CLAS Exam 2 chem2 Spring 2021

C 1) A: false, want to keep $[H^+]$ as constant as possible
B: false, H_3O^+ and OH^- are the strongest acid/base at equilibrium
C: true
d: higher [ ] will yield a higher buffer capacity
E: pKa must be ± 1 pH

A 2) $pH = pKa + \log\left[\frac{A^-}{HA}\right]$

$7 = -\log(6.5\times10^{-8}) + \log\left[\frac{A^-}{HA}\right]$

$\log\left[\frac{A^-}{HA}\right] = .1871$

$\left[\frac{A^-}{HA}\right] = 0.65 = \frac{0.25M}{[HA]}$

$[HA] = \frac{0.385\,mol}{L} \cdot (.5L) = 0.192\,mol\,HA$

$\left(\frac{0.192\,mol}{1}\right)\left(\frac{104.06\,g}{1\,mol\,NaHSO_3}\right) = 19.9g \approx \boxed{20g\ NaHSO_3}$

C 3)

HA	$\rightleftharpoons$	H^+	+ A^-	+ HCl
0.18M	$\rightleftharpoons$	-	0.27	.009
+.009	$\rightleftharpoons$	-	-.009	-.009
0.191	$\rightleftharpoons$	-	0.264	Ø

$pH = -\log(1.4\times10^{-5}) + \log\left(\frac{.264}{.191}\right) = \boxed{4.99}$

E 4) $HClO + NaOH \rightarrow H_2O + NaClO$

$H^+ + OH^- \rightarrow H_2O$

$.002 \quad .002 \rightarrow$

must be equal at equivalence point

$.1M\ NaOH \cdot (.02L) = .002$ moles

$\frac{.002 \text{ moles}}{.04L} = 0.05M$

	$HClO$	+ $NaOH$	$\rightleftarrows$	H_2O	+ $NaClO$
	.05	.05	$\rightleftarrows$		0
	-.05	-.05			+.05
	Ø	Ø			.05

	ClO^-	+ H_2O	$\rightleftharpoons$	$HClO$	+ OH^-
	.05		$\rightleftharpoons$	Ø	Ø
	-X		$\rightleftharpoons$	+X	+X
	.05-X		$\rightleftharpoons$	X	X

$K_{bClO^-} = \frac{1 \times 10^{-14}}{3.5 \times 10^{-8}} = 2.86 \times 10^{-7} = \frac{X^2}{(.05 - X)}$

$X = 1.2 \times 10^{-4}$

$pOH = -\log(1.2 \times 10^{-4})$

$pOH = 3.92$

$pH = 14 - 3.92 = \boxed{10.08}$

B 5) K_{sp}: $AgBr(s) \rightarrow Ag^+ + Br^-$

K_s: $Ag^+ + 2S_2O_3^{2-} \rightarrow [Ag(S_2O_3)_2]^{3-}$

$AgBr(s) + 2S_2O_3^{2-} \rightarrow [Ag(S_2O_3)_2]^{2-} + Br^-$

	y	$\rightarrow$	$\emptyset$	$\emptyset$
	$-2x$	$\rightarrow$	$+x$	$+x$
	$y-.04$	$\rightarrow$	$.02$	$.02$

$K' = K_{sp} \cdot K_s = \sqrt{6.6} = \sqrt{\frac{(.02)^2}{(y-.04)^2}}$

$2.569 = \frac{.02}{y-.04}$

$2.569y - 0.103 = .02$

$\boxed{y = 0.048 \text{ moles}}$

E 6) $Zn(OH)_2(s) \rightarrow Zn^{2+} + 2OH^-$

	$\emptyset$	$\emptyset$
	$+S$	$+2S$
	S	$2S$

$K_{sp} = (S)(2S)^2 = [Zn^{2+}][OH^-]^2$

$pOH = 14 - 10 = 4$

$4 = -\log[OH^-]$

$[OH^-] = 10^{-4}$

$4.5 \times 10^{-17} = (Zn^{2+})(10^{-4})^2$

$\boxed{[Zn^{2+}] = 4.5 \times 10^{-9}}$

A 7) $PbCl_{2(s)} \rightleftharpoons Pb^{2+} + 2Cl^-$

$\rightleftharpoons$	$\emptyset$	$\emptyset$
$\rightleftharpoons$	$+s$	$+2s$
	s	$2s$

$K_{sp} = (s)(2s)^2 = 4s^3$

$1.7 \times 10^{-5} = 4s^3$

$s = 1.6 \times 10^{-2}$

$Pb(H_2O)_6^{2+} \rightleftharpoons H^+ + Pb(H_2O)_5(OH)$

1.6×10^{-2}	$\rightleftharpoons \emptyset$	$\emptyset$
$-x$	$\rightleftharpoons +x$	$+x$
$1.6\times10^{-2} - x$	$\rightleftharpoons x$	x

$K_a = \frac{x^2}{1.6\times10^{-2}} = 3 \times 10^{-8}$

$x = 2.19 \times 10^{-5}$

$pH = -\log(2.19\times10^{-5})$

$\boxed{pH = 4.66}$

C 8) $K_{sp}\ CoCO_3 << K_{sp}\ NiCO_3$; Co^{2+} precipitates first

$K_{sp} = [Ni^{2+}][CO_3^{2-}]$

$6.6\times10^{-9} = (.10)(CO_3^{2-})$

$\boxed{[CO_3^{2-}] = 6.6\times10^{-8}}$

D 9) $Pb(NO_3)_2 + CaCl_2 \rightleftharpoons PbCl_{2(s)} + Ca(NO_3)_2$

$.03M + .02 \rightleftharpoons \quad \emptyset$

$Pb^{2+} + 2Cl^- \rightleftharpoons PbCl_{2(s)}$

$.03 \quad .04$

Slip rxn ↓

$PbCl_{2(s)} \rightleftharpoons Pb^{2+} + 2Cl^-$

$.03 \quad .04$

$Q = (.03)(.04)^2 = 4.8\times10^{-5}$

$\boxed{Q > K,\ \text{rxn shifts left}}$
$\boxed{\text{precipitate forms}}$

A 10) $Al^{3+} + 4OH^- \rightleftharpoons Al(OH)_4^-$

Al^{3+}	$4OH^-$	$\rightleftharpoons$	$Al(OH)_4^-$
.5	2.2	$\rightleftharpoons$	Ø
−.5	−4(.5)	$\rightleftharpoons$	+.5
≈X	0.2	$\rightleftharpoons$	0.5

$K_f = \frac{Al(OH)_4^-}{(Al^{3+})(OH^-)^4}$

$3.0 \times 10^{33} = \frac{(0.5)}{X(0.2)^4}$

$\boxed{X = 1.04 \times 10^{-31}}$

E 11) A) true, spontaneous rxn gives off energy
B) true, non-spontaneous rxn needs energy to run
C) ΔG can always vary from $\Delta G°$ based on conditions
D) true, the difference between K and Q gives a driving force
E) false, $\Delta G° < Ø$ for product favored rxn

D 12) A) 2 mol g ↔ 1 mol g ($-\Delta S$)
B) 4 mol g ↔ 2 mol g ($-\Delta S$)
C) 2 mol g ↔ 2 mol g (no change)
D) 1 mol g ↔ 4 mol g ($+\Delta S$)
E) 2 mol g ↔ 1 mol g ($-\Delta S$)

B 13) $\Delta S° = \Sigma \text{products} - \Sigma \text{reactants}$
$= (198) + (189) - [131 + 214]$
$\boxed{\Delta S° = 42 \text{ J/K}}$

B 14) $\Delta G = \Delta H - T\Delta S$

nonspontaneous at ALL temps: $+\Delta H$, $-\Delta S$

A) $+\Delta H$, $+\Delta S$
B) $+\Delta H$, $-\Delta S$
C) $-\Delta H$, $+\Delta S$
D) $-\Delta H$, $-\Delta S$
E) $-\Delta H$, $-\Delta S$

★Ch 23 - not covered by every professor★

E 15) $[Co(NH_3)_2(en)_2]Cl_3$

Co^{3+}

∴ Co has 3+ charge

Coordination # = # of ligand bonds
- NH_3 is monodentate $\times 2 = 2$
- en is bidentate $\times 2 = 4$

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Cl^- are counterions not ligands

E 16) $[Mn(CN)_6]^{4-}$
- CN is strong field ligand
- strong ligands absorb high energy photons ∴ short λ
- strong field = low spin
- diamagnetic

$\underline{\uparrow\downarrow}$ $\underline{\uparrow\downarrow}$ $\underline{\uparrow\downarrow}$

A 17) pentaamine chlorocobalt (III) chloride

$(NH_3)_5$ Cl^- Co^{3+} counter ion

$[Co(NH_3)_5Cl]^{2+}$ Cl^-

$[Co(NH_3)_5Cl]Cl_2$

C 18) CN^- is stronger field ligand than H_2O ∴ absorbs higher energy photons (short wavelength) ∴

- $[Fe(CN)_6]^{4-}$ absorbs green photons and appears yella
- $[Fe(H_2O)_6]^{2+}$ absorbs yella photons and appears green