ANSWERS: Describing and explaining shapes of molecules

2023



2022



2021



2020



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| **2019** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | Bond angle is determined by the number of electron density regions around the central atom, which are arranged into a position to minimise repulsion by having maximum separation.All molecules have 4 electron density regions / areas of negative charge around the central atom which arrange with maximum separation into a tetrahedral shape /geometry with a bond angle of (approx.) 109.5° / 109°.In CH4 all of the electron pairs are bonded, and so the shape of the molecule is also tetrahedral.In NCl3 three of the electron pairs are bonded and one is non-bonding. The observed shape of the molecule is trigonal pyramidal.In OF2, due to the presence of two non-bonding pairs of electrons / regions (or two bonding regions) on the central atom, OF2 has an observed shape that is bent / v-shaped / angular. | • Identifies the 4 regions of negative charge for eachmolecule.ORIdentifies the bonding and nonbonding pairs for onemolecule.• Recognises that electrons density regions are arrangedin a position of maximum separation / minimal repulsion. | • Links number of areas of negative charge (including bonding / nonbonding) around the central atom to the shape of TWO molecules usingminimise repulsion / maximum separation.ORLinks four regions on the central atom for two or more molecules to a bond angle of 109.5° using minimise repulsion / maximum separation. | • Justifies the shape of all molecules byreferring to allfactors that influence shape and bondangle. |

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| **2018** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | NH3 has four electron clouds / regions of negative charge around its central N atom. As the electron clouds maximise separation to minimise repulsion they take a tetrahedral geometry with a bond angle of 109.5º. Three of the regions are bonded and one is non-bonded, so the overall shape is trigonal pyramid.In contrast, BF3 only has three regions of negative charge around its central B atom. As the electron clouds maximise separation to minimise repulsion they take a trigonal planar geometry with the bond angle of 120º. While BF3 has three bonded regions like NH3, because there is no non-bonding regions BF3’s shape is trigonal planar.So although both molecules have three bonded areas to the central atom, ammonia has a fourth region of negative charge, which is not bonded. This affects its angle and shape. | • Identifies the numbers of electron clouds / areas ofnegative charge forONE molecules.ORIdentifies nonbonding/ bonding pairs of electrons for ONE molecule. | • Links areas of negative charge around the centralatom minimizing repulsion to bond angles for ONEmolecule. | • Compares and contrasts bond angle and shapes of BOTH molecules by referringto electron repulsion, areas of negative charge and bonding /nonbonding electron pairs. |

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| **2017** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | Bond angle is determined by the number of electron density regions around the central atom,which are arranged into a position to minimise repulsion / are arranged as far apart fromeach other as possible (maximum separation).HOCl has 4 electron density regions / areas of negative charge around the central O atom.This means the electron density regions around the central atom is arranged with maximumseparation in a tetrahedral shape with a bond angle of 109.5**°,** to minimise (electronelectron)repulsion. Due to the presence of two non-bonding pairs of electrons / regions (or two bonding regions) on the central O atom, HOCl has an actual shape that is bent / vshaped / angular.COCl2 has only 3 electron density regions / areas of negative charge around its central C atom so the electron density regions around the central atom is arranged with maximum separation in a trigonal planar shape with a bond angle of 120°, to minimise (electron-electron) repulsion. Since COCl2 has only bonding electron pairs (no non-bonding pairs) on its central atom, the actual shape is trigonal planar (with bond angles of 120°). | Two Lewis structures (electron dot diagrams) correctANDTwo shapes correct.Identifies the numbers of electron density regions / electron clouds / regions ofnegative charge around the central atoms for ONEmolecule.ORIdentifies non-bonding pairs and bonding pairs of electrons on the central atoms for ONE molecule. | Links areas of negative charge around the centralatom to **minimise**repulsion (maximumseparation) and bondangle OR shape for ONE molecule. | Justifies the correctbond angle and shapes of BOTH molecules by linking electron density regions around the central atom to bond angles and shape. |

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| **2016** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | Electrical conductivity depends on the presence of charged particles that are free to move.Graphite is a covalent network substance made up of carbon atoms covalently bonded to 3 other carbon atoms. This leaves one valence non-bonded / delocalised electron from each carbon atom. These electrons are free to move and so graphite is able to conduct electricity.ZnCl2 is an ionic compound that cannot conduct electricity when solid because the ions (charged particles) are fixed in place in a 3D lattice structure and unable to move. When molten, the ionic bonds between the ions break, so the ions are free to move in the molten liquid. With charged particles / ions free to move, ZnCl2 can then conduct electricity. | * Identifies that charged particles which are **free to move** are required for electrical conductivity.
* Identifies ZnCl2(*s*) as not having ions / charges particles that are **free to move**

ORidentifies ZnCl2(*l*) does have ions / charged particles that are **free to move** OR Identifies C(*s*) does have  electrons / charged particles that  are **free to move**. | * Explains conductivity by linking particles, structures, and bonding to either the conductivity of C (graphite)

OR ZnCl2 in both solid and liquid (molten) states. | * Justifies conductivity by relating particles, structures, and bonding to the conductivity of C (graphite)

AND ZnCl2 in both solid and liquid  (molten) states. |

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| **2015** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | In each CCl4 molecule, there are four negative / electron : densities / clouds / regions around the central C atom. These repel each other / are positioned as far away from each other as possible in a tetrahedral (base) arrangement, resulting in a 109.5o bond angle. All of these regions of electrons / electron densities are bonding, without any non-bonding regions, so the shape of the molecule is tetrahedral.In each COCl2 molecule, there are three negative / electron : densities / clouds / regions around the central C atom. These repel / are positioned as far away from each other as possible in a triangular / trigonal planar (base) shape, resulting in a 120° bond angle.All of these regions of electrons / electron densities are bonding, without any non-bonding regions, so the shape of the molecule is trigonal planar. | * One shape with matching bond angle correct.

ORCorrectly identifies the number of electron densities surrounding the central atom of one molecule.OR States that the shape of the  molecule is determined by the  repulsion between regions of  electron density around the  central atom.  | * Links the shape of both molecules to the electron arrangement around the central atom.

ORLinks the bond angles in BOTH molecules to the electron arrangement around the central atom.OR  Complete answer for CCl4 or  COCl2. | Evaluates the arrangement of electron densities around the central atom of BOTH molecules in order to correctly explain the shapes and bond angles. |

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| **2014** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | The bond angle ***x*** is approx. 120° and bond angle ***y*** is approx. 109.5°.The B atom has three regions of electron density around it. These are all bonding regions. The regions of electron density are arranged to minimise repulsion / are arranged as far apart as possible from each other. (This is why the bond angle is 120°.)The O atom has four regions of electron density around it. The regions of electron density are arranged to minimise repulsion / are arranged as far apart as possible from each other in a tetrahedral arrangement / two of these are bonding (and two are non-bonding). This is why the bond angle is 109.5°. | * One bond angle correct.

States the number of regions of electron density around the B atom or the O atom. | For ONE atom, the (stated) number of regions of electron density are arranged to minimise repulsion / are arranged as far as possible linked to the bond angle. | * The arrangement of the electron density around the central atoms is used to justify the shapes and bond angles for both molecules.
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| **2013** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | BF3: trigonal planar: 120° bond angles.PF3: trigonal pyramidal; ≈ / < 109.5° (107°).Shape is determined by the number of regions of electron density / electron clouds and whether they are bonding / non-bonding.BF3 has three regions of electron density / electron clouds around the central B atom. The regions of electrons are arranged as far apart as possible from each other / to minimise repulsion, which results in a trigonal planar arrangement with a bond angle of 120°. All three regions of electrons are bonding, so the overall shape is trigonal planar.PF3 has four regions of electron density / electron clouds around the central P atom. The regions of electrons make a tetrahedral arrangement with a bond angle of 109.5°. Only three regions of electrons are bonding and one is non-bonding, so the overall shape is trigonal pyramidal. *The non-bonding electrons have increased repulsion, therefore decreasing the bond angle to < 109.5*° | * TWO shapes correct.
* TWO bond angles correct.
 | * the arrangement of electrons around the central atom is used to explain the **shape** of the molecule.
* the arrangement of electrons around the central atom is used to explain the **bond angle**.
 | the arrangement of the electron density / electron clouds around the central atom is used to explain the shapes and angles of the molecules. Includes a comparison of the different shape and bond angles. |

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| **2012** | **Evidence** | **Achievement** | **Merit** | **Excellence** |
|  | The central atom in SO2 has three regions of electron density/electron clouds around it. The regions of electrons are arranged as far apart as possible from each other (in order to minimise repulsion) making a trigonal planar shape. This gives a bond angle of 120°. Only two of these regions of electrons are bonding and one is non-bonding so the shape of the molecule is **V-shaped (bent).** The central atom of H2CO, has three regions of electron density around it. The regions of electrons making a trigonal planar shape, giving a bond angle of 120°. All three of these regions of electrons are bonding so the arrangement of the bonds/molecular shape is **trigonal planar**. | * In (b) ONE shape correct.
* States that 120° means there are three regions of electron density around the central atom.
* States shape of molecule is determined by regions of electron density around the central atom.
 | * In (b) the arrangement of electrons around the central atom is used to explain the shape of both molecules.
* In (b) the arrangement of electrons around the central atom is used to explain the bond angle of both molecules.
 | * In (b) the arrangement of the electron density around the central atom is used to explain the shapes and angles of the molecules. Includes a comparison of the different shape but same bond angle.
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