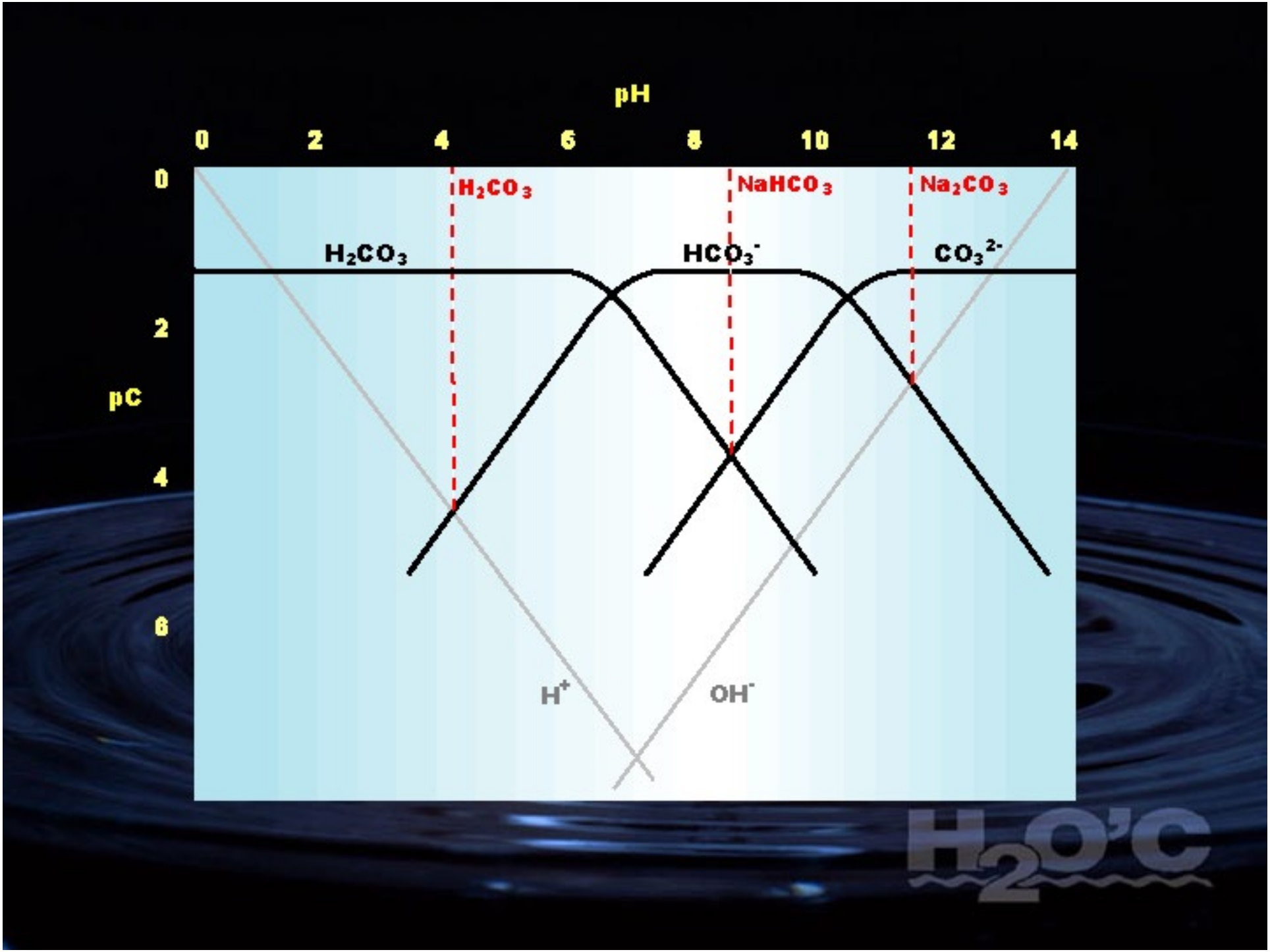
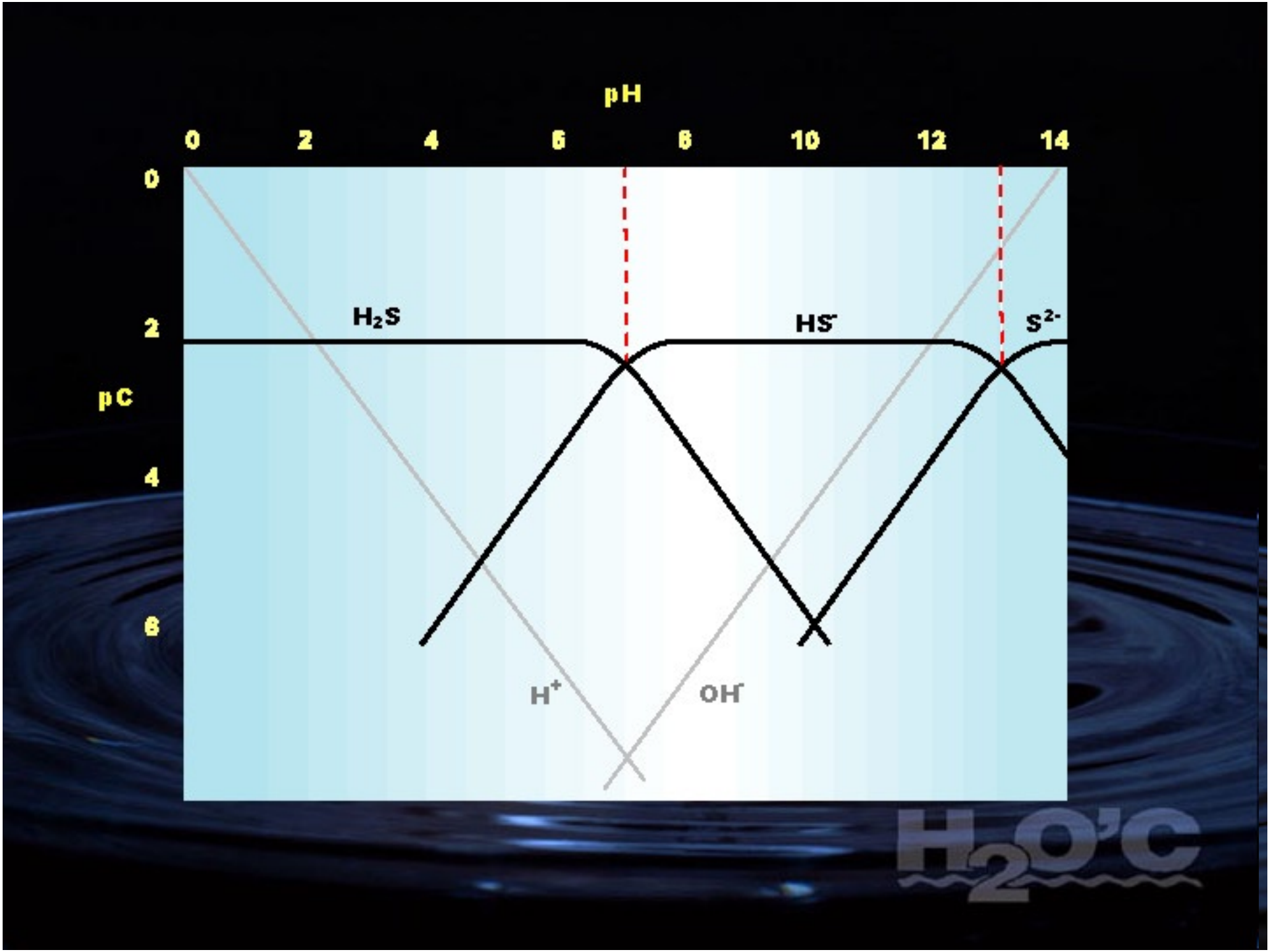
Solubility of Metals

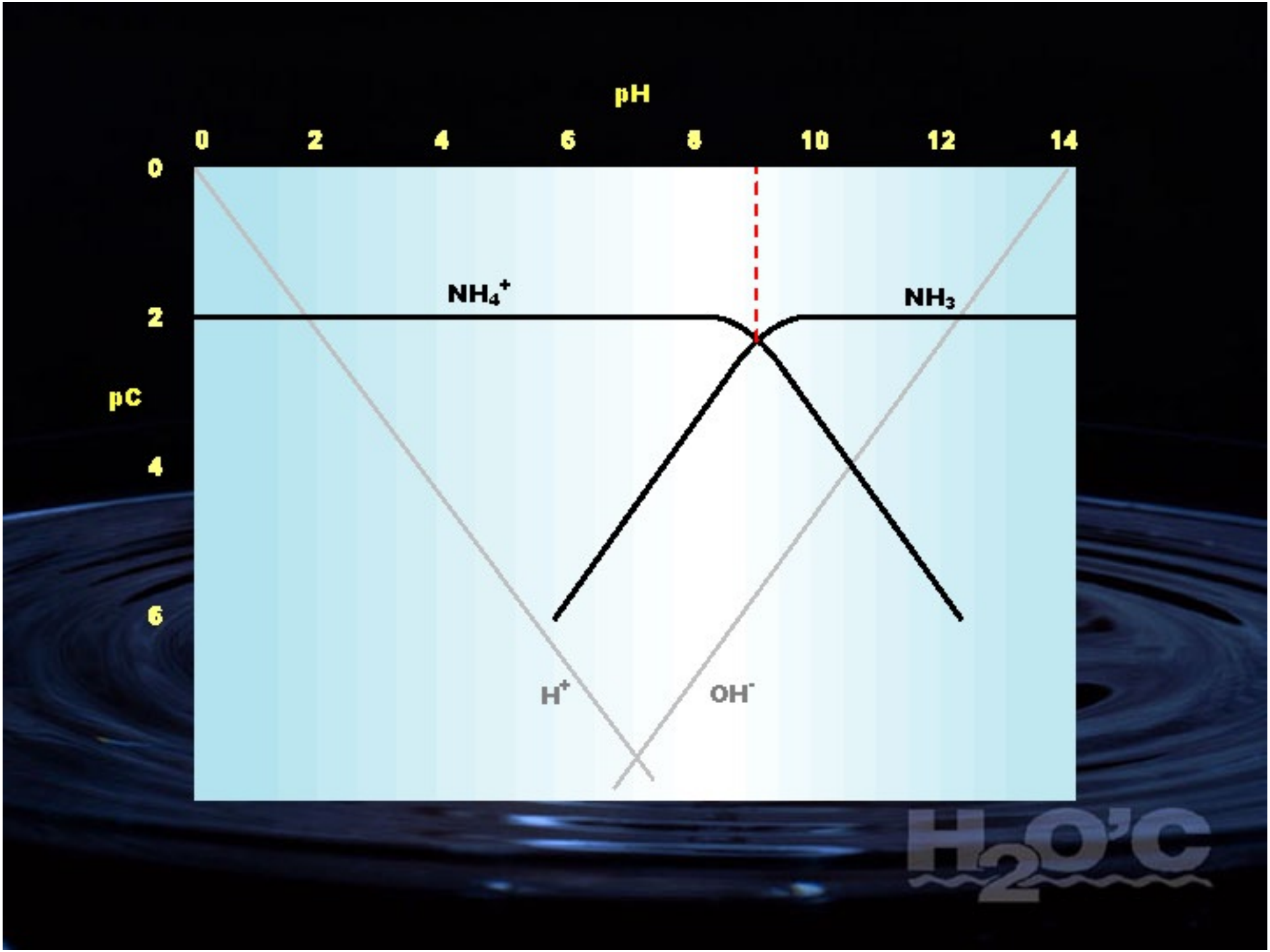
Dr. John T. O'Connor, PE

Acids & Bases

Acid	← pH →	Base
HCl	-3	Cl^-
H_2SO_4	-3	SO_4^{2-}
HNO_3	-1	NO_2^-
H_2CO_3	6.3	HCO_3^-
H_2S	7.1	HS^-
NH_4^+	9.3	NH_3
HCO_3^-	10.3	CO_2^{2-}

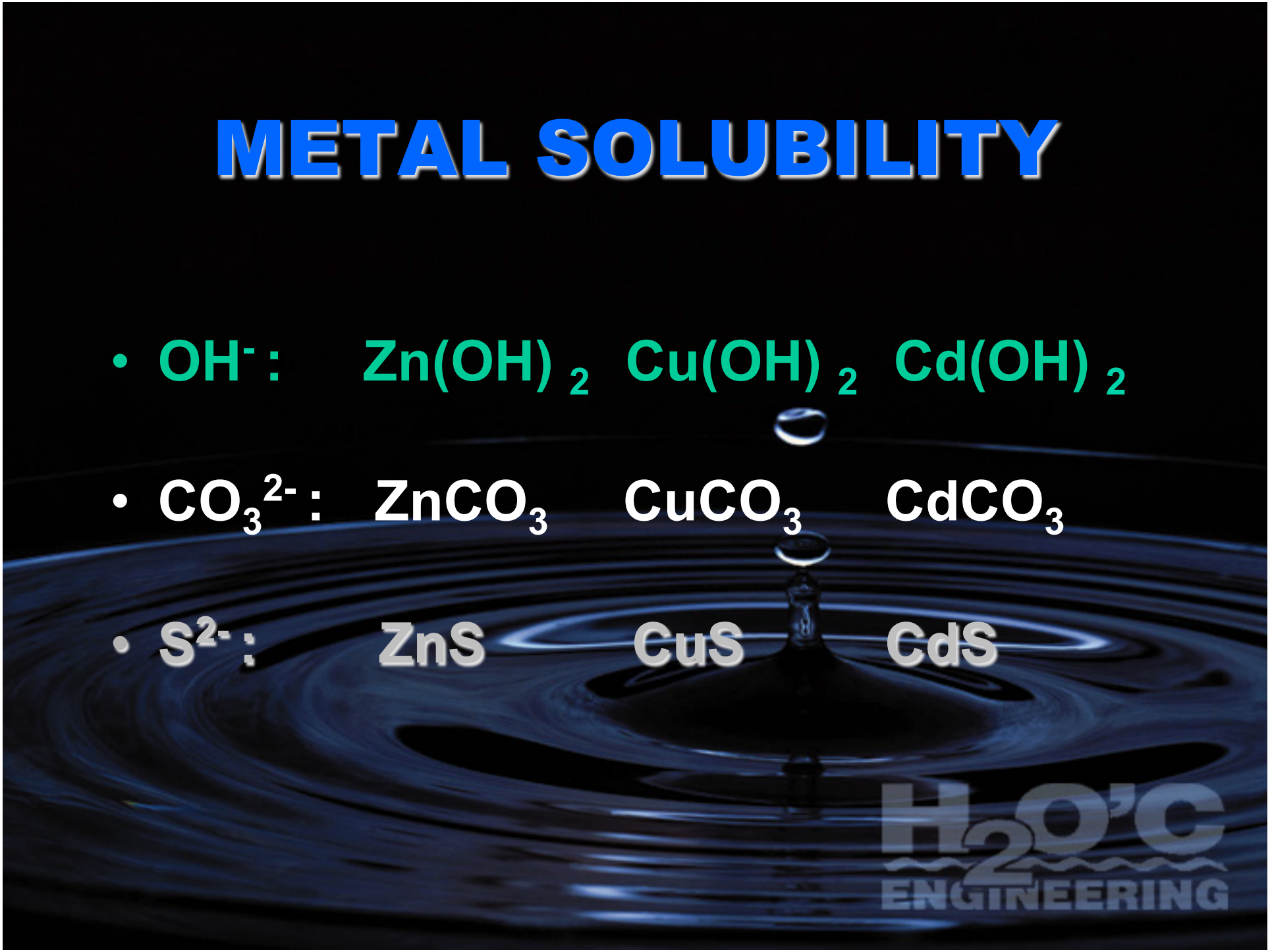

pH
0
2
4
6
8
10
12
14
pC
0
2
4
6
H2CO3
NaHCO3
Na2CO3
H2CO3
HCO3-
CO3 2-
H+
OH-
H2O'C


pH
0
2
4
6
8
10
12
14
0
2
4
6
pC
H2S
HS-
S2-
H+
OH-
H2O'C


pH
0
2
4
6
8
10
12
14
0
2
pC
4
6
NH4+
NH3
H+
OH-
H2O'C

METAL SOLUBILITY

- OH^- : $Zn(OH)_2$ $Cu(OH)_2$ $Cd(OH)_2$
- CO_3^{2-} : $ZnCO_3$ $CuCO_3$ $CdCO_3$
- S^{2-} : ZnS CuS CdS



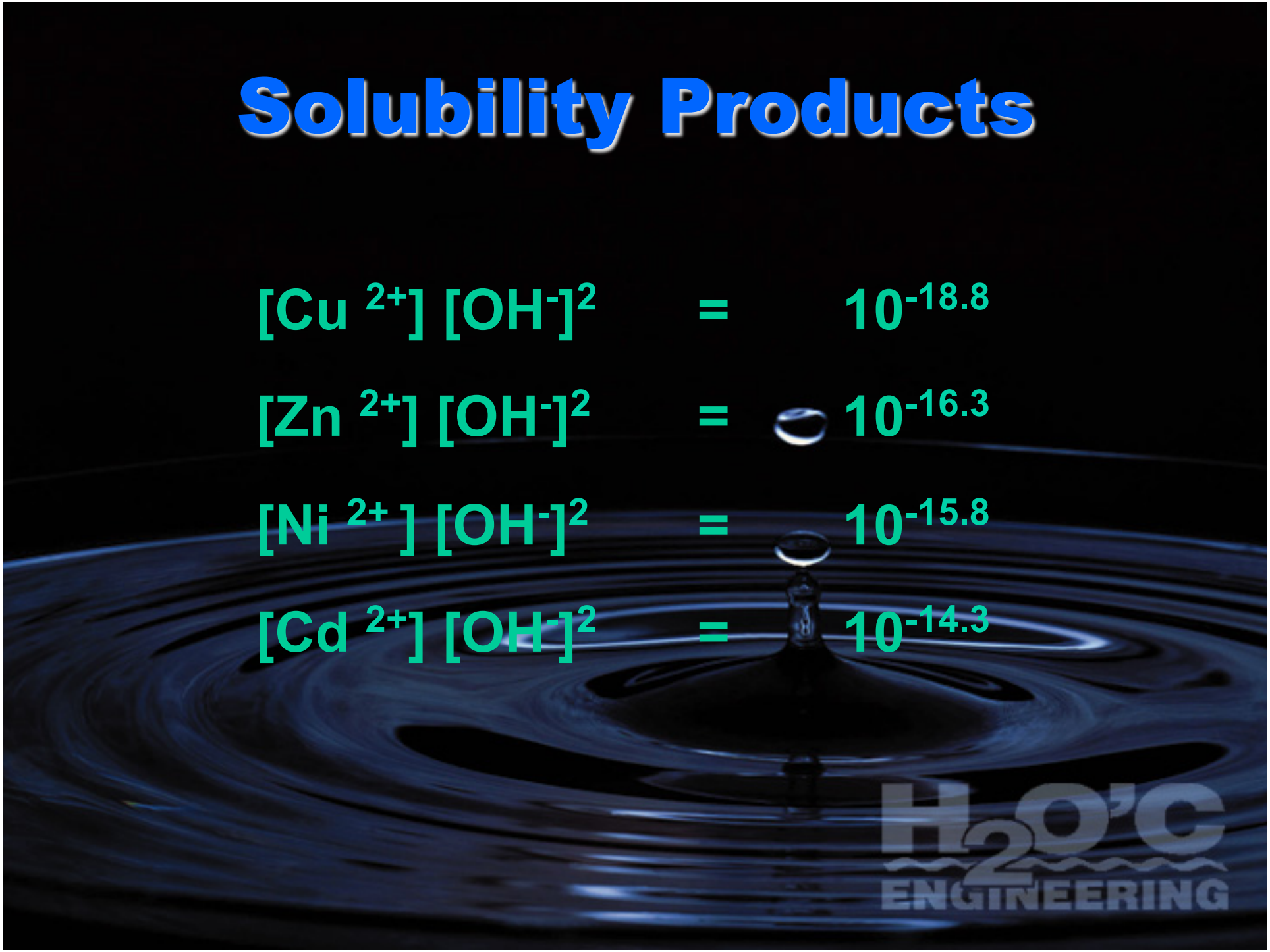
Solubility Products

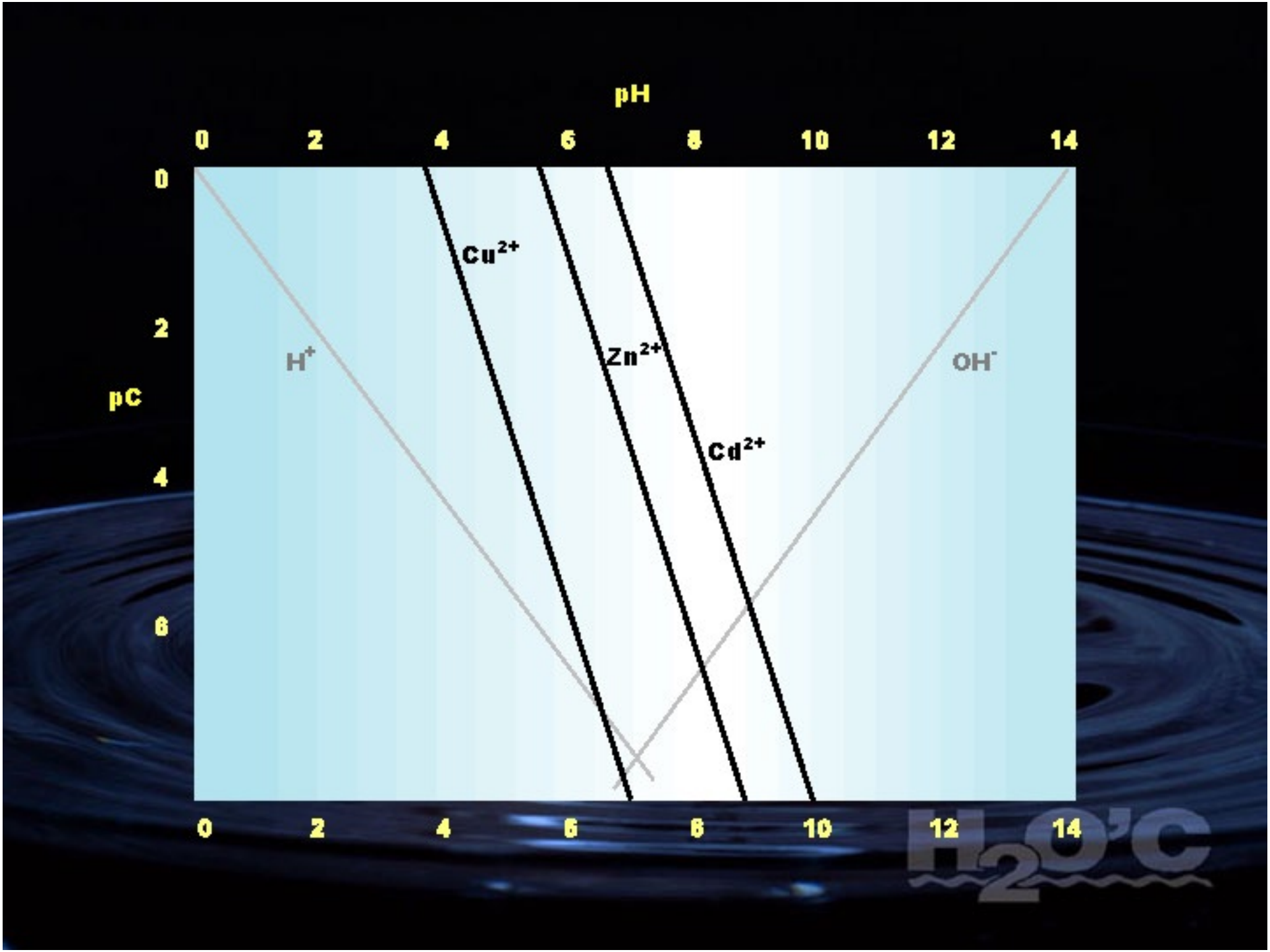
$[Cu^{2+}][OH^-]^2 = 10^{-18.8}$

$[Zn^{2+}][OH^-]^2 = 10^{-16.3}$

$[Ni^{2+}][OH^-]^2 = 10^{-15.8}$

$[Cd^{2+}][OH^-]^2 = 10^{-14.3}$




pH
0
2
4
6
8
10
12
14
pC
0
2
4
6
Cu2+
Zn2+
Cd2+
H+
OH-
H2O'C

Solubility Products

$[Cd^{2+}][CO_3^{2-}] = 10^{-11.3}$

$[Zn^{2+}][CO_3^{2-}] = 10^{-10.8}$

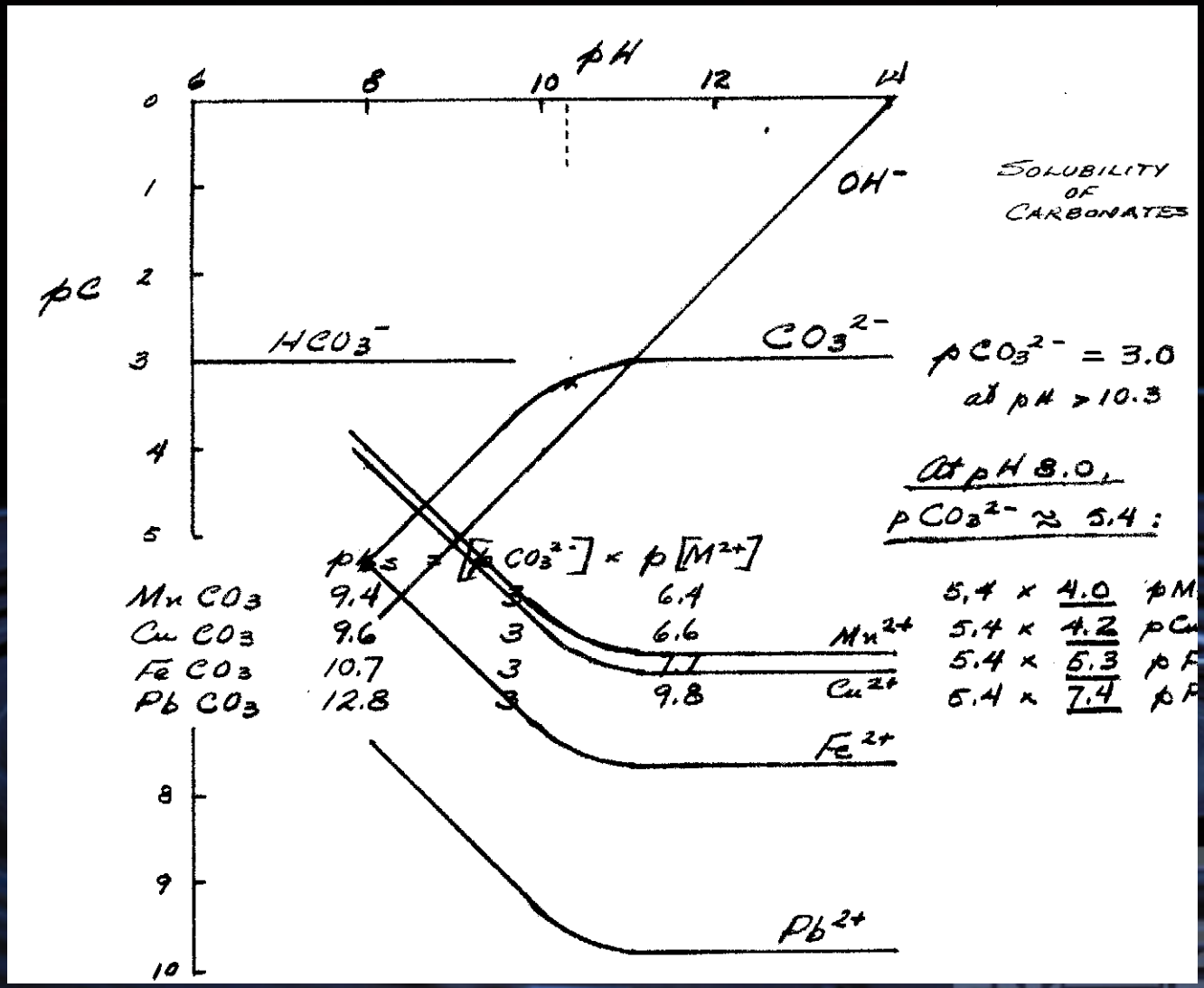
$[Cu^{2+}][S^{2-}] = 10^{-36.1}$

$[Cd^{2+}][S^{2-}] = 10^{-27.0}$

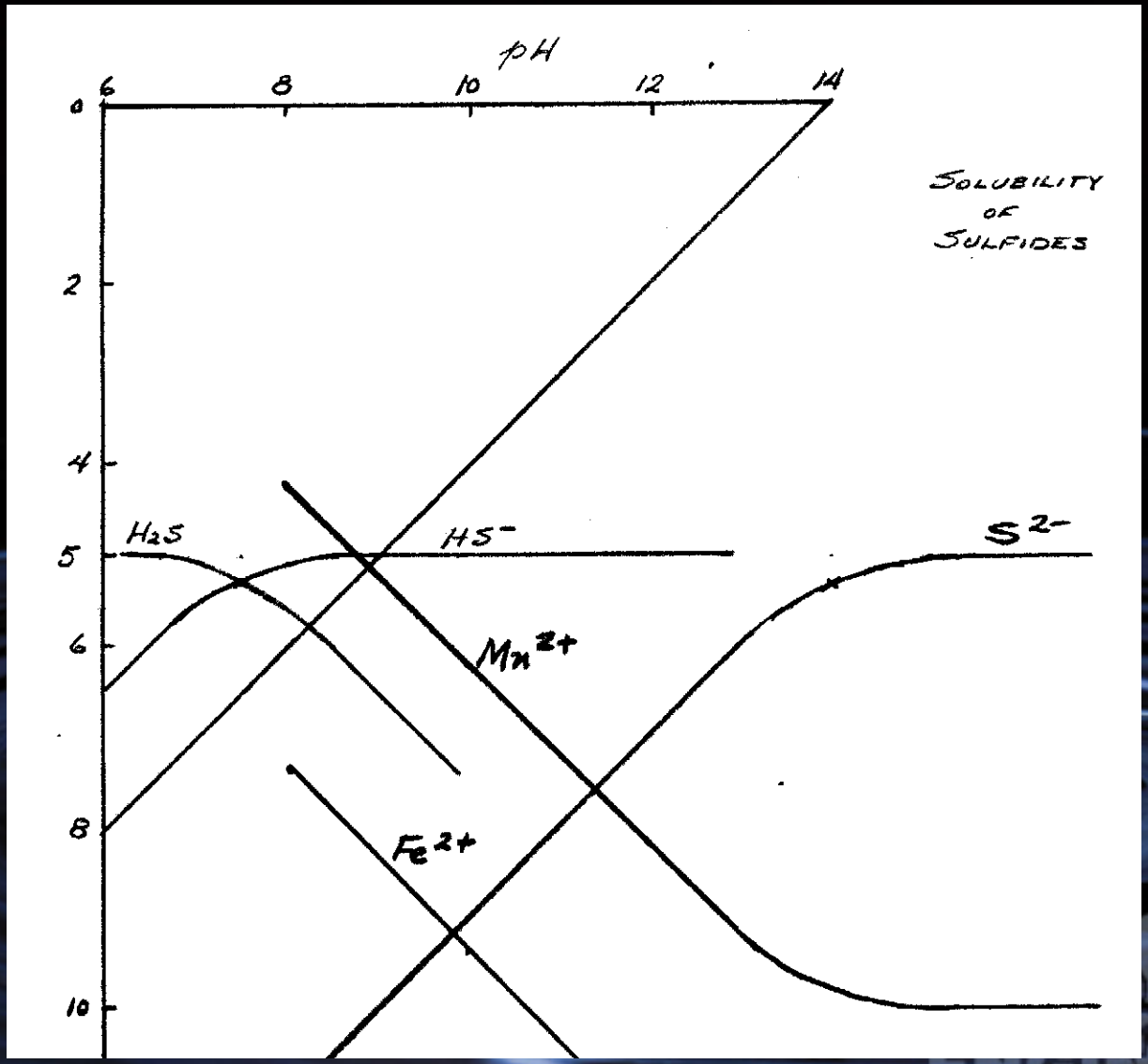
$[Zn^{2+}][S^{2-}] = 10^{-24.7}$

H2O'C ENGINEERING

Carbonate Solubility

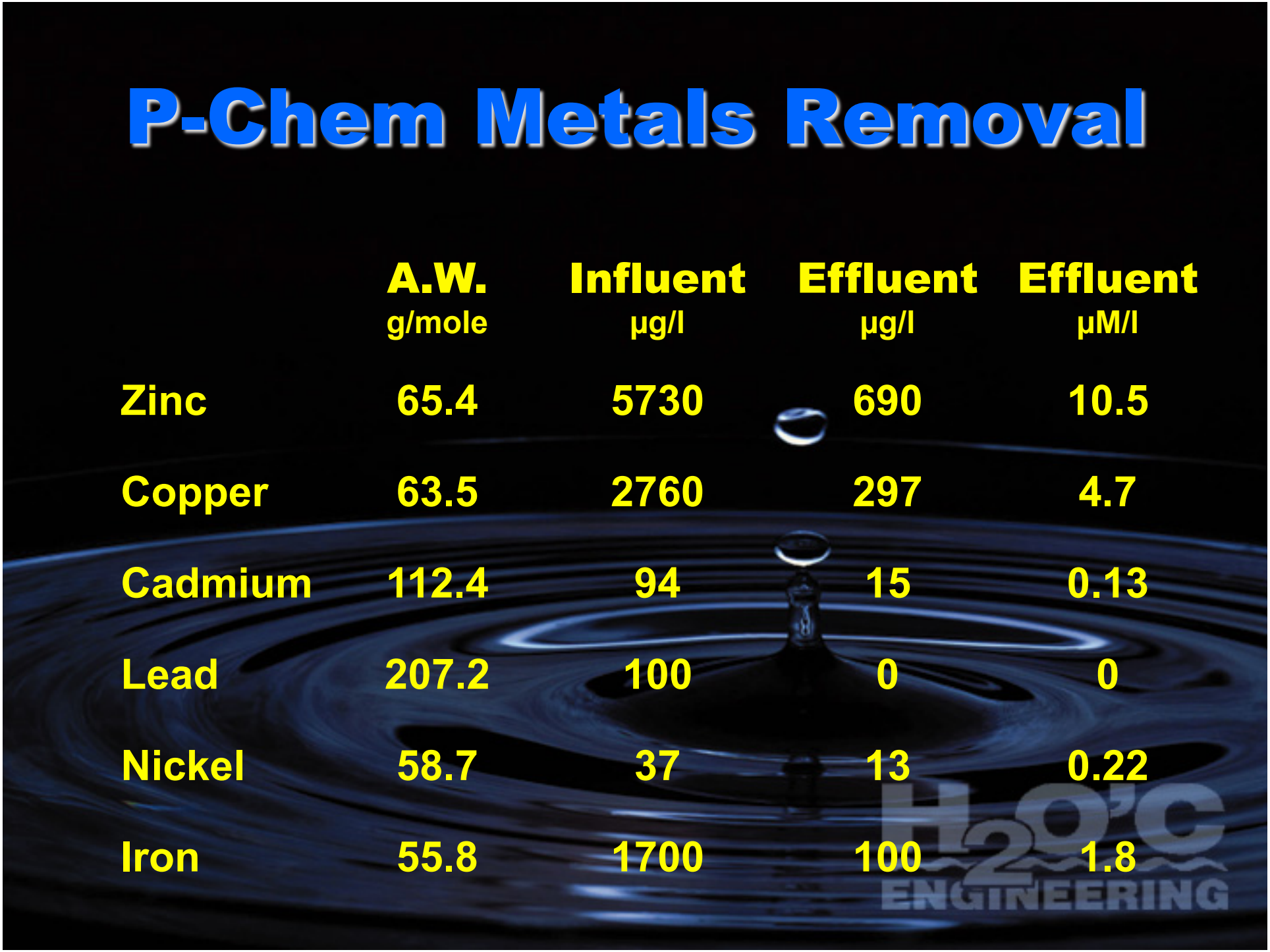


Sulfide Solubility



P-Chem Metals Removal

	A.W. g/mole	Influent µg/l	Effluent µg/l	Effluent µM/l
Zinc	65.4	5730	690	10.5
Copper	63.5	2760	297	4.7
Cadmium	112.4	94	15	0.13
Lead	207.2	100	0	0
Nickel	58.7	37	13	0.22
Iron	55.8	1700	100	1.8



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