# Homework 1
# Organic Chemistry MCAT Review
# Summer 2012
# Brent Iverson

1. The most important question in chemistry is: _____Where are the electrons_____?

2. Atoms prefer a filled _____valence_____ shell of electrons. The vast majority of stable bonding in molecules takes place in such a way that this is accomplished.

3. Neutral carbon takes part in ___4___ bonds and has ___0___ nonbonded pairs of electrons.

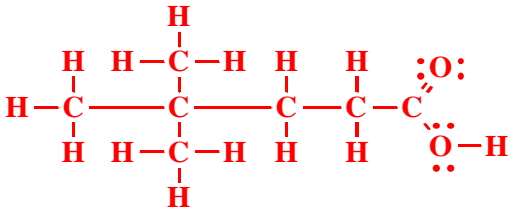
4. Neutral nitrogen takes part in ___3___ bonds and has ___1___ nonbonded pairs of electrons.

5. If a carbon atom in a molecule has three bonds and one nonbonded pair of electrons around it OR if an oxygen atom has one bond and three nonbonded pairs of electrons around it, either atom will have a ___-1___ formal charge.

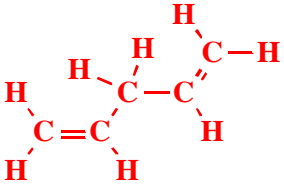
6. When two atoms of different electronegativity form a covalent bond, the majority of shared electron density is found around the _____more_____ electronegative atom.

**7.** For the following molecular formulas, draw complete Lewis line structures in which all atoms (even H atoms) are drawn, lines are used as bonds, and all lone pairs and formal charges are drawn.

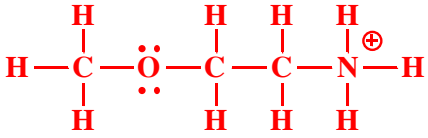
**A)** $(CH_3)_3CCH_2CH_2CO_2H$



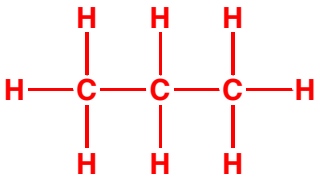
**B)** $H_2CCHCH_2CHCH_2$



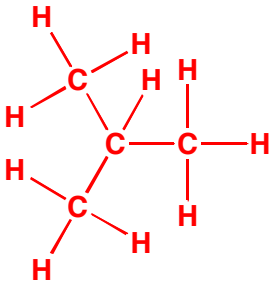
**C)** $CH_3OCH_2CH_2NH_3$



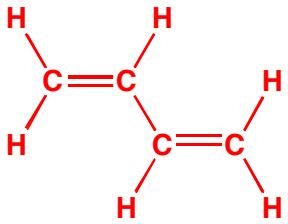
D. $CH_3CH_2CH_3$



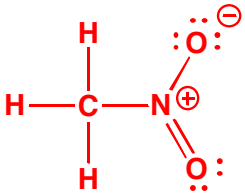
E. $(CH_3)_2CHCH_3$



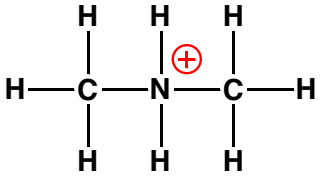
F. $CH_2CHCHCH_2$

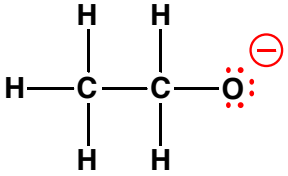


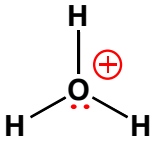
G. $CH_3NO_2$

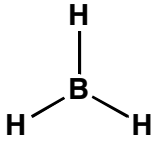


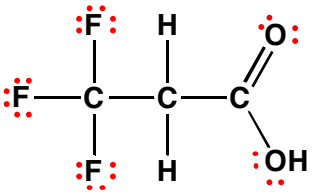
8. Some of the molecules shown below have formal charges. For those that do, write the correct formal charge next to the appropriate atom. IN ADDITION, SOME OF THE ATOMS ON THESE MOLECULES NEED LONE PAIRS ADDED. ADD ALL VALENCE LONE PAIRS OF ELECTRONS WHERE APPROPRIATE.



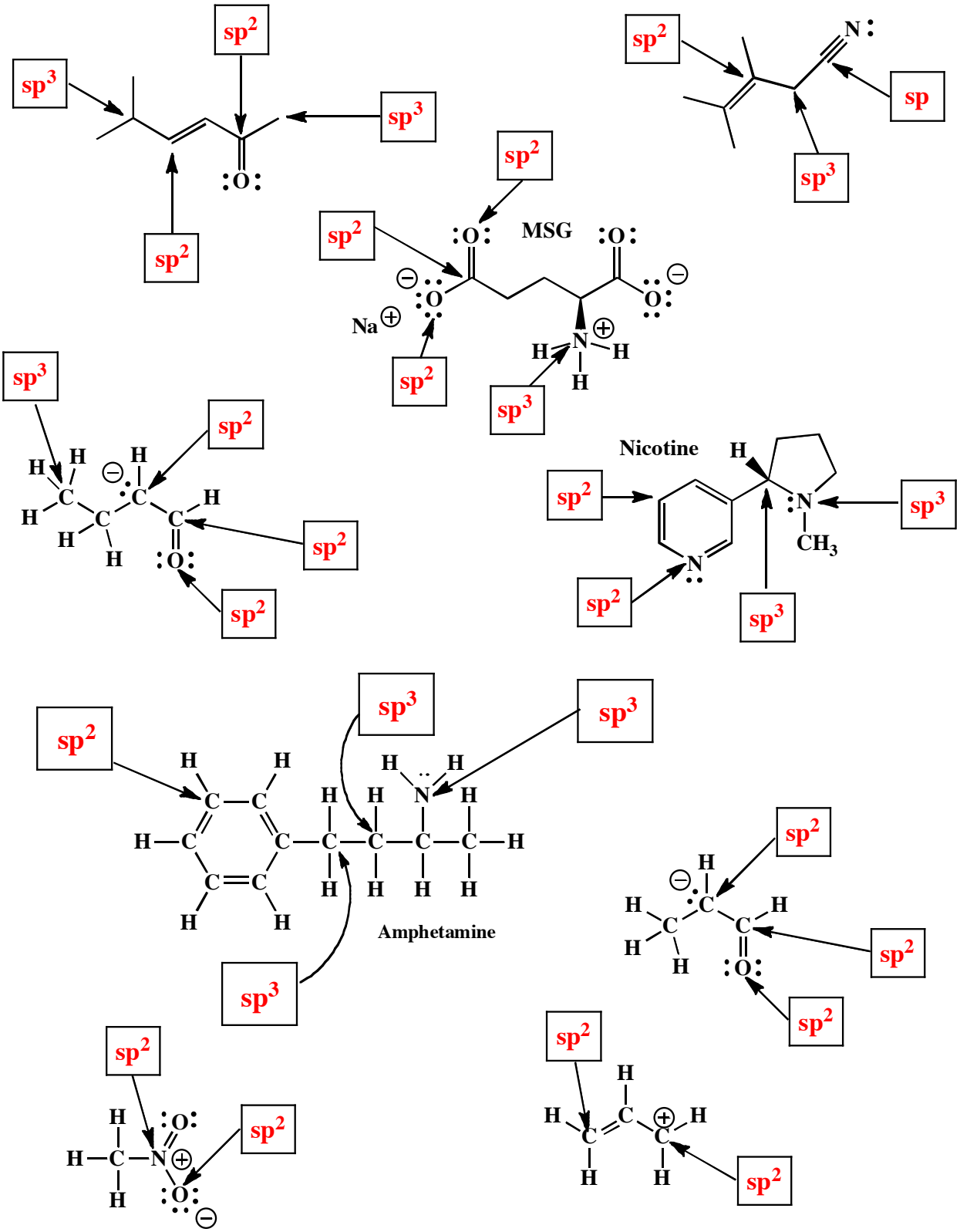




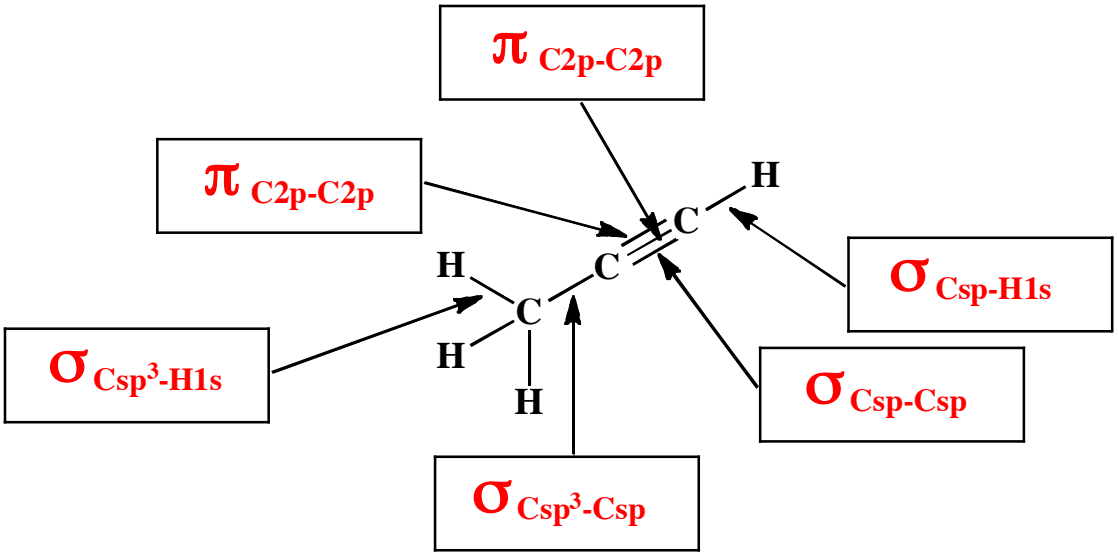


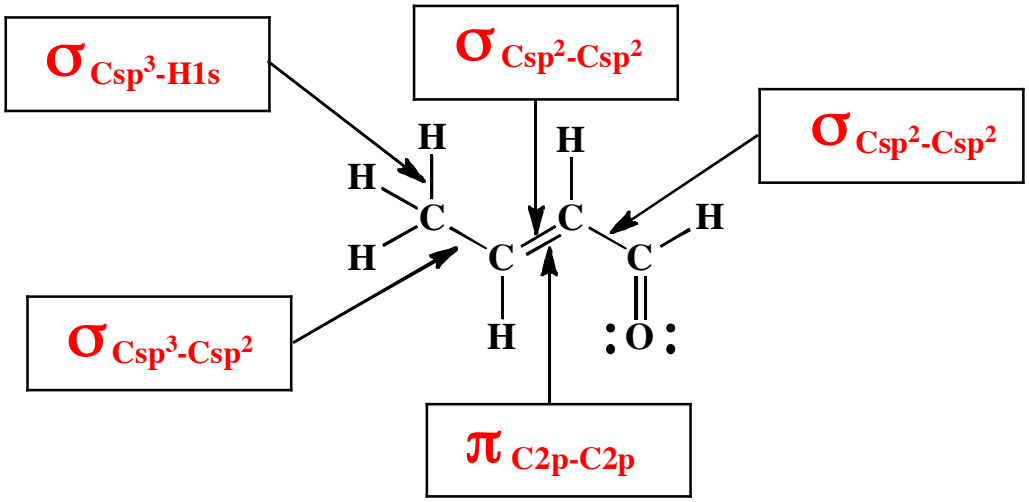


**9.** For the following molecules, write the hybridization state of each atom indicated by the arrow.

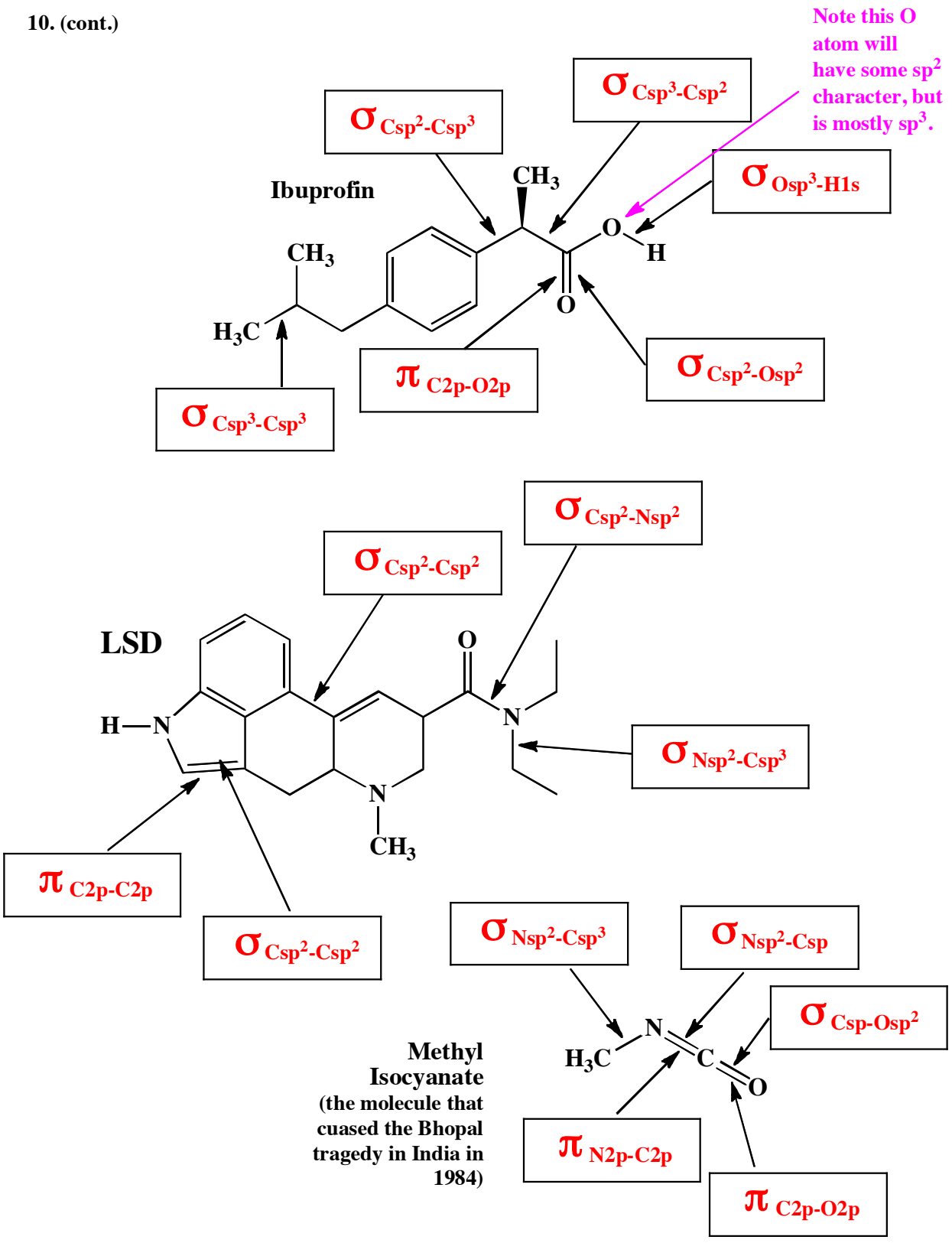


**10.** Describe each bond indicated with an arrow as the overlap of orbitals. For example, an answer might be $\sigma_{Csp^3\text{-}Csp^3}$.



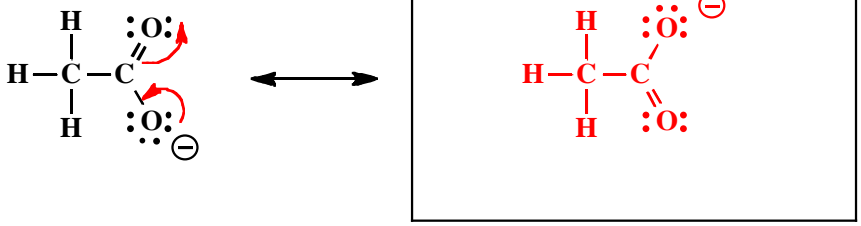
**10. (cont.)**




**Methyl Isocyanate** (the molecule that cuased the Bhopal tragedy in India in 1984)

**11.** The following molecules are best represented as the hybrid of contributing structures. **Draw the second important contributing structure** in the space provided, including all lone pairs and formal charges. **For the structure on the left, use arrows to indicate the movement of electrons to give the structure you drew.** Finally, if one of the two contributing structures makes a dominant (major) contribution to the resonance hybrid, **draw a circle around the dominant (major) contributor.** You might want to read these directions again to make sure you know what we want.

**A.**



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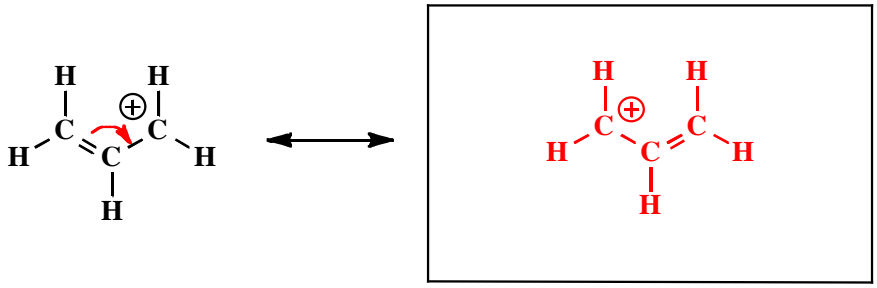

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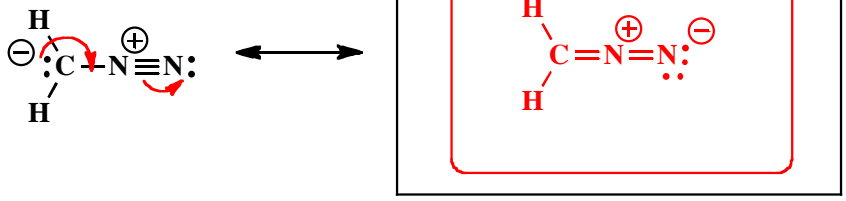
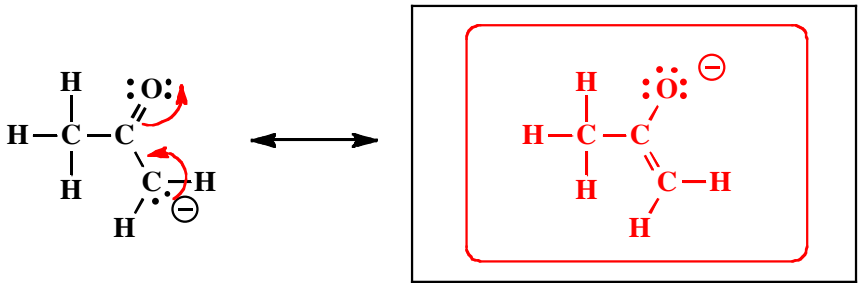
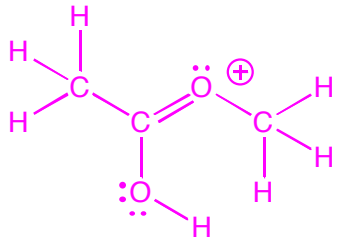


**D.**

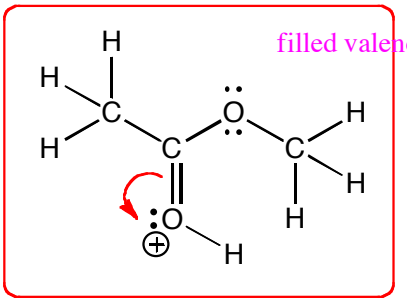


**11.** (cont.)

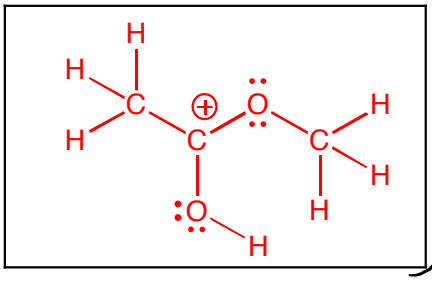


either of these are correct

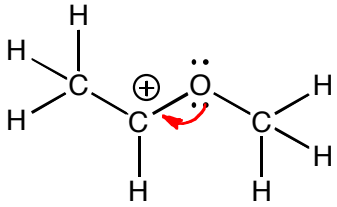
**E.**

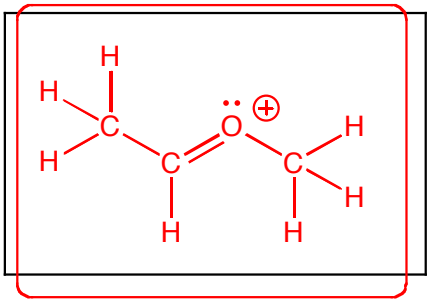


filled valence



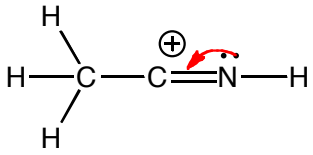
**F.**

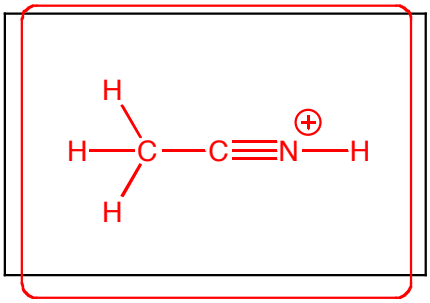




filled valence

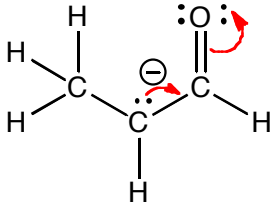
**G.**

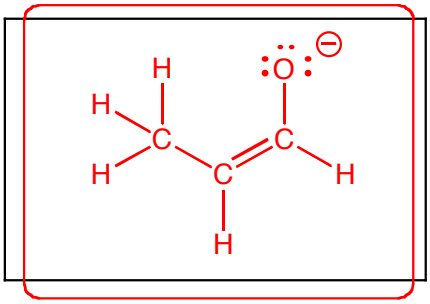




filled valence

**H.**

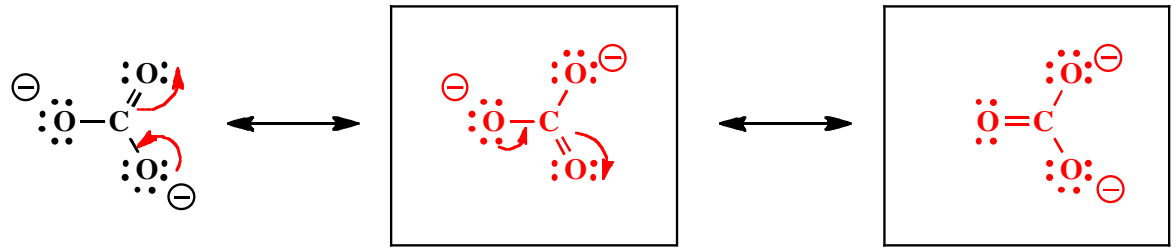




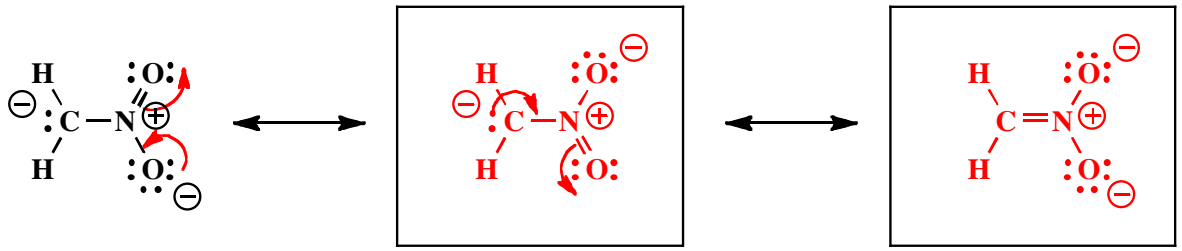
negative charge on more electronegative element

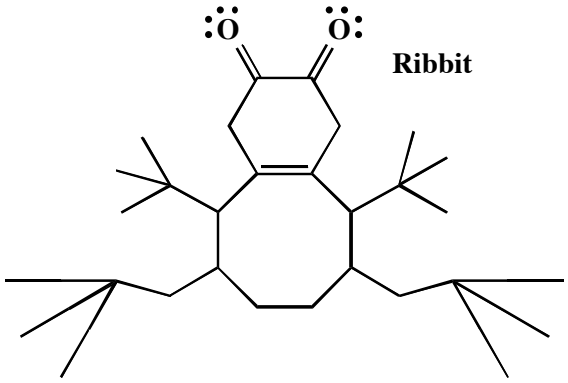
**12.** (10 pts each) The following molecules are best represented as the hybrid of three contributing structures. **Draw the second and third important contributing structures** in the spaces provided, including all lone pairs and formal charges. **For the two structures on the left in each problem, use arrows to indicate the movement of electrons to give the structures you drew.** There is **no need to draw any circles around any of these contributing strucures**. You might want to read these directions again to make sure you know what we want.

**A.**

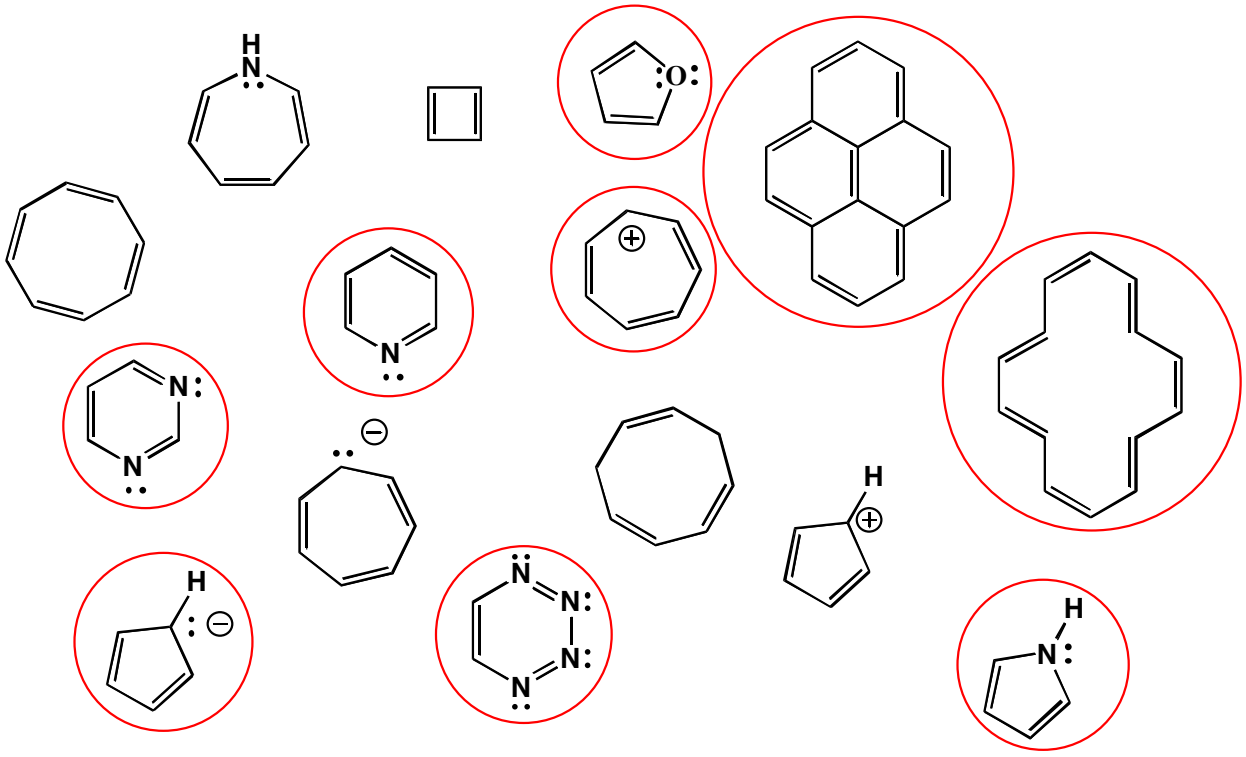


**B.**

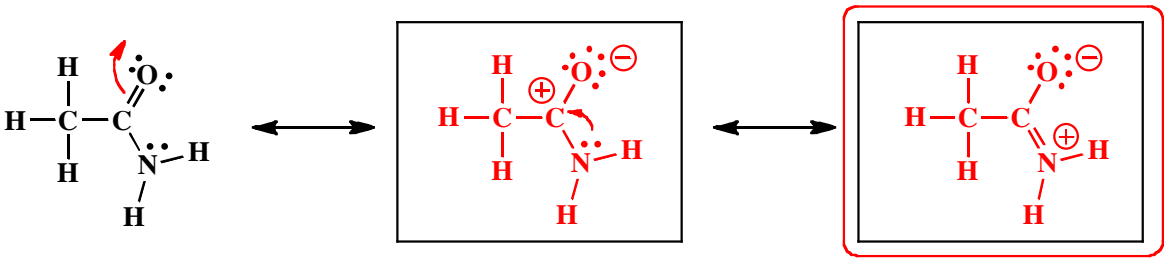




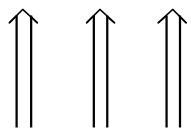
**13. Draw a circle around** all of the molecules below that **can be considered aromatic.**



**14.** On the left is drawn the Lewis structure of a simple amide. Draw the two next most important contributing structures in the spaces provided. Be sure to show all lone pairs and formal charges. You do not need to draw arrows on the structures, but you can if it helps you.

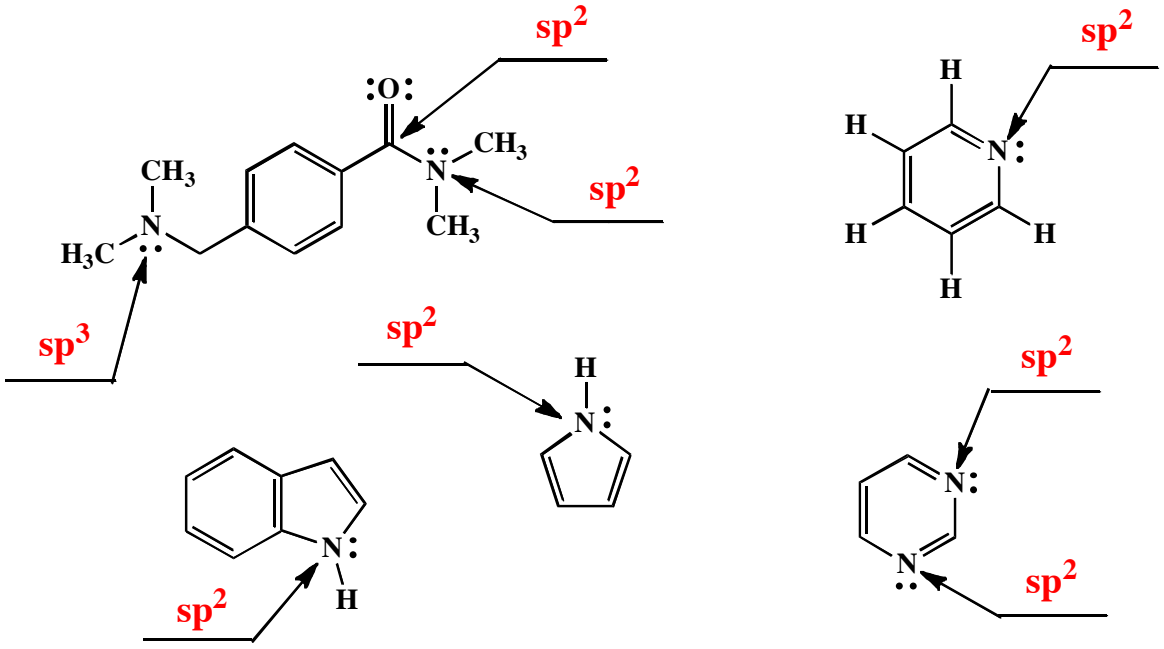


An important feature of an amide bond is that there is a partial double bond between the carbonyl carbon and nitrogen. For the contributing structures you drew in Problem **2.**, draw a circle around the one that predicts this partial double bond.

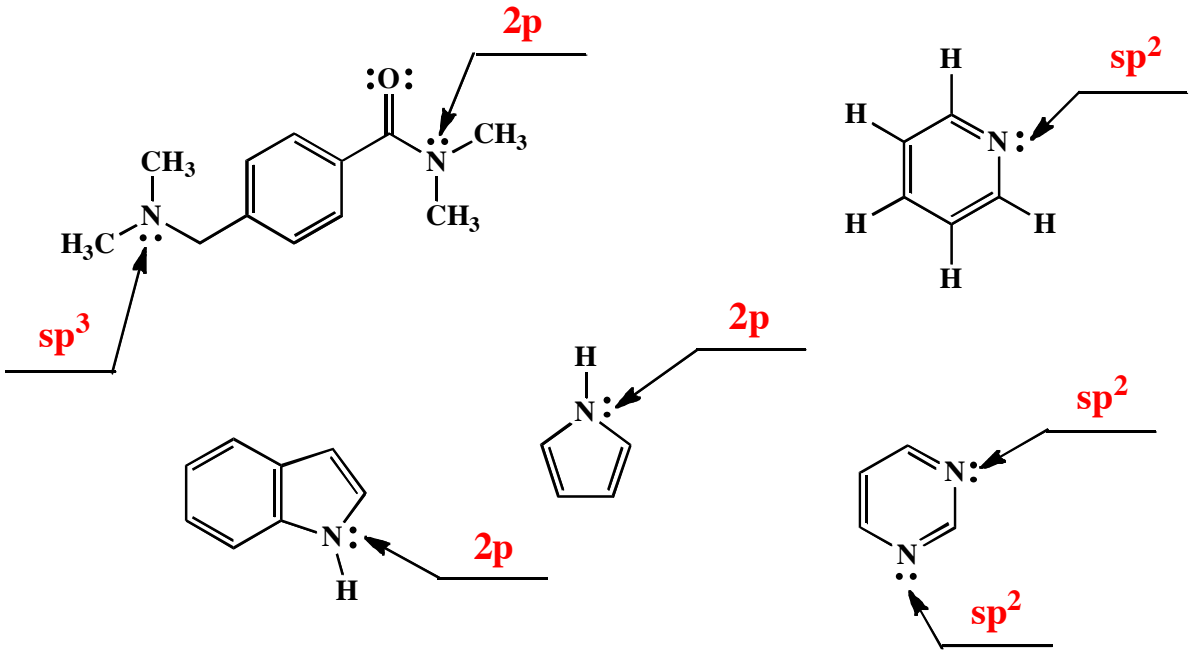


**Notice This**

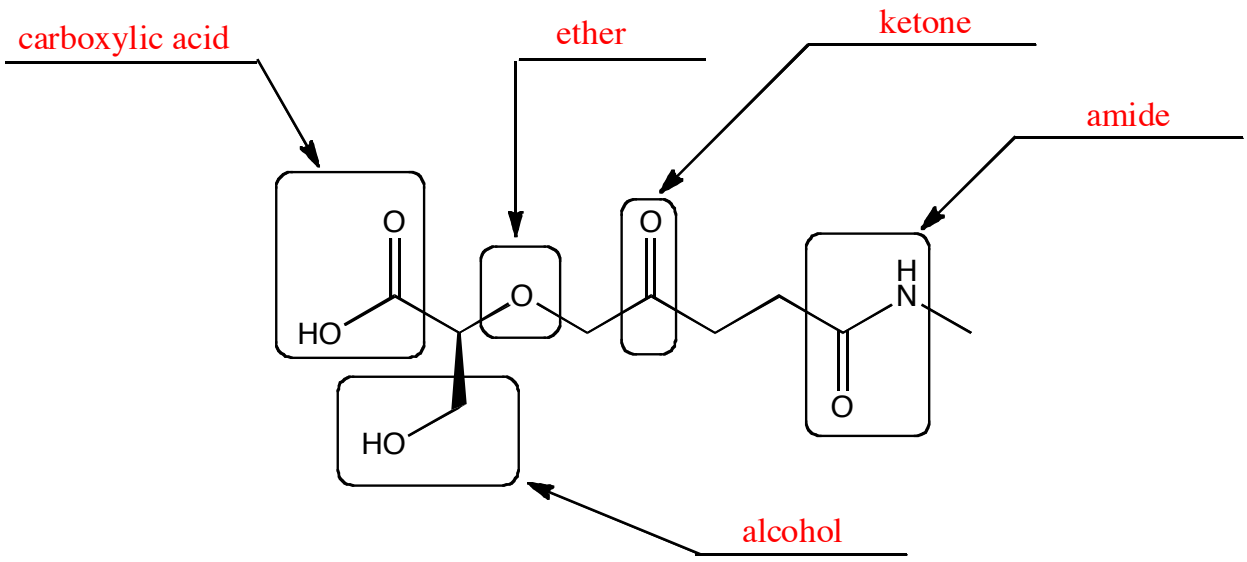
**15.** On the lines provided, state the **hybridization state of the atom** indicated by the arrow.

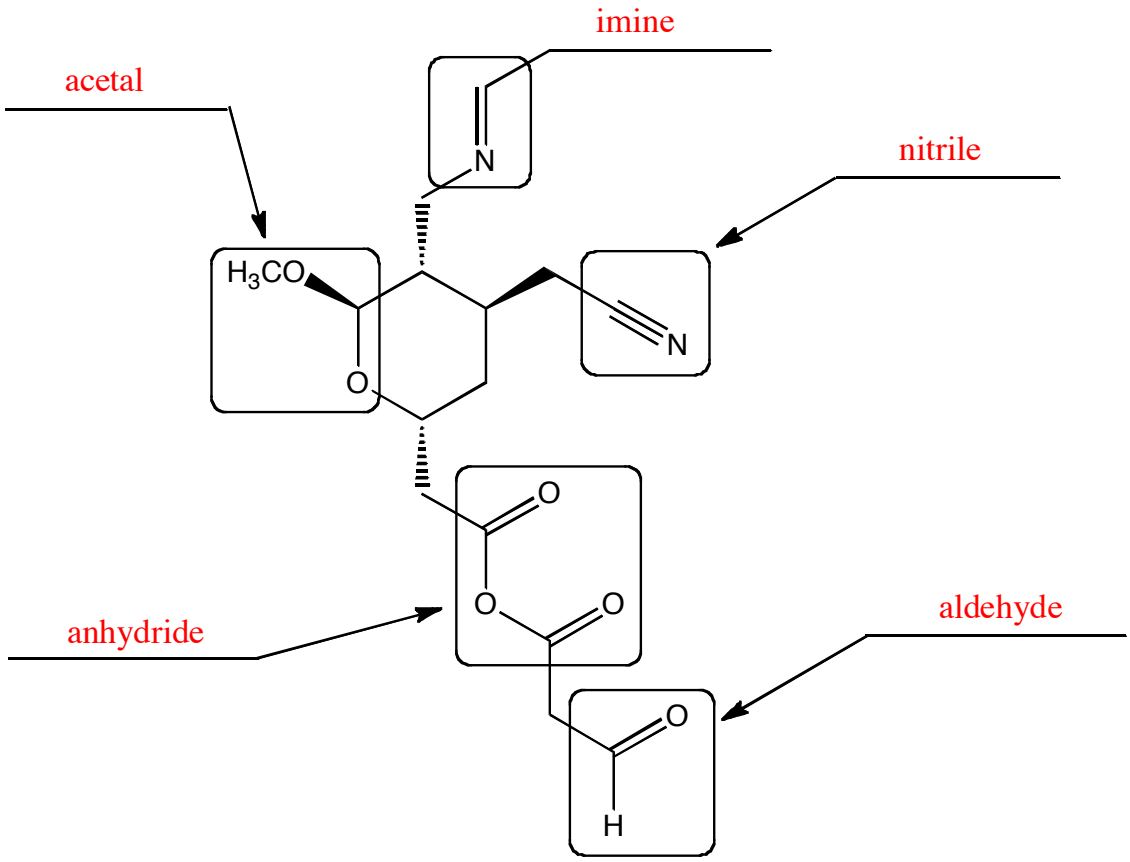



**16.** On the lines provided, state the **atomic orbital that contains the lone pair** of electrons indicated by the arrow.

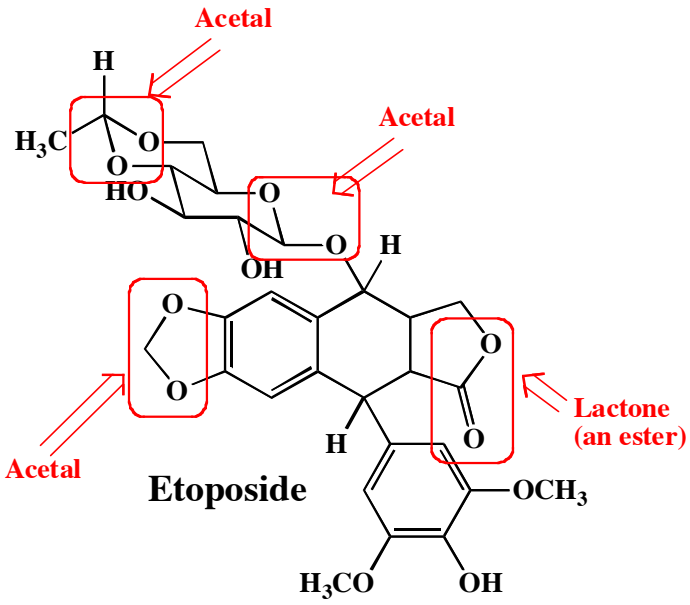


**17.** Name the circled functional groups present in the following molecules.

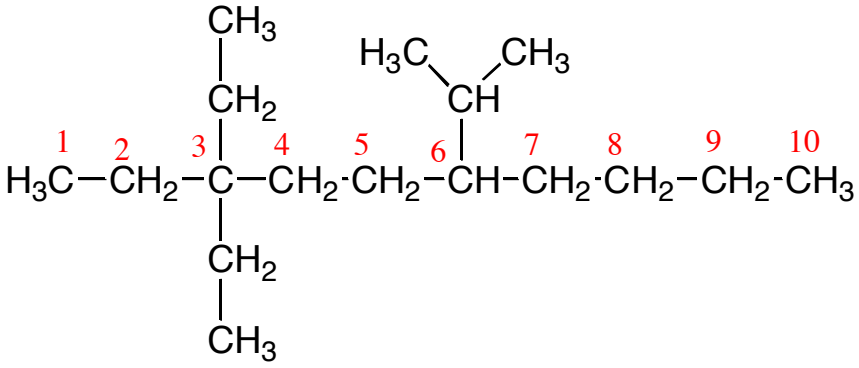


**17 (cont.)** The drug Etoposide is a chemotherapeutic agent that has been used against a number of cancers over the years. It operates by inhibiting an enzyme called topoisomerase that is required for DNA replication. Cancer cells need to replicate faster than normal cells, so drugs like Etoposide can be used to kill cancer selectively. **Look at Etoposide and identify the three acetals and one lactone.**



**18.** On the line provided, write IUPAC names for the following molecules.



3,3-diethyl-6-isopropyldecane
or 3,3-diethyl-6-(1-methylethyl)decane

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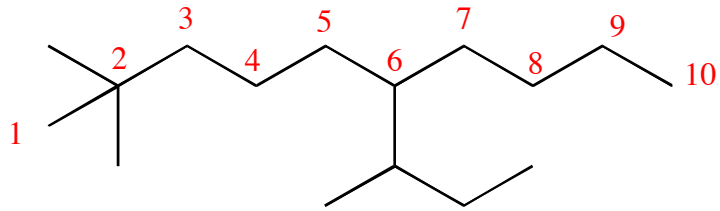

6-*sec*-butyl-2,2-dimethyldecane
or 2,2-dimethyl-6-(1-methylpropyl)decane

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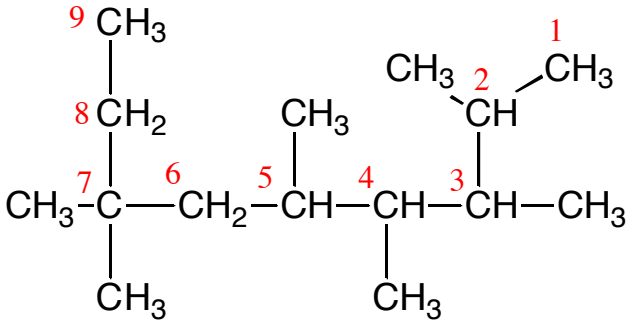

2,3,4,5,7,7-hexamethylnonane

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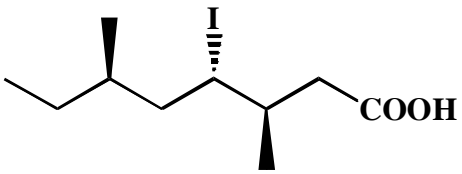
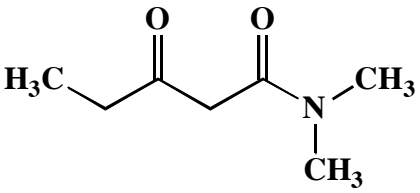
**18. (cont.)**



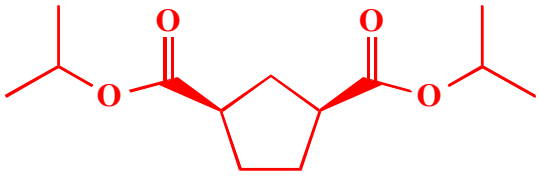

**(3*R*,4*S*,6*R*)-4-Iodo-3,6-dimethyloctanoic acid**




***N*,*N*-Dimethyl-3-oxopentanamide**

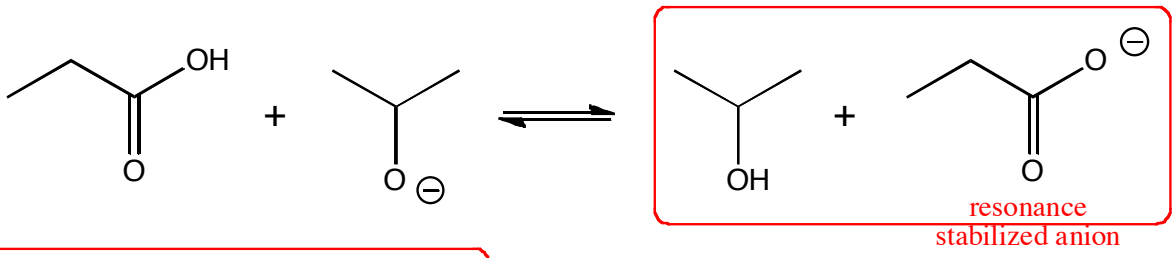
**19. In the space provided, draw the following molecule:**

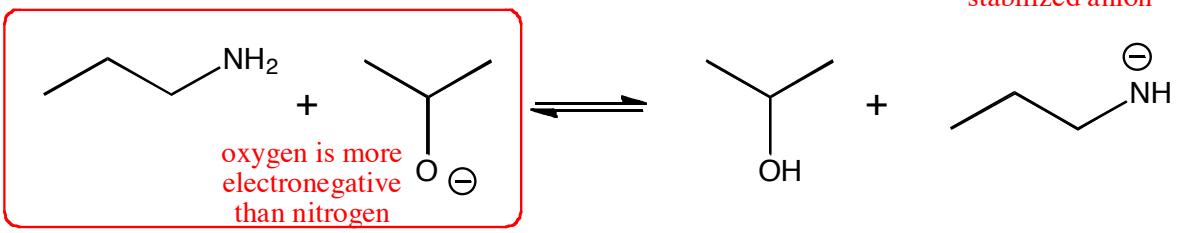
***Cis*-Diisopropyl cyclopentane-1,3-dicarboxylate**

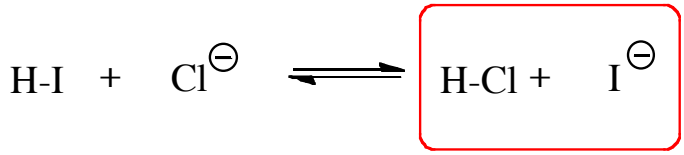


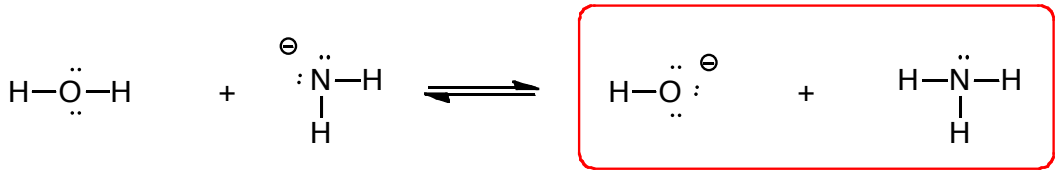
**20.** For the following acid base reactions, circle the side of the equation that predominates at equilibrium.

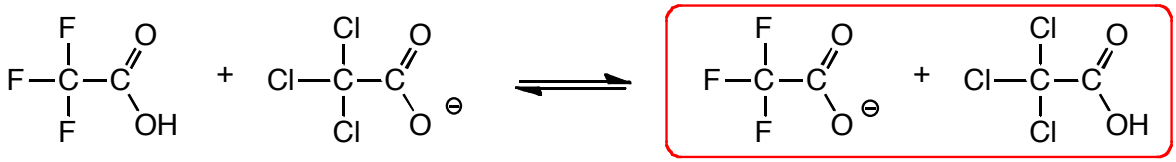
In each case identify the stronger and weaker acids by comparing relative stabilities of the anions which are the conjugate bases of the two acids. Equilibrium favors formation of the weaker acid. You will notice this means you circled the side with the more stable anion.

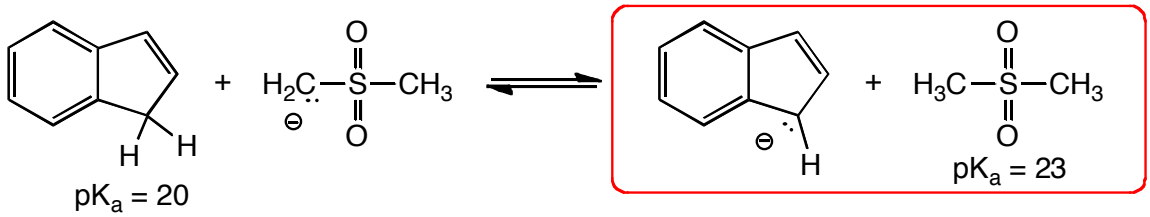


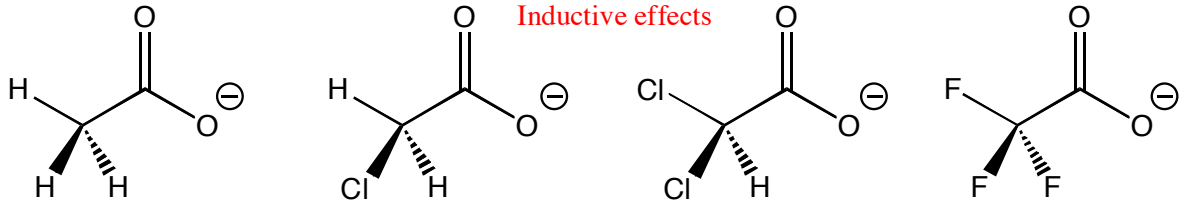



**21**. Rank the following from 1 to 4 with respect to relative anion stability, with a 1 under the most stable anion and a 4 under the least stable anion.

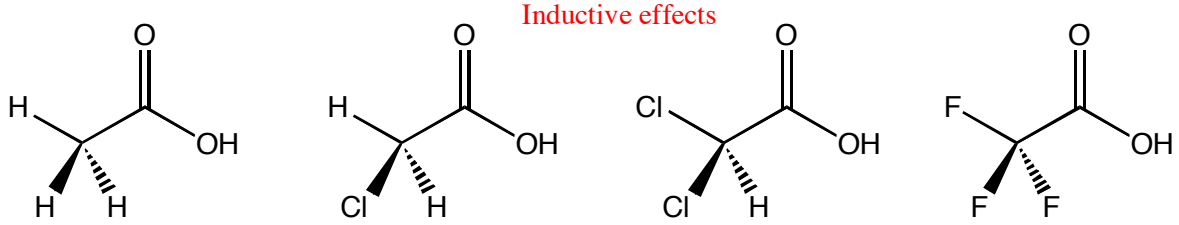
Inductive effects



**4** **3** **2** **1**

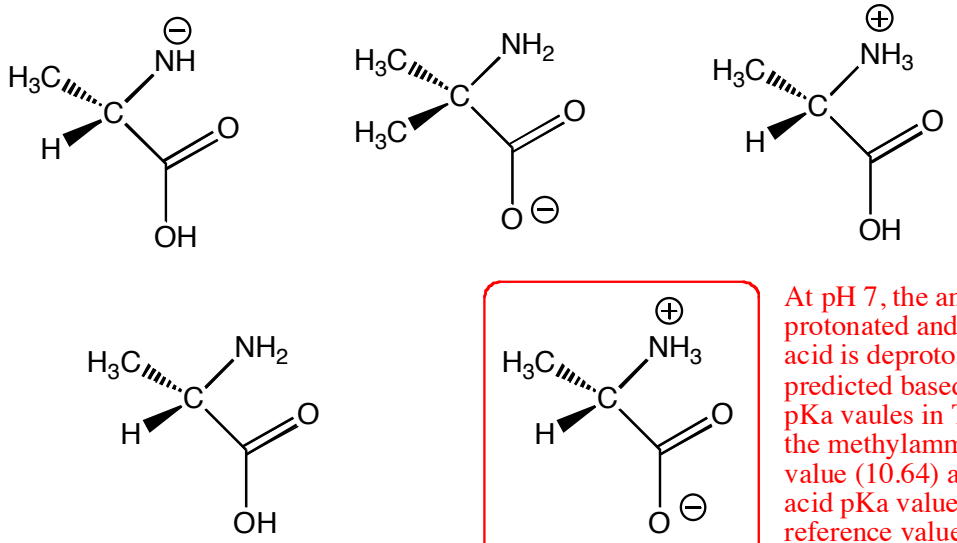
**22**. Rank the following from 1 to 4 with respect to relative acidity, with a 1 under the most acidic and a 4 under the least acidic molecule.

Inductive effects



**4** **3** **2** **1**

**23.** At pH 7.0 in water, circle the species that will be predominant for the amino acid alanine.

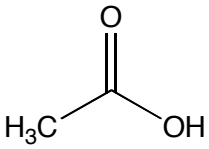


At pH 7, the amine is protonated and the carboxylic acid is deprotonated, as can be predicted based on the relevant pKa vaules in Table 4.1. Use the methylammonium ion pKa value (10.64) and the acetic acid pKa value (4.76) as reference values and compare those to the pH value of 7.

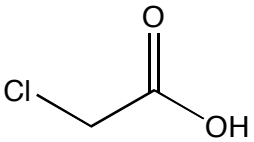
The species you circled has the special name of zwitterion

**24.** Rank the following from 1 to 4 with respect to relative acidity, with a 1 under the most acidic and a 4 under the least acidic molecule.

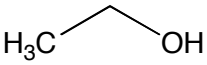
| | | | |
|---|---|---|---|
| $H_2O$ | $CH_4$ | $NH_3$ | $H_2S$ |
| **2** | **4** | **3** | **1** |
| HF | HBr | HCl | HI |
| **4** | **2** | **3** | **1** |



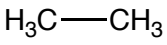

**2**



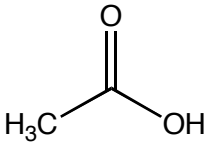

**1**




**3**

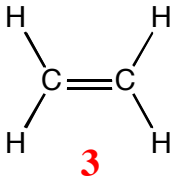



**4**

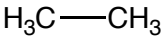



**1**


**2**

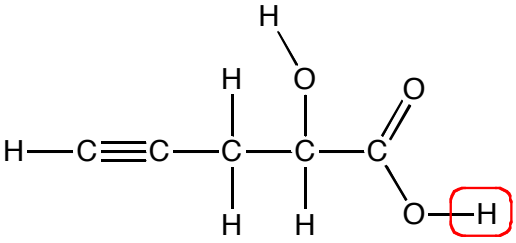


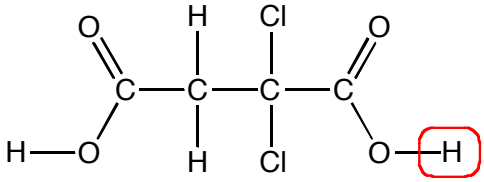

**3**

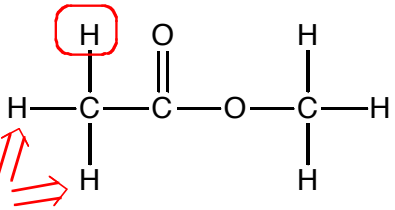



**4**

**25.** For each molecule, draw a circle around the most acidic H atom. Note there might be more than one on the same molecule, and you will get it correct if you circle any of the most acidic H atoms.




These two are just as acidic