Chemistry 12

Acid Base Part 1 Review Package

Name: Key
Date:
Block:

I. Multiple Choice:

1. In which of the following is HSO_3^- acting as a Brønsted-Lowry acid?
   A. $HSO_3^- + H_2O \leftrightharpoons H_2SO_3 + OH^-$
   B. $NH_3 + HSO_3^- \leftrightharpoons NH_4^+ + SO_3^{2-}$
   C. $HSO_3^- + HPO_4^{2-} \leftrightharpoons H_2SO_3 + PO_4^{3-}$
   D. $H_2C_2O_4 + HSO_3^- \leftrightharpoons HC_2O_4^- + H_2SO_3$

2. What is the conjugate base of $H_2PO_4^-$?

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

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

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

4. Which of the following is the strongest acid that can exist in an aqueous solution?

   A. O^{2-} B. NH_2^- C. H_3O^+ D. $HClO_4$

5. What is the pH of a 0.050M KOH solution? $14 - (-\log(0.050))$

   A. 0.30 B. 1.30 C. 12.70 D. 13.70

6. What is the value of K_b for $H_2PO_4^-$? $K_b = \frac{K_w}{K_a(H_3PO_4)}$

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

~~7. Which of the following is the net ionic equation for the neutralization of $HNO_{3(aq)}$ with $Sr(OH)_{2(aq)}$?~~

~~A. $H^+_{(aq)} + OH^-_{(aq)} \leftrightharpoons H_2O_{(l)}$~~
~~B. $Sr^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} \leftrightharpoons Sr(NO_3)_{2(s)}$~~
~~C. $2HNO_{3(aq)} + Sr(OH)_{2(aq)} \leftrightharpoons Sr(NO_3)_{2(aq)} + 2H_2O_{(l)}$~~
~~D. $2H^+_{(aq)} + 2NO_3^-{}_{(aq)} + Sr^{2+}_{(aq)} + 2OH^-_{(aq)} \leftrightharpoons Sr^{2+}{}_{(aq)} + 2NO_3^-{}_{(aq)} + 2H_2O_{(l)}$~~

8. 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.

9. Which of the following 1.0M solutions will have the greatest electrical conductivity? Strong acid

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

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

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

11. 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

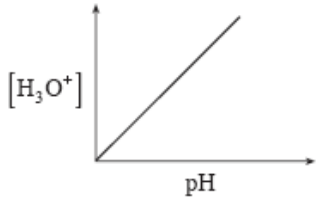
A. a strong acid is added.
B. a strong base is added.
C. the temperature is increased.
D. the temperature is decreased.

will affect K_w

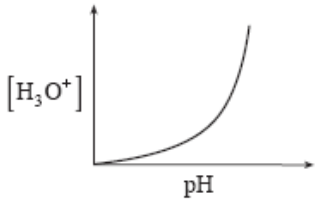
12) Which of the following graphs describes the relationship between $[H_3O^+]$ and pH ?

↑ ↓

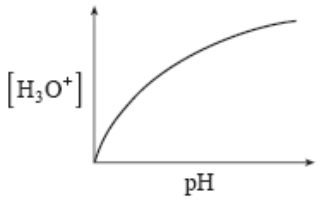
A.



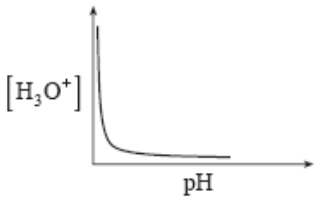
B.



C.



D.



13) When the [H3O+] 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

14. The relationship $\frac{[H_2P_2O_7^{2-}][H_3O^+]}{[H_3P_2O_7^-]}$ 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 $H_2P_2O_7^{2-}$

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

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

16. The value of K_b for HPO_4^{2-} is: $K_b = \frac{K_w}{K_a(H_2PO_4^-)}$

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

~~17. What volume of 0.100M NaOH is required to completely neutralize 15.00mL of 0.100M H_3PO_4?~~

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

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

$[OH^-]_{xs} = 0.010$

$pOH = 2.00$

$pH = 12.00$

NaOH
$(0.060)(1.00) = C_2(1.00)$
$C_2 = 0.060M = [OH^-]$

HCl
$(0.050)(1.00) = C_2(1.00)$
$C_2 = 0.050M = [H_3O^+]$

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

19. The conjugate acid of $C_6H_5NH_2$ is:

A. $C_6H_5NH^-$ B. $C_6H_5NH_3$ C. $C_6H_5NH_2^+$ D. $C_6H_5NH_3^+$

20. Which of the following is a property of 1.0M HCl but not a property of 1.0M CH_3COOH ?

S.A. W.A.

A. turns litmus red
B. ionizes completely
C. has a pH less than 7.0
D. produces H_3O^+ in solution

21. In a 1.0M HF solution, the concentration of HF, F^{-1} and OH^{-1}, from highest to lowest is:

A. $[HF]>[F^{-1}]>[OH^-]$
B. $[F^-]>[HF]>[OH^{-1}]$
C. $[OH^{-1}]>[HF]>[F^{-1}]$
D. $[OH^{-1}]>[F^{-1}]>[HF]$

22. In which of the following reactions is water behaving as a Brønsted-Lowry acid?

A. $2H_2O \leftrightharpoons 2H_2 + O_2$
B. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$
C. $NH_3 + H_2O \leftrightharpoons NH_4^+ + OH^-$
D. $NH_4^+ + H_2O \leftrightharpoons H_3O^+ + NH_3$

23. What is the $[OH^-]$ of a solution with $[H_3O^+] = 9.3 \times 10^{-2}$ M?

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

A. 9.3×10^{-16} M B. 8.6×10^{-13} M C. 1.1×10^{-13} M D. 9.3×10^{-2} M

24. The pH of 0.10M HNO_3 is:

SA = $[H_3O^+]$

A. 0.79 B. 1.00 C. 1.26 D. 13.00

25. What is the pOH of a solution made by adding 50.0mL of 0.50M NaOH to 250.0mL of water?

NaOH
$(0.50)(50.0) = C_2(300.0)$
$C_2 = 0.083$
$pOH = -\log(0.083)$

A. 0.30 B. 1.00 C. 1.08 D. 12.92

26. Which of the following 1.0M solutions will have the lowest pH? S.A.

A. HCl B. HCN C. H_3PO_4 D. $H_2C_2O_4$

27. In an aqueous solution of NaCl, the pH is:

both spectators

A. less than 7 and the solution is acidic.
B. equal to 7 and the solution is neutral.
C. greater than 7 and the solution is basic.
D. greater than 7 and the solution is acidic.

~~28. How many moles of KOH are necessary to completely neutralize 42.0mL of 3.00M HCl?~~

~~A. 0.0630 moles~~
~~B. 0.126 moles~~
~~C. 0.252 moles~~
~~D. 3.00 moles~~

29. The solution with the lowest electrical conductivity is: Weakest acid

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

30. The solution with the lowest pH is: Strongest acid

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

31. 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.

32. The value of pKw at 25°C is; $p = -\log$ $pk_w = -\log(1.00 \times 10^{-14})$

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

33. Consider the following equilibrium:

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

In pure water at a temperature of 50°C,

ex. $[H_3O^+]$ $1.0 \times 10^{-7} \rightarrow 1.0 \times 10^{-6}$ $pH = 7 \rightarrow pH = 6$

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

34. What is the pOH of 2.5 M NaOH? $-\log(2.5)$

A. -0.40
B. 0.0032
C. 0.40
D. 13.60

35. A 0.010M acid solution has a pH of 2.00. The acid could be $-\log(0.010) = 2.00$

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

$[S.A.] = [H_3O^+]$

36. 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.

37. 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

$K_w = [H_3O^+][OH^-]$ (x, x)

HCl $(1.0)(25.0) = C_2(75.0)$ $C_2 = 0.333$

KOH $(0.50)(50.0) = C_2(75.0)$ $C_2 = 0.333$

Neutral

$K_w = x^2$ $x = \sqrt{1.00 \times 10^{-14}}$

II. Short Answers:

1) Calculate the pH of 0.50M H_3BO_3.
↳ weak acid

2) Calculate the pH of 1.50M NH_3.
↳ weak base

3) Calculate the pOH of 0.25M $Sr(OH)_2$.
↳ strong base

4) A 2.00M diprotic acid has a pH of 0.50. Calculate its Ka value.
↳ 2 H's

5) Calculate the pH of a solution prepared by adding 15.0 mL of 0.500M H_2SO_4 to 35.0 mL of 0.750M NaOH.
↳ strong acid
↳ strong base

6) Determine the pH of a 0.75M solution of HPO_4^{2-}.
↳ amphiprotic!

1.

$$H_3BO_3 + H_2O \rightleftharpoons H_2BO_3^- + H_3O^+$$

	H_3BO_3	H_2O	$H_2BO_3^-$	H_3O^+
I	0.50M		0M	0M
C	$-x$		$+x$	$+x$
E	$0.50-x$		x	x

$$K_a = \frac{[H_2BO_3^-][H_3O^+]}{[H_3BO_3]} = \frac{x^2}{0.50-x} = 7.3\times10^{-10}$$

assume $0.50 - x \approx 0.50$

$$x = \sqrt{(0.50)(7.3\times10^{-10})}$$

$$= 1.9\times10^{-5} = [H_3O^+]$$

$$pH = -\log[H_3O^+]$$

$$= -\log(1.9\times10^{-5}) = \boxed{4.72}$$

2.

	NH_3	+ H_2O	⇌	NH_4^+	+	OH^-
I	1.5 M			0M		0M
C	$-x$			$+x$		$+x$
E	$1.5-x$			x		x

$$K_b = \frac{K_w}{K_a(NH_4^+)} = \frac{1.0\times10^{-14}}{5.6\times10^{-10}} = 1.8\times10^{-5} = \frac{x^2}{1.5-x}$$

assume $1.5-x \approx 1.5$

$$x = \sqrt{(1.5)(1.8\times10^{-5})}$$

$$= 5.2\times10^{-3} = [OH^-]$$

$pOH = -\log[OH^-]$

$= -\log(5.2\times10^{-3}) = 2.28$

$pH = 14 - 2.28$

$= \boxed{11.72}$

3.

$Sr(OH)_2 \longrightarrow Sr^{2+} + 2OH^-$

0.25M → 0.50M (×2)

$pOH = -\log[OH^-]$

$= -\log(0.50)$

$= \boxed{0.30}$

4.

	H_2A	+ H_2O	⇌	HA^-	+	H_3O^+
I	2.00M			0M		0M
C	−0.32M			+0.32M		+0.32M
E	1.68M			0.32M		0.32M

$[H_3O^+] = 10^{-pH}$

$= 10^{-0.50}$

$= 0.32M$

$K_a = \frac{[HA^-][H_3O^+]}{[H_2A]} = \frac{(0.32)^2}{1.68}$

$= \boxed{0.061}$

5. $[H_2SO_4] = [H_3O^+]$

$C_1V_1 = C_2V_2$

$C_2 = \frac{(0.500)(15.0)}{(50.0)}$

$= 0.15M = [H_3O^+]_i$

$[NaOH] = [OH^-]$

$C_1V_1 = C_2V_2$

$C_2 = \frac{(0.750)(35.0)}{(50.0)}$

$= 0.525M = [OH^-]_i$

basic! $[OH^-]_f$

$[OH^-]_f = [OH^-]_i - [H_3O^+]_i$

$= 0.525M - 0.15M$

$= 0.375M$

$pOH = -\log(0.375)$

$= 0.426$

$pH = 14 - 0.426$

$= \boxed{13.574}$

6. HPO_4^{2-} (acid) vs HPO_4^{2-} (base)

$K_a = 2.2 \times 10^{-13}$

$K_b = \frac{K_w}{K_a(H_2PO_4^-)} = \frac{1.0 \times 10^{-14}}{6.2 \times 10^{-8}}$

$= 1.6 \times 10^{-7}$

	HPO_4^{2-}	+ H_2O ⇌	$H_2PO_4^-$	+ OH^-
I	0.75M		0M	0M
C	$-x$		$+x$	$+x$
E	$0.75 - x$		x	x

$K_b = \frac{[H_2PO_4^-][OH^-]}{[HPO_4^{2-}]} = \frac{x^2}{0.75 - x} = 1.6 \times 10^{-7}$

assume $0.75 - x \approx 0.75$

$x = \sqrt{(0.75)(1.6 \times 10^{-7})}$

$= 3.5 \times 10^{-4}M = [OH^-]$

$pOH = -\log(3.5 \times 10^{-4})$

$= 3.46$

$pH = \boxed{10.54}$