

STUDY GUIDE - Ch.2.3 - The formation & function of molecule depend on chemical bonding between atoms.

NAME: _____

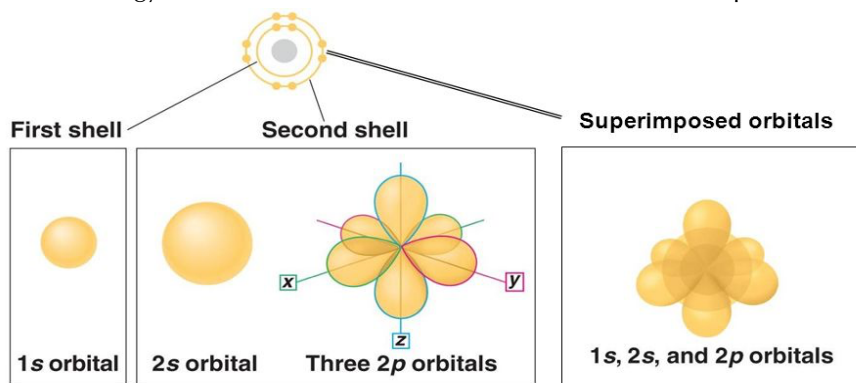
- Please **PHYSICALLY PRINT OUT** these pages and **HANDWRITE** the answers directly on the printouts. Typed work or digitally-produced answers will not be accepted.
- **Importantly, guided readings are NOT GROUP PROJECTS!!!** You, and you alone, are to answer the questions as you read. You are **not** to share them with another students or work together on filling it out. You are **not** to copy any answers from any other source including the internet. Please report any dishonest behavior to your instructor to be dealt with accordingly.
- **Get in the habit of writing legibly, neatly, and in a NORMAL, MEDIUM-SIZED FONT.** AP essay readers and I will skip grading anything that cannot be easily and quickly read so start perfect your handwriting.
- Please **SCAN** documents properly and upload them to Archie. Avoid taking photographs of or uploading dark, washed out, side ways, or upside down homework. Please use the scanner in the school's media lab if one is not at your disposal and keep completed guides organized in your binder to use as study and review tools.
- **READ FOR UNDERSTANDING** and not merely to complete an assignment. Though all the answers are in your textbook, you should try to put answers in your own words, maintaining accuracy and the proper use of terminology, rather than blindly copying the textbook whenever possible.

Remember, **that in a neutral atom, the number of electrons in the electron cloud around the nucleus equals the number of protons in the nucleus.** Though negatively charged electrons are attracted to the positive charges of the protons, electrons also repel each other. There are, therefore, some areas around the nucleus where there exists a higher probability of finding an electron at any given instance. These regions are known as **orbitals**, a maximum of two electrons occupying any given orbital. Electrons added to an atom composed of just the nucleus would fill the orbitals closest to the nucleus first. Electrons will first come to occupy a spherical area around the nucleus, this area being known as the 1s orbital. A neutral atom of hydrogen, which has one proton and, thus, one electron would have only one electron in its electron cloud, this electron being located in the first energy level, which is composed of only one orbital, the 1s orbital.

Unlike that of hydrogen, most atoms contain more than one electron. After two electrons occupy this 1s region, additional electrons will occupy a spherical area further out from the nucleus, known as the 2s orbital. This is the case for lithium, which has three protons and, thus, can attract three electrons, the third electron being pushed into the second s orbital (2s). After two electrons have been added to the 2s orbital, additional electrons added to an atom's electron cloud will occupy regions that look like dumbbell shapes, referred to as p orbitals. In the second energy level of an atom's electron cloud, you will find a maximum of three p orbitals (one referred to as 2px, one 2py, and one 2pz), each holding up to two electrons. (Note that there are no p orbitals in the first energy level discussed in the previous paragraph). If we look at atoms of the element fluorine, for example, the atom has nine protons and, thus, nine electrons, the first two being found in the region known as the 1s orbital, the next two filling the 2s orbital, and the last five occupying the areas referred to as the 2p orbitals. Because only two electrons can occupy an orbital, two out of the three 2p orbitals are filled with two electrons each, the last electron occupying the third 2p orbital, which could hold one more, but doesn't in a neutral fluorine atom. There are other atoms though that have so many electrons, all their 2s and 2p orbitals are filled, and the outermost electrons end up occupying either a spherical space with an even greater diameter known as the 3s orbital or the 3s orbital AND up to three dumbbell-shaped regions with a larger diameter known as the 3p orbitals.

If we look at the first energy level, made of one 1s orbital, the maximum number of electrons that can occupy this region is two (**the maximum possible number of electrons that can be held in the first energy level of an atom is two**). If we look at the entire second energy level, made of one 2s orbital and up to three 2p orbitals, the maximum number of electrons that are able to occupy these regions or **the maximum possible number of electrons in the second energy level of atoms is eight**. This is true for atoms that have a third energy level made of one 3s orbital and a maximum of up three 3p orbitals as well, for example.

For an atom to be stable, its outer most electron shell must be filled, no matter if it only has a 1s orbital or if it could fill both one s and three three p orbitals in that outermost energy level or energy shell.

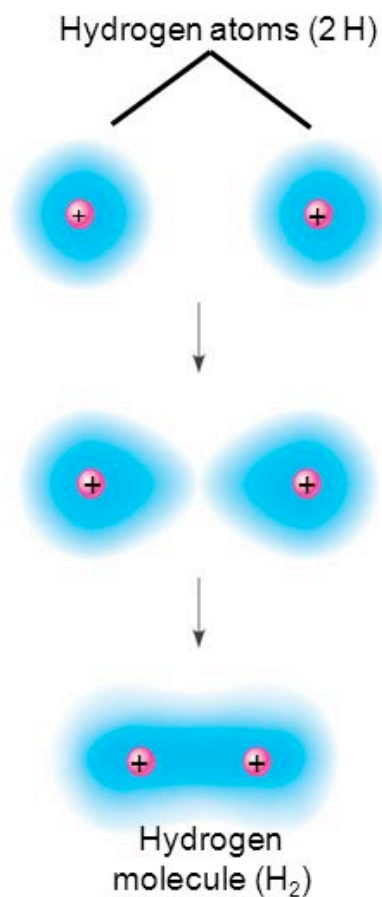


1. Atoms are stable when they have their outermost electron level, a.k.a. their **valence shell**, filled. If they don't, they can transfer or share valence electrons, which results in atoms being held closely together in attractions we call _____.
2. The two strongest types of attractions between two atoms are covalent and ionic bonds. What is a **covalent bond**?
3. What is a **molecule**?
4. Distinguish between a **single bond** and a **double bond**.
5. Explain the three steps in the **formation of a single covalent bond between two hydrogen atoms**.

1.

2.

3.



6. What is meant by the **valence** of an atom?

7. What is the difference between a molecule that is considered a pure element still and one that is considered a **compound**?

8. Complete the table below.

	Molecule? (y/n)	Compound? (y/n)	Molecular Formula	Structural Formula
Water				
Carbon dioxide				
Methane				
O ₂			O ₂	

9. What is the difference between a molecule that is considered a pure element still and one that is considered a **compound**?

10. a. What does the term **electronegativity** refer to?

b. What happens as an atom's electronegativity increases?

11. What is a **nonpolar covalent bond**?

12. What is a **polar covalent bond**?

13. a. How do the **electronegativities of an oxygen and hydrogen** atom compare?

b. How do the **electronegativities of a carbon and hydrogen** atom compare?

14. a. What are **ions**?

b. Distinguish between a **cation and an anion**.

15. What is an **ionic bond**?

16. a. If a (neutral) sodium atom has 11 protons, how many total electrons does it have in its **electron cloud**?

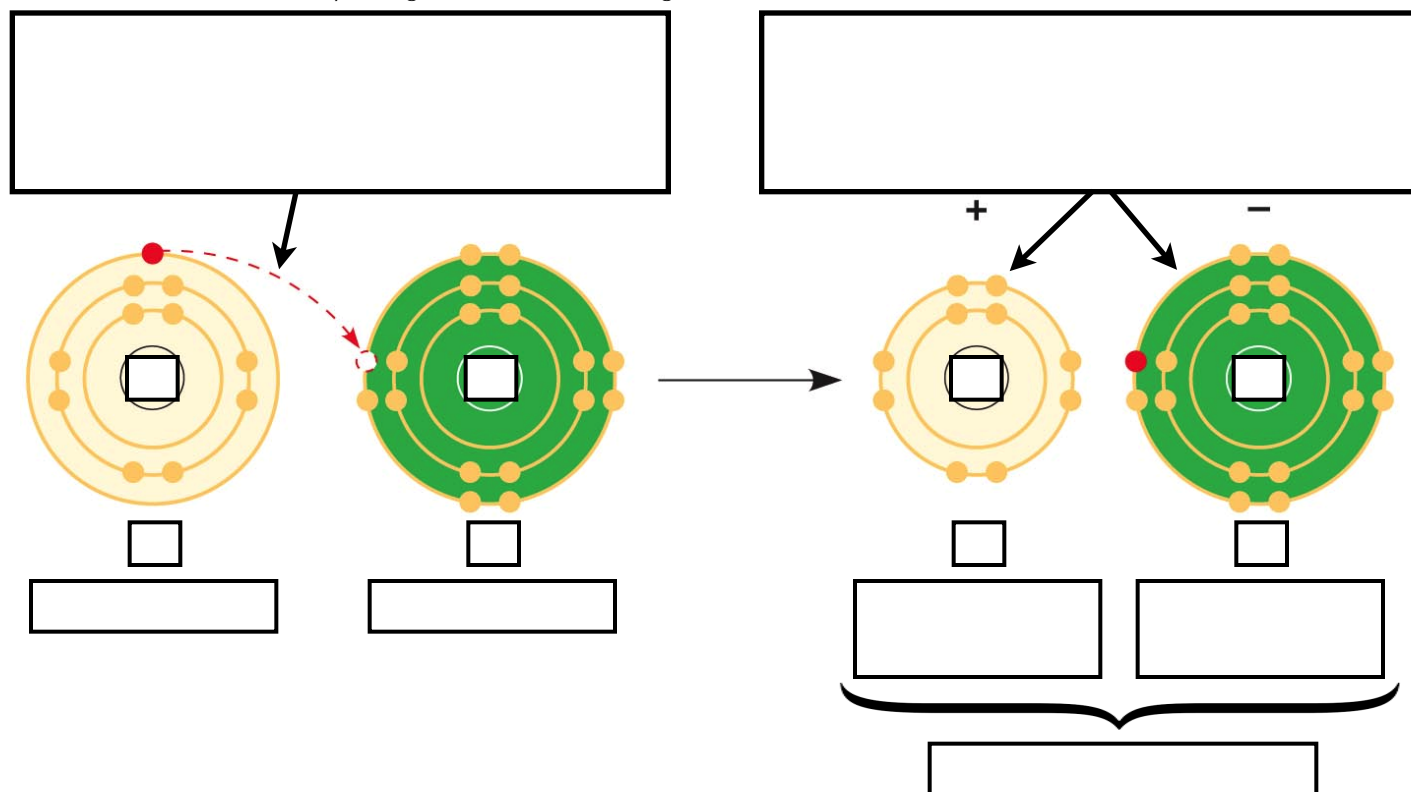
b. How many **valence electrons** does a sodium atom have? (*Valence electrons being those electrons in the valence shell or the outermost electron level (in the outermost s and p orbitals)*)

c. If a (neutral) chlorine atom has 17 protons, how many total electrons does it have in its **electron cloud**?

d. How many **valence electrons** does a chlorine atom have?

e. Based on what you know from reading the introductory paragraphs of this Ch.2.3 assignment, are sodium and chlorine stable atoms? Why or why not?

f. Explain the steps in the formation of the sodium and chloride ion, as well as the formation of the ionic bond that forms between them by filling in the boxes in the figure below.



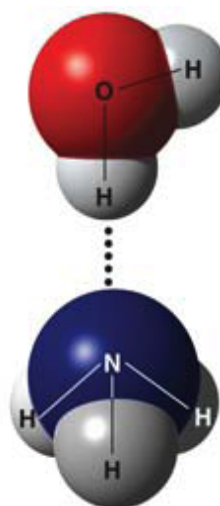
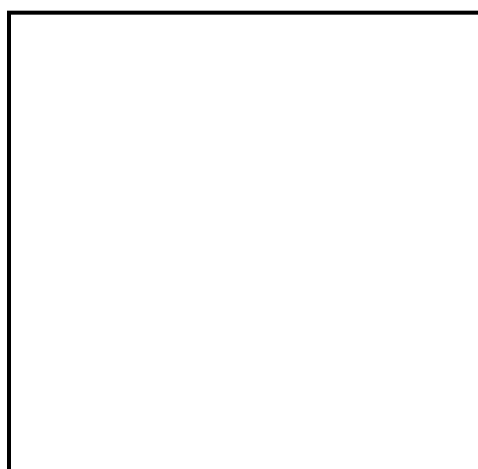
g. Why does the chloride anion have a complete valence shell?

h. Why does the sodium cation have a complete valence shell?

i. The transfer of the electron from the sodium to chlorine atom is **NOT** an ionic bond (a strong attraction between oppositely charged ions). By drawing on the figure above, **where would you say the ionic bond is "located"?**

17. What is the difference between an **ionic compounds (salts)** and **molecules**?

18 . a. Both water and ammonia are polar molecules made up of partially charged atoms. Partial charges are represented by $\delta+$ and $\delta-$. Please label the molecules of water and ammonia below with the correct partial charges.



b. Unlike strong atomic attractions such as the ionic bonds in dry crystals and covalent bonds in molecules, hydrogen bonds are considered weak intermolecular forces of attractions. Draw an arrow pointing to the location of the hydrogen bond in the figure above.

c. Explain what a **hydrogen bond** results from in the box above.

19. a. Remember, even in a molecular with nonpolar covalent bonds, in which electrons are shared equally between the two atoms in question, electrons are NOT always _____; at any instant, electrons may accumulate _____ in one part of the molecule or another.

b. What are the results of these temporary charges on molecules?

c. When do Van Der Waals Interactions tend to occur?

20. Why are **Van Der Waals Interactions** (which includes London Dispersion Forces, and sometimes may be used as a term that also refers to Dipole-Induced Dipole Forces, Dipole-Dipole Forces, and even repulsions), hydrogen bonds, and ionic bonds in water so important in biology?

21. Why is **molecular shape** crucial?

22. **Molecular shape is critical** and exemplifies the theme of **form fitting function**. In what way is morphine a **molecular mimic** of natural endorphins?

