N3 molecular geometry

So you have seen the above image by now, right? Let me explain the above image in short. N3- (azide ion) lewis structure has three Nitrogen atoms (N). There are 2 double bonds between each Nitrogen atom (N). There are 2 lone pairs on both the outer Nitrogen atoms. There is a -1 formal charge on one of the outer Nitrogen atoms (N). If you haven't understood anything from the above image of N3- (azide ion) lewis structure, then just stick with me and you will get the detailed step by step explanation on drawing a lewis structure of N3- ion. So let's move to the steps of drawing the lewis structure of N3- ion. In order to find the total valence electrons in N3- (azide ion) ion, first of all you should know the valence electrons present in a single nitrogen atom.(Valence electrons are the electrons that are present in the outermost orbit of any atom.) Here, I'll tell you how you can easily find the valence electrons of nitrogen using a periodic table. Total valence electrons in N3- ion → Valence electrons given by nitrogen atom: Nitrogen is a group 15 element on the periodic table. [1] Hence the valence electrons present in nitrogen is 5. You can see the 5 valence electrons present in the nitrogen atom as shown in the above image. Hence, Total valence electrons in N3- ion = valence electrons given by 3 nitrogen atoms + 1 more electron is added due to 1 negative charge = 5(3) + 1 = 16. For selecting the center atom, you have to remember that the atom which is less electronegative remains at the center. Now here the given molecule is N3. All the three atoms are same, so you can select any of the atoms as a center atom. Now in the N3 molecule, you have to put the electron pairs between all three nitrogen atoms (N). This indicates that all three nitrogen (N) atoms are chemically bonded with each other in the N3 molecule. Now in this step, you have to check the stability of the outer atoms. Here in the sketch of N3 molecule, you can see that the outer atoms are nitrogen atoms only. These outer nitrogen atoms are forming an octet and hence they are stable. Also, in step 1 we have calculated the total number of valence electrons present in the N3- ion. The N3- ion has a total 16 valence electrons and all these valence electrons are used in the above sketch. Hence there are no remaining electron pairs to be kept on the central atom. So now let's proceed to the next step. In this step, you have to check whether the central Nitrogen atom (N) is stable or not. In order to check the stability of the central nitrogen (N) atom, we have to check whether it is forming an octet or not. Unfortunately, the central nitrogen atom is not forming an octet here. Nitrogen has only 4 electrons and it is unstable. Now to make this nitrogen atom stable, you have to shift the electron pair from the outer nitrogen atom so that the central nitrogen atom can have 8 electrons (i.e octet). But after shifting one electron pair, the central nitrogen atom is still not forming an octet as it has only 6 electrons. So again we have to shift one more electron pair from the other nitrogen atom. After shifting this electron pair, the central nitrogen atom will get 2 more electrons and thus its total electrons will become 8. You can see from the above picture that the central nitrogen atom is forming an octet. And hence this nitrogen atom is stable. Now let's proceed to the final step to check whether the lewis structure of N3 is stable or not. Now you have come to the final step in which you have to check the stability of lewis structure of N3. The stability of lewis structure can be checked by using a concept of formal charge. In short, now you have to find the formal charge on all the nitrogen (N) atoms present in the N3 molecule. For calculating the formal charge, you have to use the following formula; Formal charge = Valence electrons – (Bonding electrons)/2 – Nonbonding electrons You can see the number of bonding electrons and nonbonding electrons for each atom of N3 molecule in the image given below. For central Nitrogen (N) atom:Valence electrons = 5 (because nitrogen is in group 15)Bonding electrons = 8Nonbonding electrons = 0 For outer Nitrogen (N) atoms:Valence electrons = 5 (because nitrogen is in group 15)Bonding electrons = 4Nonbonding electrons = 4 Formal charge=Valence electrons–(Bonding electrons)/2–Nonbonding electronsN (central)=5–8/2–0=+1N (outer)=5–4/2–4=-1 From the above calculations of formal charge, you can see that the central nitrogen (N) atom has -1 charge and the outer nitrogen atoms has -1 charges. So let's keep these charges on the respective atoms in the N3 molecule. The +1 and -1 charge from the above sketch gets canceled and the only -1 charge remains in the above sketch, which gives -1 formal charge on the N3 molecule. This overall -1 charge on the N3 molecule is represented in the image given below. In the above lewis dot structure of N3- ion, you can also represent each bonding electron pair (:) as a single bond (|). By doing so, you will get the following lewis structure of N3- ion. I hope you have completely understood all the above steps. For more practice and better understanding, you can try other lewis structures listed below. Try (or at least See) these lewis structures for better understanding: The chemical formula N3– represents the Azide ion. The Azide ion is a conjugate base of Hydrazoic acid (HN3). It is composed of three Nitrogen atoms and can have multiple resonance structures. Azides behave similarly to halogen-based compounds in that they react rapidly with other substances by displacement of the Azide group. This process gives rise to many types of substances. One of the most common Azide-based substances is Sodium Azide (NaN3). Tons of this compound are produced annually to be used in the automobile industry (airbags), as biocides, and for organic synthesis of amine in the laboratory. Other Azides such as Pb(N3)2 (Lead Azide) are used in construction as detonators. This is because most Azides are unstable and are highly prone to shock. Most Azides can be derived from Sodium Azide. Aliphatic compounds undergo nucleophilic substitution, while acyl azides can be obtained by substitution with acyl chlorides. Azide compounds are highly toxic, with Sodium Azide being on the same level of toxicity as alkali-based cyanide compounds. They have proven to be fatal and must be handled and disposed of with care. The Lewis and corresponding resonance structures provide a good deal of information about the Azide anion's properties. Some of them are listed below: Name of the ion Azide (N3–) No. of valence electrons (5 x 3) + 1 = 16 valence electrons Hybridization of the central atom sp Bond Angles 180° Molecular Geometry of N3– Linear Molecular Geometry N3- Valence Electrons Lewis structures use valence electrons to represent chemical bonds between elements. Valence electrons are found in the outermost shells of the atom, where the force of attraction from the center is the weakest. This makes the valence electrons susceptible to excitation, and therefore, they can break away to help form chemical bonds. The Azide anion comprises three Nitrogen atoms. The valence electrons from these atoms help form the Azide anion Lewis structure. N3– comprises three Nitrogen atoms that all contribute valence electrons based on their position in the periodic table of elements. Nitrogen is in group 5 of the periodic table with the electronic configuration 1s22s22p3.Therefore, the three Nitrogen atoms contribute 5 x 3 = 15 valence electrons. Since the Azide ion is an anion, it's a negative charge of -1. This negative charge contributes one valence electron as well. Therefore, the total number of valence electrons in the Azide anion [N3–] is given by: 15[N] + 1[Neg-charge] = 16 valence electrons. N3– Lewis Structure Lewis structures are a schematic representation of molecules and their constituent chemical bonds. They help give insight into a molecule's geometry, shape, and polarity, among other data. The number of valence electrons available is the first step towards the Lewis structure. This has been discussed in the previous section. Next, a skeletal structure is arranged. The three Nitrogen atoms available are placed adjacent to one another. This is a homogenous ion with three atoms belonging to the same element. We will now start placing the valence electrons to form chemical bonds and fulfill the octet requirements. Two electrons are placed between the atoms to form the chemical bonds, as shown below. The remaining valence electrons are placed around the atoms to fill their outermost shells. The two outer Nitrogen atoms are filled. However, the central Nitrogen atom, having only four valence electrons, needs to form bonds with the adjacent atoms to attain its octet. This predicament is overcome by the formation of chemical bonds between the central Nitrogen atom and its adjacent Nitrogen atoms. This is shown below: The above arrangement is stable as all of the octet requirements have been fulfilled. The final Lewis structure is shown below: There are resonance structures that can be derived for the azide ion. These are shown below. In the above resonance structures, the presence of triple bonds and the lack of an octet present challenges to the ion's stability. A double charge on a small atom-like Nitrogen is unlikely in the case of the triple bonded resonance structures. In the latter two, the lack of an octet leads to relative instability. As such, the Lewis structure shown above with double bonds and a complete octet is the one that we shall consider. N3– Hybridization To determine the hybridization of the central atom in the Azide ion, it is pertinent that we observe its Lewis structure discussed above. The central Nitrogen atom is chemically bonded to two adjacent Nitrogen atoms through double bonds. As we've discussed the concept of electron regions earlier, we can quickly determine the hybridization from this data. Two regions are surrounding the central Nitrogen atom. Therefore, the hybridization of the Azide ion is determined to sp. N3– Bond Angles The Nitrogen atoms present will repel each other in accordance with the VSEPR theory, arranging themselves in a linear manner. This leads to bond angles of 180°. N3– Molecular Geometry Observing the Lewis structure of the compound gives us insight into the molecular geometry and electronic shape of a particular compound. The Azide Lewis structure comprises three Nitrogen atoms. The central Nitrogen atom forms two double bonds with the adjacent nitrogen atoms. According to the VSEPR theory, the atoms will repel each other to give a Linear Geometry. This can be confirmed with the A-X-N method. 'A' here represents the central atom Nitrogen. Therefore, 'A' = 1. 'X' represents the number of atoms bonded to the central atom. In this case, two more Nitrogen atoms are bonded to the central nitrogen atom. Therefore, X =2. 'N' represents the number of lone pairs attached to the central atom. In this case, N = 0 as there are no lone pairs. Therefore, that would give us AX2 for the Azide ion (N3–) From the A-X-N table below, we can determine the molecular geometry for N3–. Formula Shape Bond Angle (Theoretical) AX2 Linear 180 AX3 Trigonal Planar 120 AX4 Tetrahedral 109.5 AX5 Trigonal Bipyrimidal 120, 90 AX6 Octahedral 90 AX2N Bent 120 AX2N2 Bent 109.5 From the above table, it can be observed that an AX2 arrangement corresponds to a Linear Molecular geometry. CONCLUDING REMARKS Let's quickly summarize the salient features of N3– The N3– ion comprises three atoms, with all of them being Nitrogen. One of the Nitrogen atoms takes its place in the center. The central Nitrogen atom forms double bonds with its neighbors in order to attain its octet. The hybridization of the Azide ion is sp. N3- has a Linear molecular geometry. This results in bond angles of 180°. We draw Lewis Structures to predict: -the shape of a molecule. -the reactivity of a molecule and how it might interact with other molecules. -the physical properties of a molecule such as boiling point, surface tension, etc. Video: Drawing the Lewis Structure for N3- In the Lewis Structure for N3- you'll need to place a double bonds between the Nitrogen atoms to achieve full outer shells on all atoms while only using the valence electrons available for the molecule. For the N3- Lewis structure, calculate the total number of valence electrons for the N3- molecule. After determining how many valence electrons there are in N3- , place them around the central atom to complete the octets. Be sure to use the number of available valence electrons you found earlier. There are 16 valence electrons for the Lewis structure for N3-. You should take formal charges into account with the Lewis structure for N3- to find the best structure for the molecule. Also note that you should put the N3- Lewis structure in brackets with as 1- on the outside to show that it is an ion with a negative one charge. It is helpful if you: Try to draw the N3- Lewis structure before watching the video. Watch the video and see if you missed any steps or information. Try structures similar to N3- for more practice. List of Lewis Structures I'm super excited to teach you the lewis structure of N3- ion in just 6 simple steps.Infact, I've also given the step-by-step images for drawing the lewis dot structure of N3- ion.So, if you are ready to go with these 6 simple steps, then let's dive right into it! Lewis structure of N3- ion (azide ion) contains two single bonds between each Nitrogen (N) atom. The central nitrogen atom does not have lone pairs, while the outer nitrogen atoms have 2 lone pairs. Let's draw and understand this lewis dot structure step by step. (Note: Take a pen and paper with you and try to draw this lewis structure along with me. I am sure you will definitely learn how to draw lewis structure of N3- ion). Here, the given ion is N3- ion (azide ion). In order to draw the lewis structure of N3- ion, first of all you have to find the total number of valence electrons present in the N3- ion.(Valence electrons are the number of electrons present in the outermost shell of an atom). So, let's calculate this first. Calculation of valence electrons in N3- Nitrogen is a group 15 element on the periodic table. [1] Hence, the valence electrons present in nitrogen is 5 (see below image). Hence in a N3– ion, Valence electrons given by each Nitrogen (N) atom = 5Electron due to -1 charge, 1 more electron is addedSo, total number of Valence electrons in N3– ion = 5(3) + 1 = 16 While selecting the atom, you have to put the least electronegative atom at the center. But here in the N3- ion, all the three atoms are the same. So you can consider any of the atoms as a center atom. Now in the above sketch of N3 molecule, put the two electrons (i.e electron pair) between these three nitrogen atoms to represent a chemical bond between them. These pair of electrons present between the Nitrogen (N) atoms form a chemical bond, which bonds the nitrogen atoms with each other in an N3 molecule. Don't worry, I'll explain! In the Lewis structure of N3, the outer atoms are nitrogen atoms only. So now, you have to complete the octet on these outer nitrogen atoms (because nitrogen requires 8 electrons to have a complete outer shell). Now, you can see in the above image that both the nitrogen atoms form an octet. Also, all the 8 valence electrons of N3- ion (as calculated in step #1) are used in the above structure. So there are no remaining electron pairs. Hence there is no change in the above sketch of N3. Let's move to the next step. In this step, we have to check whether the central atom (i.e central nitrogen) has an octet or not. In simple words, we have to check whether the central Nitrogen (N) atom has 8 electrons or not. As you can see from the above image, the central nitrogen atom has only 4 electrons. So it does not fulfill the octet rule. Now, in order to fulfill the octet of central nitrogen atom, we have to move the electron pair from the outer nitrogen atom to form a double bond. Still, the octet of central nitrogen atom is not fulfilled as it has only 6 electrons. So again moving the electron pair from another nitrogen atom, we will get the following structure. Now you can see from the above image that the central nitrogen atom is having 8 electrons. So it fulfills the octet rule and the nitrogen atom is stable. Now, you have come to the final step and here you have to check the formal charge on each nitrogen atom (N). For that, you need to remember the formula of formal charge; Formal charge = Valence electrons – Nonbonding electrons – (Bonding electrons)/2 For central Nitrogen: Valence electron = 5 (as it is in group 15)Nonbonding electrons = 0Bonding electrons = 8 For outer Nitrogens: Valence electron = 5 (as it is in group 15)Nonbonding electrons = 4Bonding electrons = 4 Formal charge=Valence electrons–Nonbonding electrons–(Bonding electrons)/2Central N=5–0–8/2=+1Outer N=5–4–4/2=-1 Let's keep these charges on the atoms in the above lewis structure of N3 molecule. As you can see in the above sketch, there are still +1 and -1 charges on the Nitrogen atoms. The pair of positive and negative charges gets canceled. So, there is only one -ve charge left on the nitrogen atom, which indicates the -1 formal charge on the N3- ion. Each electron pair (:) in the lewis dot structure of N3- ion represents the single bond (|). So the above lewis dot structure of N3- ion can also be represented as shown below. Related lewis structures for your practice:Lewis structure of BH3Lewis structure of C2H6Lewis structure of COCl2Lewis structure of BrF5Lewis structure of NCl3 Article by; Jay RanaJay is an educator and has helped more than 100,000 students in their studies by providing simple and easy explanations on different science-related topics. With a desire to make learning accessible for everyone, he founded Knords Learning, an online learning platform that provides students with easily understandable explanations. Read more about our Editorial process. The information on this page is ✔ fact-checked. N3– Lewis structure | Image: Learnool N3– (azide) has three nitrogen atoms. In the N3– Lewis structure, there are two double bonds around the nitrogen atom, with two other nitrogen atoms attached to it, and on the left and right nitrogen atoms, there are two lone pairs. Also, there is a negative (-1) charge on the left and right nitrogen atoms, and a positive (+1) charge on the center nitrogen atom. Alternative method: Lewis structure of N3– To properly draw the N3– Lewis structure, follow these steps: #1 Draw a rough sketch of the structure#2 Next, indicate lone pairs on the atoms#3 Indicate formal charges on the atoms, if necessary#4 Minimize formal charges by converting lone pairs of the atoms#5 Repeat step 4 if necessary, until all charges are minimized Let's break down each step in more detail. First, determine the total number of valence electrons Periodic table | Image: Learnool In the periodic table, nitrogen lies in group 15. Hence, nitrogen has five valence electrons. Since N3– has three nitrogen atoms, so… Valence electrons of three nitrogen atoms = 5 × 3 = 15 Now the N3– has a negative (-1) charge, so we have to add one more electron. So the total valence electrons = 15 + 1 = 16 Learn how to find: Nitrogen valence electrons Second, find the total electron pairs We have a total of 16 valence electrons. And when we divide this value by two, we get the value of total electron pairs. Total electron pairs = total valence electrons ÷ 2 So the total electron pairs = 16 ÷ 2 = 8 Third, determine the central atom Here, there are three atoms and all atoms are nitrogen, so we can assume any one as the central atom. Let's assume that the central atom is center nitrogen. And finally, draw the rough sketch Rough sketch of N3– Lewis structure | Image: Learnool Here, we have a total of 8 electron pairs. And two N — N bonds are already marked. So we have to only mark the remaining six electron pairs as lone pairs on the sketch. Also remember that nitrogen is a period 2 element, so it can not keep more than 8 electrons in its last shell. Always start to mark the lone pairs from outside atoms. Here, the outside atoms are left nitrogen and right nitrogen. So for left nitrogen and right nitrogen, there are three lone pairs, and for canter nitrogen, there is zero lone pair because all six electron pairs are over. Mark the lone pairs on the sketch as follows: Lone pairs marked on N3– Lewis structure | Image: Learnool Use the following formula to calculate the formal charges on atoms: Formal charge = valence electrons – nonbonding electrons – ½ bonding electrons For left nitrogen and right nitrogen atom, formal charge = 5 – 6 – ½ (2) = -2 For center nitrogen atom, formal charge = 5 – 0 – ½ (4) = +3 Here, all nitrogen atoms have charges, so mark them on the sketch as follows: Formal charges marked on N3– Lewis structure | Image: Learnool The above structure is not a stable Lewis structure because all nitrogen atoms have charges. Therefore, reduce the charges (as below) by converting lone pairs to bonds. Convert a lone pair of the left nitrogen atom to make a new N — N bond with the center nitrogen atom as follows: Lone pair of left nitrogen is converted, but still there are charges | Image: Learnool Since there are charges on nitrogen atoms, again convert a lone pair of the right nitrogen atom to make a new N — N bond with the center nitrogen atom as follows: Lone pair of right nitrogen is converted, and got the most stable Lewis structure of N3– | Image: Learnool In the above structure, you can see that the central atom (center nitrogen) forms an octet. And the outside atoms (left nitrogen and right nitrogen) also form an octet. Hence, the octet rule is satisfied. Now there are still charges on the atoms. This is okay, because the structure with a negative charge on the most electronegative atom is the best Lewis structure. And in this case, the most electronegative element is nitrogen. Therefore, this structure is the most stable Lewis structure of N3–. And since the N3– has a negative (-1) charge, mention that charge on the Lewis structure by drawing brackets as follows: N3– Lewis structure showing a negative (-1) charge | Image: Learnool Next: BH3 Lewis structure Your feedback matters. Visit our contact page.