483
version

last name

first name

signature

McCord CH301
50070

Exam 3

Oct 26, 2017
Thursday

Remember to refer to the Periodic Table handout that is separate from this exam copy.

NOTE: Please keep this exam copy intact (all pages still stapled - including this cover page). You must turn in ALL the materials that were distributed. This means that you turn in your exam copy (name and signature included), bubble sheet, periodic table handout, and all scratch paper. Please also have your UT ID card ready to show as well.

This print-out should have 20 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

001 5.0 points

In an acceptable Lewis structure for NO_3^-, what is the formal charge on the central atom?

1. -1

2. +2

3. -2

4. 0

5. +1 **correct**

6. None of the above

Explanation:

Formal charge can be expressed with the following basic formula:

$$\text{F.C.} = \text{V.E.} - (\text{Bonds} + \text{L.E.})$$

The nitrogen has no lone pairs and is connected to 4 bonds total, resulting in a formal charge of +1.

002 5.0 points

When a molecule or ion is shown via resonance structures, the proposed structures

I. can have any formal charge on the individual atoms as long as the formal charge of the molecule is less than 2

II. should be averaged to best depict the bonding

III. depict the physical vibrations of the bonds

IV. show the various bonding extremes that resonate back and forth

1. I, II, III and IV

2. II only **correct**

3. I and II only

4. II and III only

5. None of the above

6. I and IV only

7. II and IV only

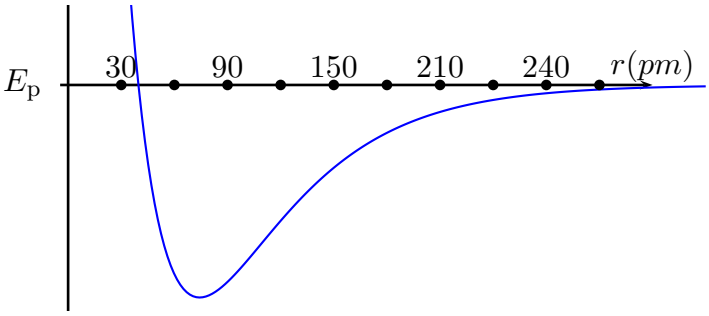
8. IV only

Explanation:

The numerous resonance structures represent the set of bonding extremes of which the average is the best indication of the actual bonding. To create an acceptable resonance structure, you must ensure that all atoms have a formal charge less than 2.

003 5.0 points

Consider the following potential energy (E_p) vs internuclear distance (r) plot for the interaction between two hydrogen atoms.



What will happen if you place two hydrogen atoms at an internuclear distance of 115 pm?

1. Attractions will dominate until the internuclear radius is equal to 0

2. There will be no attractions or repulsions at this distance

3. Attractions will dominate until potential energy is minimized **correct**

4. Repulsions will dominate until potential energy is minimized

5. Repulsions will dominate until the internuclear radius is infinite

6. Attractions will dominate until potential energy is zero

Explanation:
The bond length (minimum potential energy) is equal to about 75 pm. At any distance greater than 75 pm, attractions will dominate to reach minimum potential energy. At any distance less than 75 pm, repulsions will dominate to reach minimum potential energy.

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004 5.0 points

The lattice energy for NH_4OH is given by which reaction?

1. $2NH_4OH(s) \rightarrow 2NH_4(g) + O_2(g) + H_2(g)$

2. $NH_4OH(s) \rightarrow NH_4^+(g) + OH^-(g)$ **correct**

3. $2NH_4OH(s) \rightarrow N_2(g) + 4H_2(g) + H_2O(g)$

4. $NH_4OH(s) \rightarrow NH_4(g) + OH(g)$

5. $NH_4OH(s) \rightarrow N^{3+}(g) + 5H^+(g) + O^{2-}(g)$

Explanation:
The lattice energy is the energy needed to overcome the ionic bond (and only the ionic bond) of an ionic compound. Therefore, the reaction is $NH_4OH(s) \rightarrow NH_4^+(g) + OH^-(g)$.

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005 5.0 points

Rank the following ionic compounds from least to greatest lattice energy:

$MgCl_2$, CaO, $CaCO_3$, NaCl

1. $CaO < NaCl < MgCl_2 < CaCO_3$

2. $CaCO_3 < MgCl_2 < CaO < NaCl$

3. $NaCl < MgCl_2 < CaCO_3 < CaO$ **correct**

4. $CaCO_3 < MgCl_2 < NaCl < CaO$

5. $NaCl < MgCl_2 < CaO < CaCO_3$

Explanation:
Lattice energy depends on charge and ionic radius. Rank first based on a charge so that the largest charges have the highest lattice energy. The smallest lattice energy in the list is NaCl and the highest lattice energy is CaO. If two compounds have the same charges, the highest lattice energy will be the smaller ionic compound. This gives a final answer of:

$NaCl < MgCl_2 < CaCO_3 < CaO$

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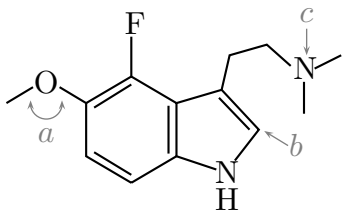
006 (part 1 of 3) 5.0 points

The molecule shown below is a rare alkaloid found in plants native to South America with profound cultural significance.



What is the correct empirical formula for this compound?

1. $C_{15}H_{17}FN_2O$

2. $C_{13}H_{12}FN_2O$

3. $C_{12}H_{15}FN_2O$

4. $C_{13}H_{17}FN_2O$ **correct**

5. $C_{13}H_{19}FN_2O$

6. $C_{13}H_{19}N_2O$

Explanation:
The empirical formula is $C_{13}H_{17}FN_2O$.

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007 (part 2 of 3) 5.0 points

Which of the following best represents the bond angle labeled a?

1. 104.5° **correct**

2. 120°

3. 109.5°

4. 118°

5. 90°

6. 180°

7. 178°

Explanation:
There are two (not shown) lone pairs on the O there which means there are 4 electron regions and therefore a tetrahedral electronic geometry which has a bond angle of 109.5°. The lone pairs are more repulsive than the bonding pairs and therefore pushes the angles down to about 104.5°.

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008 (part 3 of 3) 5.0 points

What is the electronic geometry around the central atom labeled *b*?

1. Trigonal planar **correct**

2. Seesaw

3. Bent

4. Trigonal pyramid

5. Tetrahedral

Explanation:
In the line drawing, *b* has an understood hydrogen atom attached, giving the carbon a trigonal planar structure. The nitrogen labeled *c* has an understood lone pair, which gives it a tetrahedral electronic geometry.

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009 5.0 points

What are the bond angles around the central atom of CF_4?

1. 180°

2. 109.5° **correct**

3. 135°

4. 120°

5. 90°

6. 109°

Explanation:
The structure of CF_4 has four bonds around carbon, resulting in a tetrahedral electronic geometry. The bond angles are 109.5 degrees.

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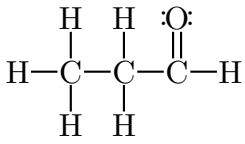
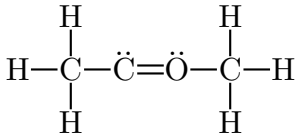
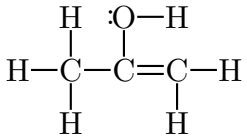
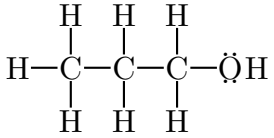
010 5.0 points

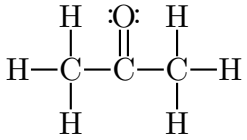
Which of the following choices is the correct line structure for propionaldehyde, CH_3CH_2CHO?

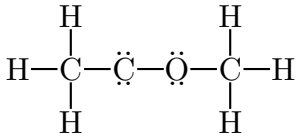
1.  **correct**

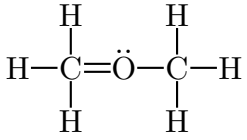
2. 

3. 

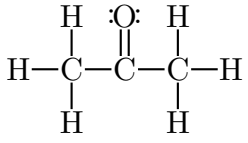
4. 

5. 

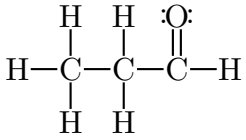
6. 

7. 

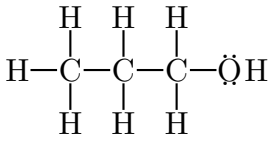
Explanation:

Acetone: 

Propionaldehyde:



Propanol:



011 5.0 points

Consider the following molecules:

CO, CO_2, CO_3^{2-}

Which molecule has the strongest covalent bonds?

1. All carbon-oxygen bonds have the same strength bonds

2. CO_3^{2-}

3. CO_2

4. Both CO_3^{2-} and CO_2 have the strongest bonds

5. CO **correct**

Explanation:

Carbon monoxide contains a triple bond between carbon and oxygen. Carbon dioxide contains a double bond between the carbon and oxygen atoms. Carbonate is a resonance structure that contains a double bond and two single bonds. Averaged, this results in approximate 1.33 bonds between the carbon and oxygen atoms. Therefore, carbon monoxide has the strongest and shortest bonds. Carbonate has the weakest and longest bonds.

012 5.0 points

Ozone (O_3) is...

1. a non-polar molecule with polar bonds.

2. a polar molecule with polar bonds.

3. a polar molecule with non-polar bonds. **correct**

4. a polar molecule with both polar and non-polar bonds.

5. a non-polar molecule with non-polar bonds.

6. a non-polar molecule with both polar and non-polar bonds.

Explanation:

Ozone is only oxygen, so all the bonds are non-polar. However, the molecule itself is bent with lone pairs that contribute to the asymmetry (and therefore polarity) of the overall molecule.

013 5.0 points

Which of the following molecules is non-polar?

1. CH_3Cl

2. BeF_2 **correct**

3. NH_3

4. H_2O

5. PCl_3

Explanation:

BeF_2 has polar bonds, but they are canceled out by its symmetric molecular and electronic structure.

014 (part 1 of 3) 5.0 points

For the next three questions, classify the bonds according to their relative difference in electronegativity.

HCl contains a(n)...

1. Nonpolar covalent bond

2. Polar covalent bond **correct**

3. Ionic bond

Explanation:

HCl is a polar covalent bond.

015 (part 2 of 3) 5.0 points

Ag_2CO_3 contains...

1. Only polar covalent bonds

2. Ionic and polar covalent bonds **correct**

3. Nonpolar and polar covalent bonds

4. Only ionic bonds

5. Ionic and nonpolar covalent bonds

Explanation:

Ag_2CO_3 is an ionic molecule. However, there is also a polyatomic ion with a polar covalent bonds.

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016 (part 3 of 3) 5.0 points

Cl_2 contains a(n)...

1. Polar covalent bond

2. Nonpolar covalent bond **correct**

3. Ionic bond

Explanation:

Cl_2 contains only a nonpolar covalent bond with a difference of electronegativity equal to zero.

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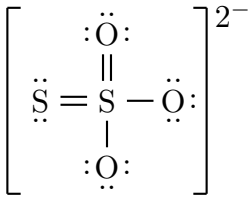
017 5.0 points

Consider the Lewis Structure drawn below:



Is this an acceptable structure for thiosulfate ($S_2O_3^{2-}$)? If not, choose the answer that best explains why this is an unacceptable drawing.

1. This is not an acceptable structure because the formal charge on the atoms does not add up to the formal charge of the polyatomic ion

2. This is not an acceptable structure because it has the wrong number of electrons

3. This is not an acceptable structure because at least one atom disobeys the octet rule

4. This structure is unacceptable because of ALL reasons listed (formal charge, number of electrons, AND the octet rule are violated) **correct**

5. This is an acceptable structure

Explanation:

Considering the top oxygen, we can see that the octet rule is violated. The total charge on the molecule adds up to negative four. The structure uses two electrons more than are available. Therefore, this structure is unacceptable, and violates all rules listed.

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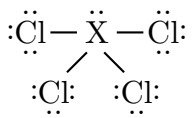
018 5.0 points

Consider the following molecule:



What is the identify of the central atom, X?

1. Oxygen

2. Selenium **correct**

3. Chlorine

4. Nitrogen

5. Carbon

6. Phosphorus

Explanation:

The molecule shown has a central atom with a formal charge equal to 0. You can solve for the valence using the formula:

$$\text{F.C.} = \text{V.E.} - (\text{Bonds} + \text{L.E.})$$

$$0 = \text{V.E.} - 6$$

Therefore, your central atom must be in group 6. It is also exhibiting expanded valence, meaning it must be at least a 3rd period element. X = Selenium.

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019 5.0 points

What is the electronic geometry of the polyatomic ion IF_4^-?

1. Octahedral **correct**

2. Tetrahedral

3. T-shaped

4. Square pyramid

5. Square planar

6. None of the above

7. Linear

8. Trigonal bipyramid

Explanation:

The structure of IF_4^- has four bonding regions and two lone pairs. This corresponds to an octahedral geometry.

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020 5.0 points

VSEPR theory can estimate imperfect bond angles based on the fact that

1. bonding regions attract each other while lone pair regions repel each other

2. lone pair regions are more repulsive than bonding regions **correct**

3. molecular orbitals hybridize

4. bonding regions are more repulsive than lone pair regions

Explanation:

Lone pair regions on the central atom are pulled closer toward the nucleus. Therefore, the repulsive forces are stronger than in a bonding region. This causes bond angles to be slightly less than predicted by the electronic geometry. Molecular orbitals do hybridize, but this is not an explanation for why a molecule will form imperfect bond angles.