3.3-010

According to Bronsted-Lowry Theory, which of the following is not an acid?

(a) HCOOH

(b) HS^{-}

(c) NH_4^+

(d) CH_4

3.3-020

According to Bronsted-Lowry Theory, which of the following is a base?

(a) HCN (b) CH_4

(c) H_2S (d) NH_3

3.3-030

The equilibrium constant for which of the following reactions in water is an acidity constant?

(a) $NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$

(b) $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

(c) $HCOO^- + H_3O^+ \rightarrow HCOOH + H_2O$

(d) $HCN + OH^- \rightarrow CN^- + H_2O$

<u>3.3-040</u>

K_a(HCOOH) is the equilibrium constant for which of the following reactions in water?

(a) $HCOOH + NH_3 \rightarrow HCOO^- + NH_4^+$

(b) $HCOOH + H_2O \rightarrow HCOO^- + H_3O^+$

(c) $HCOO^- + H_3O^+ \rightarrow HCOOH + H_2O$

(d) $HCOOH + OH^- \rightarrow HCOO^- + H_2O$

<u>3.3-050</u>

$K_a(HS^-)$ is the equilibrium constant for which of the following reactions in water?

(a) $HS^- + OH^- \rightarrow H_2O + S^{2-}$

(b) $HS^- + H_2O \rightarrow H_3O^+ + S^{2-}$

(c) $HS^- + H_2O \rightarrow OH^- + H_2S$

(d) $HS^- + H_3O^+ \rightarrow H_2O + H_2S$

3.3-060

$K_b(HS^-)$ is the equilibrium constant for which of the following reactions in water?

(a) $HS^- + OH^- \rightarrow H_2O + S^{2-}$

(b) $HS^- + H_2O \rightarrow H_2S + OH^-$

(c) $HS^- + H_3O^+ \rightarrow H_2O + H_2S$

(d) $HS^- + H_2O \rightarrow H_3O^+ + S^{2-}$

3.3-070

The equilibrium constant for the reaction

$$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$$

is

(a) $K_a(NH_4^+)$ (b) $K_b(NH_4^+)$

(c) $1 / K_a(NH_3)$ (d) $1 / K_b(NH_3)$

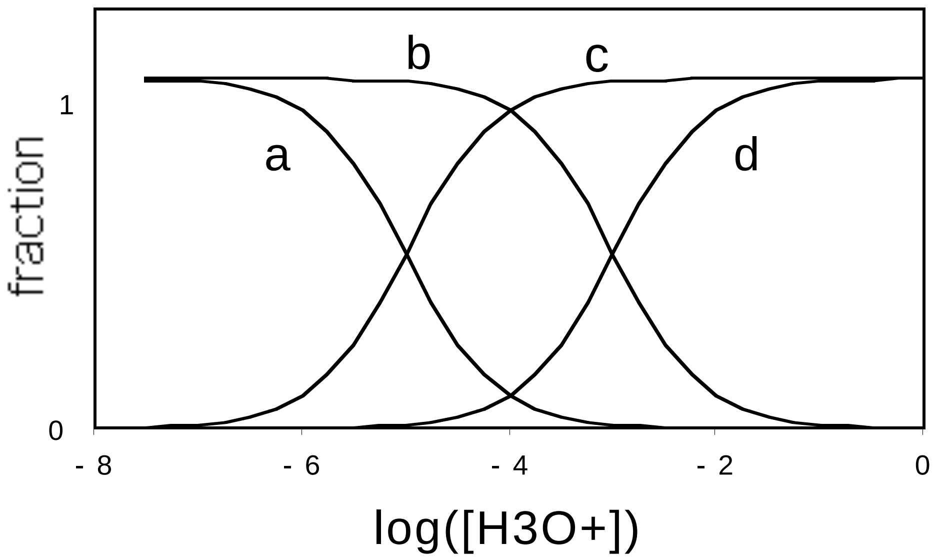
3.3-080

Which of the following is the strongest acid?

(a) H_3AsO_4 (b) $H_2AsO_4^{-}$

(c) $HAsO_4^{2-}$ (d) AsO_4^{3-}

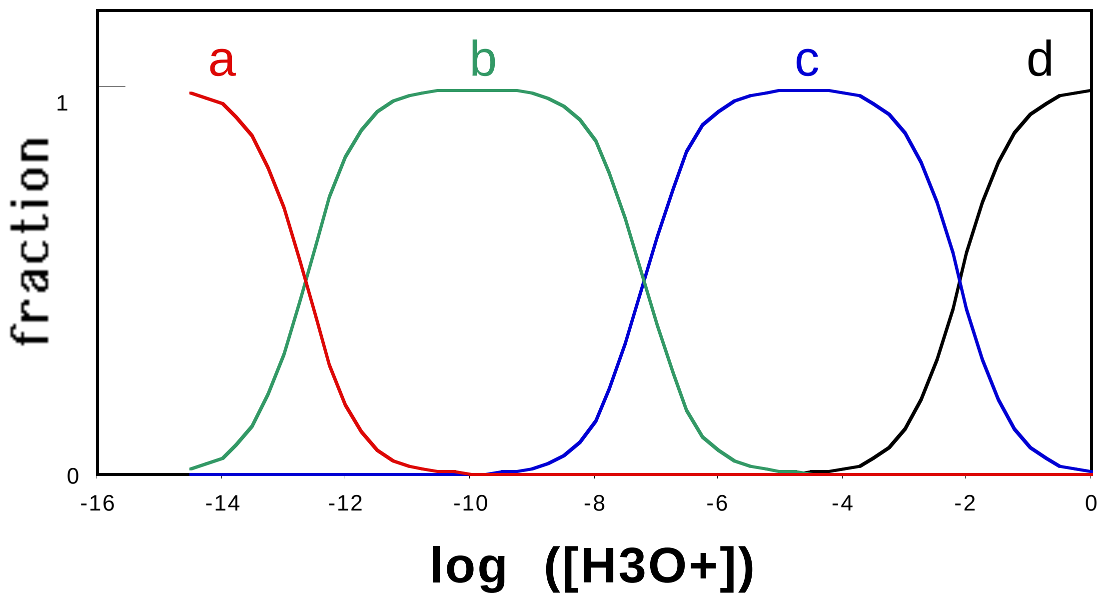
The following figure shows the fractions of the protonated (HA) and deprotonated (A^-) forms of two monoprotic acids.



Which line represents the protonated form of the stronger acid?

3.3-130

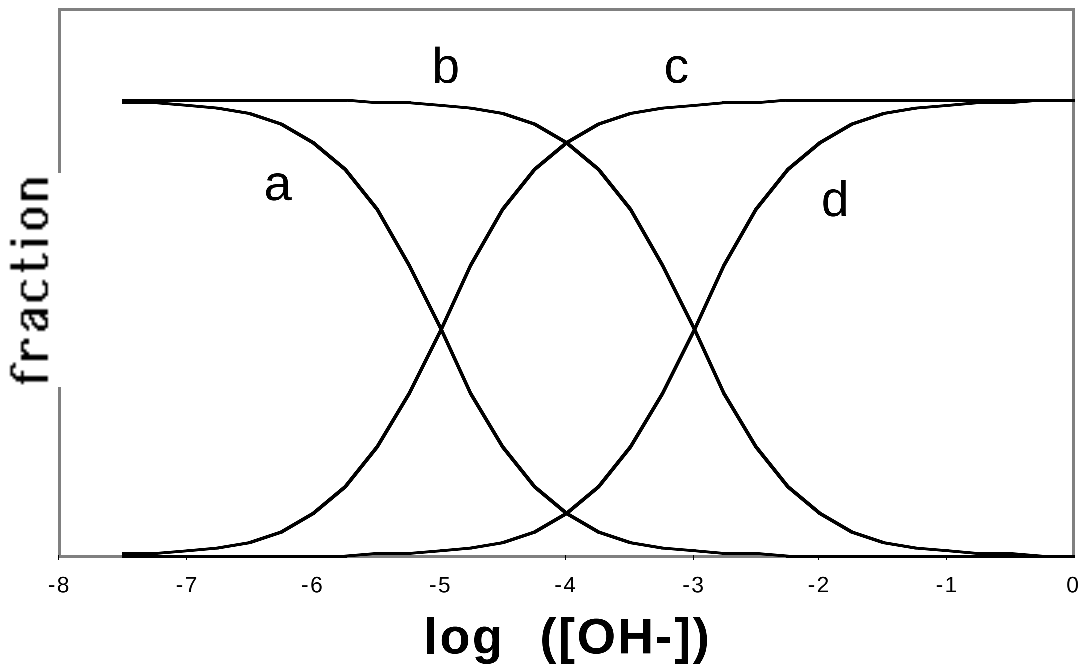
The following figure shows the fractions of the four forms of a triprotic acid H_3A.



Which line represents A^{3-}?

3.3-140

The following figure shows the fractions of the protonated and deprotonated forms of two bases.



Which curve represents the protonated form of the stronger base?

If a 1M solution was prepared of each of the following acids, which would have the highest $[H_3O^+]$?

(a) CH_3COOH ($K_a = 1.76 \times 10^{-5}$ M)

(b) HF ($K_a = 7.2 \times 10^{-4}$ M)

(c) HCOOH ($K_a = 1.8 \times 10^{-4}$ M)

(d) HOCl ($K_a = 3.5 \times 10^{-8}$ M)

3.3-160

When an acid HA is dissolved in water, which is not true?

(a) The greater the total concentration of the acid, the greater $[A^-]$.

(b) The greater the total concentration of the acid, the greater [HA].

(c) The greater the total concentration of the acid, the greater $[H_3O^+]$.

(d) The greater the total concentration of the acid, the greater the degree of dissociation.

<u>3.3-170</u>

An acid is fully dissociated when the total concentration of acid in all forms is

(a) $\gg K_a$ (b) $\sim K_a$ (c) $\ll K_a$

3.3-180

In a 1 M solution of $HClO_2$ ($K_a = 1 \times 10^{-2}$ M), $[H_3O^+]$ will be

(a) 1 M

(b) 1×10^{-1} M

(c) 1×10^{-2} M

Which of the following acid solutions has the higher $[H_3O^+]$?

(a) 1×10^{-3} M HIO_3 ($K_a = 1.6 \times 10^{-1}$ M)

(b) 1 M $HClO_2$ ($K_a = 1.1 \times 10^{-2}$ M)

<u>3.3-195</u>

Which of the following acid solutions has the higher $[H_3O^+]$?

(a) 1×10^{-3} M HClO ($K_a = 3.0 \times 10^{-8}$ M)

(b) 1×10^{-4} M $HClO_2$ ($K_a = 1.1 \times 10^{-2}$ M)

3.3-210

The ion product of water varies with temperature as follows

T(°C)	K_W (M^2)
0.0	0.12×10^{-14}
25.0	1.00×10^{-14}
60.0	9.60×10^{-14}

We can conclude that as water is heated,

(a) $[H_3O^+]$ and $[OH^-]$ both decrease

(b) $[H_3O^+]$ and $[OH^-]$ both increase

(c) $[H_3O^+]$ increases and $[OH^-]$ decreases

(d) $[H_3O^+]$ decreases and $[OH^-]$ increases

3.3-220

At 25°C, a 0.010 M solution of HCl has a $[OH^-]$ of

(a) 0.010×10^{-14} M

(b) 100.0×10^{-14} M

(c) $100.0 \times 10^{+14}$ M

(d) $0.010 \times 10^{+14}$ M

3.3-230

At 25°C, a 1.1 M solution of $HClO_2$ ($K_a = 1.1 \times 10^{-2}$ M) has a $[OH^-]$ of

(a) 9×10^{-14} M

(b) 9×10^{-13} M

(c) 9×10^{-12} M

(d) 8×10^{-12} M

3.3-240

A solution has pH=10.82.
The $[H^+]$ in this solution is

(a) 1.5×10^{-11} M

(b) 6.6×10^{-10} M

(c) 1.5×10^{-5} M

(d) 6.6×10^{-4} M

The $[OH^-]$ in this solution is

(a) 1.5×10^{-11} M

(b) 6.6×10^{-10} M

(c) 1.5×10^{-5} M

(d) 6.6×10^{-4} M

3.3-250

A solution has $[OH^-] = 4.8 \times 10^{-3}$ M.
Its pH is

(a) 11.7

(b) 8.4

(c) 4.8

(d) 2.3

3.3-260

The pH of a 0.250 *M* HA solution is 5.00. The K_a for HA is

(a) 0.250×10^{-10} M

(b) 0.250×10^{-5} M

(c) 4.00×10^{-10} M

(d) 4.00×10^{-5} M

3.3-310

The conjugate base of HS^- is

(a) S^{2-}

(b) H_2S

3.3-320

The conjugate acid of $H_2PO_4^-$ is

(a) HPO_4^{2-}

(b) H_3PO_4

3.3-330

All of the following are acid base conjugate pairs except

(a) HONO, NO_2^-

(b) $CH_3NH_3^+$, CH_3NH_2

(c) C_6H_5COOH, $C_6H_5COO^-$

(d) H_3O^+, OH^-

<u>3.3-340</u>

$K_b(HC_2O_4^-)$ =

(a) $1 / K_a(H_2C_2O_4)$
(b) $1 / K_a(C_2O_4^{2-})$
(c) $K_w / K_a(H_2C_2O_4)$
(d) $K_w / K_a(C_2O_4^{2-})$

3.3-360

Which of the following is the strongest base?

(a) H_3AsO_4

(b) $H_2AsO_4^-$

(c) $HAsO_4^{2-}$

(d) AsO_4^{3-}

3.3-370

Which of the following acids has the strongest conjugate base?

(a) $HClO_4$ (b) $HClO_3$

(c) $HClO_2$ (d) $HClO$

3.3-410

Given that

$K_a(C_5H_5NH^+) = 5.6 \times 10^{-6}$ M

$K_a(HCOOH) = 1.77 \times 10^{-4}$ M

the salt pyridinium formate ($C_5H_5NH^+HCOO^-$) is

(a) acidic (b) basic (c) neutral

3.3-420

Given that

$K_a(H_3PO_4) = 7.5 \times 10^{-3}$ M

$K_a(H_2PO_4^-) = 6.23 \times 10^{-8}$ M

$K_a(HPO_4^{2-}) = 2.2 \times 10^{-13}$ M

the salt NaH_2PO_4 is

(a) acidic (b) basic (c) neutral

the salt $Na_2H_2PO_4$ is

(a) acidic (b) basic (c) neutral

3.3-430

NH_4NO_3 is

(a) acidic (b) basic (c) neutral

$[H_3O^+]$ in a 0.1 M aqueous solution of this salt is obtained by solving

(a) $\frac{x^2}{0.1M - x} = K_a(NH_4^+)$

(b) $\frac{x^2}{0.1M - x} = K_a(HNO_3)$

(c) $\frac{x^2}{0.1M - x} = K_b(NH_3)$

(d) $\frac{x^2}{0.1M - x} = K_b(NO_3^-)$

3.3-440

KCN is

(a) acidic (b) basic (c) neutral

$[OH^-]$ in a 0.5 M aqueous solution of this salt is obtained by solving

(a) $\frac{x^2}{0.5M - x} = K_a(K^+)$

(b) $\frac{x^2}{0.5M - x} = K_a(HCN)$

(c) $\frac{x^2}{0.5M - x} = K_b(KOH)$

(d) $\frac{x^2}{0.5M - x} = K_b(CN^-)$

Given that

$K_a(CH_3NH_3^+) = 2.38 \times 10^{-11}$ M

$K_a(HCN) = 4.9 \times 10^{-10}$ M

$K_a(HOAc) = 1.8 \times 10^{-5}$ M

$K_a(NH_4^+) = 5.7 \times 10^{-10}$ M

which of the following solutions has the highest pH?

(a) 0.1M CH_3NH_3Cl

(b) 0.1M NaCN

(c) 0.1M NH_4NO_3

(d) 0.1M NaOAc

The lowest pH?

The equilibrium constant for the reaction

$HONO\ (aq) + CN^{-}\ (aq)$

$\rightarrow HCN\ (aq) + ONO^{-}\ (aq)$

is $1.1 \times 10^{+6}$ M. This value indicates that

(a) CN^{-} is a stronger base than ONO^{-}

(b) HCN is a stronger acid than HONO

(c) the conjugate base of HONO is ONO^{-}

(d) the conjugate acid of CN^{-} is HCN

<u>3.3-490</u>

The equilibrium constant for the reaction

$HClO_2$ (aq) + NO_2^- (aq)

$\rightarrow$ HNO_2 (aq) + ClO_2^- (aq)

is

(a) K_a ($HClO_2$) K_b (NO_2^-)

(b) K_a (HNO_2) K_b (ClO_2^-)

(c) K_a ($HClO_2$) / K_a (HNO_2)

(d) K_b (ClO_2^-) / K_b (NO_2^-)

3.3-510

$[NH_3]$ and $[NH_4^+]$ will be equal when $[H_3O^+]$ is

(a) $K_a(NH_4^+)$

(b) $K_b(NH_3)$

(c) $1 / K_a(NH_4^+)$

(d) $1 / K_b(NH_3)$

3.3-520

Methyl orange has a pK_a of 3.7. It will change color when the $[H_3O^+]$ is in the vicinity of

(a) 3.7 M

(b) 10.3 M

(c) $10^{-3.7}$ M

(d) $10^{-10.3}$ M

Bromthymol blue changes color when the pH is in the vicinity of 7.1. It's K_a is

(a) 7.1 M

(b) 6.9 M

(c) $10^{-7.1}$ M

(d) $10^{-6.9}$ M

3.3-530

A flask contains 100 mL of 0.1 M HOAc. To prepare a buffer with pH=pK_a(HOAc) which of the following samples should be added to the flask?

(a) 50 mL of 0.2 M $Ba(OAc)_2$

(b) 200 mL of 0.1 M $Ba(OAc)_2$

(c) 25 mL of 0.2 M $Ba(OAc)_2$

(d) 100 mL of 0.1 M $Ba(OAc)_2$

3.3-540

Which mixture has a different pH from the others?

(a) 1 L of 1 M NaOH + 1 L of 2 M HCN

(b) 1 L of 1 M NaCN + 1 L of 1 M HCN

(c) 1 L of 1 M NaOH + 2 L of 1 M HCN

(d) 1 L of 1 M NaOH + 1 L of 1 M HCN

3.3-550

Which of the following mixtures will be a buffer solution when dissolved in 500 mL of water?

(a) 0.2 mol $C_6H_5NH_2$ + 0.2 mol HCl

(b) 0.2 mol $C_6H_5NH_2$ + 0.2 mol NaOH

(c) 0.2 mol $C_6H_5NH_2$ + 0.1 mol HCl

(d) 0.2 mol $C_6H_5NH_2$ + 0.1 mol NaOH

3.3-560

Which of the following mixtures is a buffer with pH close to $pK_a(NH_4^+)$

(a) 30 mL of 0.1 M NH_4Cl
+ 10 mL of 0.1 M NaOH

(b) 30 mL of 0.1 M NH_4Cl
+ 15 mL of 0.1 M NaOH

(c) 30 mL of 0.1 M NH_4Cl
+ 20 mL of 0.1 M NaOH

(d) 30 mL of 0.1 M NH_4Cl
+ 30 mL of 0.1 M NaOH

3.3-570

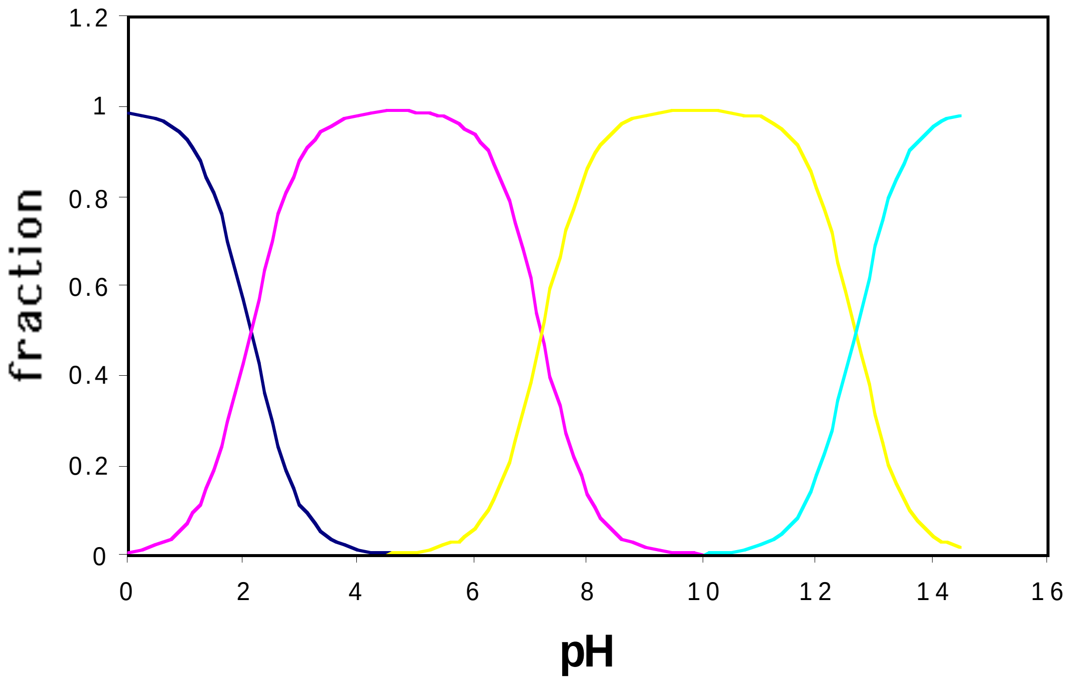
A weak base, B, has a basicity constant $K_b = 2 \times 10^{-5}$ M. The pH of any solution in which $[B]=[BH^+]$ is

(a) 4.7 (b) 5.3

(c) 8.7 (d) 9.3

3.3-581

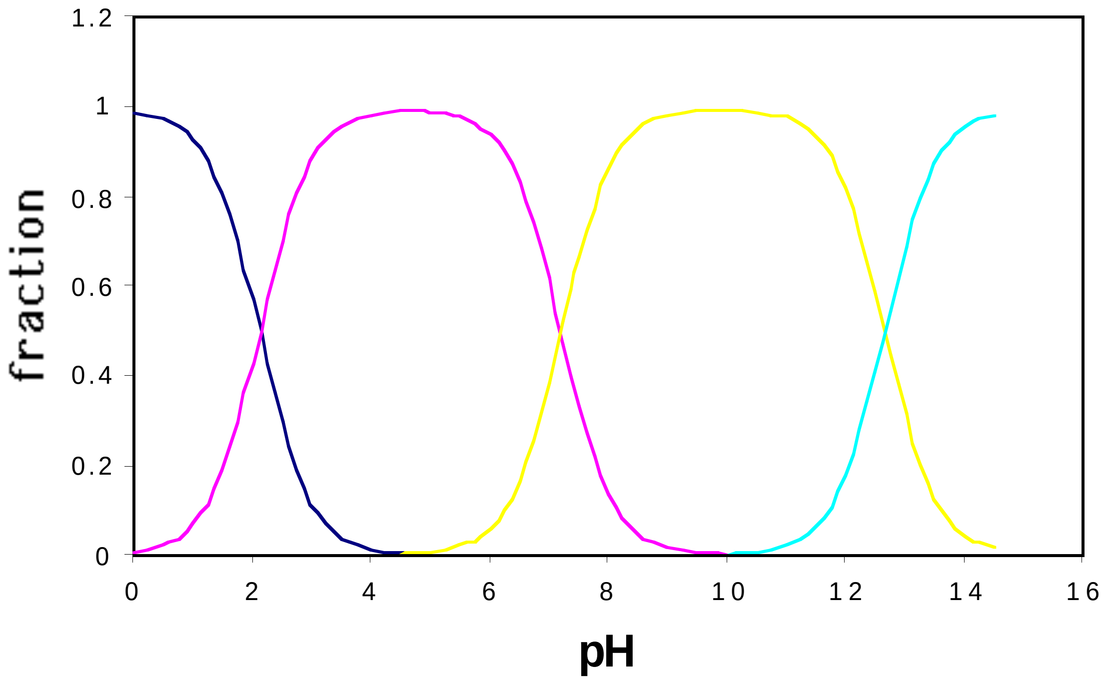
The following figure shows the composition diagram of H_3PO_4.



Which pH cannot be buffered well by phosphate?

(a) 2 (b) 5 (c) 7 (d) 13

The following figure shows the composition diagram of H_3PO_4.



To make a pH 7 buffer which mixture would you use?

(a) Na_3PO_4 and Na_2HPO_4
(b) Na_2HPO_4 and NaH_2PO_4
(c) NaH_2PO_4 and H_3PO_4

For a pH 2 buffer?

<u>3.3-590</u>

A buffer is prepared that contains 1 mol NaOAc and 1 mol HOAc. When 0.5 mol of NaOH is added, the pH

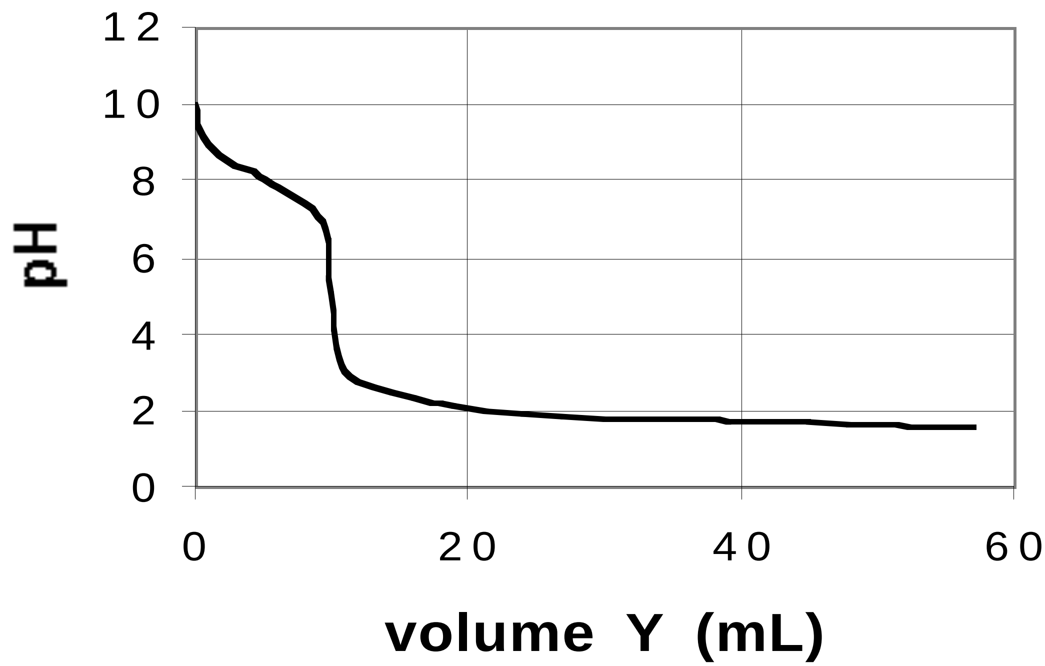
(a) doubles

(b) increases by log 2 = 0.301

(c) increases by log 3 = 0.477

(d) depends on the volume

100 mL of a solution of a solution of X is titrated with a 0.1 M solution of Y giving



Y is a

(a) strong base (c) weak base
(b) strong acid (d) weak acid

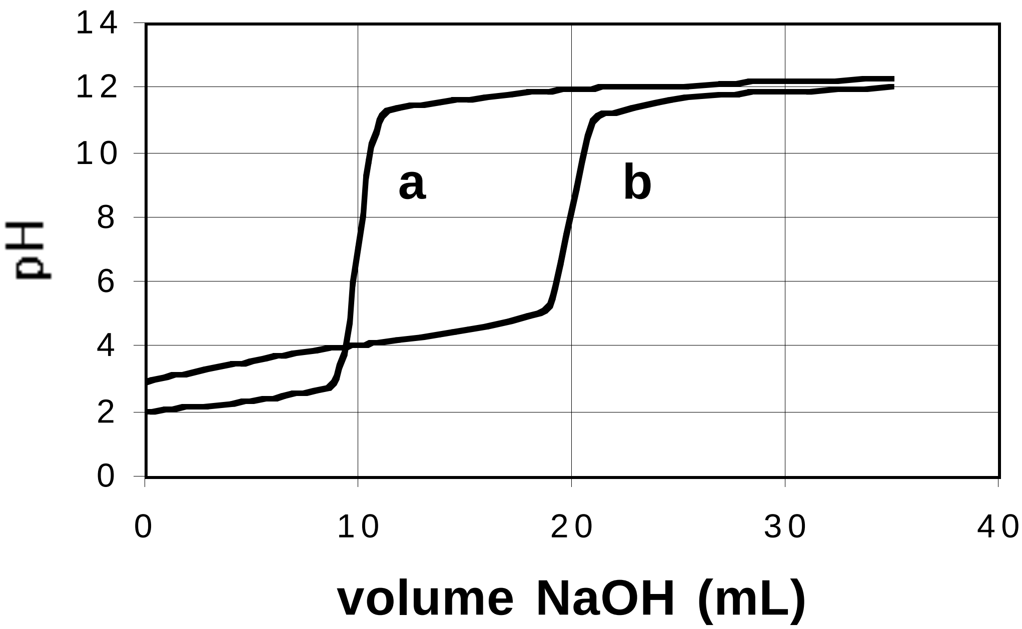
The initial concentration of X is

(a) 1 M (b) 0.1 M (c) 0.05 M (d) 0.01 M

X is a

(a) strong base (c) weak base
(b) strong acid (d) weak acid

100 mL samples of two different acids are titrated with 0.1 M NaOH giving



Which is the more concentrated acid?

Which is the weaker acid?

The molarity of acid a is

(a) 0.01 (b) 0.1 (c) 1 (d) 10

The molarity of acid b is

(a) 0.01 (b) 0.02 (c) 0.05 (d) 0.2

3.3-640

In titrating 0.10 M HCOOH (formic acid) with 0.10 M NaOH, the solution at the equivalence point is

(a) 0.10 M HCOONa

(b) 0.05 M HCOOH

(c) 0.05 M HCOONa

(d) 0.05 M NaOH

3.3-650

A 50 mL sample of 30 mM $Ba(OH)_2$ is titrated with 30 mM HCl. The solution at the equivalence point is

(a) 60 mM $BaCl_2$

(b) 30 mM $BaCl_2$

(c) 15 mM $BaCl_2$

(d) 10 mM $BaCl_2$

3.3-660

A 10 mL sample of a 0.2 M solution of the weak diprotic acid H_2X is titrated with 0.2 M KOH. The solution at the second equivalence point is

(a) 0.2 M KHX

(b) 0.2 M K_2X

(c) 0.1 M KHX

(d) 0.0667 M K_2X