

ملخص ورقة مفاهيم الاستوكيومتري وقانون حفظ الكتلة



تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ← المناهج الإماراتية ← الصف العاشر المتقدم ← كيمياء ← الفصل الثالث ← أوراق عمل ← الملف

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ملفات اكتب للمعلم اكتب للطالب | اختبارات الكترونية | اختبارات | حلول | عروض بوربوينت | أوراق عمل
منهج انجليزي | ملخصات وتقارير | مذكرات وبنوك | الامتحان النهائي | للمدرس

المزيد من مادة
كيمياء:

إعداد: yousef

التواصل الاجتماعي بحسب الصف العاشر المتقدم



صفحة المناهج
الإماراتية على
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

المزيد من الملفات بحسب الصف العاشر المتقدم والمادة كيمياء في الفصل الثالث

ملخص ورقة مفاهيم الاستوكيومتري وقانون حفظ الكتلة

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تحليل ورقة تدريب في مفهوم الاستوكيومتري

2

الوحدة العاشرة الدرس الثاني تركيز المحلول

3

الوحدة العاشرة الدرس الأول أنواع المخاليط

4

الوحدة التاسعة الدرس الثاني قانون الغاز المثالي

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10adv

chemistry

2025-2026

EOT3 -10ADV - **Inspire**
26-25

CHEMISTRY



-EoT3 -INSPIRE 25-26

yousef saryrah



1

CHM.5.3.01.011.01 Define stoichiometry

Textbook

209

Define stoichiometry

Is the study of quantitative relationships between the amounts of reactants used and amounts of products formed by a chemical reaction.

Law of conservation of mass States that matter is neither created nor destroyed in a chemical reaction or In any chemical reaction

the mass of the reactants = the mass of products





What is the study of quantitative relationships between the amounts of reactants used and amounts of products formed by a chemical reaction called?

ماذا تُسمى دراسة العلاقات الكمية بين المواد المتفاعلة المستخدمة والنواتج المتكونة على إثر تفاعل كيميائي؟

The mole ratios

النسب المولية

The stoichiometry

الحسابات الكيميائية

The balanced chemical equation

المعادلة الكيميائية الموزونة

The law of conservation of mass

قانون حفظ الكتلة



Stoichiometry is based on the law of

الحسابات الكيميائية تستند على قانون

Constant mole ratios

النسب المولية الثابتة



Avogadro's constant

ثابت أفوجادرو



Conservation of energy

حفظ الطاقة



Conservation of mass

حفظ الكتلة





What is the scientific law that states that matter is not created or destroyed but only transformed in a chemical reaction?

- ☐ **A)** law of conservation of energy
- ☐ **B)** law of conservation of mass
- ☐ **C)** law of conservation of momentum
- ☐ **D)** law of gravity



Table 1 Relationships Derived from a Balanced Chemical Equation

4Fe(s)	+	3O ₂ (g)	→	2Fe ₂ O ₃ (s)
Iron	+	oxygen	→	iron (III) oxide
4 atoms of Fe	+	3 molecules O ₂	→	2 formula units of Fe ₂ O ₃
4 mol Fe	+	3 mol O ₂	→	2 mol Fe ₂ O ₃
223.4 g Fe	+	96.00 g O ₂	→	319.4 g Fe ₂ O ₃
319.4 g reactants			→	319.4 g products

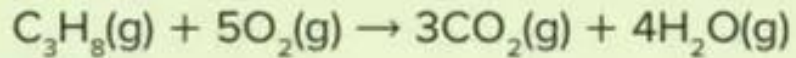
$$4 \cancel{\text{mol Fe}} \times \frac{55.85 \text{ g Fe}}{1 \cancel{\text{mol Fe}}} = 223.4 \text{ g Fe}$$

$$3 \cancel{\text{mol O}_2} \times \frac{32.00 \text{ g O}_2}{1 \cancel{\text{mol O}_2}} = 96.00 \text{ g O}_2$$

$$2 \cancel{\text{mol Fe}_2\text{O}_3} \times \frac{159.7 \text{ g Fe}_2\text{O}_3}{1 \cancel{\text{mol Fe}_2\text{O}_3}} = 319.4 \text{ g Fe}_2\text{O}_3$$



Known



Unknown

Equation interpreted in terms of molecules = ?

Equation interpreted in terms of moles = ?

Equation interpreted in terms of mass = ?



$$1 \cancel{\text{mol C}_3\text{H}_8} \times \frac{44.09 \text{ g C}_3\text{H}_8}{1 \cancel{\text{mol C}_3\text{H}_8}} = 44.09 \text{ g C}_3\text{H}_8$$

$$5 \cancel{\text{mol O}_2} \times \frac{32.00 \text{ g O}_2}{1 \cancel{\text{mol O}_2}} = 160.0 \text{ g O}_2$$

$$3 \cancel{\text{mol CO}_2} \times \frac{44.01 \text{ g CO}_2}{1 \cancel{\text{mol CO}_2}} = 132.0 \text{ g CO}_2$$

$$4 \cancel{\text{mol H}_2\text{O}} \times \frac{18.02 \text{ g H}_2\text{O}}{1 \cancel{\text{mol H}_2\text{O}}} = 72.08 \text{ g H}_2\text{O}$$

$$44.09 \text{ g C}_3\text{H}_8 + 160.0 \text{ g O}_2 = \mathbf{204.1 \text{ g reactants}}$$

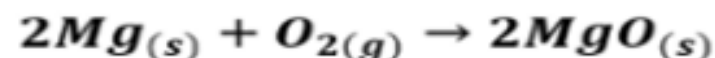
$$132.0 \text{ g CO}_2 + 72.08 \text{ g H}_2\text{O} = \mathbf{204.1 \text{ g products}}$$

$$\mathbf{204.1 \text{ g reactants} = 204.1 \text{ g products}}$$



What do the coefficients in the following balanced chemical equation indicate?

ما الذي تشير إليه المعاملات في المعادلة الكيميائية الموزونة التالية؟



Moles number	عدد المولات	I
Molecules number	عدد الجزيئات	II
Atoms number	عدد الذرات	III

I, II

I و II

Only I

I فقط

I, II and III

I، II و III

Only II

II فقط



What is the total mass of the reactants in the following
balance chemical equation?

ما مجموع كتل المواد المتفاعلة في المعادلة الكيميائية الموزونة
التالية ؟



Molar mass الكتلة المولية (g / mol)	Element العنصر
16	O
55.85	Fe

291.5 g

415.6 g

271.4 g

319.4 g

In the reaction below. Which of the following is **correct**?

التفاعل أدناه. أي من التالي صحيح؟



H = 1.008 g/mol

N = 14.007 g/mol

The sum of the masses of reactants equals 34.062 g

مجموع كتل المتفاعلات يساوي 34.062 g

The sum of the masses of reactants is smaller
than the sum of the masses of products

مجموع كتل المتفاعلات أصغر من مجموع كتل النواتج

A decrease in mass takes place during the reaction

يحدث نقص في الكتلة أثناء التفاعل

The sum of the masses of products equals 28.014 g

مجموع كتل النواتج يساوي 28.014 g

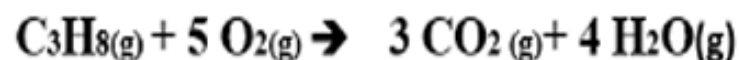




$$\text{moles of known} \times \frac{\text{moles of unknown}}{\text{moles of known}} = \text{moles of unknown}$$

How many moles of CO_2 are produced when 5 moles of C_3H_8 are reacted?

كم مول من CO_2 سينتج عند تفاعل 5 mol من C_3H_8 ؟



30 mol

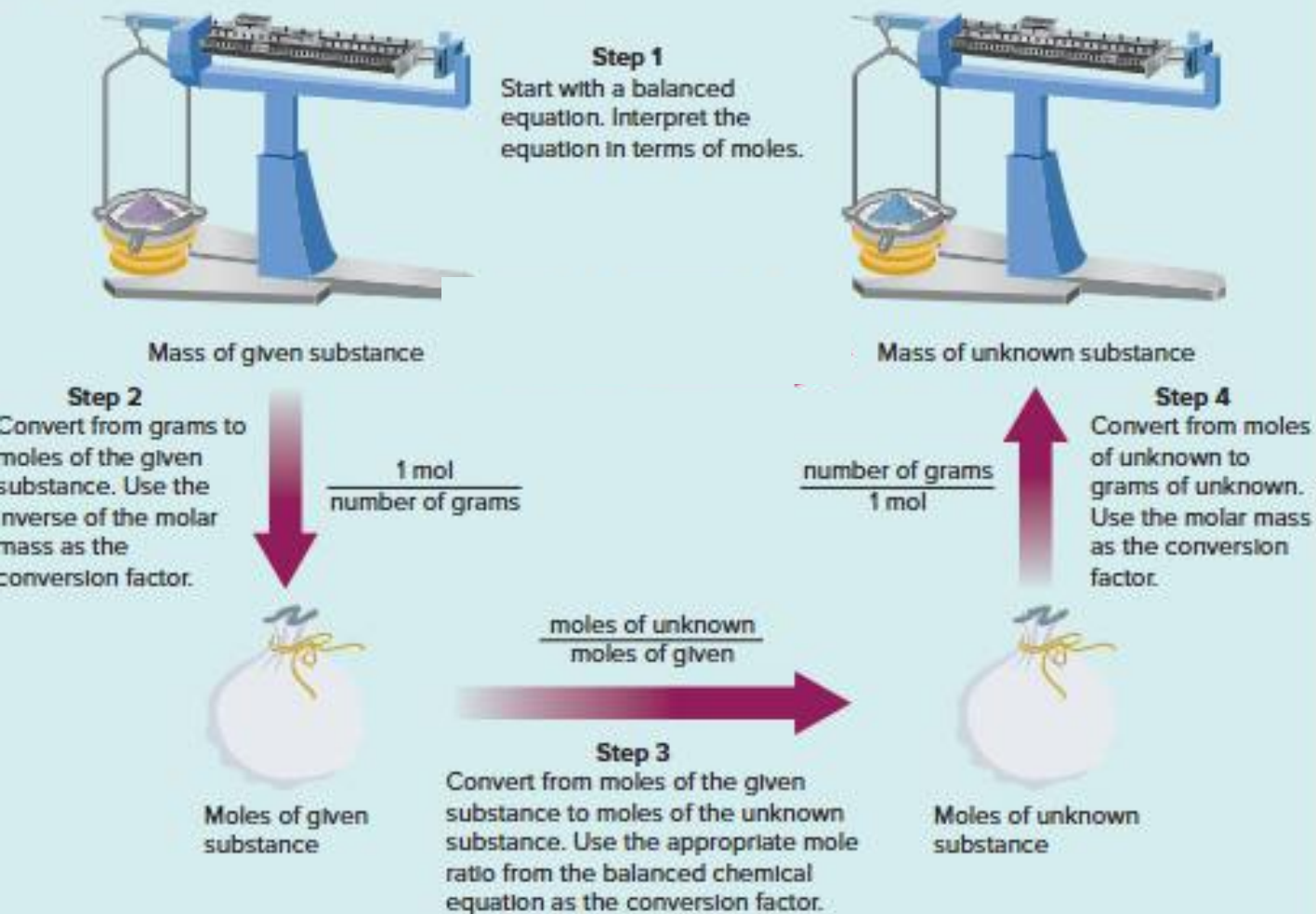
3 mol

5 mol

15 mol

Apply the Strategy

Apply the Problem-Solving Strategy to Example Problems 2, 3, and 4.



Step 1: Write and balance the chemical equation

Step 2: Convert grams given $\rightarrow$ moles of the given substance

Use invers the molar mass as the conversion factor.

Step 3: Convert from moles of given substance $\rightarrow$ moles of unknown substance.

Use mole ratio (balance equation)

Step 4 Convert moles $\rightarrow$ grams of the unknown substance

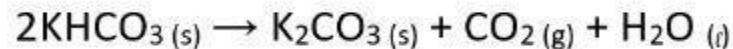
Use molar mass as the conversion factor

Full Equation:

$$[\text{Moles}_B] = \left(\frac{\text{Mass}_A (\text{g})}{\text{MM}_A (\text{g/mol})} \right) \times \left(\frac{\text{Coeff}_B}{\text{Coeff}_A} \right)$$

How many moles of carbon dioxide CO_2 will be produced if 100.0 g of potassium hydrogen carbonate KHCO_3 have decomposed?

كم مولاً ينتج من ثاني أكسيد الكربون CO_2 إذا تفكك 100.0 g من كربونات البوتاسيوم الهيدروجينية KHCO_3 ؟



(Molar Mass of $\text{KHCO}_3 = 100 \text{ g/mol}$)

(الكتلة المولية $\text{KHCO}_3 = 100 \text{ g/mol}$)

0.5 mol

☐

1 mol

☐

0.25 mol

☐

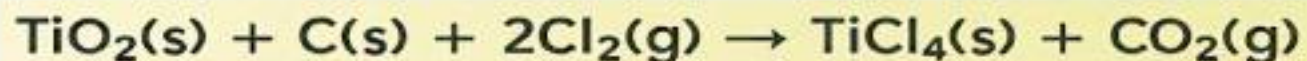
2 mol

☐

Titanium tetrachloride (TiCl_4) is extracted from titanium oxide (TiO_2) using chlorine and coke (carbon). What mass of Cl_2 gas is needed to react with **3.75 mol** of TiO_2 ?

Molar Mass of Cl_2 – 70.9 g/mol

70.9 g/mol – Cl_2 الكتلة المولية



532 g

473 g

358 g

266 g

$$[\text{Mass}_B] = \left([\text{Moles}_A] \times \frac{\text{Coeff}_B}{\text{Coeff}_A} \right) \times \text{MM}_B$$

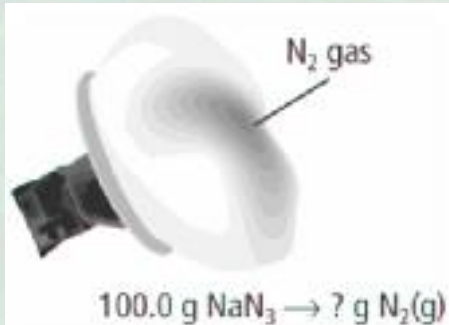
The general mass-to-mass stoichiometry pathway is:



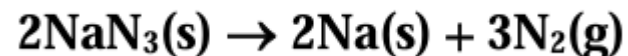
Core equation:

$$\text{Mass of B} = \text{Mass of A} \times \frac{1 \text{ mol A}}{\text{Molar Mass A}} \times \frac{\text{Coefficient B}}{\text{Coefficient A}} \times \frac{\text{Molar Mass B}}{1 \text{ mol B}}$$

Determine the **mass** of N₂ produced from the decomposition of NaN₃ shown below.



Molar mass:
NaN₃ = 65 g/mol
N₂ = 28 g/mol



Step 1: Make mass → mole conversion.

$$100.0 \text{ g } \cancel{\text{NaN}_3} \times \frac{1 \text{ mol NaN}_3}{65.02 \text{ g } \cancel{\text{NaN}_3}} = 1.538 \text{ mol NaN}_3$$

Step 2: Make mole → mole conversion.

$$1.538 \text{ mol } \cancel{\text{NaN}_3} \times \frac{3 \text{ mol N}_2}{2 \text{ mol } \cancel{\text{NaN}_3}} = 2.307 \text{ mol N}_2$$

Step 3: Make mole → mass conversion.

$$2.307 \text{ mol } \cancel{\text{N}_2} \times \frac{28.02 \text{ g N}_2}{1 \text{ mol } \cancel{\text{N}_2}} = 64.64 \text{ g N}_2$$



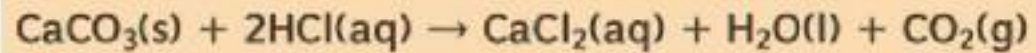
What is the mass of carbon dioxide CO_2 produced

ما كتلة ثاني أكسيد الكربون CO_2 التي تنتج من تفاعل 250 g

from the reaction of 250 g of calcium carbonate

من كربونات الكالسيوم CaCO_3 ؟

CaCO_3 ?



Molar Mass CaCO_3 = 100 g/mol

الكتلة المولية CaCO_3 = 100 g/mol

Molar Mass CO_2 = 44.0 g/mol

الكتلة المولية CO_2 = 44.0 g/mol

31.5 g

388 g

110 g

77.0 g



Zinc reacts with iodine in a synthesis reaction

as the following equation: If 3.50 mol of Zinc

is used. What is theoretical yield?



Molar Mass of $\text{ZnI}_2 = 319 \text{ g/mol}$

يتفاعل الخارصين مع اليود في تفاعل تكوين طبقاً للمعادلة التالية:

إذا تم استخدام 3.50 mol من الخارصين Zn . ما المردود النظري؟

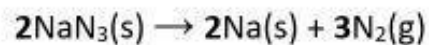
الكتلة المولية لـ $\text{ZnI}_2 = 319 \text{ g/mol}$



One of the reactions used to inflate automobile air bags involves sodium azide (NaN_3). What is the mass of N_2 produced from the decomposition of 195 g of NaN_3 ?

أحد التفاعلات المستخدمة لنفخ الأكياس الهوائية في السيارات يتضمن أزيد الصوديوم (NaN_3).

ماهي كتلة N_2 الناتجة عن تفكك 195 g من NaN_3 ؟



Molar mass:
 $\text{NaN}_3 = 65 \text{ g/mol}$
 $\text{N}_2 = 28 \text{ g/mol}$

كتلة مولية:
 $65 \text{ g/mol} = \text{NaN}_3$
 $28 \text{ g/mol} = \text{N}_2$

56.0 g

112.0 g

126.0 g

25.0 g



Limiting Reactant Definition:

The reactant which is used up completely and earlier in a chemical reaction is called a limiting reactant.

Limiting reactant is also known as **limiting reagent**.

Excess Reactant Definition:

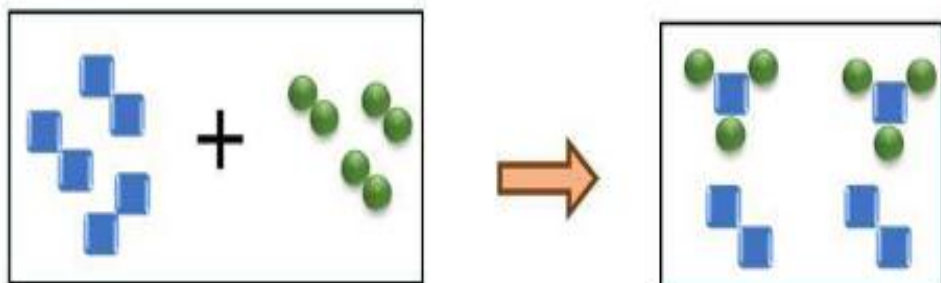
The reagent / reactant which left behind after the completion of a chemical reaction is called excess reactant or excess reagent.

The reactant which gives the least amount of product is a **limiting reactant**
The reactant which gives greater amount of product is an **excess reagent**



blue squares represent element X,
green circles represent element Y.
Which of the following is correct?

المربعات الزرقاء تمثل العنصر X،
والدوائر الخضراء تمثل العنصر Y.
أي مما يلي صحيح؟



Limiting reactant is X_2

المتفاعل المحدد هو X_2

Limiting reactant is Y_2

المتفاعل المحدد هو Y_2

X_2 is consumed first in the reaction

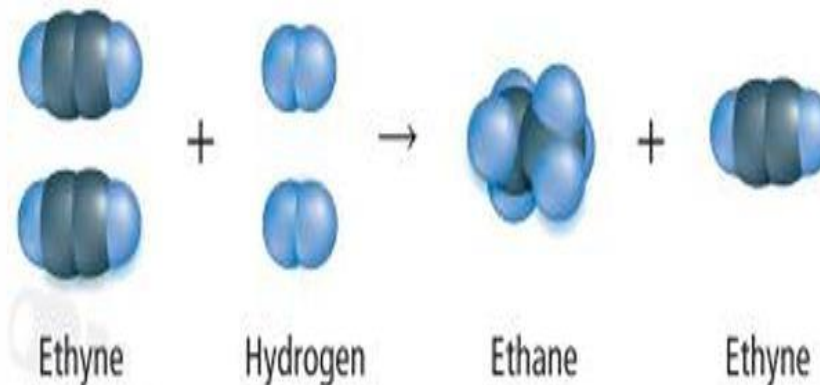
يتم استهلاك X_2 أولاً في التفاعل

At the end of the reaction an amount
of Y_2 is leftover unreacted

في نهاية التفاعل تبقى كمية
من Y_2 غير متفاعلة

What is the excess reactant in figure shown below?

ما المتفاعل الفائض في الشكل الموضح أدناه؟



A. Ethane molecules

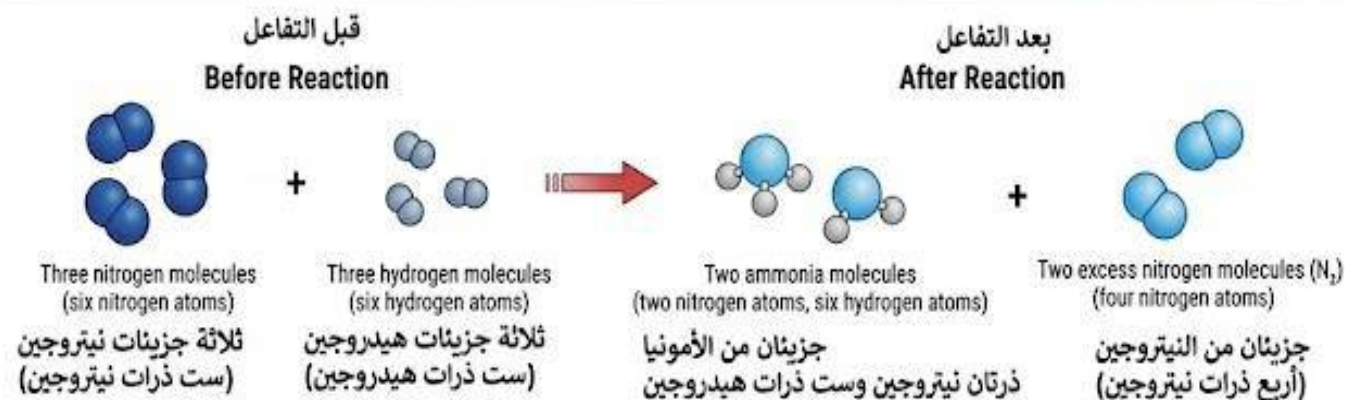
B. No limiting reactant.

C. Hydrogen molecules

D. Ethyne molecules

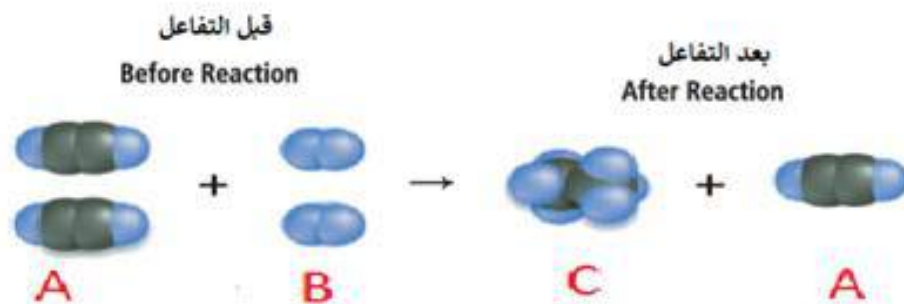
What is the limiting reactant in the figure shown below?

ما المتفاعل المُحدد في الشكل الموضح أدناه؟



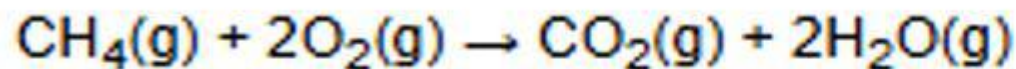
What is the limiting reactant in the figure shown below?

ما المتفاعل المُحدد في الشكل الموضح أدناه؟





In a bunsen burner flame, what does a yellow color signify?



- ☐ A) Methane gas is the limiting reactant
- ☐ B) Oxygen is the limiting reactant.
- ☐ C) Carbon dioxide is the limiting reactant.
- ☐ D) Water is the limiting reactant.

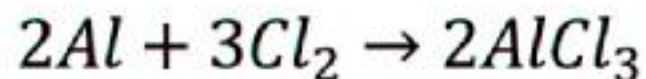




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CHM.5.3.01.013.04 Identify limiting reactant and excess reactant in a chemical reaction given the number of moles of reactants

What is the limiting reactant if we started with 2 moles of Al, and 2 moles of Cl_2 ?



Limiting Reactant
mole equation:

Given Moles:

Al	Cl_2
2 moles	2 moles

Calculation Steps:
Divide by the coefficient
by coefficient (2/2):

Al	Cl_2
2 mole	3 mole

Cl_2 :
Dividing given moles by
coefficient (2/3):

Compare:

1.0 > 0.67

Result = 0.67

Comparison:

Conclusion:

Excess Reactant:	Limiting reactant:
Al	Cl_2

Fast Formula Method

Divide each reactant mole amount by its coefficient:

$$\frac{\text{moles}}{\text{coefficient}}$$

Smallest value = limiting reactant.



Example: **The number of moles of the reactants is given**

Methane, CH_4 , burns in oxygen to form carbon dioxide, CO_2 , and water vapor, H_2O , according to the following balanced equation:



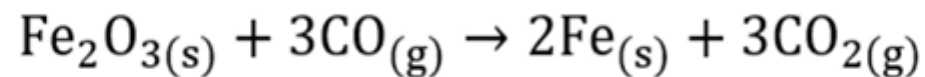
A sample of 0.250 moles of methane was burnt in 1.25 moles of oxygen. Answer questions a – f.

a) Identify the limiting reactant.

	CH_4	O_2
Number of moles $n = \frac{m}{M}$	0.250 moles	1.25 moles
Divide by reacting ratio	$\frac{0.250}{1} = 0.250$	$\frac{1.25}{2} = 0.625$
Limiting reactant	CH_4 (The smaller amount)	



Hematite Fe_2O_3 and carbon monoxide CO react according to the following balanced chemical equation :



If 25.0 mol of Fe_2O_3 and 30.0 mol of CO are used in the reaction

Which of the following is the **limiting reactant**?

يتفاعل الهيماتيت Fe_2O_3 مع أول أكسيد الكربون CO وفق المعادلة الكيميائية الموزونة التالية:

إذا استخدم 25.0 mol من Fe_2O_3 مع 30.0 mol من CO في التفاعل

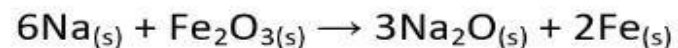
أي مما يلي هو **المتفاعل المحدد**؟

9

CHM.5.3.01.013.05 Identify limiting reactant and excess reactant in a chemical reaction given the mass of reactants

In the following reaction, if we use 100 g of sodium Na and 100 g of iron (III) oxide (Fe_2O_3), what is the limiting reactant?

في التفاعل التالي، إذا استخدمنا 100 g من الصوديوم Na و 100 g من أكسيد الحديد (III) Fe_2O_3 ، ما المتفاعل المحدد؟



Molar Mass:

Na = 23 g/mol

Fe_2O_3 = 160 g/mol

الكتلة المولية:

23 g/mol = Na

160 g/mol = Fe_2O_3

Na

☐

Fe

☐

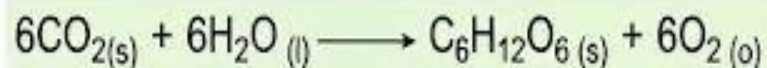
Fe_2O_3

☐

Na_2O

☐

Carbon dioxide CO_2 reacts with water H_2O in
photosynthesis reaction in green plants to produce
glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) and oxygen as shown in the
equation below.



a plant has 66 g of CO_2 and 72 g of H_2O .

What is the mass of glucose produced?

$$\text{C}_6\text{H}_{12}\text{O}_6 = 180.18 \text{ g/mol}$$

$$\text{CO}_2 = 44.0 \text{ g/mol}$$

$$\text{H}_2\text{O} = 18.02 \text{ g/mol}$$

يتفاعل ثاني أكسيد الكربون CO_2 مع الماء H_2O في عملية التمثيل

الضوئي في النباتات الخضراء لإنتاج الجلوكوز ($\text{C}_6\text{H}_{12}\text{O}_6$)

والأكسجين كما يتضح من المعادلة أعلاه:

تحتوي النبتة على 66 g من CO_2 و 72 g من H_2O .

ما كتلة الناتج من الجلوكوز؟

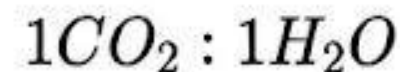
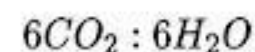
Step 1 — Convert grams to moles

$$\frac{66}{44.0} = 1.50 \text{ mol } \text{CO}_2$$

$$\frac{72}{18.02} = 4.00 \text{ mol } \text{H}_2\text{O}$$

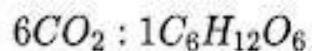
Step 2 — Determine limiting reactant

Equation ratio:



CO_2 is limiting

Step 3 —



$$1.50 \text{ mol } \text{CO}_2 \times \frac{1 \text{ mol } \text{C}_6\text{H}_{12}\text{O}_6}{6 \text{ mol } \text{CO}_2}$$

$$= 0.250 \text{ mol } \text{C}_6\text{H}_{12}\text{O}_6$$

Step 4 — Convert moles of glucose to grams

Convert to grams:

$$0.250 \times 180.18 = 45.0 \text{ g}$$



The reaction between solid sodium and iron(III) oxide is one in a series of reactions that inflates an automobile airbag: If 200.0 g of Na and 200.0 g of Fe_2O_3 are used in this reaction. **What is the mass of solid iron produced?**

يندرج التفاعل بين الصوديوم الصلب وأكسيد الحديد(III) ضمن سلسلة من التفاعلات التي تؤدي إلى نفخ كيس الهواء في السيارة: إذا استخدمنا 200.0 g من Na و 200 g من Fe_2O_3 في هذا التفاعل. **ما كتلة الحديد الصلب الناتج؟**



$$\text{Na} = 23.00 \text{ g/mol}$$

$$\text{Fe} = 56.00 \text{ g/mol}$$

$$\text{Fe}_2\text{O}_3 = 160 \text{ g/mol}$$





When chlorine gas Cl_2 reacts with solid phosphorus

عندما يتفاعل غاز الكلور Cl_2 مع الفوسفور الصلب P_4 ، ينتج خامس

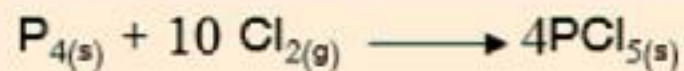
P_4 ,solid phosphorus pentachloride PCl_5 is produced.

كلوريد الفوسفور الصلب PCl_5 . إذا تفاعل 16.0 g من الكلور Cl_2

If 16.0 g of chlorine reacts with 23.0 g of P_4 , which

مع 23.0 g من P_4 ، أي مما يأتي صحيح؟

of the following is **correct**?



Element symbol	رمز العنصر	P	Cl
Atomic mass	الكتلة الذرية	30.97	35.45
(g /mol)			

كمية الناتجة (PCl_5) Amount of (PCl_5) produced	المتفاعل الفائض Excess reactant	المتفاعل المحدد Limiting reactant	
18.82 g	P_4	Cl_2	A
28.50 g	P_4	Cl_2	B
33.45 g	Cl_2	P_4	C
44.28 g	Cl_2	P_4	D

11	CHM.5.3.01.013.13 Define the percent yield of a chemical reaction	Textbook + Figure 8	227, 228
12	CHM.5.3.01.013.11 Distinguish between theoretical yield and actual yield in stoichiometric calculations	Textbook + Example problem 6 + Practice Problems	227, 228, 229
13	CHM.5.3.01.013.14 Calculate percent yield and theoretical in a chemical reaction	Textbook + Example problem 6 + Practice Problems	227, 228, 229

1. DISTINGUISHING BETWEEN YIELDS (CHM.5.3.01.013.11)

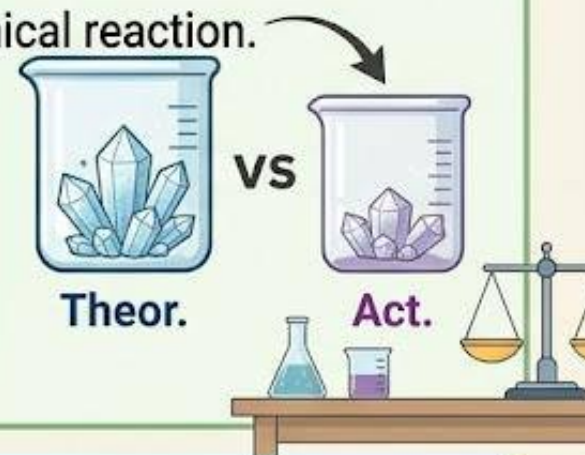
Learn to differentiate between the potential and actual outcome of a chemical reaction.

Theoretical Yield:

Definition: The maximum amount of product that can be produced from a given amount of reactant, based on stoichiometric calculations.

Actual Yield:

Definition: Box: The measured amount of product actually obtained from performing the reaction in a laboratory.



2. DEFINING PERCENT YIELD (CHM.5.3.01.013.13)

Calculate the efficiency of a chemical reaction by comparing the actual and theoretical yields.

Percent Yield is the ratio of the actual yield to the theoretical yield, expressed as a percentage.


$$\text{Percentage yield} = \left(\frac{\text{Actual Yield}}{\text{Theoretical Yield}} \right) \times 100$$





What is the actual yield of a chemical reaction?

ما المقصود بالمحصول الفعلي في التفاعل الكيميائي؟

A) The maximum possible amount of product

B) The amount of product predicted by calculations

C) The amount of product actually produced in an experiment

D) The amount of unused reactant

أكبر كمية ممكنة من الناتج
كمية الناتج المتوقعة بالحسابات
كمية الناتج التي تم إنتاجها فعليًا في التجربة
كمية المادة المتفاعلة غير المستخدمة

Why is the actual yield usually less than the theoretical yield?

لماذا يكون المحصول الفعلي غالبًا أقل من المحصول النظري؟

A) Some product may be lost during the experiment

B) Reactions always produce extra products

C) Theoretical yield is measured experimentally

D) Reactants increase during the reaction

قد يُفقد جزء من الناتج أثناء التجربة.
التفاعلات تنتج دائمًا مواد إضافية.
المحصول النظري يتم قياسه عمليًا.
كمية المتفاعلات تزداد أثناء التفاعل.





A reaction has a theoretical yield of 50.0 g and an actual yield of 42.5 g. The percent yield is:

- A. 75.0%
- B. 85.0%
- C. 117.6%
- D. 92.5%

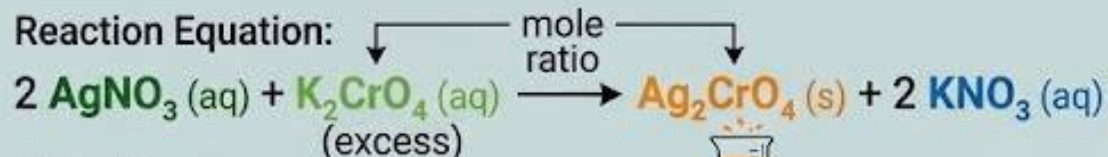
If the percent yield is 80% and the theoretical yield is 100 g, the actual yield is:

- A. 20 g
- B. 80 g
- C. 100 g
- D. 125 g



Problem Statement: Solid silver chromate (Ag_2CrO_4) forms when excess potassium chromate (K_2CrO_4) is added to a solution containing 0.500 g of silver nitrate (AgNO_3). Determine the theoretical yield of Ag_2CrO_4 . Find the **percent yield** if the reaction yields **0.455 g** of Ag_2CrO_4 .

STEP 1: THEORETICAL YIELD



Molar Masses:

$$\text{AgNO}_3 (\text{aq}) = 169.87 \text{ g/mol}$$

$$\text{Ag}_2\text{CrO}_4 = 331.73 \text{ g/mol}$$

a) Calculate Moles of AgNO_3 :

$$0.500 \text{ g AgNO}_3 \times \frac{1 \text{ mol AgNO}_3}{169.87 \text{ g AgNO}_3} = 0.002943 \text{ mol AgNO}_3$$

b) Calculate Moles of Ag_2CrO_4 (Stoichiometry):

$$0.002943 \text{ mol AgNO}_3 \times \frac{1 \text{ mol Ag}_2\text{CrO}_4}{2 \text{ mol AgNO}_3} = 0.001472 \text{ mol Ag}_2\text{CrO}_4$$

c) Calculate Mass of Ag_2CrO_4 (Theoretical Yield):

$$0.001472 \text{ mol Ag}_2\text{CrO}_4 \times \frac{331.73 \text{ g Ag}_2\text{CrO}_4}{1 \text{ mol Ag}_2\text{CrO}_4} = 0.488 \text{ g Ag}_2\text{CrO}_4$$

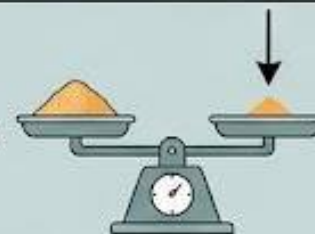
$$\text{THEORETICAL YIELD} = 0.488 \text{ g Ag}_2\text{CrO}_4$$

STEP 2: PERCENT YIELD

Formula:

$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100\%$$

Actual Yield:
0.455 g Ag_2CrO_4
(Given)



Theoretical Yield:
0.488 g

Plug in the values:

$$\text{Percent Yield} = \frac{0.455 \text{ g}}{0.488 \text{ g}} \times 100\%$$

$$\text{Percent Yield} = (0.9324) \times 100\%$$

Result

$$\text{PERCENT YIELD} = 93.2\%$$

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chemistry

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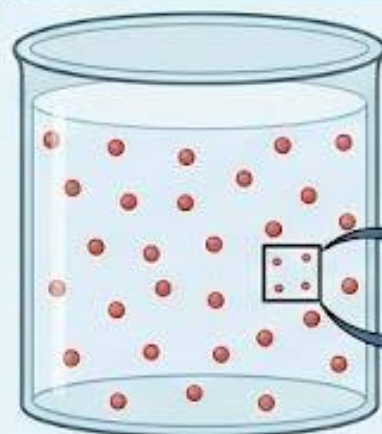


-EoT3 -INSPIRE 25-26

yousef saryrah

THE FIVE ASSUMPTIONS OF KINETIC MOLECULAR THEORY (KMT)

1. TINY PARTICLES, FAR APART.

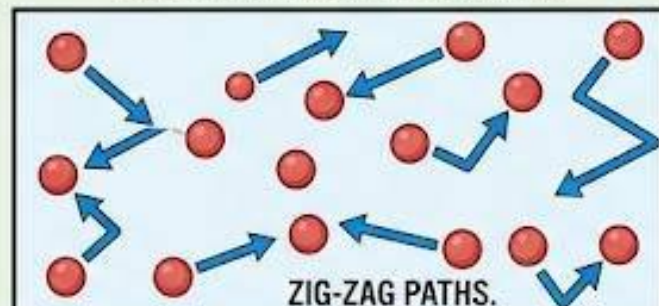


GASES CONSIST OF A LARGE NUMBER OF TINY PARTICLES THAT ARE FAR APART COMPARED TO THEIR SIZE.

MOSTLY EMPTY SPACE.

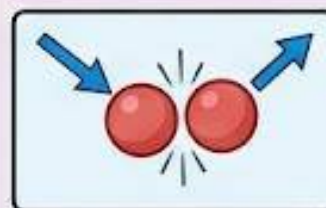
2. CONSTANT, RANDOM, STRAIGHT-LINE MOTION.

GAS PARTICLES ARE IN CONSTANT, RANDOM, STRAIGHT-LINE MOTION.



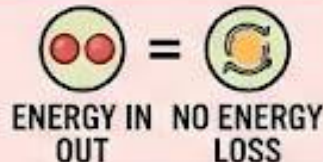
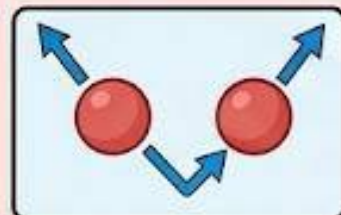
ZIG-ZAG PATHS.

3. PERFECTLY ELASTIC COLLISIONS.



COLLISIONS BETWEEN GAS PARTICLES AND WITH THE WALLS OF THE CONTAINER ARE PERFECTLY ELASTIC.

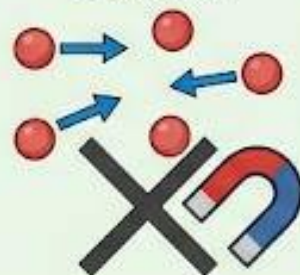
3. PERFECTLY ELASTIC COLLISIONS.



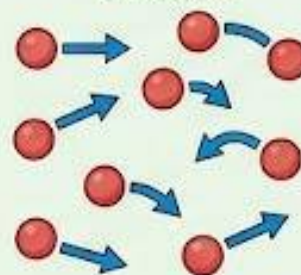
COLLISIONS BETWEEN GAS PARTICLES AND WITH THE WALLS OF THE CONTAINER ARE PERFECTLY ELASTIC.

4. NO ATTRACTIVE OR REPULSIVE FORCES.

IDEAL GAS



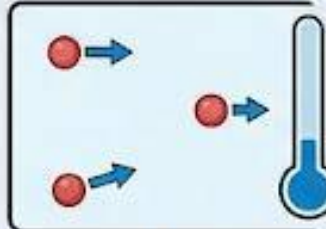
REAL GAS



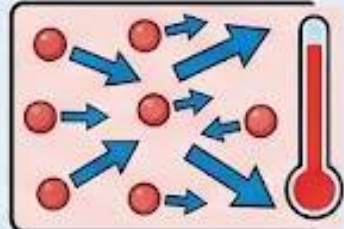
THERE ARE NO ATTRACTIVE OR REPULSIVE FORCES BETWEEN GAS PARTICLES EXCEPT DURING COLLISIONS.

5. AVERAGE KINETIC ENERGY IS PROPORTIONAL TO TEMPERATURE.

LOW TEMPERATURE (T1)



HIGH TEMPERATURE (T2)

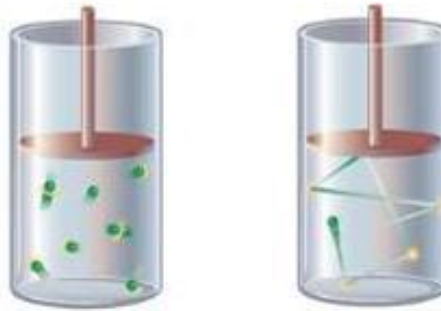


$$KE_{avg} = \frac{1}{2}mv^2 \quad KE \propto T$$

THE AVERAGE KINETIC ENERGY OF GAS PARTICLES IS DIRECTLY PROPORTIONAL TO THE TEMPERATURE.

Which is **NOT** an assumption of the kinetic-molecular theory?

أي العبارات التالية **ليست** افتراضاً لنظرية الحركة الجزيئية؟



All the gas particles in a sample have the same velocity.

لكل جسيمات الغاز في عينة ما نفس السرعة.



A gas particle is not significantly attracted or repelled by other gas particles.

لا تتجاذب أو تتنافر جسيمات الغاز مع بعض.



Collisions between gas particles are elastic.

يكون التصادم بين جسيمات الغاز مرناً.



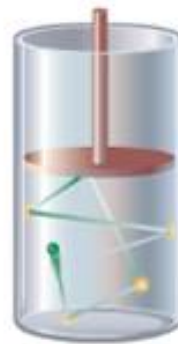
All gases at a given temperature have the same average kinetic energy.

لكل الغازات في درجة حرارة معينة نفس متوسط الطاقة الحركية.



Which of the following statements is **True**?

أي العبارات التالية **صحيحة**؟



Particles of a gas collide with each other and with the walls of their container, these collisions are inelastic.

جسيمات الغاز تتصادم مع بعضها البعض ومع جدران الوعاء وهذه التصادمات غير مرنة

Particles of a gas collide with their container only

جسيمات الغاز تتصادم بجدار الوعاء فقط

Particles of a gas never collide

جسيمات الغاز لا تتصادم

Particles of a gas collide with each other and with the walls of their container, these collisions are elastic.

جسيمات الغاز تتصادم مع بعضها البعض ومع جدران الوعاء وهذه التصادمات مرنة



15

CHM.5.2.01.003.05 Use the mathematical formula of Graham's law of effusion to calculate the relative rates of effusion of different gases and their molar masses

Graham's Law

$$\text{Rate of effusion} \propto \frac{1}{\sqrt{\text{molar mass}}}$$

The rate of diffusion or effusion of a gas is inversely proportional to the square root of its molar mass.

$$\frac{\text{Rate}_A}{\text{Rate}_B} = \sqrt{\frac{\text{molar mass}_B}{\text{molar mass}_A}}$$





- Ammonia (NH_3) has a molar mass of **17.0 g/mol**; hydrogen chloride (HCl) has a molar mass of **36.5 g/mol**. *What is the ratio of their diffusion rates?*

a) 0.42

b) 2.50

c) 1.47

d) 1.13

$$\frac{\text{Rate } NH_3}{\text{Rate } HCl} = \frac{\sqrt{M_{HCl}}}{\sqrt{M_{NH_3}}}$$
$$\frac{\text{Rate } NH_3}{\text{Rate } HCl} = \frac{\sqrt{36.5}}{\sqrt{17}} = 1.47$$

. *Calculate the ratio of effusion rates* for nitrogen (N_2) and neon (Ne).
(molar mass : $N_2 = 28$, $Ne = 20.2$)

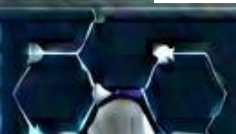
a) 0.421

b) 2.50

c) 1.47

d) 0.849

$$\frac{\text{Rate } N_2}{\text{Rate } Ne} = \frac{\sqrt{M_{Ne}}}{\sqrt{M_{N_2}}}$$
$$\frac{\text{Rate } N_2}{\text{Rate } Ne} = \frac{\sqrt{20.2}}{\sqrt{28}} = 0.849$$





Neon (Ne) has a molar mass of 20.0 g/mol;
and Hydrogen Chloride (HCl) has a molar mass of 36.5 g/mol.

What is the ratio of their diffusion rates?

غاز النيون له كتلة مولية 20.0 g/mol، وغاز كلوريد الهيدروجين له
كتلة مولية 36.5 g/mol.

ما هي نسبة معدلات انتشارها؟

0.54

0.77

1.35

1.83



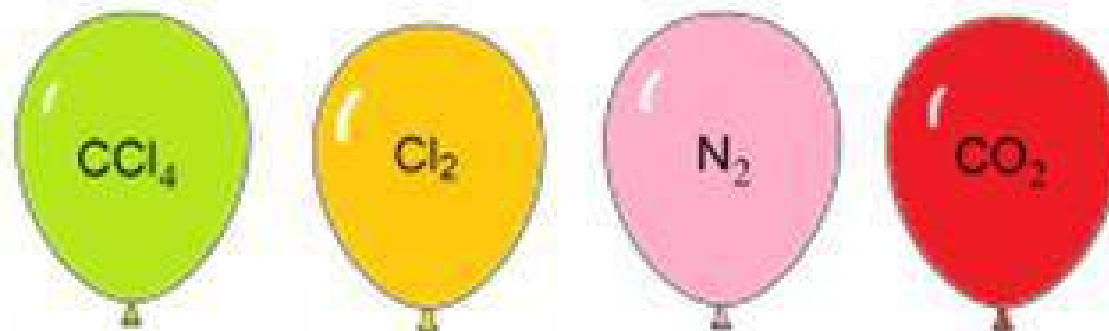


Four identical balloons were filled with different gases to the same volume.

Which balloon does the gas effuse the fastest from it?

أربع بالونات متطابقة تم ملؤها بنفس الحجم من غازات مختلفة.

أي البالونات سبتدقق الغاز منه بشكل أسرع؟



CCl_4	Cl_2	N_2	CO_2	الكتلة المولية
154	71	28	44	Molar Mass (g/mol)



Barometers are instruments used to measure atmospheric air pressure.

Manometers measure gas pressure in a closed container.

The SI unit of pressure is the pascal (Pa)

pascal (Pa) is equal to a force of one Newton per square meter or N/m².

**Table
12.1**

**Comparison
of Pressure Units**

Unit	Number Equivalent to 1 atm	
Kilopascal (kPa)	101.3 kPa	
Atmosphere (atm)	—	
Millimeters of mercury (mm Hg)	760 mm Hg	
Torr	760 torr	
Pounds per square inch (psi or lb/in ²)	14.7 psi	
Bar	1.01 bar	

$$1 \text{ atm} = \frac{760}{\dots\dots\dots} \text{ mmHg} = \frac{760}{\dots\dots\dots} \text{ torr} = \frac{101.3}{\dots\dots\dots} \text{ kPa}$$



The weather report includes a reading of atmospheric pressure, is **0.95 atm** express for this pressure by **mmHg** unit

يتضمن تقرير الأحوال الجوية قراءة للضغط الجوي ، هي **0.95 atm** عبر عن هذا الضغط بوحدة **mmHg**

a – 722 mmHg

b – 760 mmHg

c – 101.3 mmHg

d – 1 mmHg

$$0.95 \text{ atm} \times \frac{760 \text{ mmHg}}{1 \text{ atm}} = 722 \text{ mmHg}$$

The weather report includes a reading of atmospheric pressure, is **0.95 atm** express for this pressure by **kPa** unit

يتضمن تقرير الأحوال الجوية قراءة للضغط الجوي ، هي **0.95 atm** عبر عن هذا الضغط بوحدة **kPa**

a – 760 kPa

b – 101.3 kPa

c – 96.2 kPa

d – 1 kPa

$$0.95 \text{ atm} \times \frac{101.3 \text{ kPa}}{1 \text{ atm}} = 96.2 \text{ kPa}$$

Dalton's law of partial pressures says that the total pressure of a mixture of gases is equal to the sum of the pressures of all the gases of the mixture.

Dalton's Law of Partial Pressures

$$P_{\text{total}} = P_1 + P_2 + P_3 + \dots P_n$$

P_{total} represents total pressure. P_1 , P_2 , and P_3 represent the partial pressures of each gas up to the final gas, P_n .

What is the partial pressure of water vapor in an air sample when the total pressure is **1.00 atm**, the partial pressure of nitrogen is **0.79 atm**, the partial pressure of oxygen is **0.20 atm**, and the partial pressure of all other gases in air is **0.0044 atm**?

ما الضغط الجزئي لبخار الماء في عينة من الهواء عندما يكون

الضغط الكلي **1.00 atm** والضغط الجزئي للنيتروجين **0.79 atm**

والضغط الجزئي للأكسجين **0.20 atm** والضغط الجزئي لجميع

الغازات الأخرى **0.0044 atm**؟

a- 0.0056 atm

b- 0.2100 atm

c- 0.80 atm

d- 0.9956 atm

$$P_T = P_{N_2} + P_{O_2} + P_{\text{gase}} + P_{H_2O}$$

$$1.00 = 0.79 + 0.20 + 0.0044 + P_{H_2O}$$

$$P_{H_2O} = 1.00 - (0.79 + 0.20 + 0.0044)$$

$$P_{H_2O} = 5.6 \times 10^{-3} \\ = 0.0056 \text{ atm}$$



A mixture of oxygen (O_2), carbon dioxide (CO_2), and nitrogen (N_2) has a **total pressure of 0.97 atm**. What is the partial pressure of O_2 if the partial pressure of CO_2 is 0.70 atm and the partial pressure of N_2 is 0.12 atm?

- a) 0.19
- b) 0.15**
- c) 0.24
- d) 0.31

$$\begin{aligned}P_T &= P_{O_2} + P_{CO_2} + P_{N_2} \\P_{O_2} &= P_T - (P_{CO_2} + P_{N_2}) \\P_{O_2} &= 0.97 - (0.70 + 0.12) \\P_{O_2} &= 0.15 \text{ atm}\end{aligned}$$

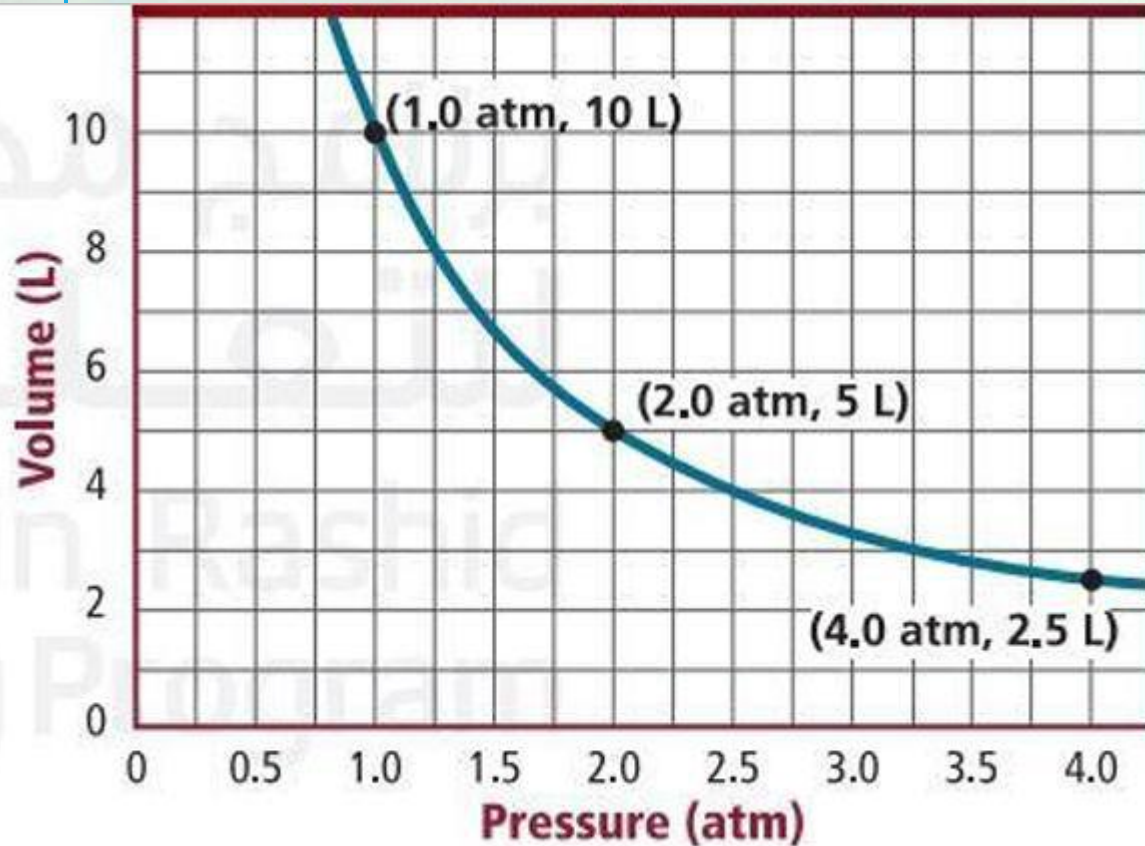
Find the **total pressure** for a mixture that contains four gases with partial pressures of 5.00 kPa, 4.56 kPa, 3.02 kPa, and 1.20 kPa.

- a) 11.8
- b) 13.8**
- c) 14.2
- d) 10.1

$$\begin{aligned}P_T &= P_1 + P_2 + P_3 + P_4 \\P_T &= 5 + 4.56 + 3.02 + 1.20 \\P_T &= 13.78 \text{ kPa}\end{aligned}$$



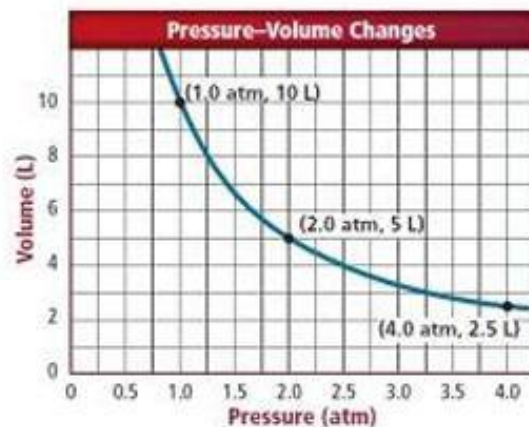
18 CHM.5.2.01.004.12 Use pressure-volume graph to determine the volume when the pressure is given and vice versa



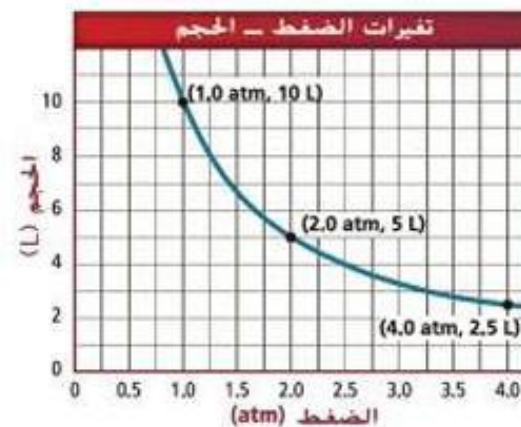
Use the graph to determine the volume if the pressure is 2.5 atm.

Use the graph to determine the pressure if the volume is 8L .

Which law is represented by the graph below?



ما القانون الذي يُمثله الرسم البياني أدناه؟



Gay-Lussac's law

قانون جاي لوساك

Boyle's Law

قانون بويل

Charles's law

قانون شارل

Henry's Law

قانون هنري

Charles's Law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

-helium balloon in a closed car occupies a volume of **2.32 L** at **40.0 °C**. If the car is parked on a hot day and the temperature inside rises to **75.0 °C**, **what is the new volume** of the balloon, assuming the pressure remains constant?

a) 3.21 L

b) 2.58 L

c) 4.62 L

d) 1.74 L

$$V_1 = 2.32 \text{ L}$$

$$T_1 = 40^\circ\text{C} + 273 = 313 \text{ K}$$

$$V_2 = ?$$

$$T_2 = 75 + 273 = 348 \text{ K}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{2.32}{313} = \frac{V_2}{348}$$

$$313 \times V_2 = 2.32 \times 348$$

$$V_2 = \frac{2.32 \times 348}{313}$$

$$V_2 = 2.58 \text{ L}$$



A sample of gas occupies a volume of **6.50 L** at **95.0 °C**. What is the Celsius temperature (**°C**) at which the volume of the gas sample will become **1.63 L**?

تشغل عينة من غاز حجمًا **6.50 L** عند درجة حرارة **95.0 °C** فما درجة الحرارة (**°C**) التي يُصبح عندها حجم عينة الغاز **1.63 L**؟





• **What volume** will the gas in the balloon at right occupy at **250 K** ?

- a) 3.07 L
- b) 2.58 L
- c) 4.62 L
- d) 1.74 L

$V_1 = 4.3 \text{ L}$ $T_1 = 350 \text{ K}$ $V_2 = ?$ $T_2 = 250 \text{ K}$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{4.3}{350} = \frac{V_2}{250}$	$350 \times V_2 = 4.3 \times 250$ $V_2 = \frac{4.3 \times 250}{350}$ $V_2 = 3.07 \text{ L}$
--	--	---



• A gas at **89°C** occupies a volume of **0.67 L**. At what Celsius temperature the volume increase to **1.12 L** ?

- a) 243.7 °C
- b) 441.3 °C
- c) 762.1 °C
- d) 332.1 °C

$V_1 = 0.67 \text{ L}$ $T_1 = 89^\circ\text{C} + 273 = 362 \text{ K}$ $V_2 = 1.12 \text{ L}$ $T_2 = ?$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{0.67}{362} = \frac{1.12}{T_2}$	$0.67 \times T_2 = 1.12 \times 362$ $T_2 = \frac{1.12 \times 362}{0.67}$ $T_2 = 605.1 \text{ K}$ $T_2 = 605.1 \text{ K} - 273$ $= 332.1^\circ\text{C}$
---	--	--





A sample of gas occupies a volume of **6.50 L** at **95.0 °C**. What is the Celsius temperature (°C) at which the volume of the gas sample will become **1.63 L**?

- a) -181 °C
- b) 365 °C
- c) -92 °C
- d) 418 °C

تشغل عينة من غاز حجمًا **6.50 L** عند درجة حرارة **95.0 °C** فما درجة الحرارة (°C) التي يُصبح عندها حجم عينة الغاز **1.63 L**؟

$$V_1 = 6.50 \text{ L}$$

$$T_1 = 95^\circ\text{C} + 273 = 368 \text{ K}$$

$$V_2 = 1.63 \text{ L}$$

$$T_2 = ?$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{6.50}{368} = \frac{1.63}{T_2}$$

$$6.50 \times T_2 = 1.63 \times 368$$

$$T_2 = \frac{1.63 \times 368}{6.50}$$

$$T_2 = 92.28 \text{ K}$$

$$T_2 = 92.28 \text{ K} - 273 = -180.7^\circ\text{C}$$



Gay-Lussac's Law

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

- 1- The pressure of the oxygen gas inside a canister is **5.00 atm** at **25.0 °C**. The canister is located at a camp high on Mount Everest. If the temperature there falls to **-10.0 °C**, **what is the new pressure** inside the canister?

- a) 3.21 atm
- b) 2.58 atm
- c) 4.41 atm**
- d) 1.74 atm

$$P_1 = 5 \text{ atm}$$

$$T_1 = 25^\circ\text{C} + 273 = 298 \text{ K}$$

$$P_2 = ?$$

$$T_2 = -10^\circ\text{C} + 273 = 263 \text{ K}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{5}{298} = \frac{P_2}{263}$$

$$P_2 \times 298 = 5 \times 263$$

$$P_2 = \frac{5 \times 263}{298}$$

$$P_2 = 4.41 \text{ atm}$$



The pressure in an automobile tire is **1.88 atm** at **25.0°C**. What will be the pressure if the temperature increases to **37.0°C**?

- a) 3.21 atm
- b) 2.58 atm
- c) 3.41 atm
- d) 1.96 atm

$P_1 = 1.88 \text{ atm}$	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$P_2 \times 298 = 1.88 \times 310$
$T_1 = 25^\circ\text{C} + 273 = 298 \text{ K}$		
$P_2 = ?$	$\frac{1.88}{298} = \frac{P_2}{310}$	$P_2 = \frac{1.88 \times 310}{298}$
$T_2 = 37^\circ\text{C} + 273 = 310 \text{ K}$		$P_2 = 1.96 \text{ atm}$

Helium gas in a **2.00-L** cylinder is under **1.12 atm** pressure. At **36.5°C**, that same gas sample has a pressure of **2.56 atm**. What was the initial temperature of the gas in the cylinder?

- a) 231.2 K
- b) 135.4 K
- c) 312.5 K
- d) 161.3 K

$P_1 = 1.12 \text{ atm}$	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$T_1 \times 2.56 = 1.12 \times 309.5$
$T_1 = ?$		
$P_2 = 2.56 \text{ atm}$	$\frac{1.12}{T_1} = \frac{2.56}{309.5}$	$T_1 = \frac{1.12 \times 309.5}{2.56}$
$T_2 = 36.6^\circ\text{C} + 273 = 309.5 \text{ K}$		$T_1 = 135.4 \text{ K}$



standard temperature and pressure (STP).

0.00°C (273K) and 1.00 atm

1 mol of any gas occupies a volume of 22.4 L at STP.

Using Avogadro's principle

Remember 1 mol = 22.4L

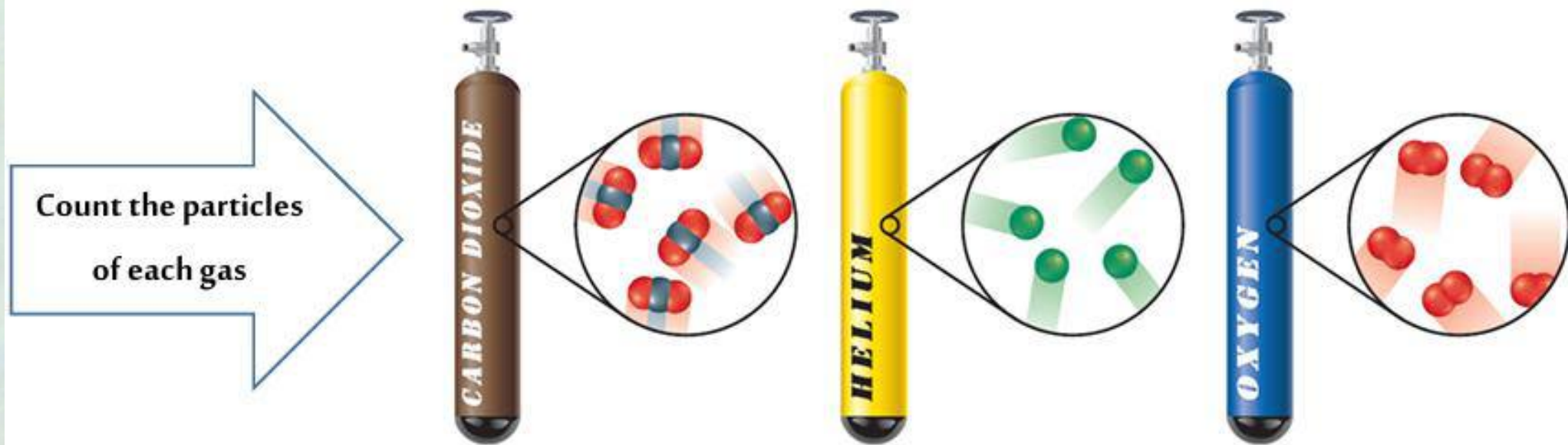
1. What is the volume of gas in liters of 3.8 moles of CO₂ gas at STP?

$$3.8 \text{ moles} \times \frac{22.4L}{1 \text{ mole}} = 85.12L$$

2. What is the volume of gas in liters of 1.5 moles of O₂ gas at STP?

$$1.5 \text{ moles} \times \frac{22.4L}{1 \text{ mole}} = 33.6L$$

Avogadro's principle states that equal volumes of gases at the same temperature and pressure contain equal numbers of particles.



How many particles are in 1 mole?

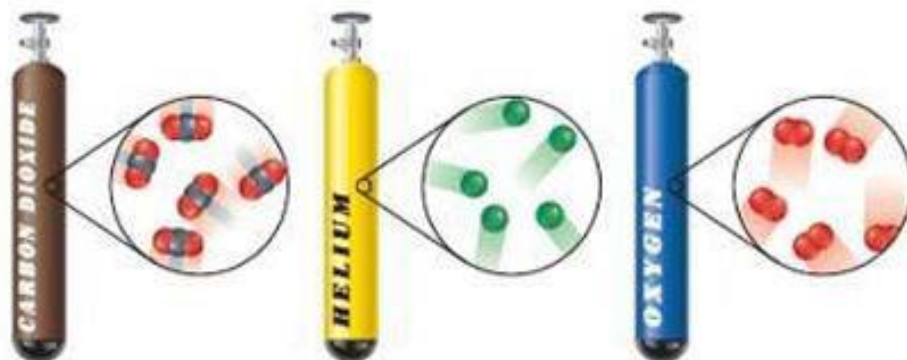


"Equal volumes of gases at the same pressure and temperature contain equal numbers of particles."

This is the statement of

"الأحجام المتساوية من الغازات تحتوي عند نفس الضغط ودرجة الحرارة

على أعداد متساوية من الجسيمات" هو نص



Combined gas law

القانون العام للغازات

Le Châtelier's principle

مبدأ لو شاتيليه

Ideal gas law

القانون الغاز المثالي

Avogadro's principle

مبدأ أفوجادرو



According to Avogadro's principle, 1 mol of any gas at STP occupies a volume of _____.

22.4 L

3.72 L

1.00 L

6.02 L

What are the standard temperature and pressure (STP) for a gas?

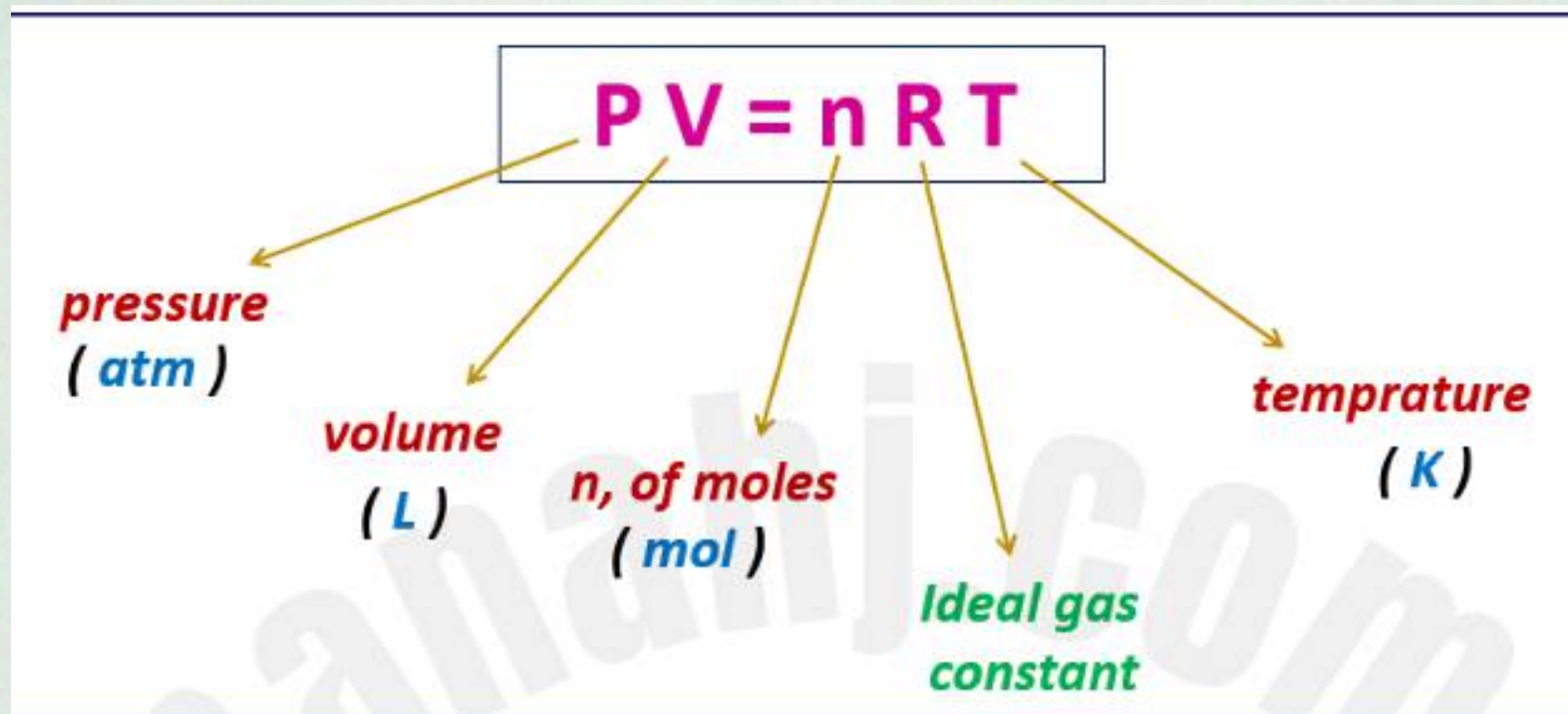
Temperature = 0 °C and pressure = 1 kPa

Temperature = 273 °C and pressure = 1 atm

Temperature = 1 °C and pressure = 0 atm

Temperature = 0 °C and pressure = 1 atm





$$R = \frac{PV}{nT} = \frac{1 \text{ atm} \times 22.4 \text{ L}}{1 \text{ mol} \times 273 \text{ K}} = 0.0821 \text{ atm} \cdot \text{L} / \text{mol} \cdot \text{K}$$

1. Determine the Celsius temperature of **2.49 mol** of a gas contained in a **1.00-L** vessel at a pressure of **143 kPa**.

- a) 6.9 °C
- b) -266 °C**
- c) -133 °C
- d) -13.7 °C

$$n = 2.49 \text{ mol}$$

$$V = 1.0 \text{ L}$$

$$P = 143 \text{ kPa} \times \frac{1 \text{ atm}}{101.3 \text{ kPa}} = 1.41 \text{ atm}$$

$$R = 0.0821$$

$$T = ?$$

$$PV = nRT$$

$$1.41 \times 1 = 2.49 \times 0.0821 \times T$$

$$T = 6.9 - 273$$

$$T = -266.1 \text{ °C}$$

2. Calculate the volume of a **0.323-mol** sample of a gas at **265 K** and **0.900 atm**.

- a) 3.9 L
- b) 5.2 L
- c) 3.6 L
- d) 7.8 L**

$$V = ?$$

$$n = 0.323 \text{ mol}$$

$$T = 265 \text{ K}$$

$$P = 0.900 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$0.900 \times V = 0.323 \times 0.0821 \times 265$$

$$V = 7.81 \text{ L}$$

3. What is the pressure, in atmospheres, of a **0.108-mol** sample of helium gas at a temperature of **20.0°C** if its volume is **0.505 L**?

- a) 10.3 atm
- b) 5.14 atm**
- c) 2.07 atm
- d) 3.24 atm

$$V = 0.505 \text{ L}$$

$$n = 0.108 \text{ mol}$$

$$T = 20^\circ\text{C} + 273 = 293 \text{ K}$$

$$P = ?$$

$$R = 0.0821$$

$$PV = nRT$$

$$P \times 0.505 = 0.108 \times 0.0821 \times 293$$

$$P = 5.14 \text{ atm}$$

4. If the pressure exerted by a gas at **25°C** in a volume of **0.044 L** is **3.81 atm**, how many moles of gas are present?

- a) $9.5 \times 10^{-4} \text{ mol}$
- b) $6.9 \times 10^{-3} \text{ mol}$**
- c) $8.5 \times 10^{-4} \text{ mol}$
- d) $3.7 \times 10^{-3} \text{ mol}$

$$V = 0.044 \text{ L}$$

$$n = ?$$

$$T = 25^\circ\text{C} + 273 = 298 \text{ K}$$

$$P = 3.81 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$3.81 \times 0.044 = n \times 0.0821 \times 298$$

$$n = \frac{3.81 \times 0.044}{0.0821 \times 298}$$

$$n = 6.9 \times 10^{-3} \text{ mol}$$



If the pressure exerted by a gas at **35°C** in a volume of **0.044 L** is **7.62 atm**

How many moles of gas are present?

$$R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$V = 0.044 \text{ L}$$

$$n = ?$$

$$T = 35^\circ\text{C} + 273 = 308 \text{ K}$$

$$P = 7.62 \text{ atm}$$

$$R = 0.0821$$

$$PV = nRT$$

$$7.62 \times 0.044 = n \times 0.0821 \times 308$$

$$n = \frac{7.62 \times 0.044}{0.0821 \times 308}$$

$$n = 0.013 \text{ mol}$$

إذا كان الضغط المبذول من غاز عند درجة حرارة **35 °C** يُساوي

7.62 atm في حجم مقداره **0.044 L**

فكم عدد مولات الغاز الموجودة؟

$$4.25 \text{ mol (a)}$$

$$0.068 \text{ mol (b)}$$

$$4.45 \text{ mol (c)}$$

$$0.013 \text{ mol (d)}$$



How much carbon dioxide gas, in grams, is in

a 2.75 L balloon at STP?

Molar mass of carbon dioxide = 44.0 g/mol

ما كمية ثاني أكسيد الكربون بالجرام الموجودة في بالون حجمه 2.75 L

عند درجة الحرارة والضغط القياسيين STP ؟

الكتلة المولية لثاني أكسيد الكربون = 44.0 g/mol

$$R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$V = 2.75 \text{ L}$$

$$m = ?$$

$$T = 273 \text{ K}$$

$$P = 1 \text{ atm}$$

$$R = 0.0821$$

$$M = 44 \text{ g/mol}$$

$$M = \frac{mRT}{PV}$$

$$44 = \frac{m \times 0.0821 \times 273}{1 \times 2.75}$$

$$m = 5.40 \text{ g}$$

$$7.25 \text{ g (a)}$$

$$6.35 \text{ g (b)}$$

$$5.40 \text{ g (c)}$$

$$3.65 \text{ g (d)}$$

	<u>Ideal gases(follow kinetic molecular theory)</u>	<u>Real gases(deviate from ideal)</u>
Particles behaviour	Particles take up no space	Particles have volume
	No attraction or repulsion	There are intermolecular interactions
	Collisions between particles are elastic	Collisions are not elastic
Conditions	High temperature	Low temperature
	Low pressure	High pressure
	Nonpolar	Polar
	Small particles(low molar mass)	Large particles(high molar mass)

Polarity and size of particles :

The nature of the particles making up a gas also affects how ideally the gas behaves.
For example,

* polar gas molecules, such as *water vapor (H_2O)*, generally have large attractive forces between their particles ,

because the oppositely charged ends of polar molecules are *pulled* together through electrostatic forces,

→ then *polar gases* deviate from ideal gas behavior .

* nonpolar gases, such as *helium (He)* generally have low attractive forces between their particles .

→ then *nonpolar gases* approach to ideal gas behavior .

When does a real gas behave like an ideal gas?

- a. When the particles are far apart and attractive forces decreases
- b. When the particles are closer together and attractive forces increases
- c. At high pressure and low temperature
- d. When the gas is liquefied if enough pressure is applied

When real gases deviate most from ideal gas behavior?

- A – At high pressures and low temperatures
- B – At low pressures and high temperatures
- C – At high pressures and high temperatures
- D - At low pressures and low temperatures

Regarding both ideal and real gases , which of the following is correct ?

- a- gases of a larger particles behave as ideal gases .
- b- polar gases like water behave as ideal gases .
- c- real gases deviate most from ideal gas behavior at a high pressures and low temperatures
- d- ideal gases experience intermolecular attractive forces and attracted , repelled by the walls of the container

When does a real gas behave like an ideal gas?

متى يسلك الغاز الحقيقي مثل الغاز المثالي؟

At high pressure and low temperature

عند الضغط العالي ودرجة الحرارة المنخفضة

When high pressure is applied and the gas changes to the liquid phase

عندما تتحول حالة الغاز إلى سائل، عند التأثير عليه بضغط مرتفع

When the particles are close to each other, and attractive forces are high

عندما تقترب الجزيئات عن بعضها البعض وتزداد قوى التجاذب

When the particles are far apart, and the attractive forces are low

عندما تبتعد الجزيئات عن بعضها البعض وتقل قوى التجاذب

Regarding both ideal and real gases.

فيما يتعلق بكل من الغازات المثالية والغازات الحقيقية.

Which of the following is **correct**?

أي مما يأتي **صحيح**؟

Polar gases like water vapor behave
as ideal gases

(a) تسلك الغازات القطبية مثل بخار الماء سلوك الغاز المثالي

Gases of larger particles like butane (C_4H_{10})
behave as ideal gases

(b) تسلك الغازات ذات الجزيئات الأكبر حجماً مثل البيوتان (C_4H_{10})
سلوك الغاز المثالي

Real gases deviate most from ideal gas behavior
at high pressures and low temperatures

(c) تنحرف الغازات الحقيقية كثيراً عن سلوك الغاز المثالي عند
الضغوط العالية ودرجات الحرارة المنخفضة

Ideal gases experience intermolecular attractive
forces, and they are attracted, repelled by the walls
of their containers

(d) الغازات المثالية لديها قوى تجاذب بين جسيماتها وتتجاذب
وتتنافر مع جدران الأوعية الموجودة فيها

$$\text{percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

1. What is the percent by mass of NaHCO_3 in a solution containing **20.0 g** of NaHCO_3 dissolved in **600.0 g** of H_2O ?

a) 3.23 %

b) 3.33 %

c) 4.25 %

d) 7.65 %

$$\text{percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

$$\begin{aligned}\text{Percent by mass} &= \frac{20}{600 + 20} \times 100 \\ &= 3.23 \%\end{aligned}$$



What is the percent by mass of sodium chloride NaCl in a solution containing 4.0 g of NaCl dissolved in 100.0 g of water H₂O?

ما النسبة المئوية بالكتلة لكلوريد الصوديوم NaCl في محلول يحتوي على 4.0 g من NaCl مذابة في 100.0 g من الماء H₂O؟

a) 3.8 %

b) 4.0 %

c) 3.3 %

d) 4.8 %

$$\text{percent by mass} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100$$

$$\begin{aligned}\text{Percent by mass} &= \frac{4}{100 + 4} \times 100 \\ &= 3.85 \%\end{aligned}$$



Molarity

$$\text{molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

The molarity of a solution equals the moles of solute divided by the liters of solution.

1. What is the **molarity** of an aqueous solution containing **40.0 g** of glucose ($\text{C}_6\text{H}_{12}\text{O}_6$) in **1.5 L** of solution? (*molar mass of $\text{C}_6\text{H}_{12}\text{O}_6$ = 180 g/mol*)

a) 0.147 M

b) 0.113 M

c) 0.125 M

d) 0.185 M

$$40 \cancel{\text{g}} \times \frac{1 \text{ mol}}{180 \cancel{\text{g}}} = 0.22 \text{ mol} \quad \text{--- } n$$
$$M = \frac{n}{V} = \frac{0.22}{1.5} = 0.147 \text{ M}$$



What is the molarity of an aqueous solution containing 40.0 g of glucose ($C_6H_{12}O_6$) in 1.5 L of solution?

ما مولارية محلول يحتوي على 40.0 g من الجلوكوز ($C_6H_{12}O_6$) في 1.5 L من المحلول؟

180.16 g/mol	الكتلة المولية للجلوكوز
	Molar mass of Glucose

a) 0.15 M

b) 0.22 M

c) 1.33 M

d) 1.14 M

$$40 \cancel{\text{g}} \times \frac{1 \text{ mol}}{180.16 \cancel{\text{g}}} = 0.22 \text{ mol} \quad n$$

$$M = \frac{n}{V} = \frac{0.22}{1.5} = 0.147 \text{ M}$$



What mass of calcium hydroxide Ca(OH)_2 is needed to produce 1500 mL of a 0.025M solution?

(Molar mass of $\text{Ca(OH)}_2 = 74.09 \text{ g/mol}$)

ما كتلة هيدروكسيد الكالسيوم Ca(OH)_2 اللازمة لتحضير محلول حجمه 1500 mL وتركيزه 0.025 M؟

(الكتلة المولية لـ $\text{Ca(OH)}_2 = 74.09 \text{ g/mol}$)

Dilution Equation

$$M_1 V_1 = M_2 V_2$$

M represents molarity.

V represents volume.

What volume (in mL) of a 2.50 M HCl stock solution is needed to prepare 400.0 mL of a 0.625 M HCl solution?

- A – 800
- B – 400
- C – 200
- D – 100

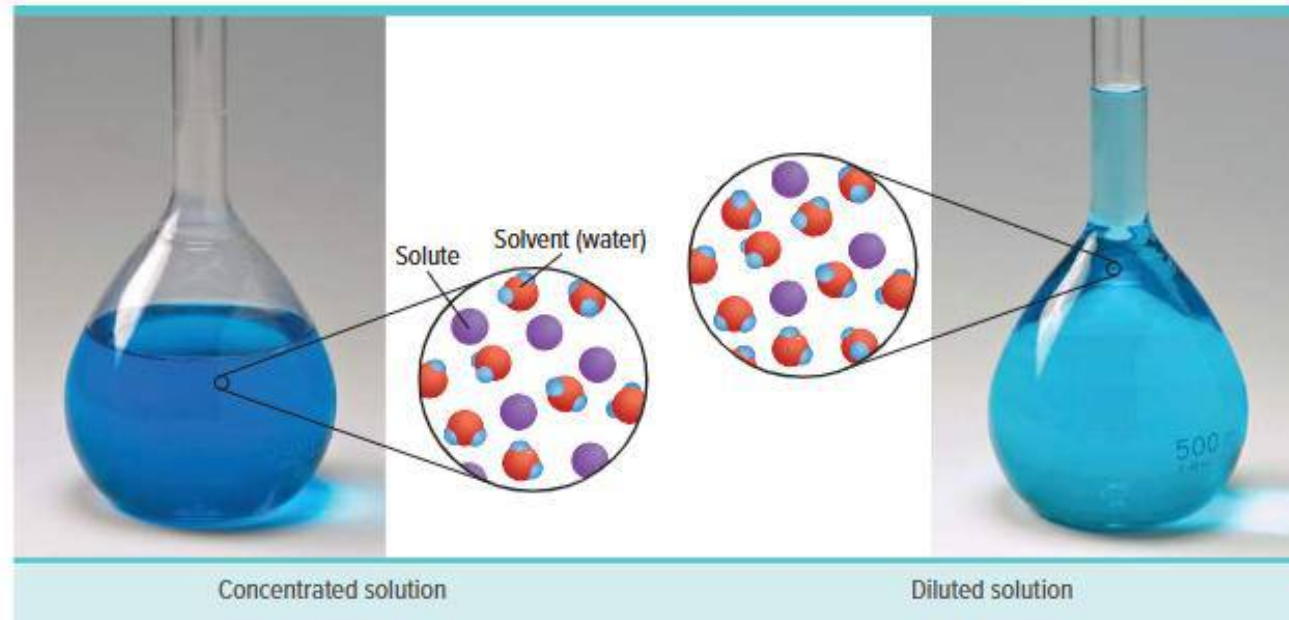


Figure 9 A concentrated solution can be diluted by adding solvent. The number of moles of solute does not change when a concentrated solution is diluted.



Which of the following is **correct** about diluting solution?

أي مما يلي **صحيح** حول تخفيف المحلول؟

The total number of moles of solute does not change

عدد المولات الإجمالي للمذاب لا يتغير ☐

The total number of moles of solute increases

عدد المولات الإجمالي للمذاب يزداد ☐

The total number of moles of solute decreases

عدد المولات الإجمالي للمذاب يقل ☐

The total number of moles of solute is doubled

عدد المولات الإجمالي للمذاب يتضاعف ☐





What volume of 2.00 M calcium chloride (CaCl_2) stock solution would you need to prepare 0.5 L of 0.5 M CaCl_2 ?

ما حجم المحلول القياسي لكبريت الكالسيوم (CaCl_2) تركيزه 2.00 M
اللازم لتحضير محلول حجمه 0.5 L من CaCl_2 تركيزه 0.5 M؟





What volume (**in mL**) of a 2.50 M HCl stock solution is needed to prepare 400.0 mL of a 0.625 M HCl solution?

- A – 800
- B – 400
- C – 200
- D - 100





How much 1M sodium hydroxide (NaOH), in milliliters, is needed to make 500 mL of 0.01M NaOH?

كم تحتاج من هيدروكسيد الصوديوم (NaOH) الذي تركيزه 1M بالمليتر لتحضير 500 mL من 0.01M NaOH؟

50 mL

5 mL

0.5 mL

500 mL



Molality

$$\text{molality } (m) = \frac{\text{moles of solute}}{\text{kg of solvent}}$$

The molality of a solution equals the moles of solute divided by kilograms of solvent.

1. What is the molality of a solution containing **10.0 g** of NaOH dissolved in **1000.0 g** of water?

(molar mass of NaOH = 40 g/mol)

1 kg
kg solvent

- a) 0.62 m
- b) 0.155 m
- c) 0.375 m
- d) 0.25 m**

$$10.0 \text{ g} \times \frac{1 \text{ mol}}{40 \text{ g}} = 0.25 \text{ mol}$$

$$m = \frac{n}{\text{kg solvent}}$$

$$m = \frac{0.25}{1}$$

$$m = 0.25 \text{ m}$$



What is the molality of a solution containing 5.0 g of sodium chloride (NaCl) dissolved in 100.0 g of water (H₂O)?

ما مولالية محلول يحتوي على 5.0 g من كلوريد الصوديوم (NaCl) ذائبة في 100.0 g من الماء (H₂O)?

Molar mass الكتلة المولية	Compound المركب
58.44 g/mol	كلوريد الصوديوم (NaCl) Sodium chloride

- a) 0.86 mol/Kg
- b) 0.18 mol/Kg
- c) 0.25 mol/Kg
- d) 0.77 mol/Kg





Which of the following express molality?

أي مما يلي يُعبر عن المولالية؟

a.

$$\frac{\text{moles of solute}}{\text{liters of solution}}$$

$$\frac{\text{عدد مولات المُذاب}}{\text{حجم المحلول (L)}}$$

b.

$$\text{moles of solute} \times \text{liters of solution} \quad \text{عدد مولات المُذاب} \times \text{حجم المحلول (L)}$$

c.

$$\frac{\text{moles of solute}}{\text{kg of solvent}}$$

$$\frac{\text{عدد مولات المُذاب}}{\text{كتلة المذيب (kg)}}$$

d.

$$\text{moles of solute} \times \text{kg of solvent} \quad \text{عدد مولات المُذاب} \times \text{كتلة المذيب (kg)}$$



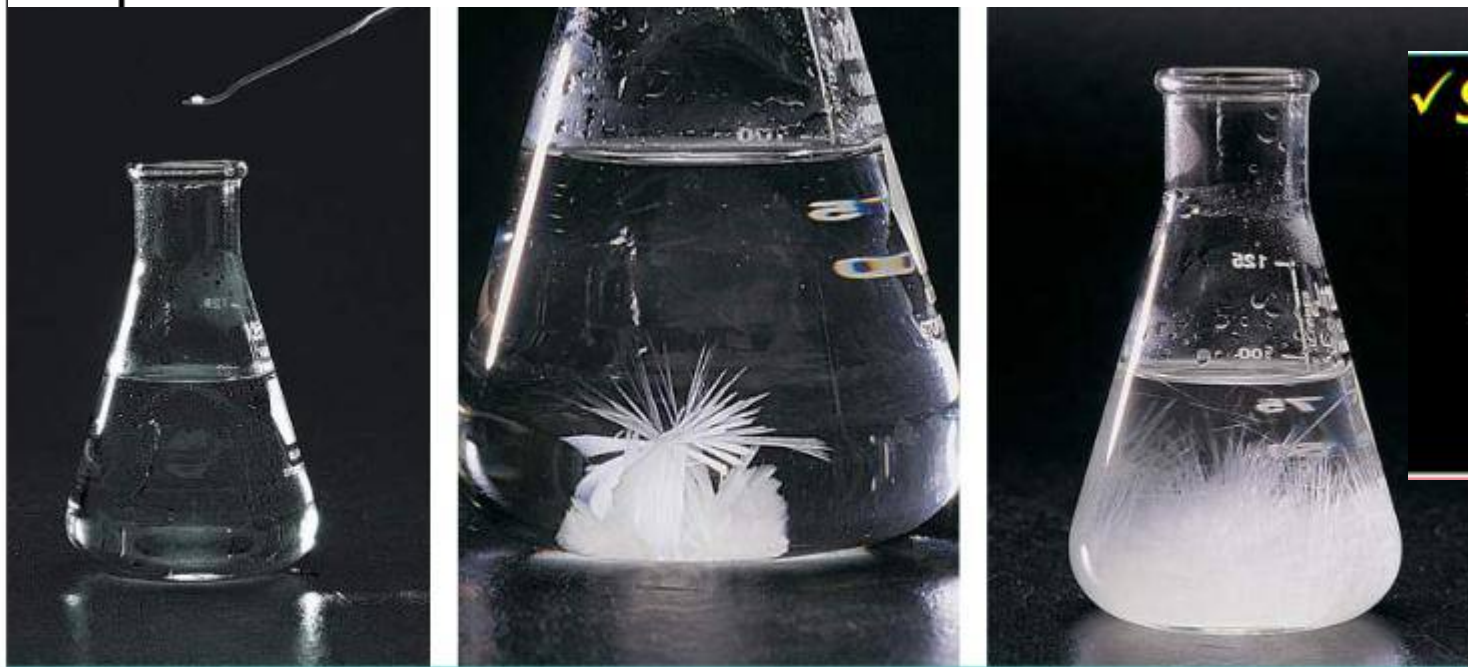


Figure 17 When a seed crystal is added to a supersaturated solution, the excess solute crystallizes out of the solution.

✓ **Supersaturated**

- Solvent holds *more* solute than is normally possible at that temperature.
- These solutions are unstable; crystallization can often be stimulated by adding a “seed crystal” or scratching the side of the flask.

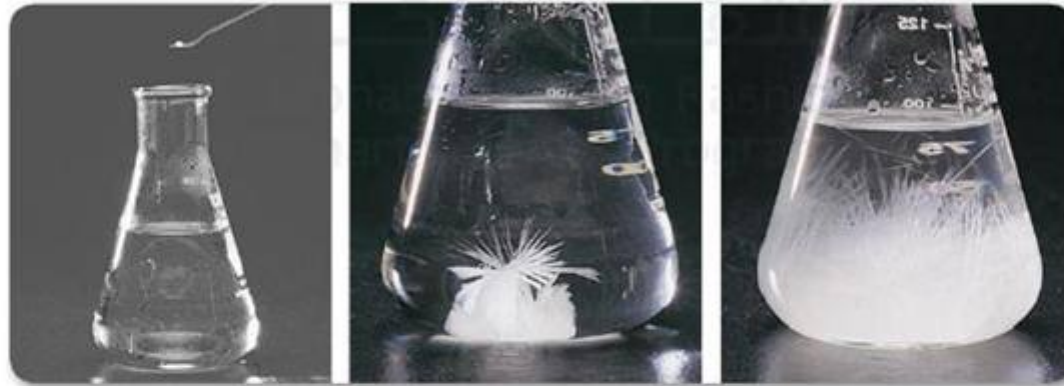
1 – Unsaturated solution: solution that contains less dissolved solute for a given temperature and pressure than a saturated solution.

2 –saturated solution: solution that contains maximum amount of dissolved solute for a given amount of solvent at a specific temperature and pressure.

3 –saturated solution: solution that contains more dissolved solute than a saturated solution at the same temperature and pressure.

Which is **correct** to when add seed crystal add to supersaturated solution ?

أي مما يلي **صحيح** عند إضافة نواة التبلور إلى المحلول فوق المشبع ؟



A. To allow excess solute to remain dissolved in lower temperature

السماح للمادة الذائبة الزائدة بأن تبقى مذابة في المحلول عند درجة حرارة منخفضة

B. To allow excess solute crystallizes out of the solution

للسماح للمادة الزائدة بالتبلور

C. To allow excess solute to remain dissolved in higher temperature

السماح للمادة الذائبة الزائدة بأن تبقى مذابة في المحلول عند درجة حرارة مرتفعة

D. To allow supersaturated solution stable when seed crystal add

لتسمح للمحلول فوق المشبع ثابتة عند إضافة نواة التبلور

Regarding to have a crystal from supersaturation solution, which of the following is **correct**?

فيما يتعلق بالحصول بلورات من المحلول فوق المشبع ، أي مما يأتي **صحيح** ؟

Add a seed crystal	إضافة نواة التبلور	1
scratching the inside of container	خدش الجزء الداخلي من الوعاء	2
Physical shock like stirring or tapping the container	صدمة مادية مثل التحريك أو الطرق على الوعاء	3

A. **1** only

B. **3** only

C. **1,2** only

D. 1,2 and 3

Regarding to have a crystal from supersaturation solution, which of the following is **incorrect**?

فيما يتعلق بالحصول بلورات من المحلول فوق المشبع ، أي مما يأتي **غير صحيح** ؟

Add a seed crystal	إضافة نواة التبلور	1
scratching the inside of container	خدش الجزء الداخلي من الوعاء	2
keep the solution out of Physical shock like stirring or tapping the container	حفظ المحلول من صدمة مادية مثل التحريك أو الطرق على الوعاء	3

A. 3 only

B. 1 only

C. 1,2

D. 2,3

Which of the following solutions contains less dissolved solute at specific temperature and pressure ?

أي المحاليل التالية يحتوي على كمية أقل من المذاب عند حرارة وضغط معينين؟

A. Saturated solution

المحلول المشبع

B. Unsaturated solution

المحلول غير المشبع

C. supersaturated solution

المحلول فوق المشبع

D. concentration solution

المحلول المركز

Which of the following solutions contains maximum amount of solute dissolved at specific temperature and pressure ?

أي المحاليل التالية يحتوي على أكبر كمية من المذاب مذابة عند حرارة وضغط معينين؟

A. concentration solution

المحلول المركز

B. Unsaturated solution

المحلول غير المشبع

C. supersaturated solution

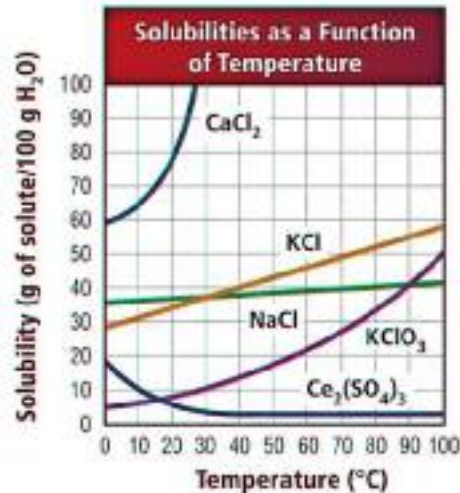
المحلول فوق المشبع

D. Saturated solution

المحلول المشبع

Using the graph below, which of the following statements is in **not correct**?

باستخدام الرسم البياني أدناه ، أي من العبارات التالية **غير صحيحة** ؟



A. KClO₃ solubility increases as temperature increases

ذائبية KClO₃ تزداد إذا ما ارتفعت درجة الحرارة

B. KCl has the highest increase in solubility with increasing temperature.

KCl له أعلى زيادة في الذائبية مع زيادة درجة الحرارة

C. Ce₂(SO₄)₂ solubility decreases rapidly as temperature increases

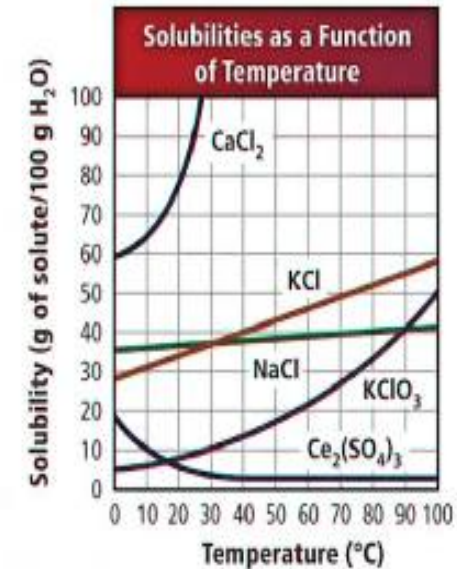
ذائبية Ce₂(SO₄)₂ تقل بسرعة عند زيادة درجة الحرارة

D. CaCl₂ has a solubility equals 64 g per 100 g of H₂O at 10°C

ذائبية CaCl₂ تساوي 64g لكل 100g H₂O عند 10°C

From the graph below determine the solubility of KClO₃ at 75°C ?

من الرسم البياني حدد: ذائبية KClO₃ عند درجة حرارة 75°C ؟



A. 40 g/ g H₂O

B. 30 g/100 g H₂O

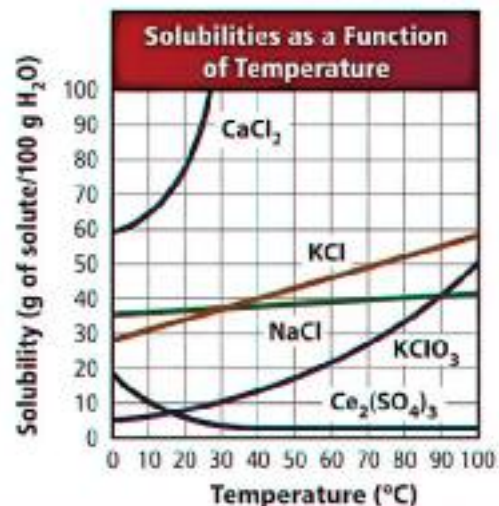
C. 30 g/ g H₂O

D. 40 g/100 g H₂O



From the graph below determine the solubility of KCl at 40°C ?

من الرسم البياني حدد: ذائبية KCl عند درجة حرارة 40°C ؟



A. 50 g/100 g H₂O

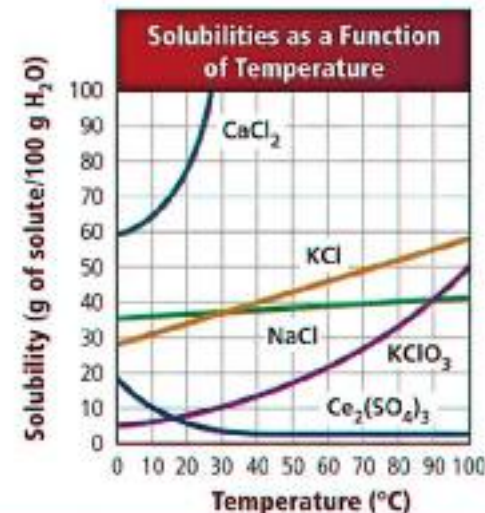
B. 40 g/ g H₂O

C. 40 g/ 100g H₂O

D. 50 g/ g H₂O

From the graph below determine the solubility of KClO₃ at 90°C ?

من الرسم البياني حدد: ذائبية KClO₃ عند درجة حرارة 90°C ؟



A. 50 g/100 g H₂O

B. 40 g/ g H₂O

C. 40 g/ 100g H₂O

D. 50 g/ g H₂O

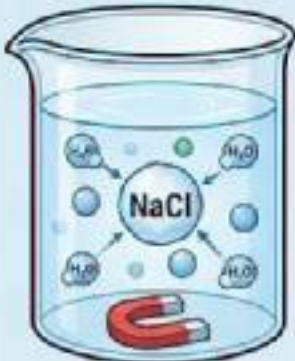


SOLVATION: Contact is Crucial



Method A - Agitation (Stirring or Shaking)

Unstirred
Low Collision Rate

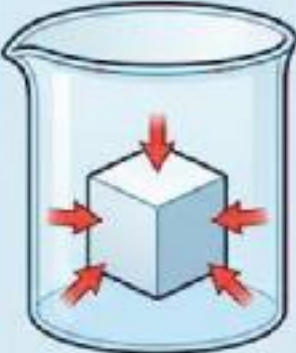


Agitated (Stirring)
High Collision Rate → Faster Dissolution



Method B - Surface Area

Whole Crystal (Low Surface Area)
Few Collision Points

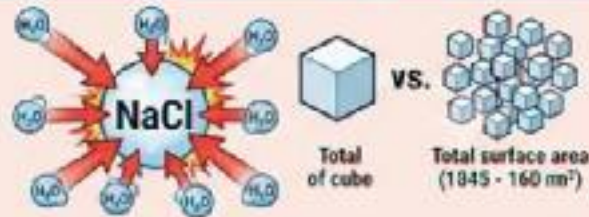


Crushed/Powder (High Surface Area)
Massive Collision Points → Faster Dissolution



Additional Factor - Temperature

Higher Temperature
High Kinetic Energy → High Collision Frequency → Faster Solvation



C - TEMPERATURE: THE EFFECT OF TEMPERATURE ON SOLVATION

Effect of Temperature when:



1. GAS DISSOLVES IN LIQUID



(↑ Temperature of Liquid → ↓ Solvation of Gas)



Explain: (e.g., Soda losing fizz)

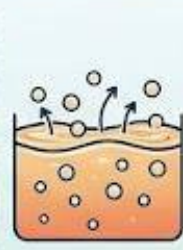


Low kinetic



COLD SODA

Less kinetic energy,
more gas retained



ROOM TEMP SODA

Increasing temperature
→ ↑ kinetic energy of gas
particles → gas escaping
→ ↓ solvation



2. SOLID DISSOLVES IN LIQUID



(↑ Temperature of Liquid → ↑ Solvation of Solid)



Explain: (e.g., Sugar in hot tea)

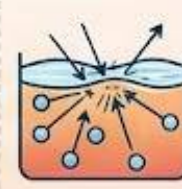


Low kinetic



COLD TEA

Fewer solvent-solute
collisions



HOT TEA

Increasing temperature
→ ↑ kinetic energy of
solvent particles →
↑ collisions → ↑ solvation



A sugar cube in iced tea will dissolve slowly, but stirring will make the sugar cube dissolve more quickly.



Granulated sugar dissolves faster in iced tea than a sugar cube. Stirring speeds the process.



Granulated sugar dissolves very quickly in hot tea.

Figure 14 Agitation, surface area, and temperature affect the rate of solvation.





1-

Which of the following factors generally **increase** the rate at which a **solid** dissolve in liquid?أي من العوامل التالية تؤدي بشكل عام إلى **زيادة** معدل ذوبان مادة صلبة ما في مادة سائلة؟

i.	Increasing the pressure of solution	زيادة في ضغط المحلول
ii.	Shaking or stirring the solution	رج أو تحريك المحلول
iii.	Increasing the surface area of the solute	زيادة مساحة سطح المذاب
iv.	Increasing the temperature of the solvent	زيادة درجة حرارة المذيب

A. i and ii only

B. i, ii and iii only

C. ii and iii only

D. ii, iii and iv only

2-

Which of the following is **slowest** to dissolve?(when using the same amount of tea and sugar)

أي مما يلي هو الأبطأ في الذوبان؟ (عند استخدام نفس الكميات من الشاي والسكر)

A. Granulated sugar in hot tea with stirring	السكر المطحون في الشاي الساخن مع التحريك
B. A cube sugar in iced tea without stirring	مكعب السكر في الشاي المثلج بدون التحريك
C. A cube sugar in hot tea with stirring	مكعب السكر في الشاي الساخن مع التحريك
D. Granulated sugar in iced tea without stirring	السكر المطحون في الشاي المثلج بدون التحريك



Regarding the effect of the temperature on the rate of solvation of substance, which of the following is **correct**?

فيما يتعلق بتأثير درجة الحرارة على سرعة ذوبان المواد، أي مما يأتي **صحيح**؟

تذوب معظم المواد الصلبة في المذيب الساخن أبطأ منها في المذيب البارد Solvation of most solid substances in hotter solvents more slowly than in colder solvents	1
تزداد كمية المادة المذابة في المذيب الساخن عنها في المذيب البارد The amount of solute increases in hot solvent than in cold solvent	2
تقل ذوبانية الغازات بزيادة درجة الحرارة Decrease the solubility of gases by increasing the temperature	3

A. 2 only

B. 1 only

C. 1,2

D. 2,3

Regarding the effect of the temperature on the rate of solvation of substance, which of the following is **incorrect**?

فيما يتعلق بتأثير درجة الحرارة على سرعة ذوبان المواد، أي مما يأتي **غير صحيح**؟

تذوب معظم المواد الصلبة في المذيب الساخن أسرع منها في المذيب البارد Solvation of most solid substances in hotter solvents more quickly than in colder solvents	1
تزداد كمية المادة المذابة في المذيب الساخن عنها في المذيب البارد The amount of solute increases in hot solvent than in cold solvent	2
تزداد ذوبانية الغازات بزيادة درجة الحرارة Increase the solubility of gases by increasing the temperature	3

A. 1 only

B. 3 only

C. 1,2

D. 2,3





Regarding the effect of the temperature on the rate of solvation of substance, which of the following is **correct**?

فيما يتعلق بتأثير درجة الحرارة على سرعة ذوبان المواد، أي مما يأتي **صحيح** ؟

1	تذوب معظم المواد الصلبة في المذيب الساخن أسرع منها في المذيب البارد Solvation of most solid substances in hotter solvents faster than in colder solvents
2	تقل كمية المادة المذابة في المذيب الساخن عنها في المذيب البارد The amount of solute decrease is hot solvent than in cold solvent
3	تزداد ذوبانية الغازات بزيادة درجة الحرارة Increase the solubility of gases by increasing the temperature

Which of the following is **correct** regarding to relation between the temperature and solubility of gas?

أي مما يأتي **صحيح** فيما يتعلق بالعلاقة بين درجة الحرارة وذائبية الغاز ؟

A. The solubility of gas decrease when temperature increase due to decrease in kinetic energy of particles	تقل ذائبية الغاز بارتفاع درجة الحرارة لأن الطاقة الحركية لجزيئات الغاز تقل.
B. The solubility of gas decrease when temperature increase due to increase in kinetic energy of particles	تقل ذائبية الغاز بارتفاع درجة الحرارة لأن الطاقة الحركية لجزيئات الغاز تزداد.
C. The solubility of gas increase when temperature decrease due to increase in kinetic energy of particles	تزداد ذائبية الغاز بانخفاض درجة الحرارة لأن الطاقة الحركية لجزيئات الغاز تزداد.
D. The solubility of gas increase when temperature increase due to decrease in kinetic energy of particles	تزداد ذائبية الغاز بارتفاع درجة الحرارة لأن الطاقة الحركية لجزيئات الغاز تقل.

A. **1** only

B. **3** only

C. **1,2**

D. **2,3**





Which of the following present the fastest dissolving when using the same amount of sugar and tea?

أي مما يلي يُعتبر الأسرع في الذوبان عند استخدام نفس الكميات من السكر والشاي؟

Granulated sugar in iced tea while stirring

السكر المطحون في الشاي المثلج مع التحريك

C

A sugar cube in iced tea

مكعب السكر في الشاي المثلج

C

Granulated sugar in hot tea while stirring

السكر المطحون في الشاي الساخن مع التحريك

C

Granulated sugar in iced tea

السكر المطحون في الشاي المثلج

C

Which of the following is **slowest** to dissolve?(when using the same amount of tea and sugar)

أي مما يلي هو الأبطأ في الذوبان؟ (عند استخدام نفس الكميات من الشاي والسكر)

A. Granulated sugar in hot tea with stirring

السكر المطحون في الشاي الساخن مع التحريك

B. A cube sugar in iced tea without stirring

مكعب السكر في الشاي المثلج بدون التحريك

C. A cube sugar in hot tea with stirring

مكعب السكر في الشاي الساخن مع التحريك

D. Granulated sugar in iced tea without stirring

السكر المطحون في الشاي المثلج بدون التحريك