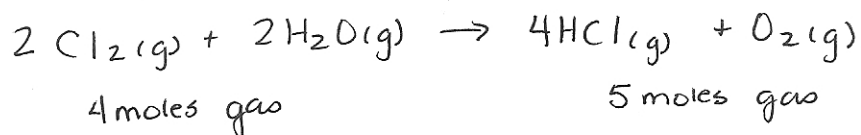


1. Conversion of K_p to K_c



$$\Delta n = 5 - 4 = 1$$

$$K_c = \frac{K_p}{(RT)^{\Delta n}} = \frac{4.6 \times 10^{-14}}{(0.0821)(298)} = \underline{1.88 \times 10^{-15}}$$

ANSWER: A) $K_c = 1.9 \times 10^{-15}$

$$2. \quad Q = \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]} = \frac{(0.2)(2.25)}{(0.20)} = 2.25 = 2 \text{ (1 sig fig)}$$

$Q > K_c \therefore$ rxn proceeds towards reactants (to the left)

ANSWER: E) NONE OF THESE

3. ANSWER: E - best answer

Comments: D is a true statement but is not LeChatelier's Principle

"stressed" is vague, I agree. Other writers use the phrase "disturbed" or talk about a "perturbation"

4. van't Hoff equation shows that K depends on T

ANSWER: B

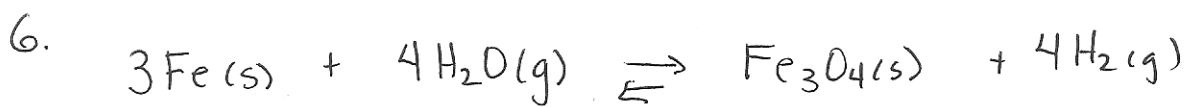
$$5. \quad K_c = \frac{[\text{SO}_2]^2 [\text{O}_2]}{[\text{SO}_3]^2}$$

I	0.128			
C	-2x	+2x	+x	
E	0.128 - 2x	2x	x	

$$K_c = \frac{[(2)(0.0130)]^2 (0.0130)}{[0.128 - (2)(0.0130)]^2}$$

$x = 0.0130 \quad K_c = 8.4 \times 10^{-4}$

ANSWER: A



solids do not appear in K_p or K_c expressions

$$K_p = \frac{(P_{\text{H}_2})^4}{(P_{\text{H}_2\text{O}})^4}$$

← from coefficients of balanced reaction.

ANSWER: E

7. $\text{pOH} = -0.47$

ALERT! outside normal range

$$[\text{OH}^-] = \text{anti log} \{- (\text{pOH})\} = 10^{+0.47} = 2.95$$

8. $0.272\text{g HA} \times \frac{1\text{mol}}{189\text{g}} \times \frac{1}{0.025\text{L}} = 5.76 \times 10^{-2} = [\text{HA}]$

ionization constant means K_a

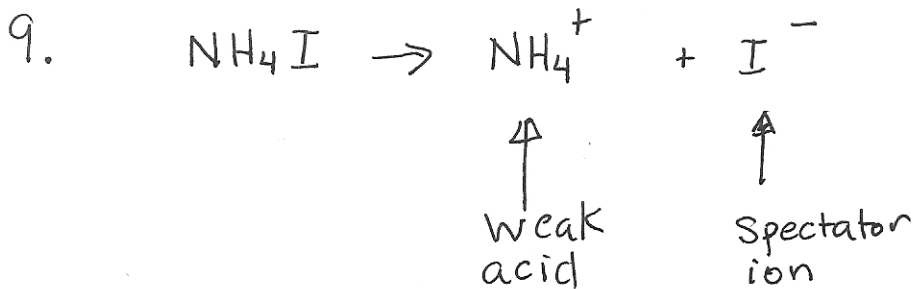
$$K_a = \frac{x^2}{\text{HA} - x} = \frac{x^2}{5.76 \times 10^{-2} - x}$$

$$\text{pH} = 4.93 \quad [\text{H}^+] = 10^{-4.93} = 1.1748 \times 10^{-5} = x$$

$$K_a = \frac{(1.1748 \times 10^{-5})^2}{5.76 \times 10^{-2} - 1.1748 \times 10^{-5}} = \frac{1.380 \times 10^{-10}}{5.7588 \times 10^{-2}}$$

$$x = 2.4 \times 10^{-9}$$

ANSWER: E



$$K_b \text{NH}_3 = 1.74 \times 10^{-5}$$

$$\therefore K_a \text{NH}_4^+ = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.74 \times 10^{-5}} = 5.75 \times 10^{-10}$$

$$[\text{NH}_4^+] = 0.300 \text{ M}$$

$$5.75 \times 10^{-10} = \frac{x^2}{0.300 - x} \approx \frac{x^2}{0.300}$$

$$x = 1.31 \times 10^{-5}$$

$$\text{pH} = 4.88$$

Note: The 263 mL does not enter into the problem.

ANSWER: C

10. $\text{pH} = ?$

0.250 M formic acid

$$K_a = 1.8 \times 10^{-4}$$

$$1.8 \times 10^{-4} = \frac{x^2}{0.250 - x} \approx \frac{x^2}{0.250}$$

$$x = 6.7 \times 10^{-3}$$

$$\text{pH} = 2.17$$

ANSWER: B

11. The answer is B because sodium chloride is not an acid or a base but I agree that the question is poorly worded.

12. $K_a = 6.3 \times 10^{-5}$ $pK_a = 4.20$

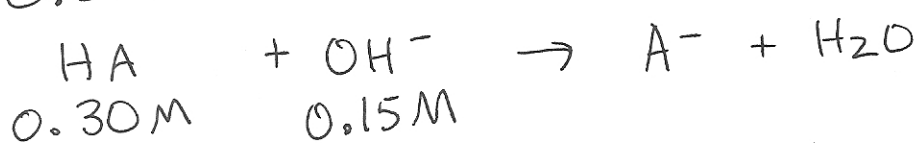
$$4.20 - 1 = 3.20$$

$$4.20 + 1 = 5.20$$

$$\text{Range} = 3.20 \text{ to } 5.20$$

ANSWER: E

13. 0.30M acetic acid (weak acid)



At the equivalence point essentially ALL of HA has been converted to A^-

It takes twice the volume of OH^- as HA to reach the equivalence point.

$$[\text{A}^-] = \frac{0.3}{3} - \text{trace that is left as HA}$$

$$K_a = 1.8 \times 10^{-5}$$

$$K_b = 5.5 \times 10^{-10} = \frac{x^2}{\frac{0.3}{3}}$$

$$\begin{array}{l} x = 7.4 \times 10^{-6} \\ pOH = 5.13 \\ pH = 8.87 \end{array} \left\{ \begin{array}{l} \text{Thymol} \\ \text{blue} \end{array} \right\}$$

14. This is a buffer. The initial concentrations will not change very much. Since the concentration of $\text{HF} > \text{F}^-$ it is reasonable to expect a slight shift towards more F^- . Answer A is very close to 1.045 and therefore the best answer.

15. NH_4Cl is a weak acid. The pH will decrease.

ANSWER: B

16. $K_{\text{sp}} = 7.6 \times 10^{-7} = s^2$
 $s = 8.7 \times 10^{-4}$

ANSWER: D

17. MX_2 114g/mol

$$\frac{3.42\text{g}}{\text{L}} \times \frac{1\text{mol}}{114\text{g}} = 3 \times 10^{-2} = s \text{ (molar solubility)}$$

$$K_{\text{sp}} = 4s^3 = 1.08 \times 10^{-4}$$

ANSWER: B

18. $1.5 \times 10^{-8} = [\text{Ba}^{2+}][\text{C}_2\text{O}_4^{2-}]$

$$1.5 \times 10^{-8} = (5.0 \times 10^{-5})[\text{C}_2\text{O}_4^{2-}]$$

FIRST $[\text{C}_2\text{O}_4^{2-}] = 3.0 \times 10^{-4}$ when Barium ion precipitates

$$1.35 \times 10^{-9} = [\text{Zn}^{2+}][\text{C}_2\text{O}_4^{2-}]$$

$$1.35 \times 10^{-9} = (2.0 \times 10^{-7})[\text{C}_2\text{O}_4^{2-}]$$

SECOND $[\text{C}_2\text{O}_4^{2-}] = 6.75 \times 10^{-3}$ when Zinc ion precipitates

$$1.1 \times 10^{-11} = [\text{Ag}^+]^2[\text{C}_2\text{O}_4^{2-}]$$

$$1.1 \times 10^{-11} = (3.0 \times 10^{-5})^2[\text{C}_2\text{O}_4^{2-}]$$

THIRD $[\text{C}_2\text{O}_4^{2-}] = 1.22 \times 10^{-2}$ when silver ion ppt.

When the second ion, zinc, begins to precipitate the $[\text{C}_2\text{O}_4^{2-}] = 6.75 \times 10^{-3}$

FOR Ba^{2+}

$$1.5 \times 10^{-8} = [\text{Ba}^{2+}](6.75 \times 10^{-3})$$

$$[\text{Ba}^{2+}] = 2.22 \times 10^{-6}$$

ANSWER: B

19. $1.0 \times 10^{-6} = s^2$ for MX $s = 1.0 \times 10^{-3}$
 $1.0 \times 10^{-6} = 4s^3$ for M_2X and MX_2
 $s = 6.3 \times 10^{-3}$

$1.0 \times 10^{-6} = 27s^4$ for MX_3 $s = \underline{\underline{1.39 \times 10^{-2}}}$
 largest s

ANSWER: C

20. $[Pb^{2+}] = 4.8 \times 10^{-6}$

$4.8 \times 10^{-6} \frac{\text{moles}}{L} \times 0.1 L = 4.8 \times 10^{-7} \text{ moles}$

$1.00 M NaI \times 10 mL = 10 \text{ mmoles} = 0.01 \text{ mol}$

total volume \rightarrow $100 mL + 10 mL$
 $Q = \left(\frac{0.01}{0.11} \right)^2 \left(\frac{4.8 \times 10^{-7}}{0.11} \right) = 3.6 \times 10^{-8}$

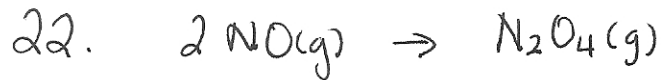
$Q > K_{sp}$ so precipitation will occur.

ANSWER: B

21. $5.9 \times 10^{-3} = (s)(0.10)$

$s = 5.9 \times 10^{-2}$

ANSWER: B



$$\Delta n = 1 - 2 = -1$$

$$K_p = K_c (RT)^{\Delta n}$$

$$K_p = K_c (RT)^{-1} \quad K_p = \frac{K_c}{RT}$$

ANSWER: D

23.

weak acids

phenol $pK_a = 7.54$

strong acids

HClO_4

weak bases

pyridine $pK_b = 8.82$

triethylamine $pK_b = 3.25$

ammonia $pK_b = 4.74$

strong bases

NaOH

possible buffers

phenol + NaOH

$\text{pH} \sim 7.54$

★ pyridine + HClO_4

$\text{pH} \sim 14 - 8.82 = 5.18$

triethylamine + HClO_4

$\text{pH} \sim 14 - 3.25 = 10.75$

ammonia + HClO_4

$\text{pH} \sim 14 - 4.74 = 9.26$

Answer: A

24. No effect

ANSWER B

25. H_2O is a base in this reaction

$C_2H_3O_2^-$ is a base

acid + base \rightarrow weaker acid + weaker base

ANSWER: B

26. ~ 7.4 middle of second flat region.