1)

a) $H_2SO_4 > HSO_4^-$

$H_2SO_4 \xrightarrow{-H^+} HSO_4^-$ (more stable)

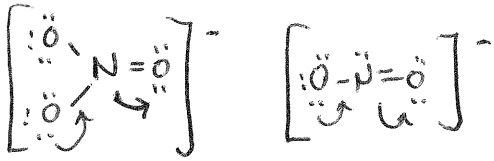
$HSO_4^- \xrightarrow{-H^+} SO_4^{2-}$

Electrostatic Argument:
Less energy is required to remove a proton from a neutral species compared to an anion.

b) $HNO_3 > HNO_2$

$HNO_3 \xrightarrow{-H^+} NO_3^-$ (more stable)

$HNO_2 \xrightarrow{-H^+} NO_2^-$



Conjugate Base Stability - Resonance:
The charge is more delocalized in NO_3^- than in NO_2^-. NO_3^- has 3 resonance structures and NO_2^- has 2. Resonance dominates over inductive effect.
(Alternatively, the nitrogen in HNO_3 has a higher oxidation state than in HNO_2. A proton is more easily lost from HNO_3 than HNO_2 because the O-H bond in HNO_3 is weaker being next to a more ~~higher~~ oxidized nitrogen.)

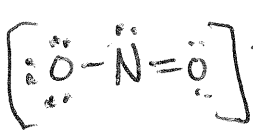
c) $H_2Te > H_2Se$

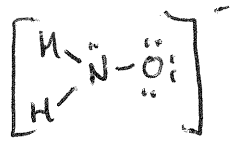
$H_2Te \xrightarrow{-H^+} HTe^-$ (more stable)

$H_2Se \xrightarrow{-H^+} HSe^-$

Bond Strength or Conjugate Base Charge Density:
H-Te bond is weaker than H-Se bond.
HTe^- has a lower charge density than that of HSe^- (Te is a larger atom).

d) $HNO_2 > H_2NOH$

$HNO_2 \xrightarrow{-H^+}$  (more stable)

$H_2NOH \xrightarrow{-H^+}$ 

Resonance and Inductive Effect:
Looking at the conjugate bases NO_2^- is more stable because it has a resonance structure that delocalizes the charge. Also the additional oxygen in NO_2^- stabilizes charge through induction.

e) $H_2S > PH_3$

$H_2S \xrightarrow{-H^+} HS^-$ (more stable) $\quad PH_3 \xrightarrow{-H^+} PH_2^-$

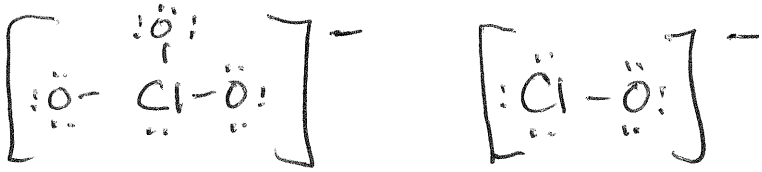
Bond Polarization:

The H-S Bond is more polar than the H-P Bond. A more polar bond will ionize more easily in a polar solvent, i.e. water.

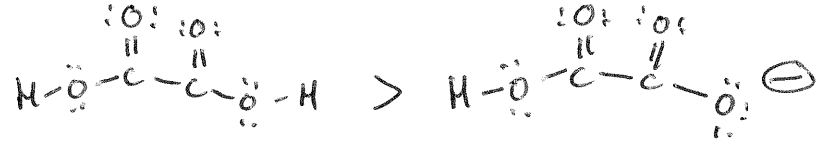
f) $HClO_3 > HClO$

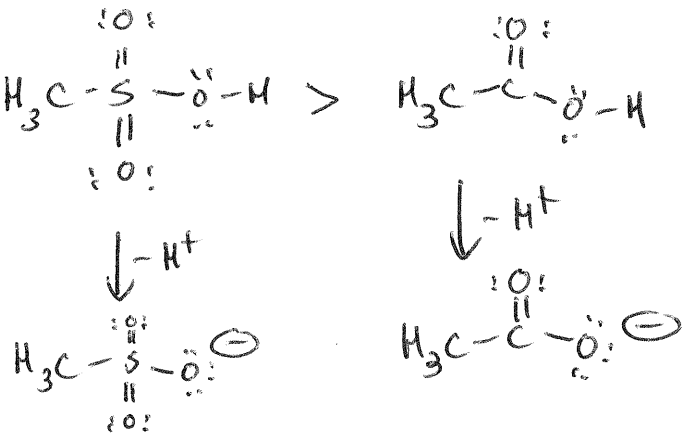
$HClO_3 \xrightarrow{-H^+} ClO_3^-$ (more stable) $\quad HClO \xrightarrow{-H^+} ClO^-$

Inductive Effect!

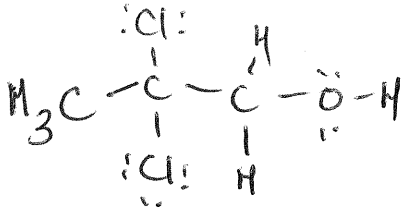
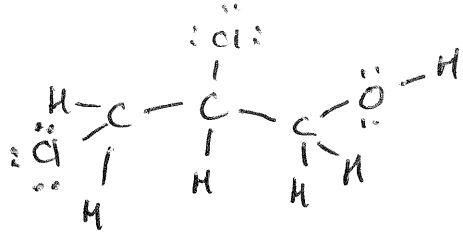


The charge is stabilized better in ClO_3^- because 3 oxygen can induce charge toward them. ClO^- has only one oxygen to induce the same amount of charge.

g)  similar to (a)

h)  similar to (d)

more stable

i)  > 

↓

This has the greater inductive effect due to both Cl being at carbon # 2.

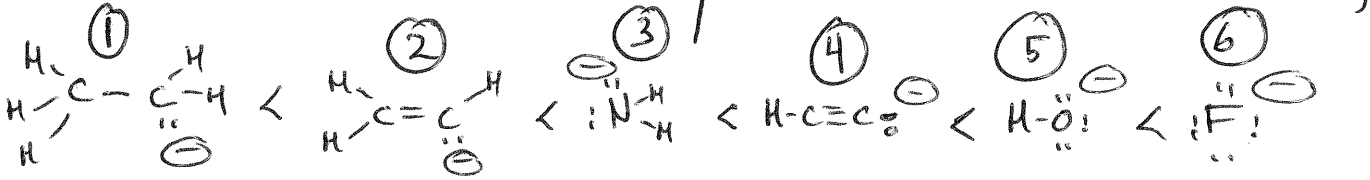
Inductive effect decreases with distance.

The greater effective nuclear charge of both Cl helps to weaken the OH bond and stabilize the CB.

2) $2NaH_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + 2H_{2(g)}$

H_2 is a weaker acid than water since the rxn is complete going from left to right (strong → weak)

3) Look at the CB stability (In general the hydrocarbon anions are least stable)

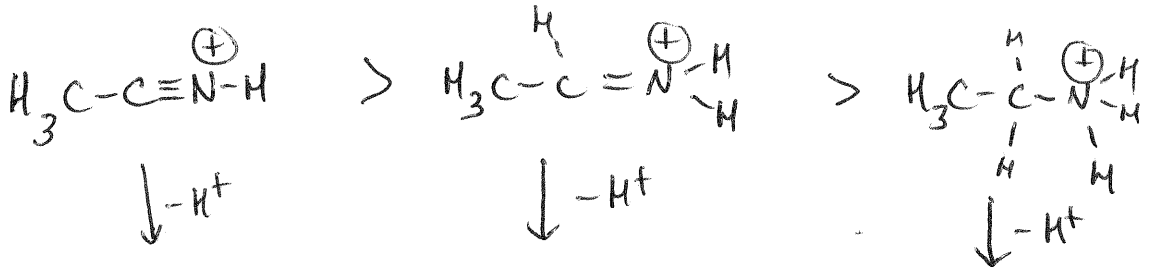


least stable (C_2H_6 least acidic)

most stable (HF most acidic)

① sp^3 hybridized C, least s character
② sp^2 " " ,
③ sp^3 " N
④ sp " C, most s character
⑤ effective nuclear charge dominates over hybridization
⑥ greater effective nuclear charge for F.

4)



$H_3C-C\equiv N-H$ > $H_3C-C=N-H$ > $H_3C-C(H)_2-NH_2$

$\downarrow -H^+$ $\downarrow -H^+$ $\downarrow -H^+$

$H_3C-C\equiv N:$ $H_3C-C=\ddot{N}-H$ $H_3C-C(H)_2-\ddot{N}H$

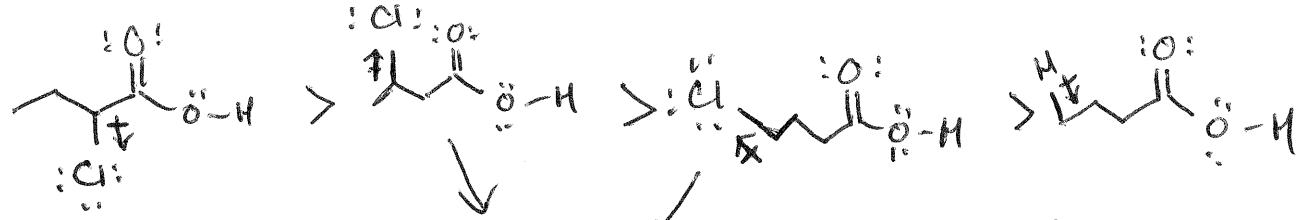
most stable CB

sp hybridized N stabilizes the lone pair e⁻ s best

Sp^2-N

Sp^3-N

5)



greatest inductive effect, most bond (OH) weakening

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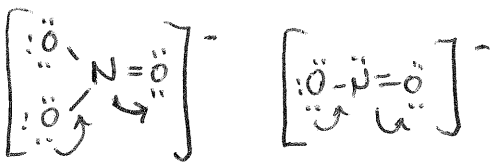

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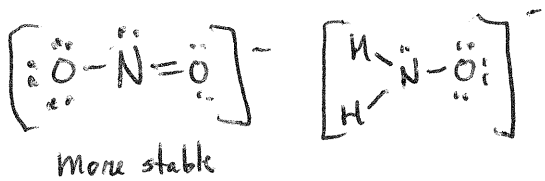

(more stable)

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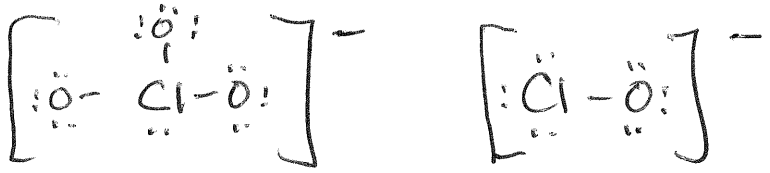

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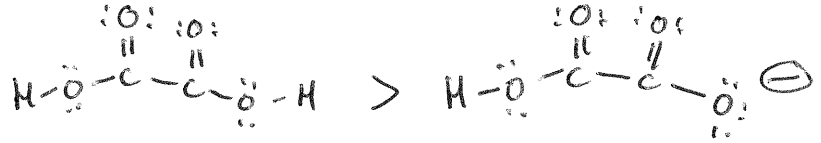
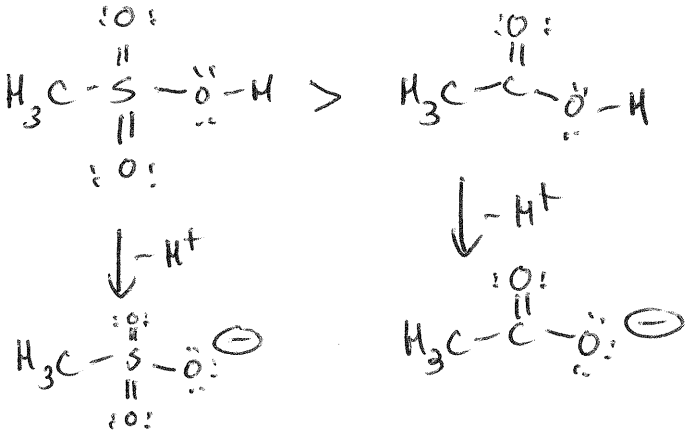
g)  similar to (a)

h)  similar to (d)

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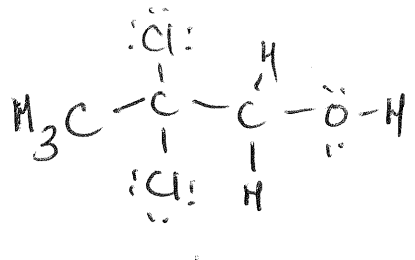
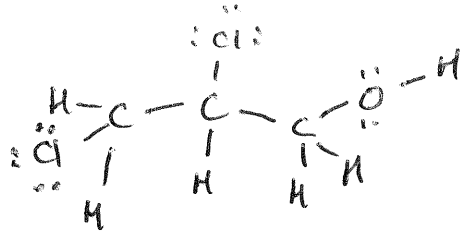
i)  > 

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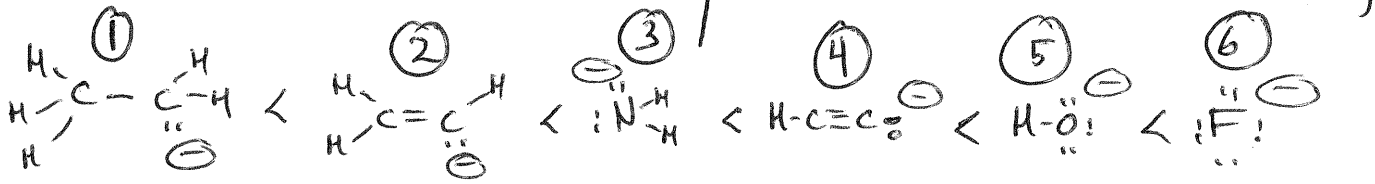

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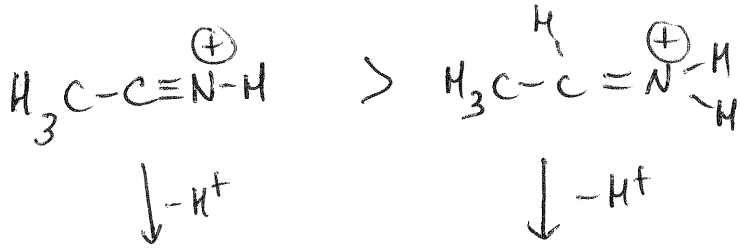

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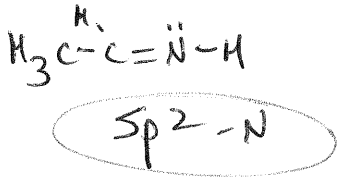
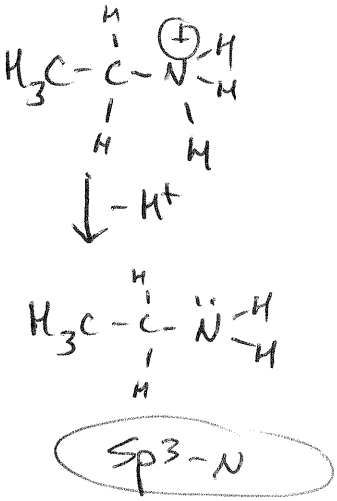
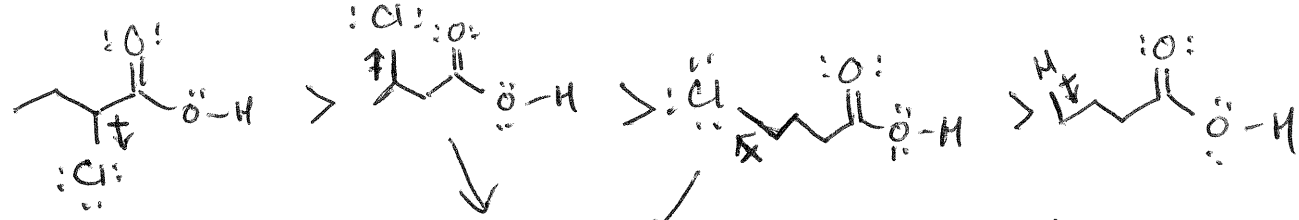


sp^2-N



sp^3-N

5)



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