Provincial Exam MC Questions: Unit 4 Acid-Base

January 1999

21. Consider the following acid-base equilibrium:

$$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$$

In the reaction above, the Brönsted-Lowry acids are

A. H_2O and OH^-
B. HCO_3^- and OH^-
C. H_2O and H_2CO_3
D. HCO_3^- and H_2CO_3

22. Consider the following solubility equilibrium:

$$Mg(OH)_{2\,(s)} \rightleftharpoons Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$$

A compound that could be added to cause this equilibrium to shift to the right is

A. Na_2O
B. NH_4Cl
C. $Sr(OH)_2$
D. $Mg(OH)_2$

23. The solution with the lowest electrical conductivity is

A. 0.10M H_2S
B. 0.10M HNO_2
C. 0.10M H_2SO_3
D. 0.10M NH_4Cl

24. The solution with the lowest pH is

A. 1.0M HF
B. 1.0M HCN
C. 1.0M HCOOH
D. 1.0M CH_3COOH

25. As the $[H_3O^+]$ in a solution decreases, the $[OH^-]$

A. increases and the pH increases.
B. increases and the pH decreases.
C. decreases and the pH increases.
D. decreases and the pH decreases.

26. The value of pK_w at 25°C is

A. 1.0×10^{-14}
B. 1.0×10^{-7}
C. 7.00
D. 14.00

27. Consider the following equilibrium:

$$2H_2O + \text{energy} \rightleftharpoons H_3O^+ + OH^-$$

In pure water at a temperature of 50°C,

A. pH < 7
B. pH + pOH = 14
C. $K_w = 1.0 \times 10^{-14}$
D. $[OH^-] < 1.0 \times 10^{-7}$

28. What is the pOH of 2.5 M NaOH?

A. −0.40
B. 0.0032
C. 0.40
D. 13.60

29. A 0.010M acid solution has a pH of 2.00. The acid could be

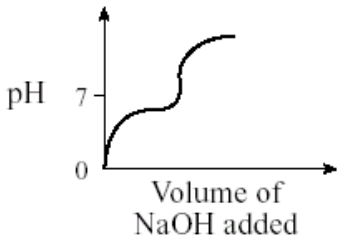
A. HNO_3
B. H_2SO_3
C. HCOOH
D. CH_3COOH

30. Which of the following salts dissolves to produce a basic aqueous solution?

A. LiF
B. $KClO_4$
C. $NaHSO_3$
D. NH_4NO_3

31. Which titration curve represents the titration of HCl with NaOH?

A.



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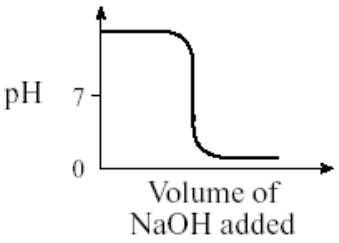

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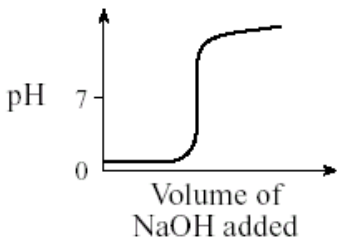

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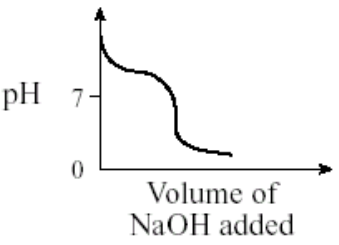


32. A buffer solution can be formed by dissolving equal moles of

A. HF and NaF
B. HCl and NaOH
C. KBr and Na_3PO_4
D. CH_3COOH and NaCl

33. Which of the following gases is a contributor to the formation of acid rain?

A. H_2
B. O_3
C. SO_2
D. NH_3

34. During a titration, an indicator is found to change colour when the $[H_3O^+] = 1 \times 10^{-6}$ M. Identify the indicator.

A. methyl violet
B. alizarin yellow
C. phenolphthalein
D. chlorophenol red

35. Consider the following:

I.	PO_4^{3-}
II.	HPO_4^{2-}
III.	$H_2PO_4^-$
IV.	H_3PO_4

The term amphiprotic can be used to describe

A. I only.
B. II and III only.
C. I, II and III only.
D. II, III and IV only.

36. Calculate the $[H_3O^+]$ in a solution prepared by mixing 25.0mL of 1.0M HCl with 50.0mL of 0.50M KOH.

A. 1.0 M
B. 0.50 M
C. 0.25 M
D. 1.0×10^{-7} M

April 1999

21. Which of the following is a property of sodium hydroxide?

A. feels slippery
B. releases H_3O^+ in aqueous solution
C. changes litmus paper from blue to red
D. reacts with magnesium to produce hydrogen gas

22. The conjugate acid of $HAsO_4^{2-}$ is

A. H_3O^+
B. AsO_4^{3-}
C. H_3AsO_4
D. $H_2AsO_4^-$

23. Which of the following 0.10M solutions has the highest electrical conductivity?

A. HF
B. HCN
C. H_2CO_3
D. H_3BO_3

24. Consider the following acid-base equilibrium:

$$H_2C_6H_5O_7^- + HPO_4^{2-} \rightleftharpoons HC_6H_5O_7^{2-} + H_2PO_4^-$$

In the equilibrium above,

A. products are favoured because $H_2PO_4^-$ is the weaker acid.
B. reactants are favoured because HPO_4^{2-} is the weaker acid.
C. products are favoured because $HC_6H_5O_7^2$ is the weaker acid.
D. reactants are favoured because $H_2C_6H_5O_7^-$ is the weaker acid.

25. Which of the following describes the relationship between $[H_3O^+]$ and $[OH^-]$?

A. $[H_3O^+][OH^-] = 14.00$
B. $[H_3O^+] + [OH^-] = 14.00$
C. $[H_3O^+][OH^-] = 1.0 \times 10^{-14}$
D. $[H_3O^+] + [OH^-] = 1.0 \times 10^{-14}$

26. Consider the following equilibrium:

$$2H_2O + \text{energy} \rightleftharpoons H_3O^+ + OH^-$$

When water has a pH of 7.5, the temperature is

A. less than 25°C and the solution is basic.
B. less than 25°C and the solution is neutral.
C. greater than 25°C and the solution is basic.
D. greater than 25°C and the solution is neutral.

27. Calculate the $[H_3O^+]$ in a 0.010M solution of $Sr(OH)_2$.

A. 5.0×10^{-13} M
B. 1.0×10^{-12} M
C. 1.0×10^{-2} M
D. 2.0×10^{-2} M

28. The value of K_b for HCO_3^- is

A. 5.6×10^{-11}
B. 2.3×10^{-8}
C. 4.3×10^{-7}
D. 1.8×10^{-4}

29. The net ionic equation for the hydrolysis of NH_4ClO_4 is

A. $NH_4ClO_{4\,(s)} \rightleftharpoons NH_4^+{}_{(aq)} + ClO_4^-{}_{(aq)}$
B. $NH_4^+{}_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_{3(aq)} + H_3O^+{}_{(aq)}$
C. $ClO_4^-{}_{(aq)} + H_2O_{(l)} \rightleftharpoons HClO_{4(aq)} + OH^-{}_{(aq)}$
D. $NH_4^+{}_{(aq)} + ClO_4^-{}_{(aq)} \rightleftharpoons NH_{3(aq)} + HClO_{4(aq)}$

30. A sample of an unknown solution is tested with the indicator chlorophenol red. The solution turns yellow on the addition of this indicator. The solution could be

A. 1.0M KF
B. 1.0M NaCl
C. 1.0M Li_2SO_4
D. 1.0M NH_4NO_3

31. Which of the following indicators has a transition point closest to the equivalence point for the titration of a weak acid by a strong base?

A. orange IV
B. thymol blue
C. methyl orange
D. bromcresol green

32. A buffer solution is formed by adding which of the following to water?

A. HCl and KOH
B. HCN and RbCN
C. NaBr and NaOH
D. HNO_3 and $LiNO_3$

33. *A solution of known concentration* is the definition of a

A. buffer solution.
B. neutral solution.
C. standard solution.
D. saturated solution.

34. Which of the following is responsible for the acidic pH of normal rainwater?

A. CO_2
B. NO_2
C. SO_2
D. NH_3

35. A solution contains a mixture of methyl orange, phenol red and thymol blue. When this solution is yellow, the pH is

A. 3.0
B. 6.0
C. 9.0
D. 12.0

36. Which of the following represents the reaction between MgO and H_2O?

A. $MgO + H_2O \rightarrow Mg(OH)_2$
B. $MgO + H_2O \rightarrow MgH_2 + O_2$
C. $MgO + H_2O \rightarrow Mg + H_2O_2$
D. $2MgO + H_2O \rightarrow 2MgOH + 1/2\ O_2$

June 1999

19. A 1.0×10^{-4} M solution has a pH of 10.00. The solute is a

A. weak acid.
B. weak base.
C. strong acid.
D. strong base.

20. Consider the following Brönsted-Lowry equilibrium system:

$$HSO_3^- + H_2PO_4^- \rightleftharpoons SO_3^{2-} + H_3PO_4$$

What are the two Brönsted-Lowry bases in the equilibrium above?

A. HSO_3^- and SO_3^{2-}
B. $H_2PO_4^-$ and SO_3^{2-}
C. HSO_3^- and H_3PO_4
D. $H_2PO_4^-$ and H_3PO_4

21. The equation representing the predominant reaction of sodium ethanoate, $NaCH_3COO$, with water is

A. $CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$
B. $CH_3COO^- + H_2O \rightleftharpoons H_3O^+ + CH_2COO^{2-}$
C. $CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$
D. $CH_3COOH + H_2O \rightleftharpoons CH_3COOH_2^+ + OH^-$

22. Which of the following solutions will have the lowest electrical conductivity?

A. 0.1M HF
B. 0.1M NaF
C. 0.1M H_2SO_3
D. 0.1M $NaHSO_3$

23. Which of the following is the strongest Brönsted-Lowry base?

A. NH_3
B. CO_3^{2-}
C. HSO_3^-
D. $H_2BO_3^-$

24. Consider the following:

	ION
I.	HCO_3^-
II.	$H_2PO_4^-$
III.	CH_3COO^-

The amphiprotic ions are

A. I and II only.
B. I and III only.
C. II and III only.
D. I, II, III.

25. The ionization of water at room temperature is represented by

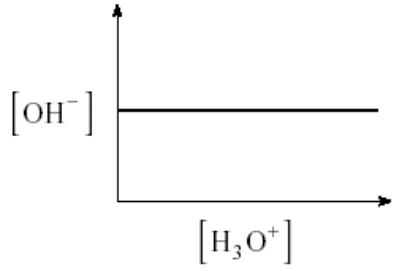
A. $H_2O \rightleftharpoons 2H^+ + O^{2-}$
B. $2H_2O \rightleftharpoons 2H_2 + O_2$
C. $2H_2O \rightleftharpoons H_2 + 2OH^-$
D. $2H_2O \rightleftharpoons H_3O^+ + OH^-$

26. Addition of HCl to water causes
A. both $[H_3O^+]$ and $[OH^-]$ to increase.

B. both $[H_3O^+]$ and $[OH^-]$ to decrease.
C. $[H_3O^+]$ to increase and $[OH^-]$ to decrease.
D. $[H_3O^+]$ to decrease and $[OH^-]$ to increase.

27. Which of the following graphs describes the relationship between $[H_3O^+]$ and $[OH^-]$ in aqueous solutions at a constant temperature?

A.



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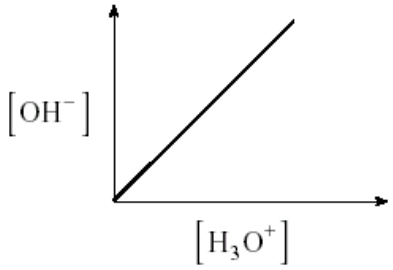

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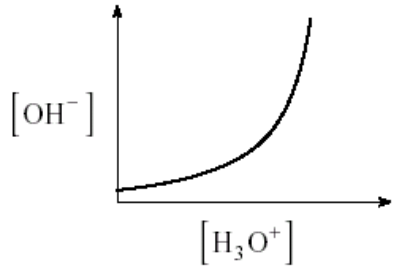

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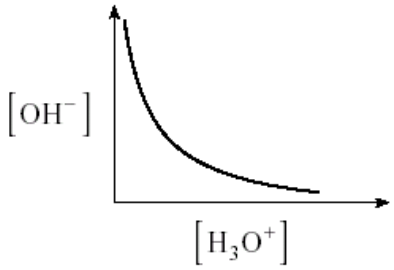


28. Consider the following:

I.	H_2SO_4
II.	HSO_4^-
III.	SO_4^{2-}

Which of the above is/are present in a reagent bottle labeled 1.0M H_2SO_4?

A. I only
B. I and II only
C. II and III only
D. I, II and III

29. The pH of a 0.10M KOH solution is

A. 0.10
B. 1.00
C. 13.00
D. 14.10

30. The equilibrium expression for the predominant reaction between the hydrogen oxalate ion, $HC_2O_4^-$, and water is

A.
$$K_a = \frac{[C_2O_4^{-2}][H_3O^+]}{[HC_2O_4^-]}$$

B.
$$K_b = \frac{[HC_2O_4^-]}{[C_2O_4^{-2}][OH^-]}$$

C.
$$K_a = \frac{[HC_2O_4^-][H_3O^+]}{[C_2O_4^{-2}]}$$

D.
$$K_b = \frac{[H_2C_2O_4][OH^-]}{[HC_2O_4^-]}$$

31. Which of the following salts will dissolve in water to produce a neutral solution?

A. LiF
B. $CrCl_3$
C. KNO_3
D. NH_4Cl

32. An indicator changes colour in the pH range 9.0 to 11.0 . What is the value of K_a for the indicator?

A. 1×10^{-13}
B. 1×10^{-10}
C. 1×10^{-7}
D. 1×10^{1}

33. Which of the following always applies at the transition point for the indicator HInd?

A. $[Ind^-] = [OH^-]$
B. $[HInd] = [Ind^-]$
C. $[Ind^-] = [H_3O^+]$
D. $[HInd] = [H_3O^+]$

34. Calculate the $[H_3O^+]$ of a solution prepared by adding 10.0mL of 2.0M HCl to 10.0mL of 1.0M NaOH.

A. 0.020 M
B. 0.50 M
C. 1.0 M
D. 2.0 M

35. Consider the following:

I.	H_3O^+
II.	CH_3COO^-
III.	CH_3COOH

The purpose of a buffer system consisting of CH3COOH and CH3COONa is to maintain a relatively constant concentration of

A. I only.
B. I and II only.
C. II and III only.
D. I, II and III.

36. Which of the following, when dissolved in water, will produce an acidic solution?

A. SrO
B. NO_2
C. CaO
D. Na_2O

August 1999

22. An Arrhenius acid is defined as a chemical species that

A. is a proton donor.
B. is a proton acceptor.
C. produces hydrogen ions in solution.
D. produces hydroxide ions in solution.

23. Consider the acid-base equilibrium system:

$$HC_2O_4^- + H_2BO_3^- \rightleftharpoons H_3BO_3 + C_2O_4^{2-}$$

Identify the Brönsted-Lowry bases in this equilibrium.

A. $H_2BO_3^-$ and H_3BO_3
B. $HC_2O_4^-$ and H_3BO_3
C. $HC_2O_4^-$ and $C_2O_4^{2-}$
D. $H_2BO_3^-$ and $C_2O_4^{2-}$

24. An equation representing the reaction of a weak acid with water is

A. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$
B. $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$
C. $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$
D. $HCOOH + H_2O \rightleftharpoons H_3O^+ + HCOO^-$

25. The equilibrium expression for the ion product constant of water is

A.
$$K_w = \frac{[H_3O^+][OH^-]}{[H_2O]}$$

B. $K_w = [H_3O^+]^2[O_2]$

C. $K_w = [H_3O^+][OH^-]$

D. $K_w = [H_3O^+]^2[O^{2-}]$

26. Consider the following equilibrium:

$$2H_2O + \text{energy} \rightleftharpoons H_3O^+ + OH^-$$

Which of the following describes the result of decreasing the temperature?

	$[H_3O^+]$	$[OH^-]$	K_w
A.	increases	increases	increases
B.	decreases	increases	decreases
C.	increases	decreases	no change
D.	decreases	decreases	decreases

27. In an acidic solution at 25°C,

A. $[H_3O^+] < [OH^-]$ and pH > 7
B. $[H_3O^+] < [OH^-]$ and pH < 7
C. $[H_3O^+] > [OH^-]$ and pH > 7
D. $[H_3O^+] > [OH^-]$ and pH < 7

28. The pH of a solution changes from 3.00 to 6.00. By what factor does the $[H_3O^+]$ change?

A. 2
B. 3
C. 100
D. 1000

29. The K_a expression for the hydrogen sulphite ion, HSO_3^-, is

A.

$$K_a = \frac{[SO_3^{2-}][H_3O^+]}{[HSO_3^-]}$$

B.

$$K_a = \frac{[H_2SO_3][H_3O^+]}{[HSO_3^-]}$$

C.

$$K_a = \frac{[SO_3^{2-}][H_3O^+]}{[H_2SO_3^-]}$$

D.

$$K_a = \frac{[SO_3^{2-}][H_3O^+]}{[HSO_3^-][H_2O]}$$

30. The $[OH^-]$ in a solution of pH 3.00 is

A. 1.0×10^{-11} M
B. 1.0×10^{-9} M
C. 1.0×10^{-6} M
D. 1.0×10^{-3} M

31. Consider the following equilibrium for an indicator:

$$HInd + H_2O \rightleftharpoons H_3O^+ + Ind^-$$

Which two species must be of two different colours in order to be used as an indicator?

A HInd and H_2O
B. HInd and Ind^-
C. H_3O^+ and Ind^-
D. HInd and H_3O^+

32. Which of the following indicators is yellow at a pH of 10.0?

A. methyl red
B. phenol red
C. thymol blue
D. methyl violet

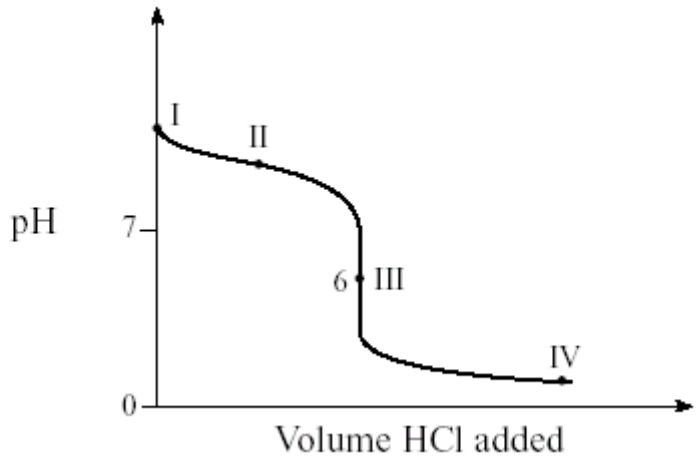
33. A sample containing 1.20×10^{-2} mol HCl is completely neutralized by 100.0mL of $Sr(OH)_2$. What is the $[Sr(OH)_2]$?

A. 6.00×10^{-3} M
B. 6.00×10^{-2} M
C. 1.20×10^{-1} M
D. 2.4×10^{-1} M

34. Which of the following titrations will have the highest pH at the equivalence point?

A. HBr with NH_3
B. HNO_2 with KOH
C. HCl with Na_2CO_3
D. HNO_3 with NaOH

35. Consider the following graph for the titration of 0.1M NH_3 with 0.1M HCl:



A buffer solution is present at point

A. I
B. II
C. III
D. IV

36. Which of the following solutions would require the greatest volume of 1.0M NaOH for complete neutralization?

A. 10.0mL of 1.0M HCl
B. 10.0mL of 2.0M H_2SO_4
C. 10.0mL of 3.0M H_3PO_4
D. 10.0mL of 4.0M $H_2C_2O_4$

January 2000

22. Which of the following is a general property of bases?

A. taste sour
B. turn litmus red
C. conduct electric current in solution
D. concentration of H_3O^+ is greater than concentration of OH^-

23. Water will act as an acid with which of the following?

I.	H_2CO_3
II.	HCO_3^-
III.	CO_3^{2-}

A. I only.
B. III only.
C. I and II only.
D. II and III only.

24. Which of the following 1.0M solutions will have the greatest electrical conductivity?

A. HI
B. H_2S
C. HCN
D. H_3PO_4

25. An acid is added to water and a new equilibrium is established. The new equilibrium can be described by

A. pH < pOH and $K_w = 1 \text{ X } 10^{-14}$
B. pH < pOH and $K_w < 1 \text{ X } 10^{-14}$
C. pH > pOH and $K_w = 1 \text{ X } 10^{-14}$
D. pH > pOH and $K_w > 1 \text{ X } 10^{-14}$

26. Consider the following equilibrium:

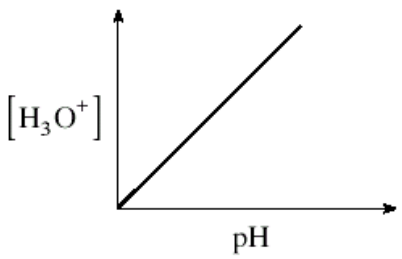
$$2H_2O_{(l)} + \text{energy} \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)}$$

The $[H_3O^+]$ will decrease and the K_w will remain constant when

A. a strong acid is added.
B. a strong base is added.
C. the temperature is increased.
D. the temperature is decreased.

27. Which of the following graphs describes the relationship between $[H_3O^+]$ and pH?

A.



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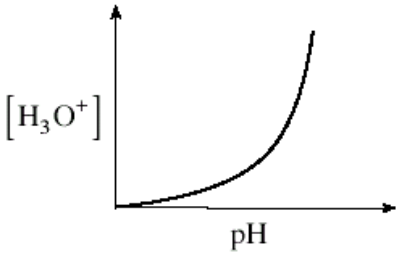

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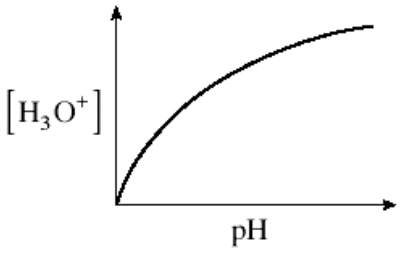

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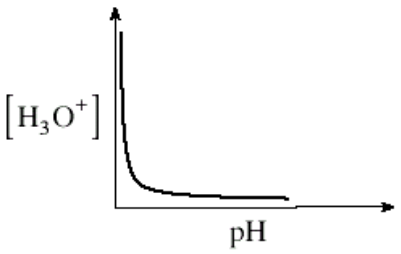


28. When the $[H_3O^+]$ in a solution is increased to twice the original concentration, the change in pH could be from

A. 1.7 to 1.4
B. 2.0 to 4.0
C. 5.0 to 2.5
D. 8.5 to 6.5

29. The relationship $\frac{[H_2P_2O_7^{2-}][H_30^+]}{[H_3P_2O_7^-]}$ is the

A. K_a for $H_3P_2O_7^-$
B. K_b for $H_3P_2O_7^-$
C. K_a for $H_2P_2O_7^{2-}$
D. K_b for $H_2P_2O_7^{2-}$

30. Which of the following describes the relationship between acid strength and K_a value for weak acids?

	Acid Strength	K_a
A.	increases	increases
B.	increases	decreases
C.	decreases	increases
D.	decreases	remains constant

31. The value of K_b for HPO_4^{2} is

A. 2.2×10^{-13}
B. 6.2×10^{-8}
C. 1.6×10^{-7}
D. 4.5×10^{-2}

32. Which of the following 1.0M solutions would have a pH greater than 7.00?

A. HCN
B. KNO_3
C. NH_4Cl
D. $NaCH_3COO$

33. What is the pH at the transition point for an indicator with a K_a of 2.5×10^{-4}?

A. 2.5×10^{-4}
B. 3.60
C. 7.00
D. 10.40

34. What volume of 0.100M NaOH is required to completely neutralize 15.00mL of 0.100M H_3PO_4?

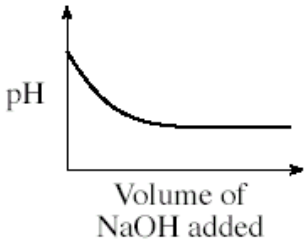
A. 5.00mL
B. 15.0mL
C. 30.0mL
D. 45.0mL

35. What is the pH of the solution formed when 0.060 moles NaOH is added to 1.00L of 0.050M HCl?

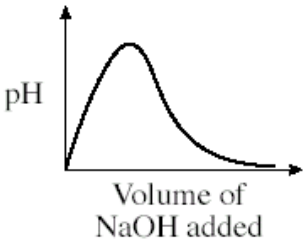
A. 2.00
B. 7.00
C. 12.00
D. 12.78

36. Which of the following graphs describes the relationship between the pH of a buffer and the volume of NaOH added to the buffer?

A.



B.



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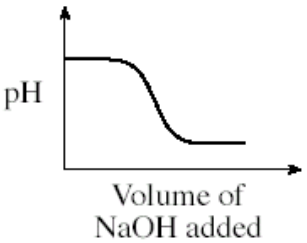

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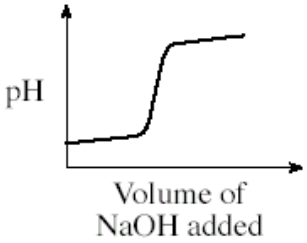


37. A gas which is produced by internal combustion engines and contributes to the formation of acid rain is

A. H_2
B. O_3
C. CH_4
D. NO_2

April 2000

22. Consider the following reaction:

$$H_3BO_{3\,(aq)} + HS^-_{\,(aq)} \rightleftharpoons H_2BO_3^-{}_{(aq)} + H_2S_{\,(aq)}$$

The order of Brønsted-Lowry acids and bases in this equation is

A. acid, base, base, acid.
B. acid, base, acid, base.
C. base, acid, acid, base.
D. base, acid, base, acid.

23. The conjugate base of an acid is produced by

A. adding a proton to the acid.
B. adding an electron to the acid.
C. removing a proton from the acid.
D. removing an electron from the acid.

24. Which of the following represents the predominant reaction between HCO_3^- and water?

A. $2HCO_3^- \rightarrow H_2O + 2CO_2$
B. $HCO_3^- + H_2O \rightarrow H_2CO_3 + OH^-$
C. $HCO_3^- + H_2O \rightarrow H_3O^+ + CO_3^{2-}$
D. $2HCO_3^- + H_2O \rightarrow H_3O^+ + CO_3^{2-} + OH^- + CO_2$

25. Water acts as an acid when it reacts with which of the following?

I.	CN^-
II.	NH_3
III.	$HClO_4$
IV.	CH_3COO^-

A. I and IV only
B. II and III only
C. I, II and IV only
D. II, III and IV only

26. In a solution of 0.10M H_2SO_4, the ions present in order of decreasing concentration are

A. $[H_3O^+] > [HSO_4^-] > [SO_4^{2-}] > [OH^-]$
B. $[H_3O^+] > [SO_4^{2-}] > [HSO_4^-] > [OH^-]$
C. $[OH^-] > [SO_4^{2-}] > [HSO_4^-] > [H_3O^+]$
D. $[SO_4^{2-}] > [HSO_4^-] > [OH^-] > [H_3O^+]$

27. Consider the following equilibrium:

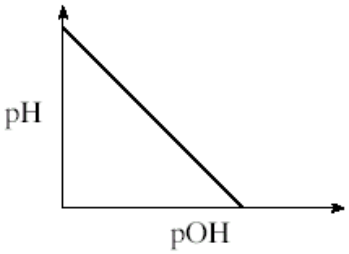
$$2H_2O_{\,(l)} + \text{energy} \rightleftharpoons H_3O^+_{\,(aq)} + OH^-_{(aq)}$$

What will cause the pH to increase and the K_w to decrease?

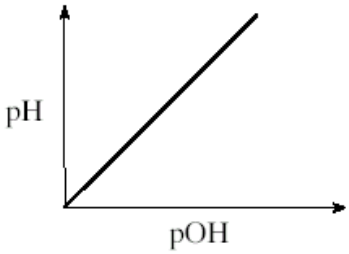
A. adding a strong acid
B. adding a strong base
C. increasing the temperature
D. decreasing the temperature

28. Which of the following graphs describes the relationship between pH and pOH?

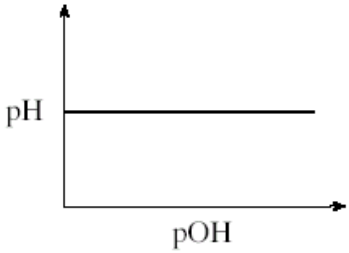
A.



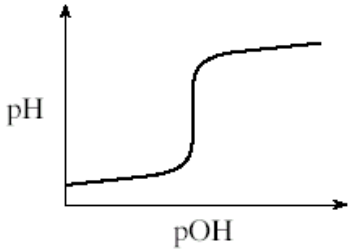
B.



C.



D.



29. $[H_3BO_3][OH^-]$
The relationship ---------- is the expression for
$[H_2BO_3^-]$

A. K*a* for H_3BO_3
B. K*b* for H_3BO_3
C. K*a* for $H_2BO_3^-$
D. K*b* for $H_2BO_3^-$

30. The value of K*b* for $H_2PO_4^-$ is

A. 1.3×10^{-12}
B. 6.2×10^{-8}
C. 1.6×10^{-7}
D. 7.5×10^{-3}

31. Which of the following solutions has a pH less than 7.00?

A. NaCl
B. LiOH
C. NH_4NO_3
D. KCH_3COO

32. Which of the following will form a basic aqueous solution?

A. HSO_3^-
B. HSO_4^-

C. HPO_4^{2-}
D. $HC_2O_4^-$

33. What is the approximate K_a value for the indicator chlorophenol red?

A. 1×10^{-14}
B. 1×10^{-8}
C. 1×10^{-6}
D. 1×10^{-3}

34. What is the pH of the solution formed when 0.040mol NaOH (s) is added to 2.00L of 0.020M HCl?

A. 0.00
B. 1.40
C. 1.70
D. 7.00

35. Which of the following titrations will always have an equivalence point at a pH > 7.00?

A. weak acid with a weak base
B. strong acid with a weak base
C. weak acid with a strong base
D. strong acid with a strong base

36. A buffer solution may contain equal moles of

A. weak acid and strong base.
B. strong acid and strong base.
C. weak acid and its conjugate base.
D. strong acid and its conjugate base
.

37. A gas which is produced by burning coal and also contributes to the formation of acid rain is

A. H_2
B. O_3
C. SO_2
D. C_3H_8

June 2000

21. The conjugate base of $H_2PO_4^-$ is

A. OH^- B. PO_4^{3-} C. H_3PO_4 D. HPO_4^{2-}

22. Aqua regia is a concentrated aqueous solution of HCl and HNO_3. The strongest acid in aqua regia is

A. HCl
B. H_2O
C. H_3O+
D. HNO_3

23. The predominant acid-base reaction between H_2O_2 and H_2O is

A. $H_2O_2 + H_2O \rightarrow 3OH^- + H^+$
B. $H_2O_2 + H_2O \rightarrow 2H_2O + O^{2-}$
C. $H_2O_2 + H_2O \rightarrow H_3O_2^+ + OH^-$
D. $H_2O_2 + H_2O \rightarrow H_3O^+ + HO_2^-$

24. Which of the following reactions favours the formation of products?

A. $HNO_2 + F^- \rightleftharpoons HF + NO_2^-$

B. $H_2CO_3 + IO_3^- \rightleftharpoons HIO_3 + HCO_3$-

C. $NH_4^+ + C_2O_4^{2-} \rightleftharpoons HC_2O_4^- + NH_3$

D. $HCN + HCOO^- \rightleftharpoons HCOOH + CN^-$

25. Which of the following 1.0M solutions will have the lowest $[H_3O^+]$?

A. H_2S
B. HNO_2
C. H_2CO_3
D. CH_3COOH

26. In a solution of 0.10M NaCN, the order of ion concentration, from highest to lowest, is

A. $[Na^+] > [OH^-] > [CN^-] > [H_3O^+]$
B. $[Na^+] > [CN^-] > [OH^-] > [H_3O^+]$
C. $[H_3O^+] > [OH^-] > [CN^-] > [Na^+]$
D. $[OH^-] > [Na^+] > [CN^-] > [H_3O^+]$

27. What will cause the value of K*w* to change?

A. adding OH^-
B. adding a catalyst
C. decreasing the pH
D. increasing the temperature

28. What is the concentration of $Sr(OH)_2$ in a solution with a pH = 11.00?

A. 2.0×10^{-11} B. 1.0×10^{-11} C. 5.0×10^{-4} D. 1.0×10^{-3}

29. The K_a expression for HTe^- is

A. $K_a = \dfrac{[H_2Te][OH^-]}{[HTe^-]}$

C. $K_a = \dfrac{[HTe^-][H3O^+]}{[H_2Te]}$

B. $K_a = \dfrac{[Te^{2-}][H_3O^+]}{[HTe^-]}$

D. $K_a = \dfrac{[HTe^-][OH^-]}{[Te^{2-}]}$

30. When comparing 1.0M solutions of bases, the base with the lowest $[OH^-]$ is the

A. weakest base and it has the largest K_b value.
B. strongest base and it has the largest K_b value.
C. weakest base and it has the smallest K_b value.
D. strongest base and it has the smallest K_b value.

31. The value of K_b for $HC_2O_4^-$ is

A. 1.7×10^{-13}
B. 1.6×10^{-10}
C. 6.4×10^{-5}
D. 5.9×10^{-2}

32. Which of the following applies at the transition point for all indicators, HInd?

A. $[HInd] = [Ind^-]$
B. $[Ind^-] = [H_3O^+]$

C. $[H_3O^+] = [OH^-]$

D. $[HInd] = [H_3O^+]$

33. Identify the indicator that has a K*a* of 1.6×10^{-7}?

A. methyl red
B. thymol blue
C. phenolphthalein
D. bromthymol blue

34. Which of the following acid solutions would require the smallest volume to completely neutralize 10.00mL of 0.100M NaOH ?

A. 0.100M HCl
B. 0.100M H_3PO_4
C. 0.100M $H_2C_2O_4$
D. 0.100M CH_3COOH

35. What is the pH of the solution formed when 0.040 mol $NaOH_{(s)}$ is added to 1.00L of 0.050M HCl ?

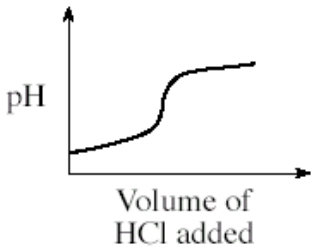
A. 1.30
B. 1.40
C. 2.00
D. 7.00

36. Which of the following titrations will have an equivalence point with a pH less than 7.00?

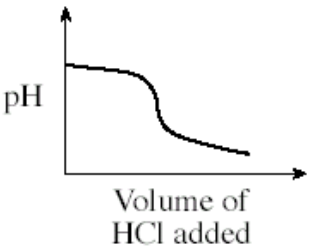
A. H_2SO_4 with NH_3
B. HNO_3 with LiOH
C. H_3PO_4 with KOH
D. HCOOH with NaOH

37. Which of the following graphs describes the relationship between pH of a buffer solution and a volume of HCl added to the buffer?

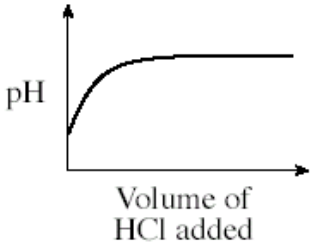
A.



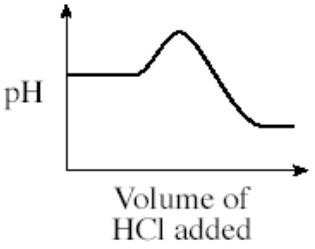
B.



C.



D.



August 2000

23. Consider the following equilibrium:

$$HC_2O_4^- + HSO_4^- \rightleftharpoons H_2C_2O_4 + SO_4^{2-}$$

The order of Brønsted-Lowry acids and bases in the reaction is

A. base, acid, acid, base.
B. base, acid, base, acid.
C. acid, base, acid, base.
D. acid, base, base, acid.

24. Which of the following will have the lowest electrical conductivity?

A. 1.00M HCl
B. 1.00M HNO_3
C. 1.00M H_2SO_4
D. 1.00M H_3PO_4

25. Which of the following represents the ionization of water?

A. $H_2O \rightleftharpoons H_2 + ½\ O_2$
B. $2H_2O \rightleftharpoons H_3O^+ + OH^-$
C. $2H_2O + O_2 \rightleftharpoons 2H_2O_2$
D. $H_2O \rightleftharpoons ½\ O_2 + 2H^+ + 2e^-$

26. Which of the following are amphiprotic?

I.	H_2O
II.	NH_4^+
III.	HCO_3^-

A. I and II only.
B. I and III only.
C. II and III only.
D. I, II and III.

27. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)}$$

The temperature is increased and a new equilibrium is established. The new equilibrium can be described by

A. pH = pOH and $K_w > 1.0 \times 10^{-14}$
B. pH = pOH and $K_w < 1.0 \times 10^{-14}$
C. pH > pOH and $K_w = 1.0 \times 10^{-14}$
D. pH < pOH and $K_w = 1.0 \times 10^{-14}$

28. What is the pH of a 0.10M $Sr(OH)_2$ solution?

A. 0.70
B. 1.00
C. 13.00
D. 13.30

29. In order to change the pH of a solution from 2.0 to 4.0 the $[H_3O^+]$ must
A. increase by a factor of 2.
B. decrease by a factor of 2.
C. increase by a factor of 100.
D. decrease by a factor of 100.

30. The K_b expression for HSe^- is

A. $K_b = \dfrac{[H_2Se][OH^-]}{[HSe^-]}$

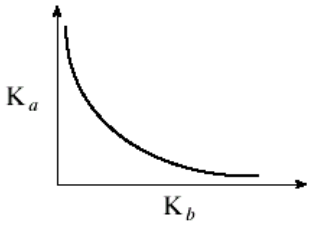
B. $K_b = \frac{[HSe^-][OH^-]}{[Se^{2-}]}$

C. $K_b = \frac{[HSe^-][H_3O^+]}{[H_2Se]}$

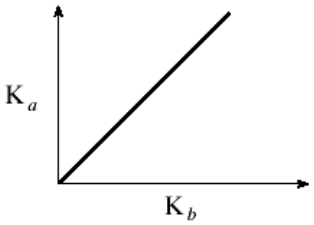
D. $K_b = \frac{[Se^{2-}][H_3O^+]}{[HSe^-]}$

31. Which of the following graphs describes the relationship between K_a and K_b for all conjugate pairs?

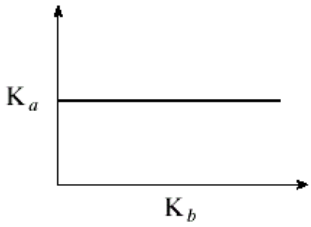
A.



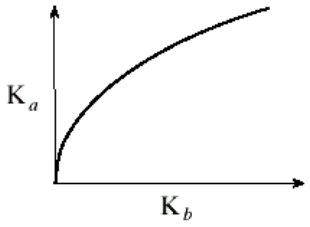
B.



C.



D.



32. The value of K_b for HSO_3^- is

A. 6.7×10^{-13}
B. 1.5×10^{-13}
C. 1.0×10^{-7}
D. 1.5×10^{-2}

33. Which of the following ions will produce an acidic solution when added to water?

A. O^{2-}
B. Na^+
C. NH_4^+
D. HCO_3^-

34. What is the $[H_3O^+]$ at the transition point for an indicator with a K_a of 3.9×10^{-8}?

A. 1.0×10^{-14} M
B. 3.9×10^{-8} M
C. 1.0×10^{-7} M
D. 2.6×10^{-7} M

35. What is the pH of the solution formed when 0.040mol KOH is added to 2.00L of 0.020M HCl ?

A. 0.00
B. 7.00
C. 12.00
D. 12.30

36. The pH of normal rainwater is a result of the presence of dissolved

A. SO_2

B. CO_2
C. NO_2
D. ClO_2

Answer Key

January 1999		April 1999		June 1999		August 1999	
21	C	**21**	A	**19**	D	**22**	C
22	B	**22**	D	**20**	B	**23**	D
23	A	**23**	A	**21**	A	**24**	D
24	A	**24**	A	**22**	A	**25**	C
25	A	**25**	C	**23**	B	**26**	D
26	D	**26**	B	**24**	A	**27**	D
27	A	**27**	A	**25**	D	**28**	D
28	A	**28**	B	**26**	C	**29**	A
29	A	**29**	B	**27**	D	**30**	A
30	A	**30**	D	**28**	C	**31**	B
31	C	**31**	B	**29**	C	**32**	A
32	A	**32**	B	**30**	A	**33**	B
33	C	**33**	C	**31**	C	**34**	B
34	D	**34**	A	**32**	B	**35**	B
35	B	**35**	B	**33**	B	**36**	C
36	D	**36**	A	**34**	B		
				35	A		
				36	B		

January 2000		April 2000		June 2000		August 2000	
22	C	**22**	A	**21**	D	**23**	A
23	D	**23**	C	**22**	C	**24**	D
24	A	**24**	B	**23**	D	**25**	B
25	A	**25**	C	**24**	A	**26**	B
26	B	**26**	A	**25**	A	**27**	A
27	D	**27**	D	**26**	B	**28**	D
28	A	**28**	A	**27**	D	**29**	D
29	A	**29**	D	**28**	C	**30**	A
30	A	**30**	A	**29**	B	**31**	A
31	C	**31**	C	**30**	C	**32**	A
32	D	**32**	C	**31**	A	**33**	C
33	B	**33**	C	**32**	A	**34**	B
34	D	**34**	D	**33**	D	**35**	B
35	C	**35**	C	**34**	B	**36**	B
36	D	**36**	C	**35**	C		
37	D	**37**	C	**36**	A		
				37	B		