

EOT3 - CHEMISTRY - ACIDS AND BASES - CHEMICAL EQUILIBRIUM



تم تحميل هذا الملف من موقع المناهج الإماراتية

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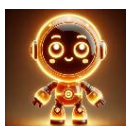
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المزيد من مادة
كيمياء:

إعداد: Sarayrah Yousef

التواصل الاجتماعي بحسب الصف الحادي عشر المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف الحادي عشر المتقدم والمادة كيمياء في الفصل الثالث

EOT3 - CHEMISTRY - ACIDS AND BASES - CHEMICAL EQUILIBRIUM

1

مواصفات امتحان مادة الكيمياء

2

تحليل ورقة تدريب امتحان نهاية الفصل في الخلايا الجلفانية

3

ملزمة وفق الهيكل - بريدج

4

ملزمة وفق الهيكل - انسباير

5

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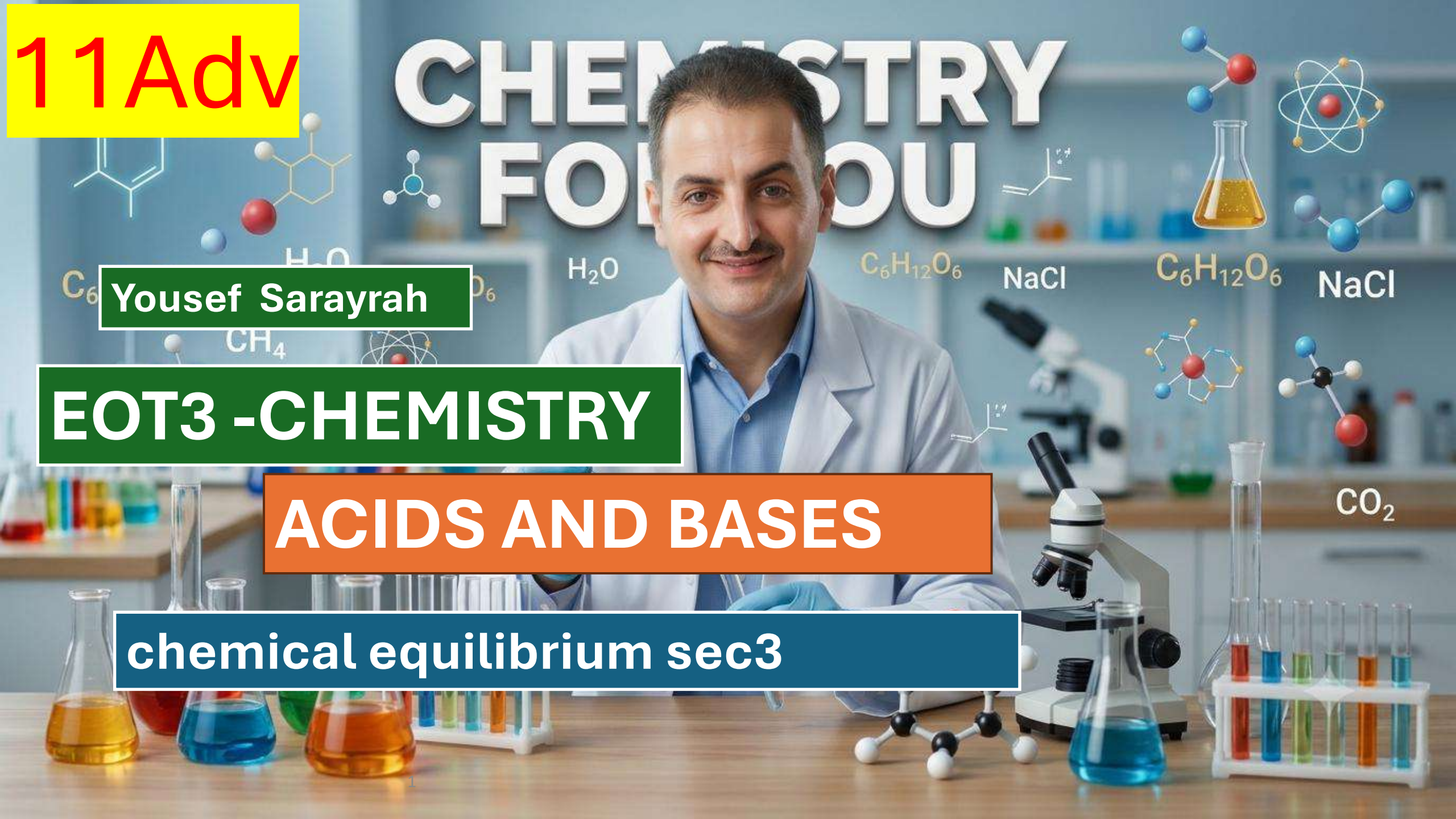
CHEMISTRY FOR YOU

Yousef Sarayrah

EOT3 -CHEMISTRY

ACIDS AND BASES

chemical equilibrium sec3



Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



1	CHM.5.4.02.006.03 Calculate the equilibrium concentration given the value of the equilibrium constant and equilibrium concentration of reactants and products	Textbook + Example problem 4+ Practice Problems
2	CHM.5.4.02.006.04 Calculate the value of K_{eq} , K_c , or K_p when the concentration or pressure of reactants and products are given at a constant temperature	Textbook + Example problem 4+ Practice Problems



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At a temperature of 1405 K, hydrogen sulfide decomposes to form hydrogen and diatomic sulfur. The equilibrium constant for the reaction is 2.27×10^{-3} .

What is the concentration of hydrogen gas if $[S_2] = 0.0540 \text{ mol/L}$ and $[H_2S] = 0.184 \text{ mol/L}$?

عند درجة حرارة 1450 K يتحلل كبريتيد الهيدروجين إلى هيدروجين وحزء كبريت، وثابت الاتزان 2.27×10^{-3}

ما تركيز غاز الهيدروجين إذا كان
 $[S_2] = 0.0540 \text{ mol/L}$
 $[H_2S] = 0.184 \text{ mol/L}$
 K_{eq}
 $[H_2] = ??$

$$K_{eq} = \frac{[S_2][H_2]^2}{[H_2S]^2}$$



$$2.27 \times 10^{-3} = \frac{[0.054][H_2]^2}{[0.184]^2}$$

$$[H_2] = 0.0377 \text{ M}$$

A - 0.0377 mol/L

B - 0.0540 mol/L

C - 0.0785 mol/L

D - 0.0945 mol/L

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The next reaction reaches equilibrium at 900 K and K_{eq} is 8.2×10^{-2} . If the equilibrium concentrations of CO and Cl_2 are 0.150M, what is the equilibrium concentration of $COCl_2$?

$$K_{eq} = \frac{[CO][Cl_2]}{[COCl_2]}$$

$$8.2 \times 10^{-2} = \frac{(0.15)(0.15)}{[COCl_2]}$$

$$[COCl_2] = 0.274 M$$

التفاعل التالي يصل إلى حالة الاتزان عند درجة حرارة 900K و K_{eq} يساوي 8.2×10^{-2} إذا كانت تراكيز الاتزان لـ CO و Cl_2 هي 0.150M، فما تركيز الاتزان لـ $COCl_2$ ؟

$$[CO] = [Cl_2] = 0.15 M$$

$$[COCl_2] = ??$$



A – 3.50 M

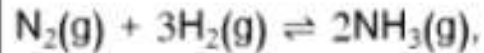
B – 2.27 M

C – 1.82 M

D – 0.274 M

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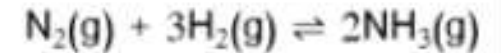
Ammonia is produced according to the equation,



At a certain temperature, $K_{\text{eq}} = 2.0 \times 10^{-4}$ for the equilibrium.

What is the $[\text{NH}_3]$ in an equilibrium mixture containing 2.00 mol/L N_2 and 4.00 mol/L H_2 ?

تنتج الأمونيا حسب المعادلة



عند درجة حرارة معينة، فإذا كانت قيمة K_{eq} تساوي 2.0×10^{-4}

ما تركيز $[\text{NH}_3]$ في خليط انزان يحتوي على 2.00 mol/L من N_2 و 4.00 mol/L من H_2 ؟

$$[\text{N}_2] = 2\text{M}$$

$$[\text{H}_2] = 4\text{M}$$

0.16 M

3.58 M

0.03 M

0.07 M

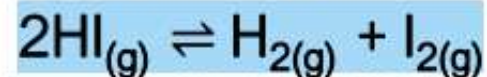
$$K_{\text{eq}} = \frac{[\text{NH}_3]^2}{[\text{H}_2]^3 [\text{N}_2]} \rightarrow 2 \times 10^{-4} :$$

$$\therefore 2 \times 10^{-4} = \frac{[\text{NH}_3]^2}{(4)^3 (2)} \rightarrow [\text{NH}_3] :$$

Coverage



At 350°C $k_{eq} = 1.67 \times 10^{-2}$:for the reversible reaction



What is the concentration of HI at equilibrium if $[\text{H}_2]$ is $2.44 \times 10^{-3} \text{ M}$ and $[\text{I}_2]$ is $7.18 \times 10^{-5} \text{ M}$

A. $3.24 \times 10^{-3} \text{ M}$

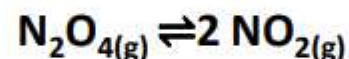
B. $1.05 \times 10^{-9} \text{ M}$

C. $3.99 \times 10^{-6} \text{ M}$

D. $1.75 \times 10^{-7} \text{ M}$

The reaction below reaches equilibrium at given temperature when $K_{eq} = 0.213$. if the equilibrium concentration of $[\text{N}_2\text{O}_4] = 0.0185 \text{ mol/L}$. what is the concentration of $[\text{NO}_2]$?

يصل التفاعل أدناه إلى حالة الاتزان عند درجة حرارة معينة عندما $K_{eq} = 0.213$. إذا كان تركيز $[\text{N}_2\text{O}_4] = 0.0185 \text{ mol/L}$ عند الاتزان ، ما تركيز الاتزان لـ $[\text{NO}_2]$ ؟



A. 0.087

B. 0.0628

C. 0.213

D. 0.004

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The reaction $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ reaches equilibrium. If the equilibrium concentrations are:

$$[\text{SO}_2] = 0.0170 \text{ mol / L}$$

$$[\text{O}_2] = 0.0230 \text{ mol / L}$$

K_{eq} is 4.32

What is the equilibrium concentration of SO_3 in mol / L

التفاعل $2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$ يصل إلى حالة الاتزان، فإذا كانت التراكيز عند الاتزان هي:

$$[\text{O}_2] = 0.0230 \text{ mol / L} \text{ و } [\text{SO}_2] = 0.0170 \text{ mol / L}$$

وثابت الاتزان K_{eq} لهذا التفاعل هو 4.32

فما تركيز الاتزان لـ SO_3 بوحدة mol / L ؟

0.6850

0.0411

0.00536

0.9970

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3	CHM.5.4.02.007.02 Write the solubility equilibrium expression for a given reaction equilibrium
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4	CHM.5.4.02.008.01 Calculate the molar solubility (concentration) of a sparingly soluble ionic compound using the solubility product constant, K_{sp}
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5	CHM.5.4.02.011.03 Explore the application of the solubility product constant in radiology while exploring its effects on human vital systems
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6	CHM.5.4.02.007.03 Write the solubility for a given reaction equilibrium
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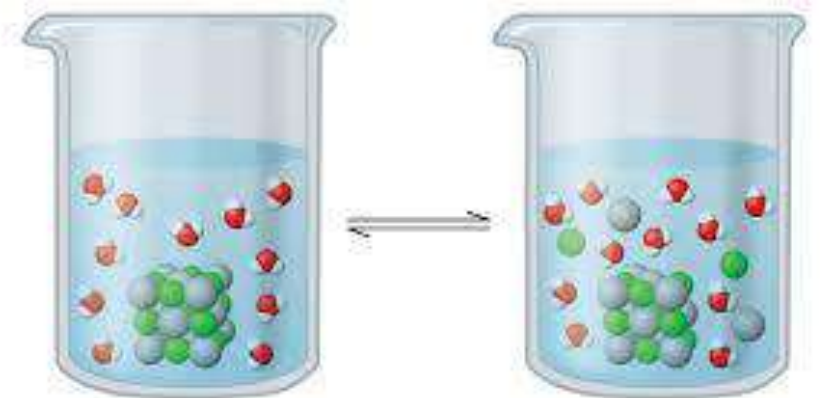
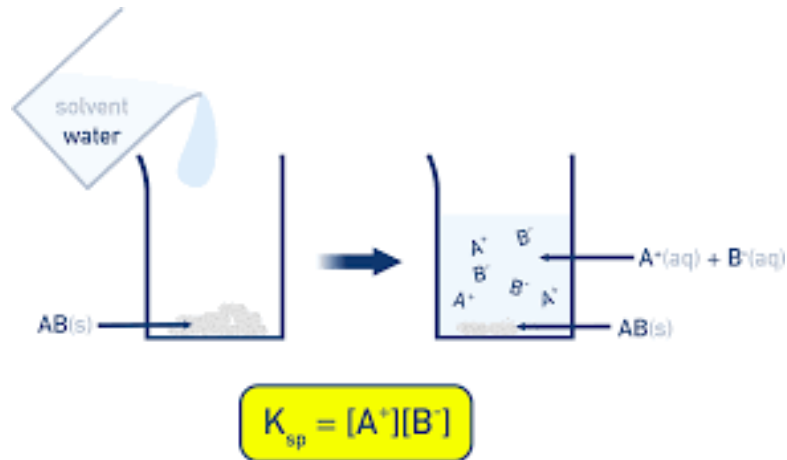
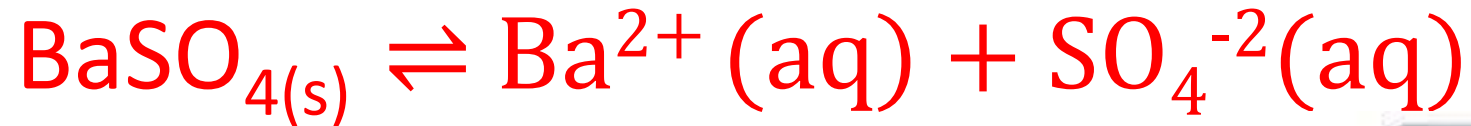
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The Solubility K_{sp} حاصل الاذابة ثابت

- Some ionic compounds dissolve readily in water, and some **barely** dissolve at all.

For the **sparingly soluble compounds** such as BaSO_4 ,



- The equilibrium constant expression for the dissolving of a **sparingly soluble** compound is called the **solubility product constant**, K_{sp} .

The Solubility Product Constant

- The solubility product constant expression is the product of the **concentrations** of the dissolved **ions**, **each** raised to the **power** equal to the coefficient of the ion in the chemical equation.

- For the sparingly soluble compounds such as BaSO_4 ,



- The solubility product constant expression K_{sp}

- $K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$

$$= 1.1 \times 10^{-10}$$

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- The values in the table can be used to determine the solubility of a **sparingly soluble compounds**.

K_{sp} can be used to:

- Calculating **Molar Solubility (s)** mol/L

Solubility Product Constants at 298 K

Compound	K_{sp}	Compound	K_{sp}	Compound	K_{sp}
Carbonates		Halides		Hydroxides	
BaCO ₃	2.6×10^{-9}	CaF ₂	3.5×10^{-11}	Al(OH) ₃	4.6×10^{-33}
CaCO ₃	3.4×10^{-9}	PbBr ₂	6.6×10^{-6}	Ca(OH) ₂	5.0×10^{-6}
CuCO ₃	2.5×10^{-10}	PbCl ₂	1.7×10^{-5}	Cu(OH) ₂	2.2×10^{-20}
PbCO ₃	7.4×10^{-14}	PbF ₂	3.3×10^{-8}	Fe(OH) ₃	4.9×10^{-17}
MgCO ₃	6.8×10^{-6}	PbI ₂	9.8×10^{-9}	Fe(OH) ₃	2.8×10^{-39}
Ag ₂ CO ₃	8.5×10^{-12}	AgCl	1.8×10^{-10}	Mg(OH) ₂	5.6×10^{-12}
ZnCO ₃	1.5×10^{-10}	AgBr	5.4×10^{-13}	Zn(OH) ₂	3×10^{-17}
Hg ₂ CO ₃	3.6×10^{-17}	AgI	8.5×10^{-17}	Sulfates	
Chromates		Phosphates		BaSO ₄	1.1×10^{-10}
BaCrO ₄	1.2×10^{-10}	AlPO ₄	9.8×10^{-21}	CaSO ₄	4.9×10^{-5}
PbCrO ₄	2.3×10^{-13}	Ca ₃ (PO ₄) ₂	2.1×10^{-33}	PbSO ₄	2.5×10^{-8}
Ag ₂ CrO ₄	1.1×10^{-12}	Mg ₃ (PO ₄) ₂	1.0×10^{-24}	Ag ₂ SO ₄	1.2×10^{-5}

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Example

Calculating solubility (s)

determine the solubility of silver iodide (AgI) in mol/L at 298 K. The equilibrium equation and solubility product constant expression are as follows.



$$K_{sp} = [\text{Ag}^{+}][\text{I}^{-}] = 8.5 \times 10^{-17}$$

The Answer

Given the balanced equation, we find that the number of moles $[\text{Ag}^{+}]$ is equal to the number of $[\text{I}^{-}]$ moles so that one can be compensated by x

$$[\text{Ag}^{+}][\text{I}^{-}] = (x) \times (x) = x^2 = 8.5 \times 10^{-17}$$

$$x = \sqrt{8.5 \times 10^{-17}} = 9.2 \times 10^{-9} \text{ mol/L}$$



$$s = \sqrt{(a+b) \frac{K_{sp}}{a^a \times b^b}}$$

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- العلاقة بين الذوبانية المولارية (s) وثابت حاصل الإذابة (K_{sp}):

- الأملاح ثنائية الأيونات (مثل $AgCl$):

$$K_{sp} = s^2 \implies s = \sqrt{K_{sp}}$$

- الأملاح ثلاثية الأيونات (مثل MgF_2):

$$K_{sp} = [s][2s]^2 = 4s^3 \implies s = \sqrt[3]{\frac{K_{sp}}{4}}$$

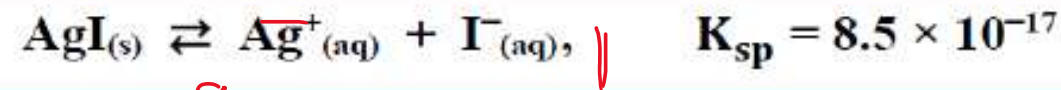
الملح شحيح الذوبان (Sparingly Soluble Salt) مركب أيوني يمتلك قابلية ضعيفة جداً للذوبان في الماء، وتتفكك منه كميات متناهية في الصغر مسببة قيمة منخفضة (مثل).

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Example

Calculate the solubility (s) of silver iodide AgI in mol/L at 298 K



$$K_{sp} = [\text{Ag}^+][\text{I}^-] = 8.5 \times 10^{-17}$$

$$s = \frac{(a+b) \sqrt{K_{sp}}}{\sqrt{a^a \times b^b}}$$

$$= \frac{(1+1) \sqrt{8.5 \times 10^{-17}}}{\sqrt{1^1 \times 1^1}}$$

$$= \sqrt{8.5 \times 10^{-17}} = 9.2 \times 10^{-9} \text{ mol/L}$$

$$[\text{Ag}^+] = 1(s) = 9.2 \times 10^{-9} \text{ mol/L}$$

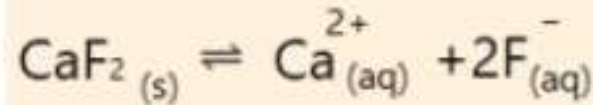
$$[\text{I}^-] = 1(s) = 9.2 \times 10^{-9} \text{ mol/L}$$

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What is the value of K_{sp} for CaF_2 compound if the solubility of calcium fluoride CaF_2 is 2.1×10^{-4} M of water at 298 K?

ما قيمة K_{sp} للمركب CaF_2 إذا كانت ذائبية فلوريد الكالسيوم CaF_2 تساوي 2.1×10^{-4} M في الماء عند درجة حرارة 298؟



$$K_{sp} = [\text{Ca}^{2+}] [\text{F}^{-}]^2$$

$$K_{sp} = [1s] [2s]^2$$

$$= [s] [4s^2]$$

$$K_{sp} = 4s^3$$

$$K_{sp} = 4(2.1 \times 10^{-4})^3$$

$$= 3.7 \times 10^{-11}$$

$$4.2 \times 10^{-4}$$

$$1.8 \times 10^{-7}$$

$$8.8 \times 10^{-8}$$

$$3.7 \times 10^{-11}$$



If the K_{sp} of calcium hydroxide Ca(OH)_2 is 5.32×10^{-6} at 298 K. What is the solubility of calcium hydroxide in mol/L?

إذا كانت قيمة K_{sp} لهيدروكسيد الكالسيوم Ca(OH)_2 تساوي 5.32×10^{-6} عند 298 K . فما ذائبية هيدروكسيد الكالسيوم بوحدة

mol/L ؟



3.30×10^{-8}



2.80×10^{-7}



1.60×10^{-3}



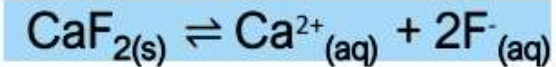
1.10×10^{-2}



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What is the value of K_{sp} for CaF_2 compound if the solubility of calcium fluoride CaF_2 is $2.06 \times 10^{-4} \text{ M}$ at 298K



A. 4.2×10^{-4}

B. 1.8×10^{-7}

C. 8.8×10^{-12}

D. 3.5×10^{-11}

Determine the solubility of silver iodide (AgI) in mol/L if the K_{sp} value of silver iodide (AgI) $K_{sp} = 8.5 \times 10^{-17}$



A. 8.5×10^{-17}

B. 9.8×10^{-9}

C. 8.8×10^{-12}

D. 3.5×10^{-11}

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What is the solubility in mol/L of lead bromide PbBr_2 at 298 K?

ما ذائبية بروميد الرصاص PbBr_2 عند 298 K (بوحدة mol/L)؟

If $K_{sp} = 6.6 \times 10^{-6}$

إذا كان $K_{sp} = 6.6 \times 10^{-6}$



0.024

0.018

0.030

0.012

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The small value of K_{sp} for BaSO_4 indicates that products are not favored at equilibrium. The concentration of barium ions at equilibrium is only $1.0 \times 10^{-5}M$, and a patient, such as the one shown in Figure 17, can safely ingest a barium sulfate solution.



Figure 17 Greater definition is possible in a gastrointestinal X-ray when patients drink a thick mixture containing barium sulfate. Barium sulfate is a poisonous substance, but it has such low solubility that only a minimal amount can dissolve in the patient's body.

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ثابت حاصل الإذابة (K_{sp})
Solubility product constant (K_{sp})

ثابت كيميائي يمثل حاصل ضرب تراكيز الأيونات الناتجة عن تفكك مركب شحيح الذوبان في محلوله المشبع. مرفوعاً لمعاملاته الموزونة.
A chemical constant representing the product of ion concentrations from a sparingly soluble compound's dissociation in its saturated solution, raised to their stoichiometric coefficients

$Al(OH)_3$ تعبير K_{sp} لملاح هيدروكسيد الألومنيوم
 K_{sp} expression for aluminum hydroxide $Al(OH)_3$

$$K_{sp} = [Al^{3+}][OH^-]^3$$

تعبير K_{sp} بدلالة الذوبانية المولارية (s) للملاح ثنائي الأيون
 XY

K_{sp} expression in terms of molar solubility (s) for a binary salt XY

$$K_{sp} = s^2$$

MgF_2 أو XY_2 تعبير K_{sp} بدلالة الذوبانية المولارية (s) للملاح ثلاثي الأيون
 K_{sp} expression in terms of molar solubility (s) for a tri-ionic salt MgF_2 or XY_2

$$K_{sp} = 4s^3$$

ماذا تعني القيمة الصغيرة جداً لثابت حاصل الإذابة ($K_{sp} = 10^{-10}$)
(What an extremely small solubility product constant value means
($K_{sp} = 10^{-10}$)

تعني أن الملاح ضعيف التفكك للغاية وشحيح الذوبان، ومعظم أجزائه تظل مترسبة كيميائياً.
It means the salt has minimal dissociation and is sparingly soluble, with most of it remaining chemically precipitated

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1. لماذا تُستخدم كبريتات الباريوم ($BaSO_4$) كعامل تباين في تصوير الجهاز الهضمي

بالأشعة رغم أن أيونات الباريوم (Ba^{2+}) سامة؟

Why is barium sulfate ($BaSO_4$) used as a contrast agent in GI radiology even though barium ions (Ba^{2+}) are toxic

أ. لأن المعدة تفرز مواد كيميائية تزيد من ذوبانها بشكل آمن.

Because the stomach secretes chemicals that safely increase its solubility.

ب. لأنها تذوب بسرعة وتفرزها الكلى على الفور.

Because it dissolves rapidly and is immediately excreted by the kidneys.

ج. لأن قيم ثابت حاصل الإذابة (K_{sp}) لها منخفضة جداً، مما يجعلها غير قابلة للذوبان تقريباً في الجسم.

Because its solubility product constant (K_{sp}) is extremely low, making it virtually insoluble in the body.

د. لأن قيمة K_{sp} العالية تمنع امتصاصها بواسطة الأنسجة الحيوية.

Because its high K_{sp} value prevents its absorption by vital tissues.

2. Which of the following represents the correct solubility product constant (K_{sp}) expression for the equilibrium of barium sulfate in water:



أ. $K_{sp} = \frac{[Ba^{2+}][SO_4^{2-}]}{[BaSO_4]}$

ب. $K_{sp} = [Ba^{2+}] + [SO_4^{2-}]$

ج. $K_{sp} = \frac{[BaSO_4]}{[Ba^{2+}][SO_4^{2-}]}$

د. $K_{sp} = [Ba^{2+}][SO_4^{2-}]$

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1. إذا كان ملح كبريتات الباريوم ($BaSO_4$) شحيح الذوبان ويمتلك قيمة K_{sp} منخفضة جداً، فماذا يعني ذلك بالنسبة لتركيز أيونات Ba^{2+} الحرة في المحلول؟
If barium sulfate ($BaSO_4$) is sparingly soluble and has a very low K_{sp} value, what does this mean for the concentration of free Ba^{2+} ions in solution?

أ. يكون تركيز الأيونات منخفضاً جداً، مما يمنع وصول الأيونات السامة إلى مستويات خطيرة داخل الجسم.
The ion concentration is extremely low, preventing toxic ions from reaching dangerous levels inside the body.

ب. يكون تركيز الأيونات عالياً جداً، مما يزيد من سرعة تفاعلها مع خلايا الجسم.
The ion concentration is very high, increasing its reaction speed with body cells.

ج. تتغير قيمة K_{sp} باستمرار لتقليل تركيز الأيونات عند دخولها الدم.
The K_{sp} value changes constantly to reduce ion concentration upon entering the blood.

د. يصبح تركيز الأيونات مساوياً لكتلة الملح الصلب المتبقي دون ذوبان.
The ion concentration becomes equal to the mass of the remaining undissolved solid salt.

6. ماذا يمثل الرمز K_{sp} في الكيمياء؟
What does the symbol K_{sp} represent in chemistry?

أ. ثابت تفكك الأحماض القوية.
Dissociation constant for strong acids.

ب. ثابت حاصل الإذابة للمركبات شحيحة الذوبان.
Solubility product constant for sparingly soluble compounds.

ج. معدل سرعة التفاعل الكيميائي.
The rate of a chemical reaction.

د. درجة الحرارة اللازمة للذوبان.
The temperature required for dissolution.



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4. ملح فوسفات الكالسيوم $Ca_3(PO_4)_2$ يتفكك إلى 5 أيونات. ما هو التعبير الرياضي المتكامل لقيمة K_{sp} له؟

Calcium phosphate $Ca_3(PO_4)_2$ dissociates into 5 ions. What is the complete K_{sp} mathematical expression for its

أ. $K_{sp} = [3Ca^{2+}][2PO_4^{3-}]$

ب. $K_{sp} = [Ca^{2+}]^3[PO_4^{3-}]^2$

ج. $K_{sp} = [Ca^{2+}][PO_4^{3-}]$

د. $K_{sp} = [Ca^{2+}]^2[PO_4^{3-}]^3$

2. أي مما يلي يمثل التعبير الصحيح لثابت حاصل الإذابة لمُحلول فلوريد المغنيسيوم MgF_2 ؟
Which of the following represents the correct solubility product expression for MgF_2 ?

أ. $K_{sp} = [Mg^{2+}][F^-]^2$

ب. $K_{sp} = \frac{[Mg^{2+}][F^-]^2}{[MgF_2]}$

ج. $K_{sp} = [Mg^{2+}][F^-]$

د. $K_{sp} = [Mg^{2+}]^2[F^-]$

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1. إذا كان لدينا الملح شحيح الذوبان هيدروكسيد الألومنيوم $Al(OH)_3$ ، فما هو التعبير الصحيح

لثابت حاصل الإذابة K_{sp} له؟

If we have the sparingly soluble salt aluminum hydroxide $Al(OH)_3$, what is its
?correct K_{sp} expression

أ. $K_{sp} = [Al^{3+}][OH^-]$

ب. $K_{sp} = [Al^{3+}]^3[OH^-]$

ج. $K_{sp} = [Al^{3+}][3OH^-]$

د. $K_{sp} = [Al^{3+}][OH^-]^3$

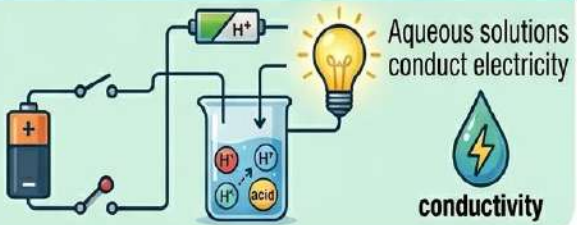


PROPERTIES OF ACIDS

PHYSICAL PROPERTIES

TASTE SOUR





Aqueous solutions conduct electricity

conductivity

CHEMICAL PROPERTIES

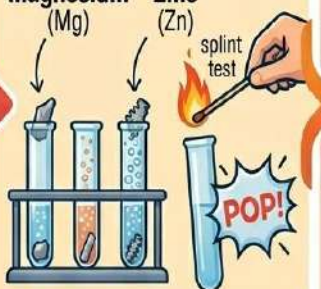
2a Reactions with Litmus Paper



Turning blue litmus paper red

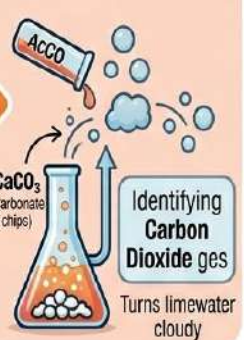
2b Reaction with Metals

Magnesium (Mg) Zinc (Zn)



Hydrogen gas Hydrogen gas

2c Reaction with Metal Carbonates



Identifying Carbon Dioxide gas

Turns limewater cloudy

Teacher's Tip Experimentally identifying H_2 and CO_2 gasses is crucial for the PISA test.

1. الخصائص الفيزيائية | Physical Properties

المذاق الحامض | Taste Sour: * تتميز الأحماض بمذاقها اللاذع أو الحامض، مثل الليمون.

Acids have a sour or tangy taste, like lemons

التوصيل الكهربائي | Conductivity:

المحاليل المائية للأحماض موصلة للكهرباء (لأنها تحتوي على أيونات H^+ حرة الحركة).

Aqueous solutions of acids conduct electricity (due to free-moving H^+ ions)

2. الخصائص الكيميائية | Chemical Properties

(أ) التفاعل مع ورق عباد الشمس | 2a) Reactions with Litmus Paper

تغير الأحماض لون ورق عباد الشمس الأزرق إلى اللون الأحمر.

Acids turn blue litmus paper red

(ب) التفاعل مع المعادن | 2b) Reaction with Metals

تتفاعل الأحماض مع معادن مثل المغنيسيوم (Mg) والزنك (Zn) لإنتاج غاز الهيدروجين.

Acids react with metals like Magnesium (Mg) and Zinc (Zn) to produce hydrogen gas

اختبار الشظية المشتعلة | Splint test: يُحدث غاز الهيدروجين صوت فرقعة ("بوب") عند تقريب شظية مشتعلة منه.

Hydrogen gas creates a "POP!" sound during a burning splint test

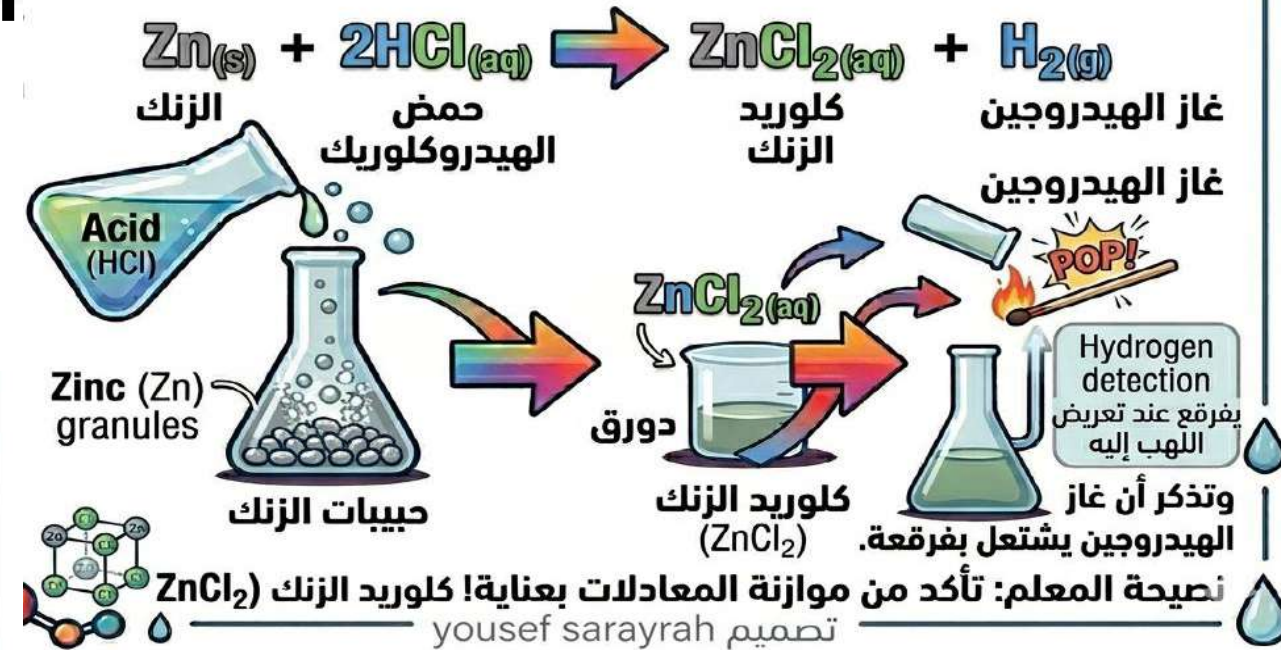
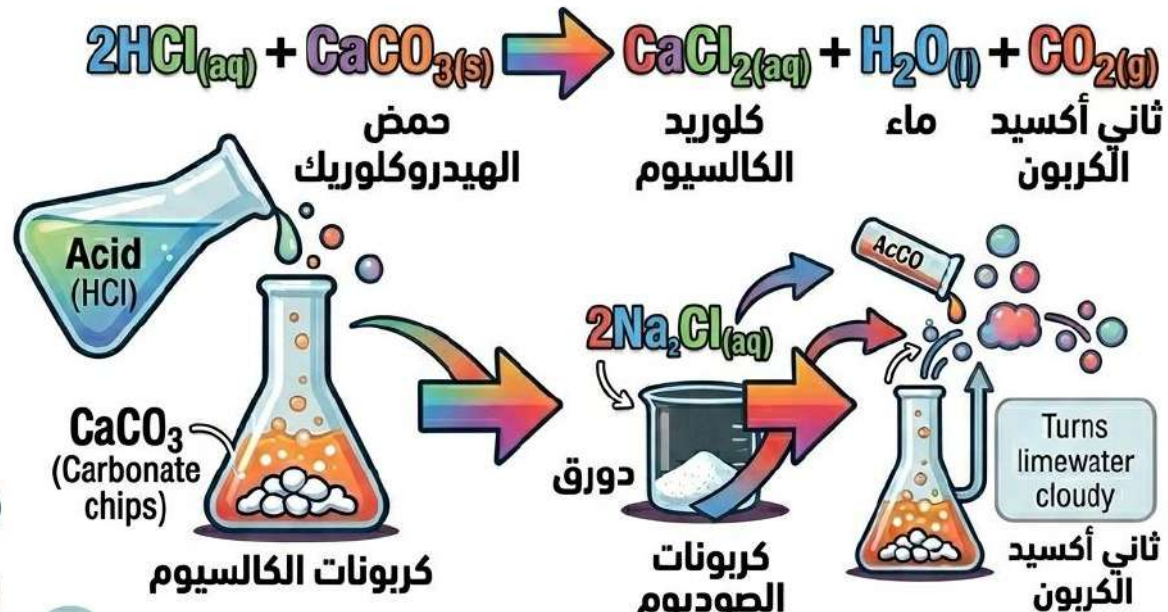
(ج) التفاعل مع كربونات المعادن | 2c) Reaction with Metal Carbonates

تتفاعل الأحماض مع كربونات الكالسيوم (قطع الكربونات) لإنتاج غاز ثاني أكسيد الكربون.

Acids react with Calcium Carbonate ($CaCO_3$ / Carbonate chips) to release carbon dioxide gas

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Chemical Reactions of Acids



Geology Test

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يعدد خصائص محاليل الأحماض والقواعد (المذاق - أثرها على الكواشف - الملمس - تفاعلاتها - التوصيل الكهربائي)

Which of the following are properties of basic solutions?

أي مما يأتي من خصائص المحاليل القاعدية؟



Taste sour

لها مذاق لاذع

☐ A

Cause blue litmus paper to turn red

تحول ورق تباع الشمس الأزرق إلى اللون الأحمر

☐ B

React with zinc to produce hydrogen gas

تتفاعل مع الخارصين لإنتاج غاز الهيدروجين

☐ C

Taste bitter and feel slippery

مُرّة المذاق وزلقة الملمس

☐ D

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يعدد خصائص محاليل الأحماض والقواعد (المذاق – أثرها على الكواشف – الملمس – تفاعلاتها – التوصيل الكهربائي)

What property does the experiment describe in the picture below?



ما الخاصية التي تصفها التجربة في الصورة أدناه؟

Taste sour

☐ A الطعم الحامض

Change in the colour of litmus paper

☐ B التغير في لون ورق تباع الشمس

The ability to conduct electricity

☐ C التوصيل الكهربائي

Feel slippery

☐ D الملمس الزلق

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When hydrochloric acid $\text{HCl}_{(\text{aq})}$ reacts with zinc metal $\text{Zn}_{(\text{s})}$, the formed gas is

عندما يتفاعل حمض الهيدروكلوريك $\text{HCl}_{(\text{aq})}$ مع فلز الخارصين $\text{Zn}_{(\text{s})}$ ، الغاز المتكون هو



hydrogen

الهيدروجين

☐ A

nitrogen

النيتروجين

☐ B

carbon dioxide

ثاني أكسيد الكربون

☐ C

carbon monoxide

أول أكسيد الكربون

☐ D



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Which of the following chemical reactions represents the reaction geologists use to detect limestone?

$\text{NaHCO}_3 + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$	A
$\text{Zn} + 2\text{HCl} \longrightarrow \text{ZnCl}_2 + \text{H}_2$	B
$\text{CaCO}_3 + 2\text{HCl} \longrightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$	C
$\text{Cu} + 4\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$	D

Which of the following chemical equations represents the reaction of acids with metal hydrogen carbonates?

$\text{NaHCO}_3 + \text{CH}_3\text{COOH} \longrightarrow \text{CH}_3\text{COONa} + \text{CO}_2 + \text{H}_2\text{O}$	A
$\text{Zn} + 2\text{HCl} \longrightarrow \text{ZnCl}_2 + \text{H}_2$	B
$\text{Na}_2\text{CO}_3 + 2\text{HCl} \longrightarrow 2\text{NaCl} + \text{CO}_2 + \text{H}_2\text{O}$	C
$\text{Cu} + 4\text{HNO}_3 \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{H}_2\text{O} + 2\text{NO}_2$	D

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Which of the following is a property of basic solutions?

React with metal carbonates to produce carbon dioxide (CO_2) gas

React with metals like zinc to produce hydrogen gas

Taste bitter and feel slippery

Taste sour

أي مما يأتي من خصائص محاليل القواعد؟

تتفاعل مع كربونات الفلزات لإنتاج غاز ثاني أكسيد الكربون (CO_2)

تتفاعل مع الفلزات مثل الخارصين لإنتاج غاز الهيدروجين

مرة المذاق وزلقة الملمس

طعمها لاذع

Litmus paper is blue when the H^+ concentration in the solution is.....

لون ورقة تباع الشمس أزرق عندما يكون تركيز H^+ في المحلول



equals OH^- concentration

يساوي تركيز OH^-

A

equals zero

يساوي صفر

B

less than OH^- concentration

أقل من تركيز OH^-

C

more than OH^- concentration

أكثر من تركيز OH^-

D



SOLUTIONS

Acidic solution

Contains **more** **hydrogen ions (H^+)** than **hydroxide ions (OH^-)**.



Neutral solution

Contains **equal** concentrations of **hydrogen ions (H^+)** and **hydroxide ions (OH^-)**.



Basic solution

Contains **more** **hydroxide ions (OH^-)** than **hydrogen ions (H^+)**.



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Which of the following is correct?

أي مما يأتي صحيح؟

In basic solution $[H^+] > [OH^-]$

في المحلول القاعدي يكون $[H^+] > [OH^-]$



In neutral solution $[H^+] > [OH^-]$

في المحلول المتعادل يكون $[H^+] > [OH^-]$



In acidic solution $[H^+] > [OH^-]$

في المحلول الحمضي يكون $[H^+] > [OH^-]$



In acidic solution $[H^+] < [OH^-]$

في المحلول الحمضي يكون $[H^+] < [OH^-]$



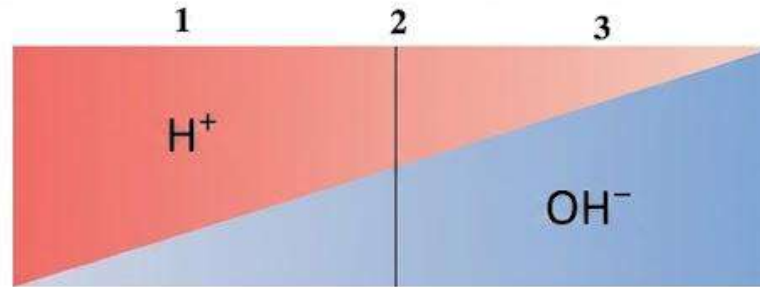
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The figure below describes the change in the concentration of hydrogen ions and hydroxide ions with

a change in the type of solution. Which of the following is **correct**?

يصف الشكل أدناه تغير تركيز أيونات الهيدروجين وأيونات الهيدروكسيد بتغير نوع المحلول، أي مما يأتي **صحيح**؟



1 is a basic solution

2 is a basic solution

3 is an acidic solution

1 is an acidic solution

☐ A 1 يمثل محلولاً قاعدياً

☐ B 2 يمثل محلولاً قاعدياً

☐ C 3 يمثل محلولاً حمضياً

☐ D 1 يمثل محلولاً حمضياً

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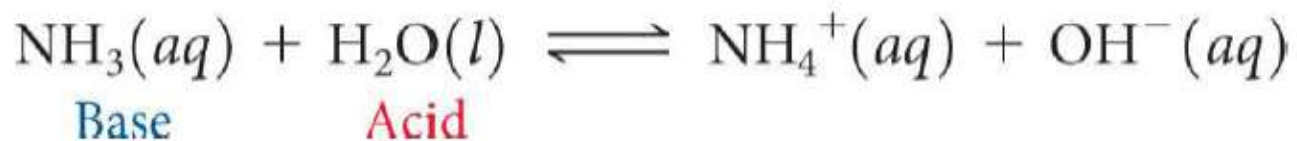
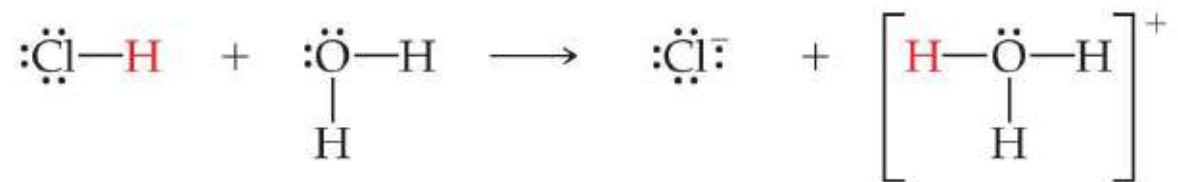


9

CHM.S.3.04.001.09 Describe the amphoteric behavior of water, H₂O, and ammonia, NH₃ (Using chemical equation, particulate diagram and space-filling models)

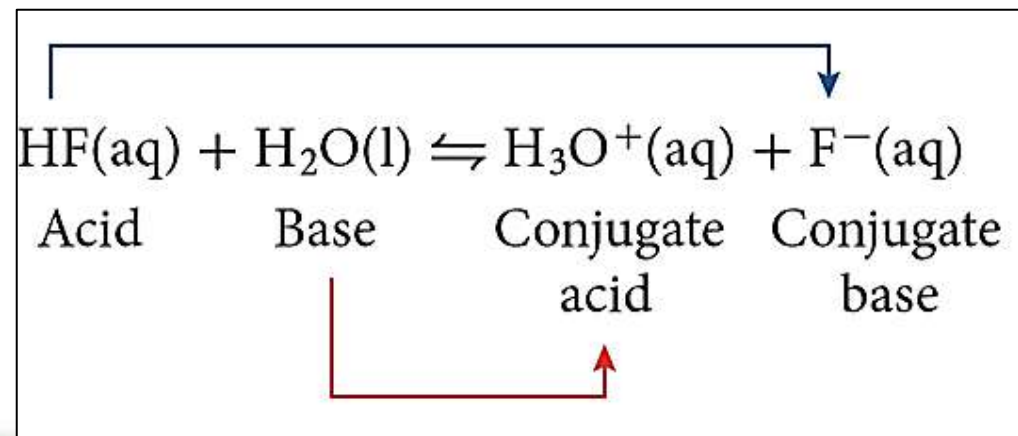
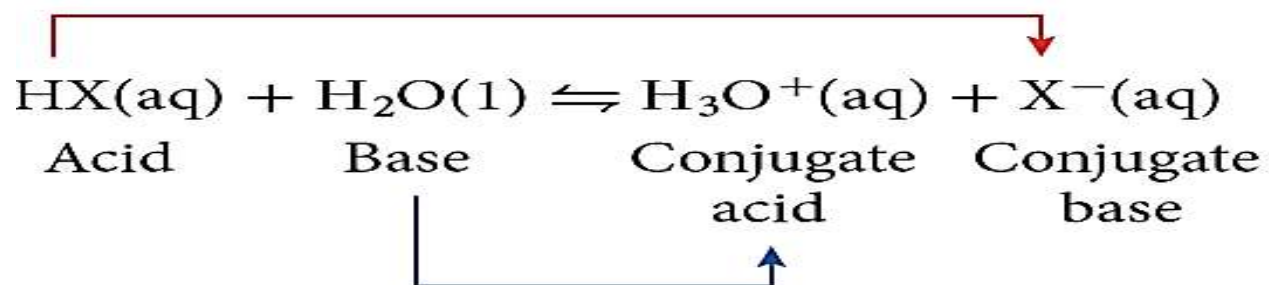
amphoteric. substances that can act as both acids and bases

Amphiprotic – a substance that is capable of acting as an acid or a base e.g. H₂O, HCO₃⁻, HSO₄⁻.



CHM.5.3.04.001.08 Define acids and bases according to Brønsted–Lowry theory, indicating the acid, base, conjugate acid, conjugate base and conjugate acid–base pairs, when chemical equations, formula or space–filling models are given

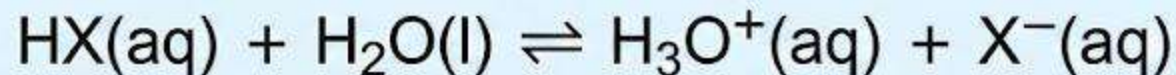
	Acids	Bases	Conjugate acid	Conjugate base	Conjugate acid-base pair
Definition	Hydrogen ion (H⁺) donor	Hydrogen ion (H⁺) acceptor	The species produced when a base accepts a hydrogen ion	The species produced when an acid donates a hydrogen ion	Consists of two substances related to each other by the donating and accepting of a single hydrogen ion



In the reaction equation below, which of the following

في تفاعل المعادلة أدناه، أي مما يلي صحيح؟

is true?



a.

HX is a Bronsted–Lowry base

يُعتبر HX من قواعد برونشتد - لوري

b.

H₂O is a Bronsted–Lowry acid

يُعتبر H₂O من أحماض برونشتد - لوري

c.

HX donates a hydrogen ion to water H₂O

يمنح HX أيون هيدروجين للماء H₂O

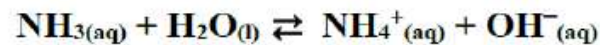
d.

HX accepts a hydrogen ion from water H₂O

يستقبل HX أيون هيدروجين من الماء H₂O

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Which of the following statements describes the following equation?



- a. H_2O is the Brønsted-Lowry base
- b. NH_3 represents Arrhenius acid
- c. NH_3 is a proton acceptor
- d. NH_3 represents Brønsted-Lowry acid

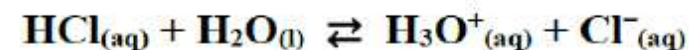
What are the conjugate pairs in the reaction? $\text{HF}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{F}^-(\text{aq})$

- a. $(\text{HF}, \text{H}_2\text{O}), (\text{F}^-, \text{H}_3\text{O}^+)$
- b. $(\text{HF}, \text{F}^-), (\text{H}_2\text{O}, \text{H}_3\text{O}^+)$
- c. $(\text{H}_3\text{O}^+, \text{F}^-), (\text{H}_2\text{O}, \text{HF})$
- d. $(\text{H}_2\text{O}, \text{F}^-), (\text{HF}, \text{H}_3\text{O}^+)$

What are the conjugate pairs in the reaction? $\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$

- a. $(\text{NH}_4^+, \text{H}_2\text{O}), (\text{OH}^-, \text{NH}_3)$
- b. $(\text{OH}^-, \text{NH}_4^+), (\text{H}_2\text{O}, \text{NH}_3)$
- c. $(\text{NH}_3, \text{NH}_4^+), (\text{H}_2\text{O}, \text{OH}^-)$
- d. $(\text{H}_2\text{O}, \text{NH}_4^+), (\text{NH}_3, \text{OH}^-)$

Which of the following statements is true for the reaction?



- a. HCl is Brønsted-Lowry acid
- b. HCl is the Brønsted-Lowry base
- c. H_2O is a proton donor
- d. HCl is a proton acceptor

What equation is H_2O as a hydrogen ion donor?

- a. $\text{HI}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{I}^-(\text{aq})$
- b. $\text{HSO}_4^-(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$
- c. $\text{HPO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{PO}_4^{3-}(\text{aq})$
- d. $\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$

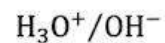
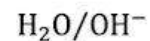
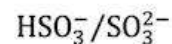
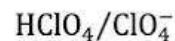


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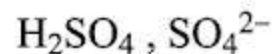
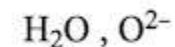
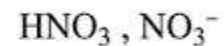
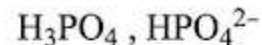
Which of the following is not a conjugate acid– base pair?

أي مما يلي ليس زوج حمض قاعدة مرافق؟



Which of the following is considered a conjugate acid –base pair?

أي مما يأتي يعتبر زوج حمض قاعدة مرافق؟



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Which of the following is the conjugate acid
of the weak base NH_3 ?

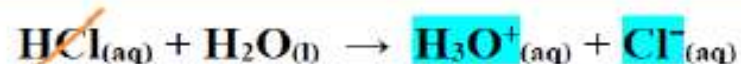
أي مما يلي حمض مرافق للقاعدة الضعيفة NH_3 ؟

- | | | |
|-----------------------|-----------------|----------|
| ☐ | NH_2^+ | A |
| ☐ | NH_3^+ | B |
| ☐ | NH_4 | C |
| ☐ | NH_4^+ | D |

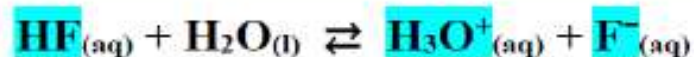


	<u>Monoprotic Acids</u>	<u>Diprotic Acids</u>	<u>Triprotic Acids</u>
<u>Definition</u>	An acid that can donate only one hydrogen ion (H^+)	Acids that contain two ionizable hydrogen atoms (2H^+)	Acids with three hydrogen ions (3H^+)
<u>Examples</u>	HCl HF HClO_4 HNO_3 CH_3COOH	H_2SO_4 H_2CO_3	H_3PO_4 H_3BO_3

When a strong monoprotic acid ionizes, it produces H_3O^+ and the acid's negative ion

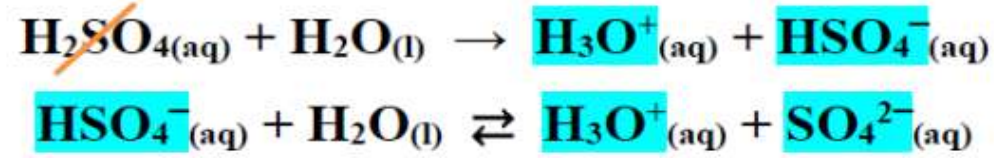


When a weak monoprotic acid is ionizes, it produces H_3O^+ , the negative ion of the acid, and molecules of the weak acid

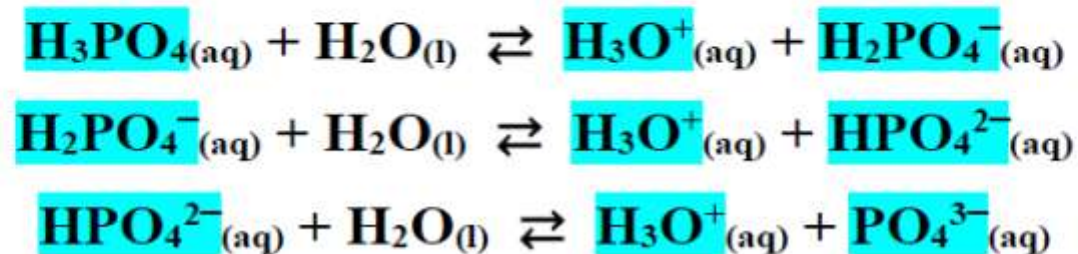


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When a strong diprotic acid ionizes, it produces H_3O^+ and the acid's negative ion



When a weak triprotic acid is ionizes, it produces H_3O^+ , the negative ion of the acid, and molecules of the weak acid



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1) Which of the following acids is a triprotic acid?

- a. CH_3COOH b. $\text{Al}(\text{OH})_3$ c. H_3BO_3 d. HNO_3

2) What is the balanced chemical equation for the ionization of $\text{CH}_3\text{CH}_2\text{COOH}$ propanoic acid in the water?



3) What is the balanced chemical equation for the second ionization of H_2SO_4 in water?



Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

	Which of the following acids is an example of a monoprotic acid?	أي مما يلي يعد مثالا على حمض أحادي البروتون؟
A	Acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$)	حمض الأسيتيك ($\text{HC}_2\text{H}_3\text{O}_2$)
B	Sulfuric acid (H_2SO_4)	حمض الكبريتيك (H_2SO_4)
C	Phosphoric acid (H_3PO_4)	حمض الفوسفوريك (H_3PO_4)
D	Carbonic acid (H_2CO_3)	حمض الكربونيك (H_2CO_3)

	If an acid can donate two ionizable hydrogen ions per molecule, what is it called?	إذا كان الحمض يستطيع منح ذرتي هيدروجين قابلتين للتأين، ماذا يطلق عليه؟
A	Monoprotic acid	حمض أحادي البروتون
B	Diprotic acid	حمض ثنائي البروتون
C	Triprotic acid	حمض ثلاثي البروتون
D	Polyprotic acid	حمض متعدد البروتون

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12

CHM.5.3.04.001.11 Define acids and bases according to Lewis theory

Lewis Acid

Definition

An electron-pair acceptor

An acid is an ion or molecule with a vacant atomic orbital that can accept (share) an electron pair

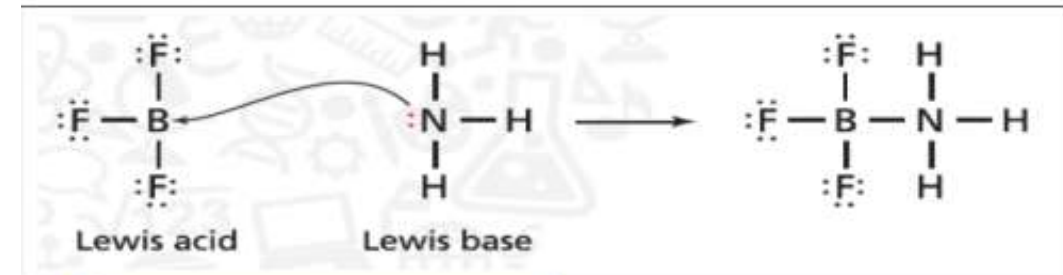
Lewis Base

An electron-pair donor

A base is an ion or molecule with a lone electron pair that it can donate (share)



acceptor donor
electron-pair

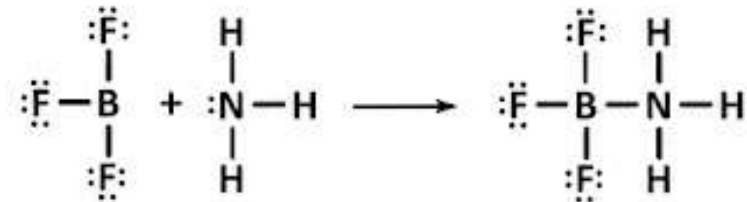


acceptor donor
electron-pair

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In the following reaction. Why BF_3 is considered as Lewis's acid?

في التفاعل التالي، لماذا يُعتبر BF_3 حمض لويس؟



☐ A لأنه يتأين لإنتاج أيونات الهيدروجين في المحلول المائي Because it ionizes to produce hydrogen ions in aqueous solution

☐ B لأنه يتفكك لإنتاج أيونات الهيدروكسيد في المحلول المائي Because it dissociates to produce hydroxide ions in aqueous solution

☐ C لأنه يمنح زوج إلكترونات لجزيء الأمونيا NH_3 molecule Because it donates an electron pair to NH_3 molecule

☐ D لأنه يستقبل زوج إلكترونات من جزيء الأمونيا NH_3 molecule Because it accepts an electron pair from NH_3 molecule



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Which of the following is correct?

	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$
1	2

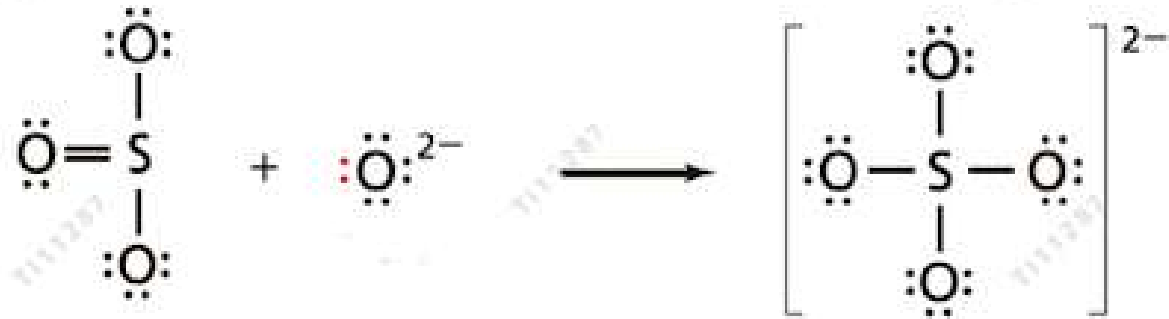
- a. the ammonia NH_3 in reaction 2 is a Brønsted-Lowry acid
- b. the ammonia NH_3 in reaction 2 is an electron pair acceptor
- c. the ammonia NH_3 in reaction 1 is a Lewis base
- d. the ammonia NH_3 in reaction 1 is a Lewis acid



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Why does O^{2-} represent Lewis's base in the following reaction?

لماذا تُعَدُّ O^{2-} قاعدة لويس في التفاعل التالي؟



Because it accepted a proton from SO_3

لأنها استقبلت بروتوناً من SO_3

☐

Because it donated a proton to SO_3

لأنها منحت بروتوناً إلى SO_3

☐

Because it donated a pair of electrons to SO_3

لأنها منحت زوجاً من الإلكترونات إلى SO_3

☐

Because it accepted a pair of electrons from SO_3

لأنها استقبلت زوجاً من الإلكترونات من SO_3

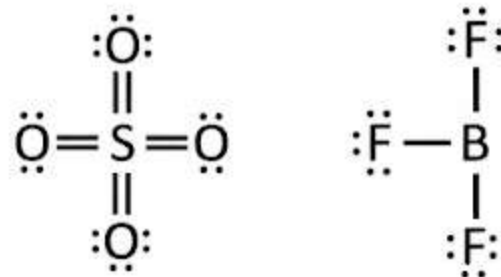
☐

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What is the similarity between the following two formulas?

ما وجه الشبه بين الصيغتين التاليتين؟



Both are Lewis acids

كلاهما أحماض لويس ☐ **A**

Both are Arrhenius acids

كلاهما أحماض أرهينوس ☐ **B**

Both are Arrhenius bases

كلاهما قواعد أرهينوس ☐ **C**

Both are Lewis bases

كلاهما قواعد لويس ☐ **D**



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13 CHM.5.3.04.003.01 Compare between strong and weak acids (using examples, particulate diagrams and ionization equations)

Strong acids	Weak acids
Acids that ionize completely	Acids that ionize only partially
All the molecules in the solution are ionized completely into ions (no molecules are left)	The solution contains molecules and ions
They produce the maximum number of ions	They produce fewer ions
They are good conductors of electricity (bright light)	They are poor conductors of electricity (dim light)
The ionization equation uses a single arrow (completion)	The ionization equation uses a double arrow (equilibrium)

Table 3 Ionization Equations

Strong Acids		Weak Acids	
Name	Ionization Equation	Name	Ionization Equations
Hydrochloric	$\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$	Hydrofluoric	$\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^-$
Hydroiodic	$\text{HI} \rightarrow \text{H}^+ + \text{I}^-$	Acetic	$\text{HC}_2\text{H}_3\text{O}_2 \rightleftharpoons \text{H}^+ + \text{C}_2\text{H}_3\text{O}_2^-$
Perchloric	$\text{HClO}_4 \rightarrow \text{H}^+ + \text{ClO}_4^-$	Hydrosulfuric	$\text{H}_2\text{S} \rightleftharpoons \text{H}^+ + \text{HS}^-$
Nitric	$\text{HNO}_3 \rightarrow \text{H}^+ + \text{NO}_3^-$	Carbonic	$\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$
Sulfuric	$\text{H}_2\text{SO}_4 \rightarrow \text{H}^+ + \text{HSO}_4^-$	Hypochlorous	$\text{HClO} \rightleftharpoons \text{H}^+ + \text{ClO}^-$

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Regarding the figure below, which of the following is correct?

فيما يتعلق بالشكل أدناه، أي مما يأتي صحيح؟



The light is dim in **1** because CH_3COOH is a strong acid

يكون ضوء المصباح باهًا في **1** لأن حمض CH_3COOH قوي

☐

The light glows brightly in **2** because HCl ionizes only partially

يتوهج المصباح توهجًا ساطعًا في **2** لأن حمض HCl يتأين جزئيًا فقط

☐

The light glows brightly in **2** because HCl is a strong acid

يتوهج المصباح توهجًا ساطعًا في **2** لأن حمض HCl قوي

☐

The light is dim in **1** because CH_3COOH ionizes completely

يكون ضوء المصباح باهًا في **1** لأن حمض CH_3COOH يتأين تمامًا

☐

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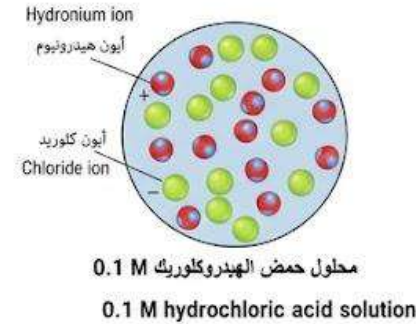
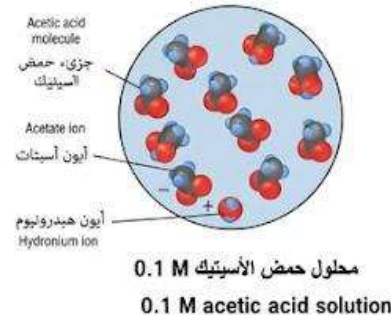


Why is the glow of lights (1 and 2) different in the picture below?	لماذا يختلف توهج المصباحين (1 و 2) في الصورة أدناه؟
2  1 	
A. Because light 1 contains a solution that produces a large number of ions	A. لأن المصباح 1 يحوي محلول ينتج عدد كبير من الأيونات
B. Because lamp 2 contains a solution of lower concentration	B. لأن المصباح 2 يحوي محلول له التركيز الأقل
C. Because light 1 contains a solution that does not produce ions	C. لأن المصباح 1 يحوي محلول لا ينتج أيونات
D. Because light 2 contains a solution that produces a large number of ions	D. لأن المصباح 2 يحوي محلول يُنتج عدد كبير من الأيونات

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What is the difference between the two figures below?

ما وجه الاختلاف بين الشكلين أدناه؟



HCl acid solution is weak conductors of electricity while the $\text{HC}_2\text{H}_3\text{O}_2$ acid solution is good conductors of electricity

محلول حمض HCl من الموصلات الضعيفة للكهرباء بينما محلول حمض $\text{HC}_2\text{H}_3\text{O}_2$ من الموصلات الجيدة للكهرباء

The HCl acid molecules contained in the solution are ionized partially while the $\text{HC}_2\text{H}_3\text{O}_2$ acid molecules contained in the solution are ionized completely

تتأين جزيئات حمض HCl التي يحتويها المحلول جزئياً بينما تتأين جزيئات حمض $\text{HC}_2\text{H}_3\text{O}_2$ التي يحتويها المحلول تماماً

HCl acid solution produces a maximum number of ions while $\text{HC}_2\text{H}_3\text{O}_2$ acid solution produces fewer ions

ينتج محلول حمض HCl أقصى عدد من الأيونات بينما ينتج محلول حمض $\text{HC}_2\text{H}_3\text{O}_2$ أيونات أقل

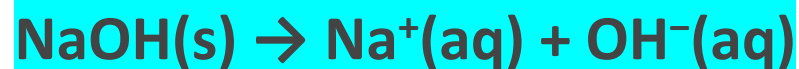
HCl acid solution produces fewer ions while $\text{HC}_2\text{H}_3\text{O}_2$ acid solution produces a maximum number of ions

ينتج محلول حمض HCl أيونات أقل بينما ينتج محلول حمض $\text{HC}_2\text{H}_3\text{O}_2$ أقصى عدد من الأيونات

✓ Strengths of bases :

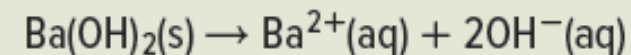
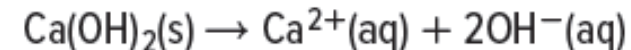
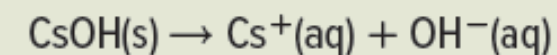
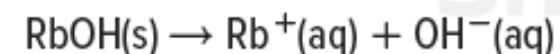
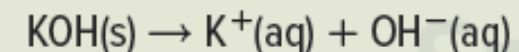
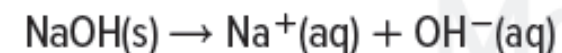
Strong bases

- ✓ are the bases that dissociate completely in an aqueous solution
- ✓ are strong electrolytes
- ✓ dissociate completely into ions when dissolved in water



Aqueous solutions of strong bases are therefore good conductors of electricity.

Table 5 Dissociation Equations for Strong Bases



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Which of the following is **true** about strong base?

أي مما يلي **صحيح** فيما يتعلق بالقاعدة القوية؟

Produces greater H^+ ions in solution

☐ تُنتج كميات كبيرة من أيونات H^+ في المحلول

It is tastes sour

☐ مذاقها حمضي

Produces fewer OH^- ions in solution

☐ تُنتج كميات قليلة من أيونات OH^- في المحلول

It dissociates completely

☒ تتفكك بشكل تام

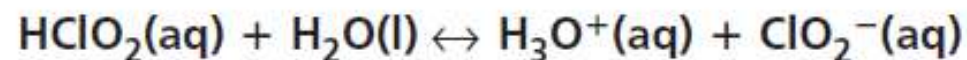
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14 CHM.5.3.04.006.01 Define acid ionization constant, K_a , while writing the ionization constant expression for different weak acids

• Acid ionization constants K_a

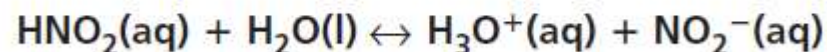
is the value of the equilibrium constant expression for the ionization of a weak acid.

a. HClO_2



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{ClO}_2^-]}{[\text{HClO}_2]}$$

b. HNO_2



$$K_a = \frac{[\text{H}_3\text{O}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$$

The weakest acids have the smallest K_a

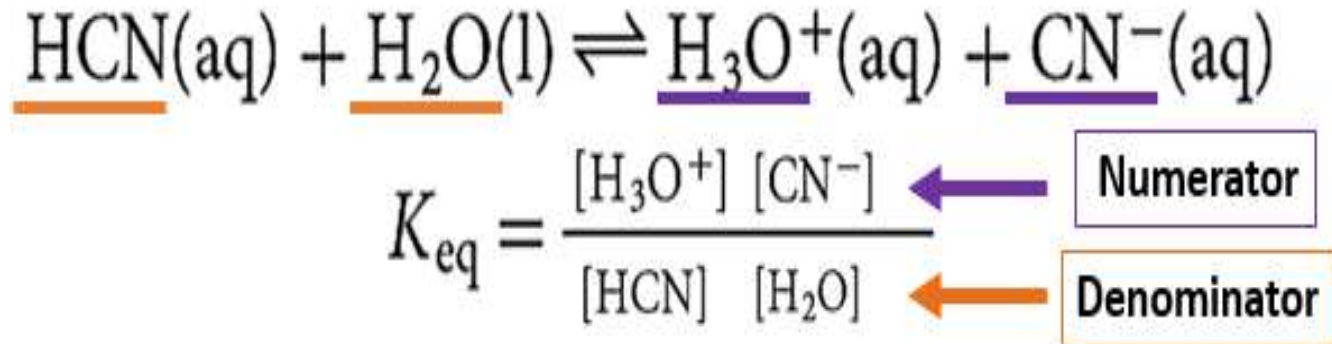
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15

CHM.5.3.04.003.02 Relate the strength of weak acids to the numerical values of K_a

Equilibrium constant, K_{eq} : provides a quantitative measure of the degree of ionization of the acid.

The ionization equation and equilibrium constant expression for hydrocyanic acid are as follows.



The value of K_a is an indication of acid strength.

Stronger acid

→ **higher $[\text{H}_3\text{O}^+]$**

→ **larger K_a**

Weaker acid

→ **lower % dissociation of HA**

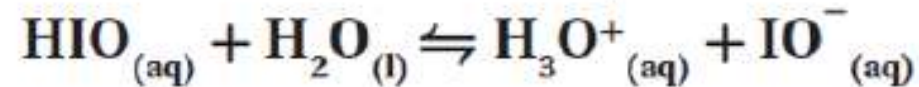
→ **smaller K_a**

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What is the acid ionization constant of the equation shown below?

ما تعبير ثابت تأين الحمض للمعادلة المبينة أدناه؟



$$K_a = \frac{[\text{HIO}][\text{H}_2\text{O}]}{[\text{H}_3\text{O}^+][\text{IO}^-]}$$

$$K_a = \frac{[\text{HIO}]}{[\text{H}_3\text{O}^+][\text{IO}^-]}$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{IO}^-]}{[\text{HIO}][\text{H}_2\text{O}]}$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{IO}^-]}{[\text{HIO}]}$$

yousef saryrah

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What is the weakest acid among the acids

ما الحمض الأضعف من بين الأحماض في الجدول أدناه؟

In the table below?

K_a (298 K)	acid الحمض
6.3×10^{-4}	HF
6.17×10^{-10}	HCN
1.75×10^{-5}	CH ₃ COOH
1.77×10^{-4}	HCOOH

- ☐ A HF
- ☐ B CH₃COOH
- ☐ C HCN
- ☐ D HCOOH

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What is the correct **descending** order of the acids in the table below according to the concentrations of ions in each solution?

ما الترتيب التنازلي الصحيح للأحماض الواردة في الجدول أدناه وفقاً لتركيز الأيونات في محلول كل منها؟

Acid الحمض	Ionization Constants (K_a) ثوابت التأيين
H_2S	8.9×10^{-8}
HF	6.3×10^{-4}
CH_3COOH	1.8×10^{-5}
H_2CO_3	4.2×10^{-7}

- a. $CH_3COOH \longrightarrow HF \longrightarrow H_2CO_3 \longrightarrow H_2S$
- b. $H_2S \longrightarrow H_2CO_3 \longrightarrow HF \longrightarrow CH_3COOH$
- c. $H_2S \longrightarrow H_2CO_3 \longrightarrow CH_3COOH \longrightarrow HF$
- d. $HF \longrightarrow CH_3COOH \longrightarrow H_2CO_3 \longrightarrow H_2S$

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What is the weakest acid among the acids in the table below?

a. H_2S

b. H_2CO_3

c. HF

d. HCN

acid	K_a
HF	6.3×10^{-4}
H_2S	8.9×10^{-8}
HCN	6.2×10^{-10}
H_2CO_3	4.5×10^{-7}



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Which of the following statements is correct according to the data in the table below?

أي العبارات التالية صحيحة فيما يتعلق بالبيانات الواردة بالجدول أدناه؟

K_a (298 K)	معادلة التأين Ionization equation	الحمض Acid
4.5×10^{-7}	$\text{H}_2\text{CO}_3 \rightleftharpoons \text{H}^+ + \text{HCO}_3^-$	الكربونيك، التأين الأول Carbonic, first ionization
4.7×10^{-11}	$\text{HCO}_3^- \rightleftharpoons \text{H}^+ + \text{CO}_3^{2-}$	الكربونيك، التأين الثاني Carbonic, second ionization

Carbonic acid is a strong acid because it is a polyprotic

حمض الكربونيك حمض قوي لأنه متعدد البروتون

☐ A

The acid in the first ionization is weaker than the acid in the second ionization

الحمض في التأين الأول أضعف من الحمض في التأين الثاني

☐ B

The acid in the second ionization is weaker than the acid in the first ionization

الحمض في التأين الثاني أضعف من الحمض في التأين الأول

☐ C

The concentrations of ions produced by the second ionization are greater than the concentrations of ions produced by the first ionization

تراكيز الأيونات الناتجة من التأين الثاني أكبر من تراكيز الأيونات الناتجة من التأين الأول

☐ D

The strength of a basic solution depends on the concentration of hydroxide ions $[\text{OH}^-]$. As the concentration of hydroxide ions $[\text{OH}^-]$ increases, so does the conductivity of the solution



➤ **Weak base**

- are the bases that dissociate or ionize partially in an aqueous solution.
- are weak electrolytes
- dissociate or ionize partially into ions when dissolved in water

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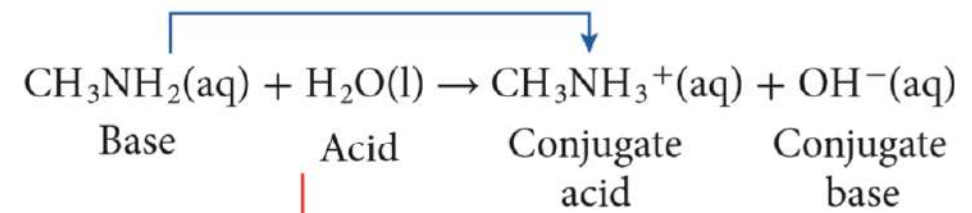


The equilibrium constant (K_b),

provides a **quantitative measure** of the **degree of ionization** of ~~the~~ **base**.

The ionization equation and equilibrium constant expression for methylamine in water are as follows.

- **Base Ionization Constant K_b** : The value of the **equilibrium constant expression** for the **ionization of a weak base**.
- The **smaller** the value of K_b , the **weaker** the **base**.



$$K_b = \frac{[\text{CH}_3\text{NH}_3^+][\text{OH}^-]}{[\text{CH}_3\text{NH}_2]}$$

Numerator
Denominator



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Table 5 Dissociation Equations for Strong Bases

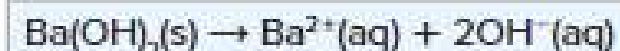
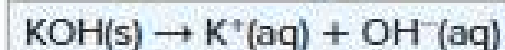


Table 6 Ionization Constants of Weak Bases

Base	Ionization Equation	$K_b(298 \text{ K})$
Ethylamine	$\text{C}_2\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O(l)} \rightleftharpoons \text{C}_2\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	5.0×10^{-4}
Methylamine	$\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O(l)} \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	4.3×10^{-4}
Ammonia	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O(l)} \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$	2.5×10^{-5}
Aniline	$\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O(l)} \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	4.3×10^{-10}

What is the weakest base among the following bases in the table below?

ما القاعدة الاضعف من بين القواعد التالية في الجدول التالي ؟

القاعدة	Base	K_b (298 K)
إيثيل أمين	Ethylamine	5.0×10^{-4}
ميثيل أمين	Methylamine	4.3×10^{-4}
أمونيا	Ammonia	2.5×10^{-5}
أنيلين	Aniline	4.3×10^{-10}

☐ A إيثيل أمين Ethylamine

☐ B ميثيل أمين Methylamine

☐ C أمونيا Ammonia

☐ D أنيلين Aniline

Which of the following is **correct** according to the bases in the table below?

أي مما يأتي **صحيح** فيما يتعلق بالقواعد الواردة في الجدول أدناه؟

K_b (298 K)	Ionization Equation معادلة التأين	Base القاعدة
2.5×10^{-5}	$\text{NH}_3(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{NH}_4^+(\text{aq}) + \text{OH}^-(\text{aq})$	Ammonia الأمونيا
5.0×10^{-4}	$\text{C}_2\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_2\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	Ethylamine إيثيل أمين
4.3×10^{-4}	$\text{CH}_3\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{CH}_3\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	Methylamine الميثيل أمين
4.3×10^{-10}	$\text{C}_6\text{H}_5\text{NH}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{C}_6\text{H}_5\text{NH}_3^+(\text{aq}) + \text{OH}^-(\text{aq})$	Aniline الأنيلين

Ethylamine solution produces the maximum number of ions

يُنتج محلول إيثيل أمين أقصى عدد من الأيونات

Ammonia solution produces the maximum number of ions

يُنتج محلول الأمونيا أقصى عدد من الأيونات

Methylamine solution contains higher concentrations of the un-ionized molecules

يحتوي محلول الميثيل أمين على أعلى تراكيز من الجزيئات غير المؤينة

Aniline solution contains lower concentrations of the un-ionized molecules

يحتوي محلول الأنيلين على أقل تراكيز من الجزيئات غير المؤينة

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PRACTICE Problems



ADDITIONAL PRACTICE

14. Write ionization equations and base ionization constant expressions for the following bases.
- | | |
|--|--|
| a. hexylamine ($\text{C}_6\text{H}_{13}\text{NH}_2$) | c. carbonate ion (CO_3^{2-}) |
| b. propylamine ($\text{C}_3\text{H}_7\text{NH}_2$) | d. hydrogen sulfite ion (HSO_3^-) |
15. **CHALLENGE** Write an equation for a base equilibrium in which the base in the forward reaction is PO_4^{3-} and the base in the reverse reaction is OH^- .



Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

16

CHM.5.3.04.003.04 Identify the relationship between the strength of an acid and its conjugate base and the strength of a base and its conjugate acid

In the strong acids:

HX represents a **strong acid**, and its **conjugate base** (X^-) is **weak**. It's 100% ionized

The base H_2O has a much **greater attraction for the H^+ ion** than does the base X^- .

Think of this as the battle of the bases: Which of the two (H_2O or X^-) has a greater attraction for the hydrogen ion?

In the case of all strong acids, water is the stronger base. Therefore, the ionization equilibrium lies almost completely to the **right**.

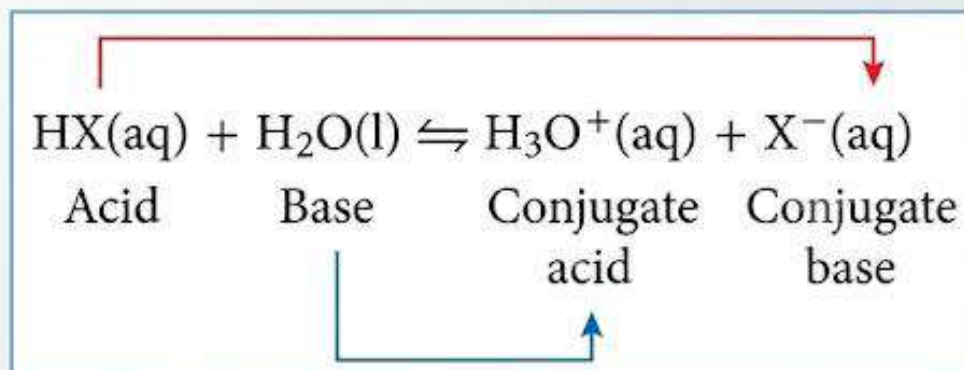
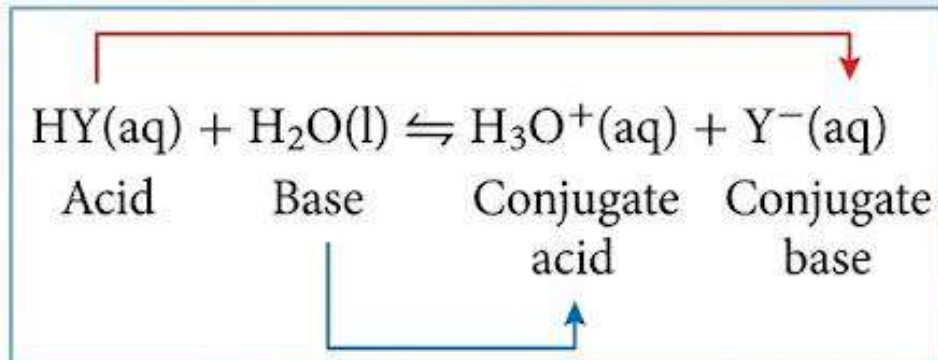
In the weak acids:

HY represents a **weak acid**, and its **conjugate base** (Y^-) is **strong**.

The **conjugate base** Y^- has a **greater attraction** for the H^+ ion than does the base H_2O .

It captures the H^+ and does the reverse reaction.

The ionization equilibrium lies far to the **left**.





Regarding the two reactions (1) , (2) in the table below. Which of the following is **correct**?

فيما يتعلق بالتفاعلين (1) و (2) في الجدول أدناه، أي مما يأتي **صحيح**؟

التفاعل (2) Reaction (2)	التفاعل (1) Reaction (1)
$\text{HY(aq)} + \text{H}_2\text{O(l)} \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{Y}^-(\text{aq})$	$\text{HX(aq)} + \text{H}_2\text{O(l)} \rightarrow \text{H}_3\text{O}^+(\text{aq}) + \text{X}^-(\text{aq})$

In reaction (1) the ionization equilibrium lies almost completely to the right because the base H_2O has a smaller attraction for the H^+ ion than does the base X^-

في التفاعل (1) يتجه اتزان التأين كله تقريباً إلى اليمين لأن القاعدة H_2O تمتلك جذباً أقل بكثير بالنسبة لأيون H^+ مما تمتلكه القاعدة X^-

In reaction (1) the ionization equilibrium lies almost completely to the left because the base H_2O has a much greater attraction for the H^+ ion than does the base X^-

في التفاعل (1) يتجه اتزان التأين كله تقريباً إلى اليسار لأن القاعدة H_2O تمتلك جذباً أكبر بكثير بالنسبة لأيون H^+ مما تمتلكه القاعدة X^-

In reaction (2) the ionization equilibrium lies almost completely to the left because the conjugate base Y^- has a much greater attraction for the H^+ ion than does the base H_2O

في التفاعل (2) يتجه اتزان التأين بعيداً إلى اليسار لأن القاعدة المرافقة Y^- تمتلك جذباً لأيون H^+ أكبر من القاعدة H_2O

In reaction (2) the ionization equilibrium lies almost completely to the right because the conjugate base Y^- has a smaller attraction for the H^+ ion than does the base H_2O

في التفاعل (2) يتجه اتزان التأين بعيداً إلى اليمين لأن القاعدة المرافقة Y^- تمتلك جذباً لأيون H^+ أقل من القاعدة H_2O

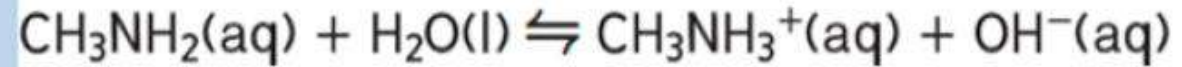


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Which of the following statements is **correct** about the reaction shown below?

أي العبارات التالية **صحيحة** بالنسبة للتفاعل أدناه؟

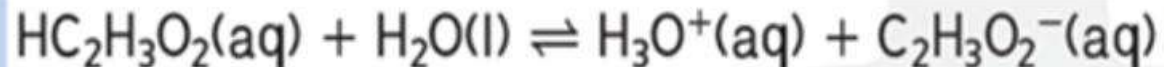


- A. CH_3NH_2 is weak and the conjugate base OH^- is strong
 B. CH_3NH_2 is strong and the conjugate base OH^- is weak
 C. H_2O has lowest attraction for H^+ ion than CH_3NH_2
 D. The equilibrium lies far to the right

- A. القاعدة CH_3NH_2 ضعيفة والقاعدة المرافقة OH^- قوية
 B. القاعدة CH_3NH_2 قوية والقاعدة المرافقة OH^- ضعيفة
 C. أيون OH^- يمتلك جذباً لأيون H^+ أقل مما يمتلكه جزيء CH_3NH_2
 D. يتجه الاتزان بعيداً إلى اليمين

Which of the following statements is **correct** about the reaction shown below?

أي العبارات التالية **صحيحة** بالنسبة للتفاعل أدناه؟



- A. The acid $\text{HC}_2\text{H}_3\text{O}_2$ is strong and the conjugate base $\text{C}_2\text{H}_3\text{O}_2^-$ is weak
 B. The base $\text{C}_2\text{H}_3\text{O}_2^-$ is weak than H_2O base
 C. The conjugate base $\text{C}_2\text{H}_3\text{O}_2^-$ has greater attraction for H^+ ion than does the base H_2O
 D. The equilibrium lies far to the right

- A. $\text{HC}_2\text{H}_3\text{O}_2$ حمض قوي و القاعدة المرافقة $\text{C}_2\text{H}_3\text{O}_2^-$ ضعيفة
 B. القاعدة $\text{C}_2\text{H}_3\text{O}_2^-$ أضعف من القاعدة H_2O
 C. القاعدة المرافقة $\text{C}_2\text{H}_3\text{O}_2^-$ تمتلك جذباً لأيون H^+ أقوى مما تمتلكه القاعدة H_2O
 D. يتجه الاتزان بعيداً إلى اليمين

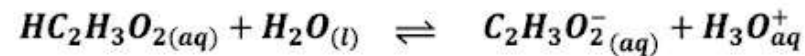
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يتعرف العلاقة بين قوة الحمض وقاعدته المرافقة وقوة القاعدة وحمضها المرافق

Which of the following is **true** according to the following reaction?

أي مما يلي **صحيح** فيما يتعلق بالتفاعل التالي؟



H₂O base has a greater attraction for the H⁺ ion than does the base C₂H₃O₂⁻

تمتلك القاعدة H₂O جذبًا للأيون H⁺ أكبر من القاعدة C₂H₃O₂⁻

☐ A

Conjugate base C₂H₃O₂⁻ is weaker than H₂O base

القاعدة المرافقة C₂H₃O₂⁻ أضعف من القاعدة H₂O

☐ B

The ionization equilibrium lies far to the left

يتجه اتزان التأين إلى اليسار

☐ C

The ionization equilibrium lies far to the right

يتجه اتزان التأين إلى اليمين

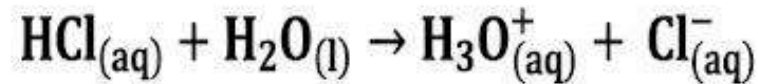
☐ D

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Which of the following is **NOT** true according to the following reaction?

أي مما يلي **غير** صحيح فيما يتعلق بالتفاعل التالي؟



Conjugate base Cl^- is weaker than H_2O base

القاعدة المرافقة Cl^- أضعف من القاعدة H_2O



A

The ionization equilibrium lies far to the right

يتجه اتزان التأين إلى اليمين



B

The ionization equilibrium lies far to the left

يتجه اتزان التأين إلى اليسار



C

H_2O base has a greater attraction for the H^+ ion than does the base Cl^-

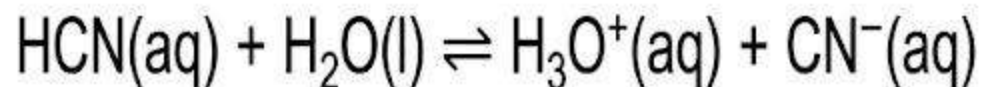
تمتلك القاعدة H_2O جذباً للأيون H^+ أكبر من القاعدة Cl^-



D

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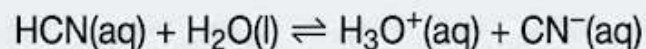
If the ionization equilibrium of the acid in the equation below lies far to **left**, then...



- ☑ the conjugate base CN^- is stronger than the base H_2O .
- ☑ H_3O^+ is a weak conjugate acid.
- ☑ the conjugate base CN^- is weaker than the base H_2O .
- ☑ HCN is a strong acid.

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Which of the following statements is correct according to the following ionization equation?



أي العبارات التالية صحيحة فيما يتعلق بمعادلة التأيين التالية؟

The equilibrium lies far to the right because the conjugate base CN^- has a greater attraction for the H^+ ion than does the base H_2O

يتجه الاتزان بعداً إلى اليمين لأن القاعدة المرافقة CN^- تمتلك جذباً للأيون H^+ أكبر من القاعدة H_2O

The equilibrium lies far to the left because the conjugate base CN^- has a greater attraction for the H^+ ion than does the base H_2O

يتجه الاتزان بعداً إلى اليسار لأن القاعدة المرافقة CN^- تمتلك جذباً للأيون H^+ أكبر من القاعدة H_2O

The equilibrium lies far to the right because the conjugate base CN^- has less attraction for the H^+ ion than does the base H_2O

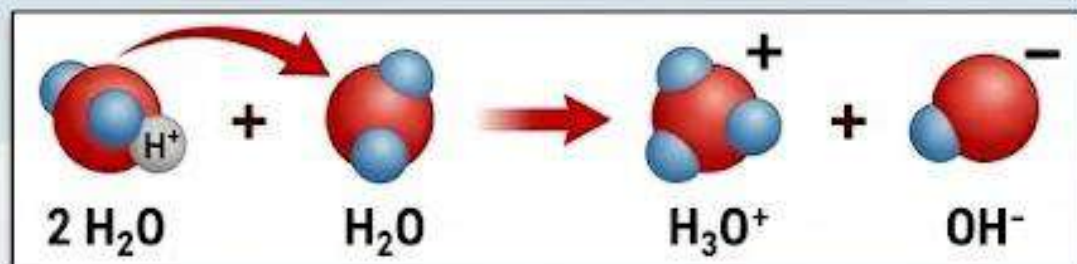
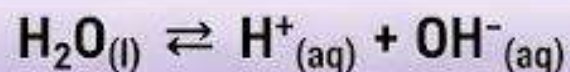
يتجه الاتزان بعداً إلى اليمين لأن القاعدة المرافقة CN^- تمتلك جذباً للأيون H^+ أقل من القاعدة H_2O

The equilibrium lies far to the left because the conjugate base CN^- has less attraction for the H^+ ion than does the base H_2O

يتجه الاتزان بعداً إلى اليسار لأن القاعدة المرافقة CN^- تمتلك جذباً للأيون H^+ أقل من القاعدة H_2O

1. Self-Ionization of Water: The Balanced Nature of Pure Water

Pure water contains equal concentrations of H^+ and OH^- ions.



In the self-ionization of water, one molecule of water acts as an **acid** (proton donor), and the other acts as a **base** (proton acceptor).

2. The Water Ionization Constant (K_w): A Constant Value

K_w is a special equilibrium constant for water's self-ionization.

Definition 1: An expression for the equilibrium constant for the self-ionization of water.

or

Definition 2: The product of the hydrogen ion and hydroxide ion concentrations in dilute aqueous solutions.

Formula and Value

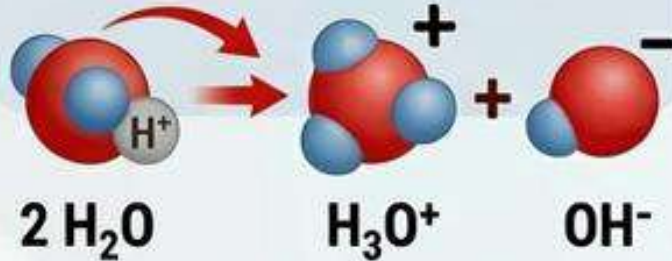
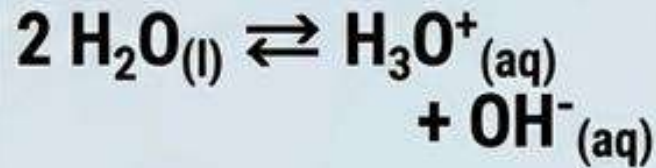
$$K_w = [H^+][OH^-]$$

$$K_w = [H^+][OH^-] = 1 \times 10^{-14} \text{ (at } 25^\circ\text{C)}$$



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SELF-IONIZATION OF WATER



Pure water naturally auto-ionizes into **hydronium** (H_3O^+) and **hydroxide** (OH^-) ions in equal amounts. This process is dynamic equilibrium.



UNDERSTANDING THE K_w CONSTANT

$$K_w = [\text{H}^+][\text{OH}^-]$$

Definition 1: An expression for the equilibrium constant for water's self-ionization.

Definition 2: The product of H^+ and OH^- concentrations in dilute solutions.



Value at 25°C : 1×10^{-14}

In dilute solutions, K_w remains **constant**, even when acids or bases are added.

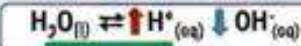
$[\text{H}^+]$ is equivalent to $[\text{H}_3\text{O}^+]$ in concentration calculations.

THE RELATIONSHIP: $[\text{H}^+]$ vs. $[\text{OH}^-]$

ADDING ACID



Seesaw tilts: $[\text{H}^+] \uparrow$ and $[\text{OH}^-] \downarrow$



$[\text{H}^+]$ reacts with OH^- to form water.

$[\text{H}^+]$ becomes $> [\text{OH}^-]$

Range for H^+ is $> 10^{-7} \text{ M}$, e.g., 10^{-2} M

$[\text{H}^+] \times [\text{OH}^-]$ is always constant (K_w)

ADDING BASE



Seesaw tilts: $[\text{OH}^-] \uparrow$ and $[\text{H}^+] \downarrow$
Shift (Basic)



$[\text{OH}^-]$ reacts with H^+ to form water.

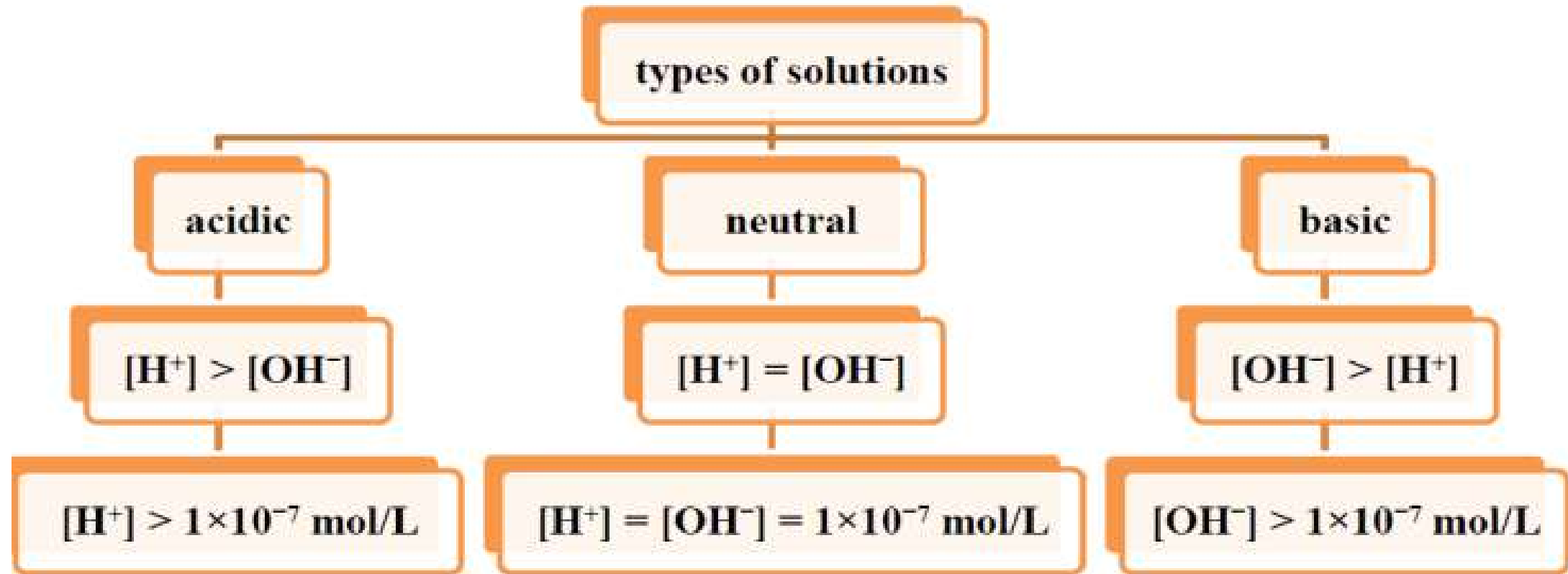
$[\text{OH}^-]$ becomes $> [\text{H}^+]$

Range for OH^- is $> 10^{-7} \text{ M}$, e.g., 10^{-4} M

An increase in one ion *causes* a decrease in the other. This is an **inverse relationship**.

yousef saryrah

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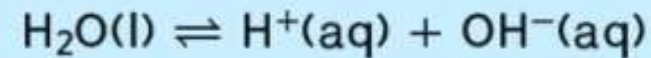
In the self-ionization reaction of water shown below.

في تفاعل التأين الذاتي للماء الموضح أدناه. ماذا يحدث إذا زاد

What happens if the concentration of H^+ ions

تركيز أيونات الهيدروجين H^+ ؟

increases?



The concentration of OH^- ions increases
and K_w value does not change

يزداد تركيز أيونات الهيدروكسيد OH^- وتبقى قيمة K_w دون
تغيير

The concentration of OH^- ions decreases
and K_w value does not change

يقل تركيز أيونات الهيدروكسيد OH^- وتبقى قيمة K_w دون تغيير

The concentration of OH^- ions increases
and K_w value increases

يزداد تركيز أيونات الهيدروكسيد OH^- وتزداد قيمة K_w

The concentration of OH^- ions decreases
and K_w value decreases

يقل تركيز أيونات الهيدروكسيد OH^- وتقل قيمة K_w

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



APPLICATIONS

Page 105

22. The concentration of either the H^+ ion or the OH^- ion is given for four aqueous solutions at 298 K. For each solution, calculate $[\text{H}^+]$ or $[\text{OH}^-]$. State whether the solution is acidic, basic, or neutral.

a. $[\text{H}^+] = 1.0 \times 10^{-13} \text{ M}$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$1.0 \times 10^{-14} = (1.0 \times 10^{-13})[\text{OH}^-]$$

$$\frac{1.0 \times 10^{-14}}{1.0 \times 10^{-13}} = \frac{(1.0 \times 10^{-13})[\text{OH}^-]}{1.0 \times 10^{-13}}$$

$$[\text{OH}^-] = 1.0 \times 10^{-1} \text{ M}$$

$[\text{OH}^-] > [\text{H}^+]$, the solution is basic.

b. $[\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$\frac{1.0 \times 10^{-14}}{1.0 \times 10^{-7}} = \frac{[\text{H}^+](1.0 \times 10^{-7})}{1.0 \times 10^{-7}}$$

$$[\text{H}^+] = 1.0 \times 10^{-7} \text{ M}$$

$[\text{OH}^-] = [\text{H}^+]$, the solution is neutral.

c. $[\text{OH}^-] = 1.0 \times 10^{-3} \text{ M}$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$1.0 \times 10^{-14} = [\text{H}^+](1.0 \times 10^{-3})$$

$$\frac{1.0 \times 10^{-14}}{1.0 \times 10^{-3}} = \frac{[\text{H}^+](1.0 \times 10^{-3})}{1.0 \times 10^{-3}}$$

$$[\text{H}^+] = 1.0 \times 10^{-11} \text{ M}$$

$[\text{OH}^-] > [\text{H}^+]$, the solution is basic.

d. $[\text{H}^+] = 4.0 \times 10^{-5} \text{ M}$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$1.0 \times 10^{-14} = (4.0 \times 10^{-5})[\text{OH}^-]$$

$$\frac{1.0 \times 10^{-14}}{1.0 \times 10^{-5}} = \frac{(4.0 \times 10^{-5})[\text{OH}^-]}{4.0 \times 10^{-5}}$$

$$[\text{OH}^-] = 2.5 \times 10^{-10} \text{ M}$$

$[\text{H}^+] > [\text{OH}^-]$, the solution is acidic.

22. The concentration of either the H^+ ion or the OH^- ion is given for four aqueous solutions at 298 K. For each solution, calculate $[\text{H}^+]$ or $[\text{OH}^-]$. State whether the solution is acidic, basic, or neutral.

a. $[\text{H}^+] = 1.0 \times 10^{-13} \text{ M}$

c. $[\text{OH}^-] = 1.0 \times 10^{-3} \text{ M}$

b. $[\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$

d. $[\text{H}^+] = 4.0 \times 10^{-5} \text{ M}$

23. **Challenge** Calculate the number of H^+ ions and the number of OH^- ions in 300 mL of pure water at 298 K.

23. **Challenge** Calculate the number of H^+ ions and the number of OH^- ions in 300 mL of pure water at 298 K.

At 298 K, $[\text{H}^+] = [\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$

$$\text{Mol } \text{H}^+ = \frac{1.0 \times 10^{-7} \text{ mol}}{1 \text{ L}} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times 300 \text{ mL}$$

$$= 3.0 \times 10^{-8} \text{ mol}$$

$$3.0 \times 10^{-8} \text{ mol } \text{H}^+ \text{ ions} \times \frac{6.02 \times 10^{23} \text{ H}^+ \text{ ions}}{1 \text{ mol } \text{H}^+}$$

$$= 1.8 \times 10^{16} \text{ H}^+ \text{ ions}$$

Number of H^+ = number of OH^-

$$= 1.8 \times 10^{16} \text{ ions}$$

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



	Calculate H^+ or OH^- to compare	acidic-basic-neutral
a. $[H^+] = 1.0 \times 10^{-13} M$		
b. $[OH^-] = 1.0 \times 10^{-7} M$		
c. $[OH^-] = 1.0 \times 10^{-3} M$		
d. $[H^+] = 4.0 \times 10^{-5} M$		

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



What is the value of $[\text{OH}^-]$ of an aqueous solution that have $[\text{H}^+] = 1.0 \times 10^{-3} \text{ M}$ at 298K? ما قيمة $[\text{OH}^-]$ لمحلول مائي يكون فيه $[\text{H}^+] = 1.0 \times 10^{-3} \text{ M}$ عند 298K؟

- | | | |
|---------------------------------|-----------------------|----------|
| $1.0 \times 10^{-11} \text{ M}$ | ☐ | A |
| $1.0 \times 10^{-3} \text{ M}$ | ☐ | B |
| $1.0 \times 10^{-4} \text{ M}$ | ☐ | C |
| $1.0 \times 10^{-14} \text{ M}$ | ☐ | D |

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PRACTICE Problems



ADDITIONAL PRACTICE

25. Calculate the pH and pOH of aqueous solutions with the following concentrations at 298 K.
- $[\text{OH}^-] = 1.0 \times 10^{-6}M$
 - $[\text{OH}^-] = 6.5 \times 10^{-4}M$
 - $[\text{H}^+] = 3.6 \times 10^{-9}M$
 - $[\text{H}^+] = 2.5 \times 10^{-2}M$
26. Calculate the pH and pOH of aqueous solutions with the following concentration at 298 K.
- $[\text{OH}^-] = 0.000033M$
 - $[\text{H}^+] = 0.0095M$
27. **CHALLENGE** Calculate pH and pOH for an aqueous solution containing 1.0×10^{-3} mol of HCl dissolved in 5.0 L of solution.

21	CHM.5.3.04.007.04 Calculate pOH when the $[H^+]$ or $[OH^-]$ is given and vice versa
22	CHM.5.3.04.007.06 Calculate $[H^+]$ and $[OH^-]$ from pH

pH and pOH

pH: the negative logarithm of hydrogen ion concentration.

2

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

pOH: the negative logarithm of hydroxide ion concentration.

3

$$pOH = -\log [OH^-]$$

What is the relationship between pH and pOH?

4

$$pH + pOH = 14$$

298 K

pH, pOH have no units

UNDERSTANDING pOH: SOLUTION GUIDE

Problem 6: Base pOH Calculation

What is the pOH value of the solution that has: $[\text{OH}^-] = 1.0 \times 10^{-6} \text{ M}$, at 298 K?



$$[\text{OH}^-] \rightarrow 1.0 \times 10^{-6} \text{ M}$$

$$\text{pOH} = -\log(1.0 \times 10^{-6})$$

$$= -(-6)$$

$$\text{pOH} = 6$$

$$\text{pOH} = -\log[\text{OH}^-]$$

Problem 7: Calculator pOH

What is the pOH value of the solution that has: $[\text{OH}^-] = 6.5 \times 10^{-4} \text{ M}$, at 298 K?



$$\text{pOH} = -\log(6.5 \times 10^{-4})$$

$$\log(6.5 \times 10^{-4}) \rightarrow -3.187...$$

$$\text{pOH} = 3.19 \text{ (rounded for sig figs)} \rightarrow 3.18$$

Problem 8: From H^+ to pOH

What is the pOH value of the solution that has: $[\text{H}^+] = 2.5 \times 10^{-2} \text{ M}$, at 298 K?

$$[\text{H}^+] \xrightarrow{-\log} \text{pH} = -\log(2.5 \times 10^{-2}) = 1.6$$

$$\text{pH} \xrightarrow{14 - \text{pH}} \text{pOH} = 14 - 1.6 = 12.4$$

$$\text{pOH} = 12.4 \text{ (rounded)}$$

Method B: Find $[\text{OH}^-]$, then pOH

$$[\text{H}^+] \xrightarrow{\frac{K_w}{[\text{H}^+]}} [\text{OH}^-] = (1.0 \times 10^{-14}) / (2.5 \times 10^{-2}) = 4.0 \times 10^{-13} \text{ M}$$

$$[\text{OH}^-] \xrightarrow{-\log} \text{pOH} = -\log(4.0 \times 10^{-13}) = 12.39...$$

$$\text{pOH} = 12.4 \text{ (rounded)}$$

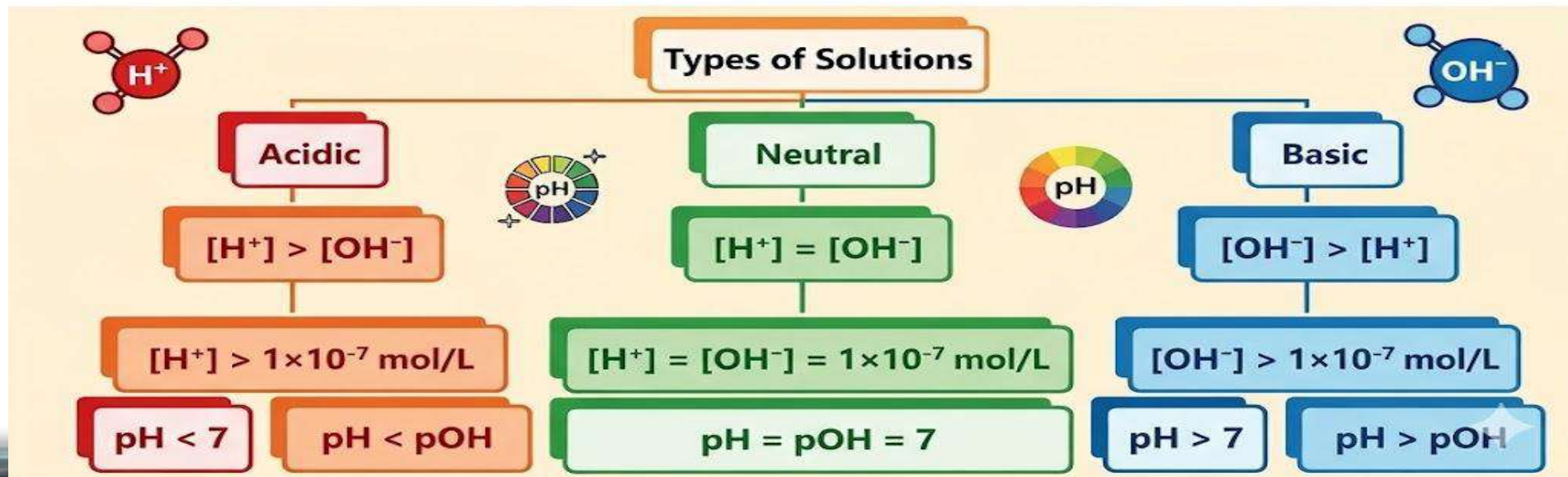
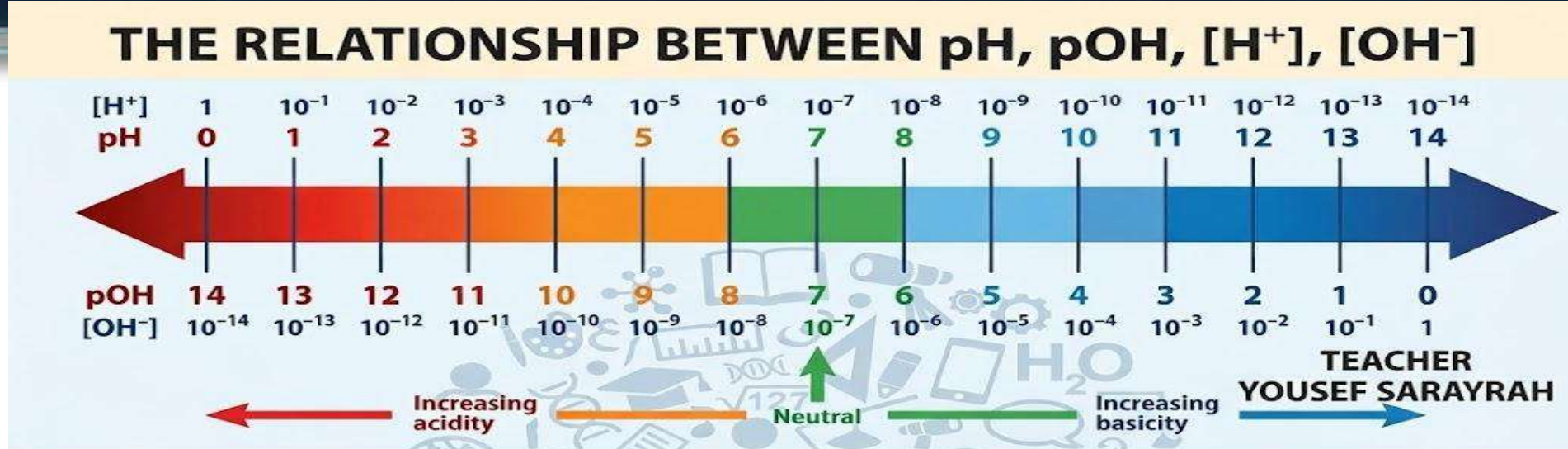
$$\text{pOH} = -\log[\text{OH}^-]$$

$$\text{pH} = -\log[\text{H}^+]$$

$$\text{pH} + \text{pOH} = 14.00 \text{ (at 298 K)}$$

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$$

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24. Calculate the pH of solutions having the following ion concentrations at 298 K. $= -\log[H^+]$

a. $[H^+] = 1.0 \times 10^{-2}M$ b. $[H^+] = 3.0 \times 10^{-6}M$

25. Calculate the pH of aqueous solutions with the following $[H^+]$ at 298 K.

a. $[H^+] = 0.0055M$ b. $[H^+] = 0.000084M$

26. **Challenge** Calculate the pH of a solution having

$[OH^-] = 8.2 \times 10^{-6}M$.

(1)
 $pOH = -\log[OH^-] = -\log(8.2 \times 10^{-6})$
 $= 5.08$

$pH + pOH = 14$

$pH = 14 - pOH = 14 - 5.08$

$pH = 8.9$

(2)
 $[H^+][OH^-] = 1 \times 10^{-14}$

$[H^+] = \frac{1 \times 10^{-14}}{[OH^-]} = \frac{1 \times 10^{-14}}{8.2 \times 10^{-6}}$
 $= 1.22 \times 10^{-9}M$

$pH = -\log[H^+] = -\log(1.22 \times 10^{-9})$
 $= 8.9$

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EXAMPLE 3

CALCULATE pOH AND pH FROM $[\text{OH}^-]$ In Figure 16, a cow is being fed straw and hay that has been treated with ammonia. The addition of ammonia to animal feed promotes protein growth in the animal. Another use of ammonia is as a household cleaner, which is an aqueous solution of ammonia gas. A typical cleaner has a hydroxide-ion concentration of $4.0 \times 10^{-3}\text{M}$. Calculate the pOH and pH of a cleaner at 298 K.

Known

$$[\text{OH}^-] = 4.0 \times 10^{-3}\text{M}$$

Unknown

$$\text{pOH} = ?$$

$$\text{pH} = ?$$

2 SOLVE FOR THE UNKNOWN

$$\text{pOH} = -\log [\text{OH}^-]$$

$$\text{pOH} = -\log (4.0 \times 10^{-3})$$

State the equation for pOH.

$$\text{Substitute } [\text{OH}^-] = 4.0 \times 10^{-3}\text{M}.$$

The **pOH** of the solution is **2.40**.

Use the relationship between pH and pOH to find the pH.

$$\text{pH} + \text{pOH} = 14.00$$

$$\text{pH} = 14.00 - \text{pOH}$$

State the equation that relates pH and pOH.

Solve for pH.

$$\text{pH} = 14.00 - 2.40 = 11.60$$

$$\text{Substitute pOH} = 2.40.$$

The **pH** of the solution is **11.60**.



EXAMPLE 4

CALCULATE $[H^+]$ AND $[OH^-]$ FROM pH What are $[H^+]$ and $[OH^-]$ in a healthy person's blood that has a pH of 7.40? Assume that the temperature of the blood is 298 K.

$$[H^+] = 4.0 \times 10^{-8}M$$

A calculator shows that the antilog of -7.40 is 4.0×10^{-8} .

The concentration of H^+ ions in the blood is $4.0 \times 10^{-8}M$.

Determine $[OH^-]$.

$$pH + pOH = 14.00$$

State the equation that relates pH and pOH.

$$pOH = 14.00 - pH$$

Solve for pOH.

$$pOH = 14.00 - 7.40 = 6.60$$

Substitute $pH = 7.40$.

$$pOH = -\log [OH^-]$$

State the equation for pOH.

$$-pOH = \log [OH^-]$$

Multiply both sides of the equation by -1 .

$$[OH^-] = \text{antilog} (-6.60)$$

Take the antilog of each side and substitute $pOH = 6.60$.

$$[OH^-] = 2.5 \times 10^{-7}M.$$

A calculator shows that the antilog of -6.60 is 2.5×10^{-7} .

The concentration of OH^- ions in the blood is $2.5 \times 10^{-7}M$.

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CALCULATION OF $[H^+]$ AND $[OH^-]$ FROM pH AND pOH

5



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

6



$$[OH^-] = 10^{-pOH}$$

What is the value of $[H^+]$ for milk with $pH = 6.5$?

- a. $1 \times 10^{-8} \text{ M}$ ☐
- b. $1 \times 10^{-7} \text{ M}$ ☐
- c. $3.16 \times 10^{-8} \text{ M}$ ☐
- d. $3.16 \times 10^{-7} \text{ M}$ ☐

What is the value of $[H^+]$ for lemon juice with $pOH = 11.6$?

- a. $2.51 \times 10^{-12} \text{ M}$ ☐
- b. $3.98 \times 10^{-3} \text{ M}$ ☐
- c. $2.51 \times 10^{-3} \text{ M}$ ☐
- d. $3.98 \times 10^{-12} \text{ M}$ ☐

At 25°C (298 K)



Yousef sarayrah

yousef saryrah

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By TEACHER YOUSEF SARAYRAH

Which of the following substances has the highest pOH value?

أي المواد التالية لها أعلى قيمة في pOH؟

Solution A	محلول A	Solution C	محلول C	Solution B	محلول B	Solution D	محلول D
$[\text{OH}^-] = 0.000033\text{M}$		$\text{pH} = 10.50$		$[\text{H}^+] = 0.0095\text{ M}$		$[\text{OH}^-] = 0.000033\text{M}$	

A. Solution A | محلول A ☐ A

B. Solution B | محلول B ☐ B

C. Solution C | محلول C ☐ C

D. Solution D | محلول D ☐ D

Link between acidity and alkalinity of aqueous solutions and the concentration of hydrogen and hydroxide ions at 25°C or 298 K

يُربط بين حمضية وقاعدية المحاليل المائية وتركيز أيونات الهيدروجين والهيدروكسيد عند 25°C أو 298 K

Which of the following substances has the **highest** $[\text{OH}^-]$?

أي المواد التالية لها أعلى قيمة لـ $[\text{OH}^-]$ ؟

محلول D Solution D	محلول C Solution C	محلول B Solution B	محلول A Solution A
$[\text{H}^+] = 2.5 \times 10^{-2}\text{M}$	$[\text{OH}^-] = 4.0 \times 10^{-3}\text{M}$	pH = 7.40	pOH = 5.60

YUSEF SARYRAH

Solution A

A محلول

☐

A

Solution B

B محلول

☐

B

Solution C

C محلول

☐

C

Solution D

D محلول

☐

D

Which is the correct arrangement according to the **pOH values** of the solutions (X), (Y), and (Z) which have the following characteristic?

ما الترتيب التصاعدي الصحيح حسب **قيمة pOH** للمحاليل (X) و (Y) و (Z) ذات الخصائص التالية ؟

(X): $\text{pH} = 10.5$

(Y): $[\text{H}^+] = 10^{-12}$

(Z): $[\text{OH}^-] = 10^{-9}$

A. (lowest) (Y) → (X) → (Z) (highest)	A. (الأقل) (Y) ← (X) ← (Z) (الأكثر)
B. (lowest) (X) → (Y) → (Z) (highest)	B. (الأقل) (Z) ← (Y) ← (X) (الأكثر)
C. (lowest) (Z) → (X) → (Y) (highest)	C. (الأقل) (Y) ← (X) ← (Z) (الأكثر)
D. (lowest) (X) → (Z) → (Y) (highest)	D. (الأقل) (Y) ← (Z) ← (X) (الأكثر)

What is the value of $[\text{OH}^-]$ in the Lemon juice at 298 K

ما قيمة $[\text{OH}^-]$ في عصير الليمون عند 298 K

By Teacher Yousef Sarayrah

عصير الليمون Lemon juice
pH = 3

$$1.0 \times 10^{-11} \text{ M}$$

☐ A

$$1.0 \times 10^{-3} \text{ M}$$

☐ B

$$1.0 \times 10^{-4} \text{ M}$$

☐ C

$$1.0 \times 10^{-14} \text{ M}$$

☐ D



PROBLEM 1: MAGNESIA SOLUTION pOH = 3.5

What is the value of $[\text{OH}^-]$ for this solution?

Step 1: $\text{pOH} = -\log[\text{OH}^-] \rightarrow [\text{OH}^-] = 10^{-\text{pOH}}$

Step 2: Substitution $[\text{OH}^-] = 10^{-3.5}$

Step 3: Calculator Value $[\text{OH}^-] \approx 3.16 \times 10^{-4} \text{ M}$



Step 4: Significant Figure Rule

(1 decimal place in pOH means 1 significant figure in concentration)

Step 5: Rounding to the correct choice:

$[\text{OH}^-] \approx 3 \times 10^{-4} \text{ M}$

(c from original is the unrounded calculator value)



PROBLEM 2: AMMONIA SOLUTION pH = 11.9

What is the value of $[\text{OH}^-]$ for this solution?

Step 1: Formula: $\text{pH} + \text{pOH} = 14.00$

Step 2: Find pOH: $\text{pOH} = 14.00 - 11.9 = 2.1$

Step 3: Substitution $[\text{OH}^-] = 10^{-2.1}$

Step 4: Calculator Value $[\text{OH}^-] \approx 7.94 \times 10^{-3} \text{ M}$

Step 5: Significant Figure Rule

(1 decimal place in pH/pOH means 1 significant figure in concentration)

Step 6: Rounding to the correct choice:

$[\text{OH}^-] \approx 8 \times 10^{-3} \text{ M}$

(a from original is the unrounded calculator value)



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23 CHM.5.3.04.006.04 Calculate the acid dissociation constant, K_a , given acid concentration, $[H^+]$ and pH



GUIDED SOLUTION: CALCULATING ACID DISSOCIATION CONSTANT (K_a)



PROBLEM STATEMENT:

What is the value of K_a for a 0.0400 M solution of acid $HClO_2$?

ما قيمة K_a :
ما قيمة K_a لمحلول حمض $HClO_2$ تركيزه 0.0400 M ؟
؟pH=1.80 ؟

FORMULA TO USE

**** $K = \frac{[H^+][S]}{[H_2S]} = 0$**

$$K_a = \frac{(10^{-pH})^2}{M - 10^{-pH}}$$

M = Initial Molar Concentration (0.0400 M)

pH = Solution pH (1.80)

K_a = Acid Dissociation Constant

STEP-BY-STEP CALCULATION

1 Formula Substitution

Substitute Known Values

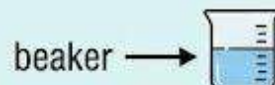
$$K_a = \frac{(10^{-1.80})^2}{0.0400 - 10^{-1.80}}$$



2 Component Calculation

Calculate Parts

Calculate $10^{-1.80}$:
 $[H^+] = 0.0158 \text{ M}$



3 Final Division

Solve for K_a

$$K_a = \frac{(0.0158)^2}{0.0400 - 0.0158}$$

$$K_a = \frac{0.00025}{0.0242}$$

$$K_a = 0.0103...$$

$$K_a = 1.0 \times 10^{-2}$$



MATCHING THE ANSWER:

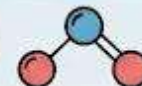
☐ 5.8×10^{-3}

☒ 1.0×10^{-2} ← CORRECT

☐ 2.6×10^{-4}

☐ 4.9×10^{-9}

SUMMARY: Using the formula is direct and accurate when initial concentration is not significantly small compared to $[H^+]$. The value of K_a for $HClO_2$ is approximately 1.0×10^{-2} .



YUSEF SARAYRAH

yousef saryrah

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Calculate the Acid Ionization Constant (K_a)
of Hydrofluoric Acid (HF)



PROBLEM STATEMENT

Given an initial HF concentration of 0.0091 M and a solution pH of 2.68. Find the K_a value.

SOLUTION OVERVIEW

1. Identify Knowns: $[HF]_{\text{initial}} = 0.0091 \text{ M}$, $\text{pH} = 2.68$
2. Convert pH to $[H^+]$: $[H^+] = 10^{-\text{pH}} = 10^{-2.68}$
3. ICE Table (Simplified): $[H^+] \approx [F^-] \approx 0.00209 \text{ M}$.
 $[HF]_{\text{eq}} \approx 0.0091 - 0.00209 = 0.00701 \text{ M}$
4. Apply K_a Expression: $K_a = \frac{[H^+][F^-]}{[HF]_{\text{eq}}}$
5. Final Calculation: $K_a \approx \frac{(0.00209)^2}{0.00701} = 6.22 \times 10^{-4}$

**CORRECT
ANSWER**

MATCHING THE CALCULATION, THE
CORRECT OPTION IS CHOICE -B
(rounded to two significant figures).



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If you are given an acid solution 0.20 M,

إذا أعطيت محلول حمض تركيزه 0.20 M و $pOH = 9.37$

$pOH = 9.37$ **What is this acid formula?**

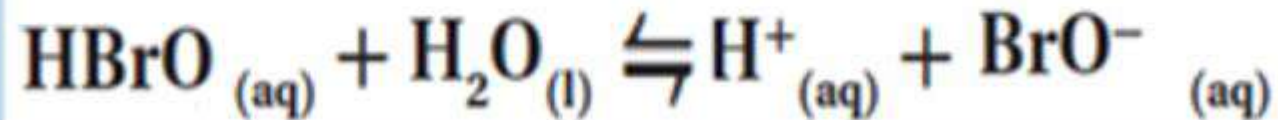
لما صيغة هذا الحمض؟

K_a (298 k)	صيغة الحمض Acid formula
6.3×10^{-4}	HF
6.2×10^{-10}	HCN
1.8×10^{-5}	CH ₃ COOH
2.8×10^{-9}	HBrO

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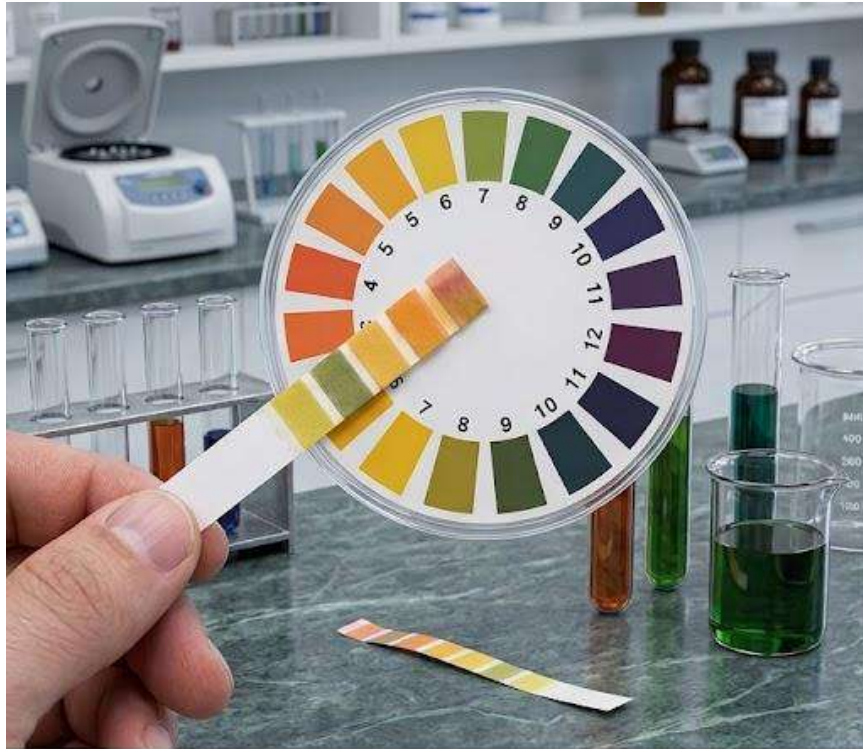
What is the value of K_a of **0.200 M** solution of hypobromous acid HBrO , **pH=4.63**?

ما قيمة K_a لمحلول حمض الهيبوبروموز HBrO تركيزه **0.200 M** و **pH=4.63**؟



- A $K_a = 2.25 \times 10^{-9}$
- B $K_a = 3.60 \times 10^{-9}$
- C $K_a = 2.74 \times 10^{-9}$
- D $K_a = 2.98 \times 10^{-9}$

24 CHM.5.3.04.005.07 List different methods used to measure the pH of a solution



Method a: pH Paper

- Provides an approximate pH measurement
- Relies on wetting a paper strip and visual color
- Compared with standard colors (1-14 scale)
- Subjective color matching required



Method b: Portable pH Meter

- Provides a more accurate pH measurement
- Used for measuring rain water pH in this instance
- Provides a digital display (e.g., 5.18)
- Direct sensor reading

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	Which tool provides a more accurate measurement of pH?	أي أداة توفر قياساً أدق للرقم الهيدروجيني pH؟
A	pH paper	ورق pH
B	Thermometer	ميزان الحرارة (ترمومتر)
C	Portable pH meter	مقياس الرقم الهيدروجيني المحمول
D	Litmus paper	ورق تباع الشمس

	A scientist needs to monitor the pH of rainwater over time. What reasoning supports the use of a portable pH meter instead of pH paper?	يحتاج عالم إلى مراقبة درجة حموضة مياه الأمطار بمرور الوقت. ما هي الأسباب التي تدعم استخدام مقياس الرقم الهيدروجيني المحمول بدلاً من ورق pH؟
A	The portable pH meter is less expensive.	مقياس الرقم الهيدروجيني المحمول أقل تكلفة
B	The portable pH meter provides consistent, accurate, and digital measurements, reducing human error in color comparison.	يوفر مقياس الرقم الهيدروجيني المحمول قياسات رقمية دقيقة ومتسقة، مما يقلل من الخطأ البشري في مقارنة الألوان.
C	The pH paper is more durable.	ورق pH أكثر متانة.
D	The pH paper is easier to use.	ورق pH أسهل في الاستخدام.

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25

CHM.5.3.04.004.01 Define neutralization reaction while writing the neutralization equation (Complete Ionic and net Ionic equations)

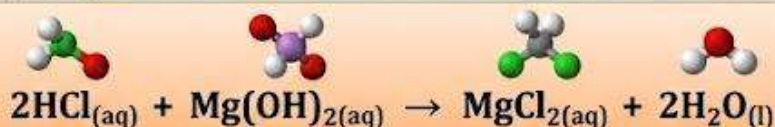
Neutralization reaction: A reaction between an acid and a base in an aqueous solution to produce a salt and water.

The neutralization reaction is a type of **double replacement** reaction. 

Salt: An ionic compound composed of a base cation (positive ion) and an anion (negative ion) of an acid. 

acid + base → salt + water

HX + YOH → XY + H₂O



Antacids relieve indigestion symptoms by neutralizing the acidic solution in the stomach.



A neutralization reaction occurs when **Mg(OH)₂** reacts with a solution of HCl acid.

Equivalence point: the point at which moles of the H⁺ ion of the acid are equal to the moles of the OH⁻ ion of the base.

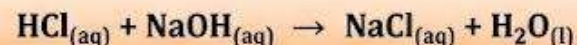
titration solution point	strong acid	weak acid
strong base	neutral (pH = 7)	basic (pH > 7)
weak base	acidic (pH < 7)	no titration



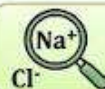
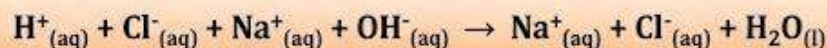
CURATED & DESIGNED BY:
YOUSEF SARAYRAH



Titration: A method of concentrating a solution by reacting a known volume of that solution with a solution of known concentration.



Ionic Existence: These exist as ions in solution:



Spectator Ions Identification: Na⁺ and Cl⁻ are spectator ions.

Net Ionic Equation:



or



To find the **concentration of an acid** solution we titrate the acid solution with a base solution of known concentration.

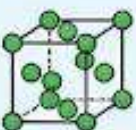
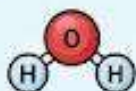
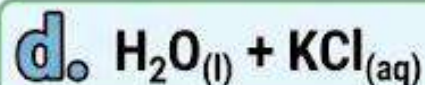
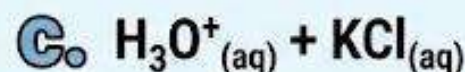
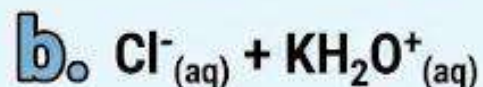
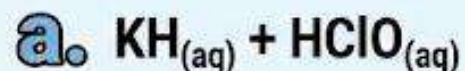
To find the **concentration of the base** solution we titrate the base solution with an acid solution of known concentration.

POSTER BY TEACHER YOUSEF SARAYTAH

1

NEUTRALIZATION PRODUCT IDENTIFICATION

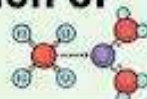
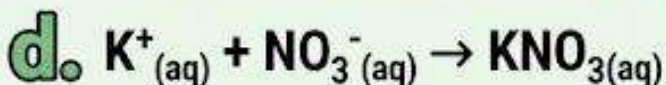
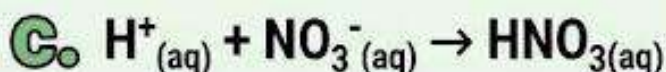
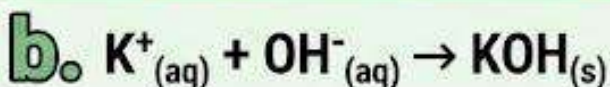
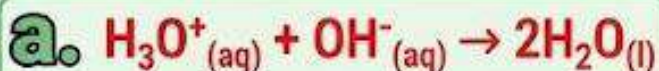
1) What substances are produced in the neutralization reaction of $\text{KOH}_{(\text{aq})}$ and $\text{HCl}_{(\text{aq})}$?



2

NET IONIC EQUATION DERIVATION

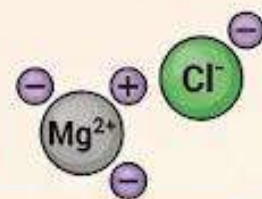
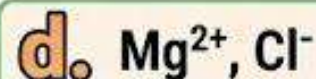
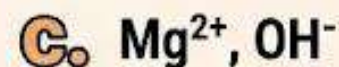
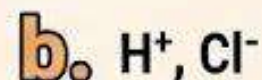
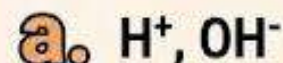
2) What is the net ionic equation for the reaction of HNO_3 with KOH ?



3

SPECTATOR ION ANALYSIS

3) What are the spectator ions produced by neutralizing HCl with $\text{Mg}(\text{OH})_2$?



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26

CHM.5.3.04.004.02 Define titration, and titrant

CHM.5.3.04.004.03 Explain how to carry out an acid–base titration

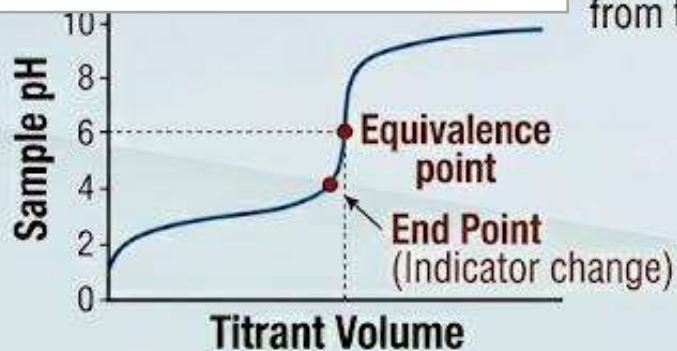
27

CHM.5.3.04.004.04 Explain the difference between the equivalence point and the end point of titration process

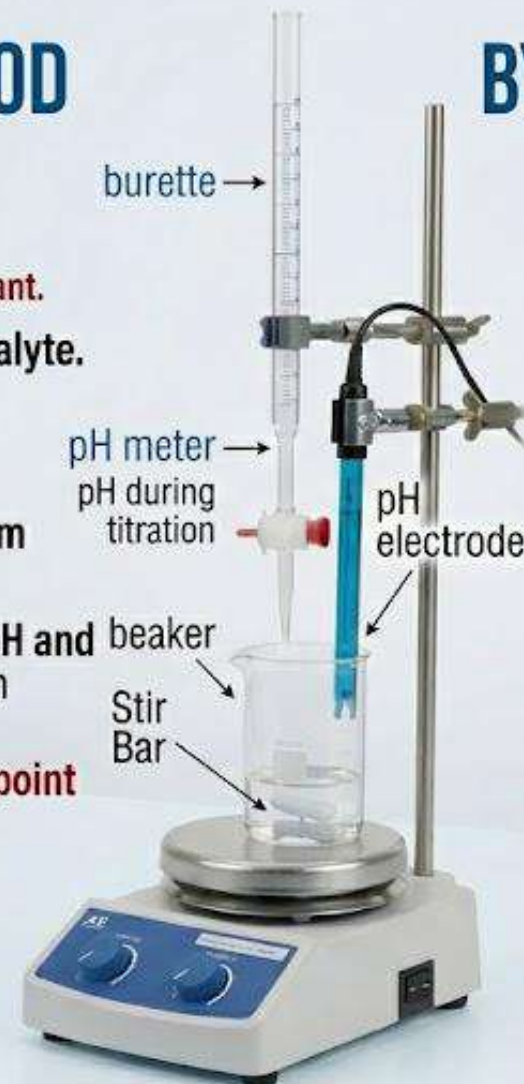


TITRATION APPARATUS & METHOD

An acid-base titration needs **an indicator** which detect the **equivalence point** of titration, and it indicates the end of the neutralization reaction.



- METHOD**
- Set up apparatus. Measure is filled with **titrant**.
 - Measure **Initial pH** Analyte.
 - Calibrate pH meter. Calibrate one pH meter. (potentiometric titration only)
 - Slowly add **Titrant** from Burette. at at addition.
 - Measure and record pH and **Titrant Volume** at each addition.
 - Spot the **equivalence point** from the pH change.



Titrant is a standard solution with **known** concentration.

equivalence point, which is the point at which moles of **H⁺** ion from the **acid** equal moles of **OH⁻** ion from the **base**.

the indicator changes color and this is called the **end point**.

BY: YOUSEF SARAYRAH

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28

CHM.5.3.04.009.02 Describe the titration curve of a weak acid with a strong base with respect to type of salt formed, pH and nature of solution at equivalence point, indicator used and its color change and volume of titrant needed for changing color of indicator

29

CHM.5.3.04.009.02 Describe the titration curve of a weak acid with a strong base with respect to type of salt formed, pH and nature of solution at equivalence point, indicator used and its color change and volume of titrant needed for changing color of indicator



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Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

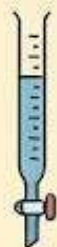


TYPES OF TITRATION CURVES, ACIDS & BASES

TYPES OF ACIDS & BASES

ACIDS

- **STRONG ACIDS**
(e.g., HCl , H_2SO_4 , HNO_3):
Complete dissociation in water.
- **WEAK ACIDS**
(e.g., CH_3COOH , HF):
Partial dissociation.



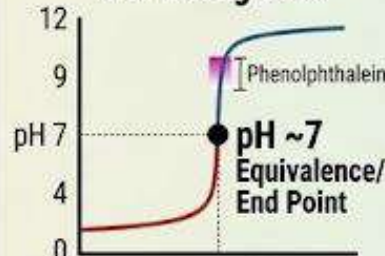
BASES

- **STRONG BASES**
(e.g., NaOH , KOH):
Complete dissociation.
- **WEAK BASES**
(e.g., NH_3 , $\text{N}(\text{CH}_3)_3$):
Partial reaction with water.



TITRATION CURVES & END POINTS

Strong Acid titrated
with Strong Base

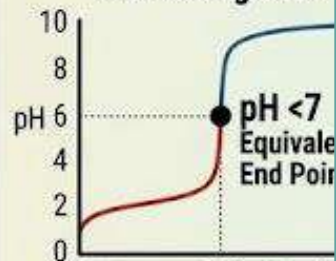


Strong Acid, Base
(e.g., Acid + Strong Base)

Weak Acid titrated
with Strong Base

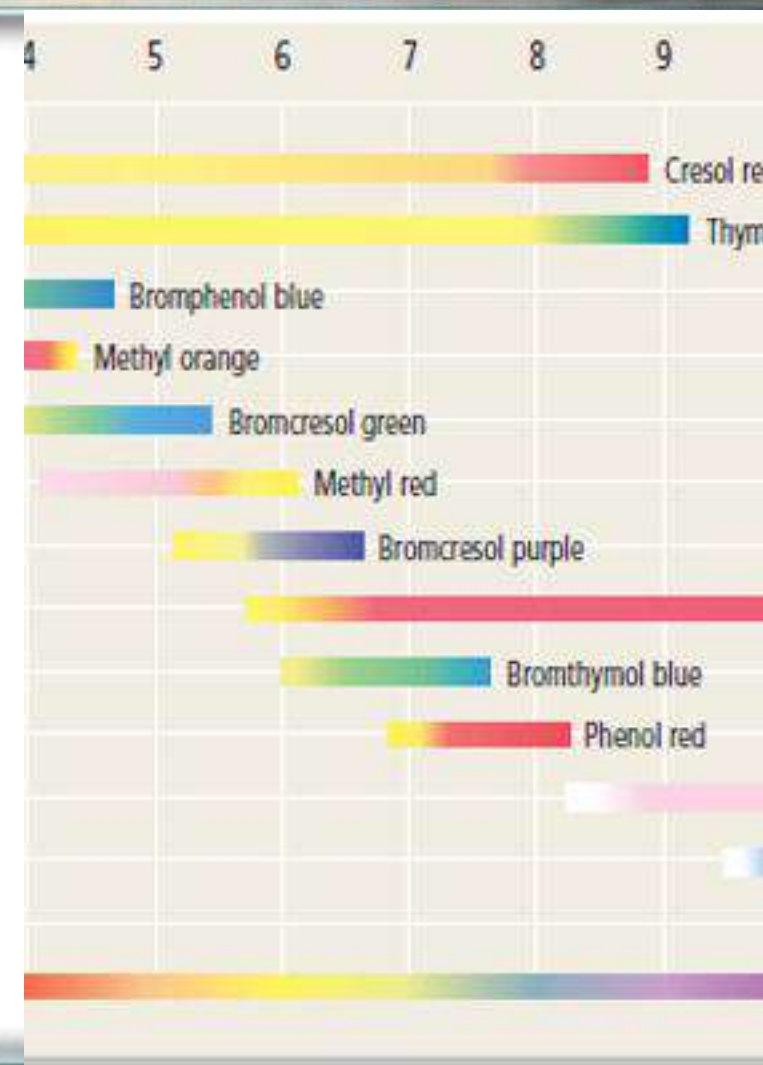


Weak Base + Weak Acid
with Strong Acid

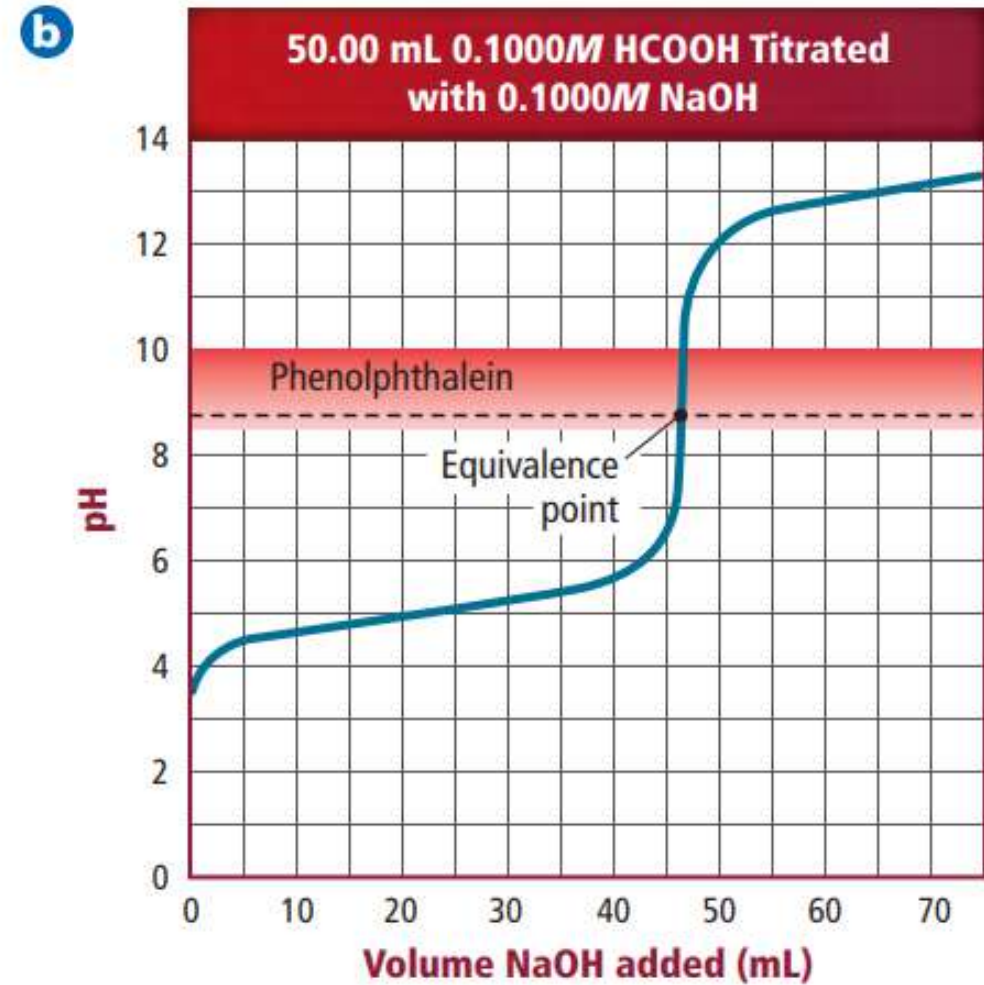
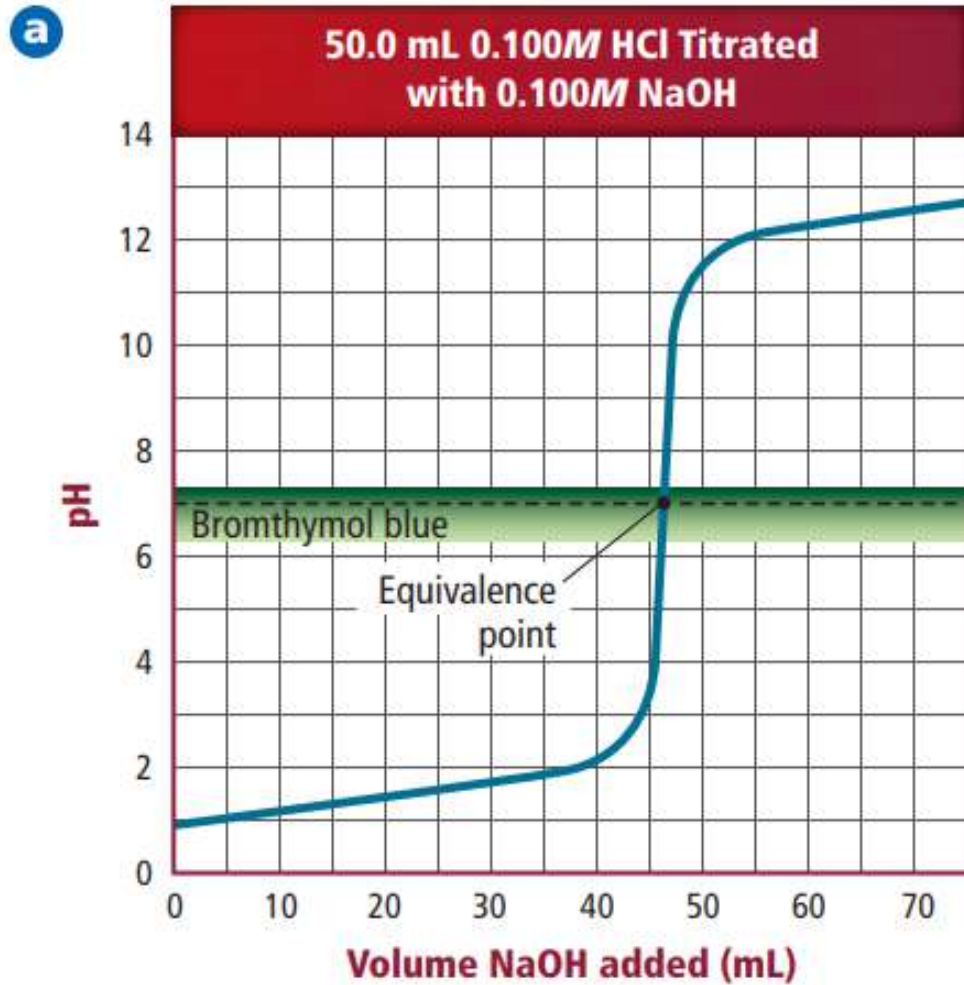


Strong Acid + Weak
Weak Base

(e.g., Methyl Red choice)

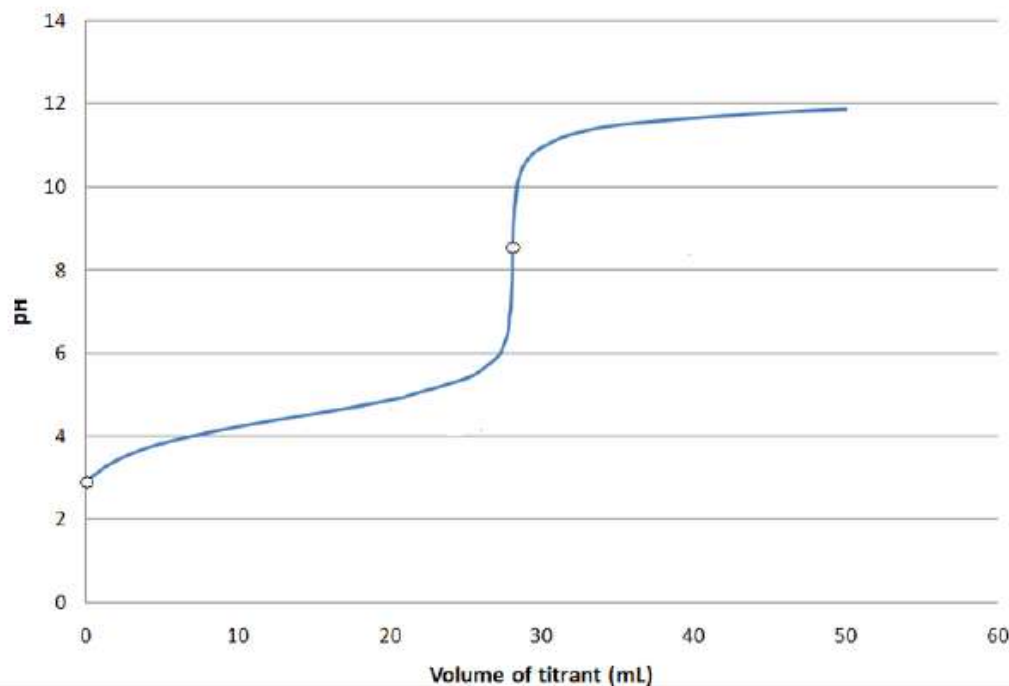


Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



What acid-base indicator would be suitable for the neutralization reaction whose titration curve is shown below?

ما كاشف الحمض -القاعدة المناسب لتفاعل التعادل الذي
منحنى معايرته موضح أدناه؟



A. Phenolphthalein (range 8.2–10)

A. الفينولفثالين (مداه 8.2–10)

B. Methyl red(range 4.2–6.2)

B. أحمر الميثيل (مداه 4.2–6.2)

C. Methyl orange(range 3.2–4.5)

C. الميثيل البرتقالي (مداه 3.2–4.5)

D. Bromcresol purple(range 5.1–6.8)

D. بروموكريزول بنفسجي (مداه 6.8–5.1)

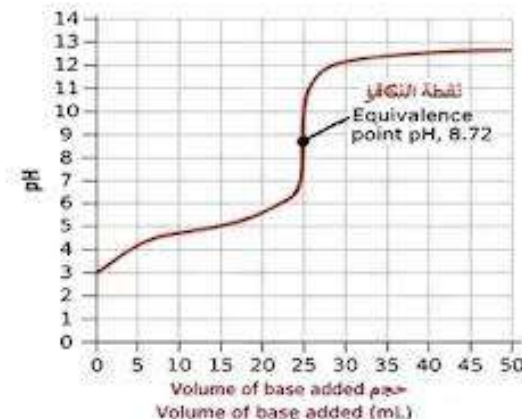
In relation to the titration curve and indicators table below.

Which of the following is **incorrect**?

فيما يتعلق بمنحنى المعايرة وجدول الكواشف أدناه.

أي مما يلي **غير صحيح**؟

الميثيل البرتقالي Methyl orange	الفينولفثالين Phenolphthalein	الكاشف Indicator
3.1-4.2	8.0-10.0	مدى الكاشف Indicator range



The equivalence point is within the methyl orange range

نقطة التكافؤ تقع ضمن مدى كاشف الميثيل البرتقالي



A

Phenolphthalein indicator's color changes at the equivalence point

كاشف الفينولفثالين يتغير لونه عند نقطة التكافؤ



B

The acid is HCOOH , and the base is NaOH

الحمض HCOOH ، والقاعدة NaOH



C

The acid is weak, and the base is strong

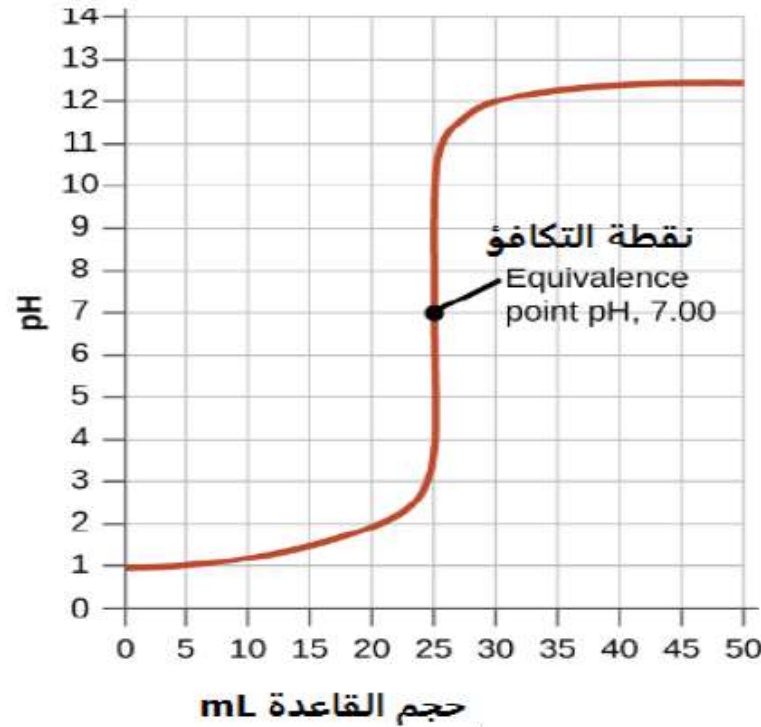
الحمض ضعيف ، والقاعدة قوية



D

What is the type of acid and base in the titration curve shown below?

ما نوع كلاً من الحمض والقاعدة في منحنى المعايرة الموضح أدناه؟



A. Strong acid and strong base

A. حمض قوي وقاعدة قوية

B. Strong acid and weak base

B. حمض قوي وقاعدة ضعيفة

C. Weak acid and strong base

C. حمض ضعيف وقاعدة قوية

D. Weak acid and weak base

D. حمض ضعيف وقاعدة ضعيفة

Coverage-EoT3-G

Which of the following is true regarding the titration curve below?

أي مما يأتي صحيح فيما يتعلق بمنحنى المعايرة أدناه؟

الكاشف	أزرق البروموفينول	الميثيل البرتقالي	أحمر الميثيل	أزرق بروموتيمول
The indicator	Bromophenol blue	Methyl orange	Methyl red	Bromothymol blue
قيم pH التي يتغير عندها لون الكاشف pH values at which the indicator's color changes	3.1 – 4.7	3.2 – 4.6	4.2– 6.2	6.0 –7.6

A

The acid is weak, and the base is weak
and the suitable indicator is Bromophenol blue

الحمض ضعيف والقاعدة ضعيفة والكاشف الملائم هو أزرق البروموفينول

B

The acid is strong, and the base is weak
and the suitable indicator is Methyl red

الحمض قوي والقاعدة ضعيفة والكاشف الملائم هو أحمر الميثيل

C

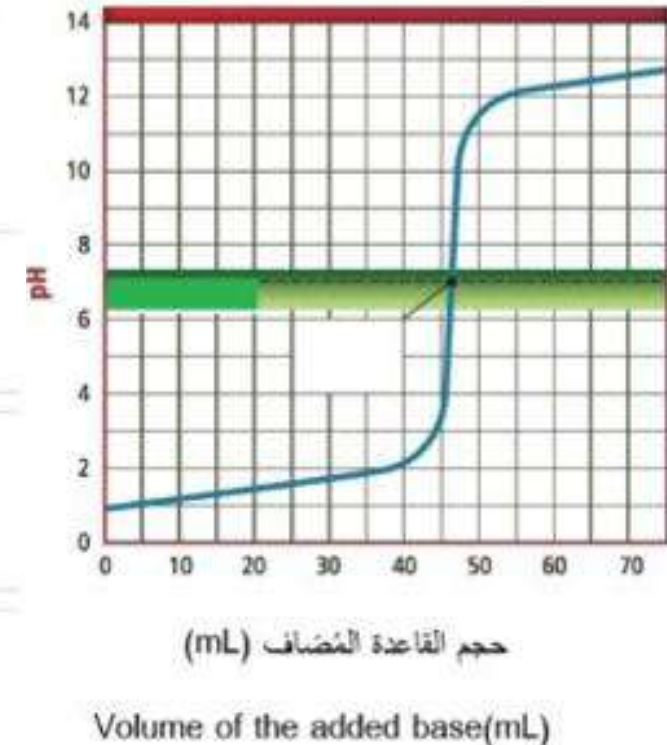
The acid is strong, and the base is strong
and the suitable indicator is Bromothymol blue

الحمض قوي والقاعدة قوية والكاشف الملائم هو أزرق بروموتيمول

D

The acid is weak, and the base is strong
and the suitable indicator is Methyl orange

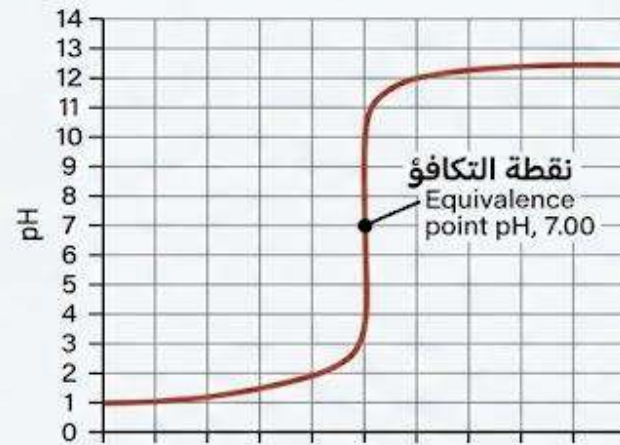
الحمض ضعيف والقاعدة قوية والكاشف الملائم هو برتقالي الميثيل



Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

Which of the following statements is **correct** according to the titration curve and indicator table shown below?

أي العبارات التالية **صحيحة** فيما يتعلق بمنحنى المعايرة وجدول الكواشف الموضحة أدناه؟



Methyl orange الميثيل البرتقالي	Methyl red أحمر الميثيل	Bromothymol blue أزرق البروموثيمول
3.2–4.6	4.2–6.2	6.0–7.6

The acid is strong and the base is weak, and methyl red is the suitable indicator

☐ A الحمض قوي والقاعدة ضعيفة، والكاشف المناسب هو أحمر الميثيل

The acid and the base are strong, and bromothymol blue is the suitable indicator

☐ B الحمض قوي والقاعدة قوية، والكاشف المناسب هو أزرق البروموثيمول

The acid and the base are weak, and bromothymol blue is the suitable indicator

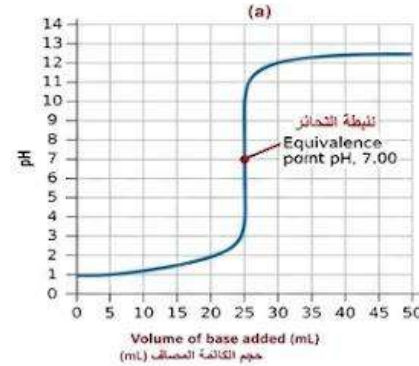
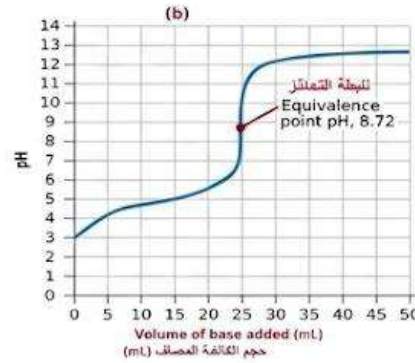
☐ C الحمض ضعيف والقاعدة ضعيفة، والكاشف المناسب هو أزرق البروموثيمول

The acid is weak and the base is strong, and methyl orange is the suitable indicator

☐ D الحمض ضعيف والقاعدة قوية، والكاشف المناسب هو الميثيل البرتقالي

أي مما يلي صحيح لكل من منحنى (a و b) الواردين أدناه؟

Which of the following is **correct** for both (a, and b) curves shown below?



أزرق البروموثيمول Bromothymol blue	أحمر الميثيل Methyl red	الكاشف Indicator
6.0-7.6	4.2-6.2	مدى الكاشف Indicator range

In curve b the acid is strong, and Methyl red is the suitable indicator

في المنحنى b الحمض قوي، والكاشف المناسب هو أحمر الميثيل

In curve b the acid is weak, and Bromothymol blue is the suitable indicator

في المنحنى b الحمض ضعيف، والكاشف المناسب هو أزرق البروموثيمول

In curve a the acid is weak, and Methyl red is the suitable indicator

في المنحنى a الحمض ضعيف، والكاشف المناسب هو أحمر الميثيل

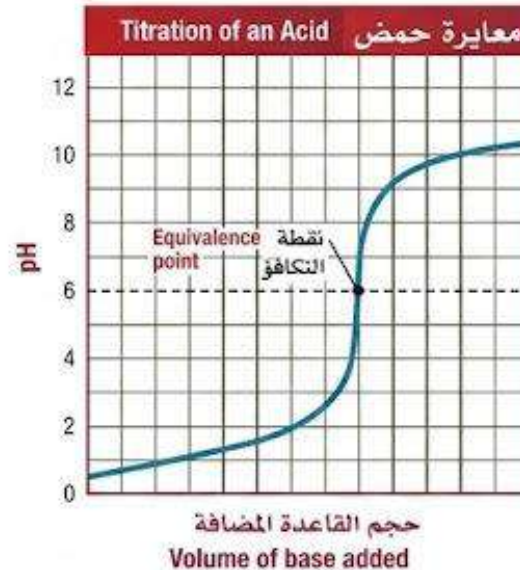
In curve a the acid is strong, and Bromothymol blue is the suitable indicator

في المنحنى a الحمض قوي، والكاشف المناسب هو أزرق البروموثيمول

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

What is the titration in the curve shown in the figure below?

ما المعايرة في المنحنى الموضح في الشكل أدناه؟



A strong acid with a strong base

حمض قوي مع قاعدة قوية ☐ A

A strong acid with a weak base

حمض قوي مع قاعدة ضعيفة ☐ B

A weak acid with a weak base

حمض ضعيف مع قاعدة ضعيفة ☐ C

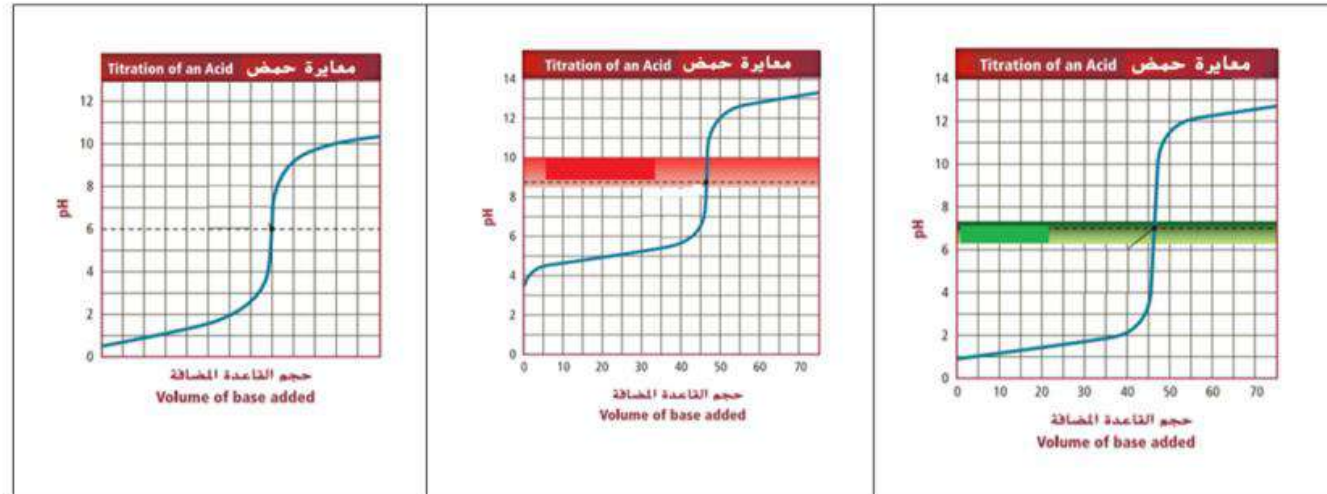
A weak acid with a strong base

حمض ضعيف مع قاعدة قوية ☐ D

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

Regarding the titration curves below. Which of the following is **correct**?

فيما يتعلق بمنحنيات المعايرة أدناه. أي مما يأتي **صحيح**؟



الكاشف Indicator	مدى الـ pH الذي يتغير عنده لون الكاشف pH range at which the indicator's colour changes
الفينولفثالين phenolphthalein	8.2 – 10.2
بنفسجي بروموكريزول Bromcresol purple	5.2 – 6.8
أزرق البروموثيمول Bromthymol blue	6.0 – 7.6

The curve (3) represents titration of a strong acid and a weak base, the right indicator is Bromcresol purple

يُمثل المنحنى (3) معايرة حمض قوي وقاعدة ضعيفة والكاشف المناسب للمعايرة هو بنفسجي بروموكريزول

The curve (2) represents titration of a strong acid and a weak base, the right indicator is phenolphthalein

يُمثل المنحنى (2) معايرة حمض قوي وقاعدة ضعيفة والكاشف المناسب للمعايرة هو الفينولفثالين

The curve (1) represents titration of a strong acid and a strong base, the right indicator is Bromcresol purple

يُمثل المنحنى (1) معايرة حمض قوي وقاعدة قوية والكاشف المناسب للمعايرة هو بنفسجي بروموكريزول

The curve (2) represents titration of a weak acid and a strong base, the right indicator is Bromthymol blue

يُمثل المنحنى (2) معايرة حمض ضعيف وقاعدة قوية والكاشف المناسب للمعايرة هو أزرق البروموثيمول

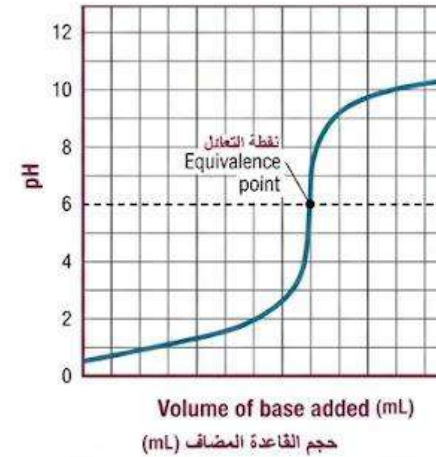
Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



Which of the following statements is **correct** according to the titration curve and indicator table shown below?

أي العبارات التالية **صحيحة** فيما يتعلق بمنحنى المعايرة وجدول الكواشف الموضحة أدناه؟

مدى الكاشف Indicator range	الكاشف Indicator
5.2-6.8	بنفسجي برومو كريزول Bromocresol purple
8.2-10.0	الفينولفثالين Phenolphthalein



The base is NH_4OH , and phenolphthalein is the suitable indicator

القاعدة NH_4OH ، والكاشف المناسب هو فينولفثالين

The base is NH_4OH , and bromocresol purple is the suitable indicator

القاعدة NH_4OH ، والكاشف المناسب هو بنفسجي برومو كريزول

The base is KOH , and bromocresol purple is the suitable indicator

القاعدة KOH ، والكاشف المناسب هو بنفسجي برومو كريزول

The base is KOH , and phenolphthalein is the suitable indicator

القاعدة KOH ، والكاشف المناسب هو فينولفثالين

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

30 CHM.5.3.04.004.06 Calculate the molarity (concentration) and volume of a solution using titration data

- 1) It takes **83 mL** of a **0.45 M NaOH** solution to neutralize **235 mL** of an **HCl** solution. What is the concentration of the **HCl** solution?



Method

- Step-by-step Solution:
 - Identify the chemical reaction.

Note: n_A and n_B are the # of moles from the balanced equation.

- Understand the formula for acid-base titration.
- Determine** values for n_A and n_B from the coefficients.
- Plug in the known values and solve for the unknown, M_A .
- Calculate the final concentration of HCl.

Balanced Equation:

Use: $\frac{M_A V_A}{n_A} = \frac{M_B V_B}{n_B}$

n_A and n_B are the # of moles from the balanced equation.



Solving for M_A :

$$M_A = \frac{M_B V_B \cdot n_A}{V_A \cdot n_B} = \frac{(0.45 \text{ M})(83 \text{ mL})(1)}{(235 \text{ mL})(1)} = 0.16 \text{ M HCl}$$

$$\frac{M_A V_A}{n_A} = \frac{M_B V_B}{n_B}$$

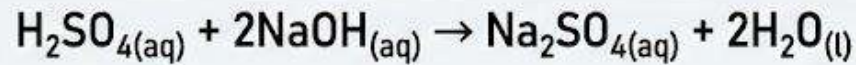


$$\frac{M_A V_A}{n_A} = \frac{M_B V_B}{n_B}$$

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26

What is the molarity of H_2SO_4 solution
if 74.30 mL of 0.4388 M NaOH solution is needed
to neutralize 45.78 mL of the acid solution?

ما مولارية محلول H_2SO_4 إذا لزم 74.30 mL من
محلول NaOH بتركيز 0.4388 M لمعادلة 45.78 من
محلول الحمض؟



Base (NaOH) Titrant

Volume: 74.30 mL
Molarity: 0.4388 M

Acid (H_2SO_4) Sample

Volume: 45.78 mL

for diprotic acid

0.3561 M **A**

0.1569 M **B**

0.4211 M **C**

0.2320 M **D**

$$M = \frac{(M \times V) \text{ NaOH}}{2 \times \text{volume H}_2\text{SO}_4}$$

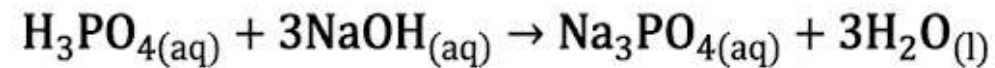
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Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



What is the molarity of H_3PO_4 solution if 15.00 mL of 0.500 M NaOH solution is needed to neutralize 25.00 mL of the acid solution?

ما مولارية محلول H_3PO_4 إذا لزم 15.00 mL من 0.500 M محلول NaOH لمعادلة 25.00 mL من محلول الحمض؟



0.0075 M ☐ A

0.0025 M ☐ B

0.1 M ☐ C

0.200 M ☐ D

for triprotic acid

$$M = \frac{(M \times V) \text{ NaOH}}{3}$$

volume H_3PO_4

Coverage-EoT3-G11-ADV -P2-INSPIRE 25-26



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