NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ EVERYDAY CHEMISTRY: UNIT 1:

INTRO / MATTER AND ENERGY (PART 1)

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)

I) Chemistry is still referred to as, *the central science*. With a few exceptions, **very little** research,

technological development and/or implementation can occur without chemistry. When there is matter

and/or energy involved ... there is chemistry.

What we can study:

chemicals that fuel ... coal, gasoline, hydrogen gas, oil

chemicals that are edible ... carbohydrates, fats, esters, water, sodium chloride, proteins

chemicals that clean ... soap, vinegar, water, ammonia, alcohol, detergent

chemicals that pollute ... coal, soaps, toxins, plastics, phosphates, sulfur dioxide

chemicals that heal ... ibuprofen, aloe, bandages, plastics, Silvadene

chemicals that identify… technetium-99m, fluorine-18, carbon-14, iodine-131

chemicals that build ... steel, cellulose, plastics, silicon, cement, clay

chemicals that decorate ... silver, paint, plastics, dyes, papers, inks

chemicals that run the economy ... oil, gold, copper, silicon, silicone, fluorine, lithium, diamonds

chemicals that conduct electricity ... copper, lithium, gold, electrolyte solutions

chemicals of charm ... perfumes, pheromones, makeup, shampoo, gold, diamonds

chemicals of history ... gunpowder, A-bomb, H-bomb, aniline dyes, steel, radium, salt, oil, gold

chemicals of crime ... arsenic, potassium cyanide, gunpowder, alcohol, luminol, DNA

chemicals of warfare ... iron, bronze, gunpowder, plutonium, phosgene

chemicals of entertainment ... alloys, cellulose, inks, plastics, paint, crayons, xenon gas

chemicals of the brain ... dopamine, serotonin, vasopressin, oxytocin

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

Try: What Has Science Done For You Lately? <https://undsci.berkeley.edu/article/0_0_0/whathassciencedone_01>

**Why Study Chemistry1?**

**I really would love you to begin to grasp that**

….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 kilometers per second 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 99.999999999999999% empty space and none of them are the ones you were born with, but they all originated in the belly of a star. Human beings have 46 chromosomes, 2 less 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 pretty amazing, especially considering that all the beautiful colors you see represent less than 1% of the electromagnetic spectrum …

Considering our extraterrestrial ancestry, our ability to learn and to explain all of the above … we are each, frankly, spectacular!

Now take a look at the following:

**Carnegie Mellon Researchers Say Use of Switchgrass Could Solve Energy Woes**

Carnegie Mellon University researchers say the use of **switchgrass could help break U.S. dependence on fossil fuels** and curb costly transportation costs.

"Our report indicates the time is right for America to begin a transition to **ethanol derived from switchgrass,**" said Scott Matthews, an assistant professor in the Civil and Environmental Engineering Department. A 25 percent hike in gas prices at the pump since December adds to the researchers' call for more ethanol derived from switchgrass, a perennial tall grass used as forage for livestock. Gasoline prices in the U.S. are approaching an average of $3 a gallon. The Carnegie Mellon findings were published in the May 1 issue of the American Chemical Society's Journal "Environmental Science and Technology."

Matthews, along with W. Michael Griffin, executive director of the Green Design Institute at Carnegie Mellon's Tepper School of Business, and William R. Morrow, a researcher in the university's Department of Civil and Environmental Engineering, said **using switchgrass as a supplement to corn to make ethanol would help ensure the availability of large volumes of inexpensive ethanol to fuel distributors and consumers**.

"We need to be thinking about how **we can make and deliver ethanol once our corn and land resources are maxed out. Switchgrass can be that next step,**" Griffin said.

The Carnegie Mellon report also found that ethanol derived from the dry, brown switchgrass, a cellulosic ethanol, could be made in sufficient quantities to deliver 16 percent ethanol fuel to all consumers in the U.S. Researchers said this would likely lead to significant decreases and stability in the price of gasoline.

"It's a renewable resource," Griffin said. "Rather than taking a depletable resource from the ground, switchgrass can be grown again and again."

**citation: ScienceDaily (May 5, 2006)** [**http://www.sciencedaily.com/releases/2006/05/060505114855.htm**](http://www.sciencedaily.com/releases/2006/05/060505114855.htm)



Check out: <https://www.youtube.com/watch?v=3p_QAsGyetM> (switchgrass to ethanol)

<https://www.youtube.com/watch?v=i5MO1lAHMVQ> (switchgrass substituting for coal)

**Why Study Chemistry2 ?**

I found this reference while doing a literature review regarding the issue surrounding the problem of ingesting grapefruit juice, with certain medications, some time back. I was not all that surprised to discover that orange juice made from Seville Oranges (a.k.a. Bitter Orange) created the same problem....When you're as old as I am, you begin to wonder about how issues branch .... BUT,

I was surprised, to find the following reference to Seville Orange as a dietary supplement. That was new to me.

And, I thought this was a great example as to why should anyone at a university study a basic chemistry course because, maybe just maybe in order to understand the issues of**: nutrition, dietary supplementation, drug interaction, biochemical/biophysical reactions to chemicals** ……Read on….

**… As an herbal stimulant**

**The extract of bitter orange (and bitter orange peel) has been marketed as dietary supplement purported to act as a weight-loss aid and appetite suppressant.1** Bitter orange contains the tyramine metabolites N-methyltyramine, octopamine and synephrine, **substances similar to epinephrine**, which act on the α-1-adrenergic (alpha-1 adrenergic) receptor **to constrict blood vessels and increase blood pressure and heart rate**.1,2,3

There is no evidence that bitter orange is effective in promoting weight loss.1

Following bans on the herbal stimulant ephedra in the U.S., Canada, and elsewhere, **bitter orange has been substituted into "ephedra-free" herbal weight-loss products by dietary supplement manufacturers**.1 Like most dietary supplement ingredients, bitter orange has not undergone formal safety testing, but it is believed to cause the **same spectrum of adverse events as ephedra**.1 Case reports have linked **bitter orange supplements to strokes, angina, and ischemic colitis**.2,3 The U.S. National Center for Complementary and Alternative Medicine found that "**there is currently little evidence that bitter orange is safer to use than ephedra.**"1

**Bitter orange may have serious drug interactions with drugs such as statins in a similar way to grapefruit.1,2,3** Following an incident in which a healthy young man suffered a myocardial infarction (heart attack) linked to bitter orange, a case study found that dietary supplement manufacturers who replaced ephedra with its analogs from "bitter orange" had in effect found a loophole in the ephedra ban, substituting a similarly dangerous substance while labeling the products as "ephedra-free".1

1) citation: <http://en.wikipedia.org/wiki/Bitter_orange>

Read while performing a Boolean search for: Seville orange bergamot grapefruit.

Supporting Literature:

[2) Bouchard](file:///C:\Users\Owner\Documents\01Notes.Quotes.Eq\01Notes%20Past%20Versions\Everyday%20Chem\%20%20Bouchard) N.D. et. al *Ischemic Stroke Associated With Use of an Ephedra-Free Dietary Supplement*

*Containing Synephrine*, Mayo Clinic Proceedings [https://www.mayoclinicproceedings.org/article/S0025- 6196(11)63207-2/fulltext](https://www.mayoclinicproceedings.org/article/S0025-%206196(11)63207-2/fulltext)

3) W.L. Stanely et al. *Citrus Coumarins* <http://pubs.acs.org/doi/abs/10.1021/jf60178a007>

II) First … Chemistry is a science. So, what is science?

A) Our 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 a variety 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

 This statement by Adler, sort of says it for me…

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

(Mortimer Adler)

III) 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 actually means *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 alchemists right up through the 1920s, even here in the USA...)

D) **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 ...but we're not

there yet. So, for now, let’s take a look at what matter *is*, then you will know more about it, an energy!

**Try This:** **What do you think?** Consider the following terms & put a “Y” next to the example(s) of

matter?

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

6) water 7) air 8) light 9) sand 10) blood 10) motion

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 pretty well, the examples of energy from the

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

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

B) Law of the Conservation of Matter, Energy (and 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.

**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 non-science means of looking at the conservation of matter... and what we mean by

chemical reactions.... Take some notes, as I demonstrate and lecture….

DORMITORY →\* DIRTY ROOM

THE MORSE CODE →\* HERE COME DOTS

SNOOZE ALARMS →\* ALAS NO MORE ZS

This idea connects to our Alchemy Lab”

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

[](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]*

|  |  |
| --- | --- |
| 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 |

Try These!

1) Use the table of mass to complete this questions

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.

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

2) 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)?

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

D) Mass: \* a measure of the quantity of matter an object possesses OR the property of an object that

causes it to have weight in a gravitational field

1) Mass is best described using physics … and that really doesn’t help first-year chemistry

students …. yet it is an elegant description. There is the concept of INERTIA (The tendency

of an object to resist changes in its motion)…

The odds of an object to resist changes in its state of motion varies with its mass. The

greater an object’s inertia, the greater the object’s mass. A more massive object will

have a greater tendency to resist changes in its motion. A less massive object, will have

a relatively lesser tendency to resist changes in it motion (It will be altered or moved,

more easily. Thus, it has less mass.)

2) basic International System (SI) unit = kilograms

Note: 1 kilogram = 1,000 grams

e.g) 1,000 g = 1 kg or 500. g = 0.500 kg



3) Weight: \* pull of gravity on the mass (weight may change, mass tends to be conserved and

does not change.)

a) SI unit: kg·m/s2 or Newton

English unit: pound (lb)

When we measure an object on a balance, we are measuring against a standard mass. And

while it isn’t surprising that mass and weight are used interchangeably –it is *incorrect* to

do so, really. You see, the concept of “weight” becomes important, **only when the force**

**exerted by gravity is changed.** Since that force is a constant from the balance to your desk

(unless your desk is at the top of Mt. Everest), the term weight is not wholly appropriate.

However, when the gravitational force changes, the **weight** of an object from one point to

another, can change, but its mass (the inertia) is essentially constant.

b) Think of an astronaut weighing 120 lbs here on Earth. We all know that when she gets to the

Moon, she will experience a sense of “weightlessness”, *to some degree*. She can ...jump

higher, hit a golf ball farther.... So, what has happened? Did she lose mass? If so, which part

of her body did she have to cut off? WHAT!? Is there any another explanation?



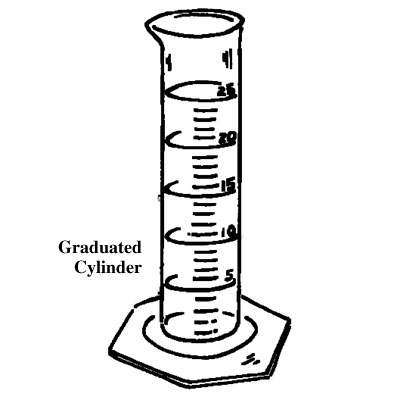
Check out: <http://www.exploratorium.edu/ronh/weight/>

E) Volume: \* the (amount of) space occupied by matter [units: mL or L]

1) regular cube: Length x Width x Height \* e.g. 1 cm x 1 cm x 1 cm = 1 cm3 or 1 cc



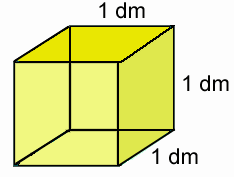
2) Archimedes and Water displacement



3) 1 Liter = 1,000 mL = 1,000 cm3 (cubic centimeter or *cc*)



http://www.squidoo.com/King\_Bidgood



<http://core.ecu.edu/chem/chemlab/equipment/evolumetricflask.htm> cubic decimeter

<http://www.chem.uiuc.edu/webFunChem/volume/volume3.htm> <http://core.ecu.edu/chem/chemlab/equipment/egcylinder.htm>

4) solids and liquids tend to have \* constant volumes

a) If you transfer a solid object from one vessel to a different yet larger vessel,

the volume of the solid \*would remain the same (would be unchanged)

b) When you transfer 100 mL of water from a 400 mL beaker to a 1,000 mL beaker,

the volume of the water (liquid) \* remains the same

5) gases have no constant volume. The volume of a gas may be reduced or expanded

dramatically, as the conditions of temperature and pressure change.

think: s.c.u.b.a., hot air ballooning, human breathing, ear's popping, home heating

systems, aerosol spray cans, butane lighters , phlebotomy etc...

F) Pressure: Pressure is the force exerted on an object, when matter (as in atoms or molecules) come in

contact with that object.

Pressure = (mass)(acceleration) or P = Force

Area Area

Conclusion: (With a plea of indulgence to my physicist friends)… Essentially pressure exerted

by a chemical is affected by

* \*The number of particles
* \*How fast a molecule moves &/or collides with the sides of a container

(This is related to the temperature of the matter, as temperature affects the

acceleration part of the equation)

* \*The mass of each particle which collides.
* Like energy, gases will move from areas of high pressure to low pressure.

Consider a single molecule of the gas, helium trapped in a sealed cylinder.

This is where pressure is measured…as the molecule hits the interior of the cylinder. Now, imagine different scenarios, in which the molecule moves faster and hits the interior. Pressure (the force exerted) would increase.

The molecule in the The molecule as it accelerates

middle of the container and impacts the interior of the

cylinder. We can measure this impact.

1) Consider a bottle of carbonated water… heat it up; let it “de-fizz” …

2) To understand the effects of area we can speak of a high heel shoe and then go watch the

breaking ruler video (link found at my website and at the bottom of the next page.)

Now consider a cylinder with a moveable piston with thousands of trapped molecules of helium

Pushing down the plunger increases pressure

Imagine pushing down on the sealed sample of helium gas. Have the number of molecules changed? Did you add more matter? … No, the molecules simply have less empty space between them. They have been pressurized (compressed).

versus

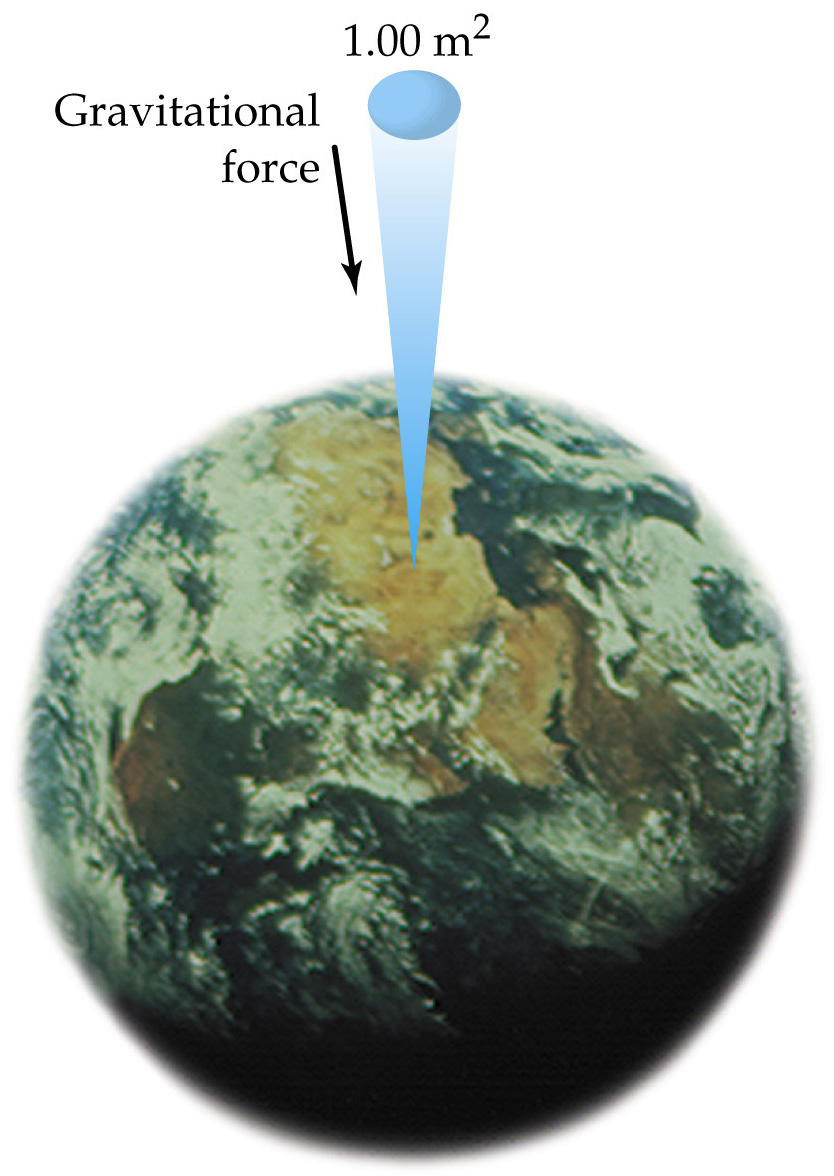
Do you understand that when compressed the molecules will slam into the sides of the cylinder

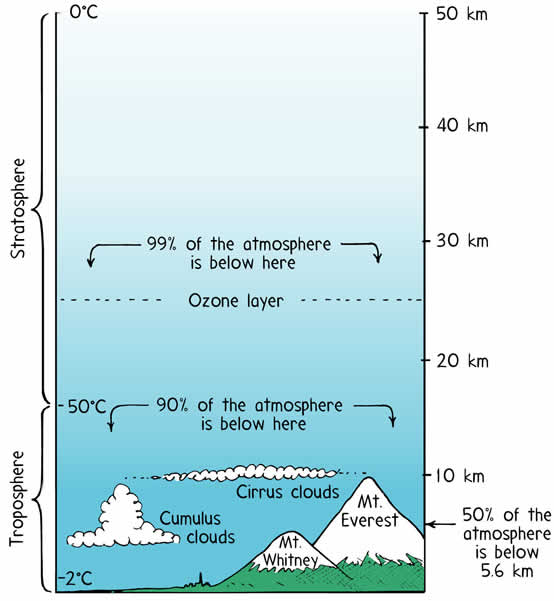
more frequently? Thus, what happens to the pressure of gas in the second cylinder?

What if you were to heat the gas in the cylinder? What will happen to the acceleration of the

molecules? And what will happen to the pressure?

Now, consider this: **We live at the bottom of an ocean of air...**



[](http://www.ucar.edu/learn/1_1_1.htm)

<http://wps.prenhall.com/wps/media/objects/602/616516/Chapter_09.html>

A column of air 1.00 m2 in cross-sectional

area extending from the earth’s surface through

the upper atmosphere has a mass of about

10,300kg, producing an *atmospheric* pressure

of approximately 101.3 kPa (also called,

1 atmosphere or 1 atm)

http://tonydude.net/NaturalScience100/Topics/2Earth/3atmosphere.html



Check Out: Breaking a ruler: <https://www.youtube.com/watch?v=0pJlTzz5pDw&t=13s>

Now... How does pressure change when we leave our ocean of air, and

dive into our ocean of water???

Surface Air Pressure = 1 atmosphere (1 atm) or 101.3 kPa





10 meters underwater = 2 atmospheres

(or 202.6 kPa)

**Think about the math …. Assuming:**

**Pressure = Force = mass (acceleration)**

**Area Area**

**As we go deeper below the surface of the**

**ocean, there is an increasing mass of**

**water above our “area”. Couple this**

**increasing mass of water, to the mass of the**

**gaseous atmosphere it is not too surprising**

**to conclude that the pressure is increasing!**

Personal note: I am still in wonderment, that any

cellular creatures can live **and thrive** **2,100 meters** (and more) below the surface of the ocean

at the level of the hydrothermal vents! e.g. frilled

shark, giant tube worms, vampire squid, pacific

viperfish.... How does that work??? Really … I don’t get it… I have questions!



20 meters = 3 atm (or 303.9 kPa)

underwater



30 meters = 4 atm (or 404.12 kPa)

MCj02001950000[1]

**The Mechanics as to How We Breath! It’s About Pressure!**



**Expiration**:

Pulmonary (Lung) volume decreases as the diaphragm returns to a (more) neutral position & the rib cage drops down. This decrease in volume, increases the intrapulmonary pressure and air is pushed out of the lungs into the atmosphere.

**Inspiration**: Pulmonary volume increases as the diaphragm drops & the rib cage rises. This increases lung volume & decreases intrapulmonary pressure and air is pushed into the lungs from the area of greater pressure, outside the body

1 atm

1 atm

1 atm

**1.004 atm**

1 atm

**0.9973atm**

1 atm

1 atm

Rayner-Canham: Descriptive Inorganic Chemistry

Notice that the atmospheric pressure (the pressure outside of the body) is 1 atm. It does not change in

this example. Only the intrapulmonary pressure changes. Air is exchanged as it moves from an area of

relatively higher pressure to an area relatively lower pressure. The part of the brain which controls

much of the action of the diaphragm is the medulla oblongata.

Can you begin to imagine the implications to breathing as a person climbs very high mountains,

or in a situation where the chest is compressed?

G) Extensive vs. Intensive Properties: As well as being described as anything with mass and volume,

Matter has \* extensive and intensive physical properties

|  |  |
| --- | --- |
| **An Extensive Property is**  dependent upon "**how** **much**" of the substance there is Or, it is one that changes as the size of the sample changes | **An Intensive Property is**  specific to the substance and is INDEPENDENT of the system's size. An intensive property scales with changes in,or to the size of the system . |
| Mass | Density |
| Volume | Pressure |
| Length | temperature (for a system in thermal equilibrium) |
| enthalpy (energy) | Malleability (metal pounded to a sheet) |
| number of molecules | Melting point |
| Weight | Odor |

**Proof 1:**  Think of ice, but think of a massive, a titanic (?) iceberg, if you will ... and then think of an ice cube from your

freezer. Assume they are both pure water (ice) at -10ºC.

Both of the temperatures are identical ... hence temperature is intensive (it does not depend upon the size of the system)

But, now think about melting the two samples with a meeker burner. Can you suggest the temperature at which each sample of ice will melt? Both will melt at 0 ºC. They are both water, so melting point is intensive. Now, think about the amount of energy required to melt, each sample. Is the amount the same? ... No. Due to the greater mass of the iceberg we can imagine it will take a phenomenally larger amount of energy to melt the iceberg to liquid water ... hence energy is extensive (dependent on the size). Note that this energy is calculated by ΔH = mass(Hfusion) … a mass-dependent equation.

iceberg vs.

ice cube

<http://www.hdwallpapersdepot.com/iceberg-wallpapers.html>

**Proof 2:** Here’s another way to think of this: When you add two variables together and the result doubles then the

property that changed is extensive. Any property that remains the same, is an intensive property.

Imagine a cylinder with a moveable piston with 1 Liter of a gas at STP. Now, to it, add to it a second 1-liter sample of the same gas at STP.

Think: The volume doubles, the mass doubles. (Thus, each is extensive).

But, the new system will still be at standard temperature (0ºC) and standard pressure at

(1 atm), making temperature and pressure (in this case) intensive. The density of the gas is the same (volume scaled with mass), thus density is an intensive property.

**PRACTICE**:

Think of two identical blocks of ice. Each block is its own system.

**Each block is 50.0 grams and at −10 ºC**.

system **A**  system **B** ***Got it??***

Okay, now, **add the two** blocks together into a single system, (**C**).  **Compare C to A (*or* B)**

1. Upon combination, what has happened to the temperature? Did it increase / decrease / remain the same? \*rts
   1. Thus, temperature is an \* intensive property
2. What has happened to the number of molecules of ice-water? Did it increase / decrease / rts? \*Increased
   1. Thus, the number of molecules is an \*extensive property
3. What happens to the amount of energy required to melt C into a liquid, compared to A? \*Increased
   1. Thus the amount of energy required to melt a larger mass is an \*extensive property
4. What happens to the melting point of the ice systems as you compare C to A? \*rts
   1. Thus, melting point is an \*intensive property
5. What has happened to the mass of C relative to A? \*doubled or increased
   1. Thus, mass is an \*extensive property.
6. What has happened to the volume when comparing C to A? \*doubled or increased
   1. Thus, volume is an \*extensive property.
7. What has happened to the density of C relative to A? \*rts
   1. Thus, density is an \*intensive property

And, that last question raises a **really interesting point** ….Since the volume increased (**or scaled**) with the

new, larger mass, the **ratio for density (M/V) is constant**. Hence, volume changed in proportion with mass

(scales with mass) making the density an intensive property, or independent of the system's size.

**Thus,** (and here’s the interesting point….) **when two extensive properties are divided by each other the**

**result is an intensive property…assuming constant temperature and pressure.**

e.g ... **Mass** (extensive) **= Density** (intensive) I think that is sort of **COOL**! Ideas intermeshing…

**Volume** (extensive)

Thus, we can use intensive properties like melting point, density, specific heat to help identify matter. You

see (and this is the important learning), these data are \*constants for a sample of matter … They do not

change as long as we compare different samples at the same conditions of temperature and pressure. If we

change either the temperature or pressure … things get interesting….

(Note: To check your answers, go online to my website <http://scientiaestubique.weebly.com/> and highlight the \* marked

areas. Change the font to black, and the answers will appear! Yeah, it’s magic.)

G) Density = Mass

Volume

Maybe the following is a different way of seeing density...

1)Density is a measure of \* the *compactness* with which mass is packed.

Note: \* density ≠ heaviness

a) essentially, at a constant temperature and pressure, the density of a substance is a

constant. Density is intensive but it can change…

i) as you increase the mass of a substance, the sample become more voluminous

(Volume, scales with the mass)

b) Compression (especially of a gas sample) increases density \*(it gets more compacted)

c) Heating matter, tends to result in the decrease of a material's density

....gases when heated, tend to increase volume (expand).... thus decrease density

....solid metals when heated, tend to increase in volume and thus expand ...

i) in the above cases of heating, the substance becomes \*less compacted

**TRY THIS: ∞**Consider two cubes of pure iron

Barbara has 20 cm3 of iron and Meghan has 60 cm3 of iron, *at the same temperature and*

*pressure*. Which statement is FALSE?

\_\_\_ Meghan’s sample has 3 times the density of Barb's sample.

\_\_\_ Meghan's sample has 3 times the volume of Barb’s sample.

\_\_\_ Meghan's sample has 3 times the mass of Barb's sample.

Defend your reasoning: \*The temperature and pressure of the iron samples are the same, thus

the density is the same. Density is a constant. Volume of a sample scales with the mass, thus

M/V is the same.

**TRY THIS: ∞** Which member of the following pairs has the greater density? (Circle one member of each pair

as the answer) One pair is a trick ... in one of the pairs both examples have the same density ... can you

figure it out and why?

pair 1) liquid water (H2O(l)) *or* ice (H2O(s))

pair 2) helium (He(g)) at 0°C and 1 atm *or* air at 0°C and 1 atm

pair 3) olive oil *or* water

pair 4) 25 L of CO2(g) at 0°C and 1 atm *or* 1 L of CO2(g) at 0°C and 1 atm

Identify the “trick pair and defend your thinking as to why it is a "trick pair": Be sure to have a “because”

statement that cites data, a specific theory from your notes, cites an equation or uses an appropriate metaphor.

\* The 4th pair is the trick pair. The densities are the same. The members of the pair are the

same chemical and each is at the same temperature and pressure. They have the same

density *because* density of a chemical is a constant (the same), regardless of volume or

mass, when the conditions of temperature and pressure are the same.

2) Density and Water....

a) Liquid water is the densest at approximately 4 ºC. (really 3.98 ºC ... but, c'mon!)

∞ At this temperature, water has a density of 1.00 gram/mL

∞ Below 4 ºC, and above 4 ºC, water is less dense than 1.00 g/mL

b) About **71 percent** of the Earth's surface is water-covered, and the oceans hold

about **96.5 percent** of that water. Use the following graphs to determine what

percent of that 71% is:

i) drinkable (potable) water? \* 3 % and, of that %, what percent is

ii) accessible to us? \* < 1 % Of this accessible water, what percent is

iii) due to humidity? \* 9.5 %

A screenshot of a cell phone screen with text

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From: VanLoon and Duffy: Environmental Chemistry: A Global Perspective 4th ed 2017, p. 226

Source: U.S. Geological Survey <http://ga.water.usgs.gov/edu/waterdistribution.html> , accessed November 2016,

and taken from Gleick, P.H., Water resources, in Encyclopedia of Climate and Weather, ed. Schneider, S H,

Oxford University Press, New York; vol. 2 pp 817-23 1996

c) Water is Wild!

1. Liquid water can absorb a great deal of energy. (Consider a boiling cup of water)

But also:

ii) The solid phase of most substances is the densest phase ...BUT ...

iii) For water, the solid phase (we call that phase, \* ice ) is

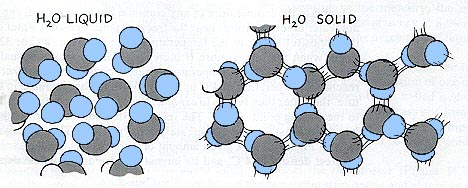
\* less dense than the liquid phase!

Therefore, ice floats .... and it's a good thing that it does... Imagine

the consequences (or perhaps, ramifications to life) if it were not to

float…

Or, as Paul Hewitt (the author of Conceptual Physics (2006, p 318) writes ....with some editing by me...



Water molecules in crystal form have an open-structured hexagonal   
 arrangement, so water expands upon freezing (water becomes less dense).

**How Ponds and Lakes Freeze**

There are 2 key temperatures to remember. **Water is densest around 4°C** but it does not freeze until 0°C ....

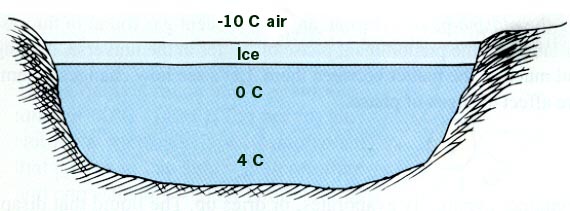
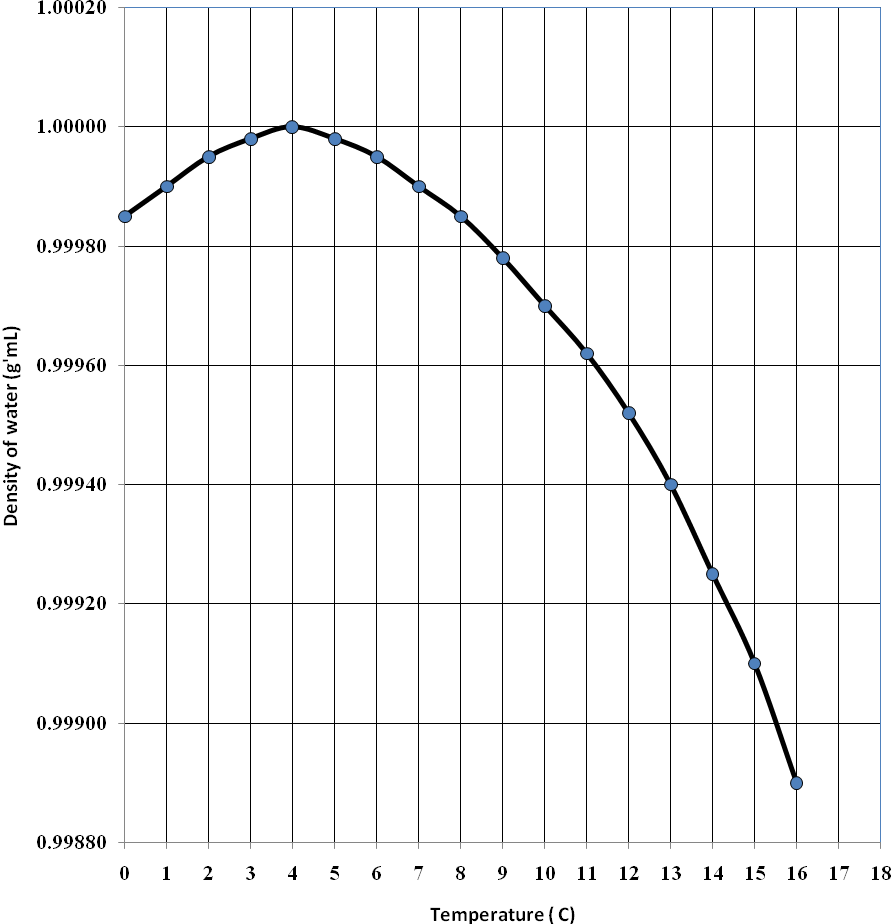
As air above a lake cools, (e.g. from 16°C to 4°C) the water at the top contracts **and becomes denser** than the water below the top layer. This cooler, denser water sinks and **warmer** water rises and takes its place at the top.



This circulation of water, will eventually, bring the vast amount of the lake's water to 4°C. This is as dense as the water can get. Now, think ... water can't become any denser ... but it can become *less* dense ... once it freezes.

Remember, energy moves from high levels to low levels, so as the air continues to cool, (it's winter!!!), the warmer water will continue to lose energy to the air, drop below 4 °C and become *less* dense ... The UPPERMOST (top) layer of water *is especially vulnerable* to this temperature change and drop in density, because the top layer is *less insulated* from changes in air temperature.

So, as the top water layer cools below 4°C, the water incurs a *further decrease* in (water) density. Because the top layer of water is becoming less dense, the matter must be "spreading out", increasing its volume (EXPANDING!) Thus an expansion of the top layer's volume (same mass, with lower density = greater volume). So, the (colder) top layer becomes less dense than the water below. The water at the top stays on top, and ultimately freezes at 0°C and lower.

 Density as a function of Temperature

from: *Conceptual Physics* p 319 (Paul Hewitt)

Question: Use the graph on the preceding page. Consider that climate change is a real issue, and that the

temperature of the Earth’s atmosphere and water is increasing

As water warms from 12 °C to 15 °C, what happens to its density? \*Density of water decreases.

As this change in density occurs, using D=M/V what must then happen to the water’s

volume (space occupied)? \*increases

As this happens, what will happen to the depth/height of sea level? \*increase



[This Photo](https://ipkitten.blogspot.com/2012/07/friday-fantasies.html) by Unknown Author is licensed under [CC BY](https://creativecommons.org/licenses/by/3.0/)

**Check out: Sci Show How Cold-Blooded Animals Survive Winter:**

[**https://www.youtube.com/watch?v=tvzTbKULHmA**](https://www.youtube.com/watch?v=tvzTbKULHmA)

**Think: Why might cells “bust open” if frozen? Use your life experience and the**

**reading on a pond freezing over for a possible reason**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

**So the big Take Home Messages are:**

* Matter has the characteristics of \*mass and volume
* Matter can also be discussed in terms of its \*extensive (changeable) and intensive (pretty constant under the same conditions of pressure and temperature
* In a closed system, during a chemical reaction \*matter is conserved. It can’t just disappear
* Pressurized gases will move from a higher-pressure area to a lower pressure areas
* \*Melting Point and density can be used to identify samples of matter, assuming the samples are compared at the same temperature and pressure.
* \*The density of matter, like water, can change if \*the temperature or pressure on a sample is changed.
* Lakes freezing is an example of an environmental change that occurs when temperature changes, thus altering the density of water. Also, as water warms, it occupies more volume.

**Okay, we have defined and discussed issues such as: matter, energy, mass, volume, weight,**

**pressure and density. Earlier in the notes, I used the word, chemicals, …. So,**

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.

b) Compounds: a 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 can be chemically decomposed into simpler compounds or back

to their elements.

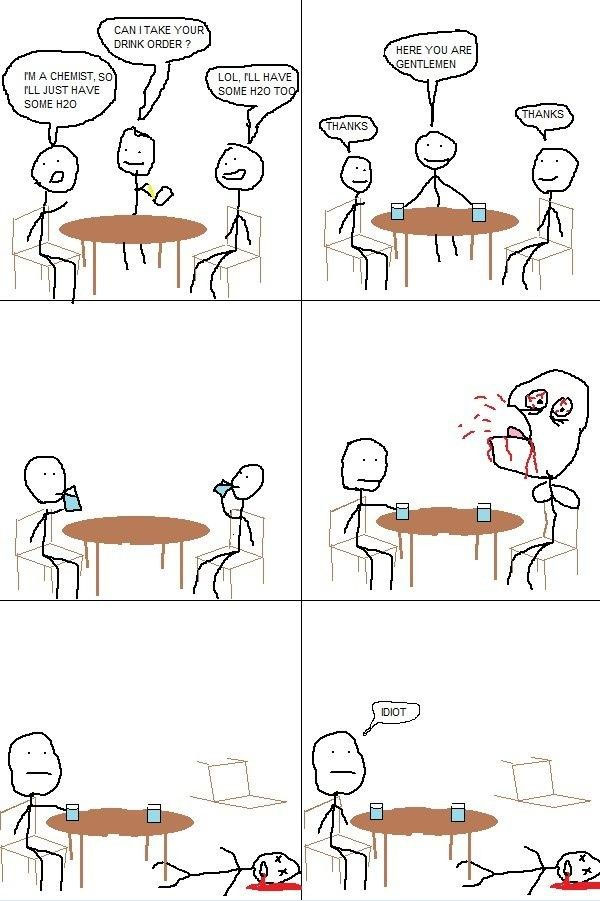
CdCO3(s) → CdO(s) + CO2(g) or 2 H2O → 2 H2(g) + O2(g)

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

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/>

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.

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

concentrations

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

e) 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 the 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 are all still attached to each other.

The only thing which changes is 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.



[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/)

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

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

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

![](data:None;base64,)

![](data:None;base64,) **GIMME A METAPHOR!!**

Think of a tossed salad when thinking about

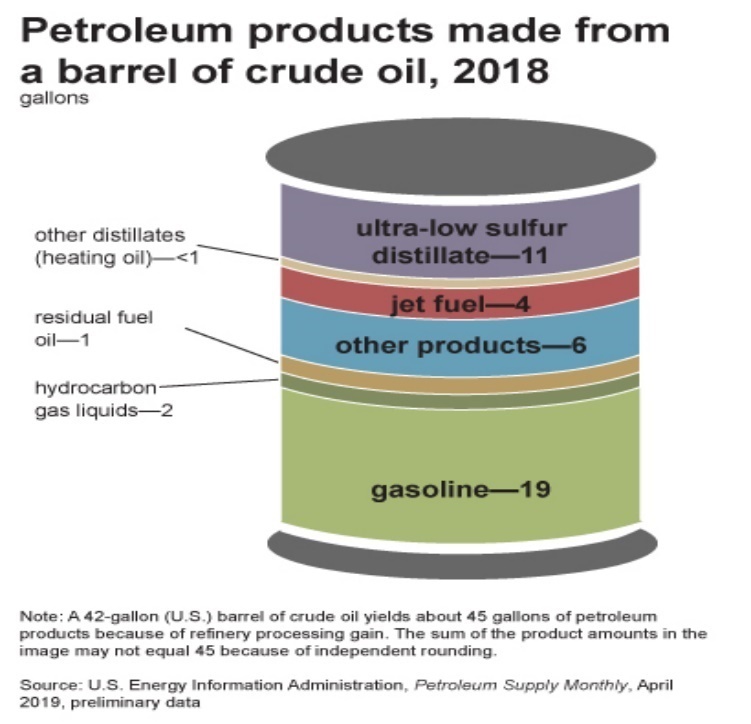
a mixture. A tossed salad has multiple components

just physically placed next to each other. The

proportions can vary. The components can be

physically separated from each other.

2) Take for instance, everything chemistry provides us from one 42-gallon barrel♦ of petroleum.



|  |
| --- |
| The vast amount of oil is used to produce fuels of some sort (the most being gasoline) |
| Approximately 6.5 gallons of each bbl♦ makes our: |
| Aspirin |
| Plastics (et. al.) skis, helmets, cleats, fishing lines, polishes, shoes, vinyl, basketballs, faucet washers, dice, bandages, toilet seats, PVC piping, plastic wrap …. |
| Paints |
| Rubber for gaskets, tires, wiper blades |
| Nylon / Yarn |
| Polymer Fibers for Slacks / Dresses |
| Perfumes |
| Detergents / Ammonia / Deodorants |
| Inks |
| Hair Coloring Dyes / Clothing Dyes |
| Dashboards / Vinyl Siding |
| Roofing Shingles |
| Cortisone / Antihistamines |
| Antiseptics |
| Makeup: lipstick, foundation, mascara |
| Fertilizers / Insecticides / Pesticides |
| Candles |
| Hand Lotion |
| Contact lenses / TV screens |
| Shaving cream |
| Shampoo |
| Latex: condoms, balloons  <https://www.ranken-energy.com/index.php/products-made-from-petroleum/> |

<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>

C) What is a chemical reaction? We will get to this more in-depth a bit later … but for now, we can

describe is as any type of reaction in which \*new bonds are made

1) Often 2 or more visual clues occur:

a) a bold color change. Eg) white to black, colorless to yellow

b) a new solid (called a \*precipitate ) is produced.

c) a new gas is produced (There is bubbling)

d) a new liquid is produced (tough to see)

e) there is an energy exchange between the environment and chemicals. Energy is either

absorbed from the environment (use of a Bunsen burner) or released to the

environment by the reacting chemicals. The beaker or vessel gets warmer or cooler.

Consider: **164 kJ + 2 NH4Cl(s) + Ba(OH)2(s) 🡪 2 NH3(g) + 2 H2O(ℓ) + BaCl2(s)**

reactants products

Reactants = “\*ingredients ”

Products = well, um…products!

kJ = energy

When the units of kJ are on the reactant side, there is a net absorption of energy from the environment

relative to the amount of energy released. This is called an endothermic reaction

When the units kJ are on the product side, there is a net release of energy from the formation of products

into the environment. This is called an exothermic reaction.

This energy is lost to the environment (the surrounding air or water). The temperature of the surroundings goes up!

Examples of exothermic reactions

2 Al(s) + 6 HCl(aq) → 2 AlCl3(aq) + 3 H2(g) + 1,055 kJ

4 Fe(s) + 3 O2(g) → 2 Fe2O3(s) + 1,648 kJ

CH4(g) + O2(g) → CO2(g) + 2 H2O(ℓ) + 890 kJ (This released energy is essentially associated with the flame!!!)

TAKE HOME MESSAGE: Were exothermic reactions to occur in water or air we should expect to

see an increase in the temperature of the water or air, as the reactions proceed … Think about how

a room warms as an exothermic fire burns in the fireplace … But also, think about how ice freezing

is exothermic … Energy must be extracted or lost from the liquid water to turn to ice … Thus, a freezer

must be in constant operation to keep removing the lost heat from all the food stored in it….

Examples of endothermic reactions: Reactions in which more energy is absorbed by the reactants, as

bonds are broken, then is released as new bonds are made. The resulting products tend to be greater in energy that the reactants (we are “storing energy). The temperature of the surrounding air or water in which the chemicals react, decreases.

Photosynthesis: 2803 kJ + 6 CO2(g) + 6 H2O(ℓ) → C6H12O6(aq) + 6 O2(g)

Physical Change: Dissolving of NH4NO3 in water

This energy is absorbed from the water surrounding the NH4NO3. The energy is used to drive the dissolving process; thus the temperature of the water goes down.

24 kJ + NH4NO3 + H2O(ℓ) → NH4+1(aq) + NO3-1(aq)

**Try This:** Identify the chemical reactions. A chemical reaction may be exothermic or endothermic.

Answer each of the following questions **by selecting or by providing the most correct answer**. Remember to be critical readers and thinkers, remember to analyze, circle important terms, and redefine terms.

Really look for new bonds being made. Or, you may look for 2 to 3 of the 5 visual signs of a chemical reaction. Bold color change; new solid produced; new gas produced; new liquid produced; energy exchange. **Go to my website** [**www.scientiaestubique.com**](http://www.scientiaestubique.com) **, open the Unit 1 Part 1 note packet for the answers.**

1) Given: 2 N2(g) + 3 O2(g) → 2 N2O3(g) + 200 kJ

A student claimed that the above represents a chemical reaction, primarily. She mixed two colorless

gases and added energy to a flask. She noticed a blue liquid with an awful odor evolved. The flask

became very warm.

Is the student correct? \*Yes Defend your answer: \* New bonds are made. N is bonded to O on the

product side, when compared to the reactant side. Or, we could note that there is a bold color change,

new gas, and energy released (3 of the 5 visuals)

2) Given: 2 NaOH(aq) + CuSO4(aq) → Cu(OH)2 (s) + 2 Na2SO4)(aq)  + 90 kJ

A student claimed that the above represents a chemical reaction, primarily. He combined a clear

solution with a slightly blue solution making a third blue solution. Then he noticed that a blue colored

solid formed at the bottom of the test tube and the rest of the solution went clear. He didn’t notice a big

change in temperature, just a slight warming effect.

Is the student correct? \*Yes Defend your answer: \*New bonds are made. Note that the Cu is

Bonded to the (OH) species on the product side. This is new and different with respect to the reactant

side. Or, you could cite that there is a bold color change, new solid, and there was an energy exchange

in terms of the exothermic nature of the reaction.

3) Given: 10 kJ + C6H4Cl2(s) → C6H4Cl2(ℓ)

A student claimed that the above represents a chemical reaction, primarily. He had to warm a flask

containing the solid and noticed that it seemed to melt into a liquid.

Is the student correct? \*No Defend your answer: \*There are no new bonds produced. C is still

bonded to the same H and Cl atoms. Or, from a visual point of view, the liquid is not “new” it is just the

melted form of the original compound. For example frozen water (H2O(s)) is really the same chemical

as liquid water (H2O(ℓ)). This is just a physical change. There is an energy exchange. The change is

endothermic overall – but there are not enough other visual clues to classify this as a chemical *reaction*

4) A student took the temperature of 150.0 mL of water. She then dissolved 30.00 grams of NaOH(s) into

the water according to the equation:

H2O (𝓁)

NaOH (s) → Na+1(aq) + (OH)-1(aq) + 44.5 kJ

She noticed that the solid dissolved into the water, but not much else happened, except that the beaker

became hot to the touch.

1) endothermic & a chemical reaction

2) exothermic & a chemical reaction

3) exothermic & a physical change

4) endothermic & a physical change

answer = \*3

5) A student dropped some calcium metal into a beaker with about 100 mL of water. The student noticed a

bubbling almost like a boiling, and a white solid formed. The beaker became very hot to hold.

This most probably is classified as

1) endothermic & a chemical reaction

2) exothermic & a chemical reaction

3) exothermic & a physical change

4) endothermic & a physical change answer = \*2

6) A student was writing her final paper. She was doing some research and came across the following passage.

One theory as to why old paintings discolor surrounds the use of lead-based pigments. The

Romans and Greeks often used carbonate white lead, which is a mixture of PbCO3 and Pb(OH)2.

Later, other white pigments such as PbSO4 and PbO were often used. Chrome yellow/orange

pigments contained quantities of PbCrO4. Red lead, Pb3O4 was used extensively as a primer paint.

A commonly held belief is that the lead-containing pigments react with hydrogen sulfide gas

(H2S) in polluted air to form the black precipitate lead sulfide (PbS). On exposure all of the

pigments darken due to the formation of the black lead sulfide (PbS). (Karvkstis & Hecke Chemistry Connections 2003 p. 57)

In her paper, she included a sample equation:

PbCO3(s) (white) + H2S(g) → PbS(s) (black) +H2O(g) + CO2(g)

Should she classify the fading of old paintings, as described above as a chemical reaction or as a

physical change, in her paper? Why?

\*It is a chemical change. First the reading uses the term, react, and that implies chemistry. Secondly,

a new solid, and two new gases are produced in the example equation. When such new materials

are produced, it is an indication of a chemical reaction,