This Class

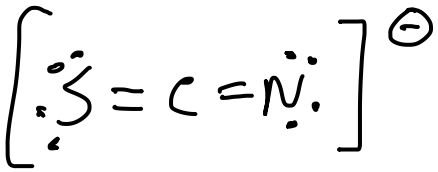
Chap 6.6 Hard-Soft Acid-Base

Concept

Next Class

Chap 9

AgF	$K_{sp} = 205$
AgCl	$K_{sp} = 1.8 \times 10^{-10}$
AgBr	$K_{sp} = 5.2 \times 10^{-13}$
AgI	$K_{sp} = 8.3 \times 10^{-17}$



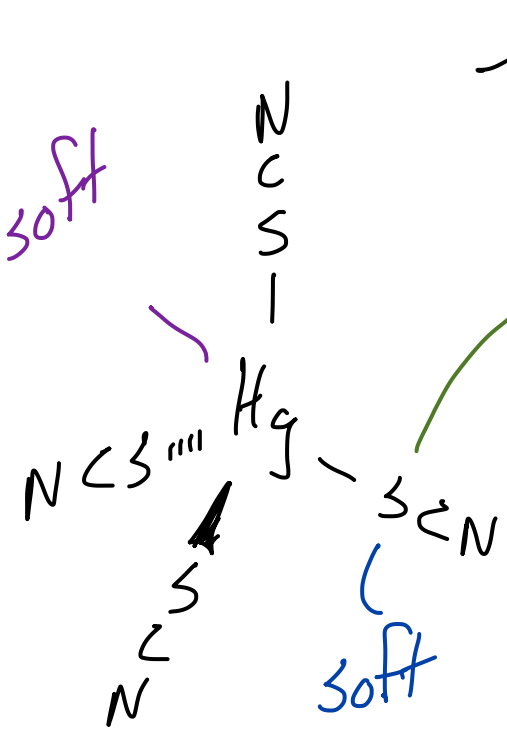
$[Hg(SCN)_4]^{2-}$ vs $[Zn(NCS)_4]^{2-}$

$$[CH_3Hg(H_2O)]^+ + HCl \rightleftharpoons CH_3HgCl + H_3O^+ \quad K = 1.8 \times 10^{12}$$

$$[CH_3Hg(H_2O)]^+ + HF \rightleftharpoons CH_3HgF + H_3O^+ \quad K = 4.5 \times 10^{-2}$$

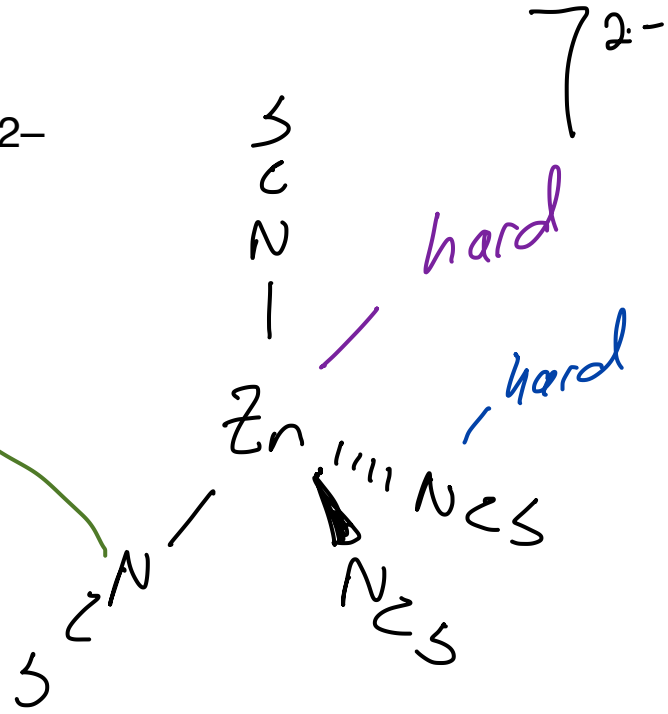
same family

$[Hg(SCN)_4]^{2-}$ vs $[Zn(NCS)_4]^{2-}$



S is in period 3 bigger

N is in period 2 smaller



basis for this idea is that atoms whose orbitals are more similar in size & E will interact more strongly

4 (-1) charge SCNs -4

30 Hg^{2+}

Hg is in the 6th row bigger

Zn^{2+}

Zn is in the 4th smaller

Small size + high charge hard large size + lower charge soft

Elements that have been left off the table are Hard acids (electron pair acceptors) Al^{3+}, H^+

Elements highlighted in yellow these are always soft acids

Elements appearing on the table but not highlight can be soft or hard depending on thier oxidation state + the molecules they interact with

												B	C				
						Mn	Fe	Co	Ni	Cu							
					Mo	Tc	Ru	Rh	Pd	Ag	Cd				Te		
					W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po		

Fe^{3+} slightly smaller + harder than Fe^{2+} slightly larger, less ⊕, and softer

lp e⁻ donor

lp e⁻ donor

lp e⁻ donors

large atoms

S, I ...

H^- is a soft base?

Yes, the single ⊕ does not attract e⁻ as well + so the e⁻ clouds is more polarizable than you might think.

smaller atoms that concentrate charge

Hard Bases	Borderline Bases	Soft Bases
		H^-
F^-, Cl^-	Br^-	I^-
H_2O, OH^-, O^{2-}		H_2S, SH^-, S^{2-}
ROH, RO^-, R_2O, CH_3COO^-		RSH, RS^-, R_2S
NO_3^-, ClO_4^-	NO_2^-, N_3^-	SCN^-, CN^-, RNC, CO
CO_3^{2-}, SO_4^{2-}, PO_4^{3-}	SO_3^{2-}	$S_2O_3^{2-}$
NH_3, RNH_2, N_2H_4	$C_6H_5NH_2$, C_5H_5N, N_2	PR_3, $P(OR)_3$, AsR_3, C_2H_4, C_6H_6

trading a weak interaction for a stronger interaction

S·H

H·H

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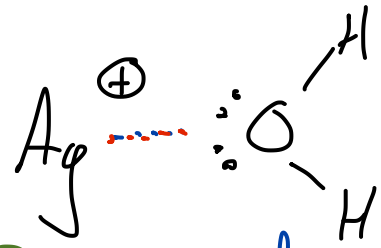
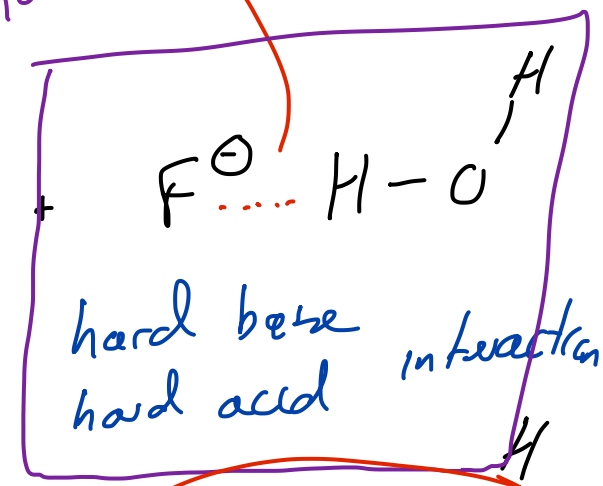
weaker interaction

+ $H_2O(l)$ ⟶

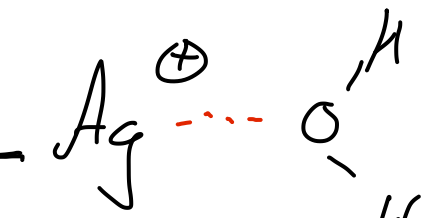


is this a hydrogen bond? yes

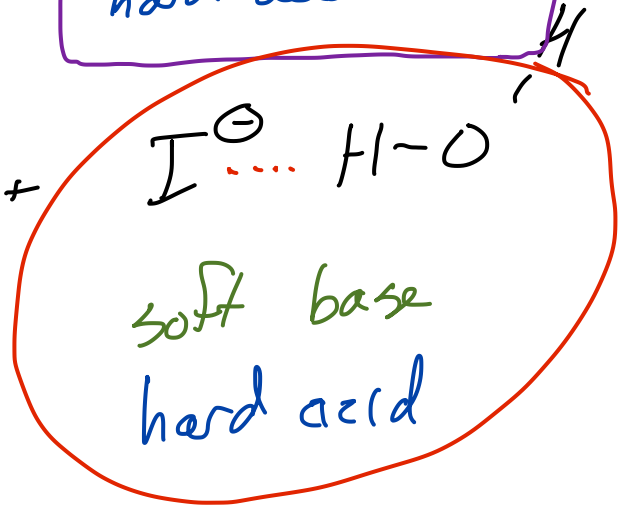
favorable



+ $H_2O(l)$ ⟶⟵



+



stronger interaction

similarly a S·S interaction will be favorable as compared to a H·S interaction

soft soft Cl^- soft soft

$$[CH_3Hg(H_2O)]^+ + HCl \rightleftharpoons CH_3HgCl + H_3O^+ \quad K = 1.8 \times 10^{12}$$

HI + HBr would be even more favorable than

soft soft F^- soft hard

$$[CH_3Hg(H_2O)]^+ + HF \rightleftharpoons CH_3HgF + H_3O^+ \quad K = 4.5 \times 10^{-2}$$

$$\eta = \frac{I - A}{2}$$

ionization energy

e⁻ affinity

dropping an e⁻ here