



## CHEMISTRY

### BOOKS - CENGAGE CHEMISTRY

#### ACIDS, BASES AND SALTS

##### Worked Examples

1. Calculate the pH of 0.001 M nitric acid.

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2. Calculate the pH of 0.02 mol  $dm^{-3}$  of  $H_2SO_4$ .

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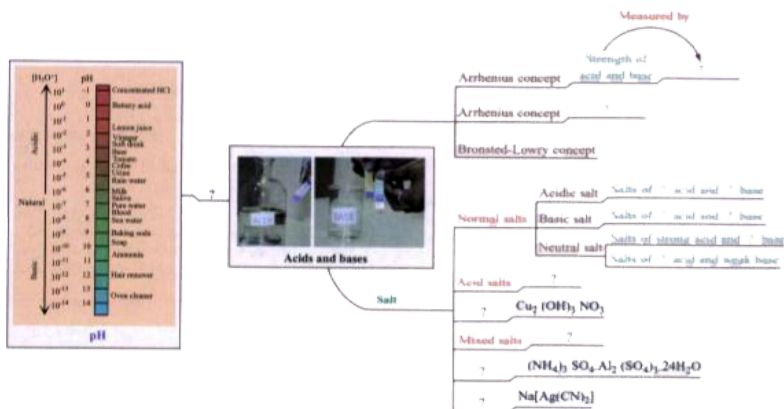
3. Calculate the pH of  $10^{-1}$  M HCl.

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4. Calculate the pH of 0.001 M NaOH.

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5. Calculate the pH  $1 \text{ dm}^3$  of sodium hydroxide solution containing 4g of sodium hydroxide.



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1. Justify the amphoteric behaviour of water on the basis of protonic concept.

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2. Classify each of the following substances into acid or base or both and mention the concept used:

$HCl(aq)$ ,  $NH_3(g)$ ,  $Na_2CO_3(aq)$ ,  $CO_2(g)$ ,  $Ag^+$ ,  $H_2O$ ,  $H_2SO_4$  and  $HCO_3^-$

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3. Write the conjugate acid and the conjugate base of the following:

$H_2O$

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4. Write the conjugate acid and the conjugate base of the following:



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5. Write the conjugate acid and the conjugate base of the following:



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6. Which one of the following is not true in the case of a base?

- A. It acts as an electron pair donor.
- B. It accepts a proton.
- C. It turns blue litmus red.
- D. All of these.

**Answer: C**



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7. In the reaction,  $NH_2 + H_2O \rightarrow NH_3^+ + OH^-$ , water is

- A. acid
- B. base
- C. neutral
- D. both acid and base

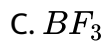
**Answer: A**



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8. Which one of the following acts both as Lowry Bronsted acid and as Lowry-Bronsted base?

- A.  $CO_3^{2-}$
- B.  $H_3O^+$

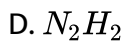


**Answer: D**



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9. The conjugate acid of  $NH_2^-$  is



**Answer: A**



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10.  $BF_3$  is an acid according to

- A. Arrhenius
- B. Lowry-Bronsted
- C. Lewis
- D. all of them

**Answer: C**



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11. Which of the following is not a Lewis base?

- A.  $Ag^+$
- B.  $H_2O$
- C.  $CN^-$
- D.  $NH_3$

**Answer: A**



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**12.** Water is a

- A. amphoteric solvent
- B. aprotic solvent
- C. protophobic solvent
- D. protophilic solvent

**Answer: A**



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**13.** The characteristics properties of an acid is due to the presence of

- A.  $H^+$



B.  $\text{OH}^-$

C.  $\text{H}_3\text{O}^+$

D.  $\text{O}^{2-}$

**Answer: C**

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**14.** A strong acid in aqueous medium exist in

A. mostly molecules

B. mostly ions

C. both molecules & ions

D. None

**Answer: B**

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15. Weak acid in solution is

- A. mostly molecules
- B. mostly ions
- C. both molecules & ions
- D. None

**Answer: C**

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16. If the pH value of a solution is 6.8 at  $25^{\circ}C$ , then solution will be of what type?

- A. strong acid
- B. strong base
- C. mild acid
- D. mild base

**Answer: C**



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**17.** If the pH value of a solution is zero, then solution will be of what type?

- A. neutral
- B. mild acid
- C. strong acid
- D. mild base

**Answer: C**



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**18.** What happens when carbon dioxide gas reacts with solution hydroxide?

A. CO is formed

B.  $CO_2$  is formed

C.  $Na_2CO_3$  is formed

D. carbon dioxide does not react with sodium hydroxide

**Answer: C**

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**19.** Which of the following is common in all Arrhenius acids?

A. Hydrogen ion

B. Hydroxide ions

C. Chloride ions

D. Sodium ions

**Answer: A**

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20. Which of the following acid does produce hydrogen ions in absence of water?

A. HCl

B.  $H_2SO_4$

C.  $NHO_3$

D. None

**Answer: D**



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21. Hydrogen ions produced by acid exist in which of the following form?

A. Hydrogen

B. Hydronium ions

C. Water ions

D. Hydroxide ions

**Answer: B**



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22. Which of the following is common in all bases?

A. Hydrogen ion

B. Hydroxide ions

C. Chloride ions

D. Pair of non bonded electron

**Answer: D**



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1. How does pH change with hydrogen ion concentration?

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2. Calculate the pH of

0.01 M NaOH

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3. Calculate the pH of

$10^{-2} M H_2SO_4$

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4. Calculate the pH of

$10^{-2} M NH_2SO_4$

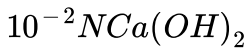
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5. Calculate the pH of



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6. Calculate the pH of



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7. The pH of caustic soda is

A.  $> 7$

B.  $< 7$

C. 7

D. 0

**Answer: A**





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8. The sum of pH and pOH for a given solution is

- A. 7
- B. 14
- C. 0
- D. 20

**Answer: B**



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9. A compound whose solution has the highest pH is

- A. NaCl
- B.  $Na_2CO_3$
- C.  $NH_4Cl$



**Answer: B**

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10. The pH of a solution is 5.0. Sufficient acid is added to the solution to decrease the pH to 2.0. The increase in hydrogen ion concentration is

- A. 100 times
- B. 1000 times
- C. 2.5 times
- D. 10 times

**Answer: B**

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11. The pH indicators are

- A. salts of strong acids and strong bases
- B. salts of weak acids and weak bases
- C. either weak acid or weak base
- D. either strong acid or strong base

**Answer: C**



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12. pH of water is 7. When a substance Y is dissolved in water, the pH becomes 13. The substance Y is a salt of

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

**Answer: D**



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**13.** Which solution will be strongly acidic?

A. When  $\text{pOH} = 4.5$

B. When  $\text{pOH} = 14$

C. When  $\text{pH} = 0$

D. Both B and C

**Answer: D**



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**14.** A salt derived from a strong base and weak acid will give a salt that is

A. acidic

B. basic

C. neutral

D. Highly acidic

**Answer: B**



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**15.** The pH of a carbonated drink is

A. less than 7

B. more than 7

C. equal to 7

D. approximately 10

**Answer: A**



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16. Which formula represent a salt?

A. NaOH

B. KCl

C.  $CH_3OH$

D.  $CH_3 - \overset{O}{\parallel} C - CH_3$

**Answer: B**

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17. Which of the given substance is an Arrhenius acid?

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18. Which solution can change the red litmus to blue

A. NaCl(aq)

B.  $\text{LiCl}(\text{aq})$

C.  $\text{CH}_3\text{OH}(\text{aq})$

D.  $\text{KOH}(\text{aq})$

**Answer: D**

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**19.** According to Lewis acid base Theory, an acid is a species that can

A. do not accept a proton

B. do not accept an electron

C. accept a proton

D. accept pair of electron.

**Answer: D**

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20. Which of the given solution will turn phenolphthalein to a pink colour solution?

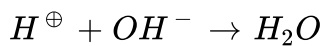
- A.  $\text{HCl}(\text{aq})$
- B.  $\text{CO}_2(\text{aq})$
- C.  $\text{NaOH}(\text{aq})$
- D.  $\text{CH}_3\text{OH}(\text{aq})$

**Answer: C**



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21. Following chemical equation represent



- A. Esterification
- B. Addition
- C. neutralisation



## D. Dissociation

Answer: C

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22. If concentration of  $H^{\oplus}$  increases in an aqueous solution, then concentration of  $OH^{-}$  ion will be

- A. Decrease
- B. Increase
- C. Remain the same
- D. Can't say

Answer: A

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23. A substance that donate a pair of electrons to form co-ordinate bond is called

- A. Lewis acid
- B. Lewis base
- C. bronsted acid
- D. bronsted base

**Answer: B**

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### Mandatory Exercise Exercise Set Iii

1. Distinguish between mixed salt and complex salt.

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2. What will be the nature of aqueous solutions of the following salts?

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3. What will be the nature of aqueous solutions of the following salts?

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4. What will be the nature of aqueous solutions of the following salts?

 [View Text Solution](#)

5. What will be the nature of aqueous solutions of the following salts?

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6. A solution of sodium acetate in water

- A. turns blue litmus red
- B. turns red litmus blue
- C. does not affect the litmus
- D. decolourises the litmus

**Answer: B**

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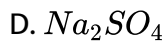
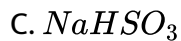
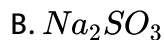
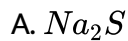
7. An aqueous solution of  $FeCl_3$  is

- A. acidic
- B. basic
- C. neutral
- D. amphoteric

**Answer: A**

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8. Which of the following is an acid salt?



**Answer: C**



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9. When Lewis base react with Lewis acid, formation of take place

A. co-ordinate bond

B. salt

C. Addition compound

D. All

**Answer: D**



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10. When an acid reacts with a metal, which one of the following gas is usually liberated?

A. ammonia gas

B. chlorine

C. hydrogen gas

D. oxygen

**Answer: C**



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11. When an acid reacts with a metal, formation of hydrogen gas take place due to

- A. oxidation
- B. reduction
- C. both
- D. Can't say

**Answer: B**



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12. Select wrong match

- A. Sodium carbonate-washing soda
- B. sodium chloride-common salt
- C. Calcium carbonate-Slaked lime
- D. Sodium Hydroxide-Caustic soda

**Answer: C**



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**13. What is the pH of 0.001 M HCl solution**

A. 1

B. 2

C. 3

D. 4

**Answer: C**



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**14. What is the pOH of  $10^{-8}$  M HCl**

A. 6



B. 8

C. 7.03

D. 6.57

**Answer: C**



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15. Which of the following does not cause acid rain?

A. Sulphur dioxide

B. Calcium oxide

C. Carbon dioxide

D. Nitrogen dioxide

**Answer: B**



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16. Mineral acids are

- A. naturally occurring
- B. man made
- C. both (A) and (B)
- D. None

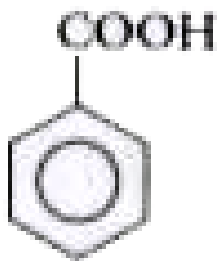
**Answer: A**



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17. More corrosive acid is

- A.  $H_2CO_3$
- B.  $H_2SO_3$
- C.  $HNO_3$



Answer: C

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18. Excess acidity caused by acid rain can be neutralized by adding

- A. more fertilizers
- B. by removing acid for soil
- C. by adding  $P_2O_5$
- D. by adding lime.

Answer: D

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19. The type of medicine used to treat indigestion is

- A. Anti histamine
- B. sulpha drug
- C. Antacid
- D. Antibiotic

**Answer: C**



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### Mandatory Exercise Exercise Set Iv

1. When small amount of washing soda is added to dilute HCl. What will you observe?

- A.  $H_2$  gas comes out
- B.  $CO_2$  gas comes out

C. only neutralisation, no gas

D. White ppt formed

**Answer: B**



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2. Which of the following is a dibasic acid?

A. HCl

B.  $H_3PO_4$

C.  $HNO_3$

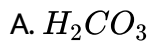
D.  $H_2SO_4$

**Answer: D**



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3. Which of the following is a weak acid?



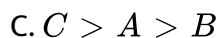
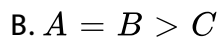
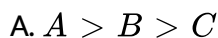
D. All of these.

**Answer: D**



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4. Hydrogen ion concentrations of three acids A, B and C are  $10^{-5}$  mole/L,  $10^{-3}$  mole/L and  $10^{-2}$  mole/L respectively. Arrange these acids in order of their decreasing acidic strength



D.  $C > B > A$

**Answer: D**



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5. Which metal can displace hydrogen from acids to form salts?

A. Zn

B. Ag

C. Au

D. Cu

**Answer: A**



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6. When zinc reacts with sodium hydroxide, the products formed are

- A. zinc hydroxide and sodium
- B. sodium zincate and water
- C. sodium zincate and hydrogen
- D. sodium zincate and oxygen

**Answer: C**

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7. One molecule of Aluminium hydroxide will require molecules of dil. HCl for complete neutralisation

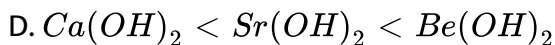
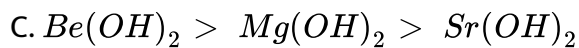
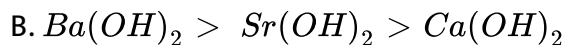
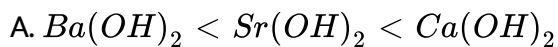
- A. 1
- B. 2
- C. 3
- D. 4

**Answer: C**



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8. Which is the correct order of basic nature?

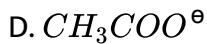


Answer: B

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9. The strongest conjugate base is

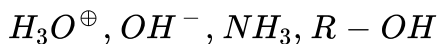




Answer: D

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10. Write the conjugate base of following



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11. 4 g NaOH dissolved in 10 L water, pH of solution be will be?

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12. Find pH of 0.1 M  $CH_3COOH(aq)$  solution  $K(CH_3COOH) = 10^{-5}$

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13. How many moles of KOH are present in 2 L, if pH of solution is 12.

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14. The molarity of  $H_2SO_4$  solution having pH value equal to 5 is

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15. 100 ml of 0.5 N NaOH solution is added to 10 ml of  $3NH_2SO_4$  solution and 20 ml of 1 N HCl solution. The mixture is \_\_\_\_\_

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16. How many moles of  $Ca(OH)_2$  required for the complete neutralisation of 3 moles of oxalic acid?

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17. pH of  $10^{-5} M$  NaCl solution at  $25^{\circ} C$  is?

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18. 50 ml solution of pH = 1 is mixed with 50 ml solution of pH = 2. The pH of the mixture will be \_\_\_\_\_

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19. NaOH(aq), HCl(aq), NaCl(aq) concentration of each is  $10^{-3} M$ . Their pH will be respectively.

A. 11, 3, 3

B. 11, 3, 11

C. 11, 3, 7

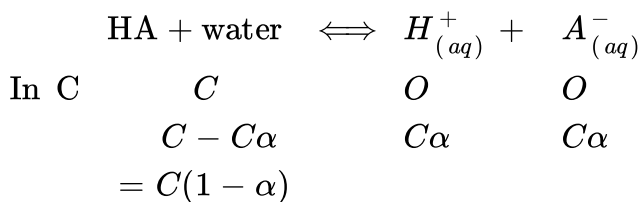
D. 3, 3, 3

**Answer: C**

## Consolidated Exercise

1. Strengths of Acids and Bases Greater the number of  $H^+$  ions produced in the aqueous solution, stronger is the acid. Similarly, greater the number of  $OH^-$  ions produced in the aqueous solution, stronger is the base. The relative strength of two weak acids can, however, be compared in a quantitative manner as explained below:

Suppose the weak acid is represented as HA. Let the initial concentration of HA be  $C$  mol/L and  $\alpha$  be its degree of dissociation. Thus,



Applying the law of chemical equilibrium,  $k_a = k_{(a)} = \frac{[H^+_{(aq)}][A^-_{(aq)}]}{[HA]}$  where  $k_{(a)}$

is called the dissociation constant of the acid. Degree of dissociation ( $\alpha$ ) of a weak acid is very small. Therefore,  $1 - \alpha \approx 1$ .  $k_{(a)} = \frac{C\alpha \cdot C\alpha}{C(1 - \alpha)} = \frac{C\alpha^2}{(1 - \alpha)} \approx C\alpha^2$  or

alpha

=

$\sqrt{\frac{k_a}{C}}$

Thus, if two acids of equimolar concentration are taken (so that  $\hat{C}$  is constant)

$$\frac{\alpha_1}{\alpha_2} = \sqrt{\frac{k_{a_1}}{k_{a_2}}}$$

Thus, the relative strength of two acids of equimolar concentration can be compared by their  $k_a$  values,

$$\frac{\alpha_1}{\alpha_2} = \sqrt{\frac{k_{b_1}}{k_{b_2}}}$$

The strength of acids and bases can be experimentally determined by their  $k_a$  or  $k_b$  values.

CH<sub>3</sub>COH or HCN? ( $k_a$  of CH<sub>3</sub>COOH =  $1.8 \times 10^{-5}$ ,  $k_a$  of

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



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2. Which of the following bases are stronger and by how much?

$NH_3$  and  $NH_2OH$

$$(k_{b(NH_3)} = 1.77 \times 10^{-5}, k_{b(NH_2OH)} = 1.1 \times 10^{-8})$$



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3. Which of the following bases are stronger and by how much?

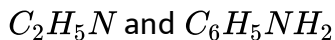


$$(k_b(N_2H_4) = 1.7 \times 10^{-6}, k_b(CH_3NH_2) = 3.7 \times 10^{-4})$$



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4. Which of the following bases are stronger and by how much?



$$(k_b(C_2H_5N) = 1.77 \times 10^{-9}, k_b(C_6H_5NH_2) = 4.27 \times 10^{-10})$$



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5. Match the following:

A	B
(1) Titration of acetic acid with NaOH solution	(a) $\text{pH} < 7$
(2) Copper sulphate solution	(b) Phenolphthalein
(3) Potassium nitrate solution	(c) $\text{pH} > 7$
(4) Titration of $\text{Na}_2\text{CO}_3$ with HCl	(d) $\text{pH} = 0$
(5) Titration of $\text{NH}_4\text{OH}$ with acetic acid	(e) Methyl orange
(6) Sodium acetate solution	(f) No suitable indicator

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## Challenging Exercise

1. Ammonium chloride is acidic in liquid ammonia. Why?

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2. Which of the following is more basic/acidic and why?

0.1 M KOH and 0.0001 M NaOH

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3. Which of the following is more basic/acidic and why?

0.01 M  $HNO_3$  and 0.001 M HCl

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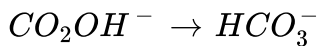
4. Acid rain has a pH of 4.5. Calculate  $[H_3O^+]$ .

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5. Human blood has a pH of 7.40. Calculate the concentration of  $H_3O^+$  and  $OH^-$ .

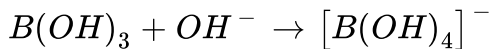
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6. For each of the following reaction, identify the Lewis acid and the Lewis base.



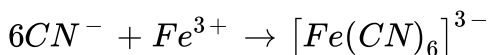
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7. For each of the following reaction, identify the Lewis acid and the Lewis base.



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8. For each of the following reaction, identify the Lewis acid and the Lewis base.



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Column I Species	Column II Characteristic
(A) $\text{HSO}_4^-$	(P) Lewis acid
(B) $\text{BF}_3$	(Q) Lewis base
(C) $\text{NH}_3$	(R) Bronsted acid
(D) $\text{OH}^-$	(S) Bronsted base

1.

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2. Phenolphthalein does not act as an indicator for the titration between

- A.  $\text{HCl}$  and  $\text{NH}_4\text{OH}$
- B.  $\text{Ca}(\text{OH})_2$  and  $\text{HCl}$
- C.  $\text{NaOH}$  and  $\text{H}_2\text{SO}_4$
- D.  $\text{KOH}$  and  $\text{CH}_3\text{COOH}$

**Answer: A**

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3. Which one of the following is true for any diprotic acid,  $H_2X$  ?

A.  $K_{a2} > K_{a1}$

B.  $K_{a1} > K_{a2}$

C.  $K_{a2} = \frac{1}{K_{a1}}$

D.  $K_{a2} = K_{a1}$

**Answer: B**

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4. Let the solubilities of  $AgCl$  in  $H_2O$ , and in  $0.01\text{ M } CaCl_2$ ,  $0.01\text{ M } NaCl$ , and  $0.05\text{ M } AgNO_3$  be  $S_1$ ,  $S_2$ ,  $S_3$ ,  $S_4$ , respectively. What is the correct relationship between these quantities.

A.  $S_1 > S_2 > S_3 > S_4$

B.  $S_1 > S_2 = S_3 > S_4$

C.  $S_1 > S_3 > S_2 > S_4$

D.  $S_4 > S_2 > S_3 > S_1$

**Answer: C**

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5. An acid-base indicator has a  $K_a = 3.0 \times 10^{-5}$ . The acid form of the indicator is red and the basic form is blue. Then

A. pH is 4.05 when indicator is 75% red.

B. pH is 5.00 when indicator is 75% blue.

C. Both (a) and (b) are correct.

D. None of these.

**Answer: C**

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6. A salt X is dissolved in water having pH = 7. The resulting solution has a pH more than 7. The salt is made by neutralisation of

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

**Answer: D**

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7. The  $K_a$  values of  $CaCO_3$  and  $CaC_2O_4$  in water are  $4.7 \times 10^{-9}$  and  $1.3 \times 10^{-9}$ , respectively, at  $25^\circ C$ . If a mixture of two is washed with  $H_2O$ , what is  $Ca^{2+}$  ion concentration in water?

A.  $7.746 \times 10^{-5}$

B.  $5.831 \times 10^{-5}$

C.  $6.856 \times 10^{-5}$

D.  $3.606 \times 10^{-5}$

**Answer: A**

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8.  $\text{CaCO}_3$  and  $\text{BaCO}_3$  have solubility product values  $1 \times 10^{-8}$  and  $5 \times 10^{-9}$ , respectively. If water is shaken up with both solids till equilibrium is reached, the concentration of  $\text{CO}_3^{2-}$  ion is

A.  $1.5 \times 10^{-8}$

B.  $1.225 \times 10^{-4}$

C.  $2.25 \times 10^{-9}$

D. None of these.

**Answer: B**

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9. A solution with pH = 2 is more acidic than one with a pH = 6 by a factor of

A. 4

B. 12

C. 400

D.  $10^4$

**Answer: D**

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10. The pH of an acid buffer can be raised by 2 units by



- A. Increasing the concentration of both weak acid and salt by two moles
- B. Increasing the concentration of both the acid and salt by 10 times.
- C. Diluting the solution by 10 times.
- D. Increasing the concentration of the salt by 10 times and decreasing concentration of the acid by 10 times.

**Answer: D**



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