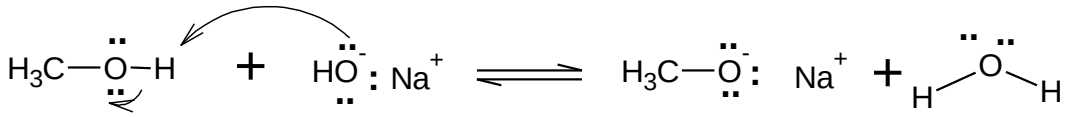
ChemV12A, Organic Chemistry I

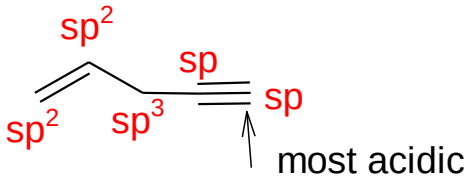
1.) Consider the neutralization reaction between sodium hydroxide (NaOH) and methanol (CH_3OH). (Hint: Recall that NaOH is a strong base) (30 pts)

a.) Show the arrow-pushing mechanism for this reaction. Complete Lewis structures must be used (e.g., all atoms, bonds, lone pairs, and formal charges).



b.) The pKa for methanol is 14 and the pKa for water is 16. In which **direction** (forward or reverse) will the above equilibrium move? **forward** (methanol is more acidic)

2.) Consider the organic molecule depicted below. Use the provided structure to answer the following questions. (18 pts)



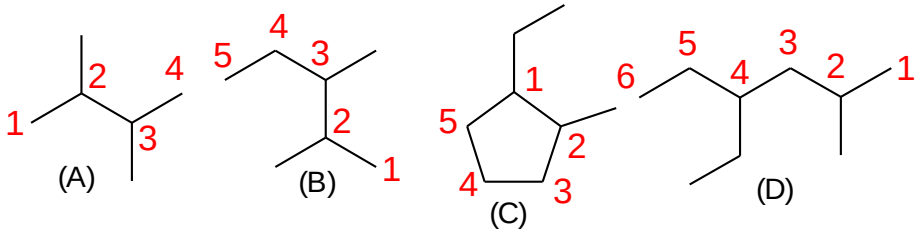
a.) Label the **hybridization** at each carbon.

b.) What is the overall molecular formula for the above structure? **C_5H_6**

c.) Label which hydrogen will be the most acidic and **explain** why.

Hydrogens on **terminal alkynes are more acidic** than hydrogens on sp^2 or sp^3 hybridized carbons due to the **greater s-character**, making the hydrogen more partially positive.

3.) Give the correct IUPAC names for the following compounds. (20 pts, 5 pts ea)



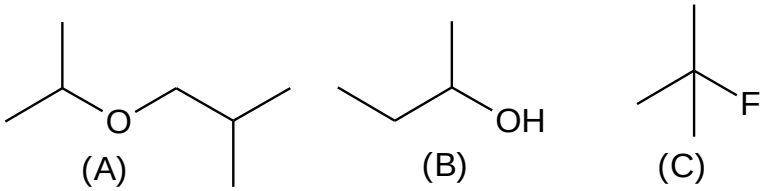
(A) **2,3-dimethylbutane**

(B) **2,3-dimethylpentane**

(C) **1-ethyl-2-methylcyclopentane**

(D) **4-ethyl-2-methylhexane**

4.) Consider the following pair of molecules. (34 pts)



a.) Give **both** the IUPAC and the common name for structure (A).

IUPAC: **1-(2-propoxy)-2-methylpropane**

COMMON: **isobutylisopropyl ether**

b.) Give **both** the IUPAC and the common name for structure (B).

IUPAC: **2-butanol**

COMMON: ***sec*-butyl alcohol**

c.) Give **both** the IUPAC and the common name for structure (C).

IUPAC: **2-fluoro-2-methylpropane**

COMMON: ***tert*-butyl fluoride**

d.) Is structure (B) more likely to behave as an **acid** or a **base**? **Explain**.

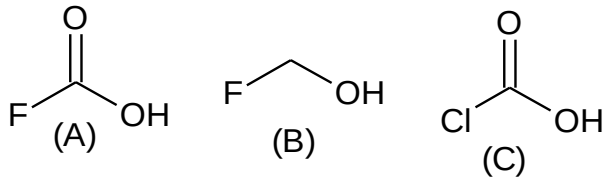
Acid. Oxygen is **highly electronegative** so is pulling electron density away from the H to make it easier to lose and unlikely to take a positive formal charge.

5.) Give the **balanced equation** for the acid-base neutralization between *tert*-butanol ($(CH_3)_3COH$, pKa = 18) and methylamine (CH_3NH_2, pKa = 40). **Label** the (1) acid, (2) base, (3) conjugate acid, and (4) conjugate base. (16 pts)

$$\mathbf{(CH_3)_3COH + CH_3NH_2 \rightleftharpoons (CH_3)CO^- + CH_3NH_3^+}$$

ACID *BASE* *CONJ BASE* *CONJ ACID*

6.) Consider the following molecules. (25 pts)



a.) Arrange the molecules (A-C) by **increasing acidity,** starting with the **weakest**.

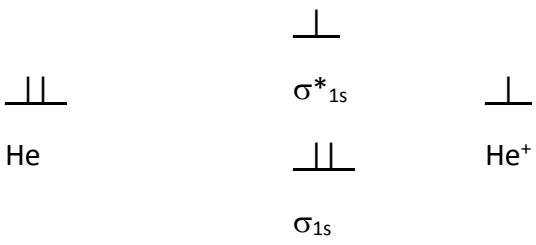
(B) < (C) < (A)

b.) **Explain** your reasoning in (a).

Both (A) and (C) have **resonance** to stabilize their conjugate bases; (B) does not, making it the weakest acid.

F is more electronegative than Cl, so will pull more electron density away from the acidic H in the OH bond via **inductive withdrawal**.

7.) Draw the molecular orbital diagram for He_2^+. Determine its **bond order** and whether it is stable or unstable. (14 pts)



Bond Order = ½(2 – 1) = **1/2 , stable** (> 0)

8.) Do sp^4 hybrids exist? Why or why not? (8 pts)

No. Since there are **only 3 p-orbitals** per n level (ml = -1, 0, +1), there is not a fourth p orbital to hybridize.