

(23) **Today**

Chap 6 Acid-Base and Donor-Acceptor
Chemistry

Next Class

Test 2
Chap 4 Symmetry
Chap 5 Molecular Orbital Theory

(24) **Second Class from Today**

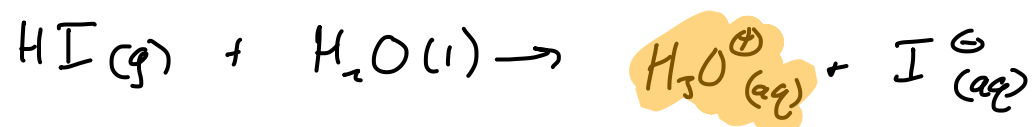
Chap 6 Acid-Base and Donor-Acceptor
Chemistry

Third Class from Today (25)

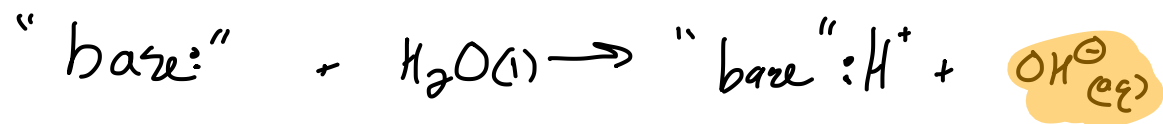
Chap 9.1 Introduction to Coordination
Chemistry

amphoteric - can act as base or acid

What's the **strongest** Brønsted-Lowry **acid** that can exist in aqueous solution?



What's the **strongest** Brønsted-Lowry **base** that can exist in aqueous solution?



What's the strongest Brønsted-Lowry acid that can exist in a given solution?

The protonated solvent

You must pick your solvents carefully when working with strong acids because the solvent puts a ceiling on the strongest acid that can exist in that solution.

What's the strongest Brønsted-Lowry base that can exist in a given solution?

the deprotonated solvent

You must pick your solvents carefully when working with strong bases because the solvent puts a ceiling on the strongest base that can exist in that solution.

Trends in Acid Strength

Section 6.3.7, 6.3.8, 6.3.9

across a period

the strength of a Brønsted-Lowry acid

increases



↑
hydrofluoric acid
weak but dangerous acid

the stability of the [⊖] charge increases as the [⊕] charge of the nucleus increases



acid strength increases from left to right



increasing nuclear charge is stabilizing the e⁻'s that are left when the H⁺ is abstracted away

the more stable we can make this neg charge the stronger this acid will be

Trends in Acid Strength

Section 6.3.7, 6.3.8, 6.3.9

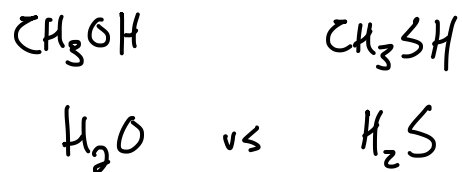
down a family $R+L$ acid strength increases

	HF	HCl	HBr	HI
K_a	10^{-4}	10^6	10^9	10^{11}

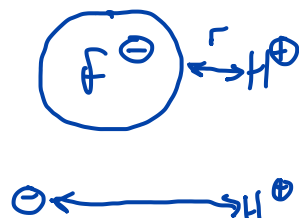
acid strength increases as we go down a family

increase Z_{eff}

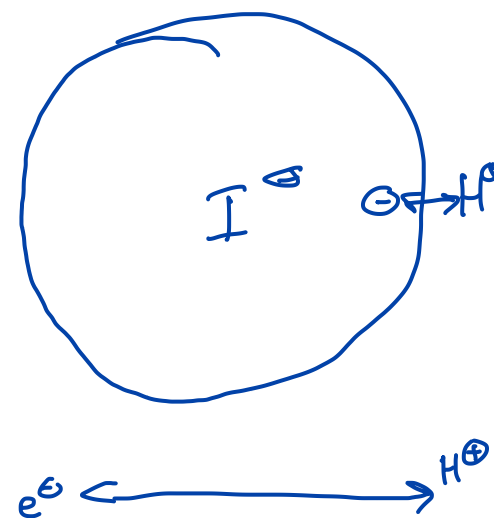
increased volume



↑
 stronger acid
 Z_{eff} is larger
 +
 e^- 's density is more diffuse



H^+ is on average closer to the e^- in F^-

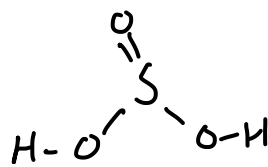
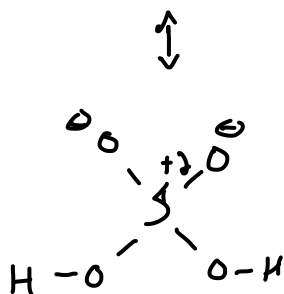
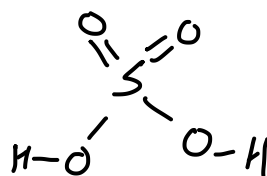
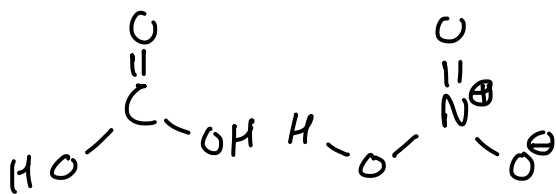
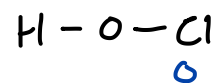
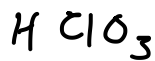
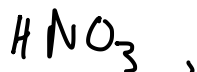
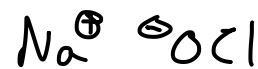


H^+ is more easily attracted to concentrated charge

Trends in Acid Strength

for "oxy-acids"

Section 6.3.7, 6.3.8, 6.3.9



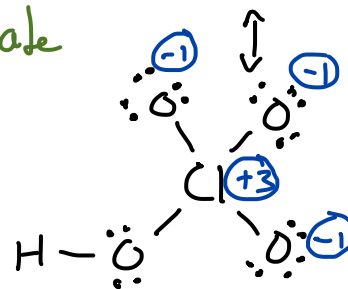
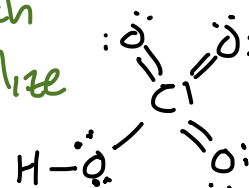
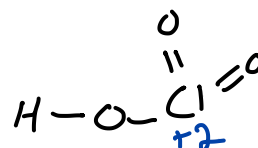
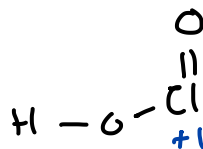
adding
more

O atoms
increases

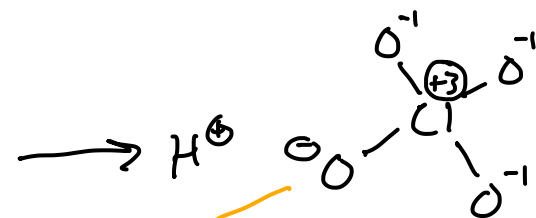
(+) charge
on central

atom which
helps stabilize

the
conjugate
base



neg O next to
neutral Cl ...
no help stabilizing
⊖



neg O next to a
3+ Cl which
helps stabilize ⊖
on O

stable in the sense
acid-base chemistry

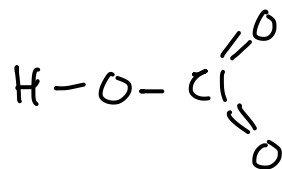
ClO_4^- is very reactive in redox chemistry
dangerously reactive with organic materials

Trends in Acid Strength

Section 6.3.7, 6.3.8, 6.3.9

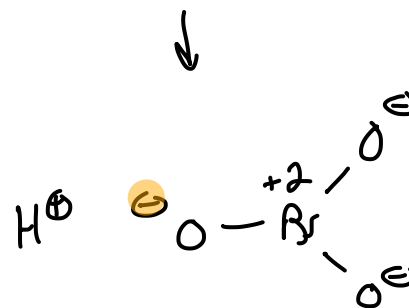
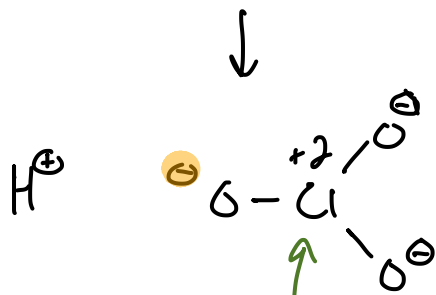
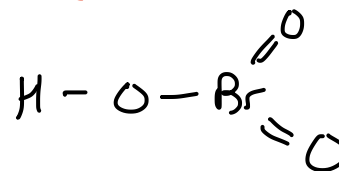
for "oxy-acids"
with the
same # of
O atoms, the one
with the
more electronegative
central atom
is the
stronger acid

stronger

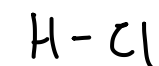


vs

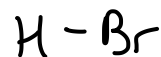
weaker



charges are the same on the central atom,
but the more electronegative atom is
able to stabilize the \ominus more effectively



weaker



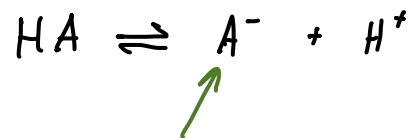
stronger



Trends in Acid Strength

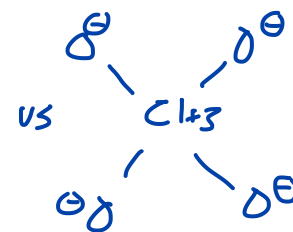
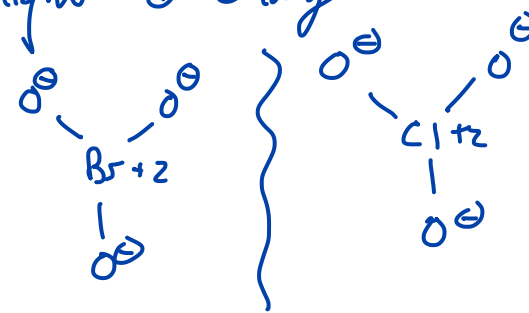
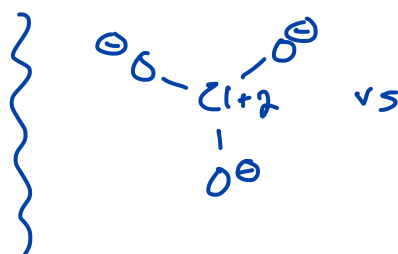
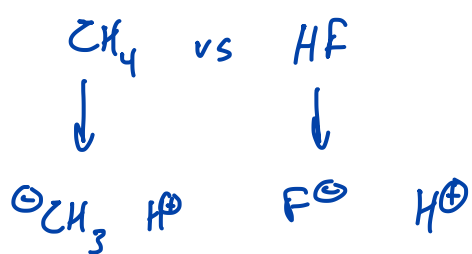
Section 6.3.7, 6.3.8, 6.3.9

in general for Brønsted-Lowry acids



↑
the more stable the A^- is the easier it is for the HA to donate its proton

Get the \ominus close to a \oplus charge or a higher \oplus charge



Spread the \ominus out over a larger volume

HBr vs HF by putting the charge on a large atom

$\text{CH}_3\text{CH}_2\text{OH}$ vs $\text{CH}_3\text{C}(=\text{O})\text{OH}$ by spreading the charge out via delocalization

Trends in Acid Strength

$$E \approx \frac{Z^2}{r}$$

Section 6.3.7, 6.3.8, 6.3.9

For Lewis acids

Lewis ... think e^- pairs

H^+ is always an acid ... what can H^+ do e^- pair. wise
can't donate so ... e^- pair acceptor

The higher the charge the more attractive the cation is
to e^- 's

Na^+ vs Al^{3+} - +3 of Al^{3+} will make it more Lewis acidic
never add water to $AlCl_3$

Na^+ vs Mg^{2+} - +2 of Mg^{2+} makes it a better Lewis acid than
 Na^+

Fe^{2+} vs Fe^{3+}

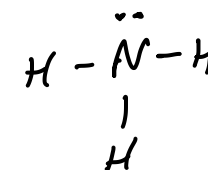
The smaller the atom with the \oplus charge, the better it will be at
attracting e^- 's Al^{3+} much more Lewis acidic than Ga^{3+}

Base Strength and Solvation

Section 6.3

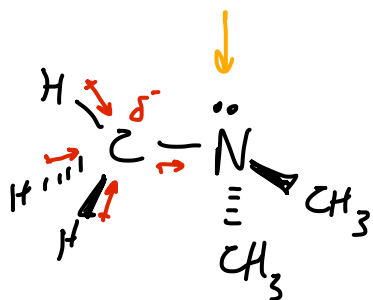
• the less stable the e^- 's are, the better they are at attracting H^+ 's
• more e^- rich more basic, right?

Gas phase basicity



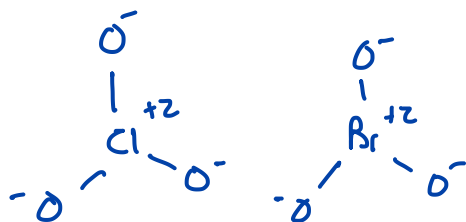
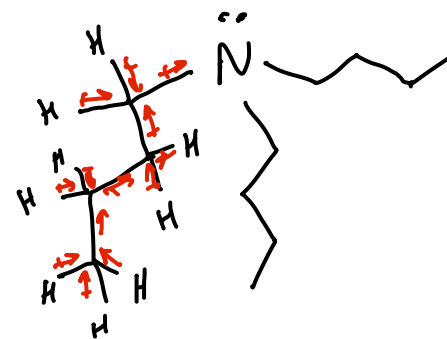
doing reactions in the gas phase simplifies the factors that influence base strength

this N is less e^- rich



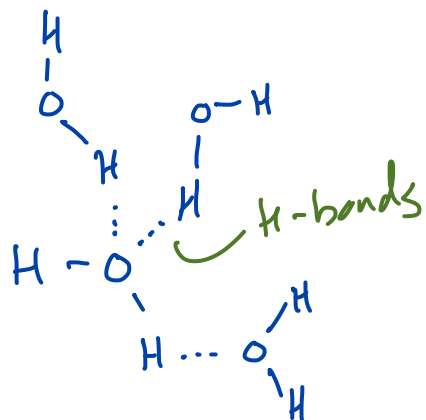
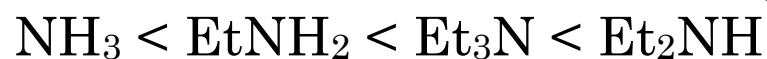
the alkyl groups are pushing e^- density towards the N making the N more e^- rich

this N is more e^- rich

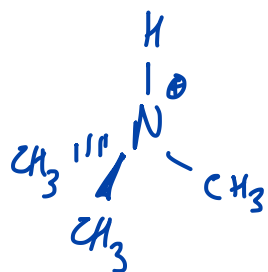


Increasing base strength in water

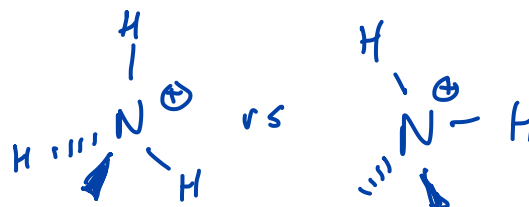
*more methyl groups
more e⁻ density
but a weaker base
than the
methyl amine*



*these can interact
with water*



vs



*cannot form
as many H-bonds
with H₂O*

*can form
more H-bonds
with H₂O*