

1. Which of the following does NOT represent an acid followed by its conjugate base?

- a)  $\text{H}_3\text{O}^+ / \text{H}_2\text{O}$
- b)  $\text{HCN} / \text{CN}^-$
- c)  $\text{HCl} / \text{Cl}^-$
- d)  $\text{HC}_2\text{H}_3\text{O}_2 / \text{OH}^-$
- e) All are acids followed by their conjugate base

2. According to the Bronsted-Lowry definition, a base is

- a) a substance that increases the hydroxide ion concentration of a solution
- b) a substance that can accept a proton from an acid
- c) a substance that can donate an electron pair to the formation of a covalent bond
- d) a substance that increases the anion formed by the autoionization of the solvent
- e) a substance that donates a proton

3. The equilibrium constant for the reaction

$\text{A}^- + \text{H}^+ \rightleftharpoons \text{HA}$  is called:

- a)  $K_a$
- b)  $K_b$
- c)  $1/K_a$
- d)  $K_w/K_b$
- e)  $K_wK_a$

4. At 0 degrees Celsius, the  $K_w$  for water is  $1.2 \times 10^{-15}$ . The pH of pure water at this temperature is

- a) 7.00
- b) 6.88
- c) 7.56
- d) 7.46

e) none of these

5. Given  $\text{HCN(aq)} + \text{HCO}_3^-(\text{aq}) \rightleftharpoons \text{CN}^-(\text{aq}) + \text{H}_2\text{CO}_3(\text{aq})$

If  $K < 1$ , what is the strongest base in this system?

- a) HCN
- b)  $\text{HCO}_3^-$
- c)  $\text{CN}^-$
- d)  $\text{H}_2\text{CO}_3$
- e)  $\text{H}_2\text{O}$

6. The following acids are listed in order of decreasing acid strength in water.

$\text{HI} > \text{HNO}_2 > \text{CH}_3\text{COOH} > \text{HClO} > \text{HCN}$

According to Bronsted-Lowry theory, which of the following ions is the weakest base?

- a)  $\text{I}^-$
- b)  $\text{NO}_2^-$
- c)  $\text{CH}_3\text{COO}^-$
- d)  $\text{ClO}^-$
- e)  $\text{CN}^-$

7. Which of the following is an acid?

- a)  $\text{HCOOH}$
- b)  $\text{CH}_3\text{OH}$
- c)  $\text{KOH}$
- d)  $\text{NH}_3$
- e)  $\text{CH}_3\text{NH}_2$

8. What is the strongest acid?

- a)  $\text{HClO}_2$
- b)  $\text{HClO}_3$
- c)  $\text{HClO}_4$
- d)  $\text{HF}$

e) HOCl

9. Which of the following reactions does not proceed significantly to the right in aqueous solution?

- a)  $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{Cl}^-$
- b)  $\text{H}_3\text{O}^+ + \text{OH}^- \rightleftharpoons 2\text{H}_2\text{O}$
- c)  $\text{H}_2\text{O} + \text{HSO}_4^- \rightleftharpoons \text{H}_2\text{SO}_4 + \text{OH}^-$
- d)  $\text{HCN} + \text{OH}^- \rightleftharpoons \text{H}_2\text{O} + \text{CN}^-$
- e)  $\text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{HSO}_4^-$

10. What is the  $[\text{H}^+]$  in a solution which shows a pH of 2.30?

- a) 2.3M
- b) 11.7M
- c)  $5.0 \times 10^{-3}\text{M}$
- d)  $2.0 \times 10^{-12}\text{M}$
- e) none of these

11. What is the pH of a solution at 25 degrees Celsius in which  $[\text{OH}^-] = 3.4 \times 10^{-5}\text{M}$ .

- a) 4.5
- b) 10.5
- c) 9.5
- d) 6.3
- e) none of these

12. What is the pH of a 10.0 M solution of  $\text{HNO}_3$ ?

- a) 10
- b) 1.0
- c) 0
- d) -1.0
- e) none of these

13. Nitrous acid,  $\text{HNO}_2$ , has an ionization constant  $K_a = 4.0 \times 10^{-4}$ . The pH of a 0.25 M  $\text{HNO}_2$  solution is:

- a) 2.00
- b) 2.30
- c) 2.70
- d) 3.70
- e) none of these

14. In a solution prepared by dissolving 0.10 mole of an acid HX in enough water to make 1.00 L of solution, the pH is observed to 1.35. What is the  $K_a$  for this acid?

- a)  $2.0 \times 10^{-2}$
- b)  $3.6 \times 10^{-2}$
- c)  $4.5 \times 10^{-2}$
- d)  $5.0 \times 10^{-12}$
- e) None of these

15. A 0.05 M aqueous solution of a weak monoprotic acid is 1.2% ionized at equilibrium at 25 degrees celsius.  $K_a$  for this acid is:

- a) 0.034
- b)  $6.4 \times 10^{-8}$
- c)  $7.3 \times 10^{-33}$
- d) 29
- e) none of these

16. What is the pOH of a 0.10 M solution of  $Ba(OH)_2$ ?

- a) 13.30
- b) 0.70
- c) 1.00
- d) 13.00
- e) none of these

17. The  $[\text{OH}^-]$  in a 0.50 M pyridine solution ( $\text{C}_5\text{H}_5\text{N}$ ;  $K_b = 1.7 \times 10^{-9}$ ) is:

- a) 0.50 M
- b)  $2.9 \times 10^{-5}$  M
- c)  $1.8 \times 10^{-9}$  M
- d)  $3.3 \times 10^{-10}$  M
- e) none of these

18. The equilibrium constant for the reaction

$\text{NH}_4^+ + \text{OH}^- \rightleftharpoons \text{NH}_3 + \text{H}_2\text{O}$  is:

- a)  $1/K_b$  for  $\text{NH}_3$
- b)  $1/K_a$  for  $\text{NH}_4^+$
- c)  $K_w/K_a$  for  $\text{NH}_4^+$
- d)  $K_w/K_b$  for  $\text{NH}_3$
- e)  $K_b$  for  $\text{NH}_3/K_w$

19. What is the pH of a 0.05 M solution of ascorbic acid, Vitamin C ( $K_{a1} = 7.9 \times 10^{-5}$ ;  $K_{a2} = 1.6 \times 10^{-12}$ )

- a) 1.3
- b) 2.7
- c) 3.1
- d) 5.4
- e) 6.5

20. Given:  $\text{HAc}$        $K_a = 1.8 \times 10^{-5}$

$\text{H}_2\text{CO}_3$     $K_{a1} = 4.3 \times 10^{-7}$

$K_{a2} = 5.6 \times 10^{-11}$

Which of the following 0.01M solutions will have the highest pH?

- a)  $\text{HAc}$
- b)  $\text{NaAc}$
- c)  $\text{Na}_2\text{CO}_3$
- d)  $\text{H}_2\text{CO}_3$
- e)  $\text{NaHCO}_3$

21. If  $K_a$  for HCN is  $6.2 \times 10^{-10}$ , what is  $K_b$  for  $\text{CN}^-$ ?

- a)  $6.2 \times 10^{-24}$
- b)  $6.2 \times 10^4$
- c)  $1.6 \times 10^{-5}$
- d)  $1.6 \times 10^{-23}$
- e) none of these

22. Which of the following substances can be dissolved in water to give a basic solution?

- a)  $\text{NH}_4\text{Cl}$
- b)  $\text{NaBr}$
- c)  $\text{KF}$
- d)  $\text{NaHSO}_4$
- e)  $\text{KNO}_3$

23. What is the pH of a 1.0 M aqueous solution of  $\text{NaCl}$ ?

- a) 7.0
- b) greater than 7.0
- c) less than 7.0
- d) not enough information
- e) too tired to answer

24. What is the pH of a 1.0 M aqueous solution of  $\text{KNO}_2$ ?

- a) 7.0
- b) greater than 7.0
- c) less than 7.0
- d) not enough information

25. Which of the following is the STRONGEST Lewis acid?

- a)  $\text{Na}^+$
- b)  $\text{Al}^{3+}$

- c)  $\text{CH}_3\text{COO}^-$
- d)  $\text{Mg}^{2+}$
- e)  $\text{Cl}^-$

26. All of the following species can function as Bronsted-Lowry bases in solution EXCEPT:

- a)  $\text{H}_2\text{O}$
- b)  $\text{NH}_3$
- c)  $\text{S}^{2-}$
- d)  $\text{NH}_4^+$
- e)  $\text{HCO}_3^-$

27. What is the pH of a 0.36M solution of sodium acetate?

- a) 9.15
- b) 4.85
- c) 2.59
- d) 11.41
- e) 7.00

28. Which of the following will NOT give an acid solution when dissolved in water?

Hint : Check section 14.10 in your book.

- a)  $\text{K}_2\text{O}$
- b)  $\text{P}_2\text{O}_5$
- c)  $\text{CO}_2$
- d)  $\text{NO}_2$
- e)  $\text{SO}_3$

29. HCN is a weak acid ( $K_a = 6.2 \times 10^{-10}$ )  $\text{NH}_3$  is a weak base ( $K_b = 1.8 \times 10^{-5}$ ). A 1.0 M solution of  $\text{NH}_4\text{CN}$  would be

- a) strongly acidic
- b) weakly acidic
- c) neutral

d) weakly basic

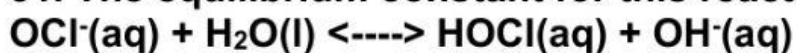
30. The equilibrium constant for this reaction is approximately 0.001.



Which is the strongest conjugate base in this reaction?

- a)  $\text{HPO}_4^{2-}(\text{aq})$
- b)  $\text{HCO}_3^{-}(\text{aq})$
- c)  $\text{H}_2\text{PO}_4^{-}(\text{aq})$
- d)  $\text{CO}_3^{2-}(\text{aq})$
- e) there is no base in this reaction

31. The equilibrium constant for this reaction is  $3.6 \times 10^{-7}$



What is  $K_a$  for HOCl?

- a)  $2.8 \times 10^{-8}$
- b)  $3.6 \times 10^{-7}$
- c)  $6.0 \times 10^{-4}$
- d)  $2.8 \times 10^6$