Ch. 14-16 Review

$$H_2C_2O_4(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + HC_2O_4^-(aq)$$

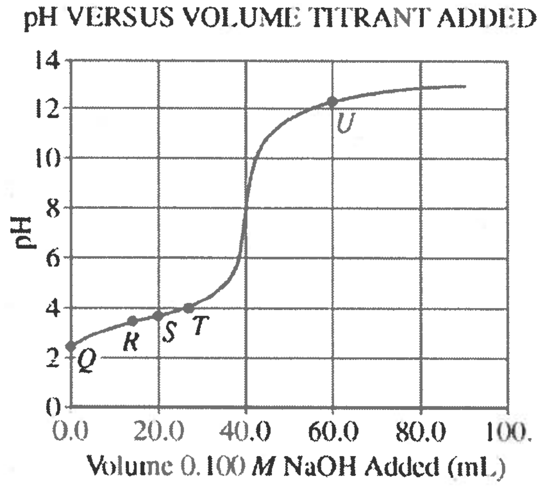
$$HC_2O_4^-(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + C_2O_4^{2-}(aq)$$

$$H_2O(l) + H_2O(l) \rightleftarrows H_3O^+(aq) + OH^-(aq)$$

11. All the reactions represented above occur in an aqueous solution of oxalic acid. Which of the following represent a Brønsted-Lowry conjugate acid-base pair?

(A) $H_2C_2O_4(aq)$ and $C_2O_4^{2-}(aq)$
[✓ (B)] $HC_2O_4^-(aq)$ and $C_2O_4^{2-}(aq)$
(C) $HC_2O_4^-(aq)$ and $H_2O(aq)$
(D) $H_3O^+(aq)$ and $OH^-(aq)$

Questions 14-17 refer to the following.



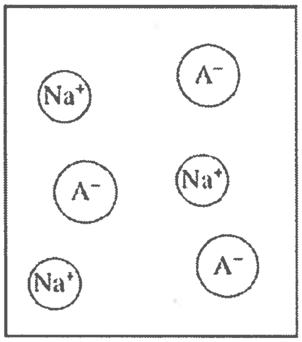
A 50.0 mL sample of an acid, HA, of unknown molarity is titrated, and the pH of the resulting solution is measured with a pH meter and graphed as a function of the volume of 0.100 M NaOH added.

14. At point R in the titration, which of the following species has the highest concentration?

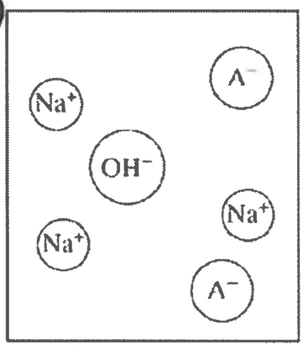
[✓ (A)] HA
(B) A^-
(C) H_3O^+
(D) OH^-

15. Which of the following is the best particulate representation of the species (other than H_2O) that are present in significant concentrations in the solution at point U in the titration?

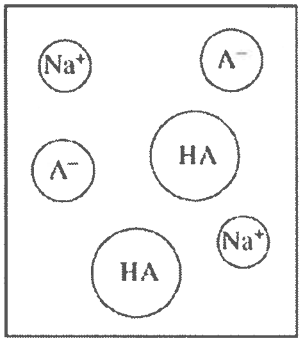
(A)



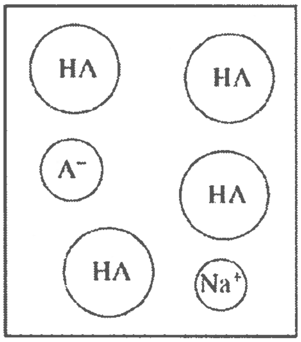
[✓ (B)]



(C)



(D)



16. At which point on the titration curve is $[A^-]$ closest to twice that of $[HA]$?

(A) *R*
(B) *S*
[✓ (C) *T*]
(D) *U*

17. A student carries out the same titration, but uses an indicator instead of a pH meter. If the indicator changes color slightly past the equivalence point, what will the student obtain for the calculated concentration of the acid?

$40 \cdot .1 = 50 \cdot M$

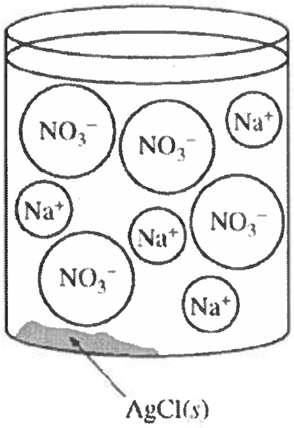
$.8 \cdot .1 = .08$

(A) Slightly less than 0.0800 *M*
[✓ (B) Slightly more than 0.0800 *M*]
(C) Slightly less than 0.125 *M*
(D) Slightly more than 0.125 *M*

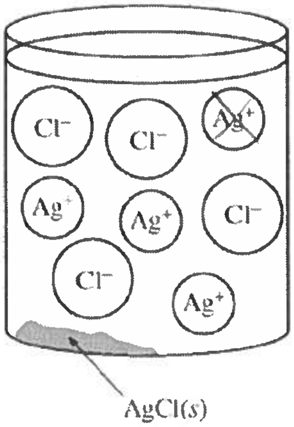
$$Ag^+(aq) + Cl^-(aq) \rightleftarrows AgCl(s)$$

28. A student mixes dilute $AgNO_3(aq)$ with excess $NaCl(aq)$ to form $AgCl(s)$, as represented by the net ionic equation above. Which of the diagrams below best represents the ions that are present in significant concentrations in the solution? (K_{sp} for AgCl is 1.8×10^{-10}.)

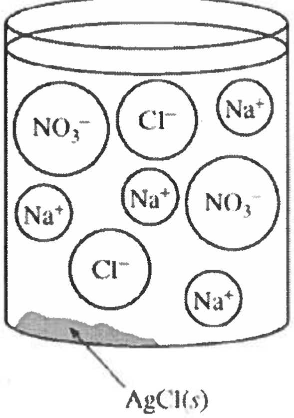
(A)



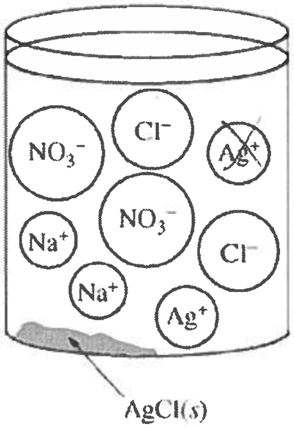
(B)



[✓ (C)]



(D)



Questions 48-52 refer to the following.

Concentration (*M*)	pH of Acid 1	pH of Acid 2	pH of Acid 3	pH of Acid 4
0.010	3.44	2.00	2.92	2.20
0.050	3.09	1.30	2.58	1.73
0.10	2.94	1.00	2.42	1.55
0.50	2.69	0.30	2.08	1.16
1.00	2.44	0.00	1.92	0.98

The pH of solutions of four acids prepared at various concentrations were measured and recorded in the table above. The four acids are, in no particular order, chlorous, hydrochloric, lactic, and propanoic.

48. For which acid is the value of the acid-dissociation constant, K_a, the smallest?

[✓ (A) Acid 1]
(B) Acid 2
(C) Acid 3
(D) Acid 4

49. Which of the four acids listed in the table is hydrochloric acid?

(A) Acid 1
[✓ (B) Acid 2]
(C) Acid 3
(D) Acid 4

50. Of the following species, which has the greatest concentration in a 1.0 *M* solution of acid 1 at equilibrium?

(A) OH^-
(B) H_3O^+
[✓ (C) Acid 1]
(D) The conjugate base of acid 1

51. If equal volumes of the four acids at a concentration of 0.50 *M* are each titrated with a strong base, which will require the greatest volume of base to reach the equivalence point?

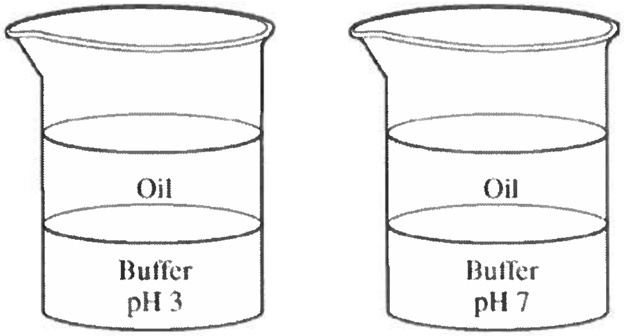
(A) Acid 1
(B) Acid 2
(C) Acid 3
[✓ (D) All the acids will require the same volume of base to reach the equivalence point.]

52. A 25 mL sample of a 1.0 *M* solution of acid 1 is mixed with 25 mL of 0.50 *M* NaOH. Which of the following best explains what happens to the pH of the mixture when a few drops of 1.0 *M* HNO_3 are added?

(A) The pH of the mixture increases sharply, because HNO_3 is a strong acid.
(B) The pH of the mixture decreases sharply, because H_3O^+ ions were added.
[✓ (C) The pH of the mixture stays about the same, because the conjugate base of acid 1 reacts with the added H_3O^+ ions.]
(D) The pH of the mixture stays about the same, because the OH^- ions in the solution react with the added H_3O^+ ions.

$$\underset{\textit{yellow}}{HIn(aq)} + H_2O(l) \rightleftarrows \underset{\textit{blue}}{In^-(aq)} + H_3O^+(aq)$$

7. The indicator HIn is a weak acid with a pK_a value of 5.0. It reacts with water as represented in the equation above. Consider the two beakers below. Each beaker has a layer of colorless oil (a nonpolar solvent) on top of a layer of aqueous buffer solution. In beaker X the pH of the buffer solution is 3, and in beaker Y the pH of the buffer solution is 7. A small amount of HIn is placed in both beakers. The mixtures are stirred well, and the oil and water layers are allowed to separate.



Beaker X Beaker Y

(a) What is the predominant form of HIn in the aqueous buffer in beaker Y, the acid form or the conjugate base form? Explain your reasoning.

(b) In beaker X the oil layer is yellow, whereas in beaker Y the oil layer is colorless. Explain these observations in terms of both acid-base equilibria and interparticle forces.

a) $K_t = \frac{[H^+][In^-]}{[HIn]}$ $\frac{K_a}{[H^+]} = \frac{[In^-]}{[HIn}$ $\frac{1\cdot10^{-5}}{1\cdot10^{-7}} = 100 = \frac{[In^-]}{[HIn]}$

The retron of $[In^-]$ to $[HIn]$ is 100 so there is 100 times more $[In^-]$ than $[HIn]$

b) As the pH decreases the indicator is forced in to the HIn form. Since HIn is neutral it will be more soloble in the non-polar oil.

1. Answer the following questions about the solubility and reactions of the ionic compounds $M(\overset{-1}{OH})_2$ and $M\overset{-2}{CO_3}$, where M represents an unidentified metal.

   (a) Identify the charge of the M ion in the ionic compounds above. M^{+2}

   (b) At 25°C, a saturated solution of $M(OH)_2$ has a pH of 9.15.

      (i) Calculate the molar concentration of $OH^-(aq)$ in the saturated solution.

      (ii) Write the solubility-product constant expression for $M(OH)_2$.

      (iii) Calculate the value of the solubility-product constant, K_{sp}, for $M(OH)_2$ at 25°C.

   (c) For the metal carbonate, MCO_3, the value of the solubility-product constant, K_{sp}, is 7.4×10^{-14} at 25°C. On the basis of this information and your results in part (b), which compound, $M(OH)_2$ or MCO_3, has the greater molar solubility in water at 25°C ? Justify your answer with a calculation.

a) M^{+2}

bi) $pOH = 14 - 9.15 = 4.85$

$[OH^-] = 10^{-4.85} = 1.41 \cdot 10^{-5}$

bii) $K_{sp} = [M^{2+}][OH^-]^2$

biii)

	$M(OH)_2 \rightleftarrows$	$M^{2+} +$	$2OH^-$
I	X	0	0
C	$-x$	$7.06 \cdot 10^{-6}$	$+1.41 \cdot 10^{-5}$
E	X	$7.06 \cdot 10^{-6}$	$1.41 \cdot 10^{-5}$

$K_{sp} = [7.06 \cdot 10^{-6}][1.41 \cdot 10^{-5}]^2 = 1.40 \cdot 10^{-15}$

c)

	$MCO_3 \rightleftarrows$	$M^{2+} +$	CO_3^{-2}
I	X	0	0
C	$-x$	$+x$	$+x$
E	X	x	x

$7.4 \cdot 10^{-14} = (x)(x)$

$x = 2.72 \cdot 10^{-7}$

The solobility of $Mg(OH)_2$ is hojer $7.06 \cdot 10^{-6} M$ then that of $MgCO_3$, $2.72 \cdot 10^{-7} M$.