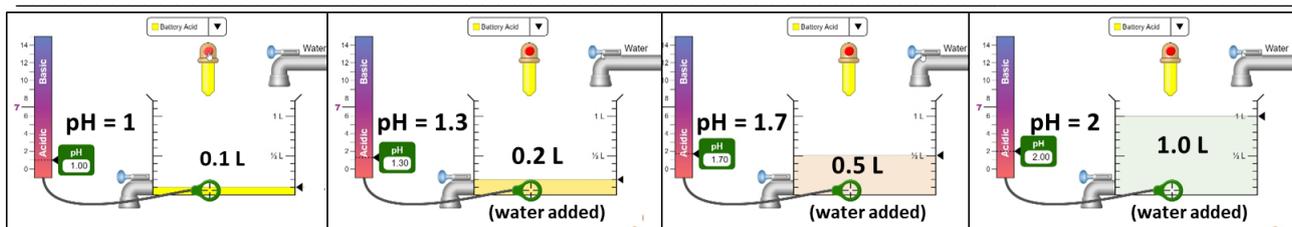


# Shedding Light on Acids and Bases Episode 5: Advanced Acid-Base Chemistry

Name: \_\_\_\_\_

- Part A**
- When HCl, which is a gas, dissolves in water, \_\_\_\_\_ ions and \_\_\_\_\_ ions are formed.
  - Complete the following general equations:  
 acid + metal  $\rightarrow$  \_\_\_\_\_ + \_\_\_\_\_  
 acid + base  $\rightarrow$  \_\_\_\_\_ + \_\_\_\_\_
  - When a base dissolves in water, \_\_\_\_\_ ions are produced.
  - A strong acid contains lots of/relatively few  $H^+$  ions while a weaker acid contains lots of/relatively few  $H^+$  ions. (circle the correct answers)

- Part B**
- A change of 1 on the pH scale means an increase (or decrease) in the concentration of  $H^+$  ions in a solution by a factor of \_\_\_\_\_.
  - An acid with a pH of 3 has \_\_\_\_\_ times as many  $H^+$  ions as an acid with a pH of 4, and \_\_\_\_\_ times as many  $H^+$  ions as an acid with a pH of 5 (assuming you have the same amount of the acid).
  - 200 mL of an acid with a pH of 2 has \_\_\_\_\_ times as many  $H^+$  ions as 200 mL of an acid with a pH of 6.
  - Acid A has a pH of 1 and has 100,000 times as many  $H^+$  ions as Acid B. What is Acid B's pH?



- A certain acid has a pH of 1. If it is watered down by an equal amount of water (so that it is only half as concentrated), its pH rises to \_\_\_\_\_, which is a change of \_\_\_\_\_.
- A certain acid has a pH of 1.7. If it is watered down by an equal amount of water (so that it is only half as concentrated), its pH rises to \_\_\_\_\_, which is a change of \_\_\_\_\_.
- The pH of any acid that is watered down by half (so that its concentration halves) will rise by \_\_\_\_\_ on the pH scale.

- Part C**
- Fill in the table.

pH	example	Concentration: grams (g) of $H^+$ ions per litre (L)
6	clean rain water	
5	coffee	
4	orange juice	
3	grape juice	
2	lemon juice	
1	stomach juices	
0	hydrochloric acid	

13. Pure water has a pH of 7. It contains tiny tiny amounts of both  $H^+$  ions and  $OH^-$  ions in equal number. Where do the ions come from? \_\_\_\_\_  
 \_\_\_\_\_
14. A basic solution of pH 11 has the same number of  $OH^-$  ions as an acid of pH \_\_\_\_\_ has  $H^+$  ions.
15. A basic solution of pH 9.5 has the same number of  $OH^-$  ions as an acid of pH \_\_\_\_\_ has  $H^+$  ions.
16. Complete the following equations (and include the states) for the reaction between HCl and NaOH.  
 (a)  $HCl_{(aq)} + NaOH_{(aq)} \rightarrow$  \_\_\_\_\_( ) + \_\_\_\_\_( )  
 (b)  $H^+_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow$  \_\_\_\_\_( ) + \_\_\_\_\_( ) + \_\_\_\_\_( )
17. Why are the  $Na^+$  and the  $Cl^-$  ions called “spectator” ions in the above reaction? \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_
18. Write the equation for the reaction in Q16 above, but leave out the spectator ions.  
 \_\_\_\_\_  
 \_\_\_\_\_
19. When magnesium reacts with hydrochloric acid, hydrogen gas and magnesium chloride are formed. Complete the equations below.  
 (a) (standard)  $Mg_{(s)} + 2HCl_{(aq)} \rightarrow$  \_\_\_\_\_( ) + \_\_\_\_\_( )  
 (b) (ionic)  $Mg_{(s)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow$  \_\_\_\_\_( ) + \_\_\_\_\_( ) + \_\_\_\_\_( )
20. Which ion acts as a spectator ion? \_\_\_\_\_
21. Complete the ionic equation from Q19 without the spectator ions.  
 \_\_\_\_\_  
 \_\_\_\_\_
22. Describe what actually happens at the atomic level when magnesium atoms react with hydrochloric acid. \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Skill-Builders:**

23. Hydrochloric acid reacts with calcium in a very similar way to the way it reacts with magnesium (magnesium and calcium are both in Group 2 of the Periodic Table and both have 2 electrons in their outer shells).  
 In the reaction, calcium chloride ( $CaCl_2$ ) and hydrogen gas are produced. Write out the equations for the reactions below using your answers to Q19 and Q21 a guide:  
 (standard, like Q19a above)  $Ca_{(s)} + 2HCl_{(aq)} \rightarrow$  \_\_\_\_\_( ) + \_\_\_\_\_( )  
 (ionic, like Q19b above) \_\_\_\_\_  
 (ionic, without the spectator ions, like Q21) \_\_\_\_\_
24. Lithium is in the same group as sodium on the periodic table (Group 1) so they both react in a similar way to each other. Likewise, fluorine and chlorine are in the same group (Group 17) so they also react in a similar way to each other.  
 Hydrofluoric acid (HF) reacts with lithium hydroxide (LiOH) to produce water and a type of salt called lithium fluoride (LiF). Write the standard chemical equation and the ionic equations for this reaction (using Q16 and Q18 above as a guide).  
 (standard, like Q16a)  $HF_{(aq)} + LiOH_{(aq)} \rightarrow$  \_\_\_\_\_( ) + \_\_\_\_\_( )  
 (ionic, like Q16b) \_\_\_\_\_  
 (ionic, without the spectator ions (like Q18)) \_\_\_\_\_