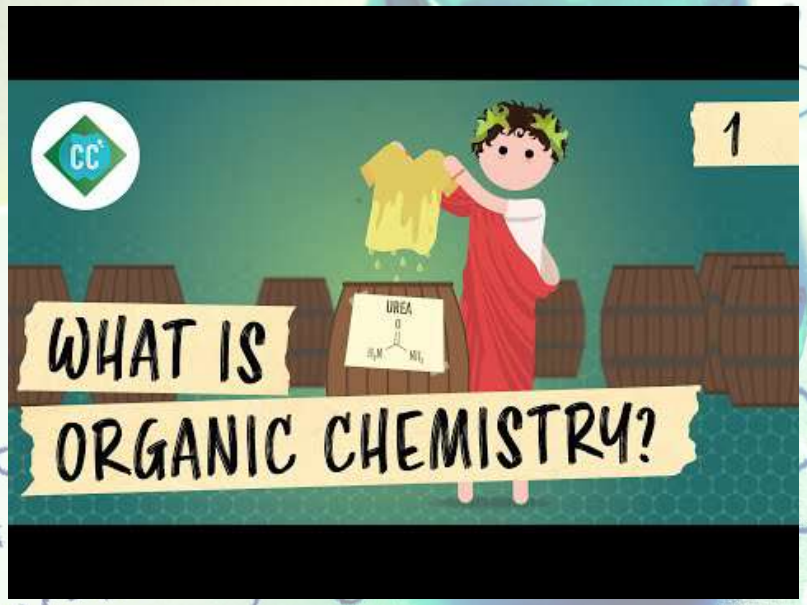
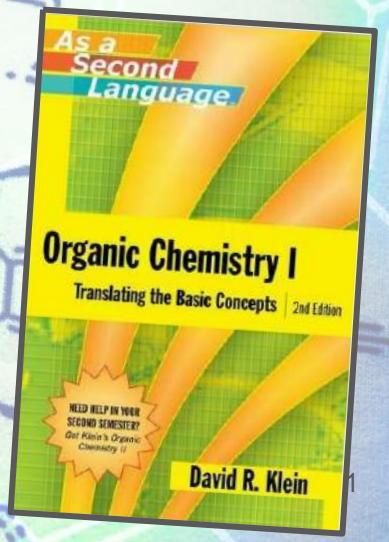
Chapter 1:
A Review of General Chemistry and Bond-Line Drawings

Welcome to Organic Chemistry!





Adapted from David Klein's *Organic Chemistry as a Second Language* textbook - 2nd edition

So WHAT is organic chemistry?

- **Organic chemistry** is the study of **carbon**-containing molecules and their reactions

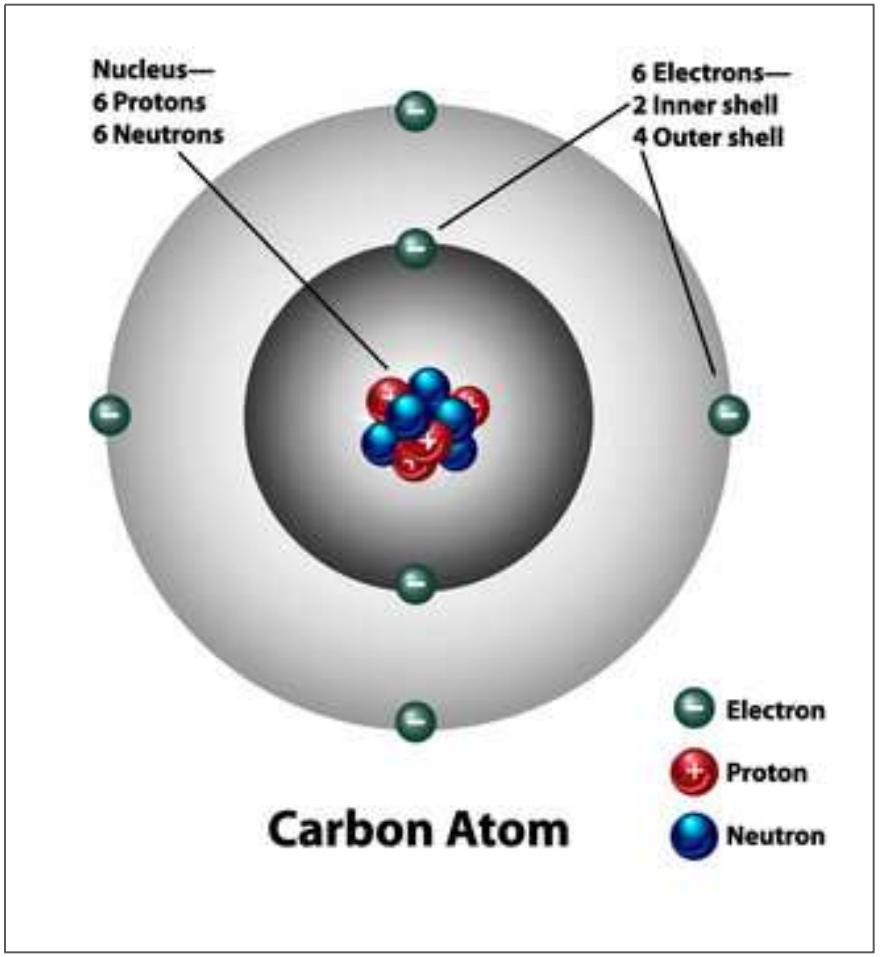
- **What happens to a molecule during a reaction?**
  - A collision must occur (with sufficient energy)
  - "Old" bonds break and "new" bonds form
    - Breaking bonds generally require an addition of energy (endothermic)
    - Forming bonds generally releases energy (exothermic)
    - *We study energy changes in chem II - thermochemistry*

- **The BIG question: WHY do reactions occur?**
  - We will need at least 2 semesters of your time to answer this question!
  - **FOCUS ON THE ELECTRONS**

Basic Review of General Chemistry

- **Protons** (+1) and **neutrons** (neutral) reside inside the nucleus

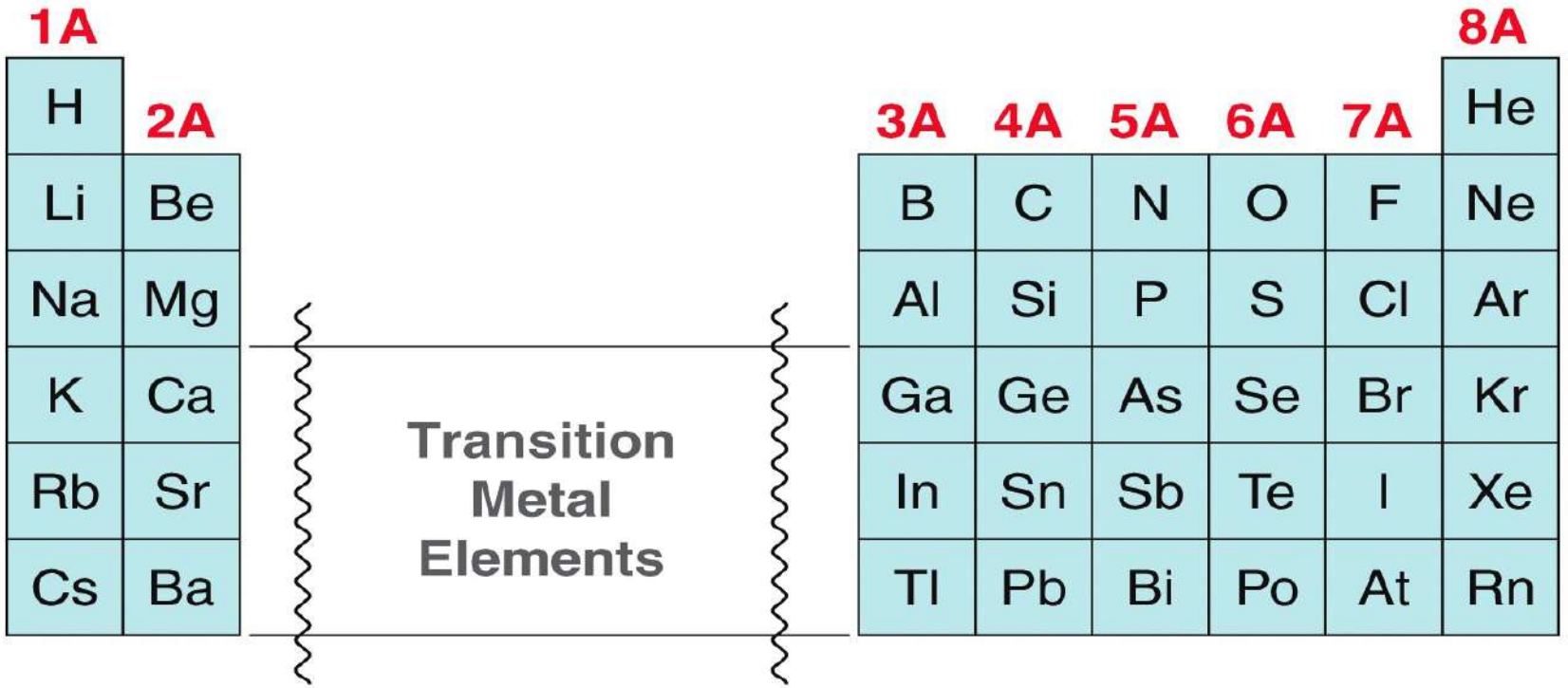
- **Electrons** (-1) reside outside the nucleus.
  - Some electrons are close to the nucleus and others are far away. *(recall electron config's)*
  - Atoms gain/lose electrons *(ionic bonding)* or share electrons *(covalent bonding)*



- *Look at carbon for example. Which electrons are the valence electrons?*
- *Why are valence electrons important?*

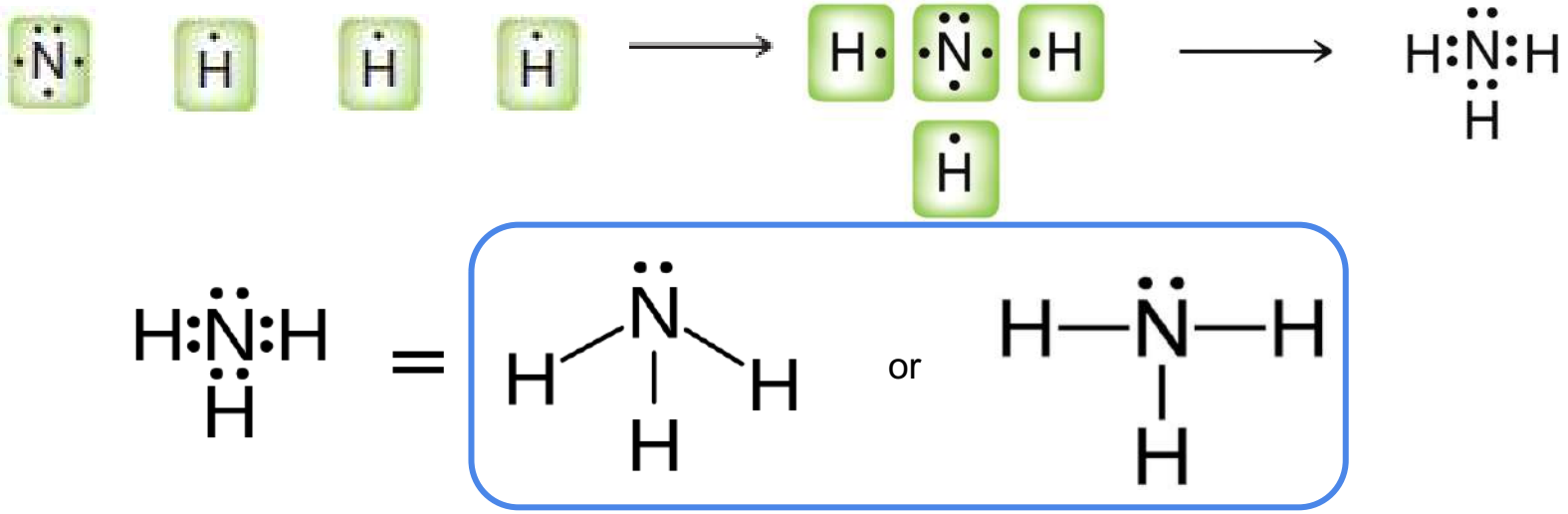
Basic Review of General Chemistry

- **Review counting valence electrons!** Mark them on your periodic table, if needed.
- *What is the "magic" number of valence electrons that atoms will generally try to achieve?*
- *How many bonds does each group make?*



Basic Review of General Chemistry

- **Review simple Lewis Structures:**
  - Draw the individual atoms using dots to represent the valence electrons.
  - Put the atoms together so they share **PAIRS** of electrons to make complete octets. *WHAT is an octet?*
    - Take NH_3 , for example…

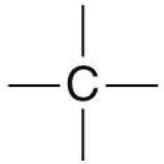
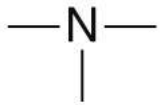
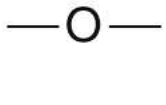
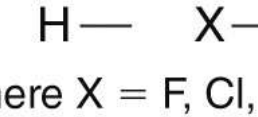


Remember that the "bond" line drawn represents TWO electrons!

Which one of the images is a "more accurate" representation of the NH_3 molecule?

Basic Review of General Chemistry

- Atoms that are most commonly bonded to carbon include N, O, H, and halides (F, Cl, Br, I) (aka halogens)
- With some exceptions, each element generally forms a specific number of bonds with other atoms

Tetravalent	*Trivalent*	*Divalent*	*Monovalent*
			 (where X = F, Cl, Br, or I)
Carbon generally forms ***four*** bonds.	Nitrogen generally forms ***three*** bonds.	Oxygen generally forms ***two*** bonds.	Hydrogen and halogens generally form ***one*** bond.

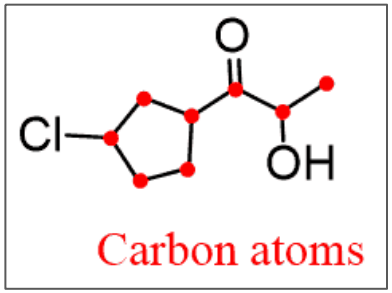
Remember, you can have double and triple bonds!

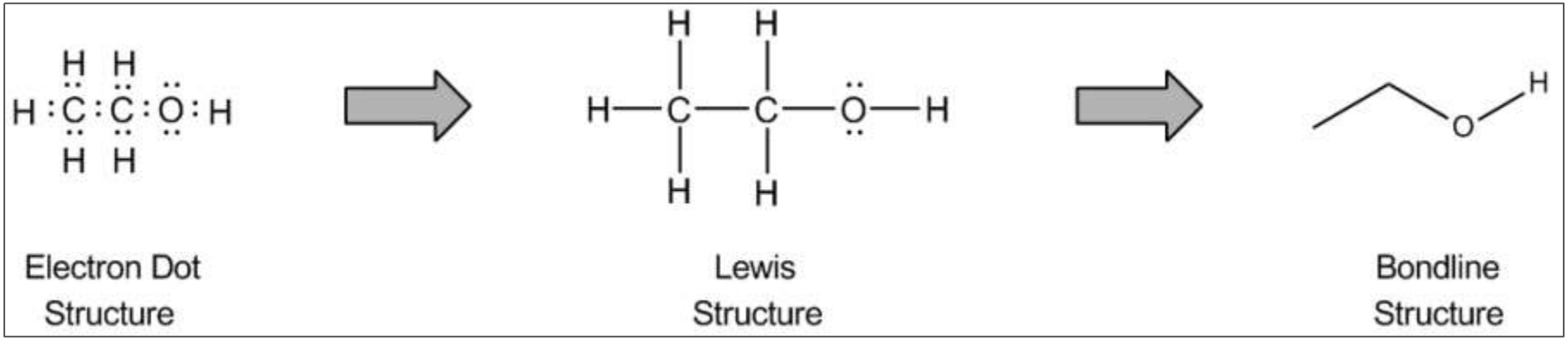
For example: N could have 3 single bonds, a single and a double, or a triple bond.

Two-part video review of Gen Chem

Ch 1.1 - How to Read Bond-Line Drawings

- **Bond-line drawings** (skeletal drawings) show all of the connections of the carbons in a molecule, almost like a backbone
  - The "end" of each line represents a carbon atom
    - Chains of carbons will zigzag
  - Hydrogens attached to carbons are NOT shown
  - All other atoms must be shown (and H's attached to them!)

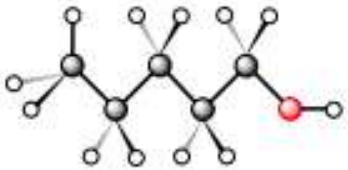
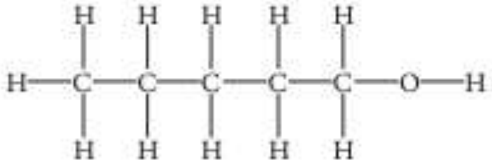
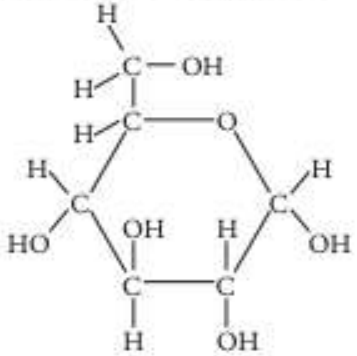
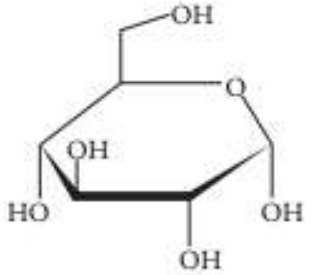
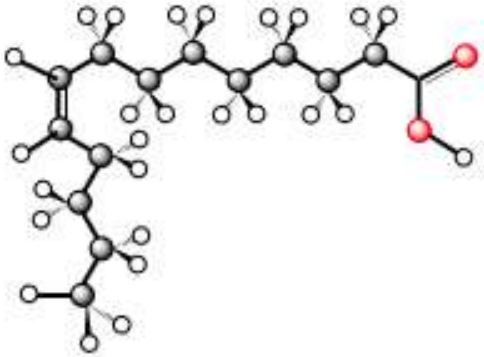
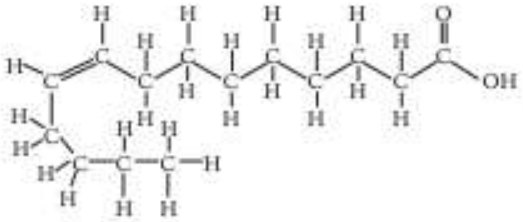
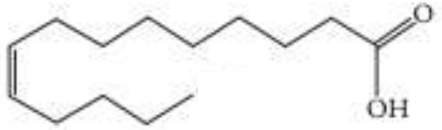




They may or may not explicitly show the bond from O to H. It just depends on what you are "doing" with the drawing - so be flexible!

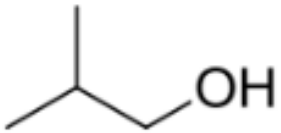
Model 1 – Molecular Drawings

Mark where each C is on the bond-line drawing

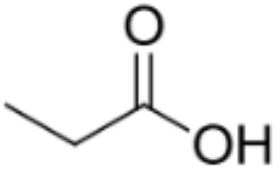
Ball-and-stick model of 1-pentanol	Lewis structure of 1-pentanol	Line drawing of 1-pentanol
		
Ball-and-stick model of glucose	Lewis structure of glucose	Line drawing of glucose
		
Ball-and-stick model of unsaturated fatty acid	Lewis structure of unsaturated fatty acid	Line drawing of unsaturated fatty acid
		

Mark each carbon in the bond-line drawing - count how many total C's in each molecule.

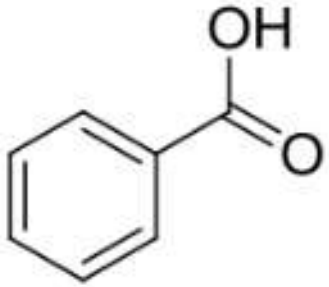
Total C's: ____



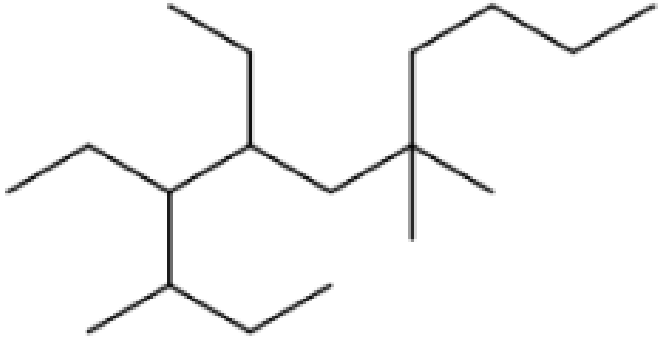
Total C's: ____



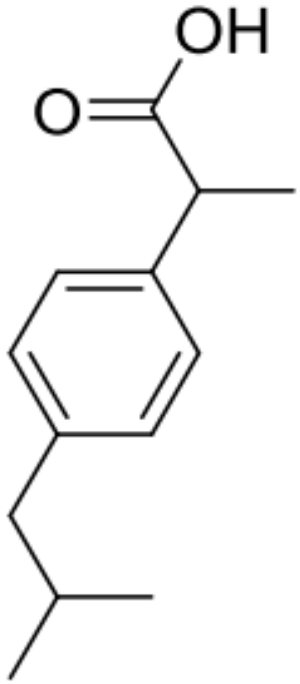
Total C's: ____



Total C's: ____

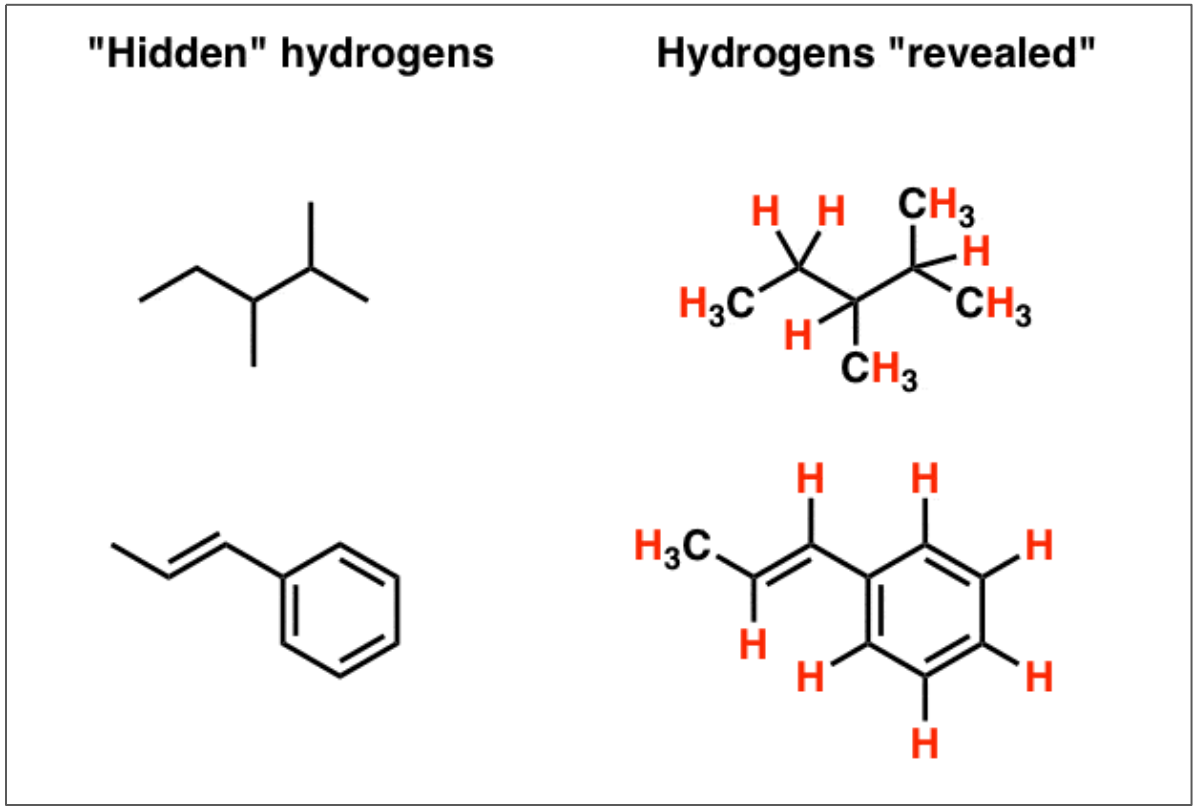


Total C's: ____



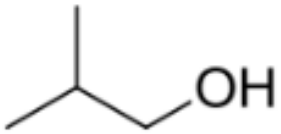
Total C's: ____

- **Counting Hydrogens:**
  - Neutral carbons ALWAYS make 4 bonds!
    - So count the bonds you see and the remaining bonds will be the number of H's attached to the carbon!
    - Watch out for H's that are actually shown that are attached to atoms other than C, especially if you are asked to find the total number of hydrogens!

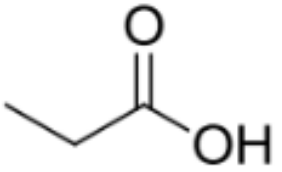


Show the hydrogens in the bond-line drawing - count how many total H's in each molecule.

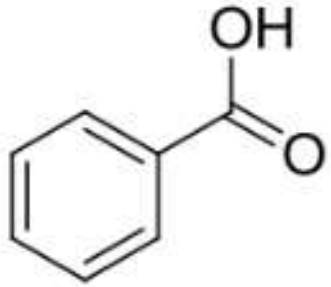
Total H's: ____



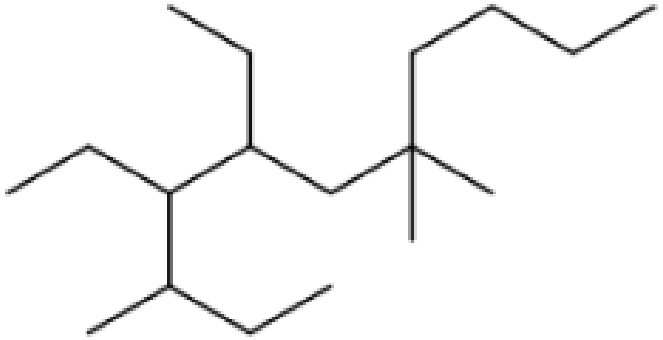
Total H's: ____



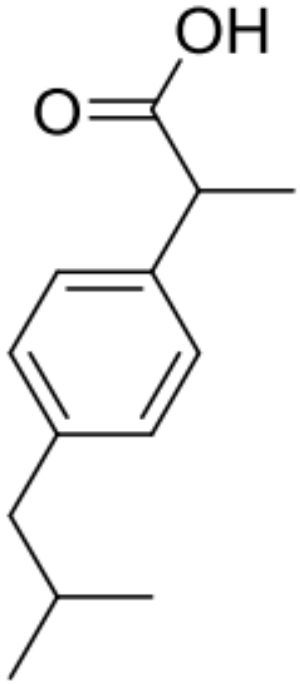
Total H's: ____



Total H's: ____



Total H's: ____

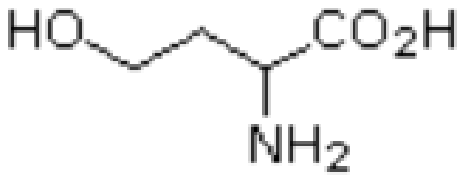


Total H's: ____

Types of Formulas - you will encounter many variations of chemical formulas for molecules so learn to "read" what you see!

- **Molecular formula:** Simply gives the quantity of each type of atom. It doesn't necessarily give you any information on how the structure is actually connected in 3D space.
  - *Drawback: you can have many isomers with the same formula!*
    - *Isomers are compounds that have the same quantity/types of atoms but are connected differently.*
  - *Doesn't show double or triple bonds*
  - EX: C_6H_{14} and C_2H_6O

Write the molecular formula for the examples below.

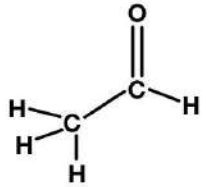
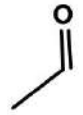
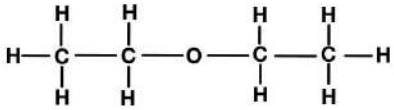
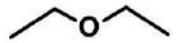


- **Structural Formula:** (basically a Lewis Structure) This is a good middle-ground between the molecular formula and the bond-line drawing. It shows how the atoms are connected and uses symbols.

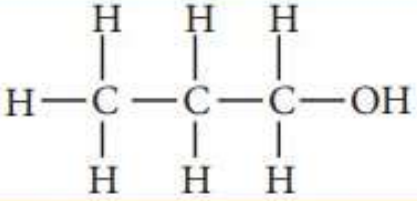
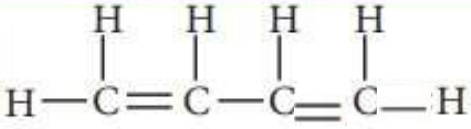
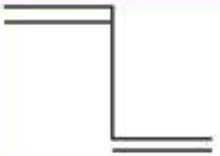
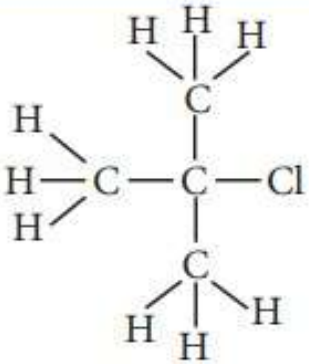
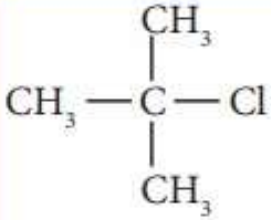
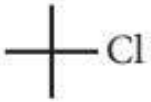
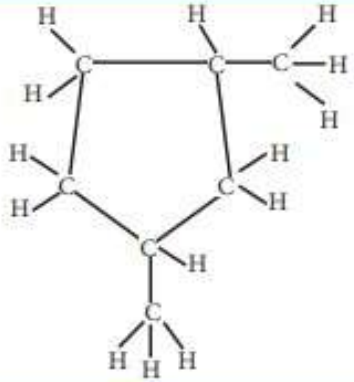
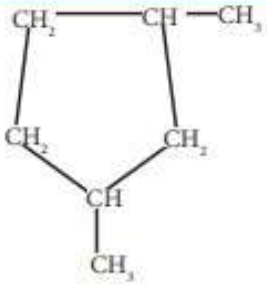
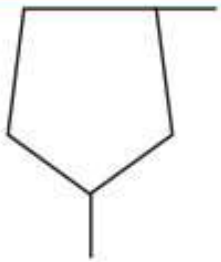
Helpful Video! Stop @ 4 min.

- **Condensed Formula:** Looks similar to the molecular formula, but it gives more specific information about how the atoms are connected together (the order) *Read these from left → right in "chunks" around the C's! *You will see double and triple bonds between carbons shown, but not necessarily between C and O!*
  - EX: $CH_3CH{=}CHCH_2CH_3$

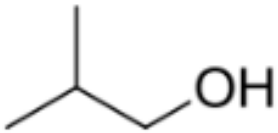
These have so many variations, we will keep it basic!

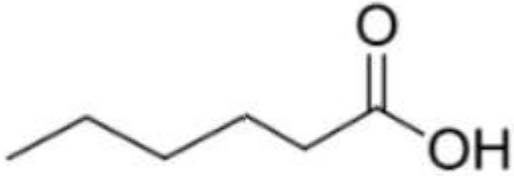
Structural Formula	Condensed Formula	Skeletal Formula
	CH_3CHO	
	$(C_2H_5)_2O$	

Examples of Various Ways to Represent Formulas

Molecular forumula	Complete structural formula (dash line structure)	Condensed Structure	Bond line Structure
n-propanol C_3H_8O		$CH_3–CH_2–CH_2–OH$	
1,3-butadiene C_4H_6		$CH_2=CH–CH=CH_2$	
t-butyl chloride C_4H_9Cl			
1,3-dimethyl cyclopentane C_7H_{16}			

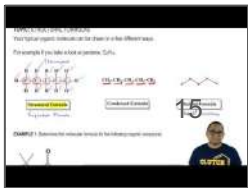
Write the molecular formula and structural formula for each molecule. ***There may be multiple structural formulas that can still be correct!***





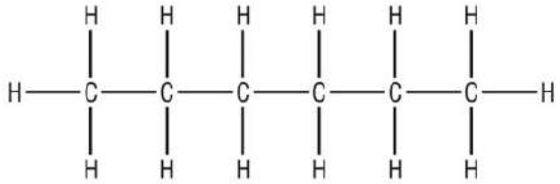
Helpful Video!

Read section 1.1 “How to Read Bond-Line Drawings” on pages 1-5 of the Klein “Chemistry as a Second Language” packet. Complete problems 1.2 - 1.11 on page 3 and problems 1.13 - 1.20 on page 4.



Tips for turning structural formulas into bond-line drawings

1. Connected carbons are drawn in a zigzag format



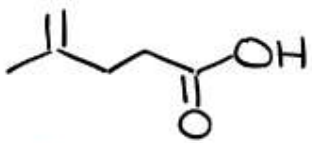
Is the same as…

1. When drawing bonds, try to draw the other bonds as far apart as possible *(recall electrons repel w/ VSEPR)*

Do this

compare to

DONT do this



Do this

compare to

DONT do this

DO this

compare to

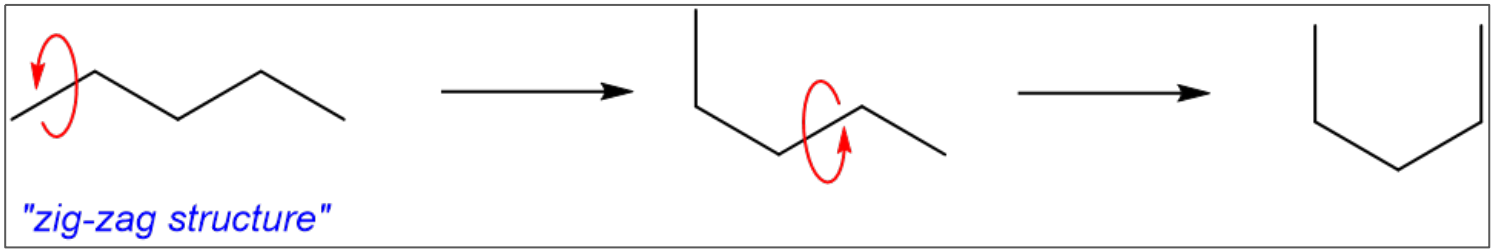
DONT do this

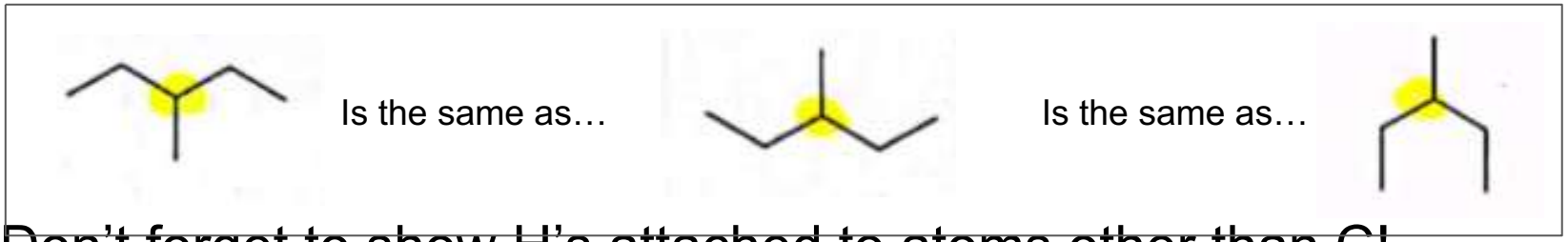
Special Note: Double bonds CAN be drawn in a zigzag! They are trigonal planar and have 120° bond angles.

Triple bonds are linear (180°) They should not be drawn as a zigzag!

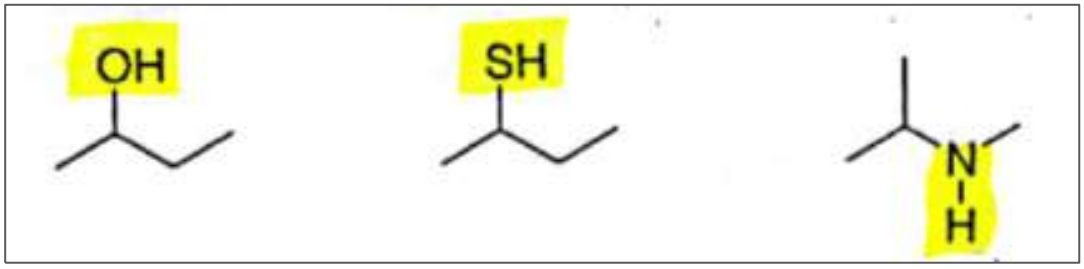
Tips for turning structural formulas into bond-line drawings

3. When drawing zigzags it doesn't matter which direction you start, especially for single bonds because they are free to rotate!



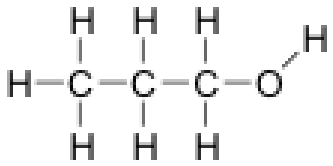


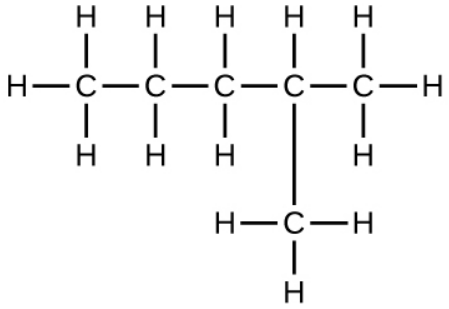
3. Don't forget to show H's attached to atoms other than C!

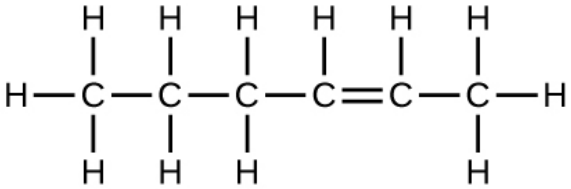


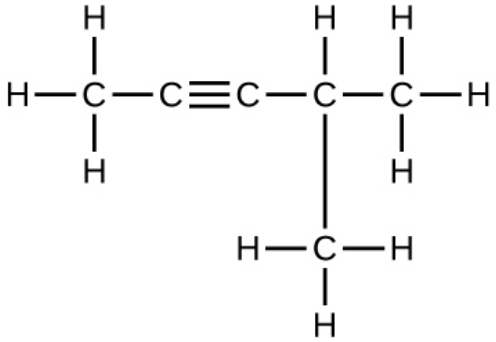
Special note: We don't have to draw lone pairs in organic chemistry - more to come on that topic!

Turn the structural formulas into bond-line drawings









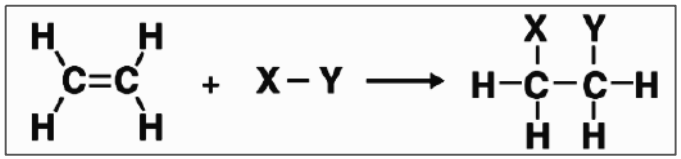
Read sections 1.2 “How to Draw Bond-Line Drawings” **AND** 1.3 “Mistakes to Avoid” on pages 5-7 of the Klein packet. Complete problems 1.21 - 1.24 on pages 6-7 in the packet.

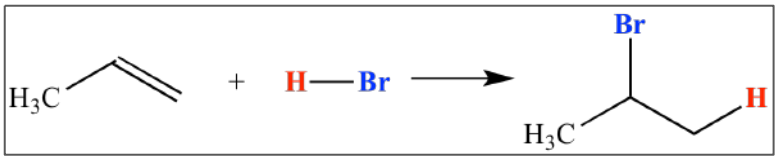
Ch 1.4 - More Exercises *(What Change has Occurred?)*

One of the big ideas of organic chemistry is chemical reactions. At this point we don't care about *how* the reaction took place, we just want to understand *what changed*.

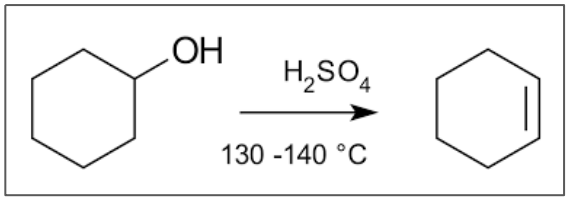
3 "Changes" to Identify:

- **Addition Reaction** *(watch those H's)*
  - Characteristic "disappearance" of a double bond because H's need to bond to the electrons within the double bond

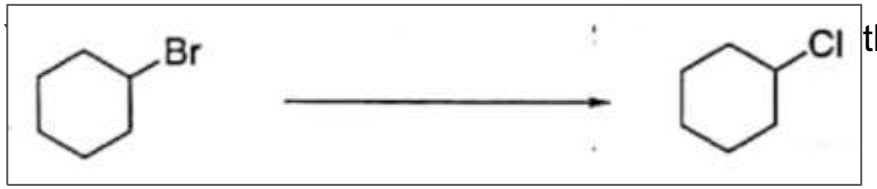




- **Elimination Reaction** *(watch those H's)*
  - Characteristic "appearance" of a double bond because when the H's are removed the electrons bond together that were left over



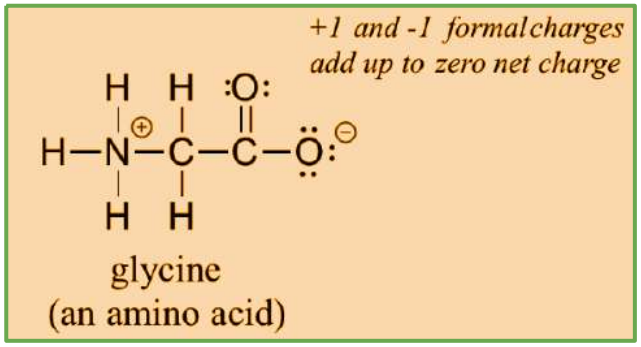
- **Substitution Reaction**
  - th ar

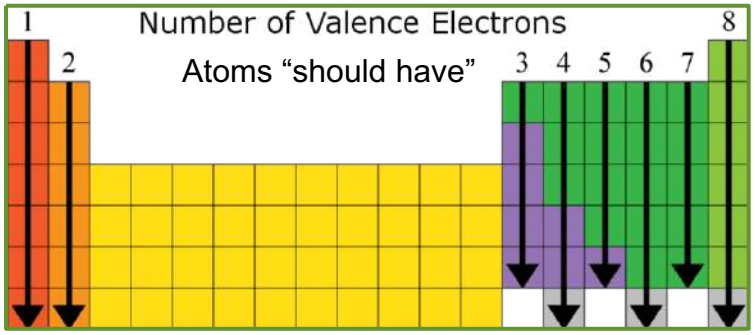


Read section 1.4 "More Exercises" on page 8 of the Klein packet. Complete problems 1.25 - 1.32 on pages 9-10 in the packet.

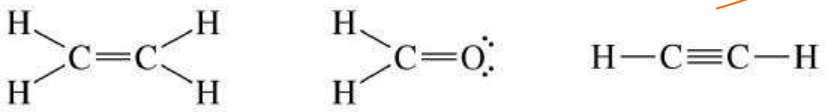
Ch 1.5 - Identifying Formal Charges

Formal Charges are used as a "bookkeeping" method for *specific atoms* to show where electrons can be distributed. This is calculated for each atom. *It is not the same thing as* ***overall charge*** *because you can have multiple pos./neg. individual charges that could cancel out.*



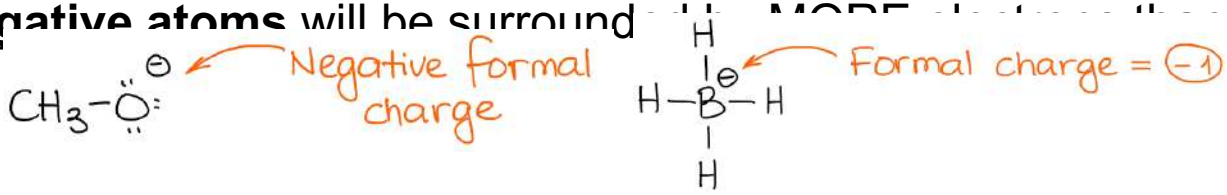


- **Neutral atoms** will be surrounded by the same number of electrons as they "should have" in the



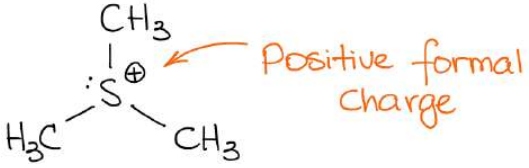
All neutral! So we don't see any charges!

- **Negative atoms** will be surrounded by MORE electrons than they "should have"



***Electron-rich areas!**

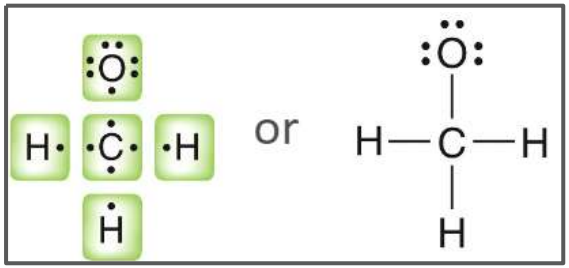
- **Positive atoms** will be surrounded by LESS electrons than they "should have"

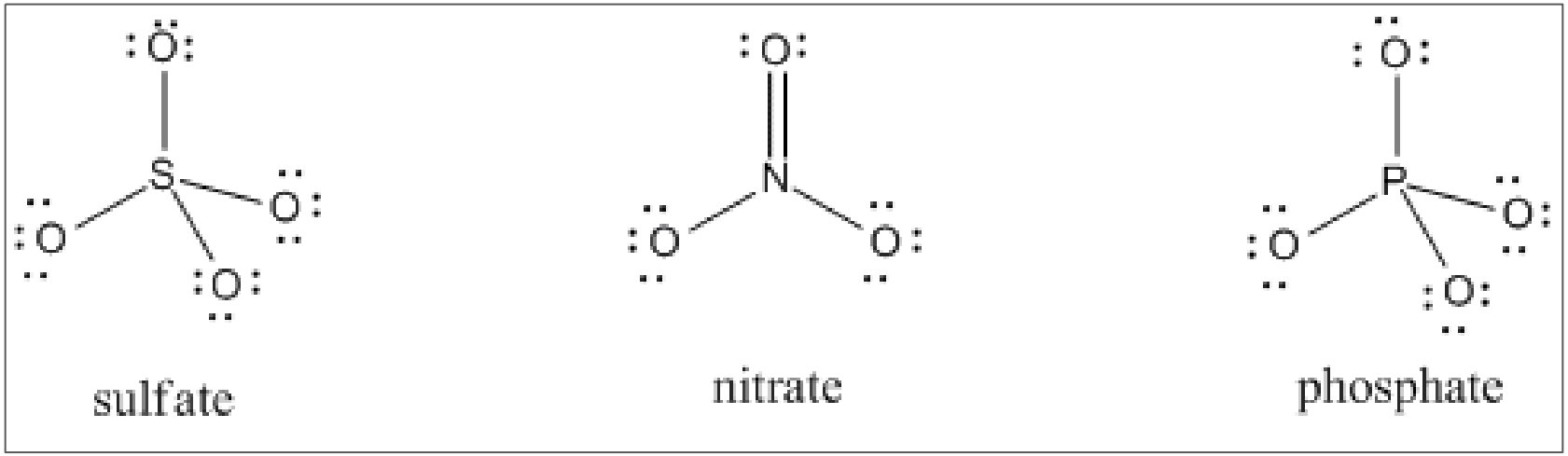


***Electron-poor areas!**

Moral of the story: COUNT how many electrons you SEE around the atom and compare it to how many atoms the atom SHOULD HAVE according to the group it is in on the periodic table! **Formal charge = "Should have" - "actually has"**

How to count: A lone pair = 2 electrons & EACH BOND = 1 electron

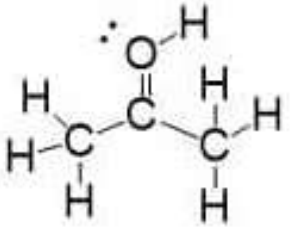


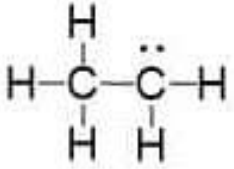


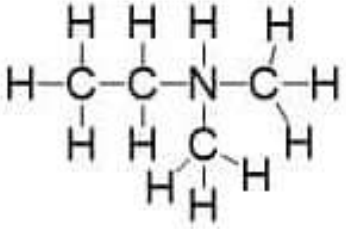
Practice finding the formal charge on each atom. Then, determine the overall charge of the molecule!
(Hint: they are your favorite old polyatomic ions!)

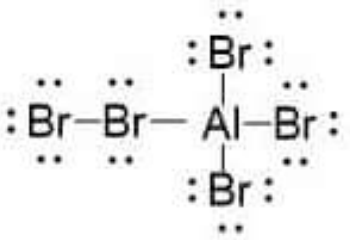
Great videos to help calculate formal charges!

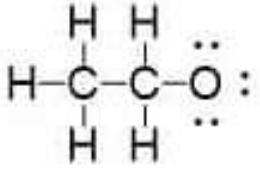
Assign formal charges to the atoms in the molecules (C, N, O, Al, Br.). <u>ALL lone pairs are shown on the molecules</u>! If they are neutral as shown, mark them with an N or *.

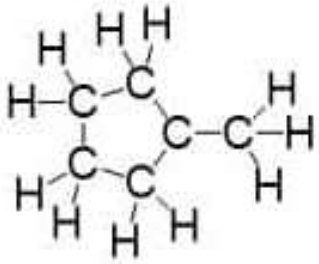
a) 

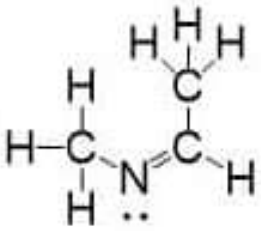
b) 

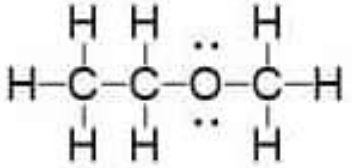
c) 

d) 

e) 

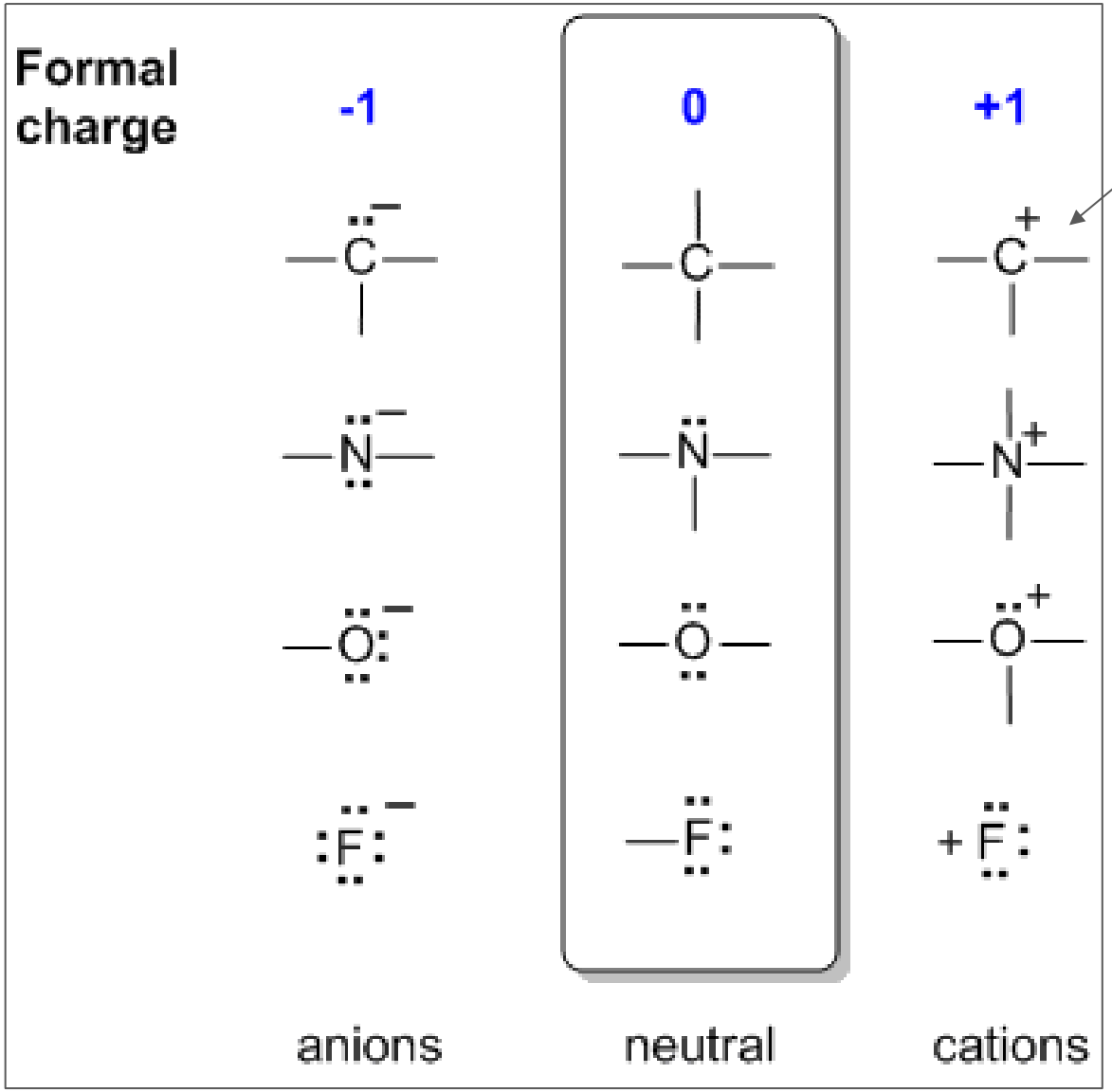
f) 

g) 

h) 

Have you noticed any patterns?

Basic Formal Charge Chart w/ Lone Pairs Shown



C+ is the only one that will not use all 4 orbitals. It's fourth orbital is actually empty!

Notice: The atoms always use 4 orbitals. Each orbital can be used to make a bond or hold a lone pair. *(no expanded octets)*

#bonds + #LP = 4

This will help you later on!

The bonds can also be double or triple, this charge just shows the quantity of bonds to those atoms to get the charge shown.

Read section 1.5 "Identifying Formal Charges" on pages 10-14 of the Klein packet. Complete problems 1.34 - 1.45 on pages 12-13 in the packet.

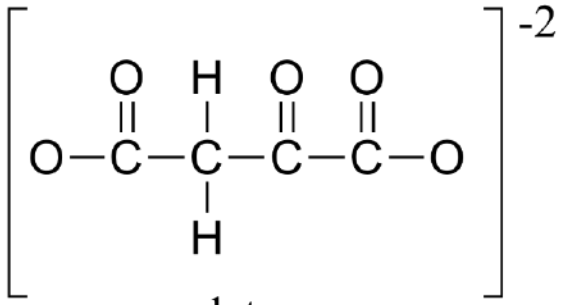
Ch 1.6 - Finding Lone Pairs That Are Not Drawn

Drawings MUST always show formal charges and then you can work backwards to "see" the lone pairs! It is too easy to mistake dots or smudges!

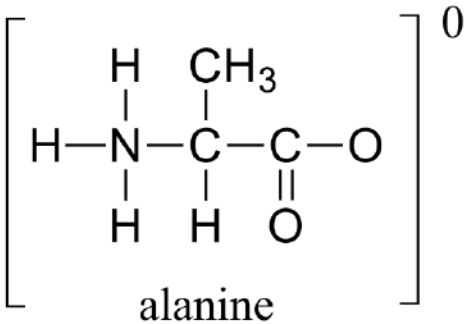
- I will **never** take off points if you include lone pairs! Just realize most of the time you will not be shown them in organic chemistry and you won't have to draw them unless I explicitly tell you to! *(remember #LP's + #Bonds = 4 for regular octet atoms!)*

Charge	Example atoms from groups 13 - 17				
	Boron	**Carbon**	**Nitrogen**	**Oxygen**	**Fluorine**
Positive +	Special case! No Octet! B	Special case! No Octet! C	N	O	F
Neutral 0	B	C	N	O	F
Negative -	B	C	N	O	F

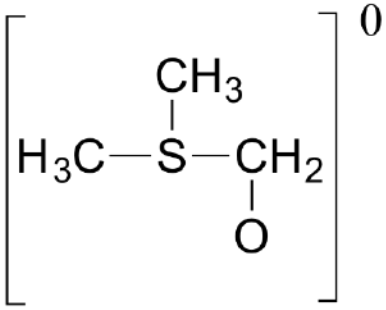
Use the overall charge on the outside of the molecule to <u>assign formal charges</u> to atom(s) inside of the molecule. <u>Make sure to draw all lone pairs!</u>

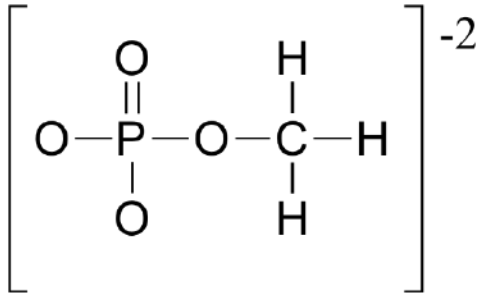
a) 

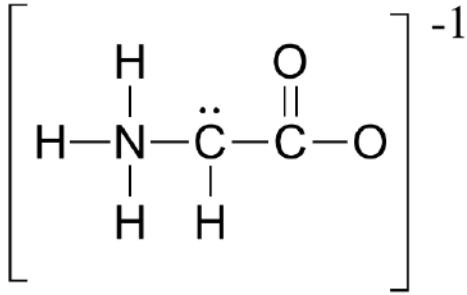
malate

b) 

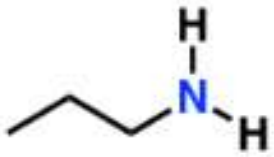
alanine

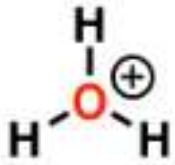
c) 

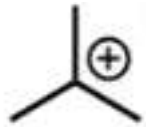
d) 

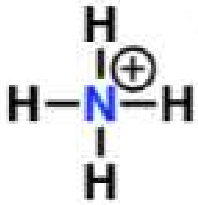
e) 

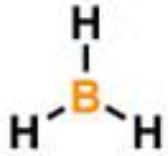
Using the information provided, draw all lone pairs present in the molecules!

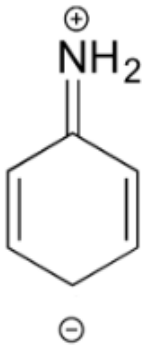


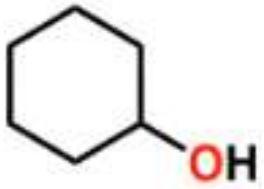


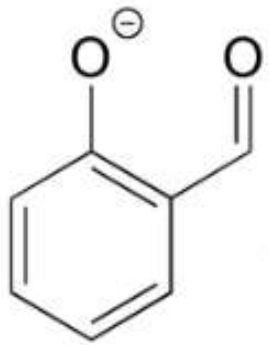










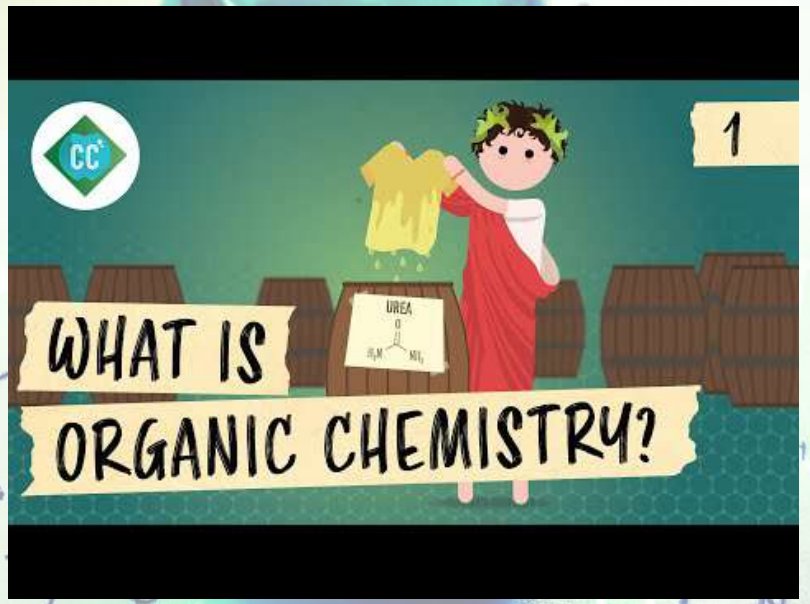


Read section 1.6 “Finding Lone Pairs That are Not Drawn” on pages 14-19 of the Klein packet.
Complete problems 1.47 - 1.68 on pages 16-19 in the packet.

END OF TEACHER SLIDES, STUDENT SLIDES TO FOLLOW

Chapter 1:
A Review of General Chemistry and Bond-Line Drawings

Welcome to Organic Chemistry!



Adapted from David Klein's *Organic Chemistry as a Second Language* textbook

So WHAT is organic chemistry?

- **Organic chemistry** is the study of **carbon**-containing molecules and their reactions

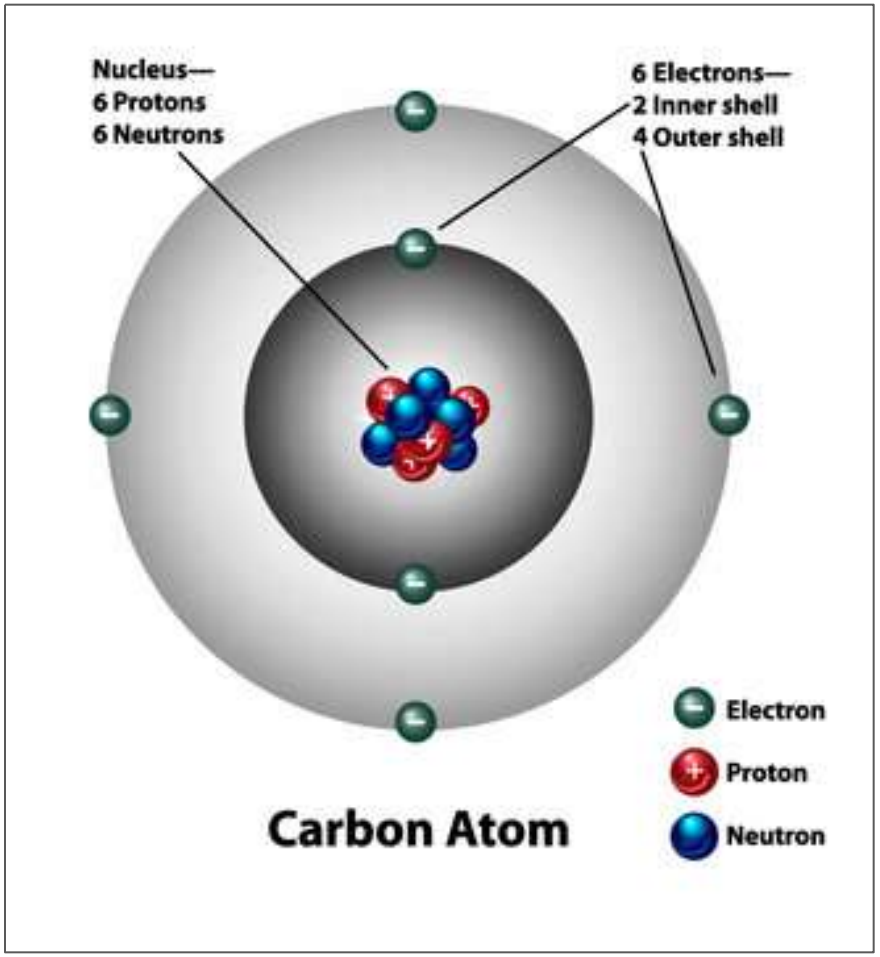
- **What happens to a molecule during a reaction?**
  - A collision must occur (with sufficient energy)
  - "Old" bonds break and "new" bonds form
    - Breaking bonds generally require an addition of energy (endothermic)
    - Forming bonds generally releases energy (exothermic)
    - *We study energy changes in chem II - thermochemistry*

- **The BIG question: WHY do reactions occur?**
  - We will need at least 2 semesters of your time to answer this question!
  - **FOCUS ON THE ELECTRONS**

Basic Review of General Chemistry

- **Protons** (+1) and **neutrons** (neutral) reside inside the nucleus

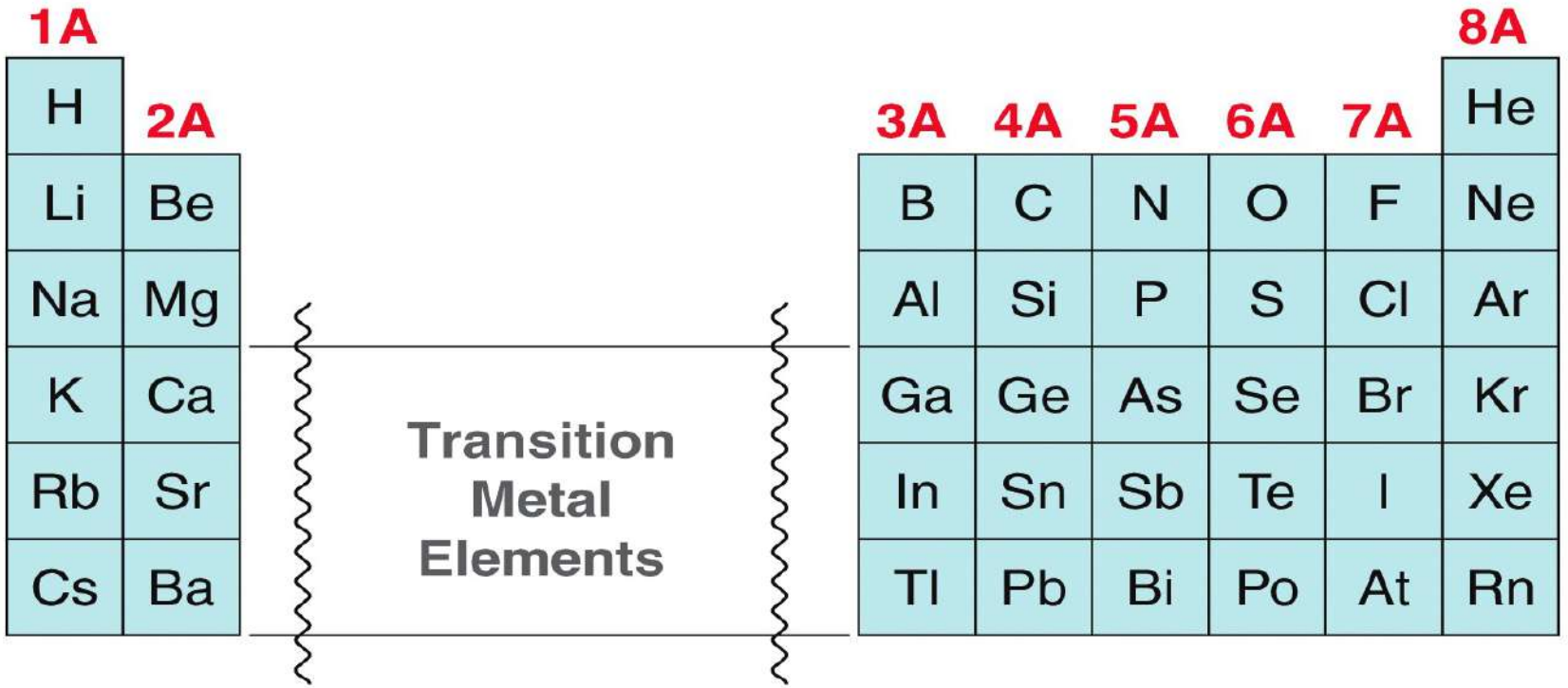
- **Electrons** (-1) reside outside the nucleus.
  - Some electrons are close to the nucleus and others are far away. *(recall electron config's)*
  - Atoms gain/lose electrons *(ionic bonding)* or share electrons *(covalent bonding)*



- *Look at carbon for example. Which electrons are the valence electrons?*
- *Why are valence electrons important?*

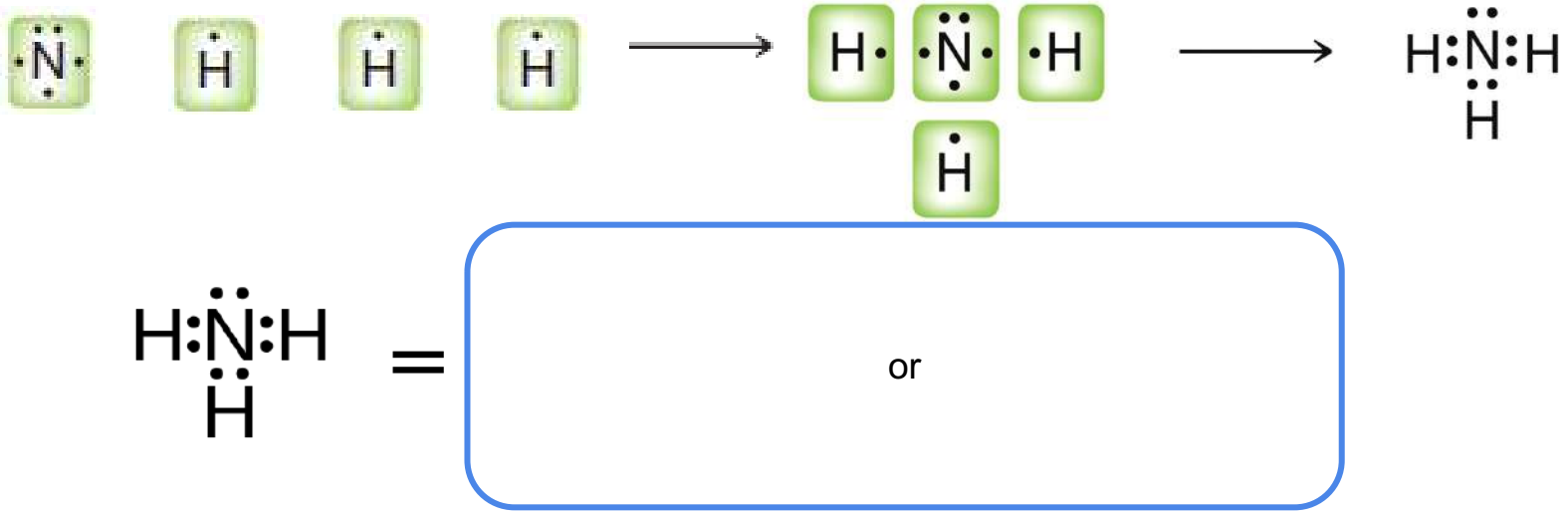
Basic Review of General Chemistry

- **Review counting valence electrons!** Mark them on your periodic table, if needed.
- *What is the "magic" number of valence electrons that atoms will generally try to achieve?*
- *How many bonds does each group make?*



Basic Review of General Chemistry

- **Review simple Lewis Structures:**
  - Draw the individual atoms using dots to represent the valence electrons.
  - Put the atoms together so they share **PAIRS** of electrons to make complete octets. *WHAT is an octet?*
    - Take NH_3 , for example…

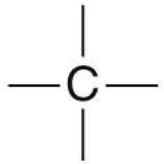
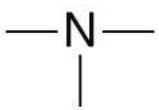
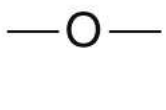
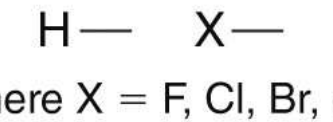


Remember that the "bond" line drawn represents TWO electrons!

Which one of the images is a "more accurate" representation of the NH_3 molecule?

Basic Review of General Chemistry

- Atoms that are most commonly bonded to carbon include N, O, H, and halides (F, Cl, Br, I) (aka halogens)
- With some exceptions, each element generally forms a specific number of bonds with other atoms

Tetravalent	*Trivalent*	*Divalent*	*Monovalent*
			 (where X = F, Cl, Br, or I)
Carbon generally forms ***four*** bonds.	Nitrogen generally forms ***three*** bonds.	Oxygen generally forms ***two*** bonds.	Hydrogen and halogens generally form ***one*** bond.

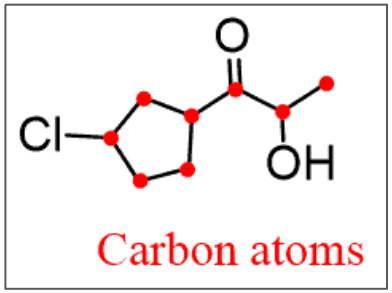
Remember, you can have double and triple bonds!

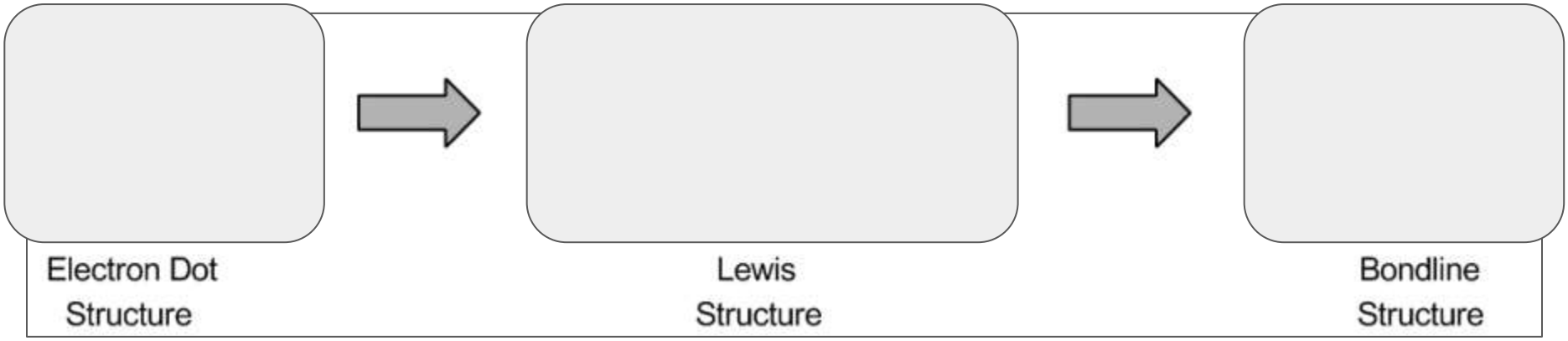
For example: N could have 3 single bonds, a single and a double, or a triple bond.

Two-part video review of Gen Chem

Ch 1.1 - How to Read Bond-Line Drawings

- **Bond-line drawings** (skeletal drawings) show all of the connections of the carbons in a molecule, almost like a backbone
  - The "end" of each line represents a carbon atom
    - Chains of carbons will zigzag
  - Hydrogens attached to carbons are NOT shown
  - All other atoms must be shown (and H's attached to them!)

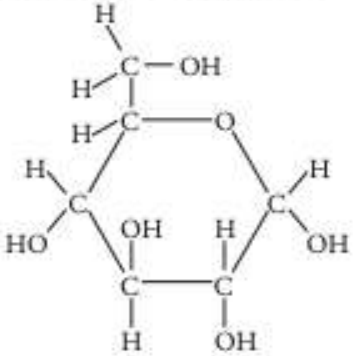
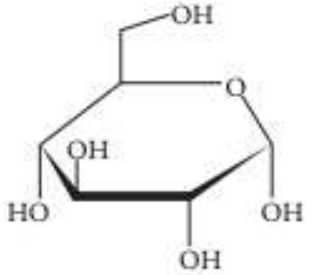
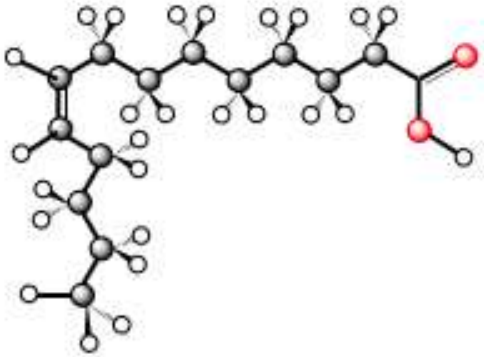
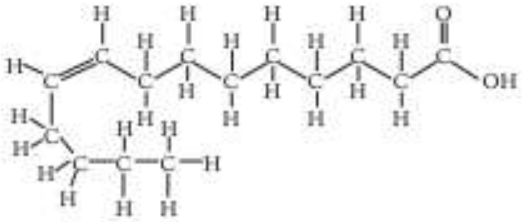
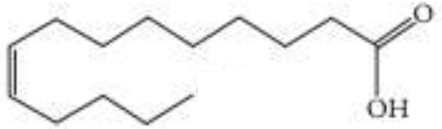




They may or may not explicitly show the bond from O to H. It just depends on what you are "doing" with the drawing - so be flexible!

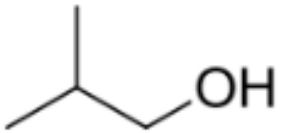
Model 1 – Molecular Drawings

Mark where each C is on the bond-line drawing

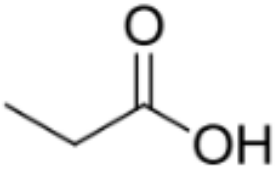
Ball-and-stick model of 1-pentanol	Lewis structure of 1-pentanol	Line drawing of 1-pentanol
Ball-and-stick model of glucose	**Lewis structure of glucose**	**Line drawing of glucose**
		
Ball-and-stick model of unsaturated fatty acid	**Lewis structure of unsaturated fatty acid**	**Line drawing of unsaturated fatty acid**
		

Mark each carbon in the bond-line drawing - count how many total C's in each molecule.

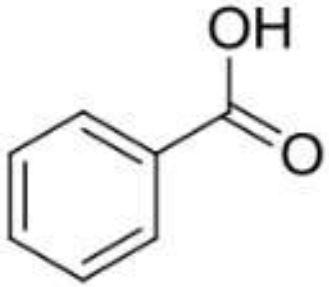
Total C's: ____



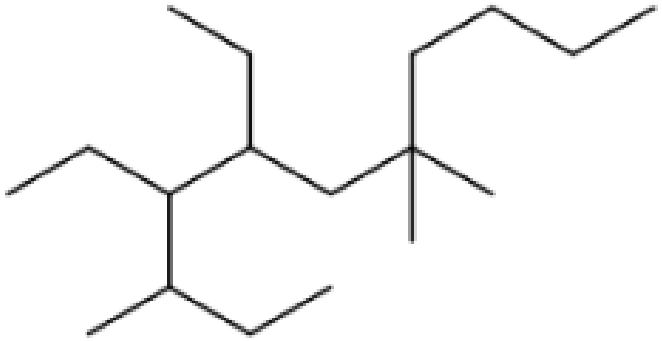
Total C's: ____



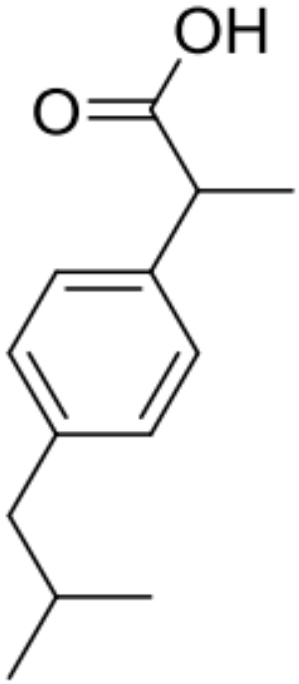
Total C's: ____



Total C's: ____

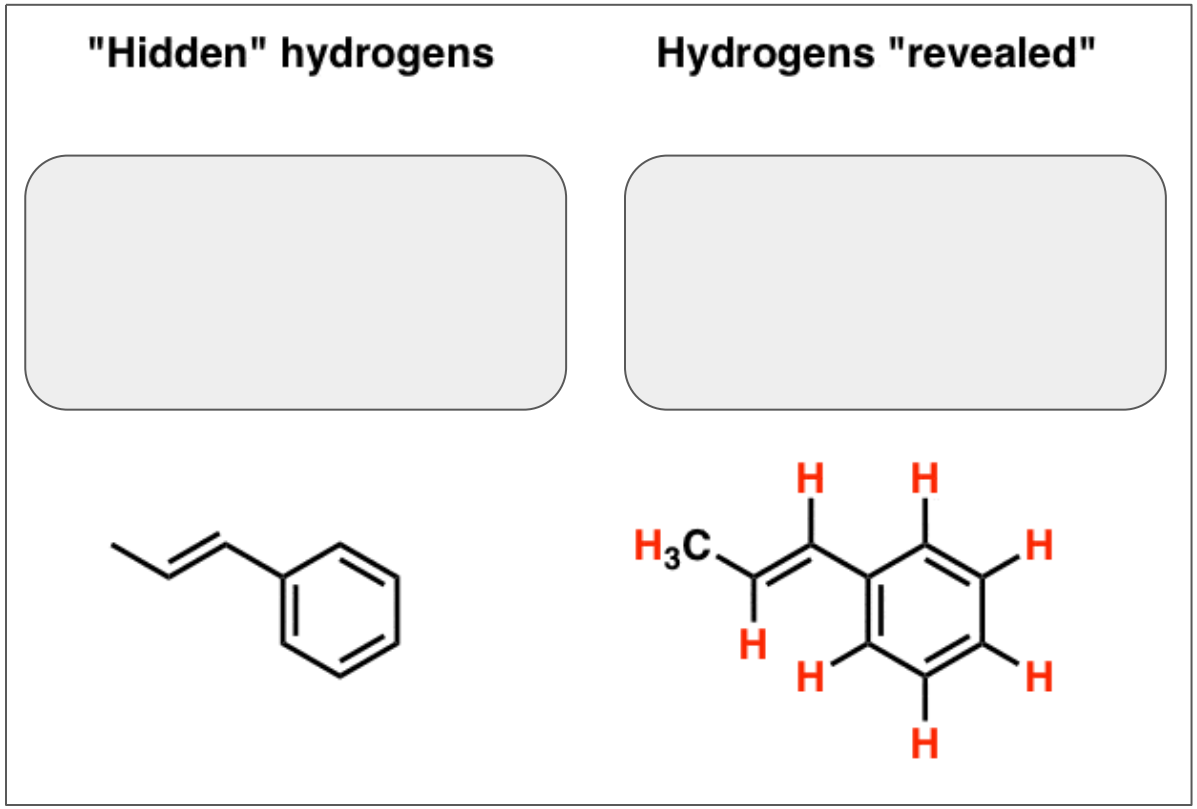


Total C's: ____



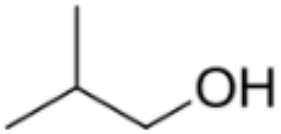
Total C's: ____

- **Counting Hydrogens:**
  - Neutral carbons ALWAYS make 4 bonds!
    - So count the bonds you see and the remaining bonds will be the number of H's attached to the carbon!
    - Watch out for H's that are actually shown that are attached to atoms other than C, especially if you are asked to find the total number of hydrogens!

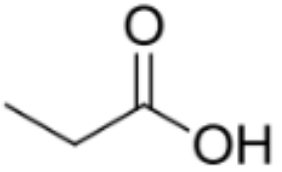


Show the hydrogens in the bond-line drawing - count how many total H's in each molecule.

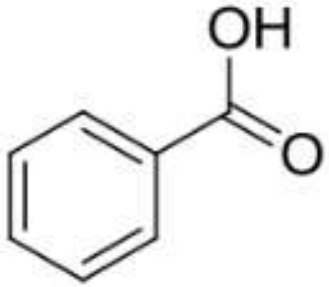
Total C's: ____



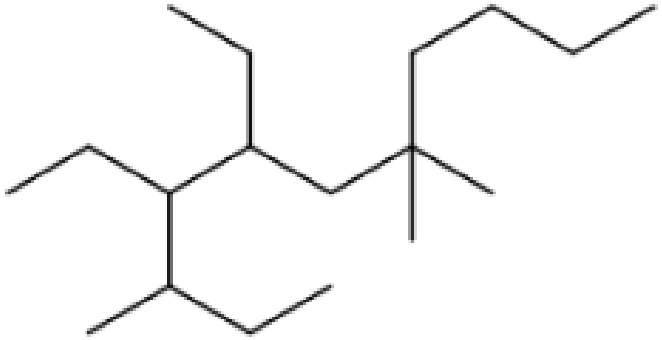
Total C's: ____



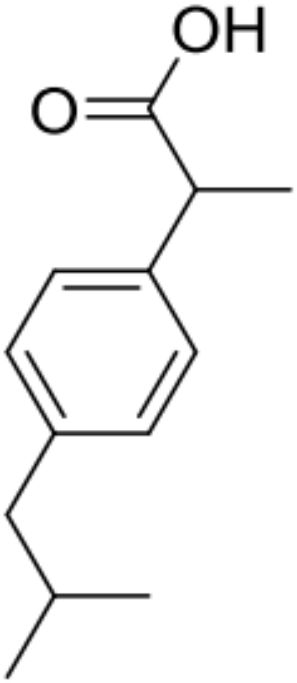
Total C's: ____



Total C's: ____



Total C's: ____

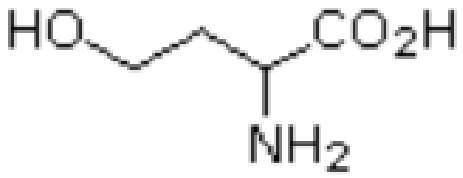


Total C's: ____

Types of Formulas - you will encounter many variations of chemical formulas for molecules so learn to "read" what you see!

- **Molecular formula:** Simply gives the quantity of each type of atom. It doesn't necessarily give you any information on how the structure is actually connected in 3D space.
  - *Drawback: you can have many isomers with the same formula!*
    - *Isomers are compounds that have the same quantity/types of atoms but are connected differently.*
  - *Doesn't show double or triple bonds*
  - EX: C_6H_{14} and C_2H_6O

Write the molecular formula for the examples below.

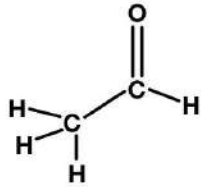
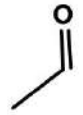
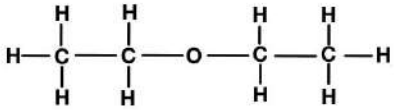
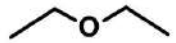


- **Structural Formula:** (basically a Lewis Structure) This is a good middle-ground between the molecular formula and the bond-line drawing. It shows how the atoms are connected and uses symbols.

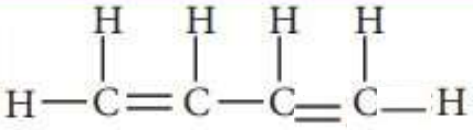
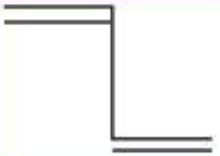
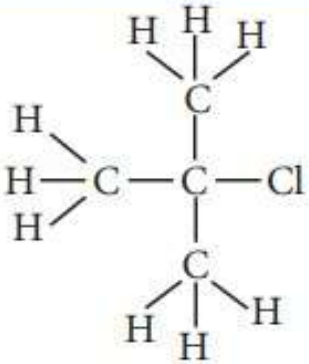
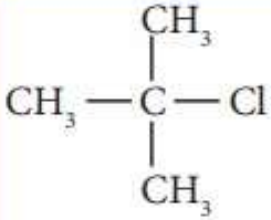
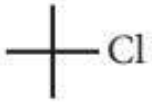
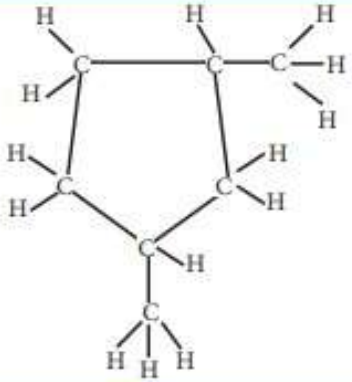
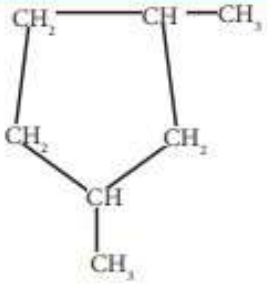
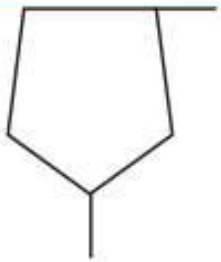
Helpful Video!
Stop @ 4 min.

- **Condensed Formula:** Looks similar to the molecular formula, but it gives more specific information about how the atoms are connected together (the order) *Read these from left → right in "chunks" around the C's! *You will see double and triple bonds between carbons shown, but not necessarily between C and O!*
  - EX: $CH_3CH{=}CHCH_2CH_3$

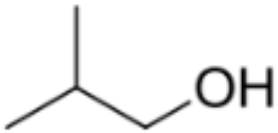
These have so many variations, we will keep it basic!

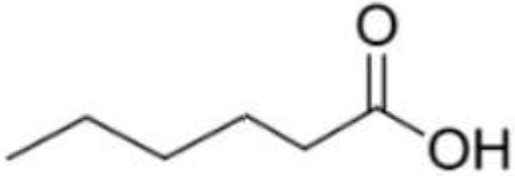
Structural Formula	Condensed Formula	Skeletal Formula
	CH_3CHO	
	$(C_2H_5)_2O$	

Examples of Various Ways to Represent Formulas

Molecular forumula	Complete structural formula (dash line structure)	Condensed Structure	Bond line Structure
n-propanol C_3H_8O			
1,3-butadiene C_4H_6		$CH_2=CH-CH=CH_2$	
t-butyl chloride C_4H_9Cl			
1,3-dimethyl cyclopentane C_7H_{16}			

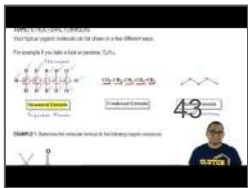
Write the molecular formula and structural formula for each molecule. ***There may be multiple structural formulas that can still be correct!***





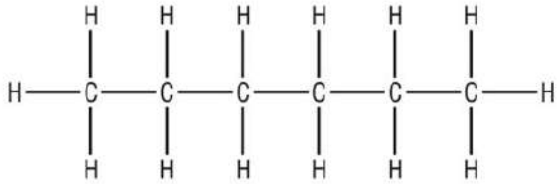
Helpful Video!

Read section 1.1 “How to Read Bond-Line Drawings” on pages 1-5 of the Klein “Chemistry as a Second Language” packet. Complete problems 1.2 - 1.11 on page 3 and problems 1.13 - 1.20 on page 4.



Tips for turning structural formulas into bond-line drawings

1. Connected carbons are drawn in a zigzag format



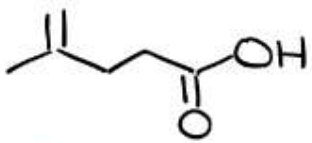
Is the same as…

1. When drawing bonds, try to draw the other bonds as far apart as possible *(recall electrons repel w/ VSEPR)*

Do this

compare to

DONT do this



Do this

compare to

DONT do this

DO this

compare to

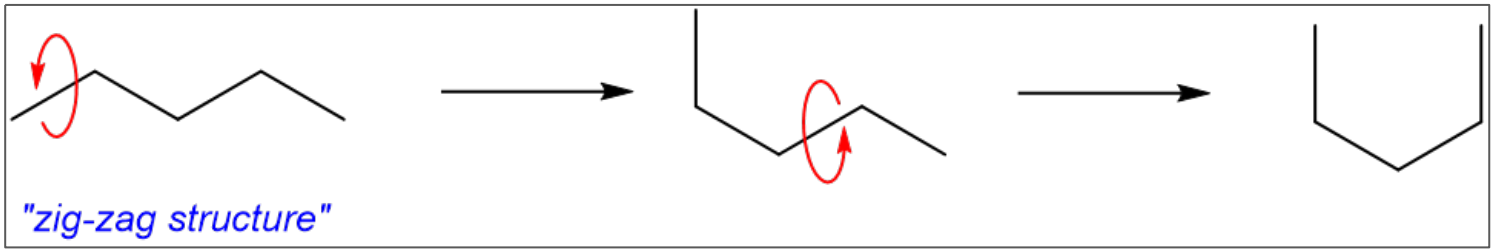
DONT do this

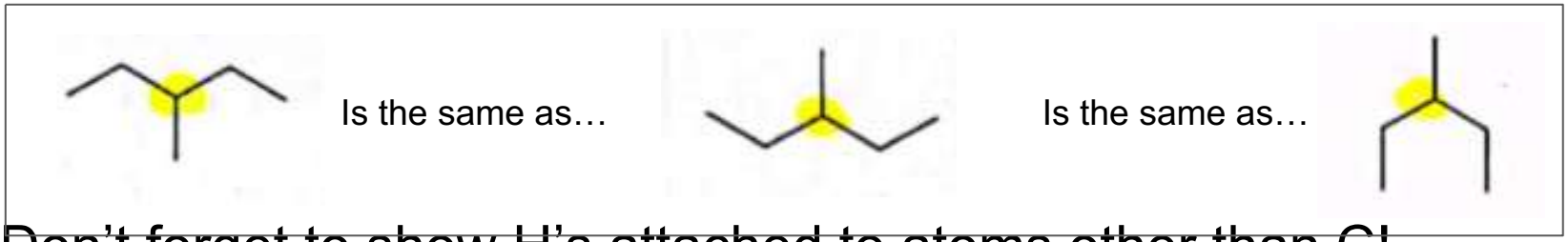
Special Note: Double bonds CAN be drawn in a zigzag! They are trigonal planar and have 120° bond angles.

Triple bonds are linear (180°) They should not be drawn as a zigzag!

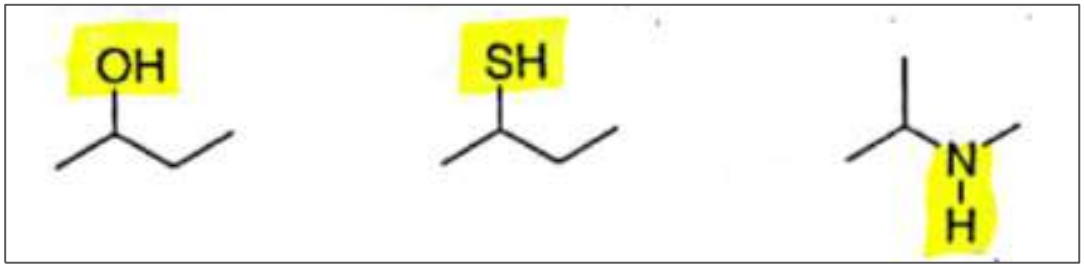
Tips for turning structural formulas into bond-line drawings

3. When drawing zigzags it doesn't matter which direction you start, especially for single bonds because they are free to rotate!



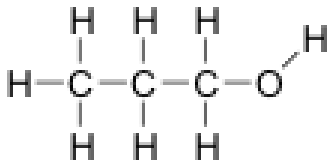


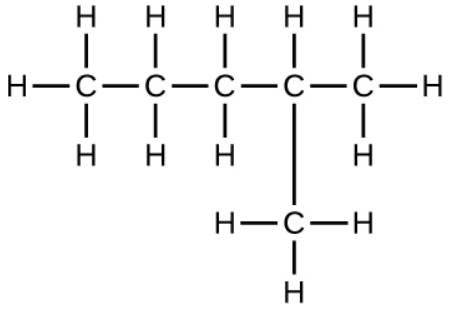
3. Don't forget to show H's attached to atoms other than C!

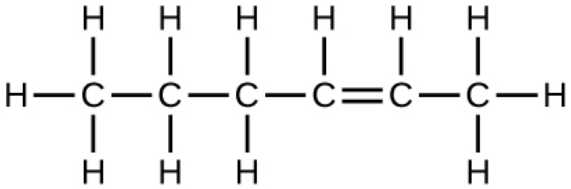


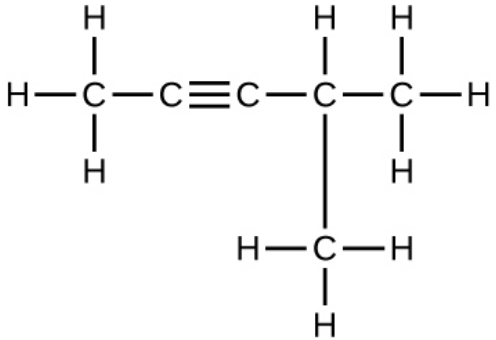
Special note: We don't have to draw lone pairs in organic chemistry - more to come on that topic!

Turn the structural formulas into bond-line drawings









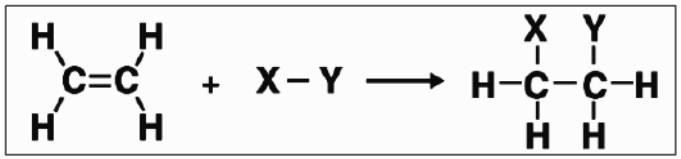
Read sections 1.2 “How to Draw Bond-Line Drawings” **AND** 1.3 “Mistakes to Avoid” on pages 5-7 of the Klein packet. Complete problems 1.21 - 1.24 on pages 6-7 in the packet.

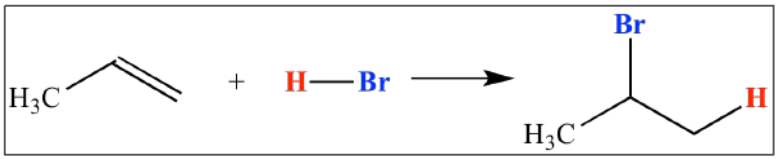
Ch 1.4 - More Exercises *(What Change has Occurred?)*

One of the big ideas of organic chemistry is chemical reactions. At this point we don't care about *how* the reaction took place, we just want to understand *what changed*.

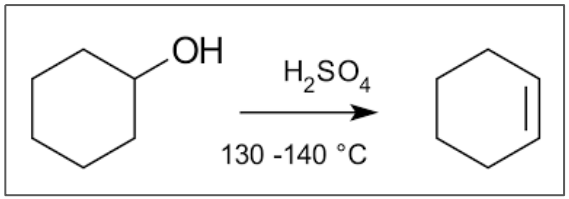
3 "Changes" to Identify:

- _____ *(watch those H's)*
  - Characteristic "disappearance" of a double bond because H's need to bond to the electrons within the double bond

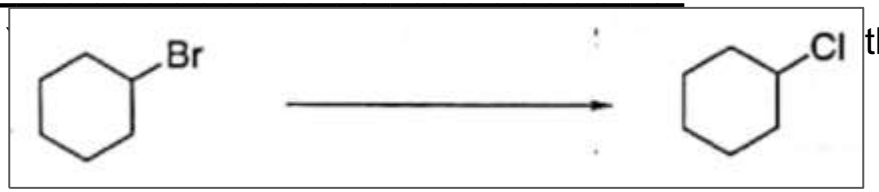




- _____ *(watch those H's)*
  - Characteristic "appearance" of a double bond because when the H's are removed the electrons bond together that were left over



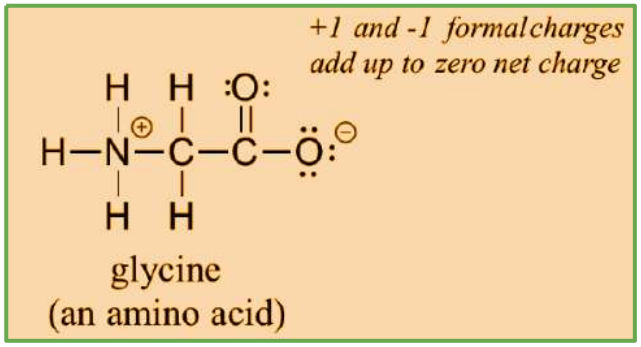
- _____
  - th ar

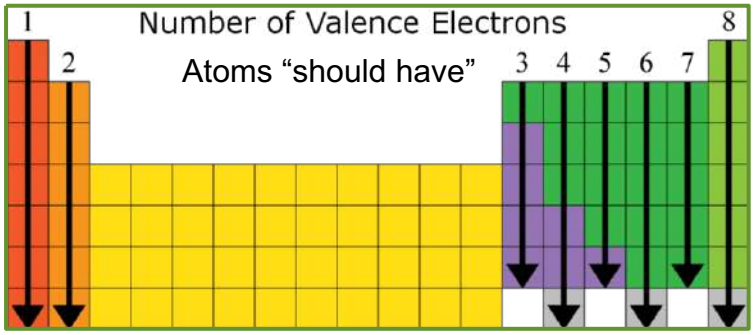


Read section 1.4 "More Exercises" on page 8 of the Klein packet. Complete problems 1.25 - 1.32 on pages 9-10 in the packet.

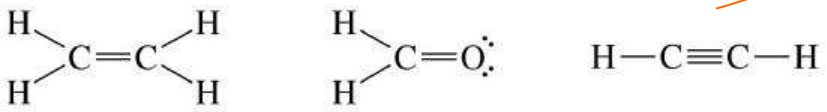
Ch 1.5 - Identifying Formal Charges

Formal Charges are used as a "bookkeeping" method for *specific atoms* to show where electrons can be distributed. This is calculated for each atom. *It is not the same thing as* ***overall charge*** *because you can have multiple pos./neg. individual charges that could cancel out.*



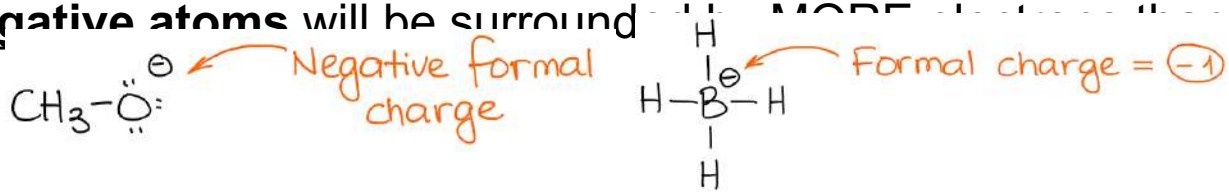


- **Neutral atoms** will be surrounded by the same number of electrons as they "should have" in the



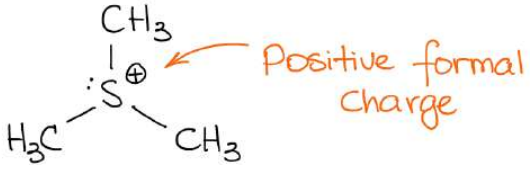
All neutral! So we don't see any charges!

- **Negative atoms** will be surrounded by MORE electrons than they "should have"



***Electron-rich areas!**

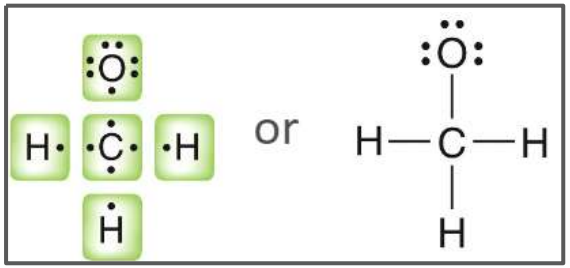
- **Positive atoms** will be surrounded by LESS electrons than they "should have"

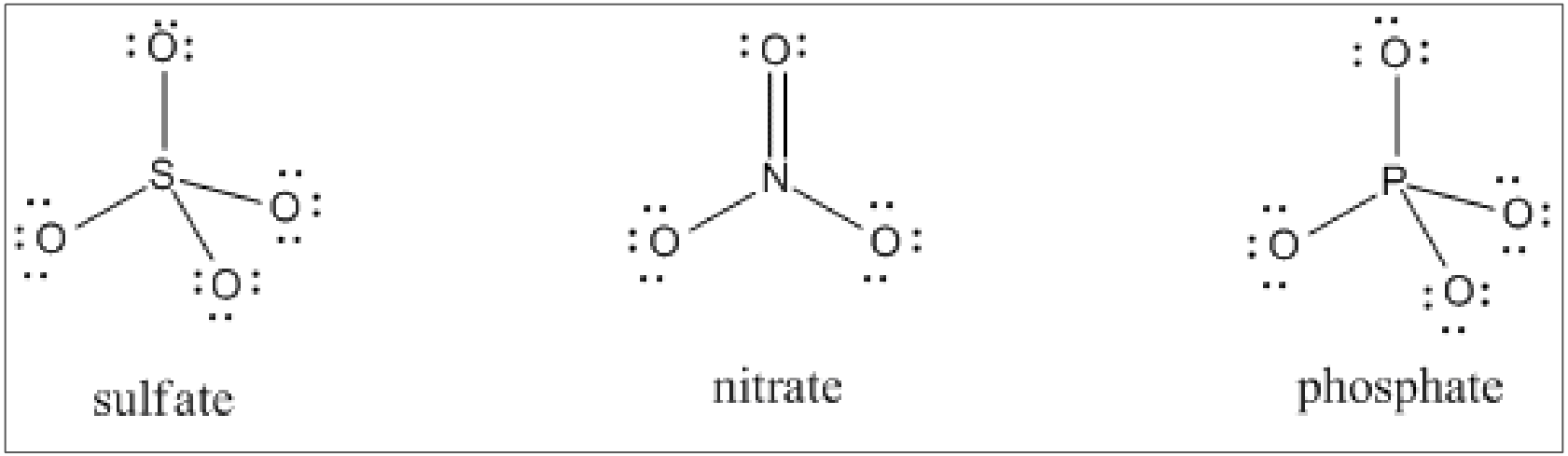


***Electron-poor areas!**

Moral of the story: COUNT how many electrons you SEE around the atom and compare it to how many atoms the atom SHOULD HAVE according to the group it is in on the periodic table! **Formal charge = "Should have" - "actually has"**

How to count: A lone pair = 2 electrons & EACH BOND = 1 electron

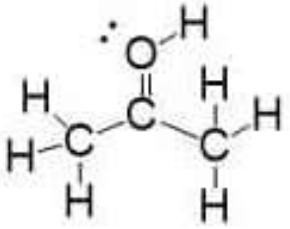


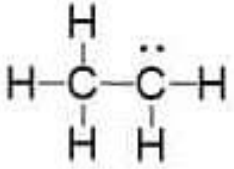


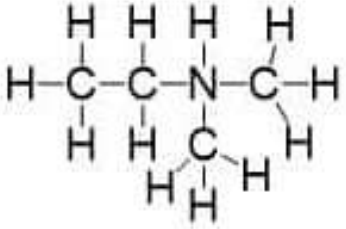
Practice finding the formal charge on each atom. Then, determine the overall charge of the molecule!
(Hint: they are your favorite old polyatomic ions!)

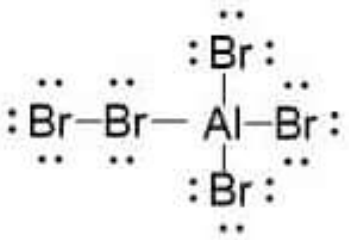
Great videos to help calculate formal charges!

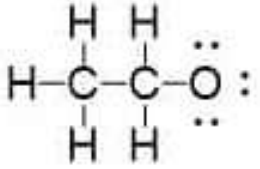
Assign formal charges to the atoms in the molecules (C, N, O, Al, Br.). ALL lone pairs are shown on the molecules! If they are neutral as shown, mark them with an N or *.

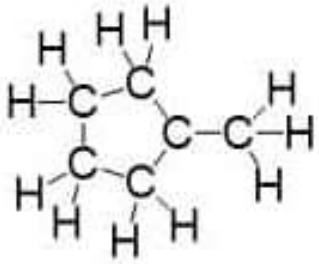
a) 

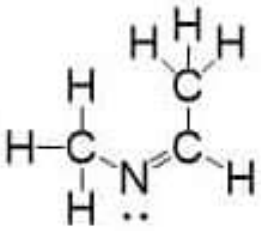
b) 

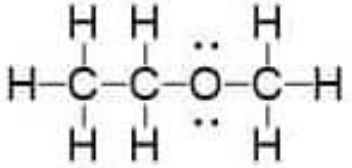
c) 

d) 

e) 

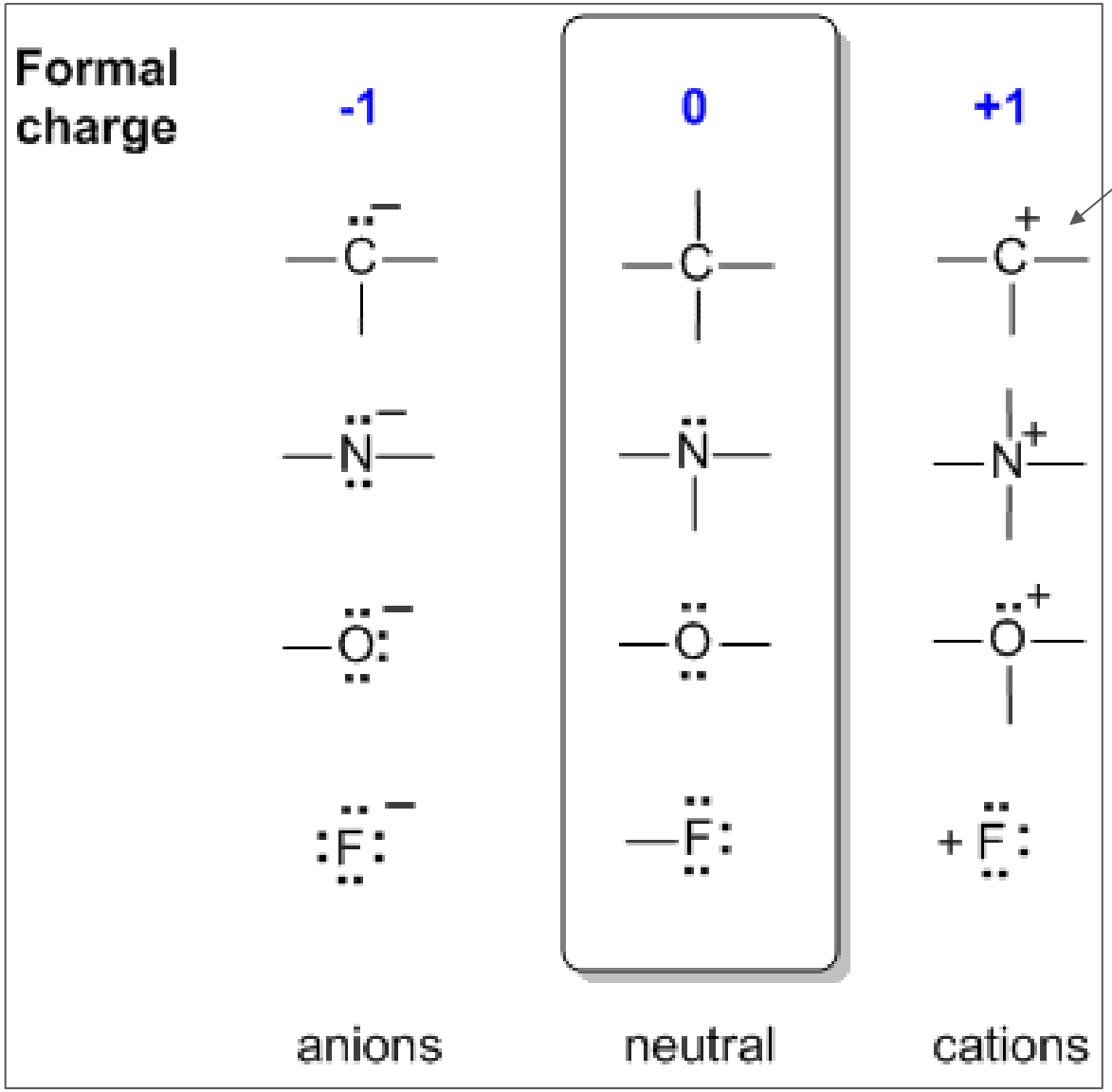
f) 

g) 

h) 

Have you noticed any patterns?

Basic Formal Charge Chart w/ Lone Pairs Shown



C+ is the only one that will not use all 4 orbitals. It's fourth orbital is actually empty!

Notice: The atoms always use 4 orbitals. Each orbital can be used to make a bond or hold a lone pair. *(no expanded octets)*

#bonds + #LP = 4

This will help you later on!

The bonds can also be double or triple, this charge just shows the quantity of bonds to those atoms to get the charge shown.

Read section 1.5 "Identifying Formal Charges" on pages 10-14 of the Klein packet. Complete problems 1.34 - 1.45 on pages 12-13 in the packet.

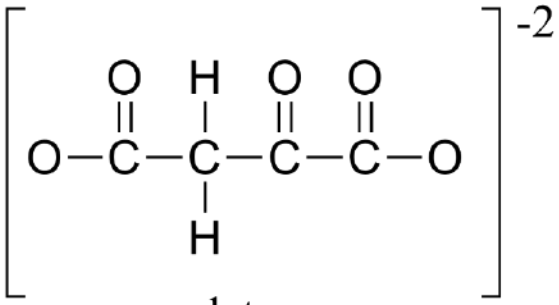
Ch 1.6 - Finding Lone Pairs That Are Not Drawn

Drawings MUST always show formal charges and then you can work backwards to "see" the lone pairs! It is too easy to mistake dots or smudges!

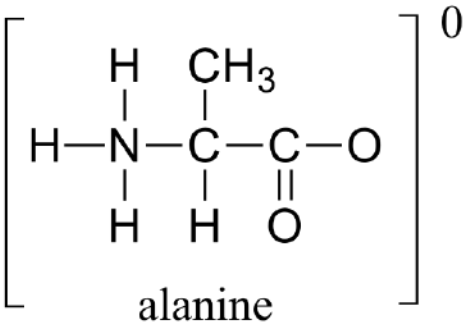
- I will **never** take off points if you include lone pairs! Just realize most of the time you will not be shown them in organic chemistry and you won't have to draw them unless I explicitly tell you to! *(remember #LP's + #Bonds = 4 for regular octet atoms!)*

Charge	Example atoms from groups 13 - 17				
	Boron	**Carbon**	**Nitrogen**	**Oxygen**	**Fluorine**
Positive +	Special case! No Octet! B	Special case! No Octet! C	N	O	F
Neutral 0	B	C	N	O	F
Negative -	B	C	N	O	F

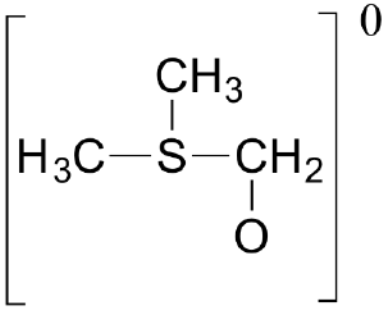
Use the overall charge on the outside of the molecule to <u>assign formal charges</u> to atom(s) inside of the molecule. <u>Make sure to draw all lone pairs!</u>

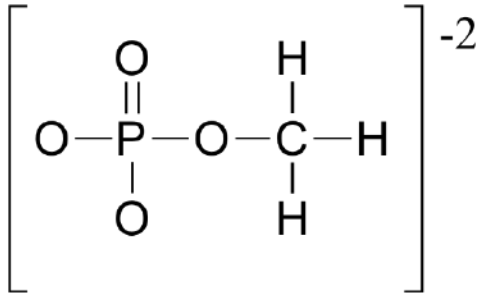
a) 

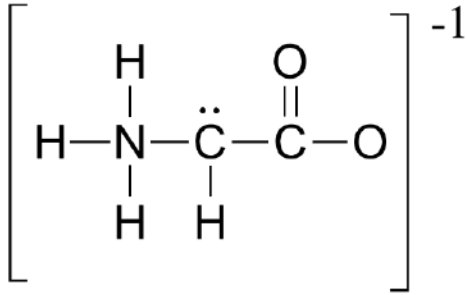
malate

b) 

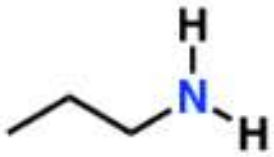
alanine

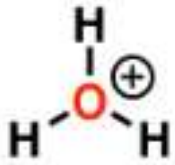
c) 

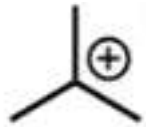
d) 

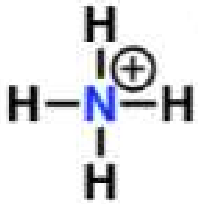
e) 

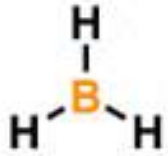
Using the information provided, draw all lone pairs present in the molecules!

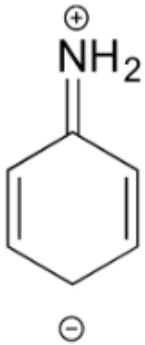


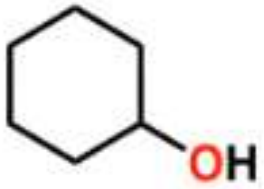


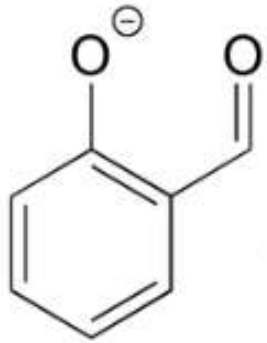












Read section 1.6 “Finding Lone Pairs That are Not Drawn” on pages 14-19 of the Klein packet.
Complete problems 1.47 - 1.68 on pages 16-19 in the packet.

What you need to know for the Chapter 1 Test