ACIDS, BASES AND SALTS

يجب التمييز بين حمض لويس وارهينيوس وبرونستد والقاعدة

Theory	Acid Definition	Base Definition
Arrhenius Theory	Any substance which **releases H^+ ions** in water solution.	Any substance which **releases OH^- ions** in water solution
Brønsted-Lowry Theory	Any substance which **donates a proton.**	Any substance which **accepts a proton.**
Lewis Theory	Any substance which can **accept an electron pair.**	Any substance which can **donate an electron pair.**

$HCl \xrightarrow{H_2O} H^+ + Cl^-$

$NaOH \xrightarrow{H_2O} Na^+ + OH^-$

أزواج مترافقه

$H_2SO_4 + H_2O \rightleftharpoons HSO_4^- + H_3O^+$

$AlCl_3 + Cl^- \longrightarrow AlCl_4^-$

Lewis acid تستقبل e

Lewis base تمنح e

Properties of Acidic solutions

An Acid is a substance that produces hydrogen ions (H^+ or Hydronium ion, H_3O^+)

1) Taste sour or tart (طعم حامض أو لاذع)
2) Cause a pricking sensation (الإحساس بالوخز) on the skin
3) Turn blue litmus to red
4) React with several metals (e.g., Zn and Mg) releasing $H_{2(g)}$ ⇒ acids corrode metals. من أهداف التجربة
5) Corrosive: burn your skin (مادة أكالة: تحرق بشرتك)
6) Acids can be oxidizing agent such as HNO_3 and H_2SO_4 BUT HCl and and H_3PO_4 not oxidizing agent.
7) Act as electrolytes in solution ➡ conduct electricity due to the free ions
8) React with carbonates releasing $CO_{2(g)}$

react with base to form salt and water ($HCl + NaOH \rightarrow NaCl + H_2O$)

Uses of acids استخدامات الحمض

H_3PO_4	H_2SO_4	HCl	CH_3COOH or $HC_2H_3O_2$
soft drinks, fertilizer, detergents	fertilizer, car batteries	gastric juice, Stomach acid	Vinger

Strong Acids	Weak Acids
100% dissociation in water, good proton donors تأين كلي	< 5% dissociation in water, poor proton donors تأين جزئي
Sulfuric acid, H_2SO_4	Acetic acid, CH_3COOH or $HC_2H_3O_2$
Hydrochloric acid, HCl	Citric acid, $C_6H_8O_7$
Nitric acid, HNO_3	
Perchloric acid, $HClO_4$	

والقواعد كذلك الأمر...

Properties of Bases

Produce or cause an increase in hydroxide ions (OH^-) in H_2O

1) Taste bitter (طعم مر)
2) Have a slippery touch (ملمس انزلاقي), 'soapy' feel
3) Turn red litmus blue
4) Destroy body tissue/ dissolve fatty (lipid) material
5) Strong bases are caustic (كاوية)
6) Act as electrolytes in solution
7) Neutralise solutions containing hydrogen ions (H^+)
8) Most of hand soaps, detegents and drain cleaners are bases

Uses of bases استخدامات القواعد

$NaOH$	$Mg(OH)_2$	NH_3
lye (غسول), drain and oven cleaner, preparation of soaps and detergents	laxative, antacid	cleaners, fertilizer

Acidic aqueous solutions result from the reaction of a

أمثلة على تفاعل الأحماض وذوبانها في الماء مثل
الأكاسيد والحموض الضعيف وغيرها

Check it

1-Nometallic hydride with water

$$HCl\,(g) + H_2O \rightarrow H_3O^+(aq) + Cl^-(aq)$$

2-Nometallic oxide with water

$$SO_3(g) + 2H_2O \rightarrow H_3O^+(aq) + HSO_4^-(aq)$$

$$CO_2(g) + 2H_2O \rightarrow H_3O^+(aq) + HCO_3^-(aq)$$

3- molecular species with water such as citric acid, ascorbic acid (vitamin C) and acetic acid found in vinegar,

$$CH_3COOH(aq) + H_2O \rightarrow H_3O^+(aq) + CH_3COO^-(aq)$$

أمثلة على تفاعل الواعد وذوبانها في الماء مثل الأكاسيد والقواعد الضعيفة وغيرها

Check it

Basic aqueous solutions can result from

1- action of water on a soluble oxides (e.g., CaO) or hydroxides (e.g., NaOH)

$O^{2-}(aq, \text{from } CaO) + H_2O \rightarrow 2OH^-(aq)$

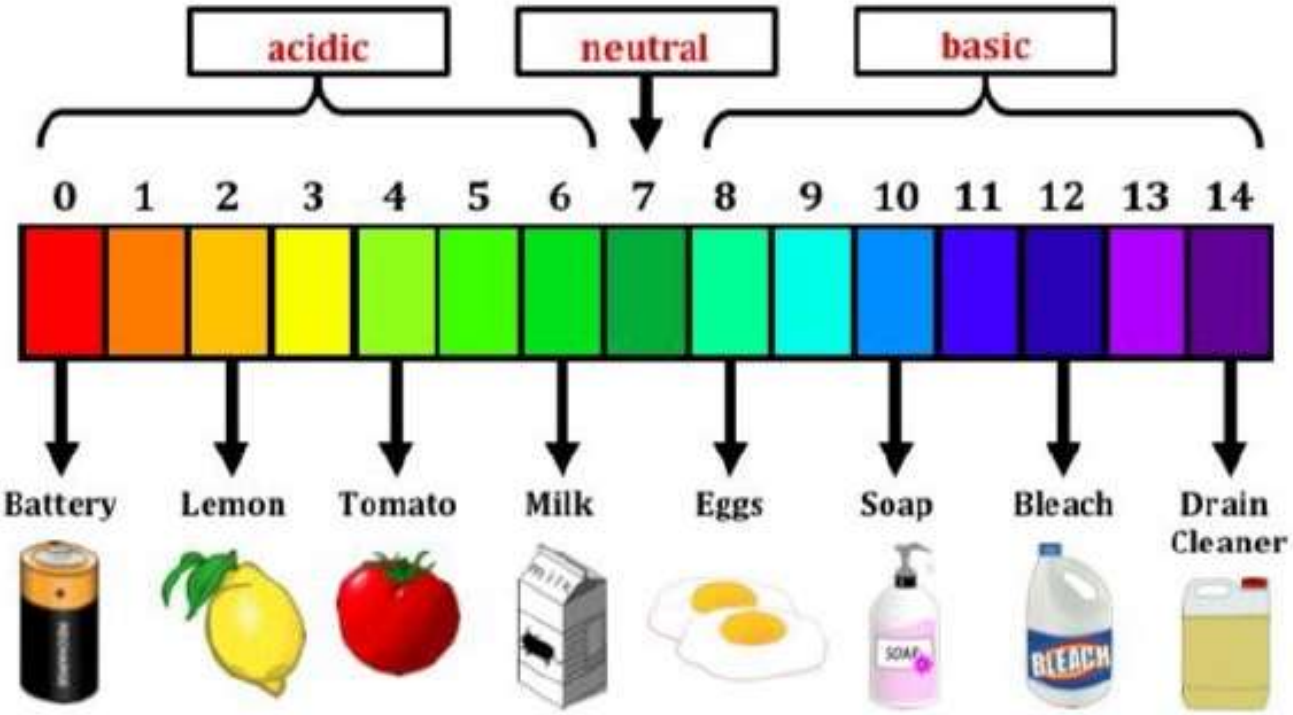
2-Anion that reacts with water

$CO_3^{2-}(aq, \text{from } Na_2CO_3) + H_2O \rightarrow HCO_3^-(aq) + OH^-(aq)$

3- molecular species that reacts with water

$NH_3(aq) + H_2O \rightarrow OH^-(aq) + NH_4^+(aq)$

pH:
a measure of the concentration of H_3O^+ ions in solution



pH less than 7

Lower pH value indicates a stronger acid.

INCREASING ACIDITY

7

NEUTRAL

INCREASING BASICITY

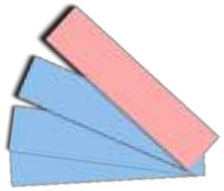
pH greater than 7

Higher pH value indicates a stronger base.

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

Acid-base indicators

S. No.	Indicator	Smell/Colour in acidic solution	Smell/Colour in basic solution
	Litmus	Red	Blue
	Phenolphthalein	Colourless	Pink



3. **Universal indicator :** is a mixture of several indicators. It shows different colours at different concentrations of H^+ ions in the solution.

pH = 7 → neutral solution Neutral salts: NaCl and Na_2SO_4

pH less than 7 → acidic solution $FeCl_3$, $AlCl_3$ and NH_4Cl

pH more than 7 → basic solution

$CaCO_3$, Na_2CO_3 and Na_3PO_4

- **pH meter: give a precise value of pH**

الأكثر دقة لقياس درجة الحموضة

Reactions of acids with metals

When acids react with metals, the products are a salt and hydrogen. In general:

Acid + metal → salt + hydrogen

For example: **Zn and Fe also react with hydrochloric acid**

$$2HCl(aq) + Mg(s) \rightarrow MgCl_2(aq) + H_2(g)$$

Mg, Zn and Fe also react with sulfuric acid.

The products are a salt and hydrogen gas. For example:

$$H_2SO_4(aq) + Fe(s) \rightarrow FeSO_4(aq) + H_2(g)$$

السلسلة مهمة جدا

K	Potassium	most reactive
Na	Sodium	
Ca	Calcium	
Mg	Magnesium	
Al	Aluminium	
C	*Carbon*	
Zn	Zinc	
Fe	Iron	
Sn	Tin	
Pb	Lead	
H	*Hydrogen*	
Cu	Copper	
Ag	Silver	least reactive
Au	Gold	
Pt	Platinum	

(added for comparison)

- Categorizing the metals according to their reactivity:
  - ✓ Very rapid reaction: K, Na
  - ✓ Rapid reaction: Ca, Mg
  - ✓ Slow reaction: Al, Zn, Fe, Sn
  - ✓ No reaction: Pb, Cu, Ag, Au

Note : Copper (Cu) is a very unreactive metal, and it **does** not **react with hydrochloric acid**. It is above **copper** in a metal reactivity series, so **copper** cannot replace the hydrogen in **HCl** to form $CuCl_2$.

يجب الحذر عند التعامل مع الحموض والقواعد ذات التراكيز العالية لأنها تسبب حروق الجلد وتهيج الأغشية المخاطية

Caution:

- Be very careful in handling dilute and concentrated acids and bases ⇒ cause severe skin burns and irritation to mucous membranes (الأغشية المخاطية).

غسل الحموض والقواعد مباشرة بماء كافي ثم بيكربونات الصوديوم

- Clean up acid and base spills directly with excess water, and baking soda, $NaHCO_3$.

- Refer to the Laboratory Safety section at the beginning of this manual.

الجانب العملي

	Mg	Zn	Cu
6 M HCl	Fast	Medium	NR
6 M H_3PO_4			NR
6 M CH_3COOH	slow	slow	NR

فاعلنا عدة حموض بنفس التراكيز م metal مختلف وكان أنشطها ال mg ..... ارجع إلى سلسلة النشاط

1) Making salts by reacting acids with metals

*Used for reactive metals, but DANGEROUS if the metal is too reactive (e.g. Na or K) because reaction is **exothermic**.*

General equation: **METAL + ACID → SALT + HYDROGEN**

e.g. $Zn_{(s)} + H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)} + H_{2(g)}$

$$E.g., 2HCl + Zn \longrightarrow ZnCl_2 + H_2$$

مهم تكتب معادلة كيميائية

Effect of Acid Concentration on Reaction Rate

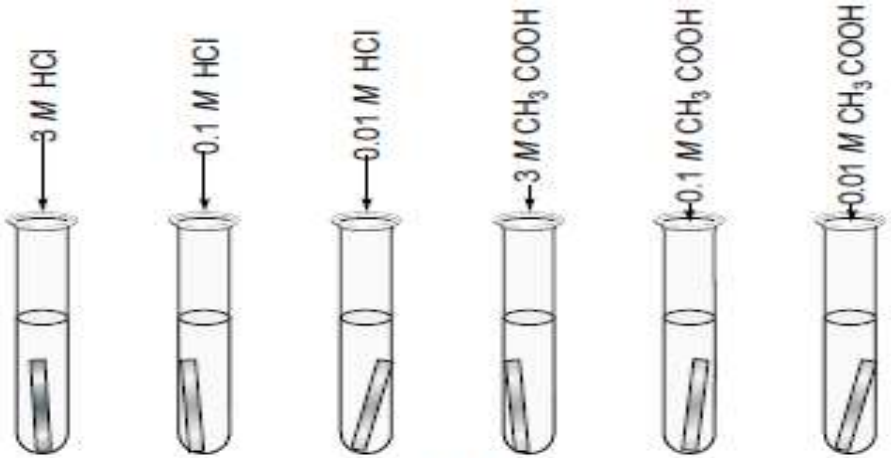


Figure 6.7 A setup for testing the effect of different acids and acid strengths on their reactivity with a metal.

الجزء الثاني كان عبارة عن تراكيز مختلفة
عبرنا انه العلاقة بين السرعة والتركيز طردية
3M then 0.1M then 0.01M

-The reaction rate is greatest with 3 M HCl and lowest with 0.10 M HCl.
-The reaction of the Mg in the HCl solutions (strong acid) is more rapid than in acetic acid (weak acid) solutions of like concentrations.

the chemical reaction rate is directly proportional to the concentration of reactants

$$\text{rate} = k[\ ]^n = -\frac{\Delta[\ ]}{\Delta t}$$

"a rate law"

k = rate constant

n = order of the reactant and can be $\emptyset$, a fraction, or a whole #.

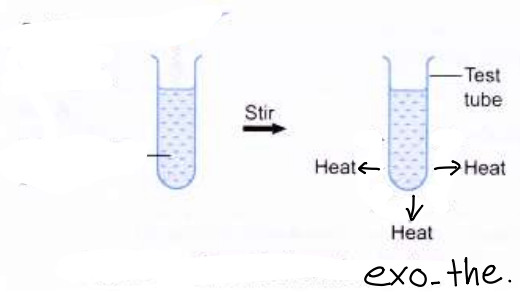
Reaction of Acids and Bases With Each Other

الجزء الثالث معادلة التعادل

$$\text{Acid} + \text{Base} \rightarrow \text{Salt} + H_2O$$

Neutralisation Reaction : Reaction of acid with base is called as neutralization reaction.

E.g., $HCl + NaOH \rightarrow NaCl + H_2O$



الجزء الرابع
ذوبنا كربونات الصوديوم بالماء وشفنا سلوكها هل هي حمض او قاعدة ؟ استخدمنا ورقة تباع الشمس ... قاعدة

$$Na_2CO_3 = 2Na^+ + CO_3^{2-}$$

$$Na^+ + H_2O \neq$$

$$CO_3^{2-} + H_2O = HCO_3^- + OH^-$$

C. pH Measurements

الجزء الخامس
بيعتمد على ال Universal indicator
بناء على سلسلة الألوان

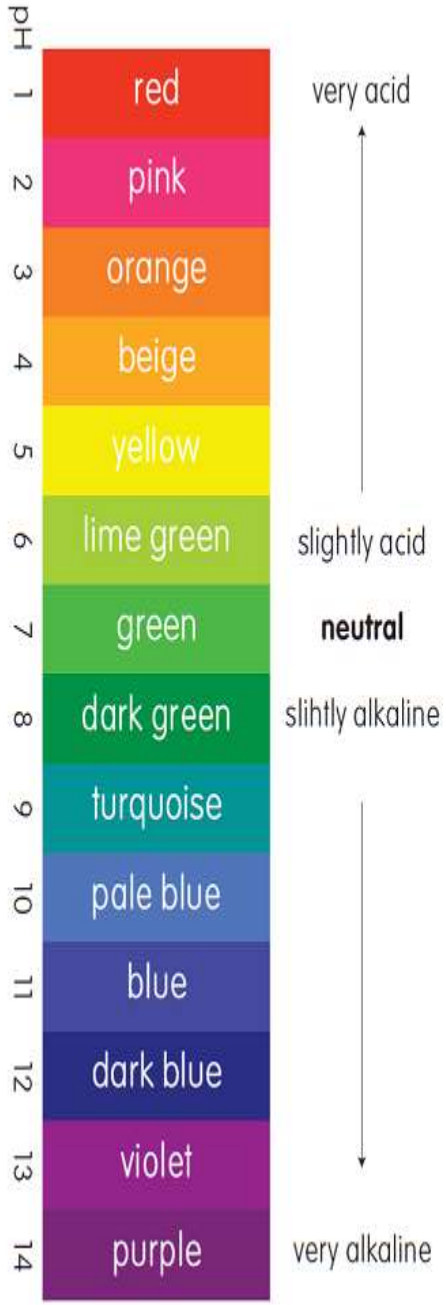
أثناء الغليان تم تحرير غاز CO2 لذا تكون ال ph تساوي 7 ... تم منع تحول ال CO2 إلى carboxylic acid ليعطي سلوك الحامضية

Water	Approximate pH	Briefly account for the pH if not equal
Boiled, deionized	7	lack of CO_2
Unboiled, deionized	less than 7	Contain CO_2 ⇒ make it acidic
Tap	8	contains different ions

Solution	Approximate pH	Balanced equation showing acid ity/basicity
0.010 M HCl	3	$HCl \longrightarrow H^+ + Cl^-$
0.010 M CH_3COOH	5	$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$
0.01 M NaOH	11	$NaOH \longrightarrow Na^+ + OH^-$
0.010 M NH_3	10	$NH_3 \rightleftharpoons NH_4^+ + OH^-$
Vinegar	~5	$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

درجة الحموضة تقريبية
ليست للحفظ
لكن ميز ان الحمض الأقوى اقرب للصفر

كتابة المعادلات مهمة جدا



الإسئلة

Do it

Prelaboratory Assignment: Acids, Bases, and Salts

1. In an aqueous solution,
a. name and write the formula of the ion that makes a solution acidic.
b. name and write the formula of the ion that makes a solution basic.
2. a. Muriatic acid is used to adjust the pH of swimming pools. What is the formula of muriatic acid? Does the pH of the swimming pool increase or decrease as a result of adding muriatic acid? Explain.
b. Battery acid is a rather concentrated solution of sulfuric acid. What is the formula of sulfuric acid?
3. Aqueous salt solutions often are *not* neutral with respect to pH. Explain.
4. a. Milk of magnesia is used as a laxative and to treat upset stomachs. What is the formula of milk of magnesia?
b. Washing soda is often added to detergent formulations to make the wash water more basic. What is the formula of the anhydrous form of washing soda? Does it increase or decrease the pH of the wash water? Explain.

5. Three solutions have the following pH:

• Solution 1: pH 7.4,

Solution 2: pH 10.6,

Solution 3: pH 3.7

a. Which solution contains the highest H_3O^+ ion concentration? _____

b. Which solution is the most acidic? _____

c. Which solution is the most basic? _____

6. Metallic ions with a higher positive charge are more strongly hydrated and tend to be more acidic in solution. Comparing a 0.12 *M* $FeCl_3$ solution to a 0.12 *M* $FeCl_2$ solution, which solution would have a lower pH? Explain.

e. What spectator ions remain in solution in the reaction mixture?

f. Write the net ionic reaction that accounts for the appearance of the precipitate.

Random questions

DIRECTIONS: Calculate the following.

1. A solution has an $[H^+] = 4.3 \times 10^{-3}$ *M*. Find the $[OH^-]$, the pH and pOH.

$[OH^-] = 1.0\times10^{-14}/4.3\times10^{-3} = 2.3\times10^{-12}$

$pH = -\log(4.3\times10^{-3}) = 2.37$

$pOH = -\log(2.3\times10^{-12}) = 11.64$

2. A solution has an $[H_3O^+] = 8.41 \times 10^{-10}$ *M*. Find the $[OH^-]$, the pH and pOH.

$[OH^-] = 1.0\times10^{-14}/8.41\times10^{-10} = 1.19\times10^{-5}$

$pH = -\log(8.41\times10^{-10}) = 9.075$

$pOH = -\log(1.19\times10^{-5}) = 4.924$

3. A solution has an $[OH^-] = 5.5 \times 10^{-3}$ *M*. Find the $[H^+]$, the pH and pOH.

$[H^+] = 1.0\times10^{-14}/5.5\times10^{-3} = 1.8\times10^{-12}$

$pH = -\log(1.8\times10^{-12}) = 11.74$

$pOH = -\log(5.5\times10^{-3}) = 2.26$

4. A solution has an $[OH^-] = 3.71 \times 10^{-6}$ *M*. Find the $[H^+]$, the pH and pOH.

$[H^+] = 1.0\times10^{-14}/3.71\times10^{-6} = 2.70\times10^{-9}$

$pH = -\log(2.70\times10^{-9}) = 8.569$

$pOH = -\log(3.71\times10^{-6}) = 5.431$

5. Lemon juice has a pH of 2.0. Determine the $[H_3O^+]$ and $[OH^-]$ in lemon juice.

$[H_3O^+] = \text{antilog}(-2.0) = 0.01\ M$

$pOH = 14.0 - 2.0 = 12.0$

$[OH^-] = \text{antilog}(-12.0) = 1\times10^{-12}\ M$

Revised: 2018-10-23

Experiment 4 *Prelaboratory*

Acids And Bases

Name _____

1. In an aqueous solution,

a. identify the "species" that makes a solution acidic.

high concentration of (H^+)

b, identify the "species" that makes a solution basic.

contains more (OH^-) ions.

2. Aqueous salt solutions often are not neutral with respect to pH. Explain.

the ions forming the salt are conjugate acids or bases of those species used to prepare the salt, thus can exhibit acidity or basicity

3. a. Milk of magnesia is used as a laxative and to treat upset stomachs. What is the formula of milk of magnesia? $Mg(OH)_2$

b. Washing soda is often added to detergent formulations to make the wash water more basic. What is the formula of the anhydrous form of washing soda? Does it increase or decrease the pH of the wash water? Explain. Na_2CO_3

will increase the pH because the increase of OH^- concentration in the solution.

$Na_2CO_3 + 2H_2O \longrightarrow 2NaOH + H_2O + CO_2$

4. Three solutions have the following pH:

- Solution 1: pH 12.1
- Solution 2: pH 6.2
- Solution 3: pH 10.2

a. Which solution contains the highest H_3O^+ ion concentration? 2

b. Which solution is the most acidic? 2

c. Which solution is the most basic? 1