

Lesson 7 – acids and bases.

What is a strong acid and weak acid as compared to a concentrated or dilute acid?

Is a concentrated acid a strong acid?

The above questions are often asked so we will try and clarify the difference between strong and weak acids as compared to concentrated and dilute acids.

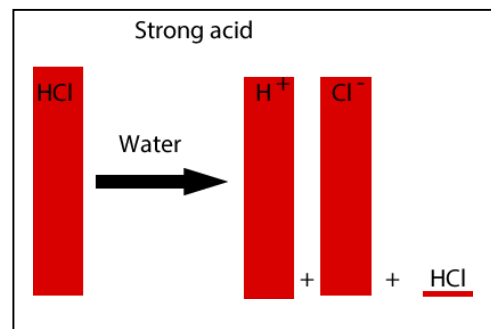
A strong acid is one that almost totally ionises in water.

Strong acids include:

$\text{HNO}_3$  (nitric acid)

$\text{H}_2\text{SO}_4$  (sulphuric acid)

$\text{HCl}$  (hydrochloric acid)



A weak acid on the other hand is one that hardly ionises in water.

Weak acids include:

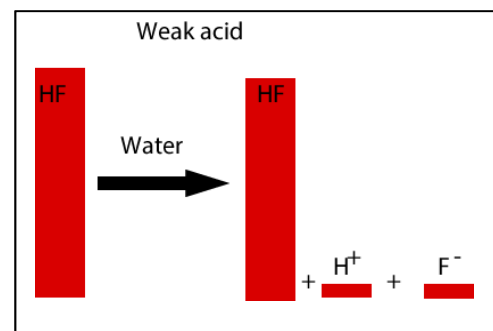
$\text{H}_2\text{CO}_3$  (carbonic acid)

$\text{CH}_3\text{COOH}$  (All organic fatty acids)

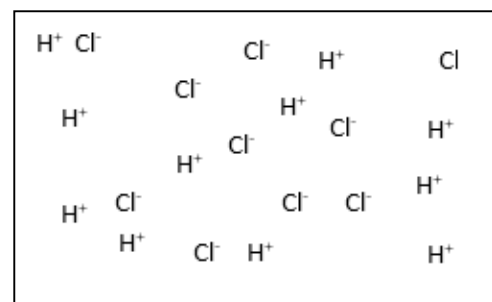
$\text{HF}$  (Hydrofluoric acid)

$\text{HCOOH}$  (formic acid)

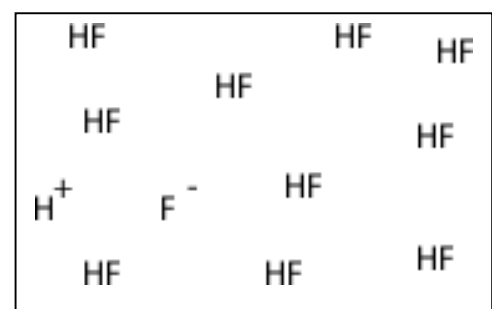
$\text{H}_3\text{PO}_4$  (Phosphoric acid)



Consider the ten molecules of  $\text{HCl}$  in one litre of water, shown on the right.  $\text{HCl}$  is a strong acid since a large proportion of the molecules have ionised in solution.



Whereas  $\text{HF}$  being a weak acid only has a very small proportion of its ten molecules, in one litre of water, ionised.



The concentration of both acids, however, is the same, ten molecules per litre.

So, concentration is the amount of acid per volume whereas strength of acid refers to the proportion of molecules that ionise in the water.

1. Consider the following diagrams. They show a number of different acid molecules in a one litre volume of water. Label the following statements True or False.

a) Diagram A represents a weak acid.

*True. The proportion of ionisation is not high.*

b) Diagram C represents a dilute acid. *False*

c) Diagram B shows a strong acid. *True*

d) Diagram C and diagram D represent acids with the same concentration. *True*

e) Diagram C and diagram D represent acids with the same strength.

*False – acid GH is a weak acid compared to acid HY*

- 2) Both carbonic acid and phosphoric acid are weak acids, however, phosphoric acid is slightly stronger than carbonic acid.

Which diagram represents phosphoric acid and which diagram represents carbonic acid? Explain your selection.

*A and C – GH has a lower proportion of its molecules ionised than HX. So GH is a weaker acid than HX, however, both have a relatively low percentage of ionisation hence they are both weak.*

- 3) Given two solutions a 1.00 M  $\text{H}_2\text{CO}_3$  and a 1.00 M HCl comment on the :

- pH of each solution

*1.00 M HCl will have a pH of 0 where as 1.00 M  $\text{H}_2\text{CO}_3$  will have a much higher pH but below 7 as it is still an acidic solution.*

- Concentration of each solution.

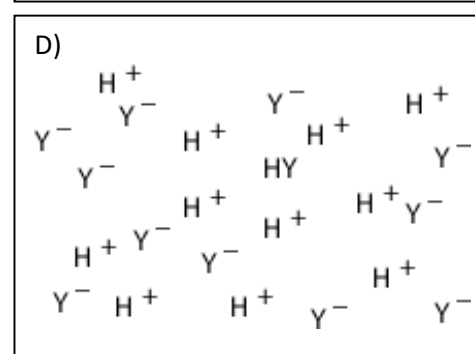
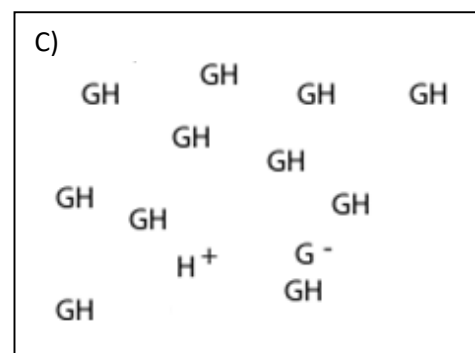
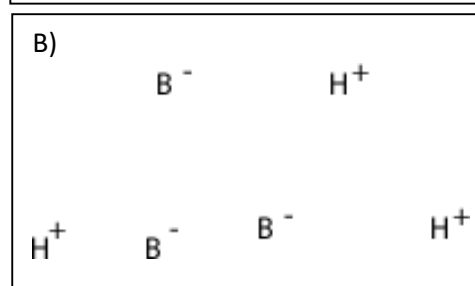
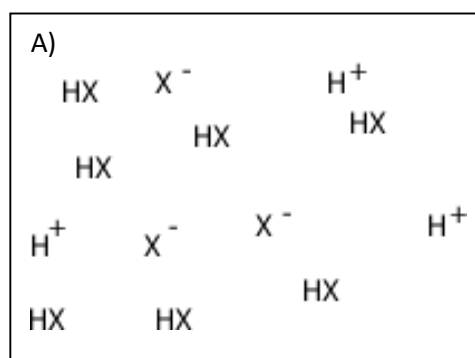
*The concentration of each solution is the same 1.00 M*

- 4) Two bottles were labelled 0.0100 M HF and 0.0100 M HCl.

i. What can you say about the concentration of ions in each solution?

*HF is a weaker acid than HCl hence it will undergo less ionisation in solution than HCl and so produce less ions. 0.0100 M HCl will have a greater concentration of ions than 0.0100 M HF.*

- ii. The pH of a 100 mL sample of the 0.1000 M HF solution was measured and compared to the pH of a 200 mL sample of the 0.0100 M HCl solution. What can you say about the pH of each solution?  *$\text{pH} = -\log_{10}[\text{H}_3\text{O}^+]$ , hence, the volume of the solution is irrelevant it is the  $[\text{H}_3\text{O}^+]$  that determines the pH and so HCl will have a much lower pH than HF.*



iii.

Two bottles contain the exact volume of acid HY and were labelled as ,  
Bottle A – pH = 1 M HY and Bottle B – pH = 5 M HY.

i. Which bottle has the lowest number of  $H_3O^+$  ions, A or B?

*Bottle B*

$$=[H_3O^+] = 10^{-pH} = 10^{-5}M$$

ii. For every  $H_3O^+$  ion in the bottle given to question i. above, how many ions are present in the other bottle?

$$\text{Concentration of ions in bottle A} = 10^{-1} = 0.1$$

$$\text{Concentration of ions in bottle B} = 10^{-5} = 0.00001$$

*so for every one ion in bottle B there are 10,000 ( $10^4$ ) ions in bottle A*