Lewis Structures

Definition

Chemical structures in which all the electrons in the valence shells are shown as dots (..) or solid lines (—) are called Lewis structures. It shows how valence electrons are arranged among atoms in a molecule.

A Lewis structure shows the symbol of the element surrounded by a number of dots equal to the number of electrons in the outer shell of an atom of that element. In Lewis structures, the atomic symbol represents the core; that is, the nucleus and all inner shell electrons.

Example 3: Draw a Lewis structure for each compound C_2H_2.

Step 1: Arrange the atoms

H C C H

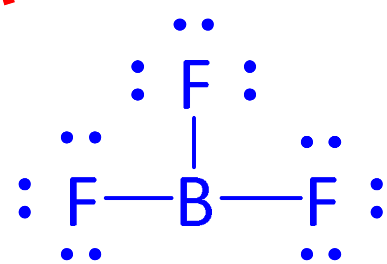
Step 2: Count the total number of valence electrons

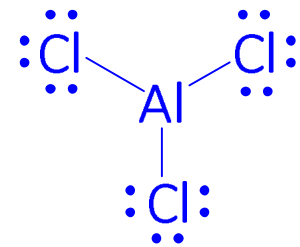
$2C \times 4e^- = 8e^-$

$\underline{2H \times 1e^- = 2e^-}$

Total $= 10e^-$

Lewis structures for BeH_2 , BF_3 and $AlCl_3$ show that these atoms have only four and six electrons, respectively, around the central atom. There is nothing we can do about this! There simply aren't enough electrons to form an octet.





4e$^-$s around Be 6e$^-$s around B 6e$^-$s around Al

There is nothing we can do about this! There simply aren't enough electrons to form an octet.

Because the Be and B atoms have less than an octet of electrons, these molecules are highly reactive.

Both carbon–oxygen bonds in the acetate anion are 127 pm in length, midway between the length of a typical C-O single (135 pm) and a typical C=O double bond (120 pm). Each oxygen atom has some negative charge.

The Lewis structure does not depict this reality.

The experimental observations for the acetate anion are better represented by a picture in which the electrons are equally distributed between the two oxygens.

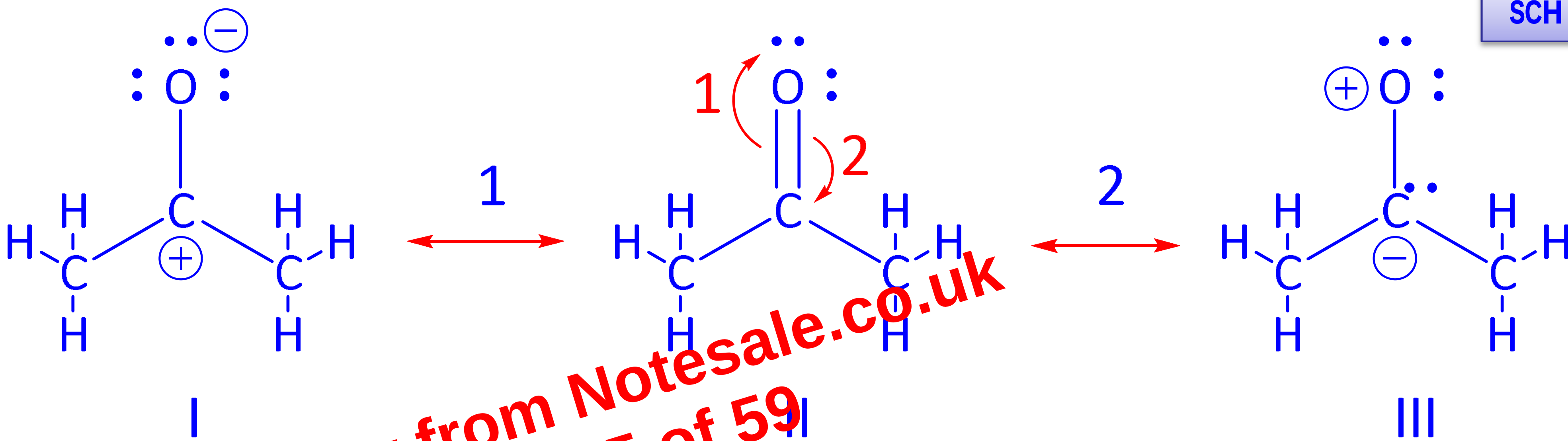
5. Resonance hybrids are more stable than any of the Lewis structures used to describe them. Molecules described by resonance structures are said to be resonance-stabilized. In other words, resonance leads to stability. Generally speaking, the larger the number of resonance forms, the more stable a substance is because its electrons are spread out over a larger part of the molecule and are closer to more nuclei.

Not all resonance structures contribute equally to a resonance hybrid. We describe four ways to predict which structure contributes more to the hybrid.

The following preferences will help you to estimate the relative importance of the various contributing structures. In fact, we can rank structures by the number of these preferences they follow. Those that follow the most preferences contribute the most to the hybrid, and any structure that violates all four of these preferences can be ignored.

Preference 4: Negative Charge on a More Electronegative Atom

Structures that carry a negative charge on a more electronegative atom contribute more than those with the negative charge on a less electronegative atom. Conversely, structures that carry a positive charge on a less electronegative atom contribute more than those that carry the positive charge on a more electronegative atom. Following are three contributing structures for acetone:



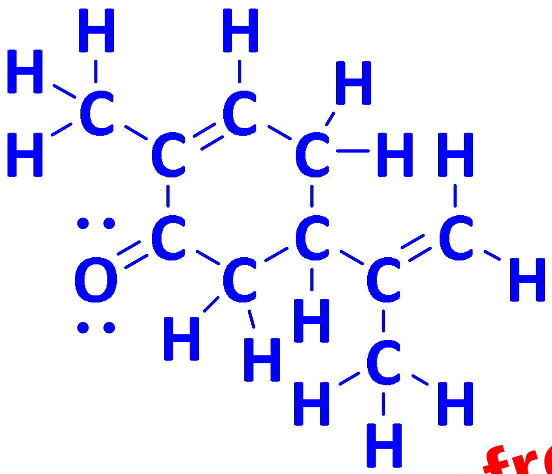
Lesser contribution

Greater contribution

Should not be drawn

Structure II makes the largest contribution to the hybrid. while I contributes less because it involves separation of charges and because carbon has an in complete octet. Nevertheless, on structure I, the more electronegative O atom has the negative charge and the less electronegative C atom has the positive charge. Structure III violates all four preference rules and should not be drawn.

Skeletal structure



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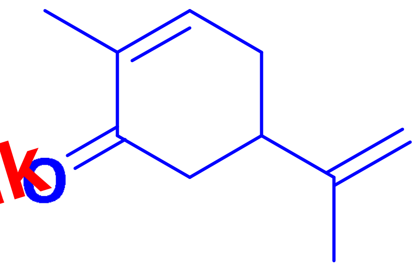

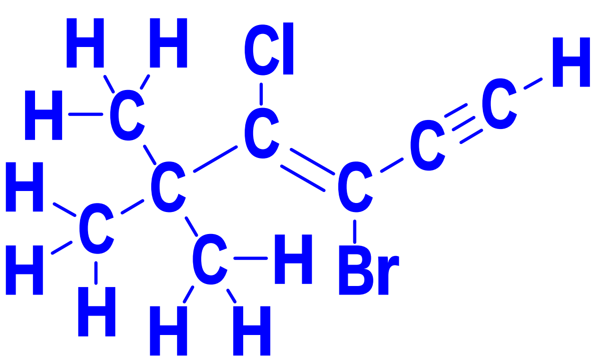

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