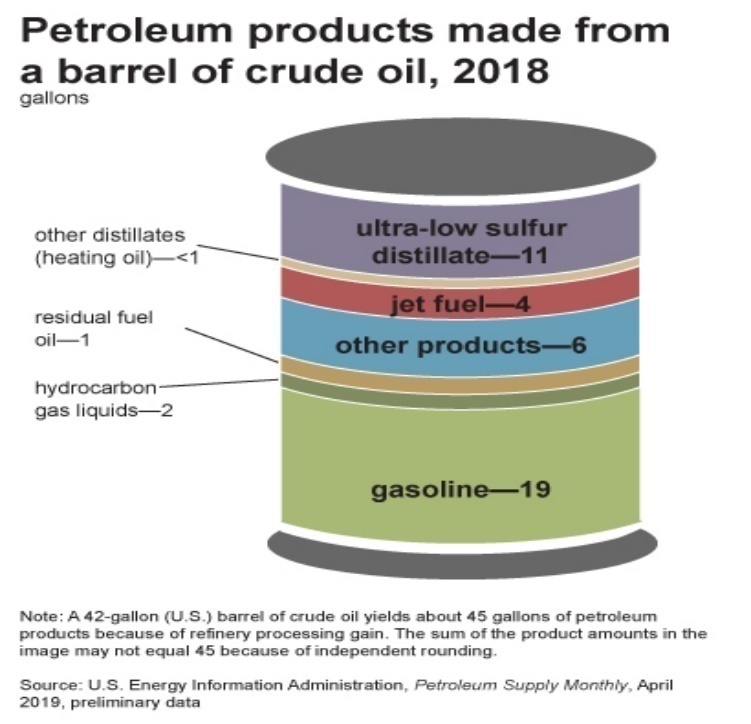
The vast amount of oil is used to produce some

sort of fuel (with gasoline leading the way).

Approximately 6.5 gallons of each bbl provides us

with the compounds needed for:

|  |
| --- |
| Aspirin |
| Plastics (et. al.) skis, helmets, cleats, fishing lines, polishes, shoes, vinyl, basketballs, washers, dice, bandages, toilet seats …. |
| Paint |
| Rubber |
| Nylon / Yarn |
| Slacks / Dresses |
| Perfumes |
| Detergents |
| Inks |
| Hair Coloring / Clothing Dyes |
| Dashboards |
| Roofing Shingles |
| Cortisone |
| Antiseptics |
| Makeup: lipstick, foundation, mascara |
| Fertilizers / Insecticides |
| Candles |
| Hand Lotion |
| Contact lenses |
| Shaving cream |
| Shampoo |
| Latex: balloons, condoms |



<http://www.eia.doe.gov/kids/energy.cfm?page=oil_home-basics>

According to the above website, a 42-U.S. gallon barrel of crude oil provides

about 45 gallons of petroleum products. This gain from processing the crude

oil is approximately 7%.

This probably is due to changes in intermolecular forces of attraction

(see bonding unit) Smaller/Less massive hydrocarbons tend to exert weaker

intermolecular forces and have a lesser "pull" on surrounding molecules,

giving a less dense (and possibly more voluminous) mass of molecules.

♦The unit, bbl., is used to designate the standardized 42- gallon barrel, in which the crude

oil was shipped. The unit bbl. may have been used to avoid confusion with the unit

bl (for bale). There is a myth out there that it began with John D. Rockefeller, who

supposedly sealed every barrel of Standard Oil with a blue lid. However, the unit bbl.

was in use for about 1 century prior to JD Rockefeller and the oil boom of 1880s.



Data: <https://www.eia.gov/totalenergy/data/monthly/#petroleum>



Check Out from Penn State: <https://www.e-education.psu.edu/fsc432/node/5>