

# Class problem

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1a) Solid calcium fluoride ( $\text{CaF}_{2(s)}$ ) is added to pure water so that at equilibrium some solid remains dissolved. Given that the solubility product is  $3 \times 10^{-11} \text{ M}^3$ , what is the equilibrium concentration of  $\text{F}^-$  in water?



Since some solid remains at equilibrium, the solubility relationship must be satisfied

$$[\text{Ca}^{2+}][\text{F}^-]^2 = 3 \times 10^{-11} \quad (1)$$

Two unknowns,  $\text{Ca}^{2+}$  and  $\text{F}^-$ , and one equation?

Two options:

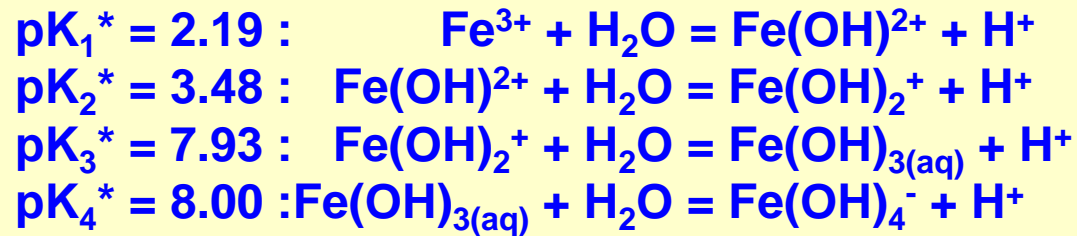
- use stoichiometry of dissolution
- charge balance (useful if we know all other constituents present)

# Metal-Complexation Reactions with OH<sup>-</sup>

**Table 8.2** Stability constants for complexation of metals by OH<sup>-</sup>

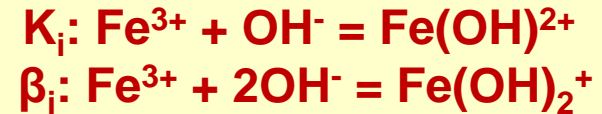
	<i>i</i>	Log <i>K<sub>i</sub></i>	Log * <i>K<sub>i</sub></i>	Log β <sub><i>i</i></sub>	Log *β <sub><i>i</i></sub>
Ag <sup>+</sup>	1	2.00	-12.00	2.00	-12.00
	2	2.00	-12.00	4.00	-24.00

Listing all reactions and constants sequentially

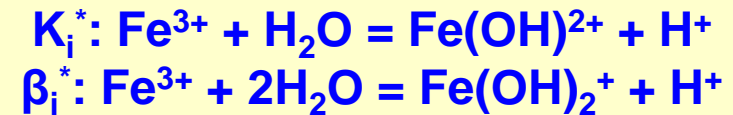


Co <sup>2+</sup>	1	4.80	-9.20	4.80
	2	4.90	-9.10	9.70
	3	1.10	-12.90	10.80
Cr <sup>3+</sup>	1	10.00	-4.00	10.00
	2	8.38	-5.62	18.38
	3	6.87	-7.13	25.25
	4	2.98	-11.02	28.23
Cu <sup>2+</sup>	1	6.00	-8.00	6.00
	2	8.32	-5.68	14.32
	3	0.78	-13.22	15.10
	4	1.30	-12.70	16.40
Fe <sup>2+</sup>	1	4.50	-9.50	4.50
	2	2.93	-11.07	7.43
	3	3.57	-10.43	11.00
Fe <sup>3+</sup>	1-OH	11.81	-2.19	11.81
	2	10.52	-3.48	22.33
	3	6.07	-7.93	28.40
	4	6.00	-8.00	34.40

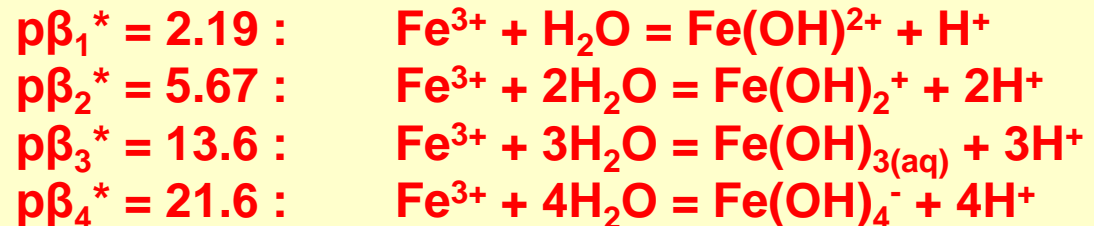
In terms of OH<sup>-</sup>



In terms of H<sup>+</sup>



Listing all reactions and constants cumulatively (in terms of component Fe<sup>3+</sup>)

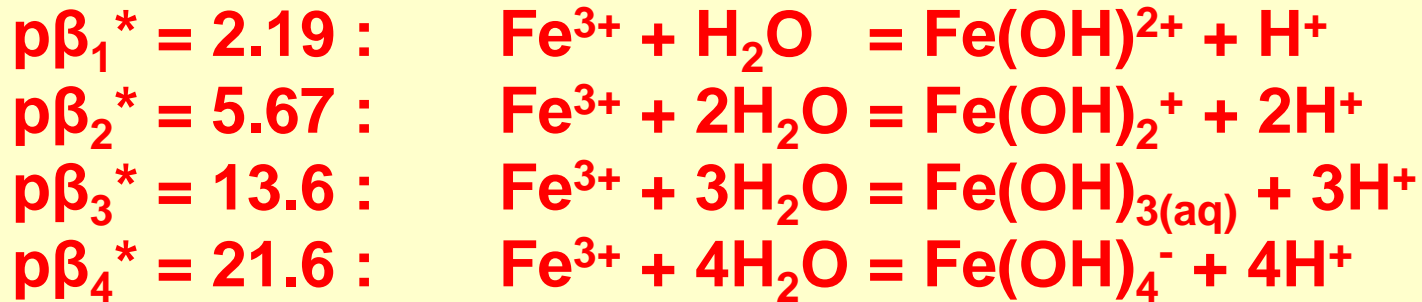


-31.00

-2.19  
-5.67  
-13.60  
-21.60

# Solubility Expressions

## Listing all reactions and constants



At any state of the system,

$$\begin{aligned} [\text{TOTFe}_{\text{diss}}] &= [\text{Fe}^{3+}] + [\text{Fe}(\text{OH})^{2+}] + [\text{Fe}(\text{OH})_2^+] + [\text{Fe}(\text{OH})_{3(\text{aq})}] + [\text{Fe}(\text{OH})_4^-] \\ &= [\text{Fe}^{3+}](1 + \beta_1^*/[\text{H}^+] + \beta_2^*/[\text{H}^+]^2 + \beta_3^*/[\text{H}^+]^3 + \beta_4^*/[\text{H}^+]^4) \end{aligned}$$

# Solubility Curve for $\text{Fe}(\text{OH})_{3(s)}$

$$[\text{TOTFe}_{\text{diss}}] = [\text{Fe}^{3+}] + [\text{Fe}(\text{OH})^{2+}] + [\text{Fe}(\text{OH})_2^+] + [\text{Fe}(\text{OH})_{3(\text{aq})}] + [\text{Fe}(\text{OH})_4^-]$$

$$= [\text{Fe}^{3+}](1 + \beta_1^*/[\text{H}^+] + \beta_2^*/[\text{H}^+]^2 + \beta_3^*/[\text{H}^+]^3 + \beta_4^*/[\text{H}^+]^4)$$

