

## Module 9: The Mole



### تم تحميل هذا الملف من موقع المناهج الإماراتية

موقع المناهج ← المناهج الإماراتية ← الصف الثاني عشر العام ← كيمياء ← الفصل الأول ← ملفات متنوعة ← الملف

تاريخ إضافة الملف على موقع المناهج: 2026-09-26 23:47:23

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منهج انجليزي | ملخصات وتقارير | مذكرات وبنوك | الامتحان النهائي | للمدرس

المزيد من مادة  
كيمياء:

إعداد: Waswas Issa

### التواصل الاجتماعي بحسب الصف الثاني عشر العام



صفحة المناهج  
الإماراتية على  
فيسبوك

الرياضيات

اللغة الانجليزية

اللغة العربية

التربية الاسلامية

المواد على تلغرام

### المزيد من الملفات بحسب الصف الثاني عشر العام والمادة كيمياء في الفصل الأول

حل مراجعة نهائية وفق الهيكل الوزاري الجديد منهج بريدج

1

مراجعة وفق الهيكل الوزاري الجديد المسار 101-C منهج بريدج

2

حل أسئلة مراجعة عامة القسم الالكتروني المسار M

3

حل تجميعية أسئلة وفق الهيكل الوزاري الجديد المسار M باللغتين العربية والانجليزية

4

مراجعة نهائية وفق الهيكل الوزاري الجديد منهج بريدج

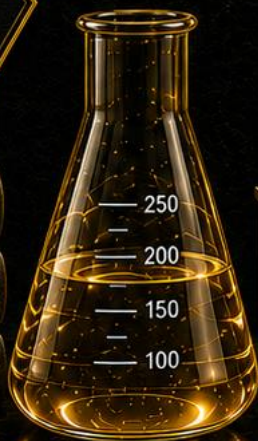
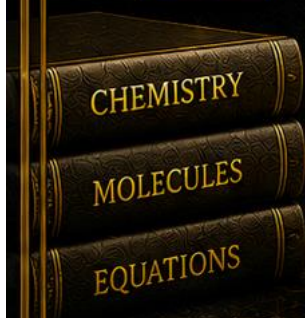
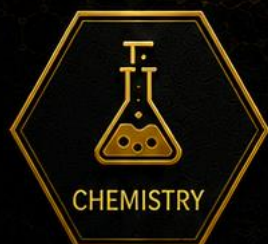
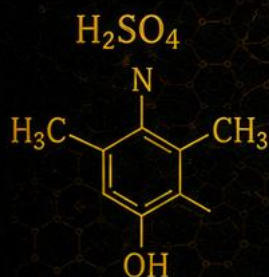
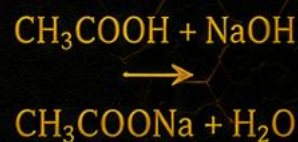
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طريقك نحو التفوق

# CHEMISTRY

## Grade 12 GENERAL

• TERM 1 •  
2026 – 2027



CONCEPT  
FOCUSED



CLEAR  
EXPLANATIONS



PRACTICE  
QUESTIONS



HIGHER  
LEVEL

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**فيديوهات شرح وحل**  
**الملزمة كاملة متوفرة**

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Grade 12  
General

Chemistry  
TERM 1 • 2026 – 2027



## Module 9:

*Chemistry*  
COUNTING  
CONNECTS  
THE WORLD

# The Mole

|                       |                       |                      |
|-----------------------|-----------------------|----------------------|
| 6<br>C<br>Carbon      | 7<br>N<br>Nitrogen    | 8<br>O<br>Oxygen     |
| 14<br>Si<br>Silicon   | 15<br>P<br>Phosphorus | 16<br>S<br>Sulfur    |
| 32<br>Ge<br>Germanium | 33<br>As<br>Arsenic   | 34<br>Se<br>Selenium |



AVOGADRO'S  
NUMBER



MOLAR  
MASS



MOLES  
IN REACTIONS



REPRESENTATIVE  
PARTICLES

$$n = \frac{m}{M}$$



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## **Lesson (1)**

# **Measuring Matter**

## **Part 1**

# **Counting Particles**

## **Part 2**

# **The Mole**

## **Part 3**

# **Representative Particles**

## **Part 4**

# **Converting between Moles and Particles**

## Part 1

## Counting Particles

❖ In everyday life, we use **counting units** to make **counting easier**.

❖ Each counting unit always represents a **fixed number**.

| Counting Unit | Number | Example/s                                                                                                                                              |
|---------------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Pair</b>   | 2      |  <p><b>GLOVES</b><br/>Pair = 2</p> <p><b>SOCKS</b><br/>Pair = 2</p> |
| <b>Dozen</b>  | 12     |  <p><b>EGGS</b><br/>Dozen = 12</p>                                 |
| <b>Gross</b>  | 144    |  <p><b>PENCILS</b><br/>Gross = 144<br/>12 Dozens</p>               |
| <b>Ream</b>   | 500    |  <p><b>PAPER</b><br/>Ream = 500<br/>500 sheets of paper</p>        |

Why do **chemists** need a **special counting unit**?



Chemists deal with: **atoms, molecules, formula units, or ions**



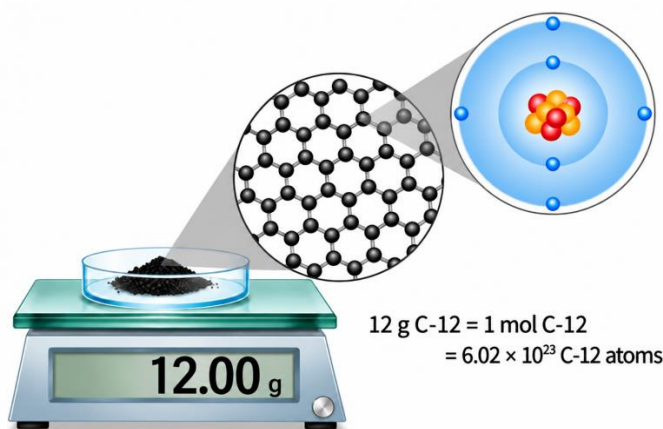
These particles are **Extremely tiny** and exist in **huge numbers**.

To solve this problem, chemists invented a **special counting unit called the mole**.

## Part 2

## The Mole

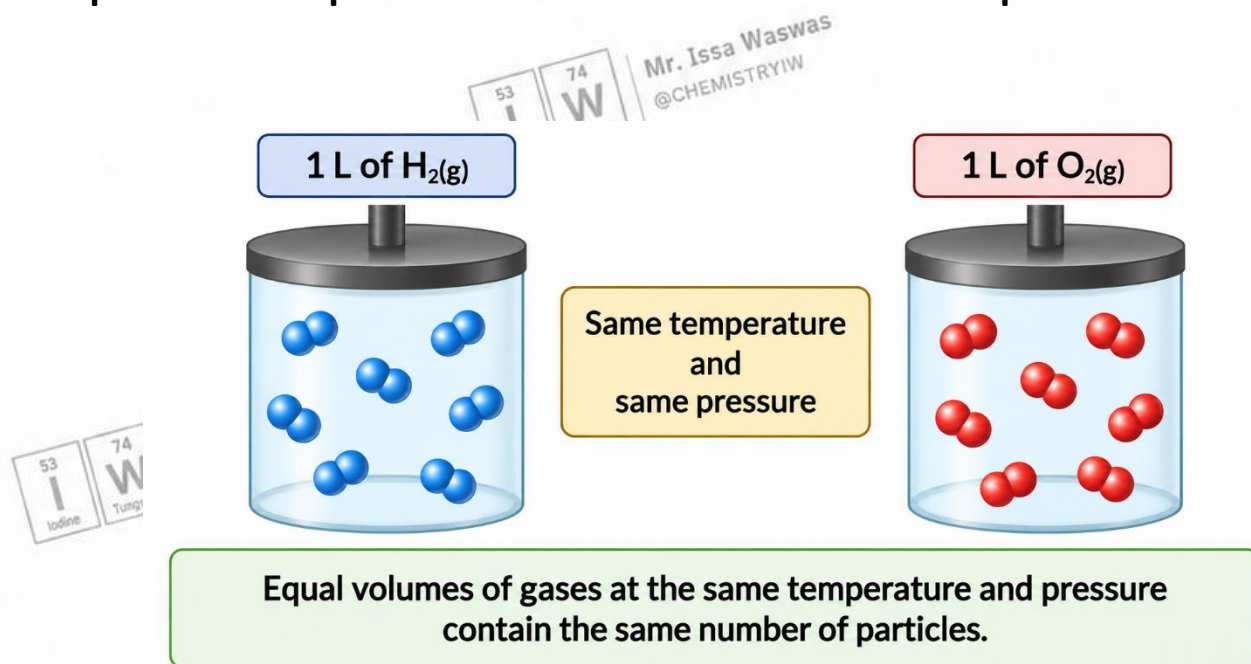
- ❖ The **mole (mol)** is the **SI base unit** used to **measure** the **amount of a substance**.
- ❖ **Historically**, A mole **was defined** using the number of carbon atoms in exactly **12 g of carbon-12 (C-12)**.



- ❖ **One mole** contains a very large number of particles:

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ representative particles}$$

- ❖ The number  $6.02 \times 10^{23}$  is called **Avogadro's number**, named after the Italian scientist **Amedeo Avogadro**.
- ❖ In **1811**, Avogadro proposed that **equal volumes of gases at the same temperature and pressure contain the same number of particles**.



- ❖ Avogadro's number is **extremely large**.
- ❖ For example,  $6.02 \times 10^{23}$  **marbles** would cover Earth's surface to a depth of **more than 14 km**.
- ❖ The **mole provides a convenient way to measure amounts of substances**.

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ representative particles}$$

**Practice — Rank from Smallest to Largest**

In Column B, rank the quantities from Column A from smallest to largest.

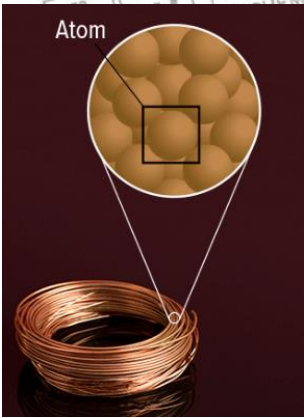
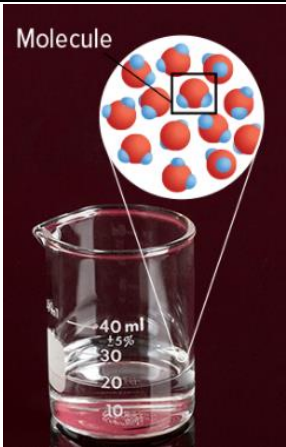
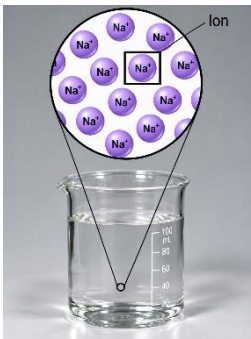
| Column A              | Column B  |
|-----------------------|-----------|
| 0.5 mol               | 1. _____  |
| 200                   | 2. _____  |
| 5                     | 3. _____  |
| 6,000,000,000         | 4. _____  |
| $6.02 \times 10^{23}$ | 5. _____  |
| dozen                 | 6. _____  |
| four moles            | 7. _____  |
| gross                 | 8. _____  |
| pair                  | 9. _____  |
| ream                  | 10. _____ |

## Part 3

## Representative Particles

- ❖ A **representative particle** is the type of particle used to represent and count a substance.

## Types of Representative Particles

| Atoms                                                                              | Molecules                                                                           | Formula Units                                                                        | Ions                                                                                  |
|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Atomic elements<br>Single atoms                                                    | Molecular substances<br>Usually (NM+NM)                                             | Ionic compounds<br>Usually (M+NM)                                                    | Charged particles                                                                     |
|  |  |  |  |
| 1 mol of <b>copper</b><br><b>atoms</b> (Cu)                                        | 1 mol of <b>water</b><br><b>molecules</b> (H <sub>2</sub> O)                        | 1 mol of <b>sodium</b><br><b>chloride formula units</b><br>(NaCl)                    | 1 mol of<br><b>sodium ions</b><br>(Na <sup>+</sup> )                                  |

Each sample contains  $6.02 \times 10^{23}$  representative particles

## Practice — Identify the Representative Particle

Atoms

Molecules

Formula Units

Ions

| No. | Substance                                | Representative Particle Type |
|-----|------------------------------------------|------------------------------|
| 1   | Calcium fluoride ( $\text{CaF}_2$ )      |                              |
| 2   | Nitrogen gas ( $\text{N}_2$ )            |                              |
| 3   | Gold (Au)                                |                              |
| 4   | Nitrate ion ( $\text{NO}_3^-$ )          |                              |
| 5   | Methane ( $\text{CH}_4$ )                |                              |
| 6   | Aluminum (Al)                            |                              |
| 7   | Potassium bromide (KBr)                  |                              |
| 8   | Calcium ion ( $\text{Ca}^{2+}$ )         |                              |
| 9   | Ammonia ( $\text{NH}_3$ )                |                              |
| 10  | Potassium oxide ( $\text{K}_2\text{O}$ ) |                              |

## Part 4

# Converting between Moles and Particles

Before converting **moles** ↔ **particles**, remember how a **conversion factor** works.

**Example: Dozen → Number of Objects**

**Relationship:**

$$1 \text{ dozen roses} = 12 \text{ roses}$$

From this relationship, we can make **two conversion factors**:

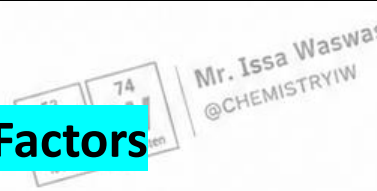
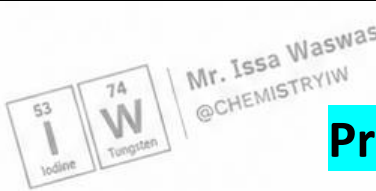
$$\frac{12 \text{ roses}}{1 \text{ dozen roses}} \text{ or } \frac{1 \text{ dozen roses}}{12 \text{ roses}}$$



**Example**

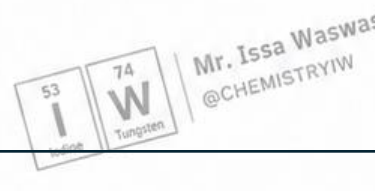
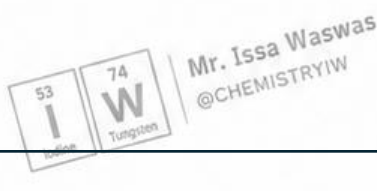
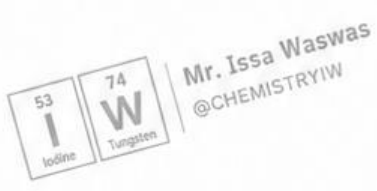
How many **roses** are in **3.5 dozen roses**?

Choose the conversion factor that **cancels the given unit** and **leaves the desired unit**.



## Practice —Conversion Factors

1. A school purchases **4 reams of paper**. Create a conversion factor and determine the total **number of papers**.



2. A store has **864 pencils**. How many **grosses** of pencils are there?

## Moles and Particles: Conversion Factors

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ particles}$$

(Avogadro's number)

### Moles → Particles

Multiply by Avogadro's number

$$\frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mol}}$$

**Example:**

Convert 3.50 mol of  $\text{CO}_2$  to particles.

### Particles → Moles

Divide by Avogadro's number

$$\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ particles}}$$

**Example:**

Convert  $4.82 \times 10^{23}$  atoms of Al to moles.

Choose the conversion factor that cancels the given unit.

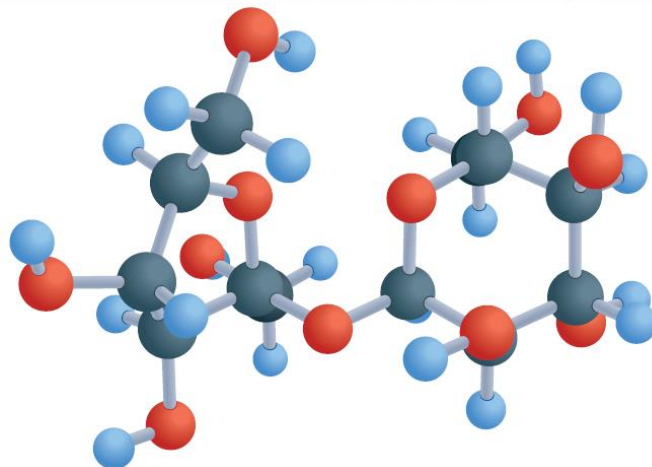
### Practice Question:

Sucrose ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) is a molecular substance. A sample contains 2.50 mol of sucrose.

a) What is the **representative particle** of sucrose?

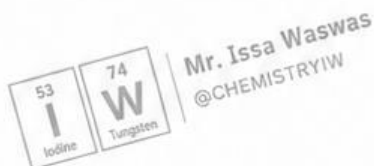
b) Which **conversion factor** should be used to convert moles of sucrose to representative particles?

c) Calculate the **number of representative particles** in 2.50 mol of sucrose.

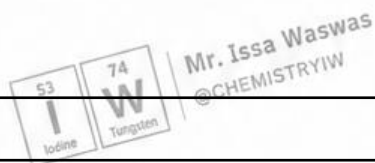


**EXAMPLE Problem 1**

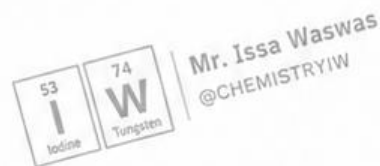
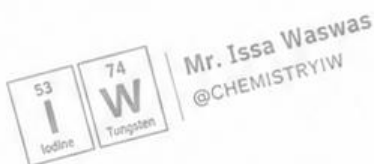
**PARTICLES-TO-MOLES CONVERSION** Zinc (Zn) is used as a corrosion-resistant coating on iron and steel. It is also an essential trace element in your diet. Calculate the number of moles of zinc that contain  $4.50 \times 10^{24}$  atoms.

**PRACTICE Problems****ADDITIONAL PRACTICE**

1. Zinc (Zn) is used to form a corrosion-inhibiting surface on galvanized steel. Determine the number of Zn atoms in 2.50 mol of Zn.



2. Calculate the number of molecules in 11.5 mol of water (H<sub>2</sub>O).



3. Silver nitrate ( $\text{AgNO}_3$ ) is used to make several different silver halides used in photographic films. How many formula units of  $\text{AgNO}_3$  are there in 3.25 mol of  $\text{AgNO}_3$ ?

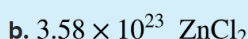
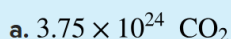
4. **CHALLENGE** Calculate the number of oxygen atoms in 5.00 mol of oxygen molecules. Oxygen is a diatomic molecule,  $\text{O}_2$ .

5. How many moles contain each of the following?

a.  $5.75 \times 10^{24}$  atoms Al

b.  $2.50 \times 10^{20}$  atoms Fe

**6. CHALLENGE** Identify the representative particle for each formula, and convert the given number of representative particles to moles.



### Summary

- Some systems cannot be studied directly because they are **too small, too large, too fast, or too slow**.
- The **mole (mol)** is a unit used to **count particles of matter indirectly**.
- 1 mol** of a substance contains **Avogadro's number** of representative particles:

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ representative particles}$$

- Representative particles** include **atoms, molecules, formula units, and ions**.
- Conversion factors** based on Avogadro's number are used to convert between **moles and representative particles**.

$$\text{Moles} \rightarrow \text{Particles: } \frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mol}}$$

$$\text{Particles} \rightarrow \text{Moles: } \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ particles}}$$

- One mole of carbon-12 atoms has a mass of exactly 12 g**

Grade 12 General

Chemistry (P1)

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**فيديوهات شرح وحل  
الملزمة كاملة متوفرة**

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## Quiz

## Lesson 1

## Measuring Matter

1) Which of the following best defines a **molecule**?

- A) A single charged atom
- B) Two or more atoms covalently bonded together
- C) The SI base unit for amount of substance
- D) The number of particles in one mole

2) Which of the following best defines a **mole**?

- A) A unit used to measure the mass of a substance
- B) The number of atoms in one gram of a substance
- C) A unit used to measure the volume of a substance
- D) The SI base unit used to measure the amount of a substance

3) Which statement about Avogadro's number is **correct**?

- A) It is  $6.02 \times 10^{22}$  and represents the particles in 1 mol
- B) It is  $6.02 \times 10^{23}$  and represents the particles in 1 mol
- C) It is  $6.02 \times 10^{23}$  and represents the particles in 1 g
- D) It is  $6.02 \times 10^{24}$  and represents the particles in 1 mol

4) Which of the following relationships is **INCORRECT**?

- A) 1 pair = 2 items
- B) 1 dozen = 12 items
- C) 1 gross = 144 items
- D) 1 ream = 100 sheets

5) Why did chemists need a **special counting unit** such as the mole?

- A) Atoms and particles are too large to count
- B) The number of particles in a substance is extremely large
- C) Conventional counting units can only be used for solids
- D) The mole is used to measure the volume of particles

6) Which of the following **representative particles** can be measured using moles?

- A) Atoms, molecules, and formula units
- B) Grams, molecules, and atoms
- C) Liters, ions, and formula units
- D) Moles, atoms, and grams

7) What is the main purpose of a **conversion factor**?

- A) To change the amount of a substance
- B) To determine the mass of every substance
- C) To express a known quantity in different units
- D) To increase the number of representative particles

8) Which conversion factor should be used to convert **moles to particles**?

- A)  $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ representative particles}}$
- B)  $\frac{6.02 \times 10^{23} \text{ representative particles}}{1 \text{ mol}}$
- C)  $\frac{1 \text{ representative particle}}{6.02 \times 10^{23} \text{ mol}}$
- D)  $\frac{6.02 \times 10^{23} \text{ mol}}{1 \text{ representative particle}}$

9) Calculate the **mass** in atomic mass units (amu) of 0.25 mol of carbon-12 atoms.

- A)  $3.01 \times 10^{22}$  amu
- B)  $1.81 \times 10^{24}$  amu
- C) 3.00 amu
- D) 12.0 amu

10) Calculate the number of representative particles in 11.5 mol of Ag.

- A)  $6.92 \times 10^{24}$  molecules
- B)  $6.92 \times 10^{24}$  formula units
- C)  $6.92 \times 10^{24}$  atoms
- D)  $1.91 \times 10^{22}$  atoms

11) Calculate the number of representative particles in 18.0 mol of  $\text{H}_2\text{O}$ .

- A)  $1.08 \times 10^{25}$  atoms
- B)  $2.99 \times 10^{22}$  molecules
- C)  $1.08 \times 10^{25}$  formula units
- D)  $1.08 \times 10^{25}$  molecules

12) Calculate the number of representative particles in 0.150 mol of NaCl.

- A)  $9.03 \times 10^{22}$  molecules
- B)  $9.03 \times 10^{22}$  atoms
- C)  $4.01 \times 10^{24}$  formula units
- D)  $9.03 \times 10^{22}$  formula units

13) Calculate the number of representative particles in  $1.35 \times 10^{-2}$  mol of  $\text{CH}_4$ .

- A)  $8.13 \times 10^{21}$  formula units
- B)  $8.13 \times 10^{21}$  molecules
- C)  $8.13 \times 10^{21}$  atoms
- D)  $2.24 \times 10^{22}$  molecules

14) Calculate the number of moles of barium that contains  $8.92 \times 10^{23}$  atoms.

- A) 0.676mol
- B) 1.48mol
- C) 5.37mol
- D) 14.8mol

15) Calculate the number of moles of potassium iodide that contains  $2.66 \times 10^{22}$  formula units.

- A) 0.0442mol
- B) 0.226mol
- C) 4.42mol
- D) 22.6mol

16) Calculate the number of chlorine atoms in 3.50 mol of chlorine molecules. Chlorine is a diatomic molecule,  $\text{Cl}_2$ .

- A)  $2.11 \times 10^{24}$  atoms
- B)  $4.22 \times 10^{24}$  atoms
- C)  $1.05 \times 10^{24}$  atoms
- D)  $6.02 \times 10^{23}$  atoms

In the table, write the conversion factor that correctly completes each problem.

| Given                                           | Conversion Factor | Result                                         |
|-------------------------------------------------|-------------------|------------------------------------------------|
| 1.20 mol Cu                                     |                   | $7.22 \times 10^{23}$ Cu atoms                 |
| $9.25 \times 10^{22}$ molecules CH <sub>4</sub> |                   | $1.54 \times 10^{-1}$ mol CH <sub>4</sub>      |
| $1.54 \times 10^{26}$ atoms Xe                  |                   | $2.56 \times 10^2$ mol Xe                      |
| 3.01 mol F <sub>2</sub>                         |                   | $1.81 \times 10^{24}$ molecules F <sub>2</sub> |

## أسئلة وزارية سابقة

Which of the following does **NOT** describe the mole?

أي من التالي لا يصف المول؟

Avogadro's number of molecules of a compound

عدد أفوجادرو لجزيئات المركب

☐

A unit used to count particles directly

وحدة تستخدم لعد الجسيمات مباشرة

☐

The SI base unit used to measure the amount of a substance

الوحدة الأساسية في نظام الوحدات العالمي SI التي تستخدم في قياس مقدار المادة

☐

The number of atoms in exactly 12 g of pure C-12

عدد ذرات الكربون الموجودة بالضبط في 12 جرام من الكربون - 12 النقي

☐

What is the correct ascending order of the following samples according to the number of moles from the smallest to the largest?

ما الترتيب التصاعدي الصحيح للعينات التالية حسب عدد المولات من الأصغر إلى الأكبر؟

$3.75 \times 10^{25}$  atoms Zn —  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  — 18.8 mol Fe

Avogadro's number —  $6.02 \times 10^{23}$

عدد أفوجادرو —  $6.02 \times 10^{23}$

(The smallest)  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  → 18.8 mol Fe →  $3.75 \times 10^{25}$  atoms Zn (The largest)

(الأصغر)  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  ← 18.8 mol Fe ←  $3.75 \times 10^{25}$  atoms Zn (الأكبر)

(The smallest) 18.8 mol Fe →  $3.75 \times 10^{25}$  atoms Zn →  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  (The largest)

(الأصغر) 18.8 mol Fe ←  $3.75 \times 10^{25}$  atoms Zn ←  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  (الأكبر)

(The smallest)  $3.75 \times 10^{25}$  atoms Zn → 18.8 mol Fe →  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  (The largest)

(الأصغر)  $3.75 \times 10^{25}$  atoms Zn ← 18.8 mol Fe ←  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  (الأكبر)

(The smallest) 18.8 mol Fe →  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  →  $3.75 \times 10^{25}$  atoms Zn (The largest)

(الأصغر) 18.8 mol Fe ←  $3.65 \times 10^{24}$  molecules  $C_6H_{12}O_6$  ←  $3.75 \times 10^{25}$  atoms Zn (الأكبر)

What is the number of atoms in a 0.645 mol sample of argon gas (Ar)?

كم عدد الذرات الموجودة في 0.645 mol من عينة من غاز الأرجون (Ar)?

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

$9.33 \times 10^{23}$  atom

$9.33 \times 10^{23}$  ذرة ☐

$3.88 \times 10^{23}$  atom

$3.88 \times 10^{23}$  ذرة ☐

$1.07 \times 10^{23}$  atom

$1.07 \times 10^{23}$  ذرة ☐

$4.62 \times 10^{23}$  atom

$4.62 \times 10^{23}$  ذرة ☐



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How many moles contained in  $2.50 \times 10^{24}$  molecules of ammonia  $\text{NH}_3$ ?

كم عدد المولات الموجودة في  $2.50 \times 10^{24}$  جزيء من الأمونيا  $\text{NH}_3$ ?

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

0.42 mol ☐

2.40 mol ☐

4.15 mol ☐

0.24 mol ☐



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How many formula units of  $\text{AgNO}_3$  are there in 0.75 mol of  $\text{AgNO}_3$ ?

كم عدد وحدات الصيغة  $\text{AgNO}_3$  الموجودة في 0.75 mol من  $\text{AgNO}_3$  ؟

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

$4.5 \times 10^{24}$

☐

$9.0 \times 10^{24}$

☐

$4.5 \times 10^{23}$

☐

$9.0 \times 10^{23}$

☐

What is the correct ascending order of the following samples according to the number of moles from the smallest to the largest?

ما الترتيب التصاعدي الصحيح للعينات التالية حسب عدد المولات من الأصغر إلى الأكبر؟

$1.51 \times 10^{24}$  atoms Zn -  $3.42 \times 10^{25}$  molecules  $\text{C}_6\text{H}_{12}\text{O}_6$  - 7.2 mol Fe

(The smallest)  $1.51 \times 10^{24}$  atoms Zn  $\longrightarrow$  7.2 mol Fe  $\longrightarrow$   $3.42 \times 10^{25}$  molecules  $\text{C}_6\text{H}_{12}\text{O}_6$  (The largest)

☐

(The smallest)  $3.42 \times 10^{25}$  molecules  $\text{C}_6\text{H}_{12}\text{O}_6$   $\longrightarrow$  7.2 mol Fe  $\longrightarrow$   $1.51 \times 10^{24}$  atoms Zn (The largest)

☐

(The smallest) 7.2 mol Fe  $\longrightarrow$   $1.51 \times 10^{24}$  atoms Zn  $\longrightarrow$   $3.42 \times 10^{25}$  molecules  $\text{C}_6\text{H}_{12}\text{O}_6$  (The largest)

☐

(The smallest) 7.2 mol Fe  $\longrightarrow$   $3.42 \times 10^{25}$  molecules  $\text{C}_6\text{H}_{12}\text{O}_6$   $\longrightarrow$   $1.51 \times 10^{24}$  atoms Zn (The largest)

☐

How does a chemist count the number of particles in each number of moles of a substance?

كيف يقوم الكيميائي بحساب عدد الجسيمات في كل عدد من المولات من مادة؟

Using the dozen count which is 12 objects/ dozen

باستخدام عدّ الدزينة وهو 12 جسم / دزينة

☐

Using Avogadro's number which is  $6.02 \times 10^{23}$  representative particles

باستخدام عدد أفوجادرو والذي يساوي  $6.02 \times 10^{23}$  من الجسيمات الممثلة

☐

Using the molar mass and molar ratio

باستخدام الكتلة المولية ونسب المولات

☐

Using the number of carbon isotopes

باستخدام عدد نظائر الكربون

☐

How many moles contained in  $3.15 \times 10^{23}$  molecules of methane  $\text{CH}_4$ ?

كم عدد المولات الموجودة في  $3.15 \times 10^{23}$  جزيء من الميثان  $\text{CH}_4$ ؟

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

1.90 mol

☐

0.52 mol

☐

19.0 mol

☐

5.20 mol

☐

What is the number of atoms in a 1.22 mol sample of helium gas (He)?

كم عدد الذرات الموجودة في عينة مقدارها 1.22 mol من غاز الهيليوم (He)؟

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

$7.34 \times 10^{23}$

☐

$9.33 \times 10^{24}$

☐

$1.07 \times 10^{24}$

☐

$2.03 \times 10^{23}$

☐

Grade 12 General

Chemistry (P1)

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**فيديوهات شرح وحل  
الملزمة كاملة متوفرة**

**Chemistry**  
Grade 12 General

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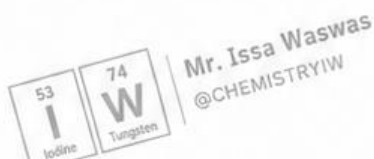
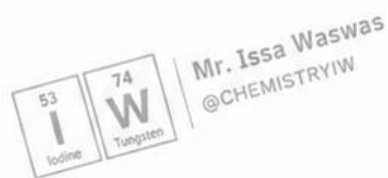
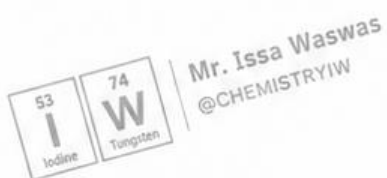
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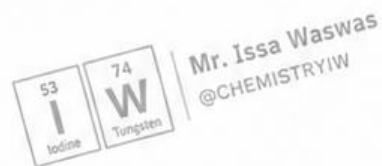
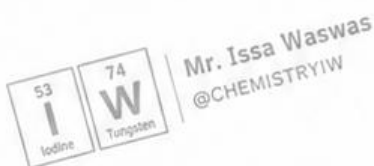


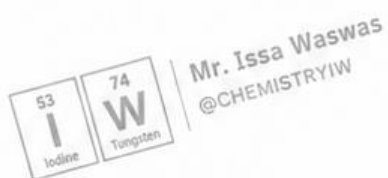
# Module 9

# The Mole

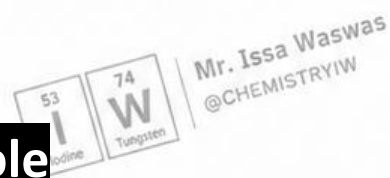
## Lesson (2)

## Mass and The Mole

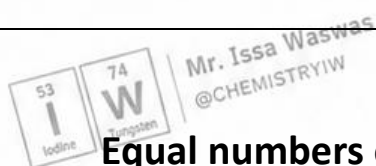




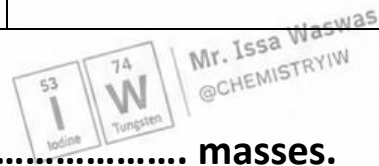
## The Mass of a Mole



|                     |                      |                    |
|---------------------|----------------------|--------------------|
| 1 dozen eggs        | 1 dozen limes        | Same or different? |
| 12 eggs             | 12 limes             | Same or different? |
| Mass = <b>752 g</b> | Mass = <b>1606 g</b> | Same or different? |



Equal numbers of different objects can have ..... masses.

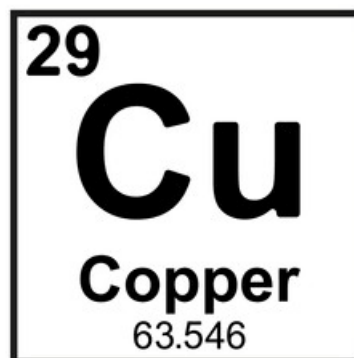
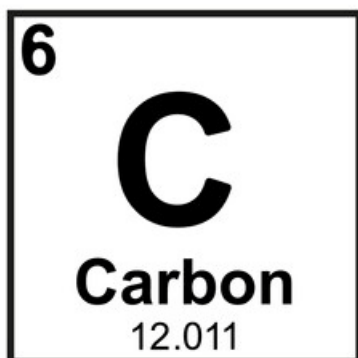


❖ **Reminder:** A mole is like a dozen because it represents a **fixed number**:

$$1 \text{ mol} = 6.02 \times 10^{23} \text{ particles}$$

❖ **However,** one mole of **different substances** can have **different masses** because their particles have different masses and compositions.

### Example: Carbon and Copper



$$1 \text{ mol C} = 6.02 \times 10^{23} \text{ C atoms} = 12.011 \text{ g}$$

$$1 \text{ mol Cu} = 6.02 \times 10^{23} \text{ Cu atoms} = 63.546 \text{ g}$$

One **mole** of **carbon** does **NOT** have the **same mass** as one **mole** of **copper**. Why?



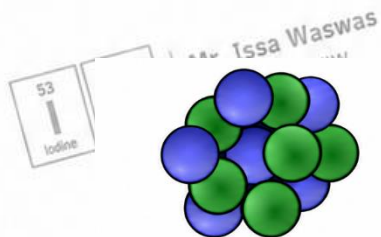
Because carbon and copper **atoms** have **different masses**.

## Atomic mass

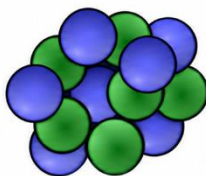
- ❖ One carbon-12 atom has a mass of exactly **12 amu**.
- ❖ The atomic masses of other elements are measured **relative to carbon-12**.
- ❖ A hydrogen-1 atom has a mass of approximately **1 amu**, or about one-twelfth the mass of a carbon-12 atom.

### Why are atomic masses decimals?

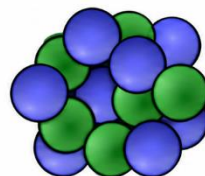
Example: Carbon: **12.011 amu**

 $^{12}\text{C}$ 

98.9%

 $^{13}\text{C}$ 

1.1%

 $^{14}\text{C}$ 

&lt;0.0001%

- ❖ Because they are **weighted averages** of the masses of all the naturally **occurring isotopes of an element**.
- ❖ Some elements have two naturally occurring isotopes, while others have many.
- ❖ Carbon's atomic mass is close to 12 because **carbon-12 is its most abundant isotope**.

## Molar Mass

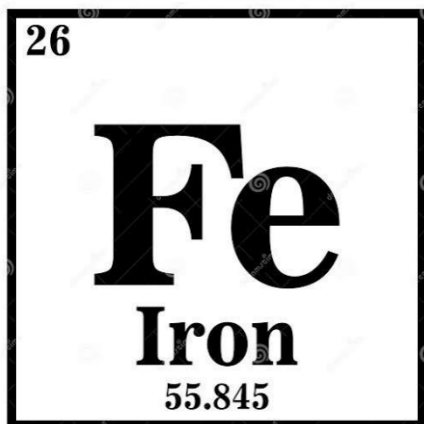
❖ **Molar mass** is the **mass of one mole** of a substance. Its unit is:

**g/mol**

❖ The **molar mass** of an element is **numerically equal** to its **atomic mass**, but the units are different:

| Quantity           | Meaning                          | Unit         |
|--------------------|----------------------------------|--------------|
| <b>Atomic mass</b> | Mass of one <b>atom</b>          | <b>amu</b>   |
| <b>Molar mass</b>  | Mass of <b>one mole</b> of atoms | <b>g/mol</b> |

Example: Iron



Atomic mass of one Fe atom = 55.845 amu

Molar mass of Fe = 55.845 g/mol

This means:

$$1 \text{ mol Fe} = 6.02 \times 10^{23} \text{ Fe atoms} = 55.845 \text{ g Fe}$$

**Using Molar Mass: The Jelly-Bean Analogy**

**1 dozen jelly beans = 35 g**

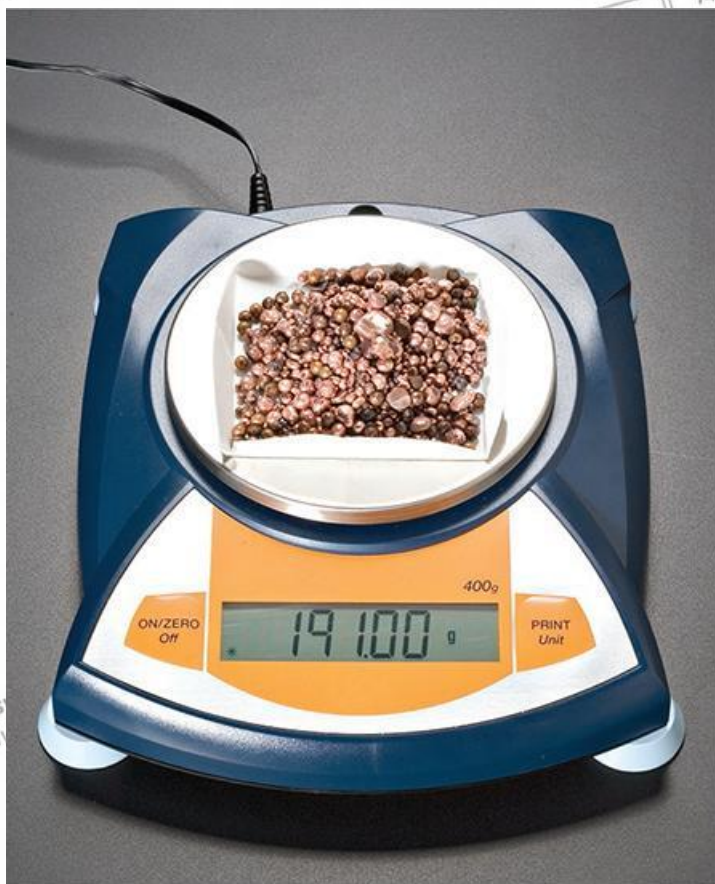
**Example 1:** What is the mass of **5 dozen** jelly beans?

**Example 2:** How many dozen jelly beans are in **105 g**?

## Converting Moles to Mass

In a laboratory, substances are measured using a balance. Therefore, if the required amount is given in moles, we must convert moles to grams.

**Example:** Calculate the mass of **3.00 mol** of copper (Molar mass of Cu = 63.546 g/mol)



**EXAMPLE Problem 2**

**MOLE-TO-MASS CONVERSION** Chromium (Cr), a transition element, is a component of chrome plating. Chrome plating is used on metals and in steel alloys to control corrosion. Calculate the mass in grams of 0.0450 mol Cr.

(Molar mass of Cr = 52.00 g/mol)

**PRACTICE Problems****ADDITIONAL PRACTICE**

15. Determine the mass in grams of each of the following.

a. 3.57 mol Al

b. 4.26 mol Si

(Molar mass of Al = 26.98 g/mol)

(Molar mass of Si = 28.09 g/mol)

16. **CHALLENGE** Convert each given quantity in scientific notation to mass in grams expressed in scientific notation.

a.  $3.45 \times 10^2$  mol Co

b.  $2.45 \times 10^{-2}$  mol Zn

(Molar mass of Co = 58.933 g/mol)

(Molar mass of Zn = 65.38 g/mol)

**EXAMPLE Problem 3**

**MASS-TO-MOLE CONVERSION** Calcium (Ca), the fifth most-abundant element on Earth, is always found combined with other elements because of its high reactivity. How many moles of calcium are in 525 g Ca?

(Molar mass of Ca = 40.08 g/mol)

**PRACTICE Problems****ADDITIONAL PRACTICE**

17. Determine the number of moles in each of the following.

a. 25.5 g Ag

b. 300.0 g S

(Molar mass of Ag = 107.87 g/mol)

(Molar mass of S = 32.07 g/mol)

18. **CHALLENGE** Convert each mass to moles. Express the answer in scientific notation.

a.  $1.25 \times 10^3$  g Zn

b. 1.00 kg Fe

(Molar mass of Zn = 65.38 g/mol)

(Molar mass of Fe = 55.85 g/mol)

## Converting between mass and atoms

### EXAMPLE Problem 4

**MASS-TO-ATOMS CONVERSION** Gold (Au) is one of a group of metals called the coinage metals (copper, silver, and gold). How many atoms of gold are in a U.S. Eagle, a gold alloy bullion coin with a mass of 31.1 g Au?

(Molar mass of Au = 196.97 g/mol)

### EXAMPLE Problem 5

**ATOMS-TO-MASS CONVERSION** Helium (He) is an unreactive noble gas often found in underground deposits mixed with methane. The mixture is separated by cooling the gaseous mixture until all but the helium has liquefied. A party balloon contains  $5.50 \times 10^{22}$  atoms of helium gas. What is the mass, in grams, of the helium?

(Molar mass of He = 4.00 g/mol)

**Additional Practice****19. How many atoms are in each sample?**

|   |                                                      |  |
|---|------------------------------------------------------|--|
| a | 55.2 g Li<br>(Molar mass of<br>Li = 6.94<br>g/mol)   |  |
| b | 0.230 g Pb<br>(Molar mass of<br>Pb = 207.2<br>g/mol) |  |
| c | 11.5 g Hg<br>(Molar mass of<br>Hg = 200.59<br>g/mol) |  |

## 20. What is the mass in grams of each sample?

|   |                                                                     |  |
|---|---------------------------------------------------------------------|--|
| a | $6.02 \times 10^{24}$ atoms Bi<br>(Molar mass of Bi = 208.98 g/mol) |  |
| b | $1.00 \times 10^{24}$ atoms Mn<br>(Molar mass of Mn = 54.94 g/mol)  |  |
| c | $3.40 \times 10^{22}$ atoms He<br>(Molar mass of He = 4.00 g/mol)   |  |
| d | $1.50 \times 10^{15}$ atoms N<br>(Molar mass of N = 14.01 g/mol)    |  |
| e | $1.50 \times 10^{15}$ atoms U<br>(Molar mass of U = 238.03 g/mol)   |  |

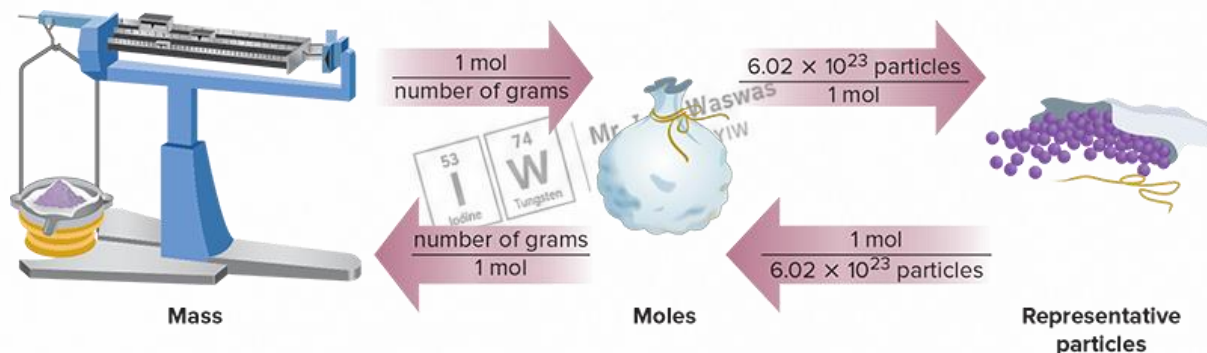
**21. Challenge:**

Convert each given mass to the number of representative particles. Identify the type of representative particle and express the answer in scientific notation.

|   |                                                                         |  |
|---|-------------------------------------------------------------------------|--|
| a | $4.56 \times 10^3 \text{ g Si}$<br><br>(Molar mass of Si = 28.09 g/mol) |  |
| b | $0.120 \text{ kg Ti}$<br><br>(Molar mass of Ti = 47.87 g/mol)           |  |

## Summary

## The Mole as the Center of Conversions



| Conversion                    | Operation                     | Conversion factor                                             |
|-------------------------------|-------------------------------|---------------------------------------------------------------|
| Grams $\rightarrow$ moles     | Divide by molar mass          | $\frac{1 \text{ mol}}{\text{molar mass in g}}$                |
| Moles $\rightarrow$ grams     | Multiply by molar mass        | $\frac{\text{molar mass in g}}{1 \text{ mol}}$                |
| Moles $\rightarrow$ particles | Multiply by Avogadro's number | $\frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mol}}$ |
| Particles $\rightarrow$ moles | Divide by Avogadro's number   | $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ particles}}$ |

Grade 12 General

Chemistry (P1)

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**الملزمة كاملة متوفرة**

**Chemistry**  
Grade 12 General

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## Quiz

## Lesson 2

## Mass and The Mole

## Part 1 True or False

For each statement below, write true or false on the line.

|  |    |                                                                                                                                                                            |
|--|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | 1. | The isotope hydrogen-1 is the standard used for the relative scale of atomic masses.                                                                                       |
|  | 2. | The mass of an atom of helium-4 is 4 amu.                                                                                                                                  |
|  | 3. | The mass of a mole of hydrogen atoms is $1.00 \times 10^{23}$ amu.                                                                                                         |
|  | 4. | The mass in grams of one mole of any pure substance is called its molar mass.                                                                                              |
|  | 5. | The atomic masses recorded on the periodic table are weighted averages of the masses of all the naturally occurring isotopes of each element.                              |
|  | 6. | The molar mass of an element is numerically equal to its atomic mass in grams.                                                                                             |
|  | 7. | The molar mass unit is mol/g.                                                                                                                                              |
|  | 8. | If the measured mass of an element is numerically equal to its molar mass, then you have indirectly counted $6.02 \times 10^{23}$ atoms of the element in the measurement. |

## Part 2: Complete and Organize

Analyze molar mass by completing the following statements.

1. The mass of one mole of carbon-12 atoms is \_\_\_\_\_ grams.
2. The mass of one mole of hydrogen is \_\_\_\_\_ gram and is \_\_\_\_\_ the mass of one mole of carbon.
3. The mass of one mole of helium-4 is \_\_\_\_\_ the mass of one mole of carbon and is equal to \_\_\_\_\_ grams.
4. One mole of manganese is equal to \_\_\_\_\_ atoms of manganese.

Organize the following equations by writing the letter of the correct equation beside each conversion type.

|                           |                                                                                                                               |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| 1. Mole to mass<br>_____  | A. mass $\times \frac{1 \text{ mol}}{\text{number of grams}}$                                                                 |
| 2. Mass to mole<br>_____  | B. number of moles $\times \frac{\text{number of grams}}{1 \text{ mol}}$                                                      |
| 3. Mass to atoms<br>_____ | C. mass $\times \frac{1 \text{ mol}}{\text{number of grams}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}}$  |
| 4. Atoms to mass<br>_____ | D. atoms $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{\text{number of grams}}{1 \text{ mol}}$ |

**Part 3 Multiple Choice**

1) What is the mass of 3.35 moles of calcium?

Molar mass of Ca = 40.08 g/mol

- A) 8.36 g
- B) 43.43 g
- C) 134 g
- D) 149 g

2) How many moles are present in 115 g of nickel?

Molar mass of Ni = 58.69 g/mol

- A) 0.510 mol
- B) 1.96 mol
- C) 6.75 mol
- D) 56.3 mol

3) How many atoms are present in 65.6 g of silicon?

Molar mass of Si = 28.09 g/mol

Avogadro's number =  $6.02 \times 10^{23}$  atoms/mol

- A)  $2.34 \times 10^{23}$  atoms
- B)  $3.95 \times 10^{24}$  atoms
- C)  $1.41 \times 10^{24}$  atoms
- D)  $5.64 \times 10^{25}$  atoms

## أسئلة وزارية سابقة

Which of the following statements are **correct** related to mass and the mole?

أي من العبارات التالية **صحيحة** فيما يتعلق بالكتلة والمول؟

|   |                                                                    |                                                              |   |
|---|--------------------------------------------------------------------|--------------------------------------------------------------|---|
| 1 | A mole always contains the same number of particles                | المول دائماً يحوي نفس العدد من الجسيمات                      | 1 |
| 2 | Moles of different substances have different masses                | مولات المواد المختلفة لها كتل مختلفة                         | 2 |
| 3 | Converting from mass to mole we use a fixed ratio for all elements | للتحويل من كتلة إلى مول نستخدم نسبة واحدة وثابتة لكل العناصر | 3 |

2 and 3

3 و 2

☐

1 and 2

2 و 1

☐

1, 2 and 3

3 و 2 و 1

☐

1 and 3

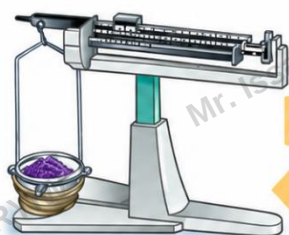
3 و 1

☐

What is the central unit of conversions between mass and particles (atoms, ions, or molecules) in the figure below?

ما الوحدة المركزية في التحويلات بين الكتلة والجسيمات (الذرات،

الأيونات، أو الجزيئات) في الشكل أدناه؟



الكتلة  
Mass

1 mol  
number of grams  
number of grams  
1 mol



عدد المولات  
Moles

$6.02 \times 10^{23}$  particles  
1 mol  
1 mol  
 $6.02 \times 10^{23}$  particles



الجسيمات الممثلة  
Representative particles

☐ Moles

عدد المولات

☐ Grams

عدد الجرامات

☒ Particles

عدد الجسيمات

☐ Atoms

عدد الذرات

What is the molar mass for nitrogen element N?

ما الكتلة المولية لعنصر النيتروجين ؟N

| HYDROGEN<br>1<br><b>H</b><br>1.00  | Periodic Table<br>Elements 1 – 18     |                                      |                                     |                                       |                                   |                                      | HELIUM<br>2<br><b>He</b><br>4.00  |
|------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|
| LITHIUM<br>3<br><b>Li</b><br>6.94  | BERYLLIUM<br>4<br><b>Be</b><br>9.01   | BORON<br>5<br><b>B</b><br>10.81      | CARBON<br>6<br><b>C</b><br>12.01    | NITROGEN<br>7<br><b>N</b><br>14.00    | OXYGEN<br>8<br><b>O</b><br>16.00  | FLUORINE<br>9<br><b>F</b><br>19.00   | NEON<br>10<br><b>Ne</b><br>20.18  |
| SODIUM<br>11<br><b>Na</b><br>23.00 | MAGNESIUM<br>12<br><b>Mg</b><br>24.31 | ALUMINUM<br>13<br><b>Al</b><br>26.98 | SILICON<br>14<br><b>Si</b><br>28.09 | PHOSPHORUS<br>15<br><b>P</b><br>30.94 | SULFUR<br>16<br><b>S</b><br>32.07 | CHLORINE<br>17<br><b>Cl</b><br>35.50 | ARGON<br>18<br><b>Ar</b><br>40.00 |



28.00 g/mol



16.00 g/mol



32.00 g/mol



14.00 g/mol

What is the mass of  $4.50 \times 10^2$  mol of cobalt Co?

ما كتلة  $4.50 \times 10^2$  mol من الكوبالت Co؟

molar mass Co = 58.933 g/mol

الكتلة المولية للكوبالت = 58.933 g/mol

$3.90 \times 10^4$  g



$4.60 \times 10^4$  g



$3.20 \times 10^4$  g



$2.65 \times 10^4$  g



A party balloon contains  $9.60 \times 10^{24}$  helium atoms.

يحتوي بالون احتفالات على  $9.60 \times 10^{24}$  ذرة من الهيليوم.

What is the mass of helium in grams?

ما كتلة الهيليوم بالجرامات؟

|                                           |                                      |
|-------------------------------------------|--------------------------------------|
| Avogadro's number = $6.02 \times 10^{23}$ | عدد أفوجادرو = $6.02 \times 10^{23}$ |
| molar mass of He = 4.00 g/mol             | الكتلة المولية للهيليوم = 4.00 g/mol |

63.8

36.9

85.7

45.5



What is the mass of  $3.75 \times 10^2$  mol of copper Cu?

ما كتلة  $3.75 \times 10^2$  mol من النحاس Cu؟

**molar mass Cu = 63.55 g/mol**

**63.55 g/mol = الكتلة المولية للنحاس**

$1.60 \times 10^3$  g

$2.45 \times 10^3$  g

$2.40 \times 10^4$  g

$5.65 \times 10^4$  g

A vessel contains  $5.117 \times 10^{24}$  nitrogen atoms. What is the mass of nitrogen in grams?

يحتوي وعاء على  $5.117 \times 10^{24}$  ذرة من النيتروجين.  
ما كتلة النيتروجين بالجرامات؟

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

molar mass of N = 14.00 g/mol

الكتلة المولية للنيتروجين = 14.00 g/mol

119

25.4

18.7

65.8

How many moles are in 191 g of Cu?

Molar mass Cu = 63.546 g/mol

كم مولاً موجود في 191 g من Cu؟

الكتلة المولية لـ Cu = 63.546 g/mol

191 g Cu

☐

1.5 mol

☐

3 mol

☐

4.5 mol

☒

2 mol

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Chemistry (P1)

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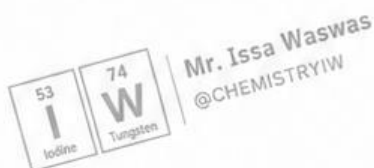
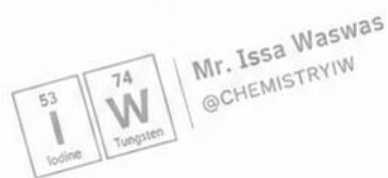
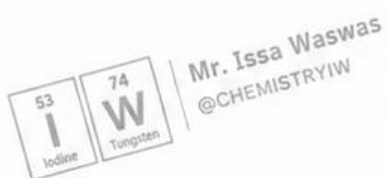
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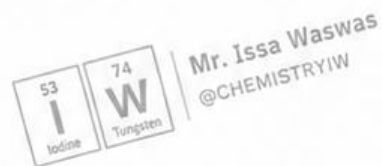
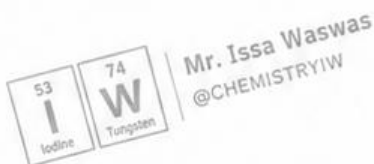


# Module 9

## The Mole

# Lesson (3)

## Moles of Compounds



## CONVERSION SUMMARY

### MASS (g) ↔ MOLES (mol) ↔ PARTICLES

Use molar mass (g/mol)

Use Avogadro's number:  
 $6.02 \times 10^{23}$  atoms/mol

#### 1 STEP: Moles ↔ Particles

$$\text{moles} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}}$$

$$\text{atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}}$$

#### 1 STEP: Mass ↔ Moles

$$\text{moles} \times \frac{\text{molar mass in g}}{1 \text{ mol}}$$

$$\text{mass} \times \frac{1 \text{ mol}}{\text{molar mass in g}}$$

#### 2 STEPS: Mass ↔ Particles

mass → moles → atoms

atoms → moles → mass

Use molar mass and Avogadro's number

### KEY RULE

If moles are given or required → 1 step  
 If converting mass ↔ particles → 2 steps  
 The mole is always the central unit.

## Chemical Formulas and the Mole

**Chemical formulas** show the **types of elements** present and the **relative numbers of atoms or ions** in a single representative particle of a compound.

**Example:**  $\text{CCl}_2\text{F}_2$

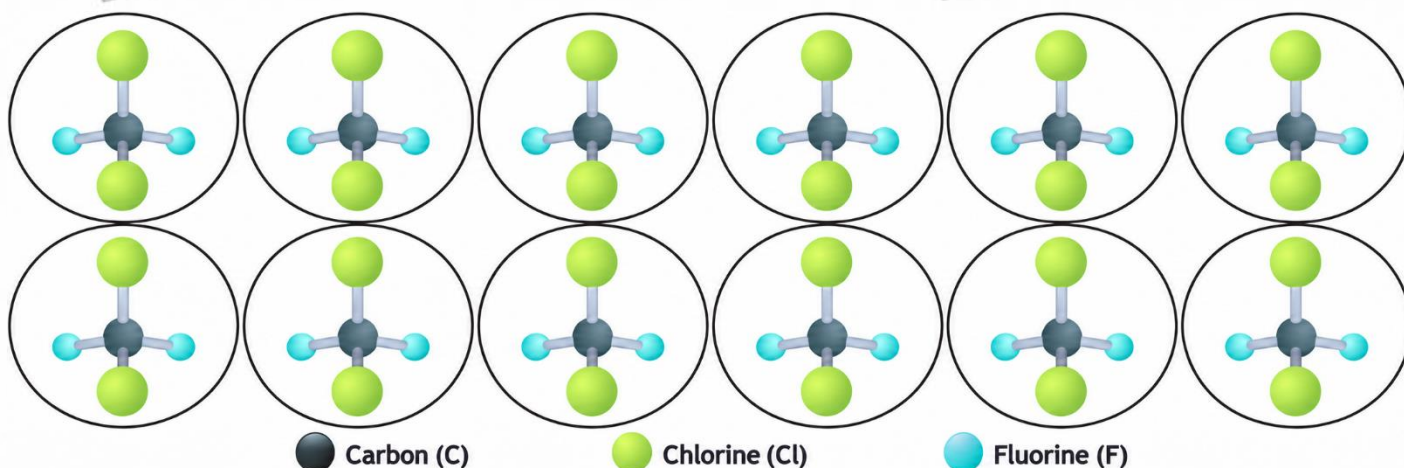
The **subscripts** show that one molecule contains:

| Element      | Number of atoms |
|--------------|-----------------|
| Carbon, C    | 1               |
| Chlorine, Cl | 2               |
| Fluorine, F  | 2               |

Therefore, the **ratio** of atoms is: **C: Cl: F = 1: 2: 2**

A **dozen  $\text{CCl}_2\text{F}_2$**  molecules contains:

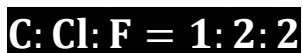
**One dozen carbon atoms • Two dozen chlorine atoms • Two dozen fluorine atoms**



In the same way, **one mole of  $\text{CCl}_2\text{F}_2$**  molecules contains:

**One mole of carbon • Two moles of chlorine • Two moles of fluorine**

The mole ratio remains:



### Writing Mole-Ratio Conversion Factors

For  **$\text{CCl}_2\text{F}_2$** :

$$\frac{1 \text{ mol C atoms}}{1 \text{ mol CCl}_2\text{F}_2}$$

$$\frac{2 \text{ mol Cl atoms}}{1 \text{ mol CCl}_2\text{F}_2}$$

$$\frac{2 \text{ mol F atoms}}{1 \text{ mol CCl}_2\text{F}_2}$$

How many **moles** of **fluorine** atoms are present in **5.5 moles** of  **$\text{CCl}_2\text{F}_2$** ?

### EXAMPLE Problem 6

**MOLE RELATIONSHIPS FROM A CHEMICAL FORMULA** Aluminum oxide ( $\text{Al}_2\text{O}_3$ ), often called alumina, is the principal raw material for the production of aluminum (Al). Alumina occurs in the minerals corundum and bauxite. Determine the moles of aluminum ions ( $\text{Al}^{3+}$ ) in 1.25 mol of  $\text{Al}_2\text{O}_3$ .

### PRACTICE Problems

#### ADDITIONAL PRACTICE

29. Zinc chloride ( $\text{ZnCl}_2$ ) is used in soldering flux, an alloy used to join two metals together. Determine the moles of  $\text{Cl}^-$  ions in 2.50 mol  $\text{ZnCl}_2$ .

| #  | Question                                                                                                                                                                     | Answer |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 30 | Plants and animals depend on glucose ( $C_6H_{12}O_6$ ) as an energy source. Calculate the number of moles of each element in 1.25 mol $C_6H_{12}O_6$ .                      |        |
| 31 | Iron(III) sulfate [ $Fe_2(SO_4)_3$ ] is sometimes used in the water-purification process. Determine the number of moles of sulfate ions present in 3.00 mol $Fe_2(SO_4)_3$ . |        |
| 32 | How many moles of oxygen atoms are present in 5.00 mol of diphosphorus pentoxide ( $P_2O_5$ )?                                                                               |        |
| 33 | <b>CHALLENGE:</b> Calculate the number of moles of hydrogen atoms in $1.15 \times 10^1$ mol of water. Express the answer in scientific notation.                             |        |

## The Molar Mass of Compounds

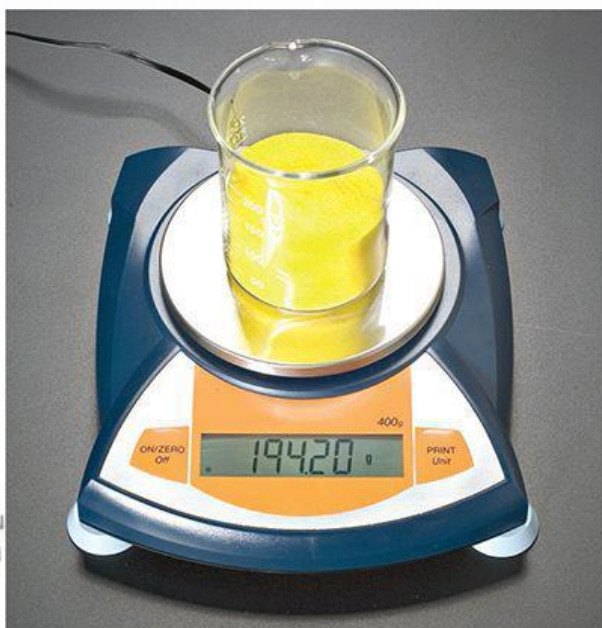
The **molar mass of a compound** is the mass of **one mole of the compound**.

Molar mass of a compound = sum of the masses of all its atoms

Example: Potassium Chromate



| Element | Molar mass  |
|---------|-------------|
| K       | 39.10 g/mol |
| Cr      | 52.00 g/mol |
| O       | 16.00 g/mol |



| #                                                                                                                     | Question                                                                                        | Answer                                                                                                                |                                                                 |                                                                   |
|-----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------|-------------------------------------------------------------------|
| <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> |                                                                                                 | <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> |                                                                 |                                                                   |
| <div>HYDROGEN</div> <div>1</div> <div>H</div> <div>1.008</div>                                                        | <div>CARBON</div> <div>6</div> <div>C</div> <div>12.01</div>                                    | <div>NITROGEN</div> <div>7</div> <div>N</div> <div>14.01</div>                                                        | <div>OXYGEN</div> <div>8</div> <div>O</div> <div>16.00</div>    | <div>SODIUM</div> <div>11</div> <div>Na</div> <div>22.99</div>    |
| <div>PHOSPHORUS</div> <div>15</div> <div>P</div> <div>30.97</div>                                                     | <div>CHLORINE</div> <div>17</div> <div>Cl</div> <div>35.45</div>                                | <div>POTASSIUM</div> <div>19</div> <div>K</div> <div>39.10</div>                                                      | <div>CALCIUM</div> <div>20</div> <div>Ca</div> <div>40.08</div> | <div>STRONTIUM</div> <div>38</div> <div>Sr</div> <div>87.62</div> |
| <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> | <div>34a</div> <div>Determine the molar mass of NaOH.</div>                                     | <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> |                                                                 |                                                                   |
| <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> | <div>34b</div> <div>Determine the molar mass of CaCl<sub>2</sub>.</div>                         | <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> |                                                                 |                                                                   |
| <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> | <div>34c</div> <div>Determine the molar mass of KC<sub>2</sub>H<sub>3</sub>O<sub>2</sub>.</div> | <div><div>53<br/>I<br/>Iodine</div><div>74<br/>W<br/>Tungsten</div></div> <div>Mr. Issa Waswas<br/>@CHEMISTRYIW</div> |                                                                 |                                                                   |

|                                       |                                      |                                      |                                     |                                       |
|---------------------------------------|--------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|
| HYDROGEN<br>1<br><b>H</b><br>1.008    | CARBON<br>6<br><b>C</b><br>12.01     | NITROGEN<br>7<br><b>N</b><br>14.01   | OXYGEN<br>8<br><b>O</b><br>16.00    | SODIUM<br>11<br><b>Na</b><br>22.99    |
| PHOSPHORUS<br>15<br><b>P</b><br>30.97 | CHLORINE<br>17<br><b>Cl</b><br>35.45 | POTASSIUM<br>19<br><b>K</b><br>39.10 | CALCIUM<br>20<br><b>Ca</b><br>40.08 | STRONTIUM<br>38<br><b>Sr</b><br>87.62 |

35a

Calculate the molar mass of  $C_2H_5OH$ .

35b

Calculate the molar mass of  $HCN$ .

35c

Calculate the molar mass of  $CCl_4$ .

|                                       |                                      |                                      |                                     |                                       |
|---------------------------------------|--------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|
| HYDROGEN<br>1<br><b>H</b><br>1.008    | CARBON<br>6<br><b>C</b><br>12.01     | NITROGEN<br>7<br><b>N</b><br>14.01   | OXYGEN<br>8<br><b>O</b><br>16.00    | SODIUM<br>11<br><b>Na</b><br>22.99    |
| PHOSPHORUS<br>15<br><b>P</b><br>30.97 | CHLORINE<br>17<br><b>Cl</b><br>35.45 | POTASSIUM<br>19<br><b>K</b><br>39.10 | CALCIUM<br>20<br><b>Ca</b><br>40.08 | STRONTIUM<br>38<br><b>Sr</b><br>87.62 |

|     |                                                                                                          |  |
|-----|----------------------------------------------------------------------------------------------------------|--|
| 36a | Identify $\text{Sr}(\text{NO}_3)_2$ as molecular or ionic, then calculate its molar mass.                |  |
| 36b | Identify $(\text{NH}_4)_3\text{PO}_4$ as molecular or ionic, then calculate its molar mass.              |  |
| 36c | Identify $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ as molecular or ionic, then calculate its molar mass. |  |

## Converting Moles of a Compound to Mass

## Converting Mass of a Compound to Moles

### How does this differ from Element calculations?

- Calculate the **compound's molar mass first if it is not given**, then **use the appropriate conversion factor to solve**.

#### EXAMPLE Problem 7

**MOLE-TO-MASS CONVERSION FOR COMPOUNDS** The characteristic odor of garlic is due to allyl sulfide  $[(C_3H_5)_2S]$ . What is the mass of 2.50 mol of  $(C_3H_5)_2S$ ?

| Element | Molar mass  |
|---------|-------------|
| C       | 12.01 g/mol |
| H       | 1.008 g/mol |
| S       | 32.06 g/mol |

#### EXAMPLE Problem 8

**MASS-TO-MOLE-CONVERSION FOR COMPOUNDS** Calcium hydroxide  $[Ca(OH)_2]$  is used to remove sulfur dioxide from the exhaust gases emitted by power plants and for softening water by the elimination of  $Ca^{2+}$  and  $Mg^{2+}$  ions. Calculate the number of moles of calcium hydroxide in 325 g of the compound.

| Element | Molar mass  |
|---------|-------------|
| Ca      | 40.08 g/mol |
| O       | 16.00 g/mol |
| H       | 1.008 g/mol |

| #  | Question                                                                                                                                                                                                                                                                                                         |
|----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 37 | <p>The United States chemical industry produces more sulfuric acid, <math>\text{H}_2\text{SO}_4</math>, in terms of mass, than any other chemical. What is the mass of 3.25 mol of <math>\text{H}_2\text{SO}_4</math>?</p> <p><b>Molar mass of <math>\text{H}_2\text{SO}_4 = 98.08 \text{ g/mol}</math>.</b></p> |
| 38 | <p>What is the mass of <math>4.35 \times 10^{-2}</math> mol of zinc chloride, <math>\text{ZnCl}_2</math>?</p> <p><b>Molar masses: <math>\text{Zn} = 65.38 \text{ g/mol}</math>; <math>\text{Cl} = 35.45 \text{ g/mol}</math>.</b></p>                                                                            |

**39 CHALLENGE:** Write the chemical formula for potassium permanganate, and then calculate the mass in grams of 2.55 mol of the compound.

**Molar mass of potassium permanganate = 158.04 g/mol.**

**40a** Determine the number of moles present in 22.6 g of  $\text{AgNO}_3$ .

**Molar mass of  $\text{AgNO}_3$  = 169.88 g/mol.**

**40b** Determine the number of moles present in 6.50 g of  $\text{ZnSO}_4$ .

**Molar masses:**  $\text{Zn} = 65.38 \text{ g/mol}$ ;  $\text{S} = 32.06 \text{ g/mol}$ ;  $\text{O} = 16.00 \text{ g/mol}$ .

**40c** Determine the number of moles present in 35.0 g of  $\text{HCl}$ .

**Molar mass of  $\text{HCl}$  = 36.46 g/mol.**

**41a CHALLENGE:** Identify  $\text{Fe}_2\text{O}_3$  as an ionic or molecular compound and convert 2.50 kg of the compound to moles. Express your answer in scientific notation.

**Molar mass of  $\text{Fe}_2\text{O}_3$  = 159.70 g/mol.**

**41b CHALLENGE:** Identify  $\text{PbCl}_4$  as an ionic or molecular compound and convert 25.4 mg of the compound to moles. Express your answer in scientific notation.

**Molar mass of  $\text{PbCl}_4$  = 349.00 g/mol.**

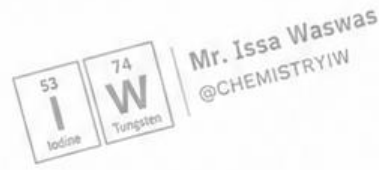
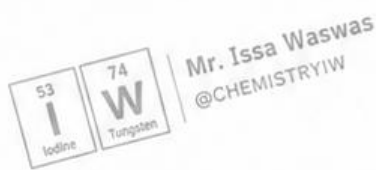
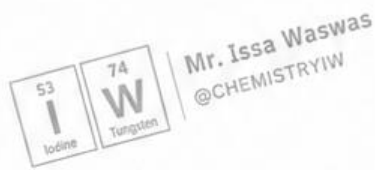
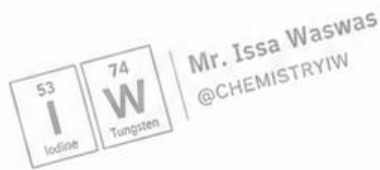
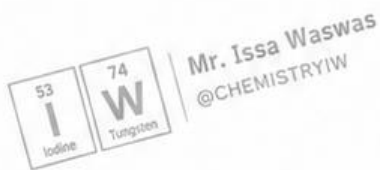
## Converting Mass of a Compound to Number of Particles

### EXAMPLE Problem 9

**CONVERSION FROM MASS TO MOLES TO PARTICLES** Aluminum chloride ( $\text{AlCl}_3$ ) is used in refining petroleum and manufacturing rubber and lubricants. A sample of aluminum chloride has a mass of 35.6 g.

- How many aluminum ions are present?
- How many chloride ions are present?
- What is the mass, in grams, of one formula unit of aluminum chloride?

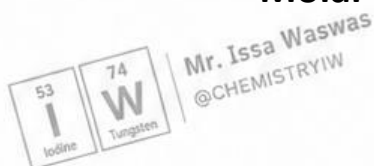
**Molar mass of  $\text{AlCl}_3 = 133.33 \text{ g/mol}$**



42. Ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ), a domestically produced fuel source, is often blended with gasoline. A sample of ethanol has a mass of 45.6 g.

- How many carbon atoms does the sample contain?
- How many hydrogen atoms are present?
- How many oxygen atoms are present?

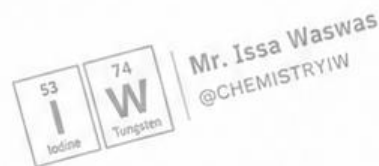
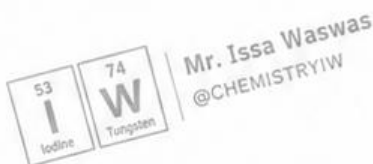
**Molar mass of  $\text{C}_2\text{H}_5\text{OH} = 46.07 \text{ g/mol}$**



43. A sample of sodium sulfite ( $\text{Na}_2\text{SO}_3$ ) has a mass of 2.25 g.

- How many  $\text{Na}^+$  ions are present?
- How many  $\text{SO}_3^{2-}$  ions are present?
- What is the mass in grams of one formula unit of  $\text{Na}_2\text{SO}_3$ ?

**Molar mass of  $\text{Na}_2\text{SO}_3 = 126.04 \text{ g/mol}$**



**44.** A sample of carbon dioxide ( $\text{CO}_2$ ) has a mass of 52.0 g.

- a.** How many carbon atoms are present?
- b.** How many oxygen atoms are present?
- c.** What is the mass in grams of one molecule of  $\text{CO}_2$ ?

**Molar mass of  $\text{CO}_2$  = 44.01 g/mol**

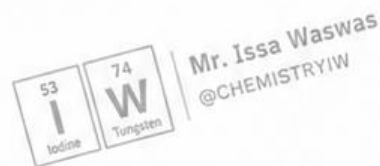
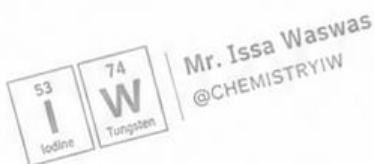
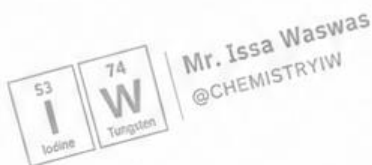
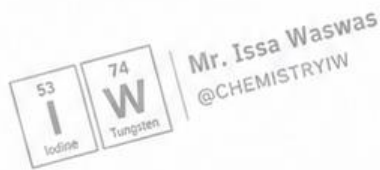
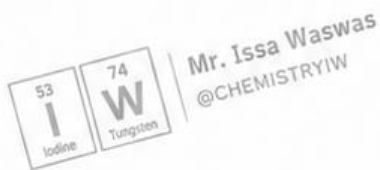
**45.** What mass of sodium chloride ( $\text{NaCl}$ ) contains  $4.59 \times 10^{24}$  formula units?

**Molar mass of  $\text{NaCl}$  = 58.44 g/mol**

**46. CHALLENGE** A sample of silver chromate has a mass of 25.8 g.

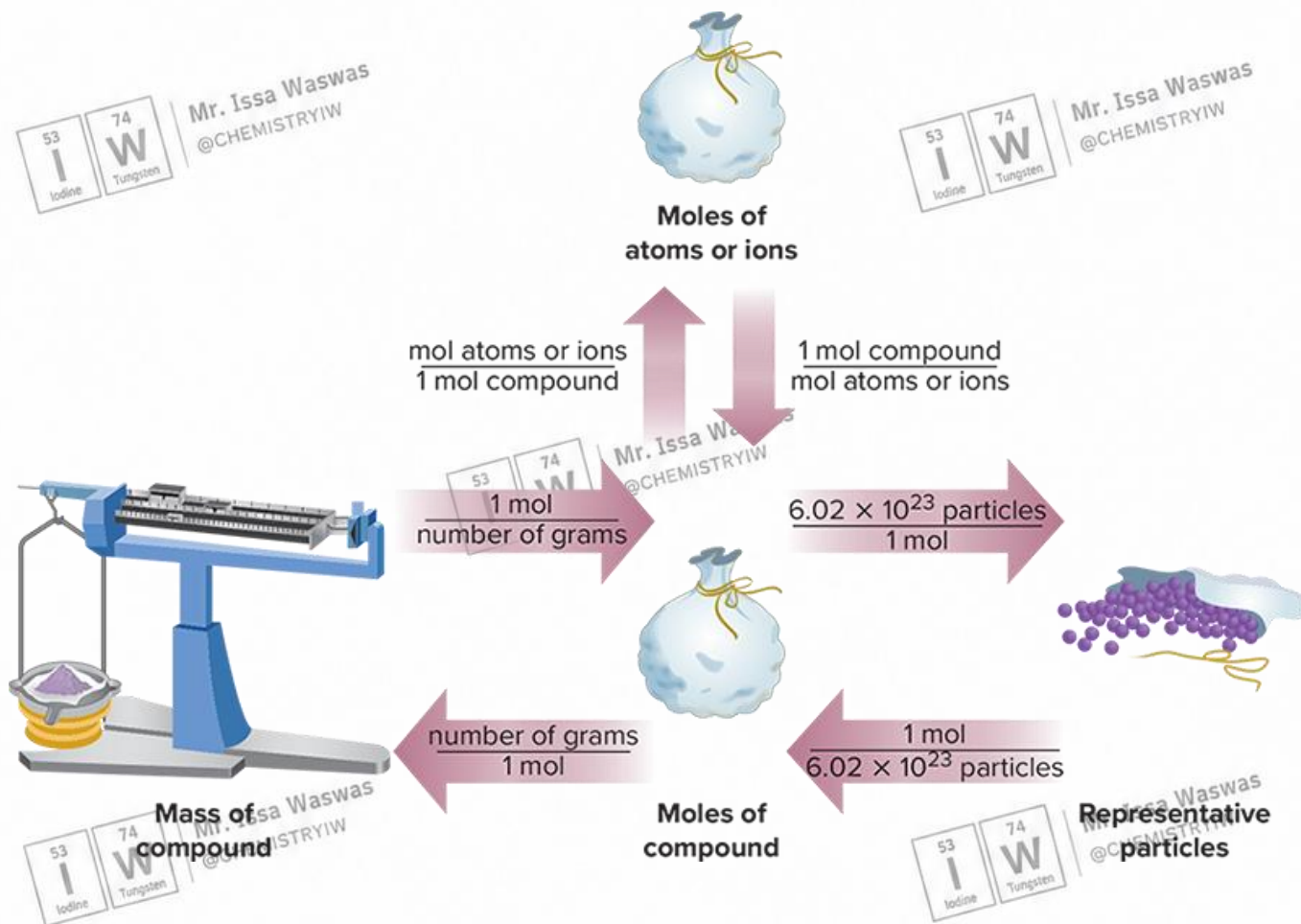
- Write the formula for silver chromate.
- How many cations are present in the sample?
- How many anions are present in the sample?
- What is the mass in grams of one formula unit of silver chromate?

**Molar mass of silver chromate = 331.74 g/mol**



# Summary

- ❖ Subscripts show the moles of each element in **1 mol of a compound**.
- ❖ Add the masses of all atoms in the formula to calculate the compound's **molar mass**.
- ❖ Use molar mass to convert between **moles and mass**.



Grade 12 General

Chemistry (P1)

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**فيديوهات شرح وحل**

**الملزمة كاملة متوفرة**

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Quiz

Lesson 3

Moles of Compounds

أسئلة وزارية سابقة

What is the molar mass of the compound  $C_2H_5OH$ ?ما الكتلة المولية للمركب  $C_2H_5OH$ ؟

|                                    |                                       |                                      |                                     |                                       |                                   |                                      |                                   |
|------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|
| HYDROGEN<br>1<br><b>H</b><br>1.00  | Periodic Table<br>Elements 1–18       |                                      |                                     |                                       |                                   |                                      | HELIUM<br>2<br><b>He</b><br>4.00  |
| LITHIUM<br>3<br><b>Li</b><br>6.94  | BERYLLIUM<br>4<br><b>Be</b><br>9.01   | BORON<br>5<br><b>B</b><br>10.81      | CARBON<br>6<br><b>C</b><br>12.01    | NITROGEN<br>7<br><b>N</b><br>14.00    | OXYGEN<br>8<br><b>O</b><br>16.00  | FLUORINE<br>9<br><b>F</b><br>19.00   | NEON<br>10<br><b>Ne</b><br>20.18  |
| SODIUM<br>11<br><b>Na</b><br>23.00 | MAGNESIUM<br>12<br><b>Mg</b><br>24.31 | ALUMINUM<br>13<br><b>Al</b><br>26.98 | SILICON<br>14<br><b>Si</b><br>28.09 | PHOSPHORUS<br>15<br><b>P</b><br>30.97 | SULFUR<br>16<br><b>S</b><br>32.07 | CHLORINE<br>17<br><b>Cl</b><br>35.45 | ARGON<br>18<br><b>Ar</b><br>39.95 |

89.0 g/mol

34.0 g/mol

46.0 g/mol

62.0 g/mol

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What is the mass of 3.25 mol of sulfuric acid,  $\text{H}_2\text{SO}_4$ ?

ما كتلة 3.25 mol من حمض الكبريتيك  $\text{H}_2\text{SO}_4$ ؟

Molar mass of  $\text{H}_2\text{SO}_4$  = 98.08 g/mol

الكتلة المولية لـ  $\text{H}_2\text{SO}_4$  = 98.08 g/mol

- ☐ 637 g
- ☐ 319 g
- ☐ 478 g
- ☐ 159 g



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Which of the following is the **correct** conversion factor for finding the number of molecules of a compound from the number of moles of the compound?

أي مما يلي هو معامل التحويل الصحيح لإيجاد عدد جزيئات مركب من عدد مولات المركب؟

☐  $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$

☐  $\frac{1 \text{ مول}}{6.02 \times 10^{23} \text{ جزيئات}}$

☒  $\text{molar mass} \times 6.02 \times 10^{23} \text{ molecules}$

☐  $\text{جزيئات} \times 6.02 \times 10^{23} \times \text{الكتلة المولية}$

☐  $\frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}}$

☐  $\frac{\text{جزيئات} \times 6.02 \times 10^{23}}{1 \text{ مول}}$

☐  $1 \text{ mol} \times 6.02 \times 10^{23} \text{ molecules}$

☐  $\text{جزيئات} \times 6.02 \times 10^{23} \times 1 \text{ مول}$

How many molecules are in 60.0 g of glucose ( $C_6H_{12}O_6$ )?

كم عدد الجزيئات الموجودة في 60.0 g من الجلوكوز ( $C_6H_{12}O_6$ )؟

Molar mass of glucose ( $C_6H_{12}O_6$ ) = 180 g/mol

الكتلة المولية للجلوكوز ( $C_6H_{12}O_6$ ) = 180 g/mol

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

☐

$7.83 \times 10^{22}$

☐

$5.16 \times 10^{23}$

☒

$9.22 \times 10^{22}$

☐

$2.01 \times 10^{23}$



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Which of the following ratios or conversion factors is **incorrect** for calculations involving the compound  $KC_2H_3O_2$ ?

أي من النسب أو معاملات التحويل التالية **غير صحيحة** لإجراء حسابات تتعلق بالمركب  $KC_2H_3O_2$ ؟

☐

$\frac{1 \text{ mol K atoms}}{1 \text{ mol } KC_2H_3O_2}$

☐

$\frac{2 \text{ mol C atoms}}{1 \text{ mol } KC_2H_3O_2}$

☐

$\frac{3 \text{ mol H atoms}}{1 \text{ mol } KC_2H_3O_2}$

☐

$\frac{1 \text{ mol O atoms}}{1 \text{ mol } KC_2H_3O_2}$

How many moles are in 22.0 g of  $\text{CO}_2$ ?

Molar mass of  $\text{CO}_2 = 44 \text{ g/mol}$

كم مولاً يوجد في 22.0 g من  $\text{CO}_2$  ؟

الكتلة المولية لـ  $\text{CO}_2 = 44 \text{ g/mol}$

☐

1.25 mol

☐

0.50 mol

☐

0.60 mol

☐

2.00 mol

How many carbon tetrachloride ( $\text{CCl}_4$ ) molecules are in 307.6 g of  $\text{CCl}_4$ ?

Avogadro's number =  $6.02 \times 10^{23}$

Molar mass of  $\text{CCl}_4 = 153.8 \text{ g/mol}$

كم عدد جزيئات رباعي كلوريد الكربون ( $\text{CCl}_4$ ) الموجودة في 307.6 g من  $\text{CCl}_4$  ؟

عدد أفوجادرو =  $6.02 \times 10^{23}$

الكتلة المولية لـ  $\text{CCl}_4 = 153.8 \text{ g/mol}$

☐

$3.01 \times 10^{23}$

☐

$6.02 \times 10^{23}$

☐

$1.20 \times 10^{24}$

☐

$1.82 \times 10^{24}$



How many moles of iron ions are present in

**3.750 mol** of iron(III) sulfate,  $\text{Fe}_2(\text{SO}_4)_3$ ?

كم عدد مولات أيونات الحديد الموجودة في

**3.750 mol** من كبريتات الحديد(III)،  $\text{Fe}_2(\text{SO}_4)_3$  ؟

|                       |       |
|-----------------------|-------|
| <input type="radio"/> | 7.500 |
| <input type="radio"/> | 12.65 |
| <input type="radio"/> | 4.450 |
| <input type="radio"/> | 18.35 |



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How many moles of sulfate ions are present in

**3.750 mol** of iron(III) sulfate,  $\text{Fe}_2(\text{SO}_4)_3$ ?

كم عدد مولات أيونات الكبريتات الموجودة في

**3.750 mol** من كبريتات الحديد(III)،  $\text{Fe}_2(\text{SO}_4)_3$  ؟

|                       |       |
|-----------------------|-------|
| <input type="radio"/> | 7.500 |
| <input type="radio"/> | 18.75 |
| <input type="radio"/> | 11.25 |
| <input type="radio"/> | 15.00 |



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A sample of calcium sulfate,  $\text{CaSO}_4$ , has a mass of **1156 g**. How many moles does it contain?

عينة من كبريتات الكالسيوم،  $\text{CaSO}_4$ ، كتلتها **1156 g**. كم مولاً تحتوي؟

Ca = 40 g/mol

S = 32 g/mol

O = 16 g/mol

|                       |      |
|-----------------------|------|
| <input type="radio"/> | 7.80 |
| <input type="radio"/> | 8.50 |
| <input type="radio"/> | 6.55 |
| <input type="radio"/> | 12.5 |

What is the molar mass of the compound  $\text{Al}_2(\text{SO}_4)_3$ ?

ما الكتلة المولية للمركب  $\text{Al}_2(\text{SO}_4)_3$ ؟

| HYDROGEN<br>1<br><b>H</b><br>1.008 | Periodic Table<br>Elements 1 – 18     |                                      |                                     |                                       |                                   |                                      | HELIUM<br>2<br><b>He</b><br>4.003 |
|------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|---------------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|
| LITHIUM<br>3<br><b>Li</b><br>6.94  | BERYLLIUM<br>4<br><b>Be</b><br>9.012  | BORON<br>5<br><b>B</b><br>10.81      | CARBON<br>6<br><b>C</b><br>12.01    | NITROGEN<br>7<br><b>N</b><br>14.01    | OXYGEN<br>8<br><b>O</b><br>16.00  | FLUORINE<br>9<br><b>F</b><br>19.00   | NEON<br>10<br><b>Ne</b><br>20.18  |
| SODIUM<br>11<br><b>Na</b><br>22.99 | MAGNESIUM<br>12<br><b>Mg</b><br>24.31 | ALUMINUM<br>13<br><b>Al</b><br>26.98 | SILICON<br>14<br><b>Si</b><br>28.09 | PHOSPHORUS<br>15<br><b>P</b><br>30.97 | SULFUR<br>16<br><b>S</b><br>32.06 | CHLORINE<br>17<br><b>Cl</b><br>35.45 | ARGON<br>18<br><b>Ar</b><br>39.95 |

|                       |              |
|-----------------------|--------------|
| <input type="radio"/> | 150.07 g/mol |
| <input type="radio"/> | 277.91 g/mol |
| <input type="radio"/> | 342.15 g/mol |
| <input type="radio"/> | 262.33 g/mol |

Which of the following statements are **correct** regarding molar mass and the mole?

أي من العبارات التالية **صحيحة** فيما يتعلق بالكتلة المولية والمول؟

|   |                                                                                                                |                                                                                              |   |
|---|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|---|
| 1 | The molar mass of an element is numerically equal to its atomic mass.                                          | الكتلة المولية لعنصر تساوي عددًا كُتلته الذرية.                                              | 1 |
| 2 | Subscripts in a chemical formula indicate how many moles of each element are present in 1 mol of the compound. | تشير الأرقام السفلية في الصيغة الكيميائية إلى عدد مولات كل عنصر الموجودة في 1 mol من المركب. | 2 |
| 3 | The molar mass of a compound is calculated from the molar masses of all the elements in the compound.          | تُحسب الكتلة المولية للمركب من الكتل المولية لجميع العناصر الموجودة فيه.                     | 3 |

|                       |             |           |
|-----------------------|-------------|-----------|
| <input type="radio"/> | 1, 2, and 3 | 1 و 2 و 3 |
| <input type="radio"/> | 1 and 2     | 1 و 2     |
| <input type="radio"/> | 2 and 3     | 2 و 3     |
| <input type="radio"/> | 1 and 3     | 1 و 3     |

What is the mass of  $8.35 \times 10^{23}$  molecules of  $\text{CCl}_4$ ?

ما كتلة  $8.35 \times 10^{23}$  جزيئًا من  $\text{CCl}_4$ ؟

Molar mass of  $\text{CCl}_4$  = 154 g/mol

الكتلة المولية لـ  $\text{CCl}_4$  = 154 g/mol

Avogadro's number =  $6.02 \times 10^{23}$

عدد أفوجادرو =  $6.02 \times 10^{23}$

|                       |                         |
|-----------------------|-------------------------|
| <input type="radio"/> | $9.03 \times 10^{-3}$ g |
| <input type="radio"/> | $7.26 \times 10^{-3}$ g |
| <input type="radio"/> | 213.6 g                 |
| <input type="radio"/> | 100.8 g                 |

A sample of calcium sulfate,  $\text{CaSO}_4$ , has a mass of

**884 g**. How many moles does it contain?

عينة من كبريتات الكالسيوم،  $\text{CaSO}_4$ ، كتلتها

**884 g**. كم مولاً تحتوي؟

Ca = 40 g/mol

S = 32 g/mol

O = 16 g/mol

☐

9.0

☐

6.5

☐

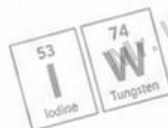
3.8

☐

8.0



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How many moles are in 82.0 g of HCN?

Molar mass of HCN = 27.0 g/mol

كم مولاً يوجد في 82.0 g من HCN؟

الكتلة المولية لـ HCN = 27.0 g/mol

☐

3.04 mol

☐

2.53 mol

☐

1.25 mol

☐

0.33 mol



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Grade 12 General

Chemistry (P1)

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**فيديوهات شرح وحل**

**الملزمة كاملة متوفرة**

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