

## Chapter 7 Exercises – Acids and Bases

1. Define a Bronsted-Lowry acid. Why are all water-ion acids considered to be Bronsted-Lowry acids?

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2. Write the chemical equation for the addition of a proton to each of the following:  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{HCO}_3^-$ ,  $\text{CO}_3^{2-}$ ,  $\text{CN}^-$ ,  $\text{OH}^-$ .

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3. The bicarbonate ion  $\text{HCO}_3^-$  is amphoteric. Illustrate this property by using appropriate equations.

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4. List all the Bronsted-Lowry acids and Bronsted-Lowry bases from among the following:  $\text{SO}_3^{2-}$ ,  $\text{AlCl}_3$ ,  $\text{Cl}^-$ ,  $\text{NH}_4^+$ ,  $\text{H}_2\text{O}$ ,  $\text{HBr}$ .

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5. Write the formulae for the following anions: aluminate, carbonate, antimonite, hypophosphite, sulfate, chlorite, hypobromite.

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6. Write the formulae for the following: mercury (II) chromate, manganese (III) phosphate, nickel (II) carbonate, silver sulfate, iron (III) nitrate.

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7. What is the relationship between the strength of an acid and the numerical value of  $k_a$ ?

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8. How will the following ions react with water:  $\text{I}^-$ ,  $\text{NO}_2^-$ ,  $\text{K}^+$ ,  $\text{Bi}^{3+}$ ,  $\text{Be}^{2+}$ ?

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9. Predict whether aqueous solutions of the following salts would be acidic, alkaline or close to normal:  $\text{KCl}$ ,  $\text{NH}_4\text{NO}_2$ ,  $\text{AlBr}_3$ ,  $\text{Na}(\text{HCOO})$ . Supply an equation for each.

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10. Predict whether aqueous solutions of the following salts would be acidic, alkaline or close to neutral:  $\text{Fe}(\text{NO}_3)_3$ ,  $\text{NH}_4\text{CN}$ ,  $\text{KI}$ ,  $\text{LiCH}_3\text{COO}$ .

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11. Identify the acids and bases according to the proton transfer concept in the following:

- a)  $\text{HNO}_3(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$   
b)  $\text{HCl}(\text{g}) + \text{NH}_3(\text{g}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{Cl}^-(\text{aq})$   
c)  $\text{H}_2\text{SO}_4(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{HSO}_4^-(\text{aq})$   
d)  $\text{H}_2\text{O}(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq})$

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12. Write equations to show how  $\text{CO}_2$  in water becomes acidic and  $\text{Na}_2\text{O}$  in water becomes basic.

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13. What is meant by hydrolysis? Give examples of three ions which each hydrolyse to give:  
a) an acidic solution and b) a basic solution.

a) 

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b) 

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14. 32.0 mL of a 0.1M  $\text{H}_2\text{SO}_4$  is required to precipitate all the barium ions from a solution of  $\text{BaCl}_2$ . What mass of  $\text{BaCl}_2$  was present in the solution?

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15. Calculate the pH of the following solutions:

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|------------------------------------|-----------------|--------------------------|-----------------|
| a) 0.10 M HBr                      | b) 0.10 M HI    | c) 0.10 M $\text{HNO}_3$ | d) 0.010 M KOH  |
| e) 0.01 M $\text{Ba}(\text{OH})_2$ | f) 0.0164 M HCl | g) 0.168 M HCl           | h) 0.0172 M HCl |

a) \_\_\_\_\_

b) \_\_\_\_\_

c) \_\_\_\_\_

d) \_\_\_\_\_

e) \_\_\_\_\_

f) \_\_\_\_\_

g) \_\_\_\_\_

h) \_\_\_\_\_

16. Calculate the pH when the following are added to 1.00 L of 0.100 M HCl solution. Assume there is no change in volume.

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|---------------------|---------------------------------------|--|
| a) 0.010 mol of KOH | b) 0.010 mol of NaOH                  | c) 0.050 mol of $\text{Ba}(\text{OH})_2$ |
| d) 0.100 mol of KOH | e) 0.100 mol $\text{Ba}(\text{OH})_2$ | f) 0.082 mol $\text{Ba}(\text{OH})_2$    |

a) \_\_\_\_\_

b) \_\_\_\_\_

c) \_\_\_\_\_

d) \_\_\_\_\_

e) \_\_\_\_\_

f) \_\_\_\_\_

17. Determine the pH of the solution formed by mixing equal volumes of the two solutions in each case.

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|-------------------------------|---|
| a) 0.10 M HCl and 0.10 M NaOH | b) 0.20 M HCl and 0.10 M NaOH                     |
| c) 0.10 M HCl and 0.20 M NaOH | d) 0.40 M HCl and 0.20 M NaOH                     |
| e) 0.20 M HCl and 0.40 M NaOH | f) 0.10 M HCl and 0.10 M $\text{Ba}(\text{OH})_2$ |

a) \_\_\_\_\_

b) \_\_\_\_\_

c) \_\_\_\_\_

d) \_\_\_\_\_

e) \_\_\_\_\_

f) \_\_\_\_\_