Acid / Base Worksheet

Exercise A: Write an equation for the dissolving of the following salts as they combine with water to form an aqueous solution:

1. $LiCl_{(s)} \xrightarrow{H_2O} Li^+_{(aq)} + Cl^-_{(aq)}$
2. $Mg(NO_3)_2 \xrightarrow{H_2O} Mg^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$
3. $Na_3PO_4 \xrightarrow{H_2O} 3Na^+_{(aq)} + PO_4^{3-}{}_{(aq)}$
4. $K_2SO_4 \xrightarrow{H_2O} 2K^+_{(aq)} + SO_4^{2-}{}_{(aq)}$
5. $MgCl_2 \xrightarrow{H_2O} Mg^{2+}_{(aq)} + 2Cl^-_{(aq)}$

Exercise B: Indicate whether aqueous solutions of the following will contain ions, molecules, or both. Write an equation for the dissolving of the following solutes:

6. Glucose $C_6H_{12}O_6$, a nonelectrolyte

$C_6H_{12}O_{6(s)} \xrightarrow{H_2O} C_6H_{12}O_{6(aq)}$ | molecules only |

7. NaOH, a strong electrolyte

$NaOH_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$ | ions only |

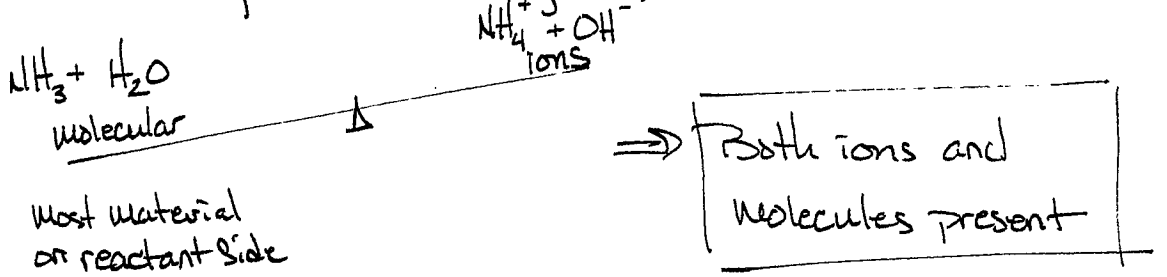
8. K_2SO_4, a strong electrolyte

$K_2SO_{4(s)} \xrightarrow{H_2O} 2K^+_{(aq)} + SO_4^{2-}{}_{(aq)}$ | ions only |

9. NH_3, a weak electrolyte that is also a base.

$$NH_{3(l)} + H_2O_{(l)} \rightleftharpoons NH_{4(aq)}^{+} + OH_{(aq)}^{-}$$

a weak electrolyte means only a few ions are formed.



Exercise C Indicate whether the following characteristics describe an acid or a base:

1. Turns blue litmus red ⟹ Acid
2. Contains more OH^- ions than H_3O^+ ⟹ Base
3. Tastes bitter ⟹ Base
4. Contains more H_3O^+ ions than OH^- ⟹ Acid
5. Tastes sour ⟹ Acid
6. Neutralizes bases ⟹ Acid
7. Turns Red litmus Blue ⟹ Base
8. Neutralizes acids ⟹ Base

Exercise D Fill in the blank space with the formula or name of an acid or base.

1. HCl hydrochloric acid
2. $NaOH$ Sodium hydroxide
3. H_2SO_4 Sulfuric acid
4. HNO_3 nitric acid
5. $Ca(OH)_2$ Calcium hydroxide
6. H_2CO_3 Carbonic acid
7. $Al(OH)_3$ Aluminium hydroxide
8. KOH potassium hydroxide

Exercise E When do you use the double dissociation arrows in equations? Write equations of the following ionizations of acid in H_2O:

1. HCl, a strong acid $HCl_{(g)} + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$
2. HF, a weak acid $HF + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + F^-_{(aq)}$
3. HNO_3, a strong acid $HNO_3 + H_2O_{(l)} \longrightarrow H_3O^+_{(aq)} + NO_3^-{}_{(aq)}$

$\longrightarrow$ strong Acid
Strong electrolyte

$\rightleftharpoons$ weak acid
weak electrolyte

Exercise F When is water a reactant in the dissolving process? Write equations for the ionization of the following bases in H_2O.

4. NaOH, a strong base $NaOH_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$

5. NH_3, a weak base $NH_{3(g)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$

6. $Mg(OH)_2$, a strong base $Mg(OH)_2 \xrightarrow{H_2O} Mg^{2+}_{(aq)} + 2OH^-_{(aq)}$

$\xrightarrow{H_2O}$ for strong OH^- base

$+ H_2O \rightleftharpoons$ for weak base

Exercise G Calculate $[H_3O^+]$ when the $[OH^-]$ has the following values:

1. $[OH^-] = 1.0 \times 10^{-10}$ $[H_3O^+] = \frac{1 \times 10^{-14}}{1.0 \times 10^{-10}} =$ 1.0×10^{-4} M H_3O^+

2. $[OH^-] = 1.0 \times 10^{-5}$ $[H_3O^+] = \frac{1 \times 10^{-14}}{1.0 \times 10^{-5}} =$ 1.0×10^{-9} M H_3O^+

3. $[OH^-] = 1.0 \times 10^{-7}$ $[H_3O^+] = \frac{1 \times 10^{-14}}{1.0 \times 10^{-7}} =$ 1.0×10^{-7} M H_3O^+

4. $[OH^-] = 1.2 \times 10^{-4}$ $[H_3O^+] = \frac{1 \times 10^{-14}}{1.2 \times 10^{-4}} =$ 8.3×10^{-11} M H_3O^+

5. $[OH^-] = 3.5 \times 10^{-8}$ $[H_3O^+] = \frac{1 \times 10^{-14}}{3.5 \times 10^{-8}} =$ 2.9×10^{-7} M H_3O^+

Exercise H Calculate $[OH^-]$ when the $[H_3O^+]$ has the following values.

1. $[H_3O^+] = 1.0 \times 10^{-3}$ $[OH^-] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-3}} = \boxed{1.0 \times 10^{-11}\ \underline{M}\ \cancel{H_3O^+}\ OH^-}$

2. $[H_3O^+] = 1.0 \times 10^{-5}$ $[OH^-] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-5}} = \boxed{1.0 \times 10^{-9}\ \underline{M}\ OH^-}$

3. $[H_3O^+] = 1.0 \times 10^{-6}$ $[OH^-] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-6}} = \boxed{1.0 \times 10^{-8}\ \underline{M}\ OH^-}$

4. $[H_3O^+] = 2.8 \times 10^{-13}$ $[OH^-] = \frac{1.0 \times 10^{-14}}{2.8 \times 10^{-13}} = \boxed{3.6 \times 10^{-2}\ \underline{M}\ OH^-}$

5. $[H_3O^+] = 8.6 \times 10^{-7}$ $[OH^-] = \frac{1.0 \times 10^{-14}}{8.6 \times 10^{-7}} = \boxed{1.2 \times 10^{-8}\ \underline{M}\ OH^-}$

Exercise I Circle the most acidic pH in the group

1. pH 5 (pH 2)

2. pH 12 pH 9 (pH 2)

3. (pH 0.2) pH 1.5 pH 2.3

4. (pH 3) pH 7 pH 10

5. pH 7.5 pH 4.4 (pH 3.2)

6. pH 5.5 pH 3.8 pH 11.2 (pH 1.6)

The lower the pH the more acidic

Exercise 5 Calculate the pH of the following solutions at 25°C. Indicate whether the solution is acidic, basic or neutral.

1. $[H_3O^+] = 1.0\times10^{-8}$ M $\quad pH = -\log[H_3O^+] = -\log(1.0\times10^{-8}) =$ **8.00 Basic**

2. $[H_3O^+] = 0.0010$ M $\quad pH = -\log[H_3O^+] = -\log(0.0010) =$ **3.00 Acidic**

3. $[OH^-] = 1.0\times10^{-12}$ M $\quad [H_3O^+] = \frac{1\times10^{-14}}{1.0\times10^{-12}} = 1.0\times10^{-2}$ M

$pH = -\log[H_3O^+] = -\log(1.0\times10^{-2}) =$ **2.00 Acidic**

4. $[OH^-] = 2.0\times10^{-5}$ M $\quad [H_3O^+] = \frac{1\times10^{-14}}{2.0\times10^{-5}} = \frac{1.0\times10^{-9}}{}$ M

$pH = -\log[H_3O^+] = -\log\left(\frac{5.0\times10^{-10}}{1.0\times10^{-9}}\right) =$ ~~9.30~~ ~~4.00~~ **Basic**

5. $[OH^-] = 1.0\times10^{-7}$ $\quad [H_3O^+] = \frac{1.0\times10^{-14}}{1.0\times10^{-7}} = 1.0\times10^{-7}$ M

$pH = -\log[H_3O^+] = -\log(1.0\times10^{-7}) =$ **7.00 Neutral**

Exercise 4: Indicate whether the following pH values are acidic, basic, or neutral at ~~20~~ 25°C.

1. Plasma pH 7.40 ⟹ Basic
2. Soft drink pH 2.80 ⟹ Acidic
3. Maple Syrup pH 6.80 ⟹ Acidic
4. beans pH 5.00 ⟹ Acidic
5. tomatoes pH 4.20 ⟹ Acidic
6. Lemon juice pH 2.20 ⟹ Acidic
7. Saliva pH 7.00 ⟹ Neutral
8. eggs pH 7.80 ⟹ Basic
9. Lime pH 12.40 ⟹ ~~Acidic~~ Basic
10. Strawberries pH 3.00 ⟹ Acidic

Exercise L Complete the following table for solutions at 25°C

	$[H_3O^+]$	$[OH^-]$	pH	acid / base / neutral
1.	1.0×10^{-2}	1.0×10^{-12}	2.00	Acid
2.	4.8×10^{-9}	2.1×10^{-6}	8.32	Base
3.	5.0×10^{-8}	2.0×10^{-7}	7.30	Base
4.	1.0×10^{-7}	1.0×10^{-7}	7.00	neutral
5.	1.0×10^{-1}	1.0×10^{-13}	1.00	Acid

Equations used: $[H_3O^+][OH^-] = 1 \times 10^{-14}$

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

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

Exercise M State whether each of the following solutions represent a buffer system, and explain why or why not.

1. HCl and NaCl

⇒ Not a buffer by our definition.
HCl is a strong acid. A buffer requires a weak acid and its conjugate base.

2. K_2SO_4

⇒ Not a buffer. No weak acid given.

3. H_2CO_3

⇒ Not a buffer. H_2CO_3 is a weak acid, but the conjugate base $NaHCO_3$ is also required.

4. H_2CO_3 and $NaHCO_3$

⇒ Yes this is a buffer. Both the weak acid and its conjugate are present.