

ChemQuest 19

Lewis Dot Structures

Name: _____

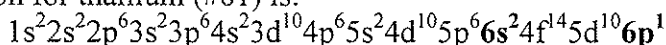
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Information: Valence Electrons

The electrons in the highest energy level are called valence electrons. Valence electrons are the electrons located farthest from the nucleus. Valence electrons are *always* in the highest energy level. The valence electrons are the most important electrons in an atom because they are the electrons that are the most involved in chemical reactions and bonding.

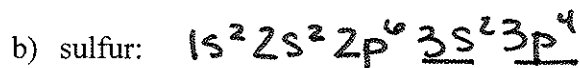
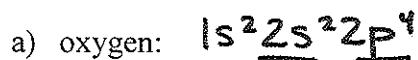
The electron configuration for thallium (#81) is:



The outermost energy level (not sublevel) is the 6th energy level. How many total electrons does thallium have in the sixth level? 3, they are in boldfaced type above. Therefore, thallium has 3 valence electrons.

Critical Thinking Questions

1. Write the electron configurations for



2. How many valence electrons does oxygen have?

6

3. How many valence electrons does sulfur have?

6

4. Verify that selenium (atomic number = 34) has six valence electrons by drawing an electron configuration and giving a brief explanation.



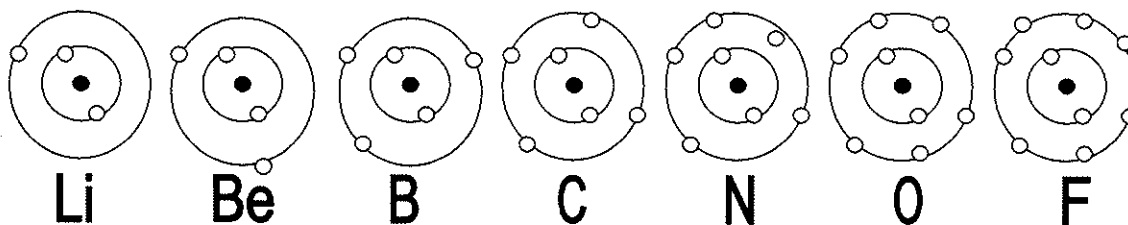
6 v.e.

electrons in the highest energy level.

Information: Bohr Diagrams

Below are seven "Bohr diagrams" for atoms #3-9.

FIGURE 1:



Critical Thinking Questions

5. In each of the Bohr diagrams in Figure 1, the first energy level only has two electrons drawn in it. Why is this?

1st energy level - only s sublevel - only holds 2 e⁻

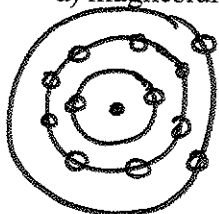
6. What is the maximum number of electrons that the second energy level can have? How many electrons can the 3rd energy level have?

2nd energy level - s, p - 8 e⁻

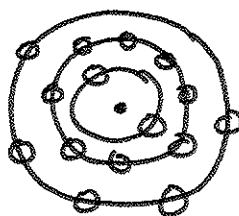
3rd energy level - s, p, d - 18 e⁻

7. Draw Bohr diagrams for the following atoms.

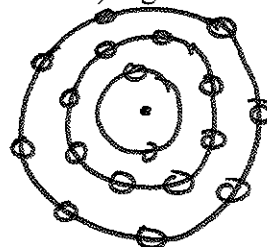
a) magnesium



b) phosphorus



c) argon



Information: Electron Dot Diagrams

Below are electron dot diagrams, also known as "Lewis Structures" for atoms #3-10.

FIGURE 2:



The position of the dots is important. For example, another atom that has three dots in its Lewis structure is aluminum. Aluminum's three dots must be positioned the same way as boron's. Thus, aluminum's Lewis structure is:

FIGURE 3:



Critical Thinking Questions

8. What relationship exists between an atom's valence electrons and the number of dots in the Lewis structure of the atom?

valence electrons is the same as # dots

9. Why does nitrogen's Lewis Structure has five dots around it while nitrogen's Bohr diagram contains 7 dots around it.

2 dots on 1st level are not valence electrons.

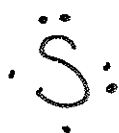
10. Recall from questions 1-4 that oxygen, sulfur and selenium all have the same number of valence electrons (6). They also are in the same column. Predict how many valence electrons tellurium (Te) will have. **6**

11. Comparing Figure 2 and Figure 3 we see that boron and aluminum have the same number of dots in their Lewis structures. Notice they are in the same column. Write the Lewis structure for gallium (Ga).

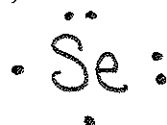


12. Write the Lewis structure for sulfur and selenium. Compare the structures you write with oxygen's Lewis structure from Figure 2.

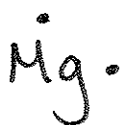
a) Sulfur



b) Selenium



13. In question seven, you drew the Bohr diagram for magnesium. Now write the Lewis Structure for magnesium. What similarities exist between the Lewis Structures for magnesium and beryllium?



same # of valence electrons

14. Complete this statement: If elements are in the same column, they must have Lewis

Structures that are similar.
similar or different

15. Why does sodium have the same Lewis structure as lithium? **same family**

16. Lewis structures are easier to draw than Bohr diagrams, but what information is lost by drawing a Lewis structure instead of a Bohr Diagram?

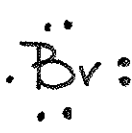
you don't know how many energy levels

17. Draw the Lewis structure for the following elements.

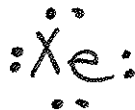
a) germanium



b) bromine



c) xenon



d) potassium



e) arsenic



18. You should be able to tell how many valence electrons an atom has by which column of the periodic table the element is in. How many valence electrons are in each of the following atoms?

a) bromine

7

b) tin

4

c) krypton

8

d) rubidium

1

ChemQuest 23

Forming Ions

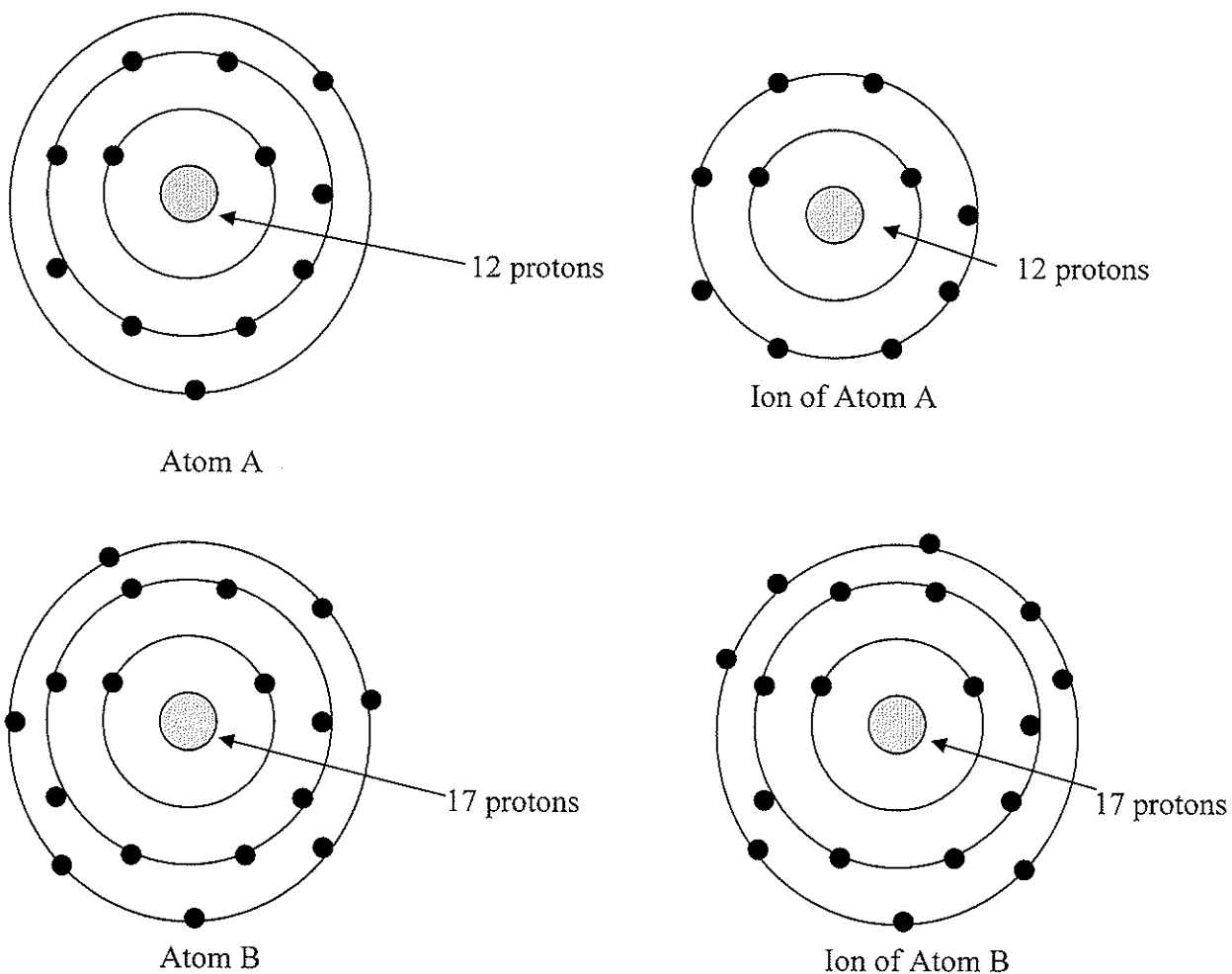
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Information: Ions

Figure 1: Below are four Bohr diagrams of atoms and ions. The two diagrams on the left are atoms; the two on the right are ions.



Critical Thinking Questions

1. Prove that both Atom A and Atom B are neutral (have a charge of zero).

$$12p - 12e = 0$$

$$17p - 17e = 0$$

2. What is the identity of Atom A and of Atom B?

Magnesium

chlorine

3. Given the above diagrams, how does an atom become an ion?

gaining or losing electrons

4. Before answering this question, note that an ion's charge must have a sign (+ or -) and a number.

- a) What is the charge on Ion A?

-2

- b) What is the charge on Ion B?

+1

5. a) How many electrons does Ion A have?

10e⁻

- b) What atom has the same number of electrons as Ion A?

Neon

6. a) How many electrons does Ion B have?

18e⁻

- b) What atom has the same number of electrons as Ion B?

Argon

7. Bromine atoms always gain one electron when they become an ion. Which atom has the same number of electrons as a bromine ion?

Krypton

8. Cesium atoms always lose one electron to become an ion. Which atom has the same number of electrons as a cesium ion?

Xenon

9. Consider your answers to questions 5-8. What do all of the atoms you named have in common?

They are all noble gases.

10. Knowing what you know about the atoms that you named in questions 5-8, why do you think atoms want to form ions the way they do?

noble gases are stable. Atoms form ions like the noble gases to become stable.

Information: Ions

As you know, all of the noble gases are very stable. Ions form in such a way so that the ion will have the same number of electrons as a noble gas. Take oxygen, for example. Oxygen has 8 electrons. To become like a noble gas it could either gain two to become like neon or it could lose six to become like helium. So what will oxygen do—gain two or lose six? **As a general rule, atoms will gain or lose the fewest number of electrons possible.**

Critical Thinking Questions

11. What does an oxygen atom do when becoming an ion? (Does it gain or lose electrons and how many?)

gain 2 e⁻

12. An oxygen atom has an overall neutral charge because it has an even number of protons and electrons. What is the overall charge on an oxygen ion?

-2

13. Consider an aluminum atom.

a) To become like argon, would aluminum have to gain or lose electrons? How many?

gain 5

b) To become like neon, would aluminum have to gain or lose electrons? How many?

lose 3

c) Considering your answers to parts a and b, what does an aluminum atom do to become an ion?

lose 3

d) What is the charge on an aluminum ion?

+3

14. When each of the following atoms becomes an ion, what will the charge be? (Your answer should include the sign and magnitude such as +1, +2, -2, etc...)

a) Ca
+2

b) Cl
-1

c) N
-3

d) K
+1

e) S
-2

f) B
+3

g) P
-3