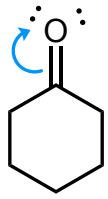
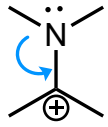
Resonance

1A. **Draw the resonance contributor** indicated by the curved-arrows shown.

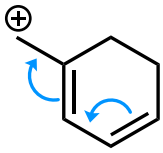
B. Based on your understanding of how to assess the stability of Lewis structures, determine which resonance structure is more stable or if they are equal in stability.



resonance contributor 1 ⟷ **resonance contributor 2**



resonance contributor 1 ⟷ **resonance contributor 2**



resonance contributor 1 ⟷ **resonance contributor 2**

Recall how we assess the relative stability of Lewis structure (in order or priority)

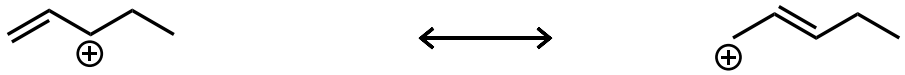
1. Lewis structures containing atoms that all have full valence shells ($8e^{1-}$, closed-shell) are more stable than those than have atoms with less than $8e^{1-}$ (open-shell)

2. Structures that without any formal charges are more stable than those containing charged atoms

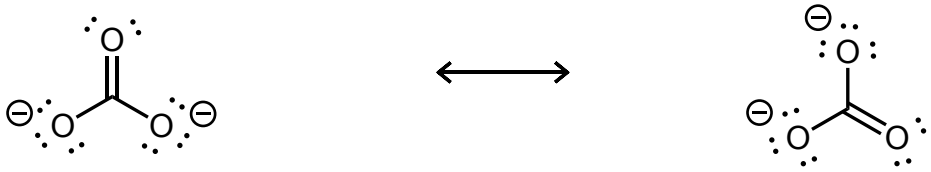
3. When placing formal charges on atoms in a structure, placing negative charges on electronegative atoms (and positive charges not on electronegative atoms) provides a more stable structure

2A. **Draw the missing curved arrow(s)** on resonance contributor 1 that are required to convert it to resonance contributor 2.

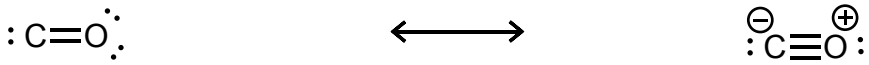
B. Based on your understanding of how to assess the stability of Lewis structures, determine which resonance structure is more stable or if they are equal in stability.



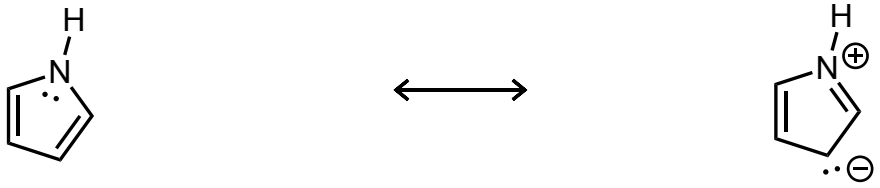
resonance contributor 1 **resonance contributor 2**



resonance contributor 1 **resonance contributor 2**



resonance contributor 1 **resonance contributor 2**



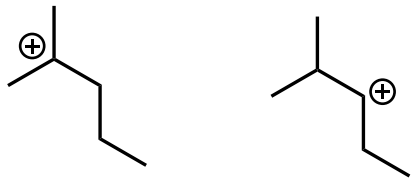
resonance contributor 1 **resonance contributor 2**

3. Determine if each pair of molecules below are **resonance contributors of the same species *or* different molecules**. Briefly justify your explanation.

Recall the rules for drawing resonance contributors:
do not break single bonds
only move electrons

Explanation:

A.

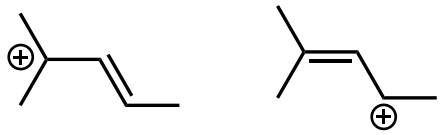


☐ resonance contributors

or

☐ different molecules

B.

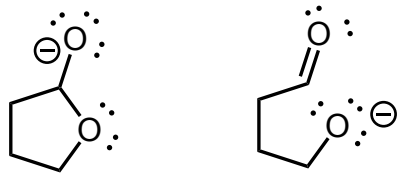


☐ resonance contributors

or

☐ different molecules

C.

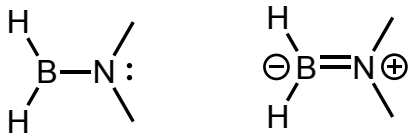


☐ resonance contributors

or

☐ different molecules

D.

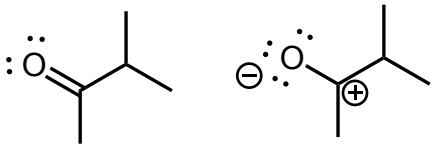


☐ resonance contributors

or

☐ different molecules

E.



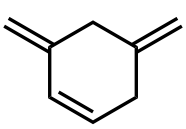
☐ resonance contributors

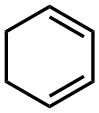
or

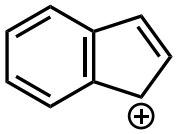
☐ different molecules

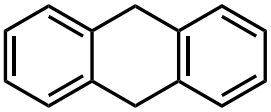
4. A. **Circle** any sp^3-hybridized carbon atoms in molecule X and **square** any sp^2-hybridized carbon atoms in each of the molecules below

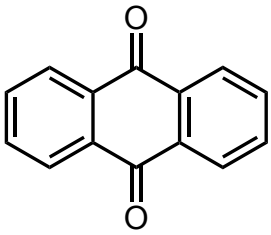
B. Then, **identify where 3 or more sp^2-hybridized atoms** are **uninterrupted** by any **sp^3-atoms**. These are referred to as conjugated π systems.

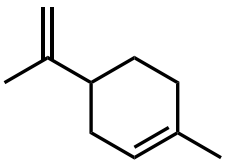




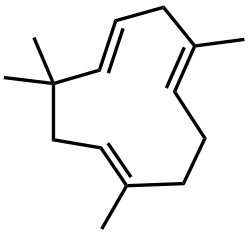








Limonene
(citrus fruits)

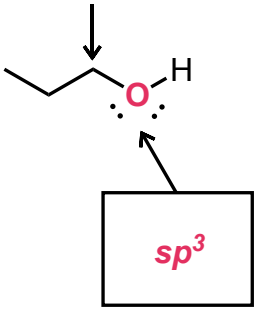


Humulene
(hops)

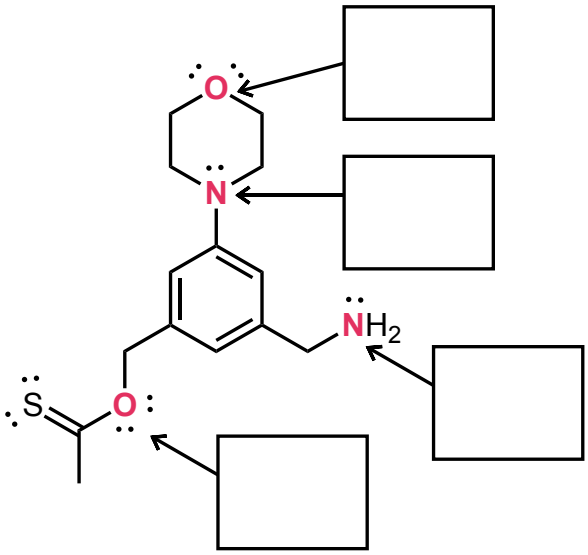
5. Based on the information provided in the "Resonance in Delocalized Lone Pairs" section of the Core Concept sheet, **assign the hybridization** of the indicated atoms below.

e.g.

no p orbital on this carbon (sp^3-hybridized)

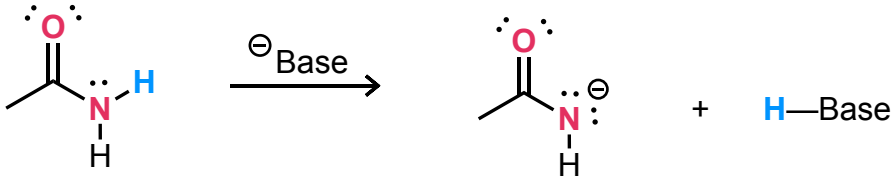


This oxygen is sp^3
since it has 4 electron regions
(2 single bonds and 2 lone pairs)
and the lone pairs on the O are localized
(there is no adjacent p orbital on the
neighboring carbon atom)



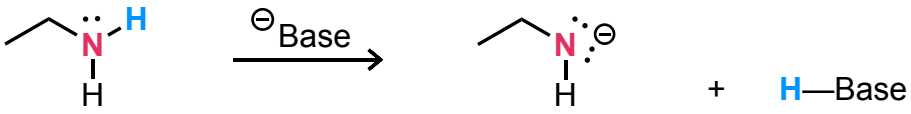
Impact of Resonance on Reactivity

6. Acetamide, below, has a pK_a value of approximately 15 whereas ethanol has a pK_a of approximately 36. Using your knowledge of acid-base chemistry and resonance, describe why acetamide is approximately 10^{21} times more acidic than ethanamine.



acetamide
pK_a ~ 15

acetylamide
conjugate base

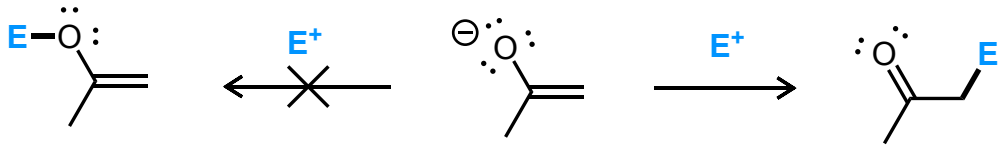


ethanamine
pK_a ~ 36

ethylamide
conjugate base

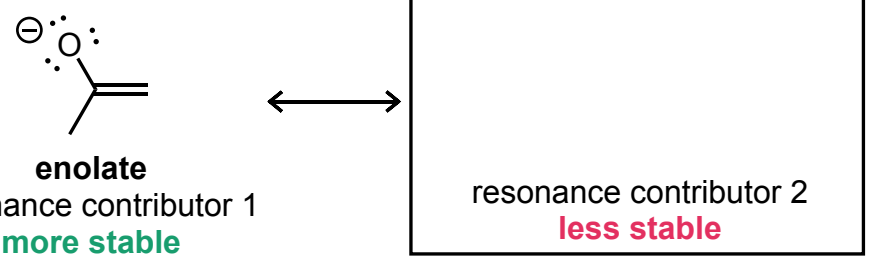
Explanation:

7. Below is a species you likely have not encountered yet: an **enolate.** The more stable resonance contributor is shown. Despite that the more stable resonance contributor has a negatively charged O atom, enolates react with electrophiles (E^+) as shown below, wherein the carbon atom bonds to E rather than the O atom.



enolate
resonance contributor 1
more stable

A. **Draw curved-arrows** on resonance contributor 1 and the related resonance contributor that explains the observation above.



enolate
resonance contributor 1
more stable

resonance contributor 2
less stable