

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

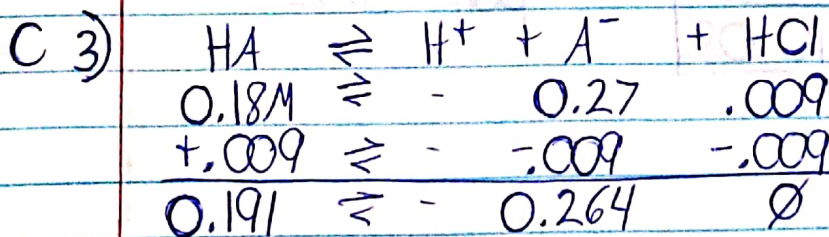
$$7 = -\log(6.5 \times 10^{-8}) + \log \left[\frac{A^-}{HA} \right]$$

$$\log \left[\frac{A^-}{HA} \right] = -1.871$$

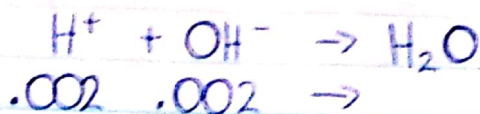
$$\left[\frac{A^-}{HA} \right] = 0.65 = \frac{0.25M}{[HA]}$$

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

$$\left(\frac{0.192 \text{ mol}}{1} \right) \left(\frac{104.06 \text{ g}}{1 \text{ mol NaHSO}_3} \right) = 19.9 \text{ g} \approx \boxed{20 \text{ g NaHSO}_3}$$



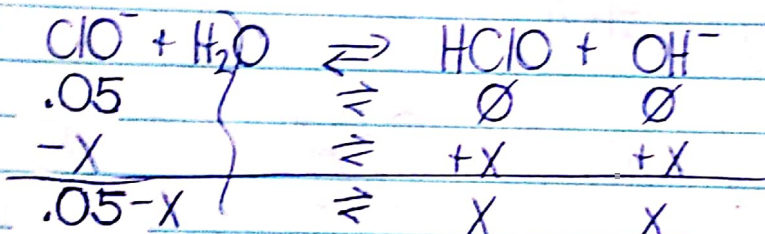
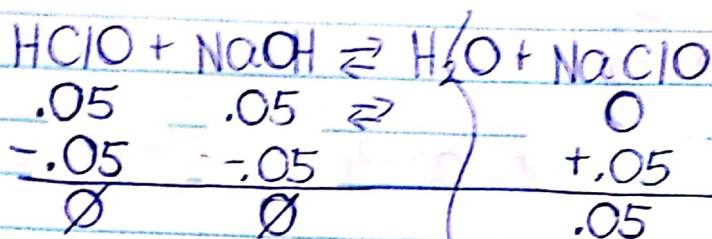
$$pH = -\log(1.4 \times 10^{-5}) + \log \left(\frac{.264}{.191} \right) = \boxed{4.99}$$



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

✓
must be equal
at equivalence point

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



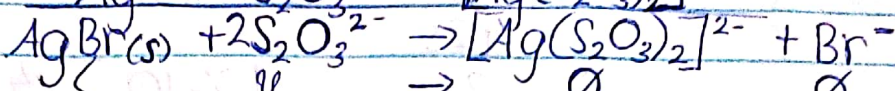
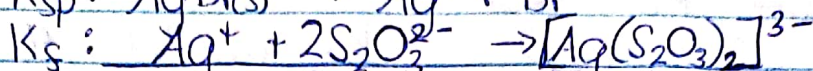
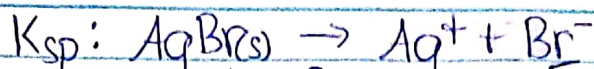
$$K_{\text{bClO}^-} = \frac{1 \times 10^{-14}}{3.5 \times 10^{-8}} = 2.86 \times 10^{-7} = \frac{x^2}{(.05 - x)}$$

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

$$\begin{aligned} \text{pOH} &= -\log(1.2 \times 10^{-4}) \\ \text{pOH} &= 3.92 \end{aligned}$$

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

B 5)



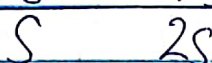
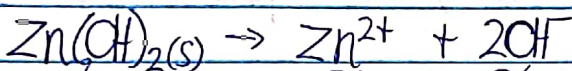
$$K' = K_{sp} \cdot K_s = \sqrt{6.6} = \sqrt{\frac{(.02)^2}{(y-.04)^2}}$$

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

$$2.569y - 0.103 = .02$$

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

E 6)



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

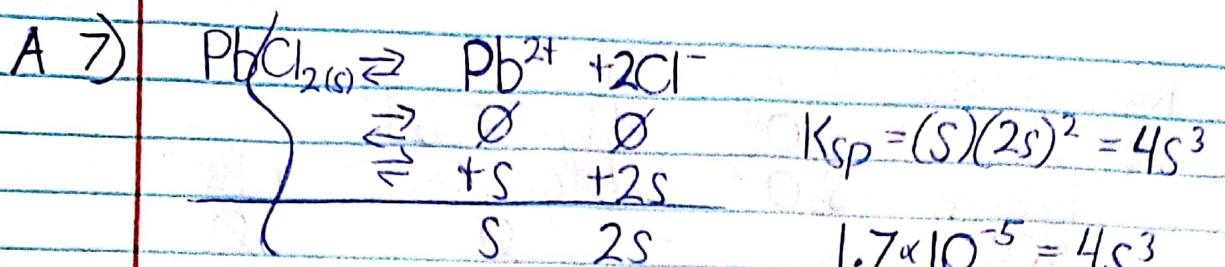
$$\text{pOH} = 14 - 10 = 4$$

$$4 = -\log[\text{OH}^-]$$

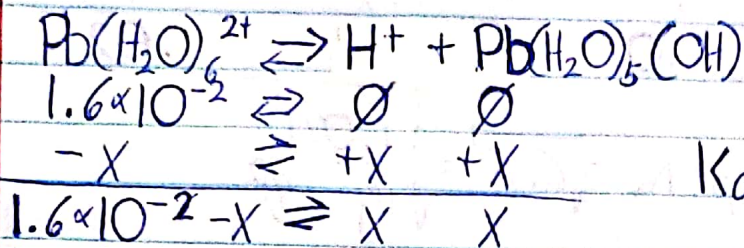
$$[\text{OH}^-] = 10^{-4}$$

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

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



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



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

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

$\text{pH} = -\log(2.19 \times 10^{-5})$

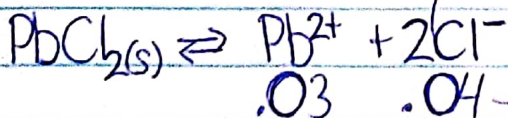
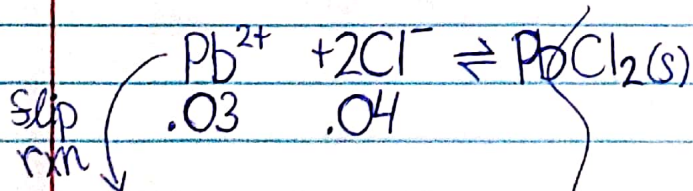
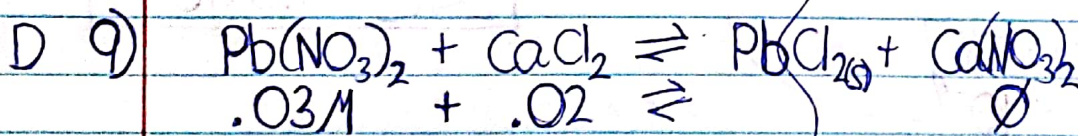
$\text{pH} = 4.66$

C 8) $K_{sp} \text{CoCO}_3 \ll K_{sp} \text{NiCO}_3$; Co^{2+} precipitates first

$K_{sp} = [\text{Ni}^{2+}][\text{CO}_3^{2-}]$

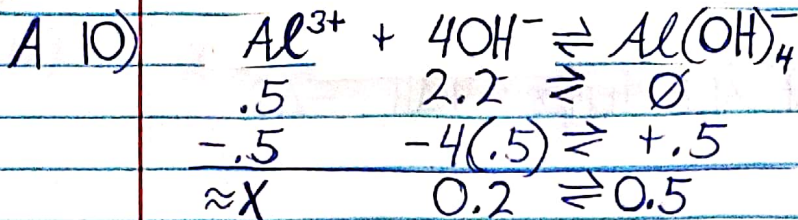
$6.6 \times 10^{-9} = (.10)(\text{CO}_3^{2-})$

$[\text{CO}_3^{2-}] = 6.6 \times 10^{-8}$



$Q = (.03)(.04)^2 = 4.8 \times 10^{-5}$

$Q > K$, rxn shifts left
precipitate forms



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

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

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

- E 11)
- A) true, spontaneous rxn gives off energy
 - B) true, non-spontaneous rxn needs energy to run
 - C) ΔG can always vary from ΔG° based on conditions
 - D) true, the difference between K and Q gives a driving force
 - E) false, $\Delta G^\circ < 0$ for product favored rxn

- D 12)
- A) 2 mol g \leftrightarrow 1 mol g (- ΔS)
 - B) 4 mol g \leftrightarrow 2 mol g (- ΔS)
 - C) 2 mol g \leftrightarrow 2 mol g (no change)
 - D) 1 mol g \leftrightarrow 4 mol g (+ ΔS)
 - E) 2 mol g \leftrightarrow 1 mol g (- ΔS)

B 13)

$$\Delta S^\circ = \sum \text{products} - \sum \text{reactants}$$

$$= (198) + (189) - [131 + 214]$$

$$\Delta S^\circ = 42 \text{ J/K}$$

B 14)

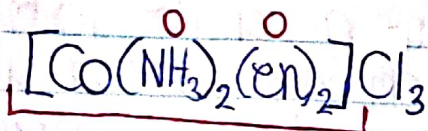
$$\Delta G = \Delta H - T\Delta S$$

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)



3+

$\therefore \text{Co}$ has 3+ charge

Coordination # = # of ligand bonds

• NH_3 is monodentate $\times 2 = 2$

• en is bidentate $\times 2 = 4$

6

Cl^- are counterions not ligands

E 16)

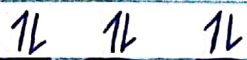


• CN is strong field ligand

• strong ligands absorb high energy photons \therefore short λ

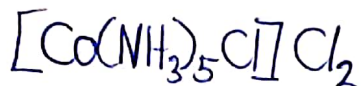
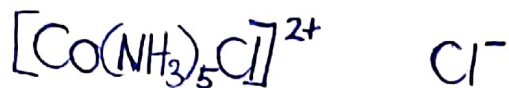
• strong field = low spin

• diamagnetic



A 17)

pentaaamminechlorocobalt(III) chloride
 $(\text{NH}_3)_5$ Cl^- Co^{3+} counter ion



C 18)

CN^- is stronger field ligand than H_2O \therefore absorbs higher energy photons (short wavelength) \therefore

- $[\text{Fe}(\text{CN})_6]^{4-}$ absorbs green photons and appears yellow
- $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ absorbs yellow photons and appears green