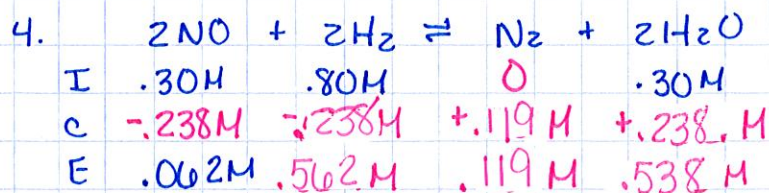
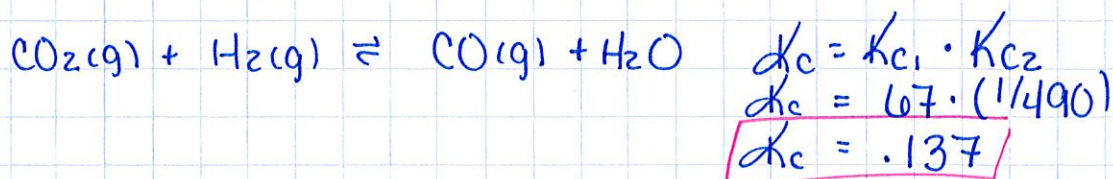
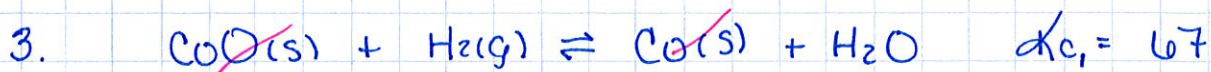


# Ch 15 & 16 Study Guide Key

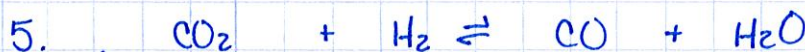
- (A) mostly reactants (small  $K_c$ )  
(B) mostly products (large  $K_p$ )

$$2. K_p = K_c (RT)^{\Delta n} = .042 \left( .08206 \frac{\text{Latm}}{\text{mol K}} \cdot 500\text{K} \right)^{-1} = 1.02 \times 10^{-3}$$



$$K_c = \frac{[\text{N}_2][\text{H}_2\text{O}]^2}{[\text{NO}]^2[\text{H}_2]^2}$$

$$K_c = \frac{[.119][.538]^2}{[.062]^2[.562]^2} = 28.37$$

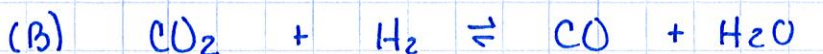


$$(A) \quad P = \frac{nRT}{V} \quad P_{\text{CO}_2} = \frac{(.2000\text{mol})(.08206 \frac{\text{Latm}}{\text{mol K}})(500\text{K})}{2.000\text{L}} = 4.103 \text{ atm}$$

$$P_{\text{H}_2} = \frac{(.1000\text{mol})(.08206 \frac{\text{Latm}}{\text{mol K}})(500\text{K})}{2.000\text{L}} = 2.052 \text{ atm}$$

$$P_{\text{CO}} = 0 \text{ atm}$$

$$P_{\text{H}_2\text{O}} = \frac{(.1600\text{mol})(.08206 \frac{\text{Latm}}{\text{mol K}})(500\text{K})}{2.000\text{L}} = 3.282 \text{ atm}$$



I	4.103	2.052	0	3.282
C	-.2276	-.2276	+.2276	+.2276
E	3.375	1.824	.2276	3.51

$$(C) \quad K_p = \frac{P_{\text{CO}} \cdot P_{\text{H}_2\text{O}}}{P_{\text{CO}_2} \cdot P_{\text{H}_2}} = \frac{(.2276)(.2276)}{(3.375)(1.824)} = 8.41 \times 10^{-3}$$



$$K_c = .078 = \frac{[\text{SO}_2][\text{Cl}_2]}{[\text{SO}_2\text{Cl}_2]} \quad .078 = \frac{[.052][\text{Cl}_2]}{[.108]}$$

$$.162\text{M} = [\text{Cl}_2]$$

$$P = MRT = (.162\text{M})(.08206 \frac{\text{Latm}}{\text{molK}})(373\text{K}) = \boxed{4.96 \text{ atm}}$$



$$[\text{Br}_2] = .245\text{g Br}_2 \left( \frac{1\text{mol}}{159.80\text{g}} \right) = \frac{1.53 \times 10^{-3}\text{mol}}{.200\text{L}} = 7.65 \times 10^{-3}\text{M}$$

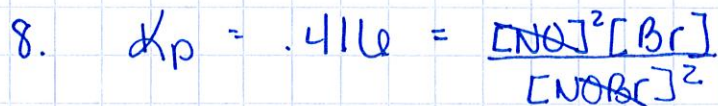
$$K_c = \frac{[\text{Br}]^2}{[\text{Br}_2]} \quad 1.04 \times 10^{-3} = \frac{[\text{Br}]^2}{7.65 \times 10^{-3}}$$

$$7.96 \times 10^{-6} = [\text{Br}]^2$$

$$2.82 \times 10^{-3}\text{M} = [\text{Br}]$$

$$n = M \cdot V = 2.82 \times 10^{-3}\text{M} \cdot .200\text{L} = 5.64 \times 10^{-4}\text{mol Br}$$

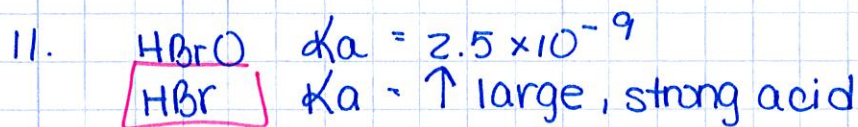
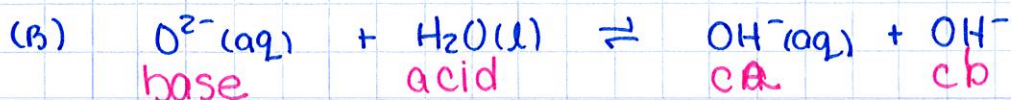
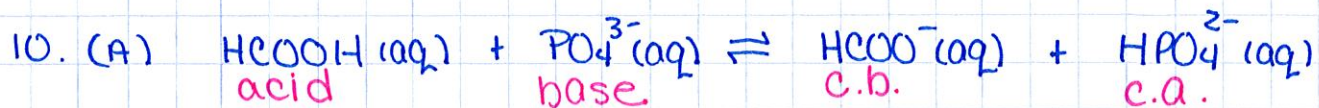
$$\text{mass Br} = 5.64 \times 10^{-4}\text{mol} \left( \frac{79.90\text{g}}{1\text{mol}} \right) = \boxed{.0451\text{g Br}}$$



$$[\text{Br}] = .416\text{M}$$

$$P = MRT = .416\text{M} \left( .08206 \frac{\text{Latm}}{\text{molK}} \right) (373) = \boxed{1.27 \text{ atm}}$$

9. (A) equilibrium would shift to the left to make more reactants, causing  $K$  to decrease.  $K = \frac{[\text{products}]}{[\text{reactants}]}$   
 (B) equilibrium would shift to the right to make more products, causing  $K_c$  to increase  
 (C) It would depend on which side has more moles: reactants > products -  $K_c$  decreases  
products > reactants -  $K_c$  increases  
 (D) depends, if its endothermic,  $K$  would decrease, exothermic,  $K$  increases  
 (E) Catalysts have no effect on  $K$ .



12.  $K_w = 1.2 \times 10^{-15} = [\text{H}^+][\text{OH}^-]$   $[\text{H}^+] = [\text{OH}^-]$  for a neutral solution

$1.2 \times 10^{-15} = x^2$

$3.46 \times 10^{-8} \text{ M} = x = [\text{H}^+] = [\text{OH}^-]$

13. Adding NaOH to water would increase  $\text{OH}^-$  ions, those react with the  $\text{H}^+$  ions in water and lowering the overall  $[\text{H}^+]$ .

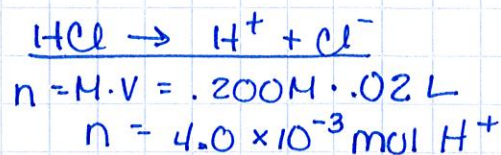
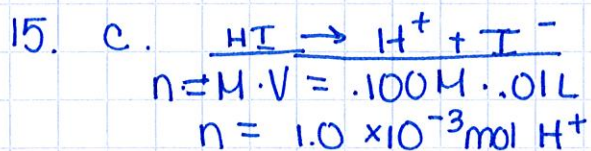
14.	$[\text{H}^+]$	$[\text{OH}^-]$	pH	pOH	Acid or Base?
	$7.5 \times 10^{-3}$	$1.33 \times 10^{-12}$	2.12	11.88	Acid
	$2.8 \times 10^{-5}$	$3.6 \times 10^{-10}$	4.56	9.44	Acid
	$5.6 \times 10^{-9}$	$1.78 \times 10^{-6}$	8.25	5.75	Base
	$5.0 \times 10^{-9}$	$2.0 \times 10^{-6}$	8.30	5.7	Base

15. (A)  $\text{pH} = -\log [\text{H}^+] = -\log [8.5 \times 10^{-4}] = 3.07$   $\text{HBr} \rightarrow \text{H}^+ + \text{Br}^-$   
 $\text{pOH} = 14 - 3.07 = 10.93$   
 $[\text{OH}^-] = 10^{-\text{pOH}} = 10^{-10.93} = 1.17 \times 10^{-11} \text{ M}$

(B)  $n = 1.52 \text{ g HNO}_3 \left( \frac{1 \text{ mol}}{63.02 \text{ g}} \right) = .0241 \text{ mol}$

$M = .0241 \text{ mol} / .575 \text{ L} = .0419 \text{ M}$   $\text{HNO}_3 \rightarrow \text{H}^+ + \text{NO}_3^-$

$\text{pH} = -\log [0.0419] = 1.38$   
 $\text{pOH} = 14 - 1.38 = 12.62$   
 $[\text{OH}^-] = 10^{-12.62} = 2.40 \times 10^{-13} \text{ M}$



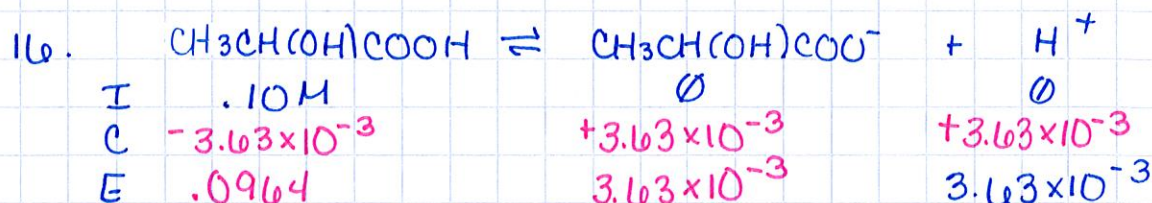
total moles =  $1.0 \times 10^{-3} \text{ mol} + 4.0 \times 10^{-3} \text{ mol} = 5.0 \times 10^{-3} \text{ mol H}^+$

$M_{\text{Tot}} = 5.0 \times 10^{-3} \text{ mol} / (.01\text{L} + .02\text{L}) = 1.67 \times 10^{-1} \text{ M}$

$\text{pH} = -\log [1.67] = .777$

$\text{pOH} = 14 - .777 = 13.2$

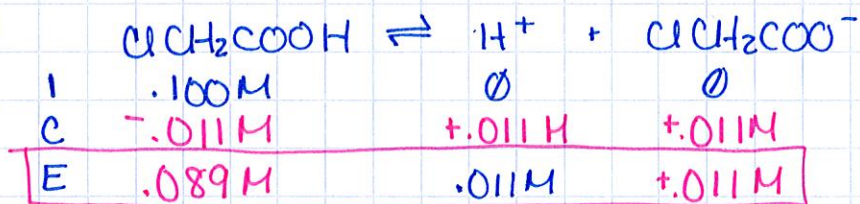
$[\text{OH}^-] = 10^{-13.2} = 1.67 \times 10^{-13} \text{ M}$



$[\text{H}^+] = 10^{-2.44} = 3.63 \times 10^{-3} \text{ M}$

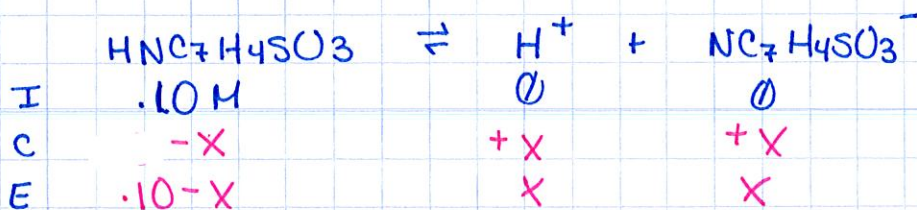
$K_a = \frac{[\text{H}^+][\text{CH}_3\text{CH}(\text{OH})\text{COO}^-]}{[\text{CH}_3\text{CH}(\text{OH})\text{COOH}]} = \frac{[3.63 \times 10^{-3}][3.63 \times 10^{-3}]}{[.0964]}$   
 $= 1.37 \times 10^{-4}$

17. % ionization =  $\frac{[\text{H}^+]_{\text{eq}}}{[\text{HA}]_0} \times 100 = 11.0\%$       $[\text{H}^+] = .11[.100\text{M}] = .011\text{M}$



$K_a = \frac{[\text{H}^+][\text{ClCH}_2\text{COO}^-]}{[\text{ClCH}_2\text{COOH}]} = \frac{[.011][.011]}{[.089]} = 1.36 \times 10^{-3}$

18.  $pK_a = 2.32$   
 $K_a = 10^{-2.32} = 4.79 \times 10^{-3}$



$$K_a = 4.79 \times 10^{-3} = \frac{X^2}{(.10 - X)}$$

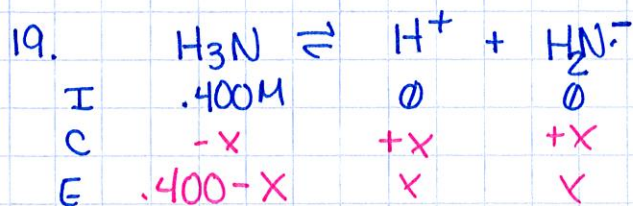
$$4.79 \times 10^{-3} = \frac{X^2}{.10}$$

$$4.79 \times 10^{-4} = X^2$$

$$2.19 \times 10^{-2} = X = [\text{H}^+]$$

$$pH = -\log[2.19 \times 10^{-2}]$$

$$pH = 1.66$$



$$K_a = \frac{[\text{H}^+][\text{H}_2\text{N}^+]}{[\text{H}_3\text{N}^+]}$$

$$1.9 \times 10^{-5} = \frac{X^2}{(.400 - X)}$$

$$1.9 \times 10^{-5} = \frac{X^2}{.400}$$

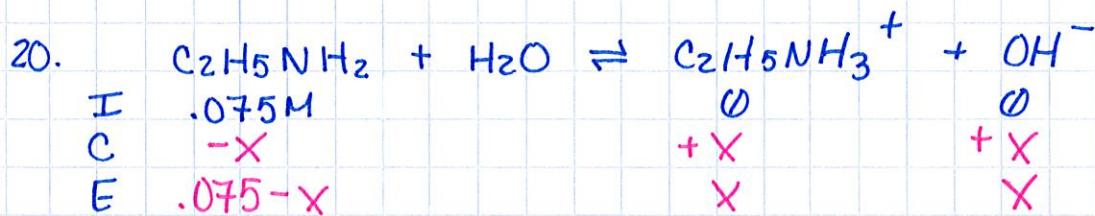
$$7.6 \times 10^{-6} = X^2$$

$$8.72 \times 10^{-3} \text{M} = X = [\text{H}^+]$$

$$\% \text{ion.} = \frac{[\text{H}^+]_{\text{eq}}}{[\text{HA}]} \times 100$$

$$= \frac{[8.72 \times 10^{-3}]}{[.400]} \times 100$$

$$= 2.18\%$$



$$K_b = 6.4 \times 10^{-4} = \frac{[C_2H_5NH_3^+][OH^-]}{[C_2H_5NH_2]}$$

$$6.4 \times 10^{-4} = \frac{X^2}{(.075 - X)}$$

$$6.4 \times 10^{-4} = \frac{X^2}{.075}$$

$$4.8 \times 10^{-5} = X^2$$

$$6.93 \times 10^{-3} M = X = [OH^-]$$

$$pOH = -\log[6.93 \times 10^{-3}]$$

$$pOH = 2.16$$

$$pH = 14 - 2.16 = \boxed{11.84}$$

21. (A) Since  $K_a \cdot K_b = K_w$ , you can calculate  $K_b$  from  $K_a$   
 (B)

phenol  
 $K_a = 2.8 \times 10^{-2}$

$$2.8 \times 10^{-2} \cdot K_b = 1.0 \times 10^{-14}$$

$$\boxed{K_b = 3.6 \times 10^{-13}}$$