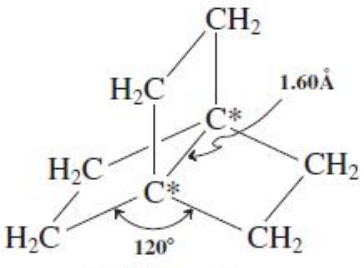
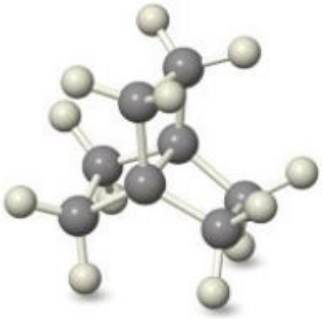
1. The unusual molecule [2.2.2] propellane is shown below. On the basis of the given structural parameters, what hybridization scheme best describes the carbons marked by asterisks? What types of orbitals are used in the bond between them? Would you expect this bond to be stronger or weaker than an ordinary C-C single bond? Also draw a MO diagram using hybrid atomic orbitals which describes the bonding of the carbons marked by asterisks.

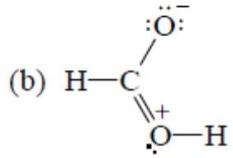


[2.2.2]Propellane



2. Write other contributing structures for each of the following. Use curved arrows to show how to transform the original Lewis formula to the new one. Be sure to specify formal charges, if any. Also specify which is the most stable resonance structure in each case.

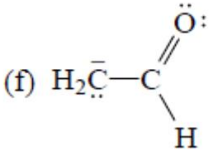
(a) $H_3C-\ddot{N}=\overset{+}{N}:$

(b) 

(c) $H_2\overset{+}{C}-\overset{-}{C}H_2$

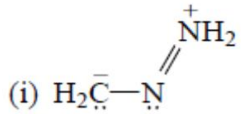
(d) $H_2\overset{+}{C}-CH=CH-\overset{-}{C}H_2$

(e) $H_2\overset{+}{C}-CH=CH-\ddot{O}:^-$

(f) 

(g) $H-\overset{+}{C}=\ddot{O}:$

(h) $H_2\overset{+}{C}-\ddot{O}H$

(i) 

3. In each of the following pairs, determine whether the two represent resonance contributors of a single species or depict different substances. If two structures are not resonance contributors, explain why.

(a) $:\ddot{N}-N\equiv N:$ and $:N=N=N:$

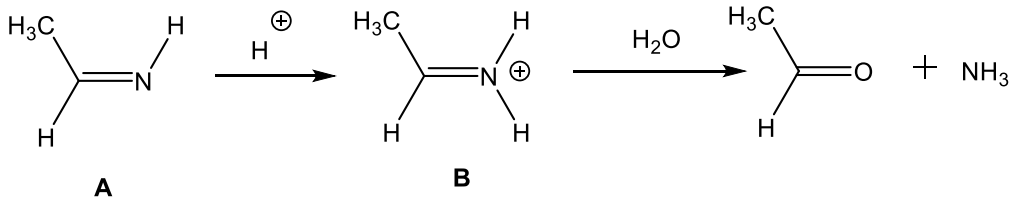
(b) $:\ddot{N}-N\equiv N:$ and $:\ddot{N}-N=\ddot{N}:$

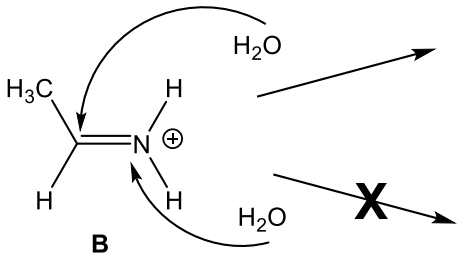
(c) $:\ddot{N}-N\equiv N:$ and $:\ddot{N}-\ddot{N}-\ddot{N}:$

4. Imines are well known derivatives of carbonyl compounds (aldehydes and ketones). Imines are prone to undergo hydrolysis under acidic conditions to produce the parent carbonyl compound as shown below for imine **A**. Based on the MO argument, answer the following questions:

a) Why does the protonation happen on nitrogen when **A** is converted to iminium ion **B**? Which MO is involved?

b) In the hydrolysis of the iminium ion **B**, the first step is the nucleophilic attack of H_2O. Why does the attack take place at the carbon atom rather than at the nitrogen atom although the latter is actually holding a positive formal charge? Explain based on the relevant MO of the iminium ion. Draw a schematic of this MO.





5. In the following structure, what is the hybridization of N1 and N2 atoms? If the molecule is protonated, where does the proton go? N1 or N2? Explain based on valence bond theory.