

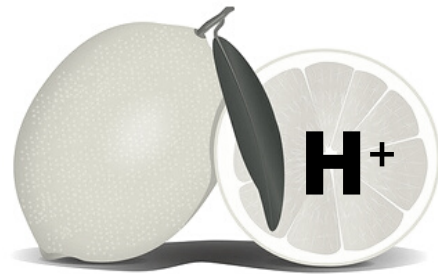
Name:

Date:

Class:

Introduction to acids

Acids are chemical compounds that release hydrogen ions (H^+) when placed in water.



pH is a measure of how acidic a solution is.



very acidic

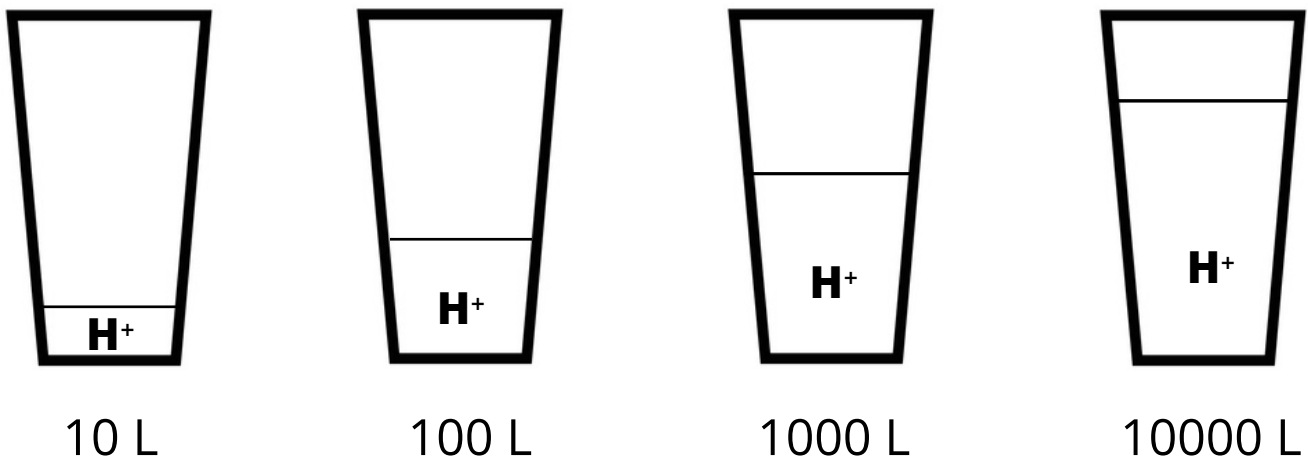
neutral

very alkaline

Construct the pH scale

Explore the relationship between pH and hydrogen ion concentration

- 1 mole of (H^+) ions
- Dilute to 10 L, 100 L, 1000 L and 10000 L

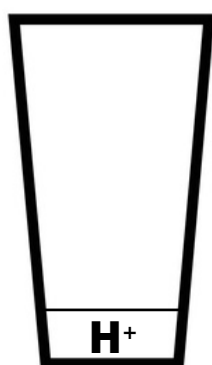
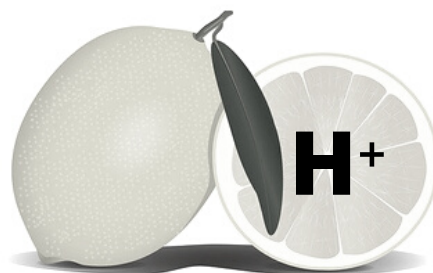


What is the concentration of (H^+) ions in each solution?

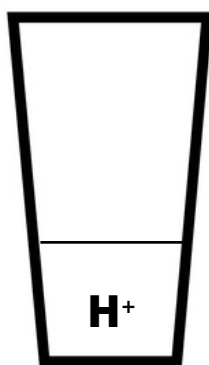
Concentration

The concentration (M) of a solution is defined as the number of **moles of solute** divided by the **volume of solution**.

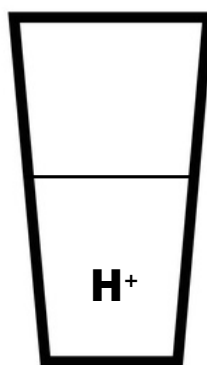
$$M = \frac{\text{moles of } H^+}{\text{liters of solution}}$$



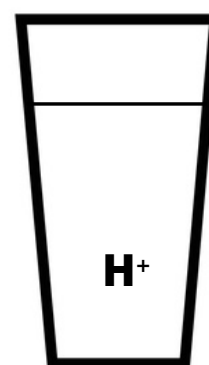
10 L



100 L



1000 L



10000 L

$$\frac{1 \text{ mol}}{10 \text{ L}} = 0.1 \text{ M}$$

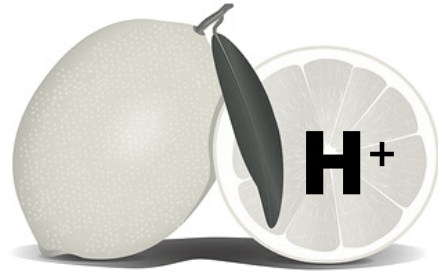
$$\frac{1 \text{ mol}}{1000 \text{ L}} = 0.001 \text{ M}$$

$$\frac{1 \text{ mol}}{100 \text{ L}} = 0.01 \text{ M}$$

$$\frac{1 \text{ mol}}{10000 \text{ L}} = 0.0001 \text{ M}$$

On a simple level, the pH scale can be viewed as a ranking of the number of hydrogen ions in a solution.

pH scale



pH can be expressed using the concentration of hydrogen ions, M

0.1 M

0.01 M

0.001 M

0.0001 M

M can be written in scientific notation

1×10^{-1} M

1×10^{-2} M

1×10^{-3} M

1×10^{-4} M

However, it would be easier to use the power instead

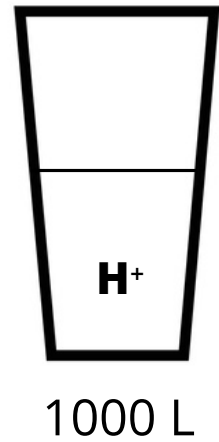
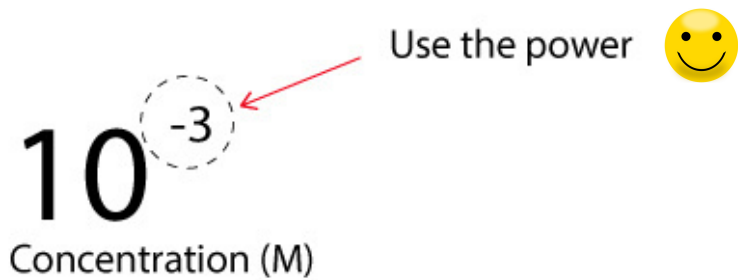
1

2

3

4

Use the power



pH can be conveniently expressed as the **positive exponent** of the H^+ ion concentration.

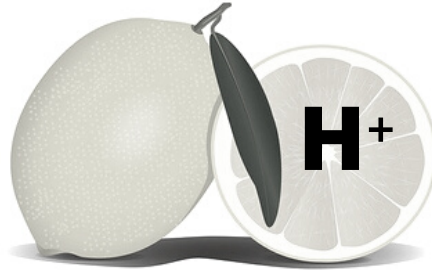


Concentration (M)	Scientific notation (M)	pH
1	1	0
0.1	1×10^{-1}	1
0.001	1×10^{-2}	2
0.0001	1×10^{-3}	3
0.00001	1×10^{-4}	4

You can see that the more acidic a solution is, the lower the pH.

- A more acidic solution has a higher concentration of H^+ ions.

Construct the pH scale



••• CONCEPT CHECK

Write the pH scale below from 0 to 14 above the lines.



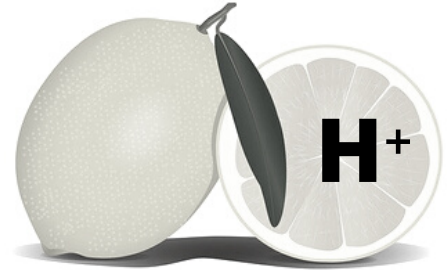
very acidic

neutral

very alkaline

Finding the pH of solutions

If we know the (H^+) ion concentrations present in a solution, we can easily calculate the pH of the solution.



Calculate the pH

It's easy if the number system has a base 10. You can express the pH as the positive exponent of the concentration.

$$1 \times 10^{-1} \text{ M}$$

$$\text{pH} = 1$$

$$1 \times 10^{-2} \text{ M}$$

$$\text{pH} = 2$$

$$1 \times 10^{-3} \text{ M}$$

$$\text{pH} = 3$$

$$1 \times 10^{-4} \text{ M}$$

$$\text{pH} = 4$$

But what if the number system does not have a base 10?

$$3.4 \times 10^{-1} \text{ M}$$

$$\text{pH} = ?$$

$$7.6 \times 10^{-3} \text{ M}$$

$$\text{pH} = ?$$

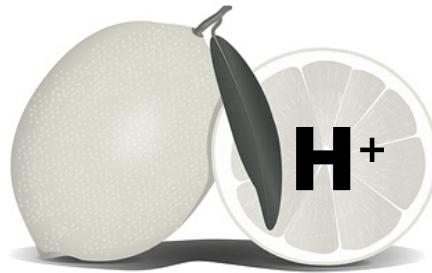
$$5.5 \times 10^{-4} \text{ M}$$

$$\text{pH} = ?$$

Estimate the pH

There are two ways to determine the pH of solutions

- Estimate the pH
- Use a calculator

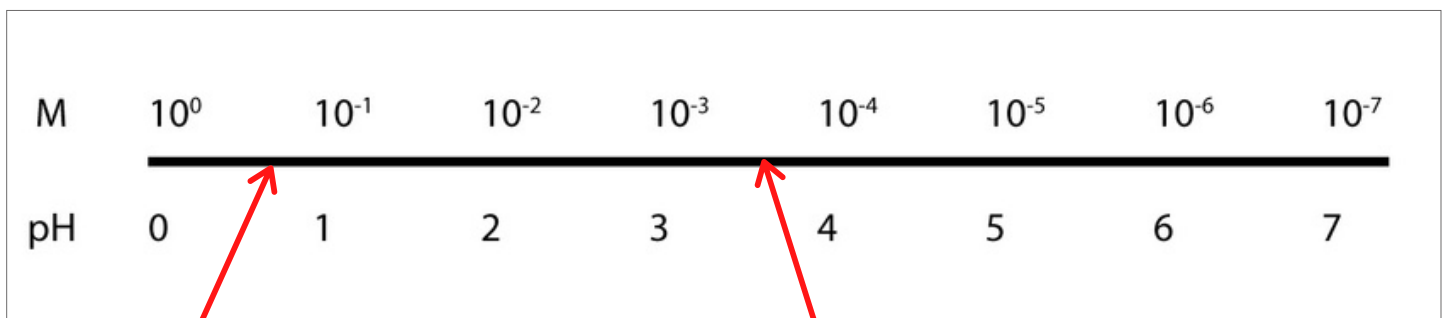


How to calculate the pH of a solution with the following concentrations of H⁺ ions?

$$3.4 \times 10^{-1} \text{ M}$$

$$5.5 \times 10^{-4} \text{ M}$$

We can estimate using a pH chart as shown below.



$$3.4 \times 10^{-1} \text{ M}$$

- conc higher than 1×10^{-1} M
- conc less than 1×10^0 M

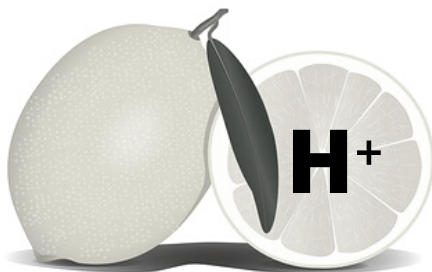
The pH is between 0 and 1

$$5.5 \times 10^{-4} \text{ M}$$

- conc higher than 1×10^{-4} M
- conc less than 1×10^{-3} M

The pH is between 3 and 4

Estimate the pH



••• CONCEPT CHECK

Estimate the pH of the following solutions, given the concentrations of the H^+ ions in solutions.

$$2.4 \times 10^{-7} \text{ M}$$

$$6.5 \times 10^{-9} \text{ M}$$

Use the pH scale chart as shown below.

M	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}
pH	0	1	2	3	4	5	6	7

$$2.4 \times 10^{-7} \text{ M}$$

- conc higher than _____ M
- conc less than _____ M

The pH is between _____

$$6.5 \times 10^{-9} \text{ M}$$

- conc higher than _____ M
- conc less than _____ M

The pH is between _____

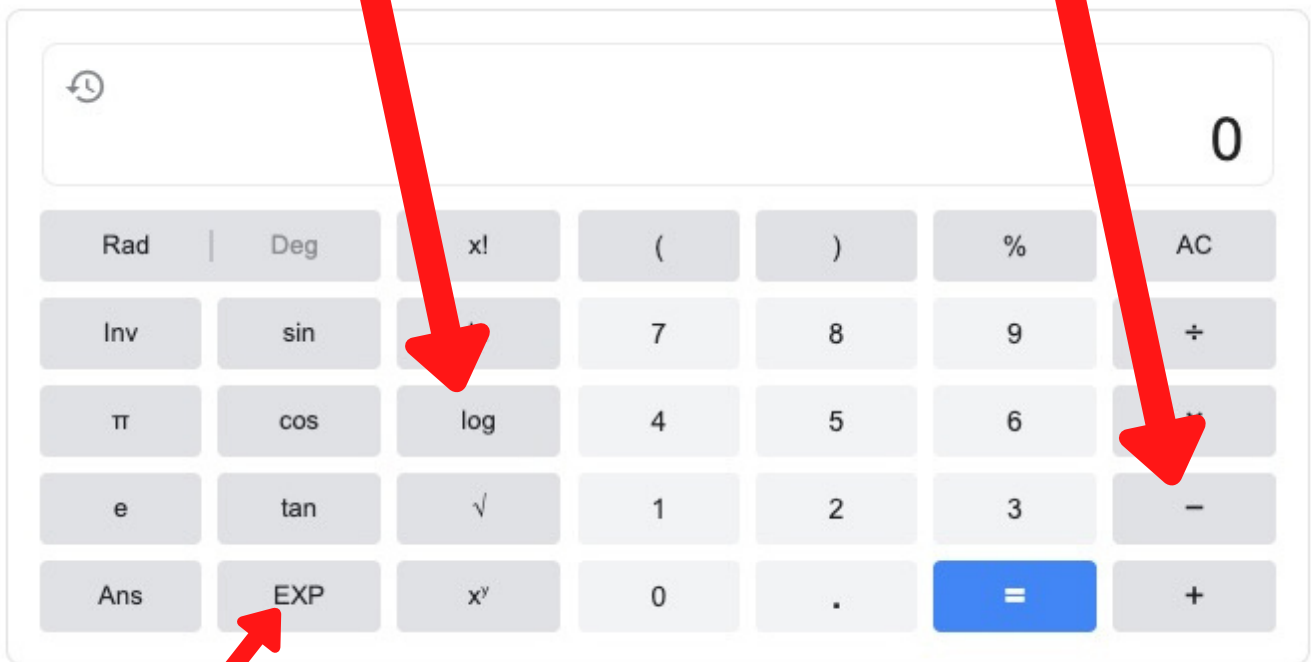
Calculate the pH

USING CALCULATORS

The three most important keys

"log" key

"-" key

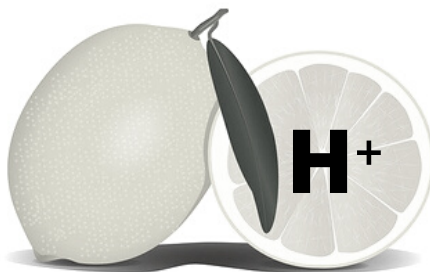


"exp" key

In some calculators, you have to use the "ee" button instead

Calculate the pH

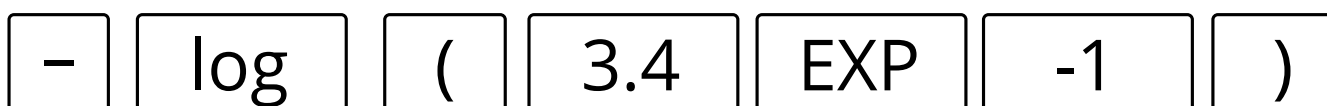
USING CALCULATORS



Calculate the pH of a solution given the (H⁺) concentration

$$3.4 \times 10^{-1} \text{ M}$$

Calculator keystrokes



Use the EXP KEY for expressing (10⁻¹)

$$\text{pH} = - \log(3.4 \text{ EXP } -1)$$

pH is the negative log of the concentration of (H⁺) ions.

Calculate the pH

••• CONCEPT CHECK

Calculate the pH of the following solutions, given the concentrations of the H⁺ ions. Note: The scientific notation (1.1 x 10⁻¹) can be written as (1.1 EXP -1) to reflect the calculator function.

Concentration of H ⁺ (M)	Formula	pH
1.1 x 10 ⁻¹	-log(1.1 EXP -1)	0.96
3.2 x 10 ⁻⁷		
2.2 x 10 ⁻³		
7.9 x 10 ⁻¹⁰		
8.9 x 10 ⁻²		
6.4 x 10 ⁻³		
2.9 x 10 ⁻⁴		
1.6 x 10 ⁻⁶		
4.0 x 10 ⁻¹⁴		
9.1 x 10 ⁻⁹		