NAME \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ UNIT 3 (PART 1): CHEMICAL REACTIONS & COMPOUNDS

This may be our largest unit. 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
* to use a simplified recognition skill to identify molecules vs. ionic compounds
* to use the same recognition skill to identify / differentiate between nonpolar covalent bonds, polar covalent bonds and ionic bonds.
* to use a different, yet still simplified recognition skill to identify / differentiate between inorganic compounds and organic compounds

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.

**catalyst**

**2 H2O2(aq) 🡪 2 H2O(ℓ) + O2(g) + 196.15kJ**

Click on, Turn up the Volume and Watch: <https://vizual-vibe.tumblr.com/post/190534384299/biggest-hydrogen-peroxide-foam-experiment-ever>

They mixed: 30% Hydrogen Peroxide (I use 28% Hydrogen Peroxide…)

Dawn Dishwashing Detergent

A catalyst … There are a number that can work, I don’t know what they used.

The catalyst is not consumed in the reaction … it simply acts like a matchmaker, and speeds the reaction along. Enzymes are biochemical catalysts … They are not consumed in reactions, but re-used over and over again. *Catalase* is such a catalyst enzyme, found in our blood. When you are bleeding you pour 3% hydrogen peroxide … The catalase breaks it down into the oxygen (the bubbles) which bathes your wound, to kill anaerobic (oxygen hating) bacteria like those causing leprosy, gangrene and tetanus. This helps 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… This thing becomes dangerously hot! But it is soooooo cool!

Note this reinforces that compounds can be broken down into simpler substances … and this is a special type of redox reaction … a disproportionation, in which the oxygen atoms of the peroxide are both reduced and oxidized! That’s very rare! Some go from oxidation states of -1 to 0 while some go from -1 to -2 … It’s so wild!

Questions: What are chemical reactions vs. physical changes? And, how can a poor first year student tell the difference between a chemical reaction and a physical change?



I) 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

\*changes in the electron clouds of those ions or atoms.

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.

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 at least **2** of the 5 visual cues

element symbols so that new when there is a bold color change

(not pre-existing) substances are produced. 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 \* new bonds are made (When bonds are just broken ...

it is not a chemical reaction … it could imply melting or dissolving in water, for example). A chemical

property involves the activity (loss / gain or sharing) of electrons.

C) 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, 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

(remember when we lit the H2(g) in the active metals test with acids, we got that popping

sound and flame?)

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

clue ….

a) For instance, take a look at lighting a Bunsen burner flame

CH4(g) + 2 O2(g) 🡪 2 H2O(g) + CO2(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 emphasize this…

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,

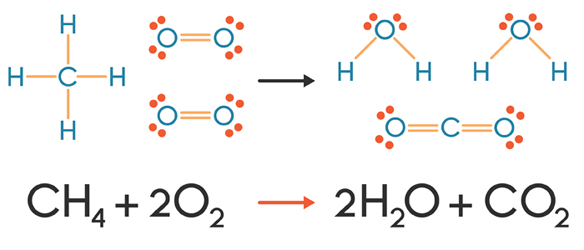
new bonds are made … This is a chemical reaction.

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>



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 + H2O(s) 🡪 H2O(ℓ)

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

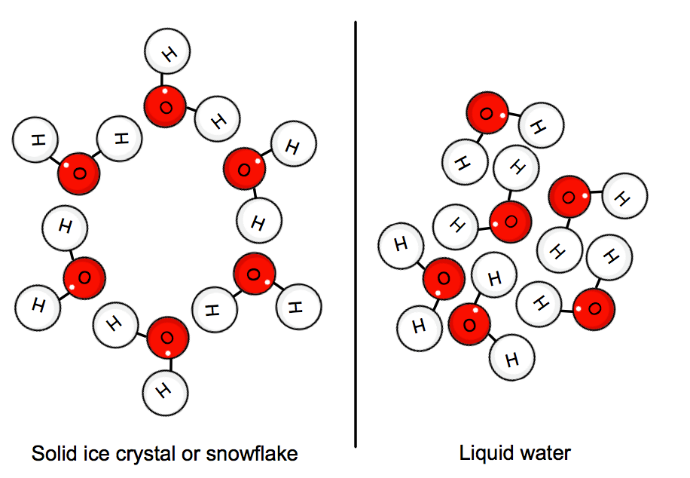
packed than the solid … due to the greater potential energy of the liquid) … but

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

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.

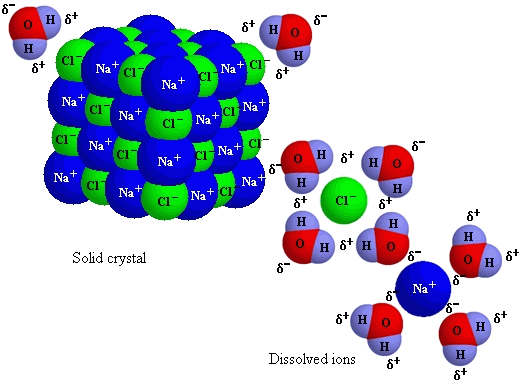
This dissolving process in water produces an aqueous solution (a substance

dissolved in water)

Thus: NaCl(aq) This symbol indicates that the chemical substance,

(NaCl) has been added to and dissolved in water.

This is the compound Thus, both NaCl and H2O are present. This symbol

 indicates the production of a mixture of materials, NOT

a new 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.

H2O

a) NaCl(s) → NaCl(aq) The (aq) indicates the formation of the mixture.

OR:

b) NaCl(s) + H2O(ℓ) → NaCl(aq)

OR:

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

H2O

b) NaCl(a) → Na+1(aq) + Cl-1(aq)

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:

Energy + H2O(s) → H2O(ℓ)

OR … simply:

H2O(s) → H2O(ℓ)

Note that there is NO REARRANGEMENT of atoms 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.

II) 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 (May involve breaking bonds, but **no new bonds are made**

&/or involving changes in the e- clouds) 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 → 2 AlCl3 + 3H2  + 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: H2 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

SiO2 + 4 HF → SiF4 + 2 H2O

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

H2O(l)

CaCl2(s) → Ca+2(aq) + 2 Cl-1(aq)

or: H2O(l)

CaCl2(s) → CaCl2(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 + CH3OH(l) 🡪 CH3OH(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 I2 🡪 2 AlI3 + 80kJ

This represents a because

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 SiF4

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 (ℓ) → (g)

4) Chemical Reaction… New bonds are made… The species seem to be rearranged when comparing the reactants to the products.

The production of AlI3 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

**NOW, WE ARE GOING TO LOOK AT BONDING AND ENERGY, IN TERMS OF CHEMICAL REACTIONS…..**

III) **What is a chemical bond?** … a relatively more stable (or lasting) attraction between atoms or ions, which

leads to the production of a new chemical compound or species.

The term, *chemical bond* or just the term, *bond*, may be due to the:

\*sharing of electrons, between atoms,

as the electrons of one atom are attracted to the nuclear charge of a second atom, and the electrons of that second atom are simultaneously attracted to the nuclear charge of the first atom

(covalent bonding)

\*electrostatic force of attraction

between \* oppositely charged species

\*(+ and – ions)

(ionic bonding)

OR

A third broad category of bond, the **metallic bond** seems to blend the two basic ideas, found above.

Metallic bonding does not however, play a huge role in our discussions, for this class, save to help explain

how to atoms of the **same metallic element** bond to form a crystal of that metallic element (e.g. a chunk of

iron or a gold ring)

IV) **Why do bonds form?** … It ain’t really all that simple of an answer…. But generally,

A) Bonds form because the process of bonding tends to \*lower the potential energy between the

charged particles that compose atoms.

Much of it goes back to \*lowering potential energy due to (coulombic) forces of attraction.

Coulombic forces simply refer to positives attracting negatives, and/or positives repelling

positives and negatives repelling negatives …. That is: opposites attract, like charges repel.

The thinking goes along these lines reactions (resulting in new bonds being formed) tend to

occur so as to decrease enthalpy \*(enthalpy is the fancy word for the overall energy of a

compound ,) and to increase the entropy \*(the distribution of that energy). The entropy of

a gas is greater than its solid phase\*(entropy has a great deal in common with potential energy).

The gas has a greater entropy because, whatever energy the sample contains, is distributed

across a greater number of free moving, individualized molecules.

**The words, enthalpy and entropy are confusing** … They were named so similarly, so that

people would associate the two … Well that just ended up confusing everyone (I mean,

everyone….!!!!)

**Try this; The word enthalpy has an “h”, for heat … meaning energy**

**The word entropy has an “r”, for random arrangement of the energy.**

1) A chemical reaction really has two processes going on … breaking the bonds of the

reactants, and making the NEW bonds found in the products.

ALL bond breaking processes are endothermic (breaking a bond absorbs energy)

ALL new bond making processes are exothermic (making new bonds releases energy)

original system **added energy**

MC900078802[1] **Visualize!!** — —

When enough energy is added the bond is broken, and the atoms separate, & essentially move away from each other.

bond length

\*This dash bond represents 2 shared e- (or 1 pair of e-)

\*A chemical bond is an example of **po**tential energy

\*This bond has a length, thus giving each atom

a **po**sition relative to each other

This system of two separate species (due to a broken bond) has more

energy than the original system, because the position between the

species has increased, due to the energy used to break the bond.

Thus bond breaking is endothermic (absorbs energy)

The new relative position is greater, hence the potential energy is greater … This greater energy in part

is due to the added bond breaking energy of the endothermic reaction. **The opposite is true of bond making,**

**because atoms must get closer (lose position) in order to bond … thus potential is converted into kinetic.**

2) We classify a chemical reaction (overall) as \*either exothermic or endothermic 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

theses 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 → AZ + YB + 700 kJ

We would tend to write: **AB + YZ → 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 \* more energy is released (lost) as new

bonds are made, then is gained as old bonds are broken.

a) From the point of view of the chemicals, the surrounding environment, the air or

the water, will become \*warmer, because energy is being lost by the chemicals to

the surroundings, as the new bonds are formed.

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.

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

e.g.) 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 (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 fire place … 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 CO2(g) + 6 H2O(ℓ) → C6H12O6(aq) + 6 O2(g)

e.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)

V) Bonding theories should help us to predict the circumstances under which bonds form as well as

the properties of the resultant compounds

A) there are three (really) broad classifications of chemical bonds … each is

***dependent upon the type of atoms or ions (species) involved in the bonding***

|  |  |  |
| --- | --- | --- |
| **Species / Type of**  **Ion or Atom** | **Type of Bond** | **Characteristic of the Bond** |
| metal ion & nonmetal ion | ionic | electrons are transferred completely, creating an electrostatic charge attraction. The electronegativity difference > 1.7 |
| nonmetal atom and nonmetal atom | covalent (2 types)   * polar covalent * nonpolar covalent | at least 1 pair of electrons (and up to 3 pair) are shared   * unequally with an   electronegativity diff. < 1.7 but > 0.4     * equally with an electronegativity difference of 0 to 0.4 |
| metal and metal | metallic | electrons delocalize and are pooled among the species and are attracted to multiple nuclear cores. |

Recall: Electronegativity is related to the ability of one atom to attract (gain) the electron(s) of

another atom. It is on a scale of 0.7 to approximately 4.0. Fluorine is the most electronegative

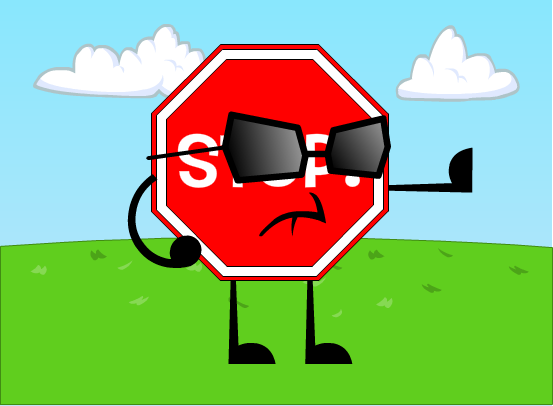
element known, with a value of 3.98 (essentially, 4.0). Oxygen is the second most

electronegative element, with a value of 3.5. The following table offers some other examples.

![A close up of a keyboard

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM2MAAAkpIAAgAAAAM2MAAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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<https://socratic.org/questions/which-elements-have-the-highest-electronegativities-on-the-periodic-table>



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**OKAY STOP!**

I would really like you to take a minute out to watch two videos

They deal with the information found on the next 7 pages or so.

It might be worthwhile to watch them as you move through the

notes. To help you, I have summarized each video … and then

I have continued with formal notes… Let me know if this is

helpful.

Watch: <https://www.youtube.com/watch?reload=9&v=OTgpN62ou24> This is a simple piece regarding

covalent vs. ionic bonding. Some of the “Take Home Messages” are:

Using the octet rule we have derived various ways of categorizing chemical bonds. Chemical bonding

however, is a continuum … it is not cut and dry …. BUT for OUR purposes we can derive a few

generalities

a) A bond is formed because for reasons (not explained here), 8 valence electrons (or only 2 in

the first shell) seem to be a stabilizing (satisfying) number.

i) hence valence electrons get swapped around, so as to achieve 8 valence electrons (or 2

valence electrons, if the first principal energy level is also the valance level, as in H)

b) Electrons may be shared. This type of bond is called a covalent bond (co = share,

valent = valence electrons)

c) Electrons may be lost and gained. This type of bond is called an ionic bond, because the loss

and gain of electrons creates oppositely charged ions, which attract each other….

Watch: <https://www.youtube.com/watch?v=PoQjsnQmxok> Professor Dave: explains bonding.

1) The narrator reviews electronegativity … It is the tendency of one atom to attract the electrons of

another atom. **But you do not need to know the values … there is a little cheat we can use,**

**which will get us pretty far.**

a) When the bond is between atoms of DIFF NONMETALS then you essentially have a polar

covalent bond. (There are exceptions … the biggest is C-H … this is NOT a polar covalent

bond)

a) When the bond is between atoms of the SAME nonmetal OR when the bond is between

C & H, then the bond will be considered to be a nonpolar covalent bond

for example, the bond between fluorine atoms in F2 F-F is nonpolar covalent

Okay, use this space to jot down ideas as they come to you … use the videos and then move on to the formal notes…

VI) Ionic Bonding produces ionic compounds:

For me, the cartoon, tells me a good deal … What is an ionic bond….?????

A picture containing text, book

Description automatically generated

A) An ionic compound is produced by ionic bonds between the species.

1) An ionic bond:

* forms when one atom \*transfers, completely an electron to another atom.
* has this complete transfer of electrons. and one species is oxidized becoming a cation, while the second species is reduced becoming an anion. The oppositely charged ions attract each other and a bond is produced, as potential energy drops.
* is purely \*electrostatic … in that it is produced by the attraction of

\*oppositely charged ions.

* is often found between a metal cation and a nonmetal anion.

e.g.) NaCl (a salt), Mg(OH)2 (a base), Fe2O3 (a metal oxide, a rust)

**VISUALIZE:**

The formation of an **ionic bond** … Note, one atom **completely transfers an**

**electron** to a second atom … producing ions, which are electrostatically attracted

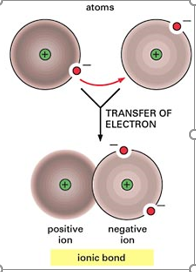
to each other. The result is an ionic compound, held together, via an ionic bond.

The key here is \*the complete transfer of the electron from one to another…

Notice how the negative ion has all of the “bonding” electrons. There is a total

transfer of ownership, as it were … Sort of like me, giving you a car … in which

the car is an electron…



Found at: <https://socratic.org/questions/covalent-bonding-vs-ionic-bonding> from Essential Cell Biology Garland Science 2004

Check out: Beverly Biology: <https://www.youtube.com/watch?v=VSc491HLzDo>

B) Very often, when added to water, an ionic compound will dissolve *AND* the electrostatic bond

is disrupted by water molecules. The ions of the compound separate, and are hydrated (surrounded)

by water, creating an \*electrolyte solution. Think Gatorade. Such a solution can conduct an

electrical current through the solution! We saw this demonstrated in lecture …. remember?

C) (Properties) Ionic compounds tend to:

* have very little odor, as they do NOT turn into gases easily. (We can only smell gases.. Hmmm!)
* have high melting points (Well over, 200°C)
* be very poor conductors of electricity, as solids …
* be made of metal ions bonded to nonmetal ions.
* somewhat soluble in water, but very poorly soluble in alcohol or gasoline
* conduct an electrical current through water, when dissolved
* solids at STP (0°C and 1 atmosphere) …. and even at room temperature (21°C !!!!)

VII) Covalent Bonding and Molecular Compounds

A) Generally speaking, the simplest unit of a substance made via covalent bonding is called

\*a molecule or a molecular substance.

1) Thus, molecular substances have covalent bonds (There is no such term as molecular bond)

a) Molecular substances may be inorganic or organic

b) Molecular substances may be molecular elements or compounds …

i) The diatomic elements exist as molecular elements.

B) Covalent bonds are due to at least 1 pair of electrons being shared, so as to complete both atom’s

valence shell.

* Electrons are shared. There is an overlap of electron space …sort of like shaking hands of linking arms…..
* Electrons may be \* shared equally or unequally
* Electrons are shared when neither atom has a *vastly* dominant electronegativity (attraction for electrons)
* Electrons in a covalent bond are attracted simultaneously to \* both nuclei
* No ions are formed in the making of a covalent bond … the species are atoms. There is NO COMPLETE TRANSFER of electrons… They find a “happy medium” between the atoms and both atoms benefit from the electrons of the bond.
* For our course, a covalent bond will exist between \* two nonmetal atoms.
* Covalent bonds are often described by their **bond length** and **bond strength** (the amount of energy required to break the bond and separate the atoms)
* Covalent bonds will be symbolized with a solid line linking two atoms

e.g.) H – Cl

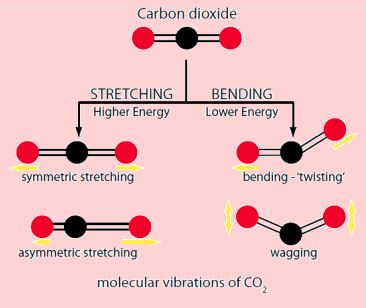
or it will be symbolized with solid wedges or hash line wedges

A picture containing object, clock

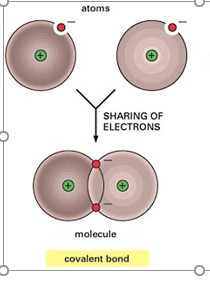
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* A close up of a device

  Description automatically generatedCovalent bonds may be single, double or triple bonds (where 1 pair, two pairs or three pairs of electrons are shared)
* Covalent bonds can stretch, bend, rotate … Recall our work on CO2 and the absorption and release of infrared energy, and climate change ….



<http://www.chm.bris.ac.uk/motm/CO2/CO2h.htm>

 **VISUALIZE**

Found at: <https://socratic.org/questions/covalent-bonding-vs-ionic-bonding> from Essential Cell Biology Garland Science 2004

C) A nonmetal atom tends to make as many covalent bonds as are required, to complete their valence

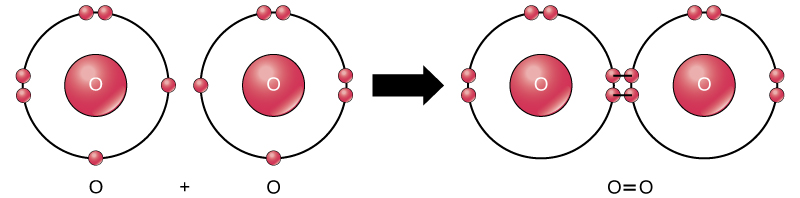
shell, with 8 electrons. (H will try to complete its valence shell, with only 2 electrons)

1) For instance, consider an oxygen atom with a ground state electron configuration of 2-6

The atom requires 2 more electrons to complete its valence shell, and thus the atom

tends to make 2 covalent bonds. This helps to explain the double bond of O2 and the two

bonds found in a water molecule.

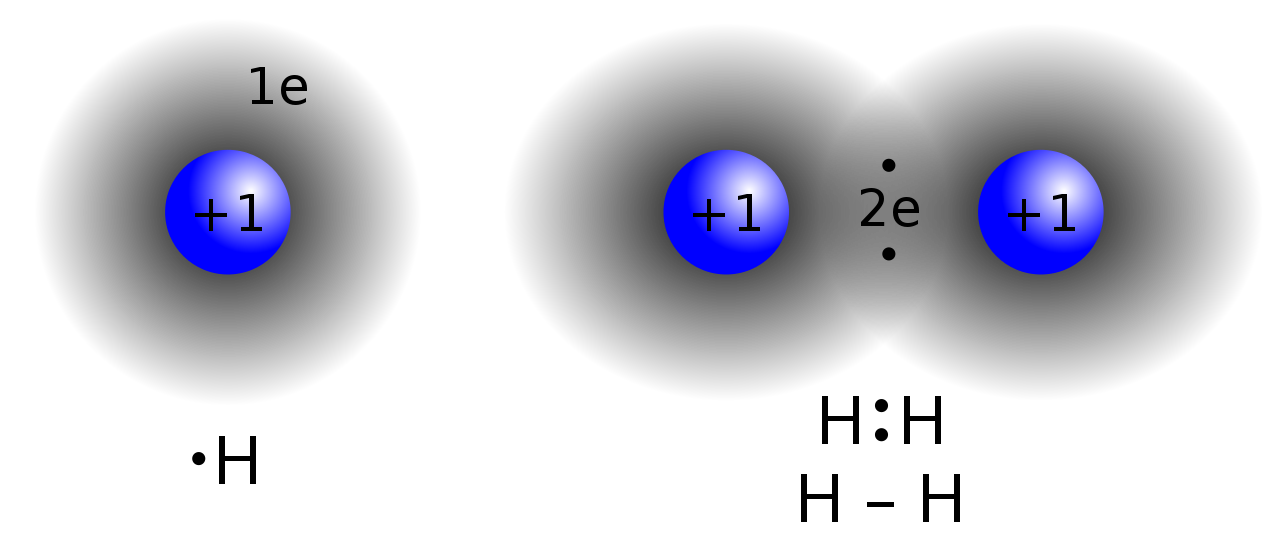


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2) Consider an atom of H, with a ground state electron configuration of 1. The atom requires

only 1 more electron to complete the valence shell, which can hold only 2 electrons. Thus,

hydrogen atoms tend to make 1 covalent bond.

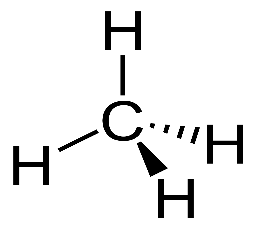


[This Photo](https://en.wikipedia.org/wiki/File:Covalent_bond_hydrogen.svg) by Unknown Author is licensed under [CC BY-SA](https://creativecommons.org/licenses/by-sa/3.0/)

3) Consider an atom of C, with a ground state configuration of 2-4.

The atom requires 4 more electrons to complete the valence shell with 8 electrons. Hence,

**atoms of carbon tend to make 4 covalent bonds**. **(KNOW THIS!!!!!!!!!!!!)**



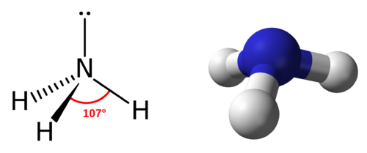
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\*4 covalent bonds

4) Nitrogen has a ground state configuration of 2-5. How many covalent bonds will an atom of

nitrogen tend to make? \*3

\*3 covalent bonds … there is one unbonded pair of electrons



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as well.

D) NonPolar Covalent Bond: A covalent bond between atoms of the same nonmetal element

as well as C-H bonds. The electronegativity difference for such a

bond is between 0 and 0.4.

1) Essentially the nonpolar (meaning “no difference”) covalent bond has an electronegativity

difference of 0 to 0.4. However, we shall not be concerning ourselves with the theory in such

depth … Thus, knowing that a nonpolar covalent bond exists between atoms of the same

nonmetal element OR Carbon to Hydrogen.

Think of it this way: Nonpolar covalent bond

same nonmetals joined

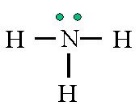
E) Polar Covalent Bond: A covalent bond between atoms of DIFFERENT nonmetal elements.

Generally there is an electronegativity difference of 0.4 to 1.6

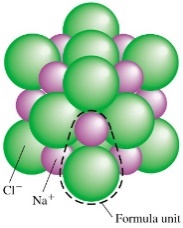
Think of it this way: Polar covalent bond

Different nonmetals joined

**TRY THIS:** Use the following 4 choices and their diagrams to answer the following four questions.



1) O2 3) NH3





2) NaCl 4) Fe crystal

1) Which of the substances is made with polar covalent bonding?

2) Which of the substances is made with nonpolar covalent bonding?

3) Which of the substances is made with ionic bonds?

4) Which of the substances is made with metallic bonds?

The answers are on the next page…

answers to TRY THIS: 1) 3 2) 1 3) 2 4) 4

F) Molecular (a.k.a. Covalent) Compounds Properties

* may exist as solids, liquids or gases at room temperature
* may / may not have an odor … but so many do!
* have a melting point, generally below 200°C
* if solid, tend to be soft, and mushy … think, wax
* may / may not be soluble in water
* tend to be NONELECTROLYTES. They may dissolve in water but tend not to break down into ions. The molecular acids are a common exception to this idea.

**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 NH4Cl(s) into

the water according to the equation

H2O(l)

NH4Cl(s) + 14.7 kJ 🡪 NH4+1(aq) + Cl-1(aq)





just 150 mL water 150 mL of water plus

the dissolving NH4Cl

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

**THINK! Is this dissolving process, endothermic or exothermic?**

**Is the chemical NH4Cl 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) 🡪 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 H2(g) 🡪 C2H4(g)

H2O(ℓ) Water, over an arrow, suggests something is being dissolved

\_\_\_4) NaOH(s) 🡪 Na+1(aq) + OH-1(aq) + 44.3 kJ in water, thus, this is just a physical change…

\_\_\_5) HCl(aq) + Fe(s) 🡪 FeCl2(aq) + H2(g) + 598 kJ

\_\_\_6) A student took the temperature of 150.0 mL of water. She then dissolved 30.00 grams of KClO3(s) into

the water according to the equation:

H2O(ℓ)

KClO3(s) + 41 kJ 🡪 K+1(aq) + ClO3-1(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 (O2(g)) gas from the air. Is the reaction exothermic or endothermic?

Wood + O2(g) → CO2(g) + H2O(g)

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

H2O(l) → H2O(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...

**Try This**

H H O

| | //

H―C―C―C―O―H

| |

H N

/ \

H H

\_\_\_1) Given the structural formula:

How many covalent bonds are represented in the molecule?

(1) 13 (2) 11 (3) 10 (4) 4

\_\_\_2) Which type of chemical bond is formed between two atoms of bromine?

(1) metallic (2) hydrogen (3) ionic (4) covalent

Which substance contains metallic bonds?

(1) Hg(ℓ) (3) NaCl(s)

(2) H2O(ℓ) (4) C6H12O6(s)

\_\_\_3)

Which of these formulas contains a polar covalent bond?

(1) Br2 (3) HF

(2) KCl(4) Na2O

\_\_\_4)

Which type of bond is formed when electrons are transferred from one atom to another?

(1) covalent (3) hydrogen

(2) ionic (4) metallic

\_\_\_5)

Which type of bond is found in sodium bromide (NaBr)?

(1) covalent (3) ionic

(2) hydrogen (4) metallic

\_\_\_6)

What is the total number of electron **pairs** that are shared between the **two carbon atoms** in a molecule of ethyne?

(1) 1 (3) 3

(2) 2 (4) 4

\_\_\_7)

Ethyne:

H―C ≡ C―H

\_\_\_8)

When an atom of chlorine and an atom of hydrogen become a molecule of hydrogen chloride (HCl), a chemical bond is:

1) broken and energy is released

2) broken and energy is absorbed

3) formed and energy is released

4) formed and energy is absorbed

\_\_\_9)



Which molecule contains a nonpolar covalent bond?

\_\_\_10)



The results of these tests suggest that:

(1) both solids contain only ionic bonds

(2) both solids contain only covalent bonds

(3) solid A contains only covalent bonds and solid B contains only ionic bonds

(4) solid A contains only ionic bonds and solid B contains only covalent bonds

A chemist performs the same tests on two homogeneous white crystalline solids, A and B. The results are shown in the table below.

\_\_\_11) The bond between Cl atoms in a Cl2 molecule is

(1) ionic and is formed by the sharing of two valence electrons

(2) ionic and is formed by the transfer of two valence electrons

(3) covalent and is formed by the sharing of two valence electrons

(4) covalent and is formed by the transfer of two valence electrons

\_\_\_12) Which solid element is malleable and conducts electricity?

(1) iron (2) iodine (3) iodine (4) phosphorus

\_\_\_13) A solid substance was tested in the laboratory. The test results are listed below.

The solid: • dissolves in water • is an electrolyte • melts at a temperature > 200°C

Based on these results the solid substance could be:

(1) Cu (2) CuBr2 (3) C (4) C6H12O6

14) Explain, *in terms of valence electrons*, why the bonding in magnesium oxide, MgO, is similar to the

bonding in barium chloride, BaCl2.

Answers:

1) 1 count up the dashes (each dash represents a covalent bond)

2) 4 bromine is a nonmetal

3) 1

4) 3 different nonmetal atoms

5) 2 transfer of electrons is a key term for the formation of an ionic bond

6) 3 sodium is a metal and bromide (bromine) is a nonmetal

7) 3

8) 3 bond formation always releases energy

9) 3 nonpolar (same) covalent (nonmetals)

10) 4 check out those melting points … they are clear giveaways. Once done, check out the conductivity in water

11) 3 chlorine is a nonmetal

12) 1 generally, the only solids which can conduct electricity are metals

13) 2 the test results are all appropriate for an ionic compound. CuBr2 is the only ionic compound (metal/nonmetal)

14) Both compounds are ionic compounds. This means that the ionic bonds were produced by the complete transfer of valence electrons

VIII) Inorganic Compounds vs. Organic Compounds: There are two huge classifications of compounds:

INORGANIC & ORGANIC.

A) It may be easier to teach you what ORGANIC compounds are … first.

1) Organic compounds tend to be ONLY MOLECULAR compounds … That is, they *tend*

to be

* made of nonmetal atoms,
* bonded to each other with covalent bonds

2) HOWEVER, Organic compounds have very special compositional requirements…..

B) Organic compounds are compounds of carbon, in which the carbon(s) is (are) the \*central

atom(s), to which all other species are united chemically via (a) covalent bond(s). (There

are very few exceptions to this definition… SiC, diamonds, CO2 and CO … These molecules are NOT considered to be organic)

BUT! ***Carbon as the central atom***, has little meaning for students without quantum mechanics.

so, we will use a somewhat more problematic definition (It has a few exceptions)

For our course, we will say that an organic compound is**\* any compound with C to C bonds or**

**C to H covalent bonds**

**1) examples:** C6H12O6, CH4, CH3OH, CH3COOH, CH3CH2NH2, CH3CH2SH,

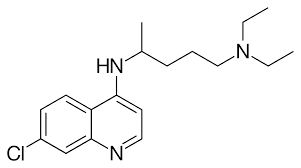
**Formulas of organic compounds tend to begin with C, and included H, and may**

**include O, N, S, Cl, F … and even some metals!**

**There are 10 to 11 million known compounds … 9 million of them are ORGANIC!!**

2) Let’s take a look at the anti-malarial drug **chloroquine**. It is a possible cure for the

covid-19 virus … Why? You got me … Malaria isn’t viral …. but some tests are

 showing promise!!!!

This picture is from Wikipedia …

At every vertex, is a carbon atom,

bonded to a hydrogen atom…

So, you will notice the predominance

of carbon (thus it is organic)… There

is more than one element (thus it is

a compound) and the bonding (all

those dashes or lines) indicate covalent

bonds between nonmetals … Thus chloroquine is an **organic molecular compound made**

**from covalent bonds (electrons are being shared so all atoms get 8 valence e-)**

C) Every carbon atom in an organic molecule will have \* 4 covalent bonds.

1) We can symbolize organic compounds with **molecular**, **condensed** & structural formulae

Study the diagram. The carbon atoms really form a jagged backbone, each carbon bonded to

another and then to hydrogen atoms to complete the need for 4 covalent bonds.

eg) H H H

| | | Molecular Formula= **C3H8** (Just count up the atoms in the structure)

H⎯C⎯C⎯C⎯ H

| | |

H H H

| | |

H⎯C⎯C⎯C⎯H

| | |

H H H

H H H

Condensed Formula = \* CH3CH2CH3

Study the diagram. Every C atom has \* 4 covalent bonds. Recall that each solid dash (⎯)

represents \* 1 pair of shared e-.

eg) H H H H O Condensed Formula=

| | | | //

H⎯C⎯C⎯O⎯C⎯C⎯C⎯O⎯H Molecular Formula =

| | | |

H H H H

How many covalent bonds does the molecule represented above, have? \* 18

eg) Study the diagram. The bonds between carbon atoms can be single bonds,

\* double bonds (2 pair of shared e-) or even \* triple bonds

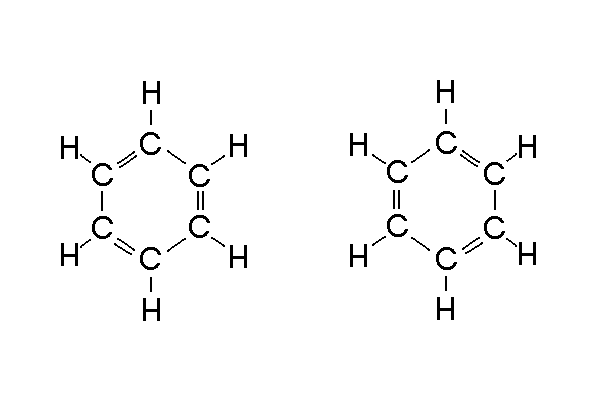
H H H Condensed Formula =

| | |

H⎯C⎯C = C⎯H Molecular Formula =

|

H



eg) Consider the structures:

which are often or

written as:

SPECIAL CHEMICAL APPLICATION: THEORY TO OUR LIVES

Take another 5 minutes please, to go to the next level… That level deals with how the *organization / orientation, or number of C to C covalent bonds affects the molecule, its chemistry, our lives.*

C) Saturated Organic Molecule versus ***UN***saturated Organic Molecule

1) \* Saturated : A broad descriptive term, which tells you that every

the term "organic molecule" may apply to hydrocarbons and their derivatives

**Carbon to Carbon** bond is \* a single covalent bond

a) if a \* double bond or a \* triple bond exist between any **pair of carbon**

**atoms** anywhere in the molecule, that molecule is considered to be \* unsaturated.

H H H H H

| | | | |

H−C−C−C−C−C−H *This is an example of a C-C single bond*

| | | | |

H H H H H

H H H H O The bonds between C atoms are \* single

| | | | // Even though there is the double bond between C and O

H−C−C−O−C−C−C−O−H this molecule is still classified as \* saturated.

| | | |

H H H H

H H H Note the double bond between two of the carbon atoms | | | This molecule is considered to be \* an **UNsaturated molecule**

H−C−C = C−H

|

H

**Question**: Which of one of these two structural formulae represents a **saturated** molecule?

H H H H O

| | | | //

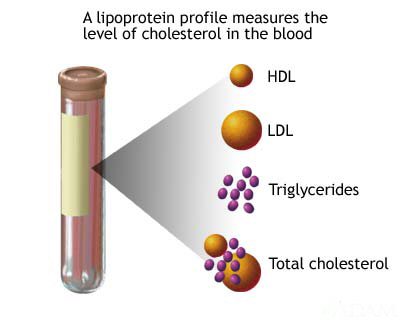
a) H−C=C−C−H b) H−C−C−C−C−H

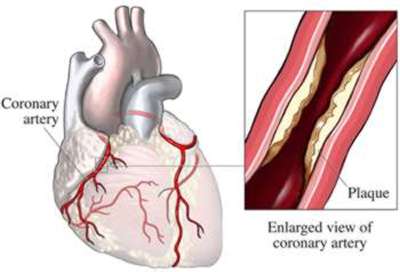
| | | | | |

H H H H H H

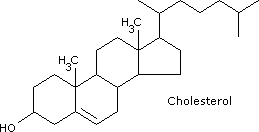
NOW, Have you ever heard the terms: ***Poly***unsaturated Fat, ***Mono***unsaturated Fat, & Hydrogenated Oils? 2) **Relevance to us:** Saturated fats (as opposed to unsaturated fats) tend to lead to the

development of cholesterol.





**Relevance To Us: Cholesterol**



As cholesterol is not water-soluble it must bind

to special proteins before it can be carried in the bloodstream, known as apoproteins. Once coated they form a package called lipoproteins,

there are 2 main types of lipoproteins:

**Low density lipoproteins** (LDL), commonly known as bad cholesterol. LDL is the major cholesterol carrier in the blood. If there is too much LDL in the blood it can build up on artery walls. A high level of LDL cholesterol may give you an increased risk of coronary [heart disease](http://www.homehealth-uk.com/medical/heartdisease.htm).

**High density lipoproteins** (HDL), is commonly known, as good cholesterol. HDL is actually good for maintaining the health of the heart and preventing the narrowing of the arteries (atherosclerosis) because it appears to carry cholesterol away from the arteries and back to the liver for disposal.

This is why the ratio between LDL and HDL cholesterol is important. Usually the body maintains a balance of cholesterol, making more if it needs it and getting rid of any excess. But sometimes this balance goes wrong. LDL levels can be lowered by eating a low fat diet and HDL levels can be raised by exercising.

**You can tell when a foodstuff, like butter or animal fat or cheese has saturated fats when**

**it is a solid at room temperature! Good to know!**

Check Out: <https://www.health.harvard.edu/staying-healthy/the-truth-about-fats-bad-and-good>

For a comparison of various lipids check out: <http://www.elmhurst.edu/~chm/vchembook/556steroids.html>

**Generally, the absence of C to C or C to H bonds will identify a compound as *inorganic***

C) Compounds which are inorganic, may have carbon … but not as the central atom … or, inorganic

compound may have no carbon. Also, inorganic compounds may be molecular OR ionic….

1) examples: NaCl, KNO3, Li2CO3 (This has ionic bonds and disqualifies it as organic),

H2O (Yep! Water is an *inorganic* molecule), SO2, NH3, SiO2, Fe2O3

**PRACTICE: Use choices 1-5. A choice may be used once, more than once, or not at all**.

1) O2 2) NaCl 3) saltwater (NaCl(aq)) 4) HBr 5) CH3OH

1) Which formula is best described by the terms; inorganic molecular compound? … careful….

2) Which formula is best described by the terms; organic, molecular, compound?

3) Which formula represents a mixture? (not a compound or element) … Another way of asking this is to

write; Technically, which of the above is made with substances, but is NOT a *single* substance?

4) Which formula represents a **molecular element**  made with nonpolar covalent bonding?

5) Which formula represents a molecular **inorganic** compound made with **polar covalent bonding**?

6) Which formula is best described by the terms: inorganic, ionic bonding, compound?

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

7) In which choice is EVERY example, representative of an organic compound?

1) KCl(s), C3H8(g), CaCO3(s), C6H12O6(s), CH3NH2(g)

2) H2O(𝓁), C3H8(g), C6H12O6(s), CH3NH2(g), HCl(g)

3) CH3NH2(g), CH3OH(𝓁), C(s), C6H12O6(aq), C12H22O11(s)

4) C12H22O11(s), C8H18(𝓁), CH3OH(𝓁), CH3(CH2)4Cl2 (𝓁), CH4(g)

8) What is the primary type of bond that exists between the species of an organic compound?

9) A student claimed that Na2SO3(s) could be described by the terms; organic & compound. You tell them that

they are half-right.

What do you tell them they are okay with … and why … With respect to what do you correct them

…and why?

10) You are studying with a friend … and they are confused about saturated organic compounds. What do you

tell them to look for? ….(Other than a way to drop the course…..)

11) How might you be able to identify whether a foodstuff you hope to use is a saturated or unsaturated fat?

Answers:

1) 4 **inorganic**: no carbon (at least not as the central atom)… **molecular**: made of nonmetals with covalent bonds ….

**compound**: at least 2 different elements bonded to each other

2) 5 **organic**: has carbon …. **molecular:** made of nonmetals with covalent bonds … **compound**: at least 2 different elements

bonded to each other

3) 3 it is an aqueous solution made of water and sodium chloride

4) 1 **element**: atoms of the same atomic number, **molecular**: made of nonmetals via covalent bonds

5) 4 **inorganic**: no carbon … **polar covalent bonding**: 2 different nonmetals

6) 2 **inorganic:** no carbon (at all) … **ionic bonding**… between a metal and nonmetal, … **compound** at least 2 different elements

bonded to each other

7) 4 3 is close, but just C is an element … not a compound….

8) Covalent bonding (or some mix of nonpolar and polar covalent bonds)

9) They are right … it is a compound, a chemical made with two or more different elements, bonded in a specific ratio … but it is not organic. There

is no carbon, and the presence of the metal suggests pretty strongly, at our level that this is ionic…..

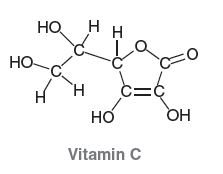
10) Check to see if the formula begins with C … Check to see if the elements of the compound are nonmetals ….

11) If it is a solid at room temperature, there is a good chance it is saturated … see the reading.

The next few pages are designed to help you as you do your own research … Organic molecular compounds can be a bit challenging….

FINDING MEANING IN A STRUCTURAL / CONDENSED OR SKELETAL FORMULA

Structural formulas are insanely helpful, as they show you the number, type and position of each atom of a molecule.



e.g.) With a little care, you can get the formula for Vitamin C from the

structural formula: There are 6 Carbons, 6 Oxygen, and 8 H

for: C6H8O6. Go ahead. Analyze the structure and count…

<https://www.clutchprep.com/organic-chemistry/practice-problems/13578/draw-the-bond-line-structure-160-for-vitamin-c>

![A close up of a logo

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V2d3h5eoOEhYaHiImKkpOUlZaXmJmaoqOkpaanqKmqsrO0tba3uLm6wsPExcbHyMnK0tPU1dbX2Nna4eLj5OXm5+jp6vHy8/T19vf4+fr/xAAfAQADAQEBAQEBAQEBAAAAAAAAAQIDBAUGBwgJCgv/xAC1EQACAQIEBAMEBwUEBAABAncAAQIDEQQFITEGEkFRB2FxEyIygQgUQpGhscEJIzNS8BVictEKFiQ04SXxFxgZGiYnKCkqNTY3ODk6Q0RFRkdISUpTVFVWV1hZWmNkZWZnaGlqc3R1dnd4eXqCg4SFhoeIiYqSk5SVlpeYmZqio6Slpqeoqaqys7S1tre4ubrCw8TFxsfIycrS09TV1tfY2dri4+Tl5ufo6ery8/T19vf4+fr/2gAMAwEAAhEDEQA/APpGiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACqlreNcXt7AygC3dVUjvlA39adeXjW2xIbaW4mkyERBgcd2Y8KP19ATxWNNZa5aSzXttNBJJM4kkgjTgYULgZPzDAHdTnJ/2aAOiorIt9SvdSt1Fla+QxGJJp1YIhzyFUhWc/gB78YqQ6hc6eNuqwNInRbm1jZwx7AoMsp/Me4zigCzdXbW97ZQqoIuJGUk9sIzf0q1WHd22qam0VzD5dh5BZoY5BukYlSuWIyE4PH3u2e60lnq2ooz2d7YyS3igbNilVcerN9wD3Byf7oPy0AbtQX9wbTTrm5VQzQxNIAehwCf6Vl3i6/Cq3EUsEu3JaCKPp7cn5h9Cp78/doe6u9d017e1tzbLNGY5riZWAQkYYIpAZiPUhR9cEUAbMT+ZCjnjcoNOrn/tWq6RcoL5RdWjEL5kMTHb24CgsD7HI5+8OFq3L/bF7C72/lWKkfJHJ80je5I4T24b3zytAGrVa1umuJ7qNlAEEuwEd/lB/rWXZatqKl7O8sZJbxANm1dqsP7zN90D3BJPPyg/LUctrrli0t3BJDOZX8ySCOPpwBjk5Ycdip78/doA6GisiPUb7UrZTYW3kcfvJp1ICt3VFIUsc8ZIUfXkVBa+I2jlNtqtrNHcKM/uoWYtzj7gyRzxkFl/2s8UAb1FY11eawsQuobRUiVv+PcrvkZe5bafl+ihz356Ult4kjvVWOztZpbtl3eUeFAzjcZOm3IxkZPB4yCKANqisGbVdQ0u6A1KFZoJCMPCm0KT/AAgknP0baT2z90Wv7Qu9QQ/2VA0ceObi5jK5PoqHBJ9zgfXkUAalFc/b+Jvs7G31iCWGdcAmOIncScAbRkgk8AgspPAbPFW5f7Zu42kg8myXHyRSfM59ywyFPthh656UAatFYdnq2o/PaXNhJJerjbwUQj+8zYKgf7pYn0HIDJtX1DSrwLqcAnhlZVR4I9vzHsvJzz2O1ifu7ugAN+isqPUbjVo1bR18u3YZ+1zoQD/uIcE/U4HpmnHU57LEep2shcnEctrG0iSn0wMlT7Hj3PNAGnRWJeXus26Ldi0QQ5+a3Cl3C+rMpOD/ALqtj36h1t4ij1BQmm2ss1wVDFH+VEU9GMgyCDg427icHjg4ANmio7dZlt1F06PL/E0alV/AEn+dSUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABSYBIOOR0NLRQAVnrBIPEbz7D5RtVQN23b2OPyrQooACARg8iiiigChq8Dz28AiQuy3ULHA6KJFJP5Cr9FFABSEZ680tFAFDQ4ZLfQrOKdCkiRKGU9Qav0UUAFZ9tBJHrt9KUIjeKEK3Ykb8/wAx+daFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAf/Z)Your research and reading will lead you to other formats to describe molecules, and they are not always so clear … For instance, look at a skeletal formula for **lycopene**. Lycopene is a powerful antioxidant which may help with heart health and providing protection against certain cancers. It is found in tomatoes, watermelon, and pink grapefruit. Its skeletal structure is:

<https://www.chemspider.com/Chemical-Structure.394156.html>

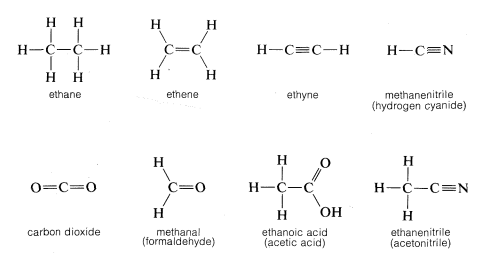
If you go “Huh?”, you would not be alone. The following pages will hopefully help you make sense of the variety of ways, organic molecules (in particular), are written.

**1) Covalent bonds are often symbolized with some sort of wedge-shape or straight line.**

a straight means the bond is in the plane of the paper. Each dash represents

1 pair of shared electrons (or simply just 2 electrons).

Most commonly, you shall see solid lines between two atoms or points on a molecule which represent (a)

 covalent bond(s).

<https://chem.libretexts.org/Bookshelves/Organic_Chemistry/Book%3A_Basic_Principles_of_Organic_Chemistry_(Roberts_and_Caserio)/02%3A_Structural_Organic_Chemistry._The_Shapes_of_Molecules_and_Functional_Group/2.1%3A_Structural_Formulas>

Wedges are sometimes used in structural formulae.

![A screenshot of a cell phone

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generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM0MQAAkpIAAgAAAAM0MQAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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For example; Drinking yourself blind comes from

methanol poisoning. Methanol

A picture containing object

Description automatically generated (wood alcohol) destroys the myelin

sheath of the optic nerve causing

permanent blindness. Ethanol (grain

alcohol) is the alcohol of beer, wine,

and liquor. It is a drug which affects

behavior, and can be poisonous in its

Methanol (Methyl alcohol) own right … but it does not affect the

<https://www.thoughtco.com/wedge-and-dash-projection-definition-602137> myelin sheath of the optic nerve.

If you drink methanol, you are in a real meth (mess…)

You can’t eat wood, so you can’t drink its alcohol … Think!

<https://images.wisegeek.com/nerve-cell-with-labels.jpg>

Here’s a comparison of two slightly different views (top and side) of methanal (also called: ***formaldehyde***)

![A picture containing object

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<https://courses.lumenlearning.com/suny-potsdam-organicchemistry/chapter/2-2-hybrid-orbitals/>

**2) The carbon atoms of an organic compound are always included in a structural formula … but they**

**may or may NOT be included, as a “C”.** **A favorite shorthand is the use of a vertex.**

A vertex is any angular point … and where these “points” exist, a chemistry student may assume that there

is a carbon atom, **AS WELL AS** the hydrogen atoms, required to complete the 4-bonds every carbon will

make.

A great example of this, is seen with what chemists call a **benzene ring**. Benzene is a hexagonally shaped

ring structure and it is very special (and common!!!) A 6-sided diagram is often used to represent a

benzene ring or some variation of a benzene ring.

Each line intersection (vertex) represents a carbon atom, as well as the hydrogen atoms required to complete

the 4-bond requirement for each C atom are assumed, unless otherwise indicated. Notice the double bonds

between carbon atoms (indicated by the circle in diagram 3)

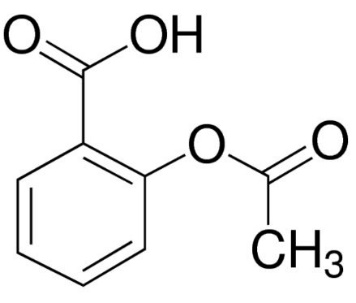
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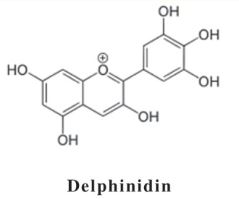
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This is a benzene molecule (C6H6) and, so is this one …. and this one too!

<https://classnotes.org.in/class11/chemistry/organic-chemistry-some-basic-principles-techniques/nomenclature-of-simple-aromatic-compounds/>

Here are two applications of a benzene ring (or some derivative) in molecules….





Aspirin (acetylsalicylic acid)

<https://www.sigmaaldrich.com/catalog/product/sigma/a5376?lang=en&region=US>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5613902/>

A variation of delphinidin, called, delphinidin 3-glucoside is the

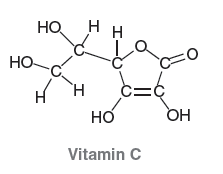
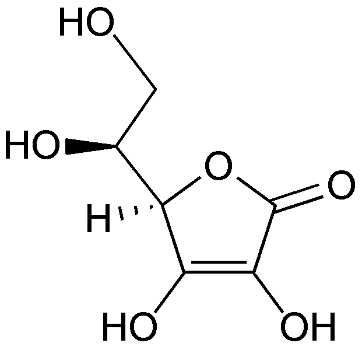
basis of the blue pigment in hydrangea and blueberries.

**3) While benzene has a backbone of just carbon atoms, it isn’t that unusual to find ring structures**

**with oxygen atoms (e.g. cyclic ethers, or cyclic esters) or nitrogen atoms (e.g. pyridine compounds)**

You may see wedge-shaped bonds. The author is simply trying to indicate the 3-dimensional position of

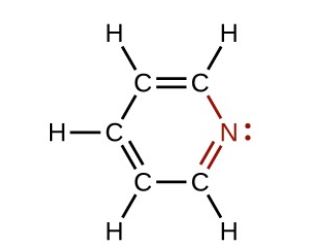
the bond and group of atoms.



Also Vitamin C …They depict the same molecule, really

<https://www.clutchprep.com/organic-chemistry/practice-problems/13578/draw-the-bond-line-structure-160-for-vitamin-c> & <https://commons.wikimedia.org/wiki/File:Ascorbic_acid_structure.png>

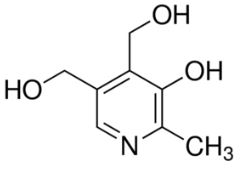
A pyridine ring is not the same as a benzene ring … but there are similarities… You will note the big difference is the inclusion of a N atom, in the ring (substituting for a C atom)



<https://courses.lumenlearning.com/chemistryformajors/chapter/amines-and-amides/>

![A drawing of a face

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM2NwAAkpIAAgAAAAM2NwAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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at0AFFFFABWPZ+G7Wy8W6l4hjlma61KCGCWNiNirFu2lRjOTvOck1sUUAY3/CM2n/Cdf8ACVedP9s/s3+zvKyPL8vzfM3YxndnjrjHatmiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigDyHStV8Uad8TPHi+GfDNvrMT6hbmWSXU1tjG32ZOMFGz9at+A9Tvm+Jvj6/wDFNjb6HLFZ6c88f2xZo4kVJjvMmFAGBk8cV2uheGP7F8ReIdV+1+f/AG1cxz+V5e3ydkSx4zk7s7c5wOtZOq+H9F0S98W+KPFF1DNpGpWlsLu2uIMpGluH68nfuLDC464HOaAIvFfijQvE3wn8Yv4e1ez1JYNHu1lNrMsnlkwPjOOmcHHriuV8ESy+Ak0/w9clj4f8R2C3OkSsSRa3ZiDS2pJ6ByS6dOdwGTV/SFsfiVN4nvP7Y0q3u9W0ZtKt7Gyuorqa0tjv/ez7HwXLSZ2A7VAA3EsTXW6z4Hs9d+Hkfha+mbENtFFDeIu14ZY1ASZeeCCAcZ6ZGcGgDN+Hmkadq/wj8HDVbG3vFtbK2uIVnjDiOUR4DgHuAxwe1dzWT4V0P/hGfCOl6J9o+1f2fax2/nbNnmbVxnbk4zjpk1rUAFFFFAHn/wAXtPs3+Gyae1tGLOTUrCJoEG1ShuowVwMYBBPSuK8S3lz4c+Gfi/4eaxLJLJp2mtPo11Jybuw3AKCRwXiOEPTI2kDGTXrPi7w3/wAJVoaad9q+y7bu3ufM8vfnypVk24yOu3Ge2c81k/Ev4c2XxI8OpYT3TWF5buXtr5I97RBhtkXGRlWXIIyOx5xigDp5dMsbq+tL65s4JruzVhbTyRhnh3gBtpPK5AAOOtW6AMACigApk0MVzBJBcRpLFIpR43UMrqRggg9QR2p9FAHmHxa8PWninxJ4K0S+aSOG7urtRJE214nFq7I6n1VgrD6Vhan4kvdW07wzo3iLC+I9B8X6fa6iAMLNneY7hf8AZkX5ug53DA4r0/WvDX9seJfD2rfa/J/sWeabyvL3ed5kLR4zkbcbs9D0x71keLvhtZeKfF3h/wARrdtZX2jXMcjlY9wuokfeI25GMNyDzjLcHPAB1osLQakdQFrCL1ohAbnyx5hjBLBN3Xbkk46ZNT0UUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABUdxbw3cDQXUMc8T/AHo5FDK3fkGpKKAKlppOnafI0lhYWts7DazQwqhI9MgVboooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACiiigAooooAKKKKACvmHxl4s8RWvjjWoLbX9UhhivpVjjjvJFVFDnAABwBRRQB7h8LL261H4aaVdahczXVxJ52+aeQu7YmcDJPJ4AH4Vf8d3M9n8P9euLSaSCeKwmeOWJirIwQ4II5B96KKAM/Sb26k+I7W0lzM9v/AMI9azeU0hKeYZZQXx03EADPXgV19FFABRRRQAVyvgi8ubu68Ui6uJZxBr00UQkct5aCKIhVz0GSTgccmiigB813cD4r2loLiUWzaNNKYd52FxNGA23pnBIz7109FFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFABRRRQAUUUUAFFFFAH/9k=) Some molecules built off the pyridine ring are important vitamins.



<http://www.softschools.com/formulas/chemistry/folic_acid_formula/483/>

Vitamin B-6 (Pyridoxine) Vitamin B-9 (Folic Acid)

This is a perfect example of a pyridine This shows a variation called a diazine … but it is

<https://www.sigmaaldrich.com/catalog/product/sigma/p5669?lang=en&region=US> closely related to a pyridine …This has 2 Nitrogen

in two rings. Note the benzene ring towards the

middle of the molecule. Folic Acid is necessary to

prevent a certain birth defect, and is so important, it

is added to most foods, like breads….

**4) The most off-putting for many students are what are called, Skeletal Formula or Structures**

Often, you just see polygon shapes and/or crooked lines. Sometimes, the polygon shape has an oxygen or nitrogen in it. Well, remember, chemists are moving fast and they use a shorthand.

Again, where two lines intersect, (a vertex) we may assume there is a carbon atom, bonded to enough (unseen) hydrogen atoms, so as to complete carbon’s required 4 bonds.

Take a look at the following formulae for a molecule of ethanol (ethyl alcohol). This is a good time to show you the condensed formula, while on our way to study skeletal formulae.

![A screenshot of a cell phone

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM2MgAAkpIAAgAAAAM2MgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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<https://study.com/academy/lesson/structural-formula-definition-examples.html>

Skeletal formulae are often, what you get on those pharmaceutical inserts describing the active drug.

Here is a look at the steroid, prednisone, from <https://en.wikipedia.org/wiki/Prednisone>

![A drawing of a person

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM4MwAAkpIAAgAAAAM4MwAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Here is a look at a very simple hydrocarbon, pentane and all forms (isomers) of it. A hydrocarbon is an organic molecule made of ONLY carbon and hydrogen. Pentane has a formula of C5H12. It has only single covalent bonds between the carbon atoms. The skeletal formula can look downright weird … but by now, I am hoping you are feeling a little more comfortable…. formulae from: <https://sites.google.com/site/ellesmerealevelchemistry/module-4-core-organic-chemistry/4-1-basic-concepts-and-hydrocarbons/4-1-1-basic-concepts-in-organic-chemistry/4-1-1-e-structural-isomers>

![A close up of a hanger

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAM1NQAAkpIAAgAAAAM1NQAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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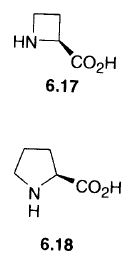
CH3CH2CH2CH2CH3 CH3CH2CHCH3CH3 CH3CCH3CH3CH3

Wherever there is a vertex, or at the end of the molecule chain, there is a C atom, and enough H to

give that C four covalent bonds.

Azetidine… fakes out other plants, which believe it is proline

A favorite story of mine, is about Lily of the Valley



Proline: a necessary amino acid for proteins

A Little Chemical Warfare!

From Chemistry In The Garden by J.R. Hanson

(Royal Society of Chemistry 2009 p. 63)

The rhizomes (primitive root structures) of the plant, lily-of-the-valley produce azetidine-2-carboxylic acid (figure 6.17) which diffuses out into the adjacent soil and facilitates the dominance of this plant. Other plants absorb this unusual amino acid and mistake it for proline (figure 6.18).

However, the resultant proteins cannot function correctly and the

plant dies, allowing the rhizomes of the lily-of-the-valley which

can tolerate this amino acid, to spread.

![A close up of a green plant

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEAYABgAAD/4RDcRXhpZgAATU0AKgAAAAgABAE7AAIAAAAGAAAISodpAAQAAAABAAAIUJydAAEAAAAMAAAQyOocAAcAAAgMAAAAPgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAE93bmVyAAAFkAMAAgAAABQAABCekAQAAgAAABQAABCykpEAAgAAAAMzMgAAkpIAAgAAAAMzMgAA6hwABwAACAwAAAiSAAAAABzqAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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