NAME _____ EVERYDAY CHEMISTRY: UNIT 1:
INTRO / MATTER AND ENERGY (Part 2)

I-VI) See Basics of Matter and Energy (Part 1)

VII) Energy: *

on Earth, it is described as:

Mechanical Energy (sum of Potential Energy and Kinetic Energy)

can be divided into 2 big categories.

Potential Energy ⟷ can be converted to ⟷ Kinetic Energy

defined as

energy of position of between species relative to an assumed standard

examples of potential energy

Chemical Bond Energy

P.E. is associated with the energy found in bonds.

Bonds have a *length or distance* and thus are their energies are associated closely with potential energy … called chemical energy.

defined as

energy of motion (some of the energy possessed by an object in motion)

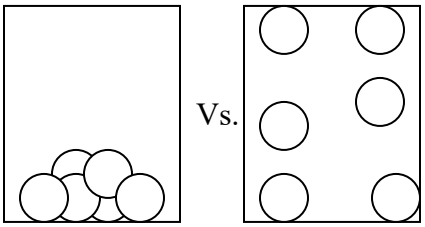
examples of kinetic energy

Electromagnetic Spectrum [Light, Thermal, Microwave]; and then there is/are: Sound energy, Moving objects ....

acceleration is a change in an object's speed and/or direction (velocity)

A) Work: W = (force)(distance) where force = (mass)(acceleration)

B) **PO**tential Energy = Energy of *

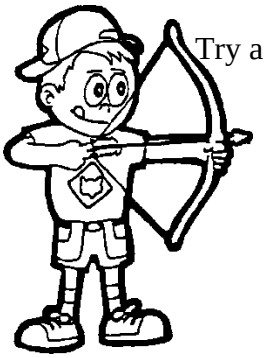


Vs.

Potential Energy **(Big Idea #2)** is essentially due to a POsition of objects: ***It is the energy (ability to do work) possessed by an object, due to its position relative to some standard (assumed) second position.***

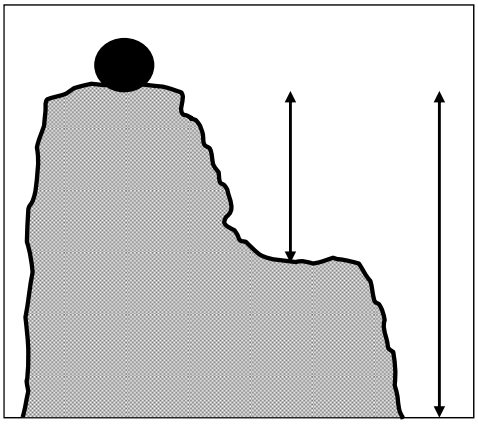
This is intimately linked to changes in chemical bond energies, phase changes, the production of light, and intermolecular forces of attraction(s)

This applies to bond theory, because as a bond is made, the POsition between the atoms, that will bond, must decrease (they must get closer to each other). This "getting closer" must occur if the positive nuclear forces of one atom are to attract the electron(s) of the other atom. As this POsition (POtential) decreases, the LCME states that the energy must go somewhere …. Often it is converted into thermal energy, and it is released.

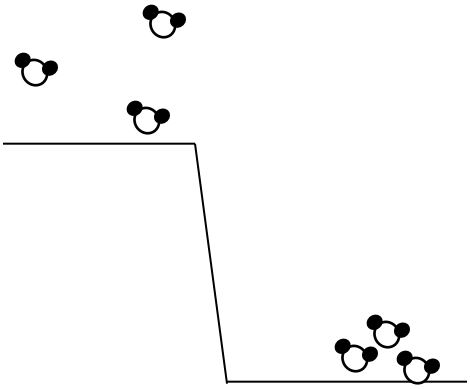


Try a bow and arrow as a metaphor for learning …some neat connections are about to be made!

http://clipart.usscouts.org/library/BSA_Cub_Scouts/Cartoons



The rock on top of a hill



Position of particles in the gas phase vs. liquid phase

https://www.britannica.com/sports/boxing/Weight-divisions
Floyd Mayweather Jr. turned and retracted.

C) Review: Law of the Conservation of Matter and Energy: Matter and Energy can NOT be created nor destroyed by ordinary chemical means … **BUT, energy can be converted into various forms of energy and/or energy can be transferred.**

1) As the potential energy between objects decreases, *

potential energy is often **converted into some form of kinetic energy**

ANIMATION: **https://www.youtube.com/watch?v=hx0tSiCQWDc** (Begin at minute 6 and watch to minute 8)

a) translation : Moving from place to place (one point to a second point)

b) rotation : Tumbling

c) vibration : *

D) Kinetic Energy: The ability to create a change or to do work, due to motion (Energy of motion)

1) Generally, the examples of energy with which we are familiar are forms of K.E :(each due to the "motion" or change in position of particles … light, radio waves, thermal energy…)

2) When 2 particles collide the K.E. can be transferred (think of a game of pool…)

3) **Thermal Energy**: unit: joules (J) and kilojoules (kJ)

a) 1 calorie: The energy required to raise 1 gram of water by 1ºC
b) 1 calorie is equal to 4.18 Joules (SI Unit)

c) Heat: (Latin: ***calor***) effectively the physical equivalent of work: James Prescott Joule demonstrated that mechanical work, electrical work and chemical work all produce a **transfer of energy**. (The Extraordinary Chemistry of Ordinary Things Snyder 4th ed. p 179)

i) Heat is the **process**: the ***transfer of energy*** between two areas of different energy content. (e.g... We need to "heat up" a cup of cold coffee. It's a transfer of thermal energy really)

ii) the transfer occurs naturally from areas of * energy to areas of *

iii) And while we're at it…**there is no such thing as cold energy**

Now, listen very carefully ….

4) **Temperature ≠ Thermal Energy (or "heat" if you insist…)**

a) When I say, **temperature**, you think: *

i) Think about the idea that temperature ≠ thermal energy

What is/are the unit(s) for measurements of temperature? *

What is the unit for the measurement of energy, in our course? *

Conclusion? *

ii) temperature measures how frequently and/or how intensely the energy of the average molecule(s) of the measured medium affects the energy of the molecules of the liquid inside the bulb of a thermometer…

or, more precisely….

"Temperature reflects the average total kinetic energy of particles in matter. ***Heat*** **is the transfer of thermal energy; it flows from regions of high temperature to regions of low temperature.** Thermal energy is stored as kinetic energy in the random modes of translation in monatomic substances, and translations and rotations of polyatomic molecules in gases. Additionally, some thermal energy may be stored as the potential energy associated with higher-energy-modes of vibration, whenever they occur in interatomic bonds in any substance. Translation, rotation, and the two types of energy in vibration (kinetic and potential) represent the degrees of freedom of motion which classically contribute to the heat capacity of a thermodynamic system." http://en.wikipedia.org/wiki/Heat_capacity

TRY THIS: When you feel a "draft" in your house, what ***starts*** the process?
Is it due to: *cold air moving into the warmer house*, or *warm air moving out of the house to the cold*?

*

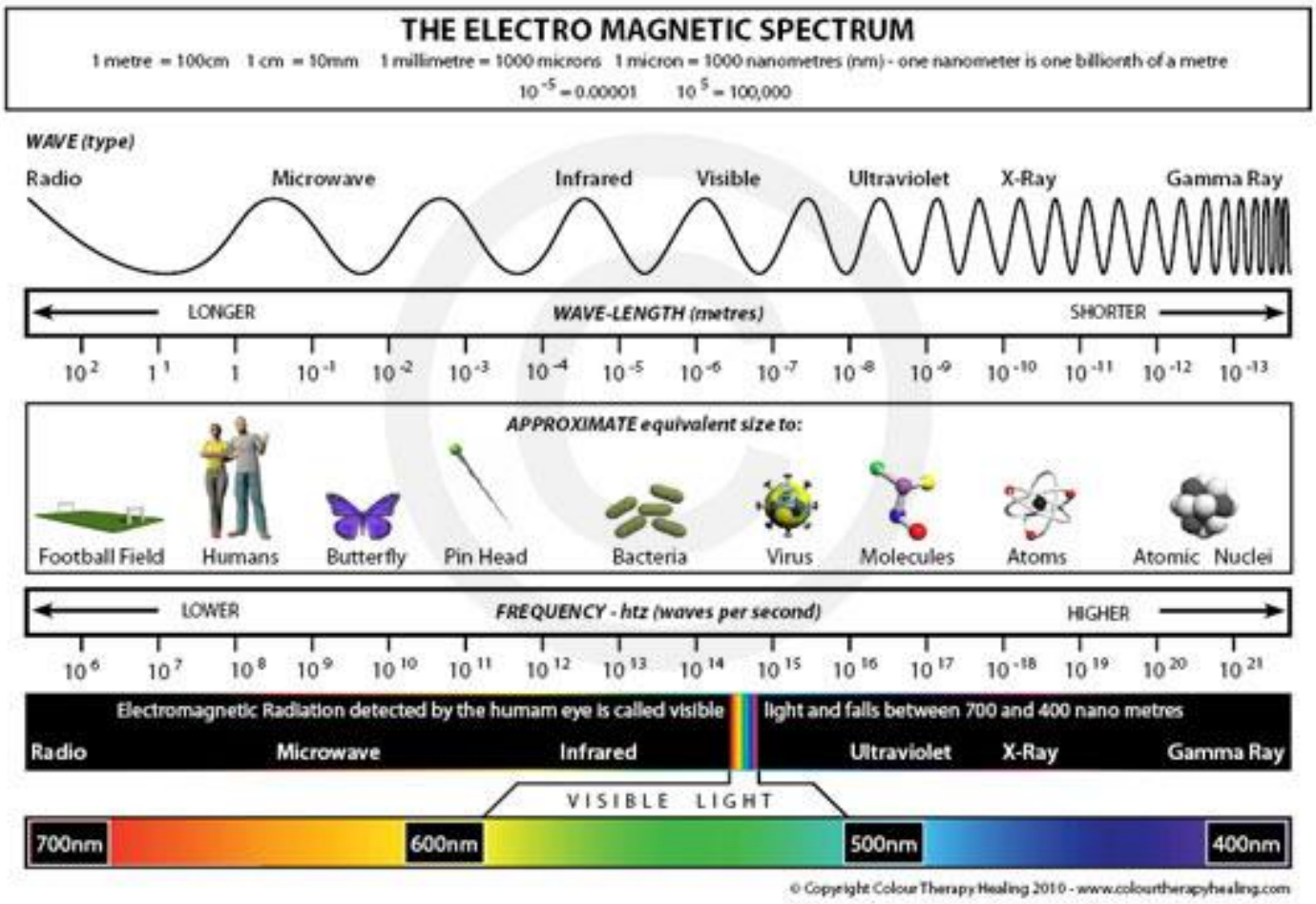
TRY THIS: A cold pack is placed on an injured leg. Identify the direction of the flow of energy between the leg and the cold pack. Does the energy flow from your leg to the cold pack or does the energy flow from the cold pack to your leg?

*

Describe how the Law of Conservation of Energy applies to the energy exchange that occurs between the cold pack and injured leg.

*

VIII) Visible Light Energy and Thermal Energy are both forms of the Electromagnetic Spectrum



http://www.colourtherapyhealing.com/colour/electromagnetic_spectrum.php

A) The electromagnetic spectrum represents several different types of radiation …but each related to the *

1) Radiation is and energy which is emitted and/or travels in the form of waves or particles ("particles" of light are called photons)

Please understand that light is a form of radiation. Most people think of radiation as *nuclear radiation* only. For the most part, nuclear radiation is a limited part of the electromagnetic spectrum (e.g., gamma radiation).

B) So, What Do We Mean By Light?

With the work of scientists such as Albert Einstein and Prince Louis de Broglie, it is fairly common to consider energy and matter to have both wave-like properties and particle-like properties.

Einstein called a light particle, **a photon.** A photon comes in little discrete packages of energy called **quanta**. A **quantum** of energy is the amount of energy required to move an electron from one energy level to another energy level … The electron's energy is said to be quantized.

1) ***Visible*** Light is just one form of electromagnetic energy. We see only visible light, but other animals can see other forms of electromagnetic energy.

   a) Visible Light is only ONE portion of the electromagnetic spectrum. Other examples are: Microwaves, Radio Waves (NOT sound waves), X-Rays, Infrared Waves

      i) Some birds and bees can see polarized light

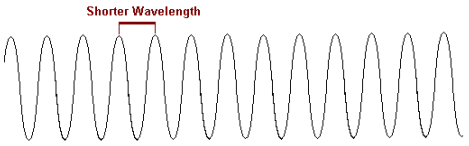
2) Visible (as a whole) or White Light is a combination of wavelengths: **ROYGBIV**

   a) The I (for indigo) is sort of the Pluto of the wavelength family. It is no longer considered to be an independent wavelength – but rather the border between blue and violet.

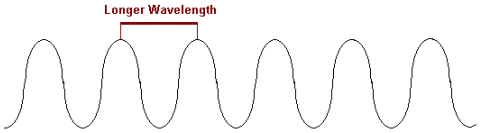
3) Two terms become important: **Wavelength and Frequency**

   Wavelength: The "size" or distance from crest to crest

   Frequency: The number of waves that pass a certain point, in 1 second (unit: Hertz)

a) 

shorter wavelength, thus: greater frequency

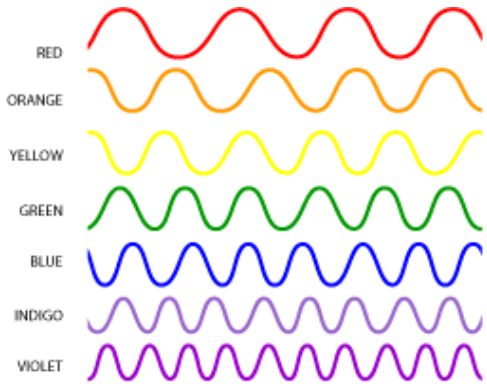
b) 

longer wavelength, thus: lower frequency

http://www.qrg.northwestern.edu/projects/vss/docs/Communications/1-what-is-wavelength.html

Check Out: https://www.youtube.com/watch?v=Ve8iqkgAl9s&t=53s Wavelength vs. Frequency (Not Bad!)

Relative Wavelengths of Visible Light



longest wavelength, thus lowest frequency

shortest wavelength, thus, greatest frequency

http://science.hq.nasa.gov/kids/imagers/ems/visible.html

c) Inference: Study the diagram of visible wavelengths (above). Compare Red to Blue.

Which has the shorter wavelength? *

This means that * has a greater / lower frequency.
(Choose 1)

Thus, we may conclude that * transfers *

d) Sidenote: As light attenuates (stretches) due to traveling farther, it red shifts

5) **Application**: Subtractive color: The electrons of dyes and pigments (e.g. lake pigments and other organic compounds such as chlorophyll) absorb certain frequencies of visible light (*). The energy NOT absorbed by the electrons is *

That * is what we see as color. Color is essentially

our interpretation of the energy which has been *subtracted from ROYGBIV

a) e.g. The electrons of the molecules of the pigments found in something like a

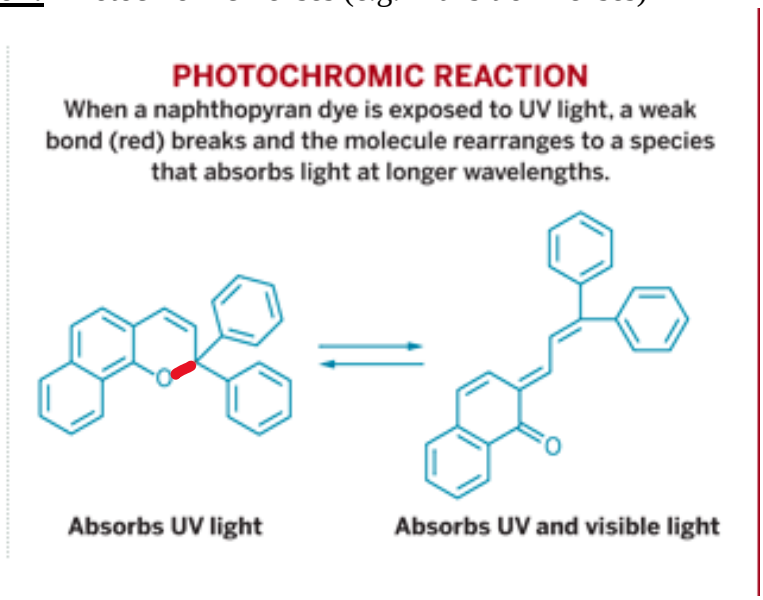
yellow banana *

So here is a wonderful application https://www.youtube.com/watch?v=X96d1YEN_fQ

(Sci Show: Why are plants green? an example of subtractive color)

Why do some scientists believe the reflection of green light to be adaptative?

6) **Application:** Photochromic Lenses (e.g. Transition Lenses)



Citation: What's That Stuff? Self-Darkening Eyeglasses C&EN 6 April 2009 Volume 87 Issue 15 by Britt E. Erickson

a) Plastic photochromic lenses work differently than glass photochromic lenses.

But we will focus just on only the plastic lenses which change color as you enter or leave sunlight.

b) According to Chris Baldy in "What's that Stuff? when photochromic dye (layered into/onto/between) plastic, is exposed to UV radiation (like the UV rays which cause us to tan…) , the dye absorbs that UV radiation, and a bond is broken, in the dye. (See the reddish line representing a covalent bond)

c) This opens the dye molecule and changes the absorption of the molecule. It absorbs at the *longer wavelengths of visible light.* This means that the lens will darken (When light is absorbed, but not released, the color is "black" or at least darker) What's That Stuff? Self-Darkening Eyeglasses C&EN 6 April 2009 Volume 87 Issue 15 by Britt E. Erickson

Demo: Light as Energy…. Which form carries the most energy?

$AgNO_{3(aq)} + NaCl_{(aq)} \rightarrow NaNO_{3(aq)} + AgCl_{(s)} \downarrow$ (white precipitate)

$$AgCl_{(s)} \xrightarrow{\text{light energy}} Cl_{2(g)} + Ag_{(s)}$$ a black-looking solid

Check out: Color Change in Leaves: The Chemicals Behind the Colours of Autumn Leaves – Compound Interest (compoundchem.com)

What pigment decomposes first?

What is the source of the gold and yellow pigments?

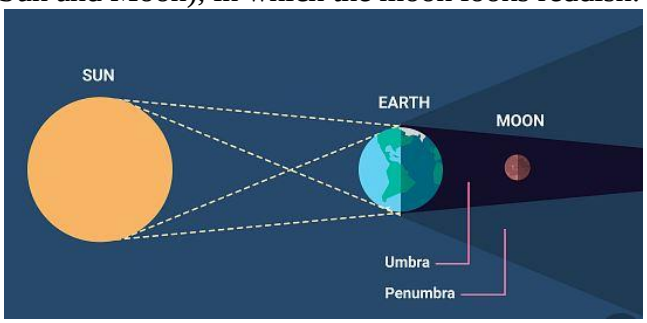
Why might a leaf be bright red on one side but dull green/gray on the other side?

Fun Fact☺ Check Out: **Why is the sky blue?** http://www.sciencemadesimple.com/sky_blue.html

What causes the sky to be blue?

Water appears blue for a slight different reason….

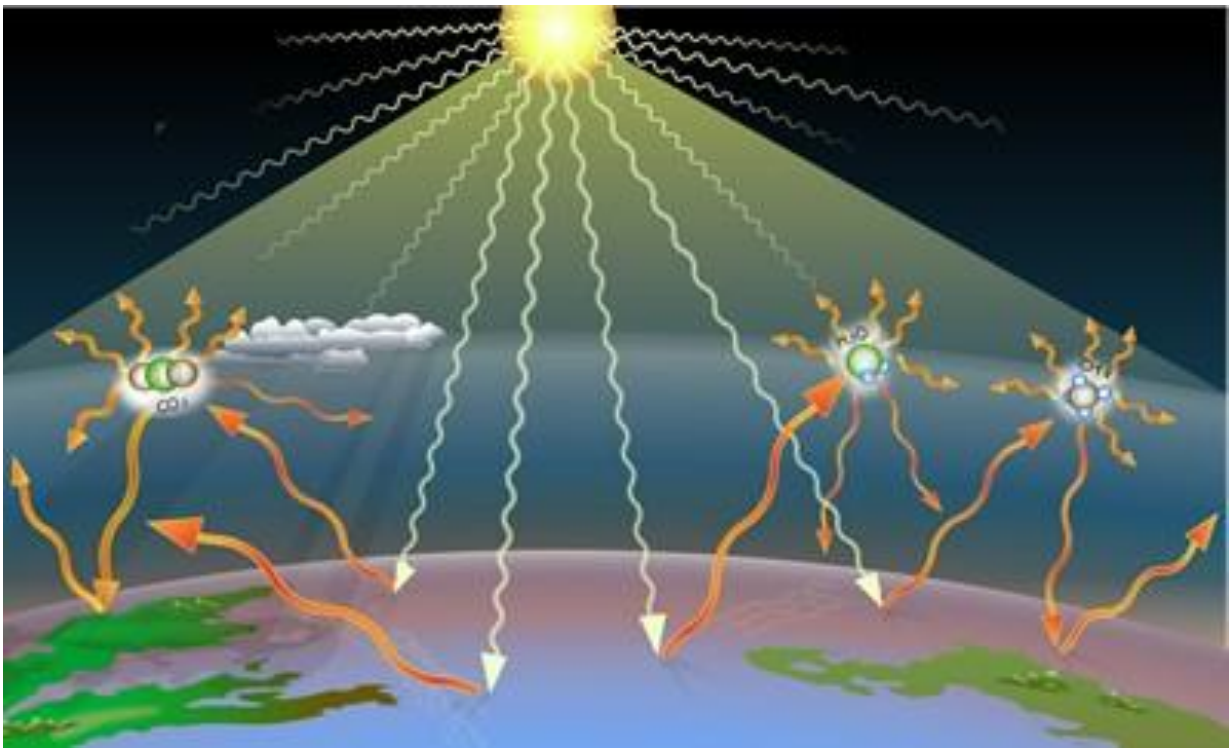
Try This! In the Autumn of 2022, there was a Blood Moon. A Blood Moon is a special sort of Lunar Eclipse (when the Earth is between the Sun and Moon), in which the moon looks reddish. What is causing a Blood Moon, to appear red in color?



https://www.timeanddate.com/eclipse/total-lunar-eclipse.html

*

How $CO_{2(g)}$ and other greenhouse gases affect Climate Change:
https://scied.ucar.edu/carbon-dioxide-absorbs-and-re-emits-infrared-radiation



By A loose necktie - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=80356809

- The names, Climate Change & Greenhouse Effect are just ever so slightly different in meaning to me.

- The Greenhouse Effect is one of the reasons there is life on this planet. Rather than having the energy of the Sun totally reflected off the Earth's surface, and thus bounced right back out into space, certain chemicals in the atmosphere absorbed and re-radiated that energy back to Earth.

  The result of reflecting solar energy back to the Earth's surface was that *

  Climate Change is a relatively new term which generally refers to the effects that an

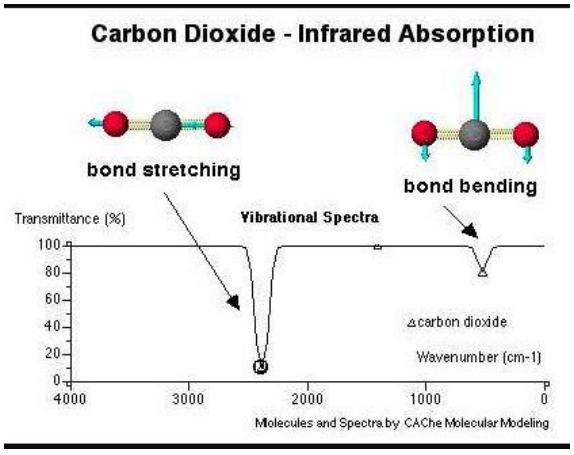
- It is sort of an issue of "Too much of a good thing…."

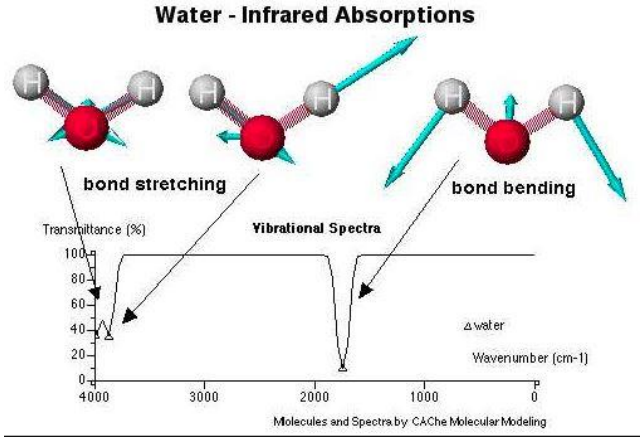
Test Question: How do greenhouse gases contribute to changes in the temperature of the Earth?

According to chemists at Elmhurst University (http://chemistry.elmhurst.edu/vchembook/globalwarmA5.html)

Carbon dioxide and water vapor are two greenhouse gas molecules. They are shown in the next series of figures along with the IR spectra (infrared spectra) and the **bending and vibrations** (changes in potential energy) caused by absorbing the IR radiation.

- The arrows on the molecules indicate the direction of the bends and vibrations of the bonds.
- The IR spectra indicates the specific energies at certain wavelengths which are absorbed.
- Radiation that is 100% transmittance is not blocked but travels straight through the sample and returns to space.
- **The dips in the lines** are caused by the absorption of energy, by the molecules, hence only 10% of the energy is transmitted back to space, in the case of $CO_{2(g)}$. 90% is retained.





IX) Identifying Chemical ***Reactions*** vs. Physical Changes

Broadly speaking, I want to introduce you to a number of ideas surrounding the chemical reaction, the use of energy, bonding, and types of compounds. This unit is important in terms of setting you up to write your final paper. It is rich in vocabulary and in recognition skills.

LEARNING GOLAS: I want you to know / to know how:

- to differentiate between a chemical ***reaction*** and a physical ***change*** (In our course I do not use the phrase "physical reaction", as I do not believe such a thing exists … I refer to the production of any mixture, or change in phase [e.g. solid water-ice melting to liquid water], as a physical ***change***. There are no new bonds made in a physical change.)

- about exothermic and endothermic chemical reactions and physical changes

Let's get started with a GREAT visual … This is fun… It is a demonstration I would do in class … just not at this scale! It is a **chemical reaction**. It is the rapid decomposition of a mixture of 30% Hydrogen peroxide into water, and oxygen gas (or dioxygen). It releases a great deal of energy. We will use it as our first model for the discussion of chemical reaction vs. physical change.

$$2\,H_2O_{2(aq)} \xrightarrow{\text{catalyst}} 2\,H_2O_{(\ell)} + O_{2(g)} + 196.15kJ$$

Click on, Turn up the Volume and Watch: https://www.youtube.com/watch?v=XXn4fP3CnJg
begin around 7 minutes.

They mixed: 35% Hydrogen Peroxide
Dawn Dishwashing Detergent
Potassium Iodide (KI) as a catalyst.

The catalyst is not consumed in the reaction … it simply acts like a matchmaker and speeds the reaction along.

This thing becomes dangerously hot! It is highly exothermic! Look at the steam produced! But it is so cool!

Enzymes are biochemical catalysts. They are not consumed in reactions but re-used repeatedly. *Catalase* is such a catalyst (enzyme), found in our blood. When you bled, we used to pour 3% hydrogen peroxide over the wound. The catalase broke H_2O_2 down into the oxygen (the bubbles) which bathed your wound, to kill anaerobic (oxygen hating) bacteria like those causing leprosy, gangrene, and tetanus. This helped to clean the wound.

In the above demonstration, oxygen gas bubbles into the Dawn detergent, creating the foam. The water ultimately vaporizes to water vapor, because of the tremendous amount of energy released (it is highly exothermic).

Be aware that dermatologists no longer recommend H_2O_2 for cleaning cuts, as the heat produced by the decomposition and the chemical in general, may damage healthy tissue and/or slow healing.

IX) Not everything which happens to matter is a **chemical reaction**. A **chemical reaction** must include the **making of NEW bonds** … which often result in the re-arrangement of the ions or atoms, due to *

These changes often (but not always) mean there has been an oxidation and reduction.

A) Physical changes do NOT involve any type of oxidation or reduction. There are no changes in the electron clouds of the species.

B) Chemical reactions may involve physical changes (liquid water may become vaporized) … but physical changes do not involve chemical reactions.

C) Where I think things get confused is that chemical reactions can end up producing physical mixtures as they are producing new chemical bonds.

One more time….

NOT EVERYTHING THAT HAPPENS IS A CHEMICAL REACTION, but many chemical reactions may involve a physical change in the matter. eg. forming an (aq) and a new solid...

2 ways to determine when a chemical reaction has occurred

On A Test	In Your Life and in Lab
When there's a re-arrangement of element symbols so that new (not pre-existing) substances are produced.	at least **2** of the 5 visual cues when there is a bold color change when a new solid (precipitate) is produced when a new gas is produced (fizzing, bubbles) when a new liquid is produced (hard to tell when this happens) when energy is absorbed or released (found in most interactions)

TAKE HOME MESSAGE: Bond Breaking (alone) does NOT mean a chemical reaction has occurred.

In reality a chemical reaction occurs only when *

D) Take a look at that chart on the prior page … There are all sorts of visual clues that a chemical change has occurred.

1) In lab, or in demos you have seen the production of precipitates and gases. You have seen bold color changes and clearly you have heated materials & or noted energy being released.

2) On a test, you want to look for the rearrangement of the element symbols. This is a clue.

a) For instance, look at the gas burning in a Bunsen burner, producing a flame.

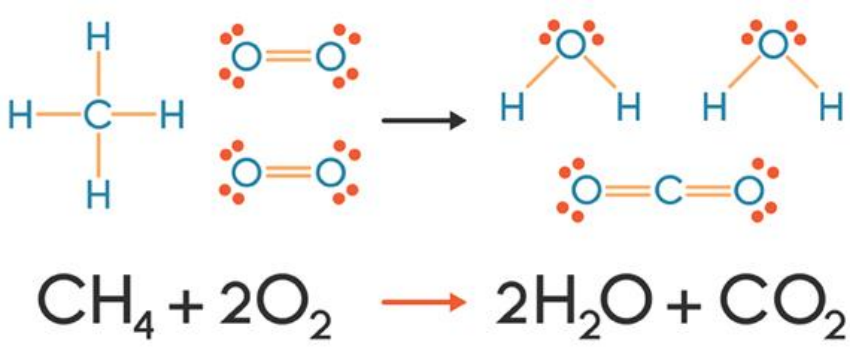
$$CH_{4(g)} + 2\ O_{2(g)} \rightarrow 2\ H_2O_{(g)} + CO_{2(g)} + 890\ kJ$$

Notice that the carbon is bonded to hydrogen, on the reactant side, but carbon is bonded to oxygen on the product side. This is a chemical reaction, due to new bonds being made. The rearrangement of the symbols helps to visualize new bonding.

Note that oxygen is bonded to another oxygen on the reactant side but on the product side, oxygen atoms are bonded to hydrogen and to carbon. Again, new bonds are made. This is a chemical reaction.

Or: Notice that 2 brand new gases, not found on the reactant side are produced, and energy is evolved (the 890 kJ)

Here is a visualization of the above process from:
https://www.learner.org/courses/chemistry/text/text.html?dis=U&num=Ym5WdElUQS9OeW89&sec=Ym5WdElUQS9OaW89



$$CH_4 + 2O_2 \longrightarrow 2H_2O + CO_2$$

Do you connect the changes in potential energy from the reactants to the products, as the released heat and flame?

Now, let me compare a chemical reaction … to a couple of physical changes …. I am switching gears here….

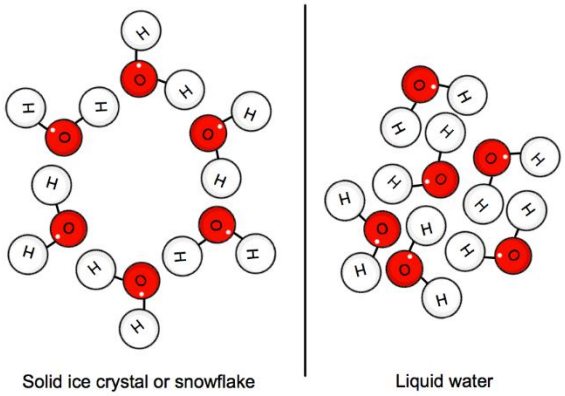
b) Take a look at melting ice to liquid water….

$$334\ kJ + H_2O_{(s)} \rightarrow H_2O_{(\ell)}$$

Notice that there are NO new bonds produced … The hydrogens are STILL bonded to the oxygen. This is a **physical change** … a solid melting to a liquid …

While energy is absorbed, no "new" gas or liquid is produced … The molecules have simply been re-arranged into a looser grouping (liquids are more loosely packed than the solid … due to the greater potential energy of the liquid) … but the liquid is not really a "new" compound …

Again, what HAS CHANGED is the spatial arrangement (or perhaps we might say, the POtential energy) between the water molecules However, a change in spatial arrangement such as melting DOES NOT IMPLY a chemical reaction.



Note that the diagrams (or structural formulae) indicate that hydrogen are *still bonded* to oxygen in the same way … No bond breaking has occurred and **no new bonds were made…when comparing reactants to products… only the arrangement in space of the individual molecules has changed…**

This means there is NO REARRANGEMENT of atoms are symbolized when comparing the reactant(s) to the product(s). On the reactant side hydrogen is bonded to oxygen and that is true on the product side as well.

This is a fine line of distinction … but it is an important and valuable one.

Bond breaking doesn't occur when we boil water!

Think about it. What is produced when we break the bonds of water (H_2O)?

c) Take a look at the term, DISSOLVING:

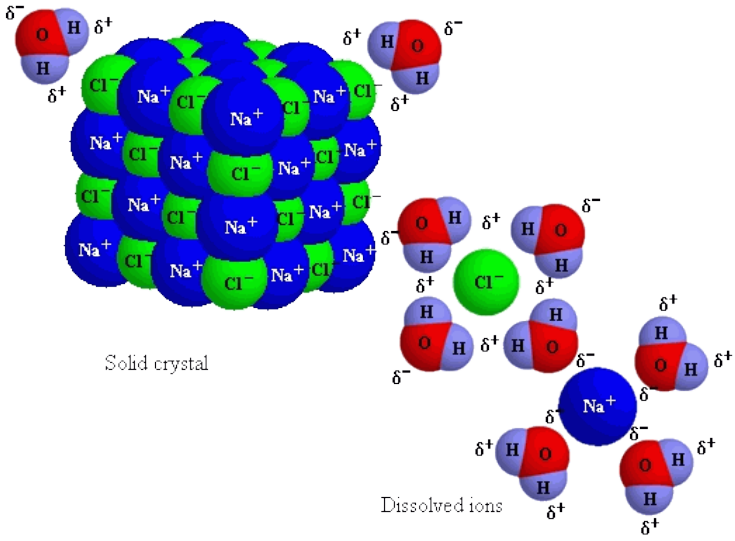
When sodium chloride solid ($NaCl_{(s)}$) is added to water, the solid *dissolves*. The bond holding the Na^{+1} to the Cl^{-1} ion is disrupted by an attraction to the surrounding water and the ions tend to separate from each other. The ions are attracted to the water molecules and are hydrated by the molecules, but this attraction is NOT the same thing as a new bond. There is no significant new sharing or loss/gain of electrons.

Boil away the water, and the $NaCl_{(s)}$ is reconstituted. This dissolving process of a solid in water is a reversible & physical change … not technically a chemical reaction.

This dissolving process in water produces an aqueous solution (a substance dissolved in water)

Thus: $NaCl_{(aq)}$ → This symbol indicates that the chemical substance, (NaCl) has been added to and dissolved in water. Thus, both NaCl and H_2O are present. This symbol indicates the production of a mixture of materials, NOT a new compound.

This is the compound



The sodium ion and chloride ion, however, are no longer bonded to each other, regardless of what the symbolism suggests. The bond between sodium ion and chloride ion has been broken … and the ions are now surrounded by (hydrated by) water molecules.

We will get to the specifics of this process later in the term … But, right now it is important to note how the symbolism of $NaCl_{(aq)}$ can be visualized.

Note that this symbolizes a ***mixture*** of ions and water … NOT a new compound. Technically NO NEW BONDS are produced.

https://socratic.org/questions/547faba7581e2a77ba3a945a

a) There are few common means of writing the dissolution of a compound in water in water. Note that there is NO REARRANGEMENT when comparing the reactant side to the product side.

a) $NaCl_{(s)} \xrightarrow{H_2O} NaCl_{(aq)}$ The (aq) indicates the formation of the mixture.

OR:

b) $NaCl_{(s)} + H_2O_{(\ell)} \rightarrow NaCl_{(aq)}$

OR:

b) $NaCl_{(a)} \xrightarrow{H_2O} Na^{+1}_{(aq)} + Cl^{-1}_{(aq)}$

Note this is a nice means of indicating dissolving … though it is not always used. It has advantages in that is shows the breaking of bonds but no new bond is made

2) **phase changes** such as the melting of ice to water are also physical changes.

a) NO NEW BONDS are produced when solid water-ice melts to liquid water.

b) It is common to write the melting of water-ice to liquid water as:

$$\text{Energy} + H_2O_{(s)} \rightarrow H_2O_{(\ell)}$$

OR … simply:

$$H_2O_{(s)} \rightarrow H_2O_{(\ell)}$$

Essentially: Review:

D) Exothermic vs. Endothermic: We can classify BOTH chemical reactions & physical changes with the shared vocabulary: exothermic and endothermic.

1) Not all chemical changes are exothermic and not all are endothermic …the same goes for physical changes. One may be exothermic while another may be endothermic.

2) We classify a chemical reaction (overall) as * based upon the amount of energy required to break bonds of reactants, relative to the amount of energy released as new bonds are made …

a) When we write a chemical reaction, we tend to write, only the difference between these two processes of breaking bonds and making new bonds.

Imagine… A-B and Y-Z react to form A-Z and Y-B.

Imagine it takes 500 kJ of energy to break up A-B and Y-Z bonds

Imagine 700 kJ of energy are released as the products A-Z and Y-B are made.

$$500\ kJ + AB + YZ \rightarrow AZ + YB + 700\ kJ$$

We would tend to write: $\mathbf{AB + YZ \rightarrow AZ + YB + 200\ kJ}$

This tells us, that 200 kJ of energy were released into the surrounding environment, (air or water) as the new bonds were made.

3) Exothermic reactions: Reactions in which *

a) From the point of view of the chemicals, the surrounding environment, the air or the water, will become *

b) Chemical reactions as well as physical changes (e.g. freezing water to ice or dissolving $NaOH_{(s)}$ in water), can be exothermic, for slightly different reasons. Each however, result in more energy being released than absorbed.

e.g.) $2\ Al_{(s)} + 6\ HCl_{(aq)} \rightarrow 2\ AlCl_{3(aq)} + 3\ H_{2(g)} +$ (1,055 kJ)

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

$4\ Fe_{(s)} + 3\ O_{2(g)} \rightarrow 2\ Fe_2O_{3(s)} + 1{,}648\ kJ$

$CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(\ell)} + 890\ kJ$ (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….

4) Endothermic reactions: Reactions in which more energy is absorbed by the reactants, as bonds are broken, then is released as new bonds are made.

e.g.) Photosynthesis: $2803\ kJ + 6\ CO_{2(g)} + 6\ H_2O_{(\ell)} \rightarrow C_6H_{12}O_{6(aq)} + 6\ O_{2(g)}$

e.g.) Physical Change: Dissolving of NH_4NO_3 in water

(24 kJ) $+ NH_4NO_3 + H_2O_{(\ell)} \rightarrow NH_4^{+1}{}_{(aq)} + NO_3^{-1}{}_{(aq)}$

This energy is absorbed from the water surrounding the NH_4NO_3. The energy is used to drive the dissolving process, thus the temperature of the water goes down.

EXOTHERMIC

Essential	Nonessential
Exemplar	Non-exemplar

ENDOTHERMIC

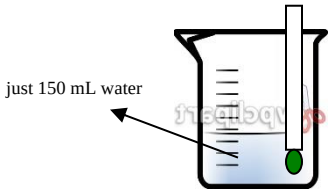
Essential	Nonessential
Exemplar	Non-exemplar

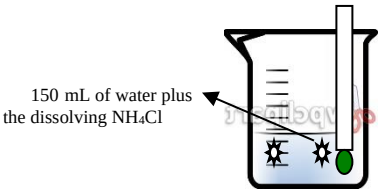
TRY THIS!

___1. *I am providing you with "before and after" diagrams for this question. Analyze them to see if they help you.*

A student took the temperature of 150.0 mL of water. She then dissolved 5.00 grams of $NH_4Cl_{(s)}$ into the water according to the equation

$$NH_4Cl_{(s)} + 14.7\ kJ \xrightarrow{H_2O_{(l)}} NH_4^{+1}{}_{(aq)} + Cl^{-1}{}_{(aq)}$$





http://www.wpclipart.com/science/beaker/beaker.jpg

THINK! Is this dissolving process, endothermic or exothermic?
Is the chemical NH_4Cl absorbing energy from the water, OR releasing energy into the water?

If the chemical were absorbing energy, what should happen to the temperature of the water?
If the chemical were releasing energy, what should happen to the temperature of the water?

She took the temperature of the resulting solution. Using the above equation and her knowledge of thermal energy, she could predict that the reaction was:

a) endothermic & the temperature of the water increased
b) endothermic & the temperature of the water decreased
c) exothermic & the temperature of the water increased
d) exothermic & the temperature of the water decreased

___2 Given the reaction : $A_{(s)} + B_{(aq)} \rightarrow C_{(s)} + D_{(aq)} + 170\ kJ$

If the reaction occurred in water, the temperature of the system at the end of the reaction should have:

a) increased b) decreased c) remained the same

Think: Is this chemical reaction endothermic or exothermic?
Are the chemicals, as they react, absorbing energy from the environment or are the chemicals, as they react, releasing energy into the environment?

If the chemicals were absorbing energy, what should happen to the temperature of the water?
If the chemicals were releasing energy, what should happen to the temperature of the water?

For questions 3 - 5 use the following choices. A choice may be used once, more than once or not at all.

a) endothermic b) *exothermic*

___3) $52.4\ kJ + 2\ C_{(g)} + 2\ H_{2(g)} \rightarrow C_2H_{4(g)}$

___4) $NaOH_{(s)} \xrightarrow{H_2O(\ell)} Na^{+1}_{(aq)} + OH^{-1}_{(aq)} + 44.3\ kJ$ Water, over an arrow, suggests something is being dissolved in water, thus, this is just a physical change…

___5) $HCl_{(aq)} + Fe_{(s)} \rightarrow FeCl_{2(aq)} + H_{2(g)} + 598\ kJ$

___6) A student took the temperature of 150.0 mL of water. She then dissolved 30.00 grams of $KClO_{3(s)}$ into the water according to the equation:

$$KClO_{3(s)} + 41\ kJ \xrightarrow{H_2O(\ell)} K^{+1}_{(aq)} + ClO_3^{-1}_{(aq)}$$

She took the temperature of the resulting aqueous solution. Using the above information and her knowledge of chemistry she could infer that the reaction was :

a) endothermic & the temperature of the surrounding water increased
b) exothermic & the temperature of the surround water increased
c) exothermic & the temperature of the surrounding water decreased
d) endothermic & the temperature of the surrounding water decreased

7) Imagine that you and a friend are sitting in front of a wood fire. The reacting chemicals in this case, are the wood and dioxygen ($O_{2(g)}$) gas from the air. Is the reaction exothermic or endothermic?

$$Wood + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(g)}$$

8) Consider liquid water freezing into solid water-ice. Is this exothermic or endothermic?

$$H_2O_{(l)} \rightarrow H_2O_{(s)}$$

9) What confuses you or what do you think you now know?

Ans:

1) b energy is absorbed by the reactants. the source of energy is most probably from the water, thus energy would move from the water to the chemicals, and the temperature of the resulting solution would be lower than the water's temperature.

2) a it is an exothermic reaction (energy is on the product side) ... the chemicals release more energy than absorbed and thus the water gains that energy.

3) a 4) b 5) b 6) d
7) exothermic ... energy is being released from the reacting chemicals ... far more than was added to get the fire going...
8) exothermic ... this is a cooling process and yes, also exothermic ... the chemical (water) must lose energy to the envrionment...

X) Vocabulary… When reading, you can tell the difference, by some of the technical terms ….. No need to memorize these … **just try to be aware of the verbs and such as you read articles … If in doubt … check out the following!**

CHEMICAL REACTIONS	**versus**	**Physical Changes / Properties**
(involve breaking AND making new bonds &/or involving changes in the e- clouds)		(May involve breaking bonds, but **no new bonds are made** Physical changes may occur with chemical reactions)
reduce / reduction		dissolve / stir (so as to make an aqueous solution)
oxidize / oxidation		**mix** / mixture
combust / burn / flammable		melt / fuse
rust / corrode		vaporize / boil / evaporate
react / **bond**		sublime or sublimate
ionize / ionized		distill
neutralize		freeze
decompose		condense
cook / grill		filter / separate
synthesize		density (when calculating, comparing samples)
precipitate		measuring / comparing masses
flash point		measuring / comparing volumes
polymerize		color
change in oxidation state		liquefied, solidified, (change in phase)
		smell

PRACTICE: **Use the reasoning of the re-arrangement (new bond making), of atoms / ions / species or lack thereof,** to identify each of the following as a chemical reaction or physical change. Provide evidence, using the symbolism. Note, we are working here on determining physical change or chemical reaction, when given a written format, as found on tests or in readings …. This is just a basic skill.

Note: I have ignored the use of (s), (ℓ), (g) and (aq) in the following examples, for the most part, because I want you to focus upon the **symbolism chemists** use, in terms of the rearrangement of the chemical species (new bond formation) or the lack of new bond formation. So focus upon whether or not the symbolism reflects a PHYSICAL CHANGE or a CHEMICAL REACTION. **Answers for 1-15 are at the end of the exercise.**

eg) Identify the following as being a physical change or a chemical reaction and then defend your answer using the concept of new bond formation (or the lack thereof).

$$2\ Al\ +\ 6\ HCl \rightarrow\ 2\ AlCl_3\ +\ 3H_2\ +\ 134\ kJ$$

This represents a *chemical reaction* because species are rearranged when comparing the reactants to the products, indicating new bonds being formed … Some evidence: H_2 is produced.

1) Identify the following as being a physical change or a chemical reaction and then defend your reasoning. Be sure your defense uses a "because" statement using the "new bonds" or lack of new bonds argument.

$$SiO_2 + 4\ HF \rightarrow SiF_4 + 2\ H_2O$$

This represents a because

2) Identify the following as being a physical change or a chemical reaction and then defend your reasoning. Be sure your defense uses a "because" statement using the "new bonds" or lack of new bonds argument

$$CaCl_{2(s)} \xrightarrow{H_2O_{(\ell)}} Ca^{+2}_{(aq)} + 2\ Cl^{-1}_{(aq)}$$

or:

$$CaCl_{2(s)} \xrightarrow{H_2O_{(\ell)}} CaCl_{2(aq)}$$

This represents a because

3) Identify the following as being a physical change or a chemical reaction and then defend your reasoning. Be sure your defense uses a "because" statement using the "new bonds" or lack of new bonds argument. I have included the phases of the compound to emphasis a point …

$$100\ kJ + CH_3OH_{(\ell)} \rightarrow CH_3OH_{(g)}$$

This represents a because

4) Identify the following as being a physical change or a chemical reaction and then defend your reasoning. Be sure your defense uses a "because" statement using the "new bonds" or lack of new bonds argument

$$2\ Al + 3\ I_2 \rightarrow 2\ AlI_3 + 80kJ$$

This represents a because

These you have seen already. They are from Unit 1 Part 1. I thought they may be of use putting ideas together. In the light of newer or at least reviewed learning.

For questions 5 -15 use the **underlined boldfaced verb** as your clue. Compare these verbs to the ones provided to you earlier in the note packet. Let me know if you think the situation describes a chemical reaction / property or a physical change or property.

5) _____ Pat **dissolved** 10.0 grams of $NaOH_{(s)}$ in water.

6) _____ Jordan quickly **grilled** the steak for every late guest.

7) _____ Terry **melted** the butter and flour together to create a rue for the sauce

8) _____ Taylor saw that the metal door handle had **oxidized,** and it needed to be replaced

9) _____ Alex was careful to **distill** the solution to isolate a sample of pure water.

10) _____ Perry used baking soda to **neutralize** the tomato sauce making the taste less tangy

11) _____ Sam **shredded** all the documents listing a social security number.

12) _____ Ryan **burned** the marshmallows in the campfire.

13) _____Sidney determined the **melting point** of the solid to be 58.3°C

14) _____Shaun noted that a can of Coke was **denser** than Diet Coke, in water

15) _____Aidan **filtered** the coffee, using unbleached, paper filters.

Answers:

1) Chemical Reaction … Species are rearranged when comparing the reactants to the products, indicating new bonds being formed … such as SiF_4

2) Physical Change … There appears to be no new bonds made … a lack of rearrangement of species … This simply represents bond breaking ….This equation represents dissolving, which is a physical change.

3) Physical Change … There are no new bonds produced. The species are NOT rearranged, when comparing the reactants to the products. This is a phase change $(\ell) \rightarrow (g)$

4) Chemical Reaction… New bonds are made… The species seem to be rearranged when comparing the reactants to the products. The production of AlI_3 is the evidence of a new bond being made.

5) physical change 6) chemical reaction 7) physical change 8) chemical reaction 9) physical change 10) chemical reaction 11) physical change 12) chemical change 13) physical change 14) physical change 15 physical change