

The Chemical World

Chemistry:

الكيمياء : العلم الذي يهتم خصائص وسلوك حالات المادة خلال دراسة الجزيئات والذرات والعمليات الكيميائية

الكيمياء

- The science that seeks to understand the properties and behavior of matter by studying what atoms and molecules do.

- It is central to our fundamental understanding of many science related fields.

الكيمياء الأساسية للعلماء الأساسية للعمليات الكيميائية

- Virtually, everything around you is composed of "Chemicals".

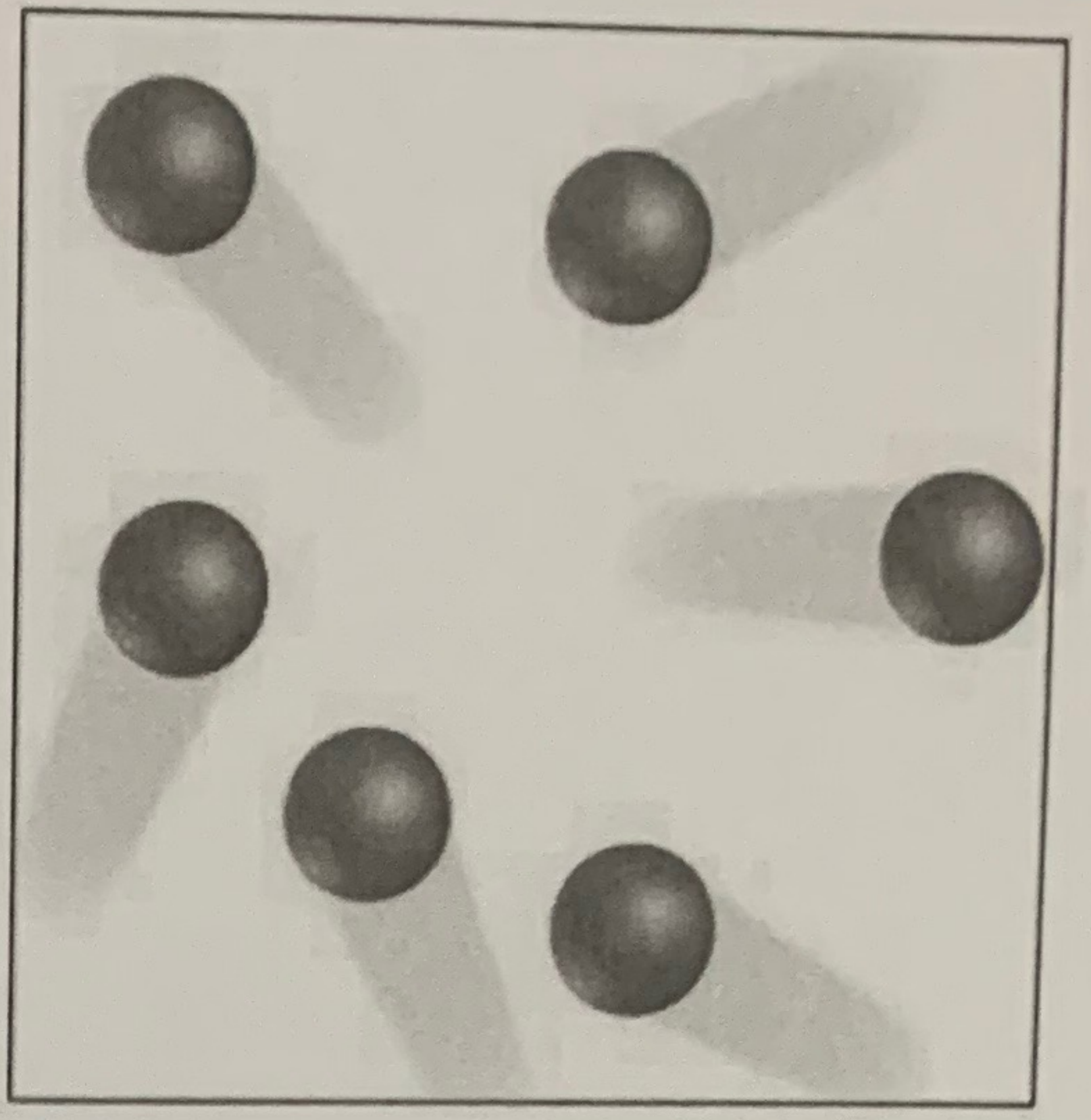
تقريباً، كل شيء حولك يتكون من كيمياء

1.1 Atoms and Molecules

- Atoms are the building blocks of matter.
الذرات بنائ المادة
- Each element is made of a unique kind of atoms (so far, 118 elements are identified in the universe, all are represented in the periodic table of elements).
كل عنصر مكون من نوع فريد من الذرات (حتى الآن، 118 عنصرا تم التعرف عليها في الكون، جميعها مُمثلة في الجدول الدوري للعناصر).
- A compound is made of two or more atoms of different kinds of elements, bonded together to form molecules (molecules are the building blocks of compounds).
المركب يتكون من ذرات من أنواع مختلفة من العناصر، متصلة معا لتشكل جزيئات (الجزيئات هي لبنات بناء للمركبات).
- The properties of a substance are determined by the properties of its molecules and atoms.
الخواص الجزيئية للمادة تحددها خواص جزيئاتها وذراتها.

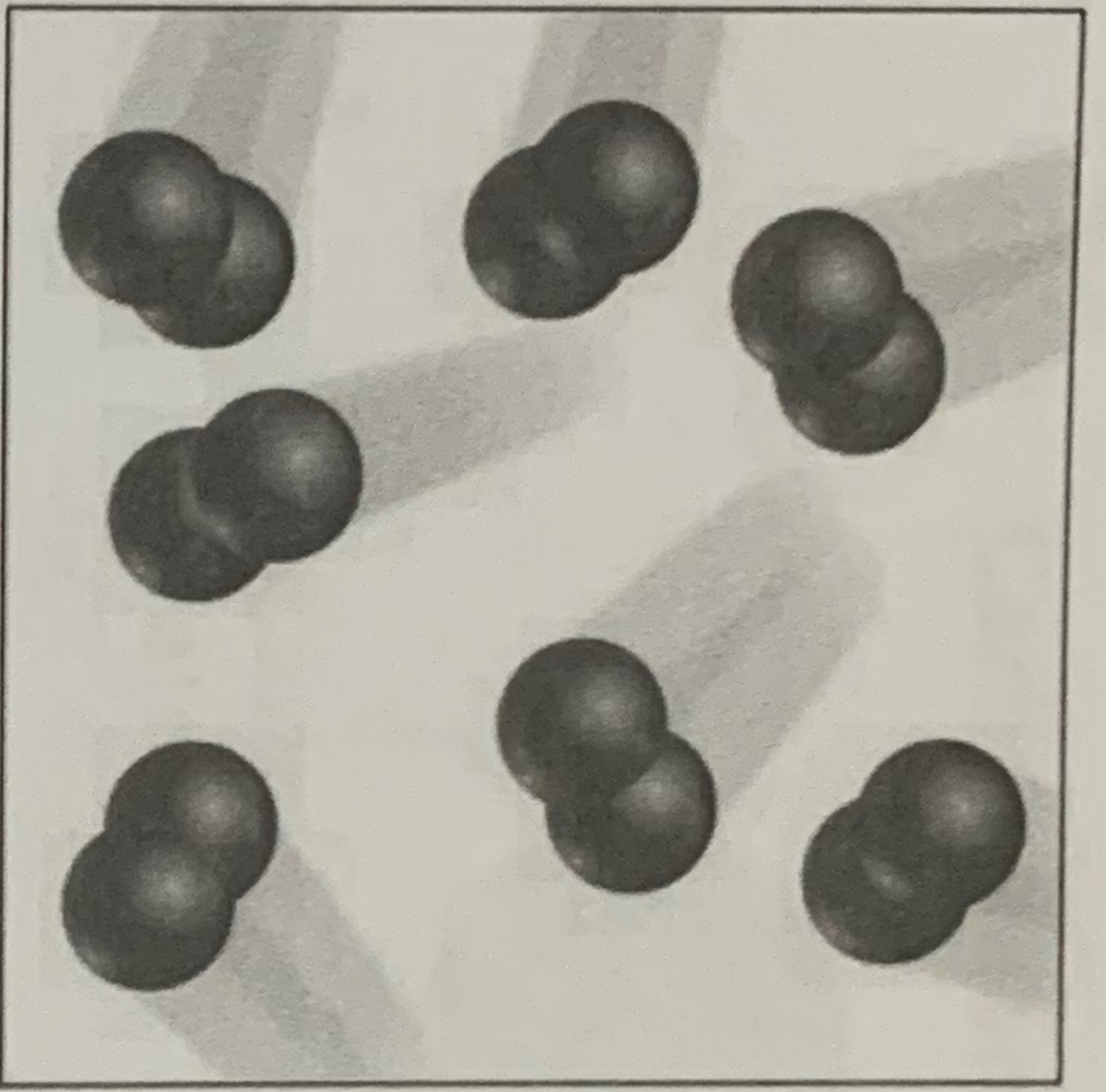
1.1 Atoms and Molecules

→ جزیئات
الذرات



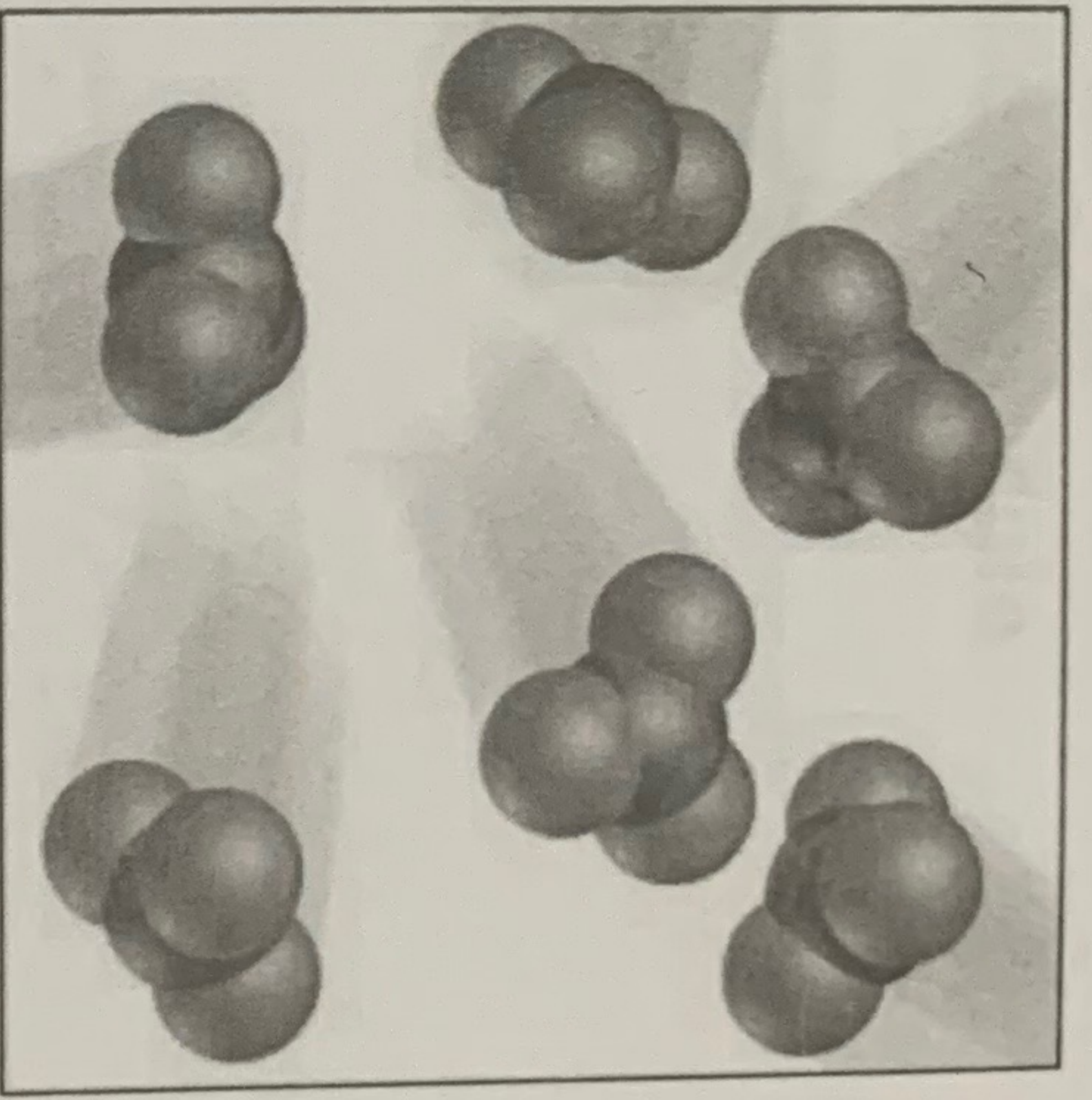
(a) Atoms of an element

ذرات عنصر



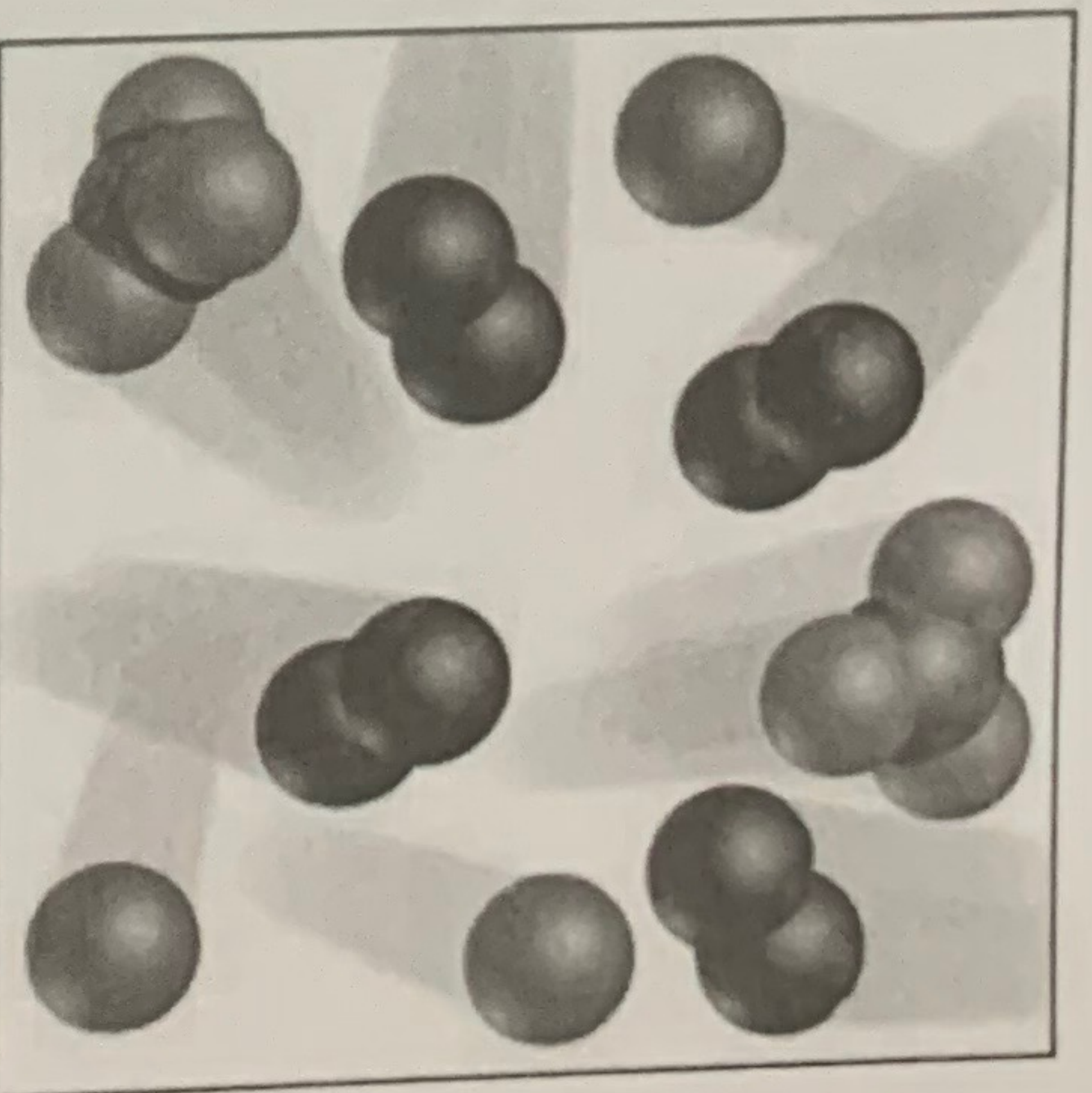
(b) Molecules of an element

جزيئات عنصر



(c) Molecules of a compound

جزيئات مركب



(d) Mixture of elements and a compound

Only one kind of atom is in any element.

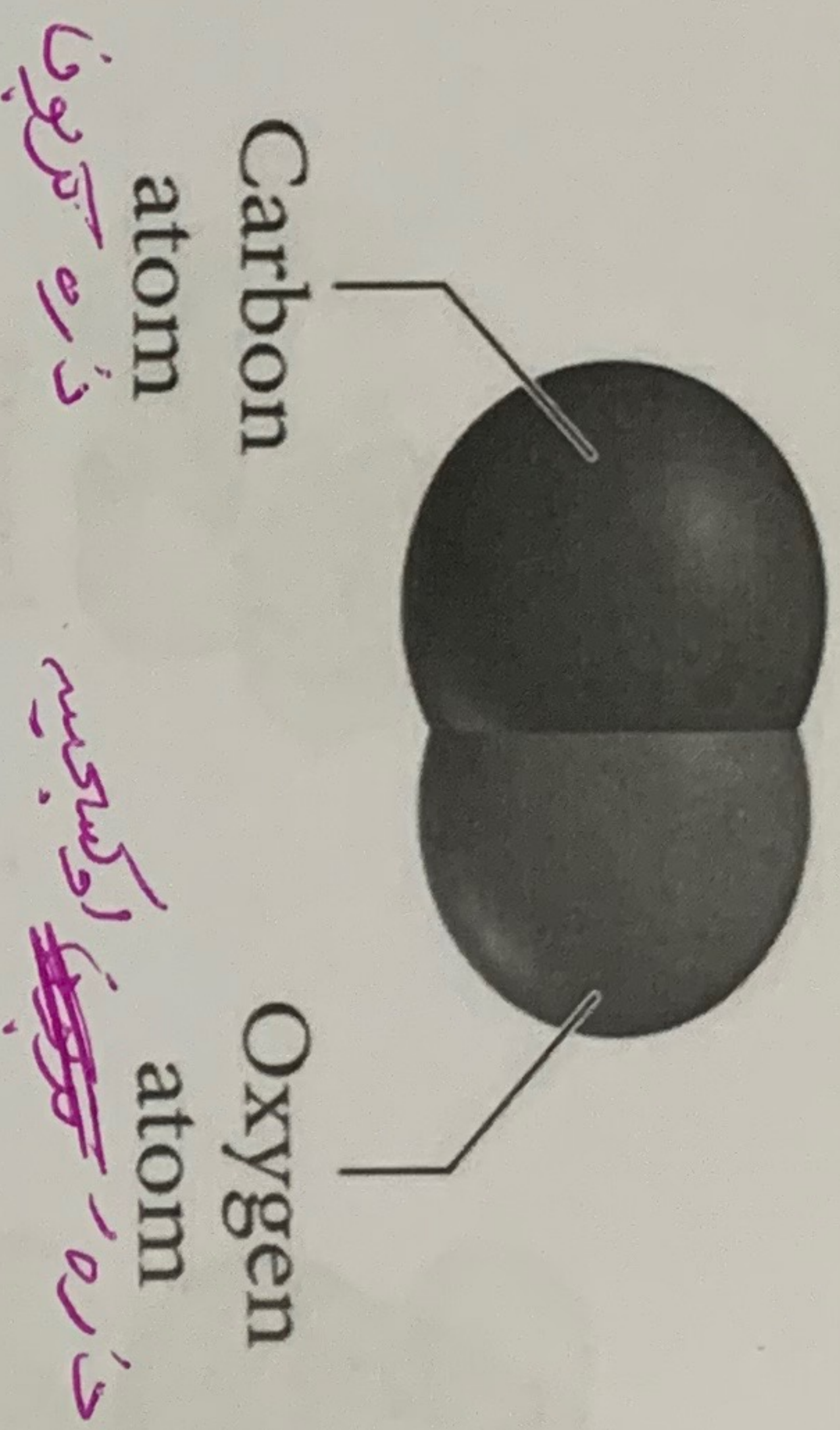
Compounds must have at least two kinds of atoms.

Notice that: some elements are present in nature in the form of "molecules" instead of "free atoms", they are called: "Molecular Elements", such as: H₂, N₂, O₂, F₂, Cl₂, Br₂, I₂

1.1 Atoms and Molecules - Example 1

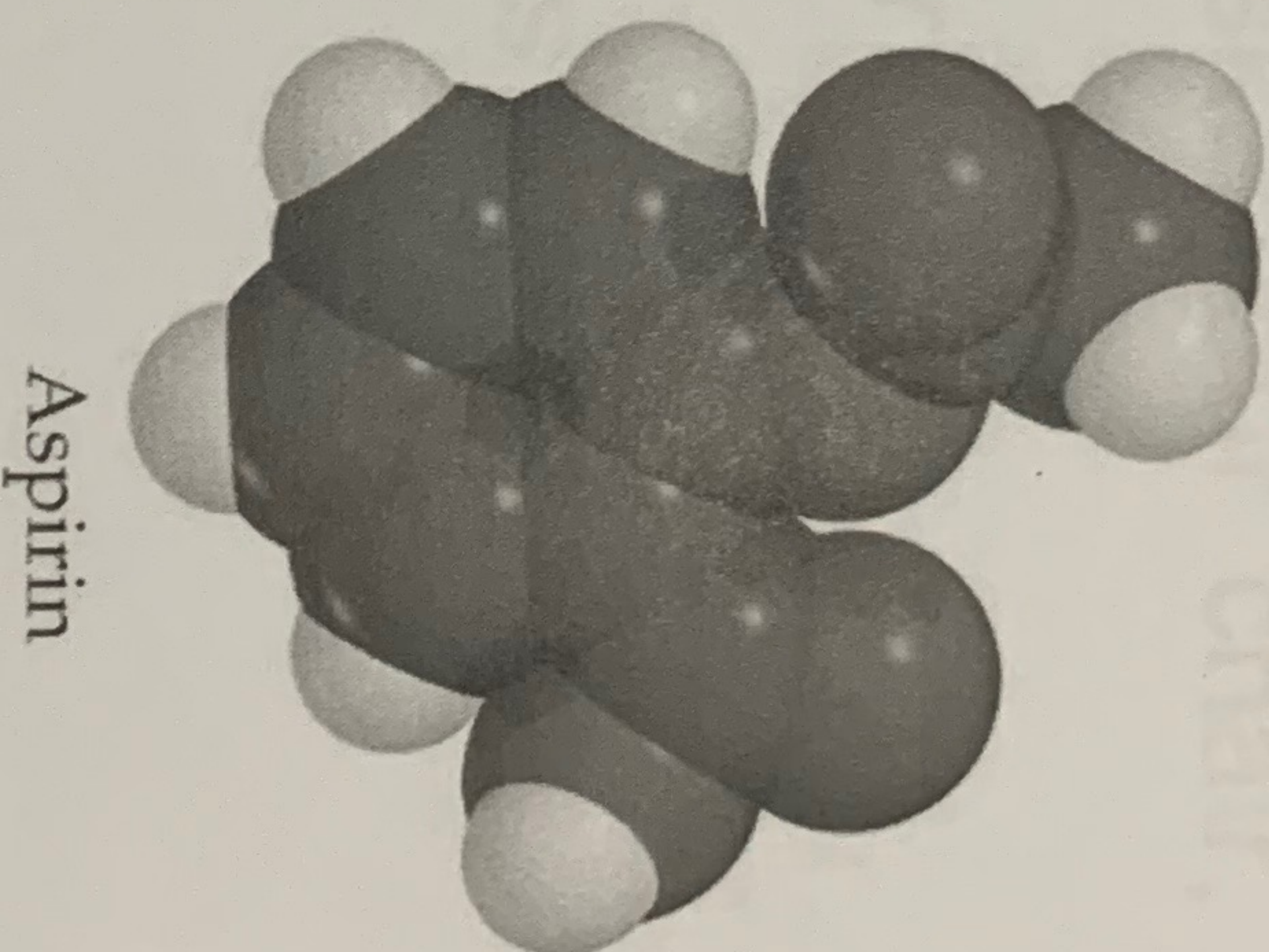
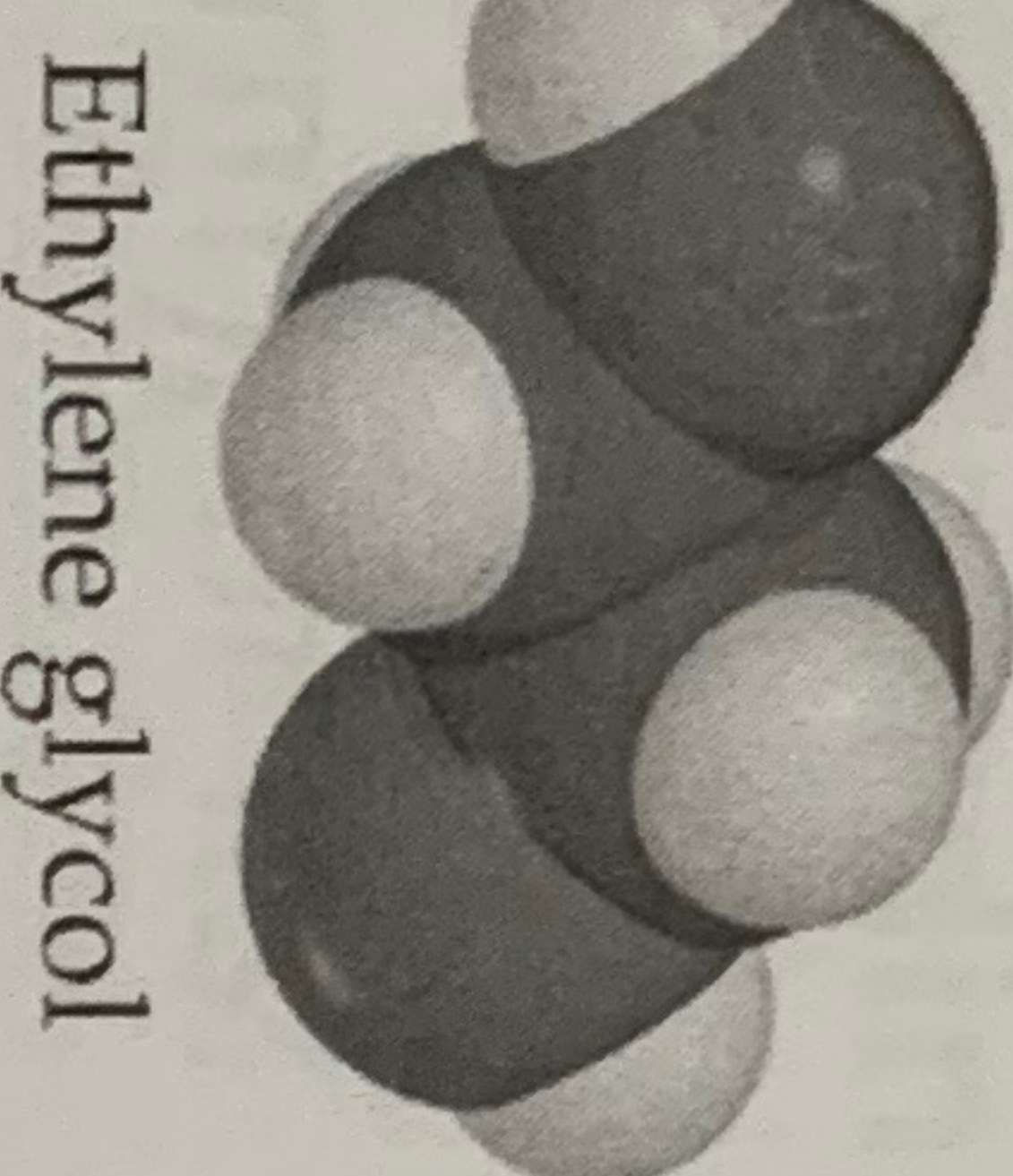
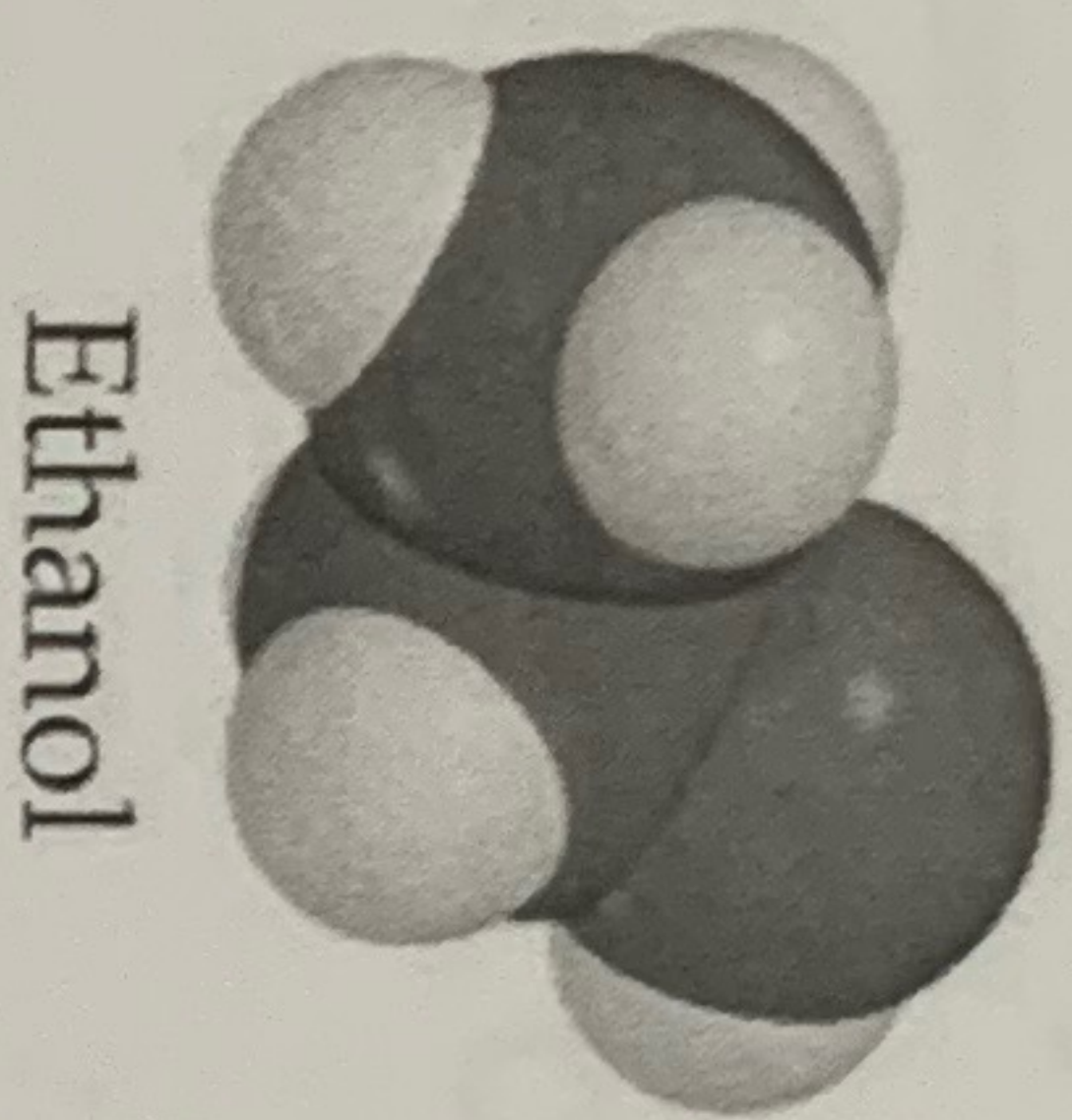
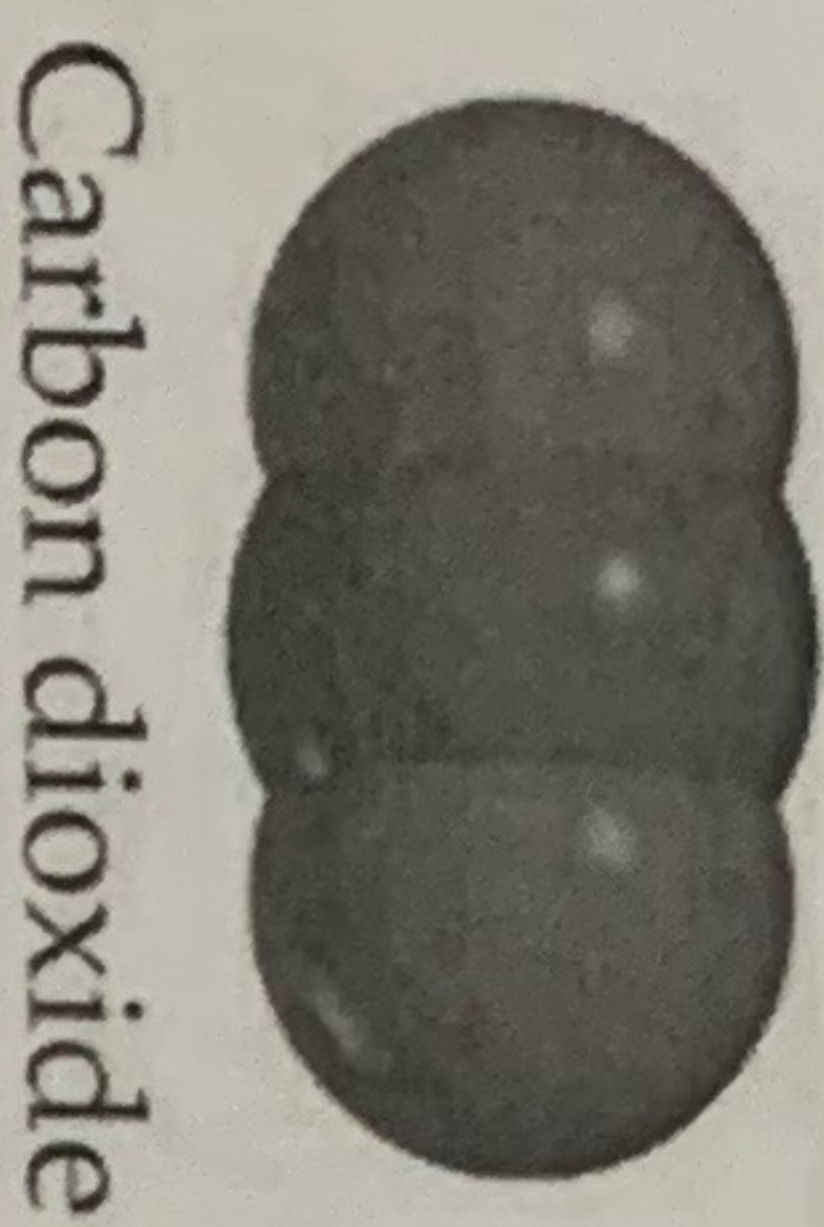
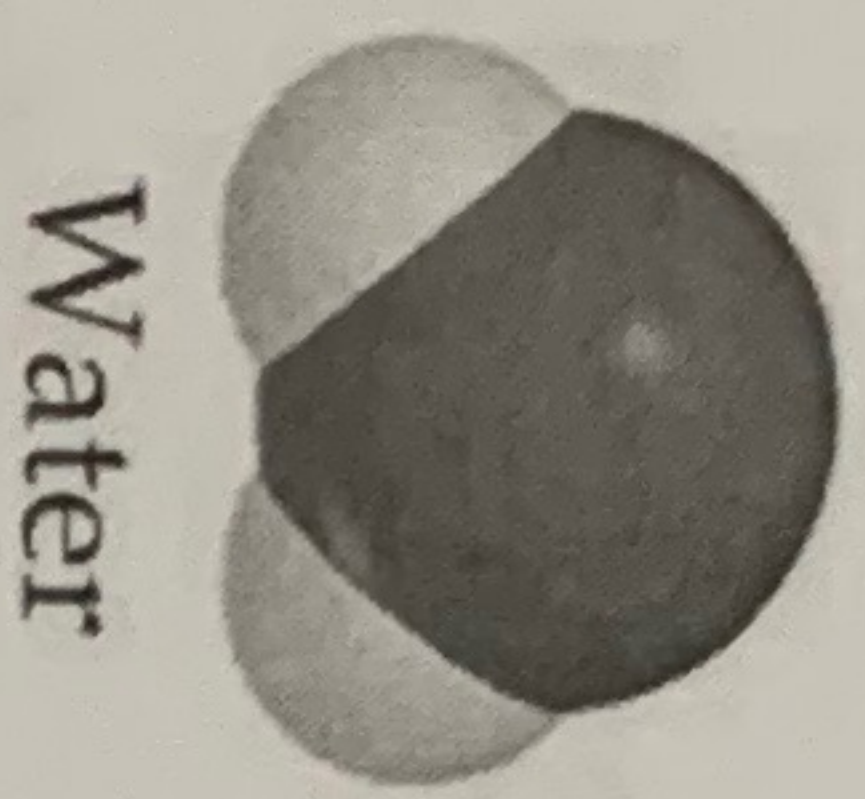
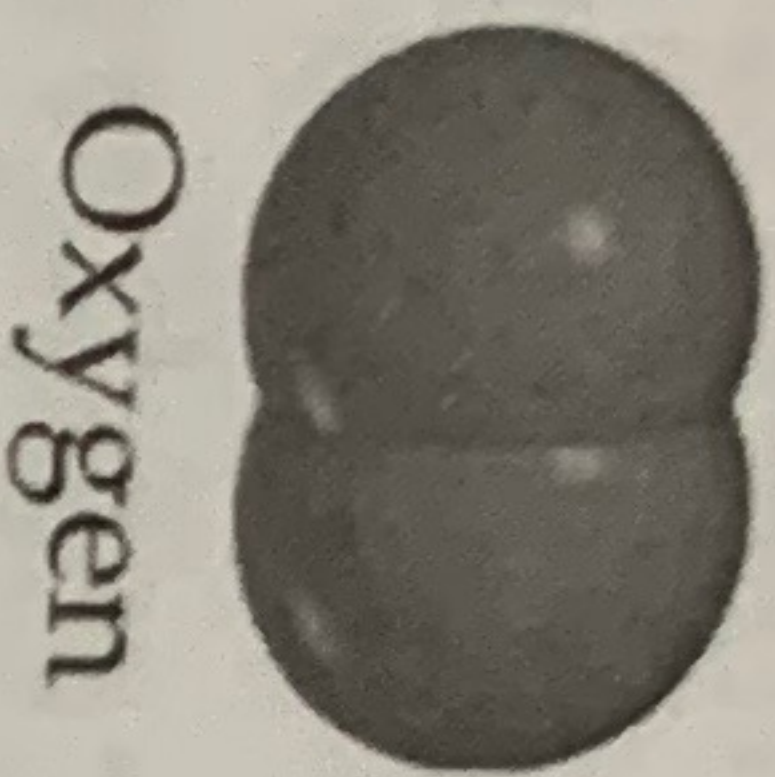
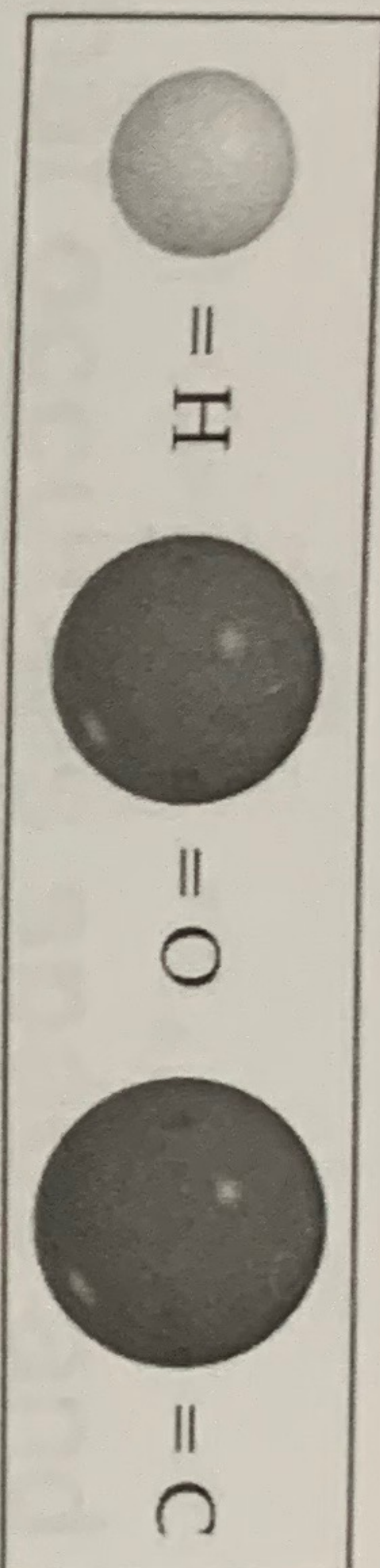
جزء اول اكسيد الكربون

Carbon monoxide molecule



- ✓ The air ^{كثير الهواء} contains carbon monoxide ^{امون اكسيد الكربون} pollutant. ^{ملوث}
- ✓ Each ^{كل} molecule ^{جزيء} contains a carbon atom ^{كربون} and an oxygen atom ^{ذره} held together by a chemical bond. ^{بالارتباط كيميائي}

1.1 Atoms and Molecules - Example 2



Note: Balls of different colors are used to represent atoms of different elements. Attached balls represent connections between atoms that are seen in nature. These groups of atoms are called molecules.

گولوں کے مختلف رنگوں کے ساتھ مختلف رنگوں کے گولے، جو آپس میں جڑے ہوئے ہوں، انہیں ایٹموں کے درمیان جوڑنے کے لیے استعمال کیا جاتا ہے۔ جو ایٹموں کے گروہوں کو دکھاتے ہیں جو کہ جڑے ہوئے ہوتے ہیں۔ ان گروہوں کو مالیکیولز کہا جاتا ہے۔

1.2 The Classifications of Matter

- Matter is anything that occupies space and has mass.

Examples: your textbook, your desk, your chair, and even

your body are all composed of matter.

- Matter can be classified according to its:

1. State (its physical form), or its:

2. Composition (the basic components that make it up).

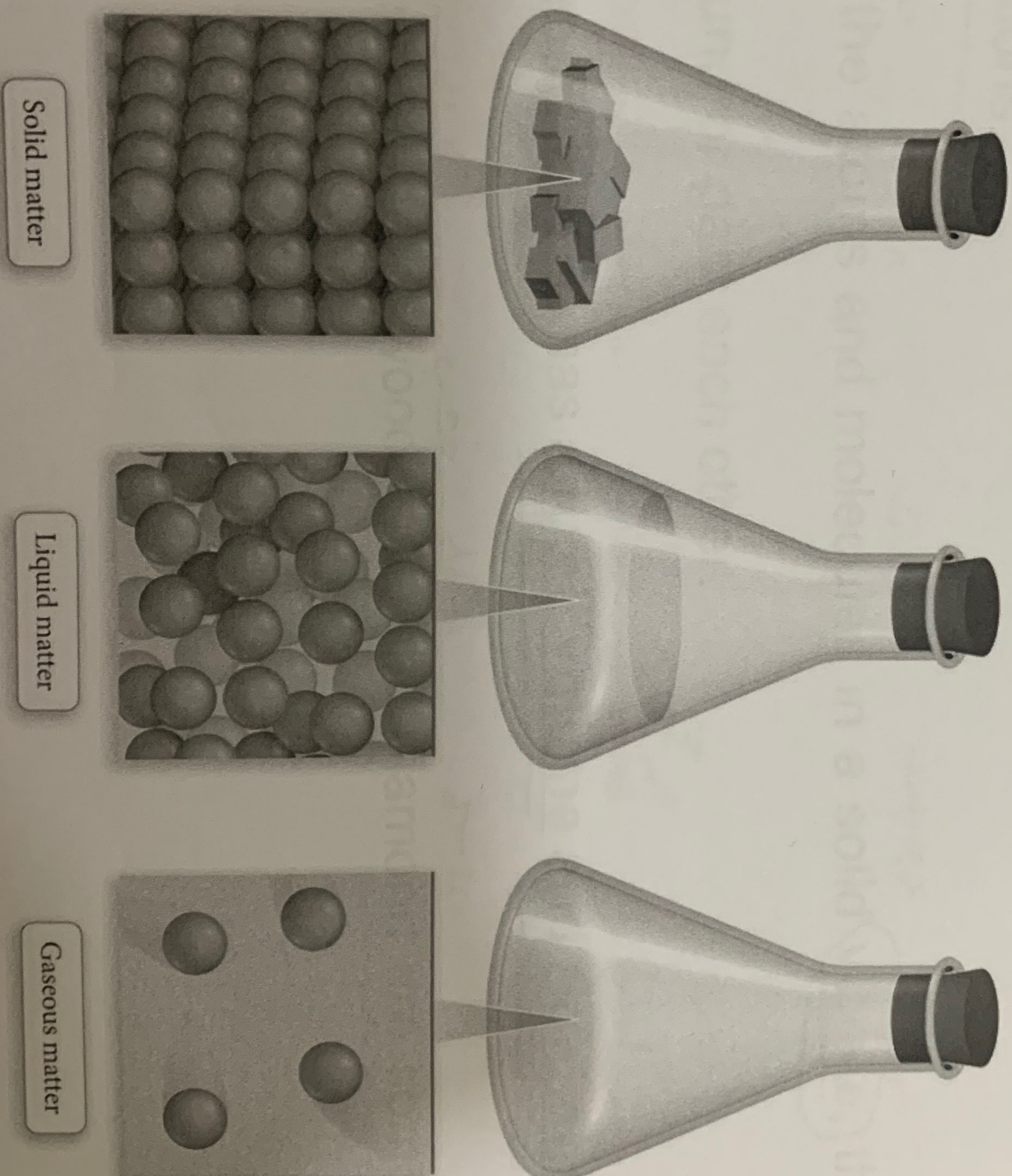
The States of Matter

➤ ^{المادّه} Matter can be classified ^{بمعدّ تصنيفها إلى} as: solid, liquid, or gas, based on ^{التي} which ^{تظهر} ^{التي} properties ^{التي} it exhibits.

➤ ^{حاله} The state of matter ^{المادّه} changes ^{تغيّر} from solid ^{صه} to liquid ^{سائل} to gas ^{غاز} with ^{مع} increasing ^{وتزداد} temperature, and vice versa!

Structure of Atoms (or Molecules)

The atoms or molecules have different structures in solids, liquids, and gases — leading to different properties.



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Solid Matter

➤ In Solid Matter, atoms or molecules pack close to each other in

fixed locations.

constant

➤ Although the atoms and molecules in a solid vibrate, they do not move around or past each other.

➤ Consequently, a solid has a fixed volume and rigid shape.

- Ice, aluminum, iron, wood, salt, and diamond are some examples of solids.

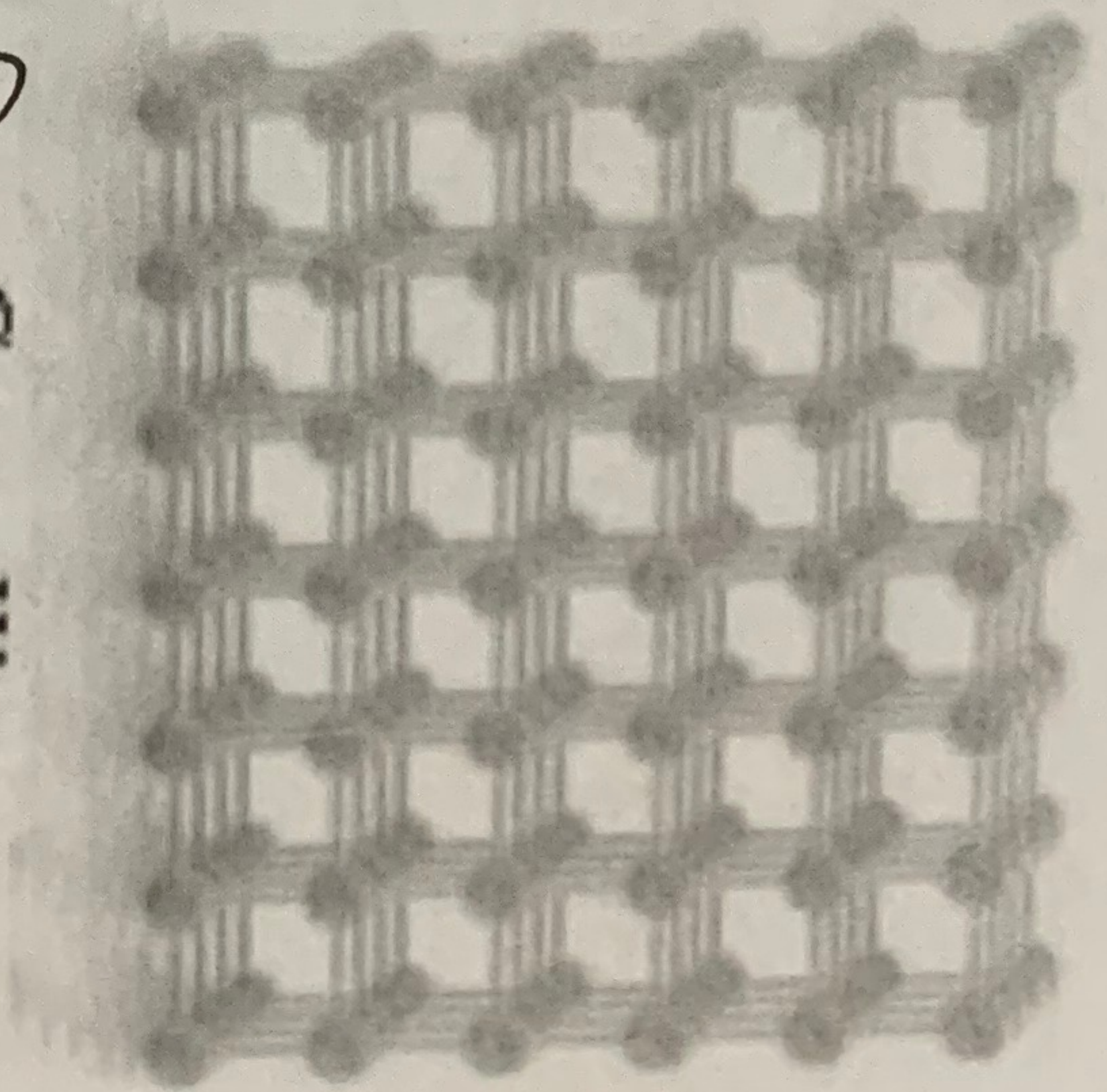
Solid Matter: Crystalline or Amorphous?

➤ Solid matter may be Crystalline, where atoms or molecules are in "patterns" with long-range repeating order.

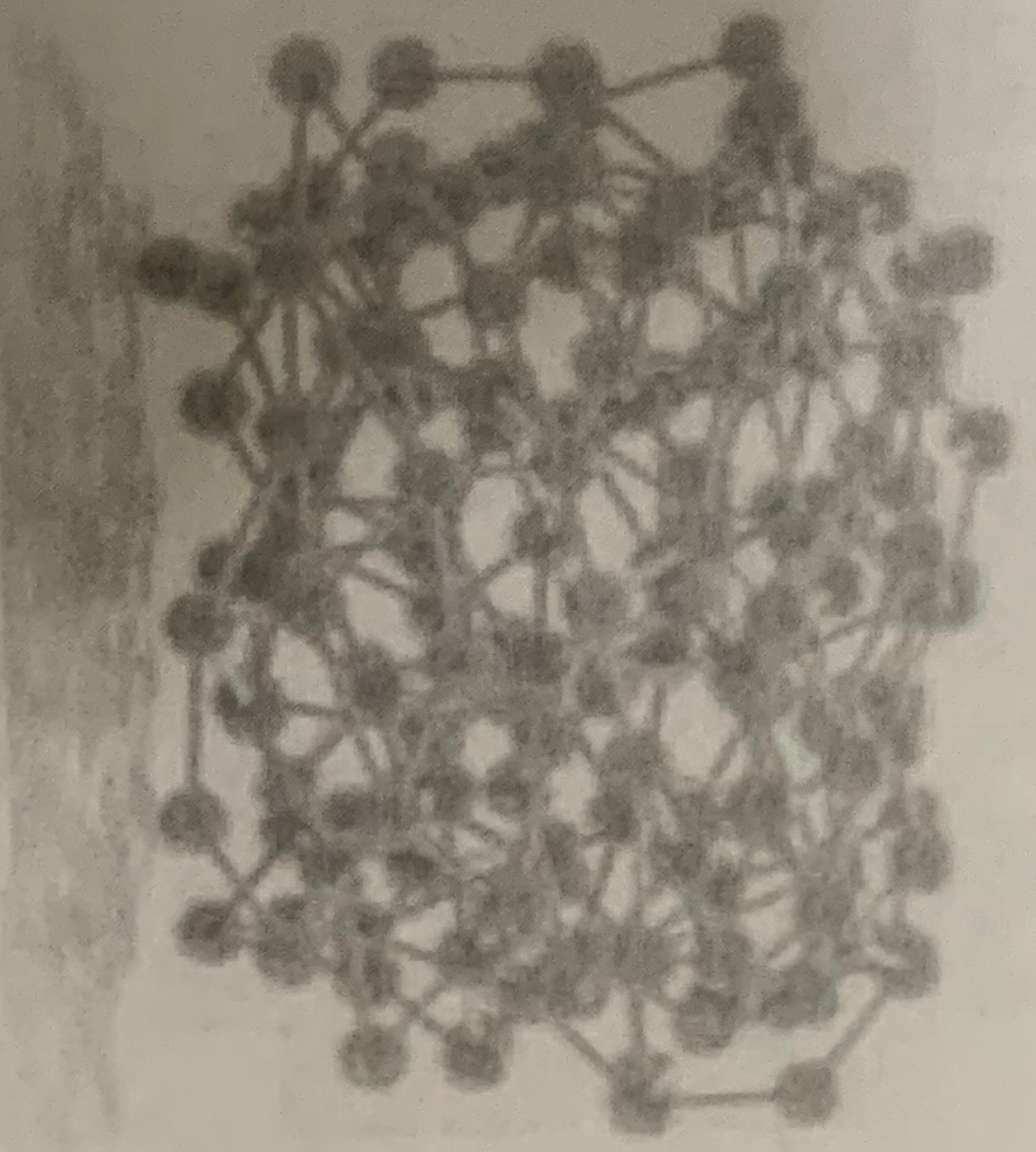
- Examples of crystalline solids include table salt (NaCl) and diamond.

➤ Others may be Amorphous, where atoms or molecules do not have any long-range order.

- Examples of amorphous solids include graphite, rubber, glass and plastic.



Crystalline



Amorphous

Liquid Matter

➤ In Liquid Matter, atoms or molecules pack about as closely as they do in solid matter, but they are free to move relative to each other.

Handwritten notes: اعلیٰ سطح پر ایٹمز اور انجینز کے ساتھ گھا (close) اور حرکت (move) کے ساتھ ہر ذرہ کے ساتھ (relative to each other).

➤ The ability of liquids to flow, makes them assume the shape of their container.

Handwritten notes: بہا کرنے کی صلاحیت (ability to flow) اور ایٹمز کی حرکت (atoms move) کے ساتھ شکل (shape) اختیار کرنے (assume the shape).

➤ Liquids have fixed volume but not a fixed shape.

Handwritten notes: ایٹمز کی حرکت (atoms move) کے ساتھ حجم (volume) کا تعین (fixed) اور شکل (shape) کا تعین (not fixed) نہیں ہوتا (is not fixed).

- Water, alcohol, oil, and gasoline are liquid substances at room temperature.

Handwritten notes: پانی، الیکول، تیل، اور گیسولین (water, alcohol, oil, and gasoline) کے ساتھ کمرے کی درجہ حرارت پر (at room temperature) مایعات (liquids) ہوتے ہیں (are liquid substances).

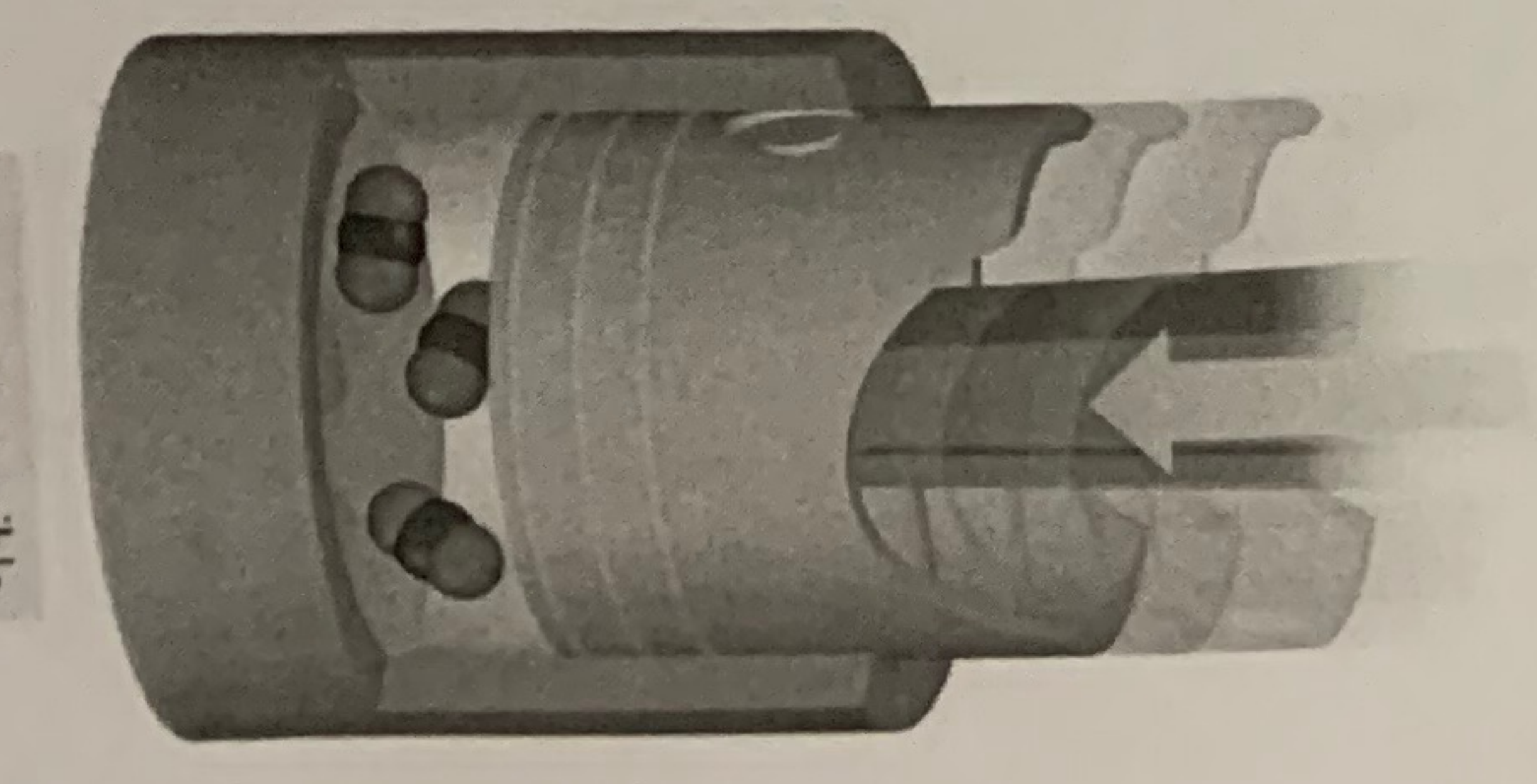
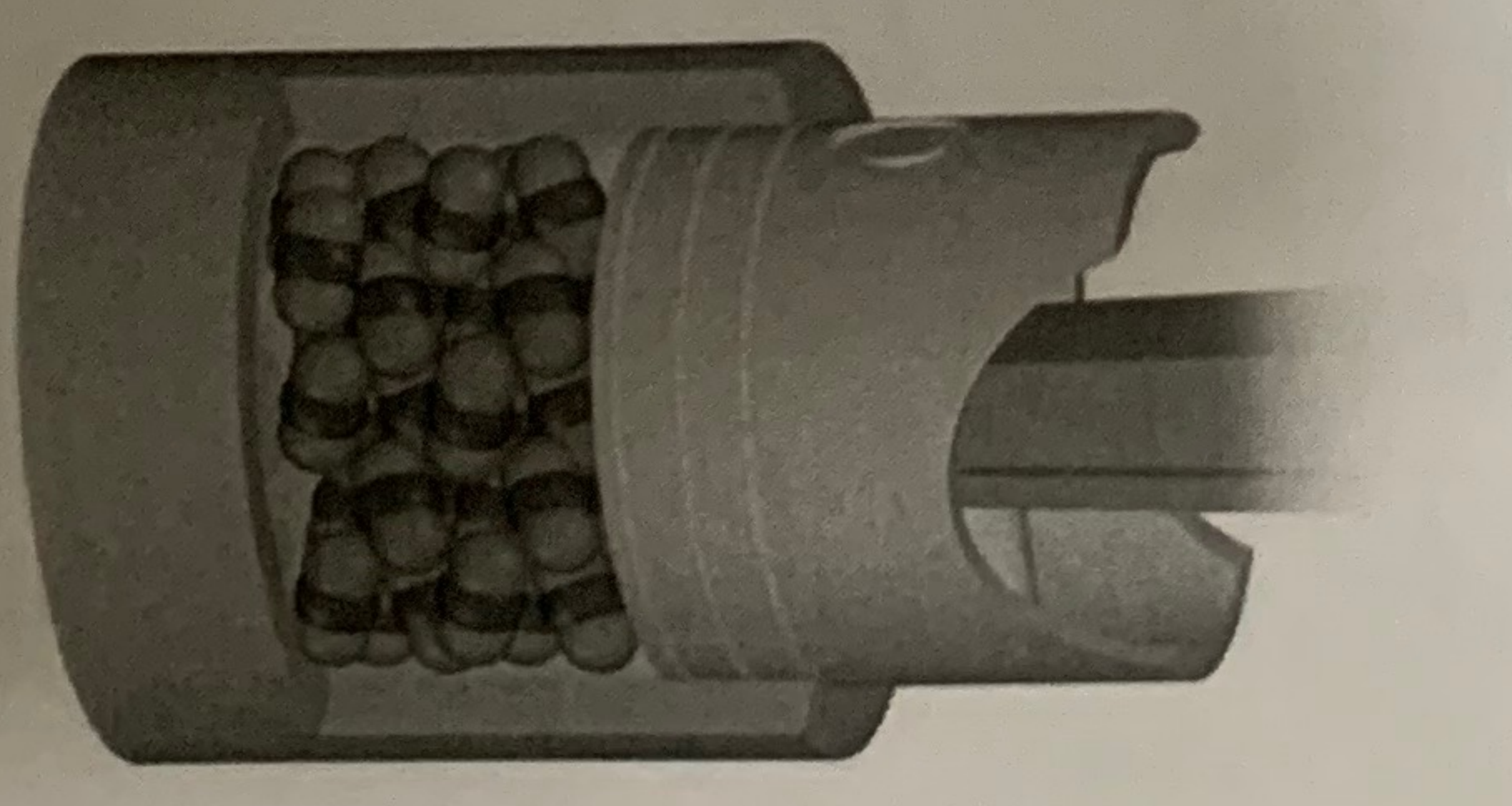
Gaseous Matter

➤ The Gaseous Matter has large spaces between atoms or molecules.

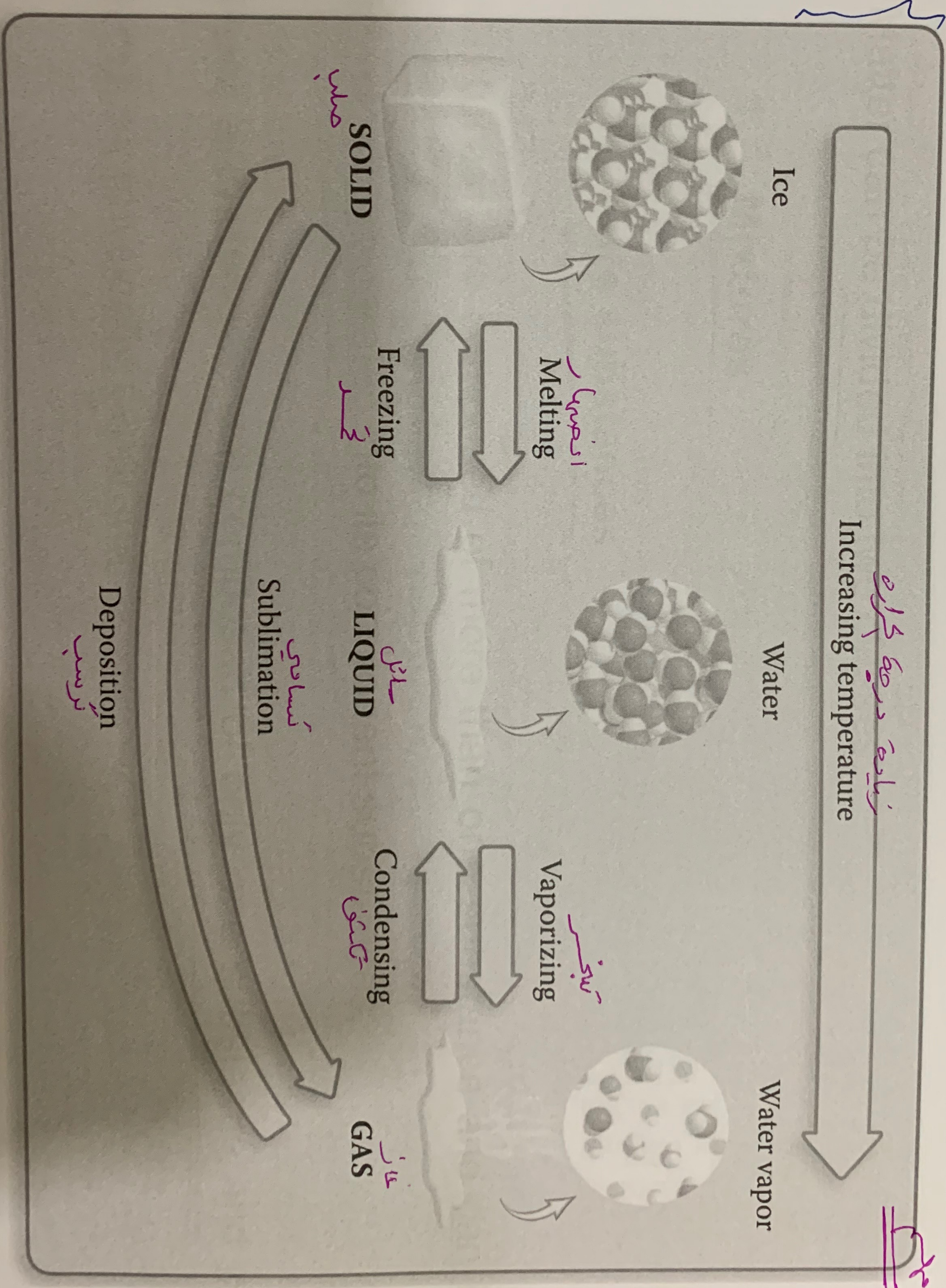
➤ Particles (atoms or molecules) of gases are free to move relative to one another.

➤ Gases have no fixed volume and no fixed shape, instead, they assume the volume and shape of their container.

These qualities make gases compressible.



Summary of State Changes of Matter



Classification of Matter According to its Composition

➤ Matter can be divided into two classes:

1. Mixtures

2. Pure substances

➤ **Mixtures:** are composed of more than one substance and can be physically separated into its component substances.

➤ **Pure substances:** are composed of only one substance and can NOT be physically separated.

Mixtures

There are two types of mixtures:

تو نوعين هم كذا لايظ

1. Heterogeneous mixtures

غير متجانسه

مخاليفه

2. Homogeneous mixtures

متجانسه

متخاليفه

✓ Heterogeneous Mixtures: do NOT have uniform properties throughout.

ايضا لايظ غير لايظ

ليس لها

خواص مكرره (موضعه)

– (sand + water), (oil + water) or (gasoline + water) are examples on heterogeneous mixtures.

رمل

ماء

زيت

ماء

بنزين

ماء

heterogeneous mixtures.

متجانسه

متخاليفه

ليها خواص موضعه

✓ Homogeneous Mixtures: have uniform properties throughout.

دو تجانس غير متجانسه

– (salt water), (sugar + water) and alloys are homogeneous mixtures.

مخاليفه

متجانسه

ماء

السبائك

* gold rings → صفيحة ذهب + Cup of tea → كوب شاي

Pure Substances

There are two types of pure substances:
دو نوعیں ہیں، پورے لائقہ

1. Compounds المتماخرات

2. Elements الذرات

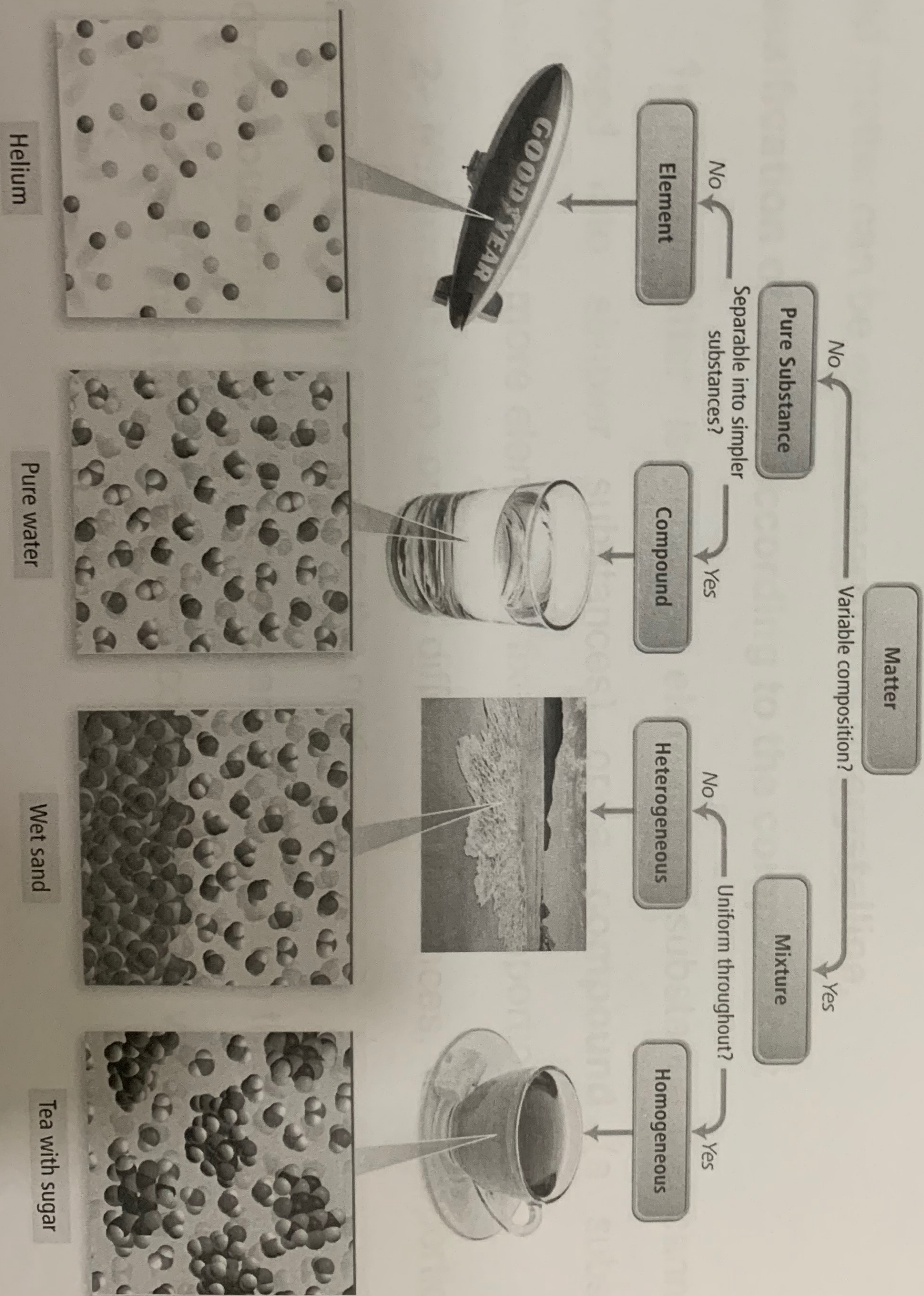
✓ Compounds: can be chemically separated into individual elements.
الذرات سے کیمیائی طور پر علیحدہ کیے جاسکتے ہیں۔
There are millions of compounds in the universe.
یونیورس میں لاکھوں مرکبات ہیں۔

➤ Water is a compound that can be separated into hydrogen and oxygen.
پانی ایک مرکب ہے جسے ہائیڈروجن اور آکسیجن میں علیحدہ کیا جاسکتا ہے۔
✓ Element: cannot be broken down further by chemical reactions.
ذرات کو کیمیائی طور پر مزید توڑنا نہیں ممکن۔

➤ Elements are the 118 members of the periodic table of elements, such as: Sodium, Iron, Gold, Silver, Hydrogen, Oxygen, Carbon etc
ذرات ہیں جو دور دورہ جدول کے 118 اعضاء ہیں، جیسے: سوڈیم، لوہا، سونہ، چاندی، ہائیڈروجن، آکسیجن، کاربن etc

Summary of Types of Matter

- Matter can be **classified** according to its composition into: **elements**, **compounds**, and **mixtures**.



Assessment

Answer the following questions:

1- The process is which a solid substance is transformed directly into a gas is called Sublimation and it requires increases of temperature.

2- ~~Condensation~~ Sublimation is the physical process which changes a gas into a liquid, and it needs decreases of temperature.

3- Which state of matter has a fixed volume but not a fixed shape. liquid

4- A gases matter is able to assume both the shape and volume of its container.

5- The ability of both liquid and gas states of matter to flow makes them able to change their shape to the shape of their reservoir.
وعاد لأصوات

6- Classify each substance as a pure substance or a mixture, and indicate the type of each of them (element, compound or homogeneous, heterogeneous):
نقي
مختلج
متجانس

- | | | | | | | | | | |
|-------------|---------------|-------------------|-------------|---------------|---------|-----------------|---------------|----------|-------------|
| a. sweat | homogeneous | b. carbon dioxide | compound | c. aluminum | element | d. sand | compound | e. rust | compound |
| f. wet sand | heterogeneous | g. air | homogeneous | h. oxygen gas | element | i. bronze alloy | heterogeneous | j. honey | homogeneous |
| | | | | | | | | | |

1.3 Physical and Chemical Changes & Properties

تغییرات فیزیکی

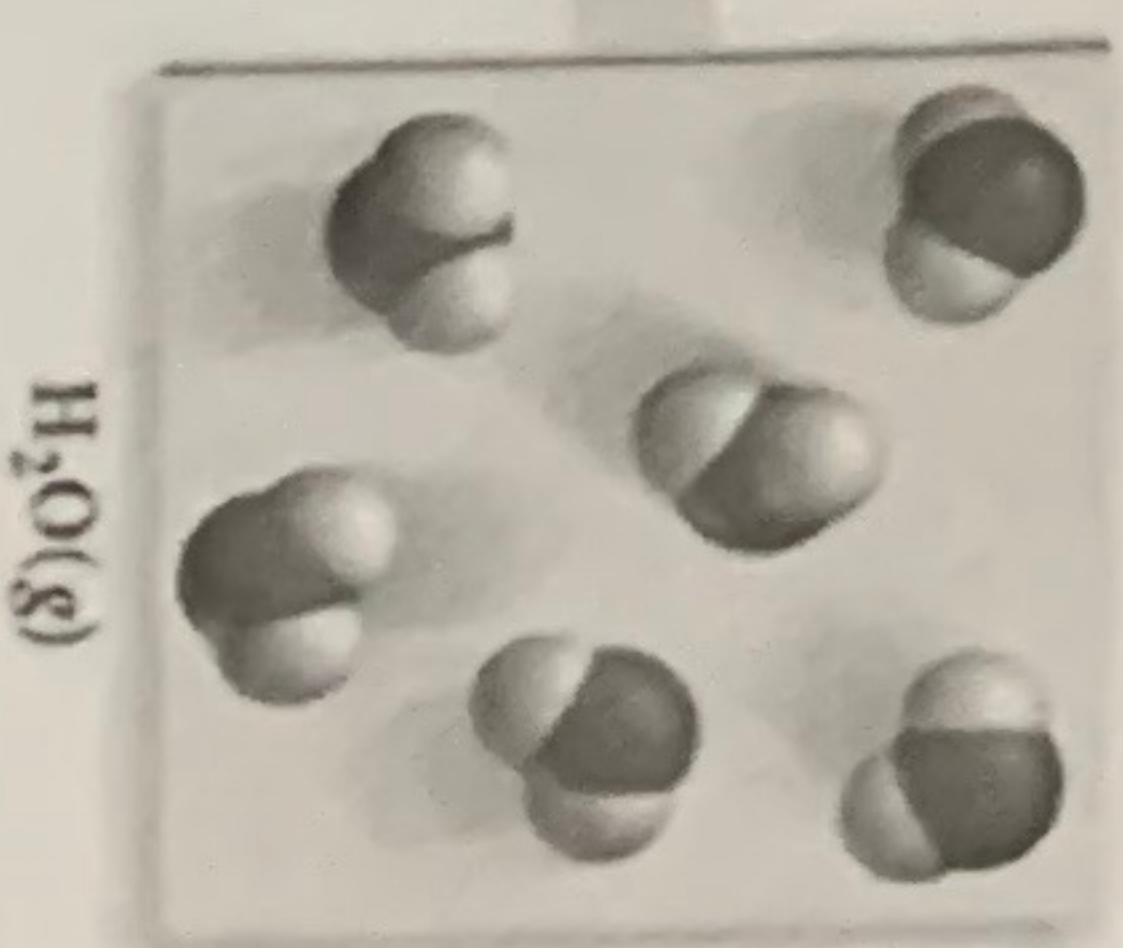
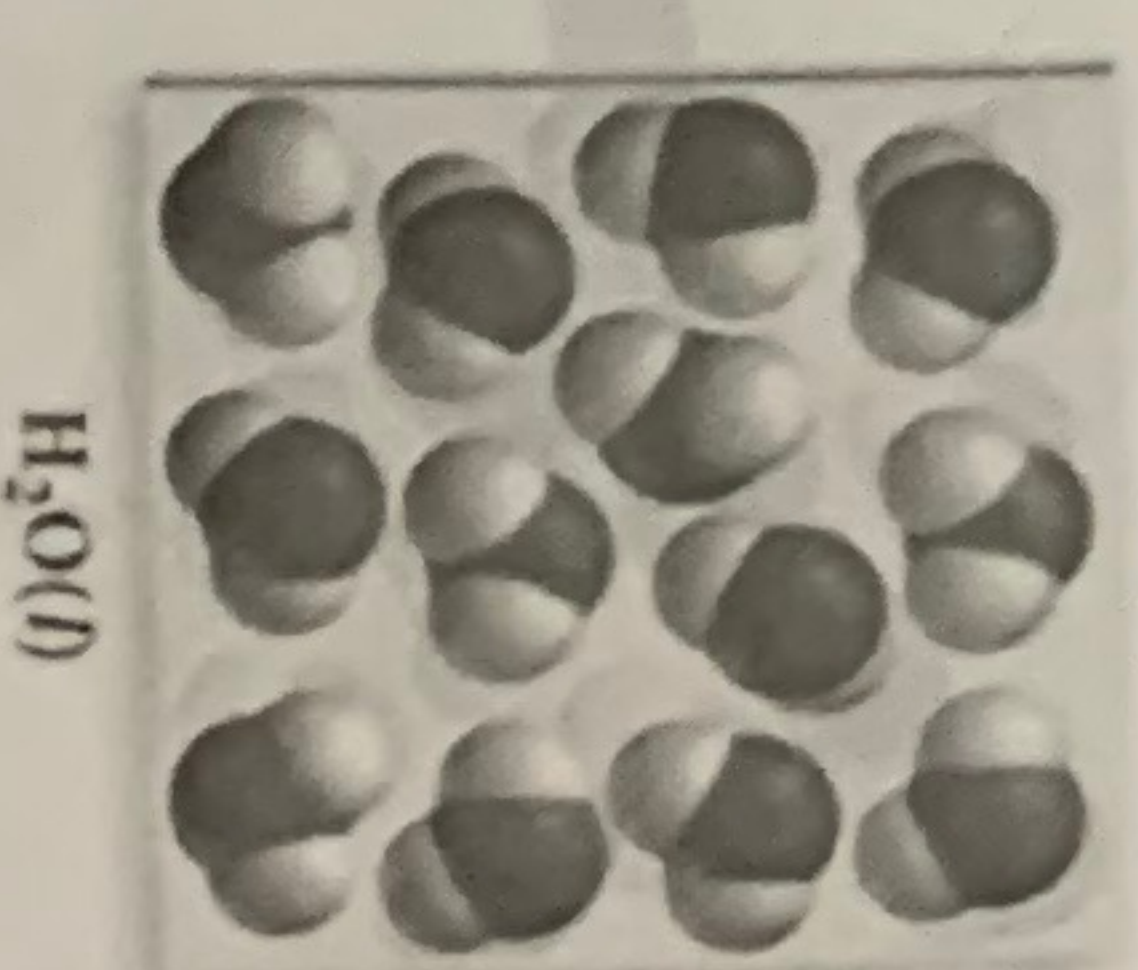
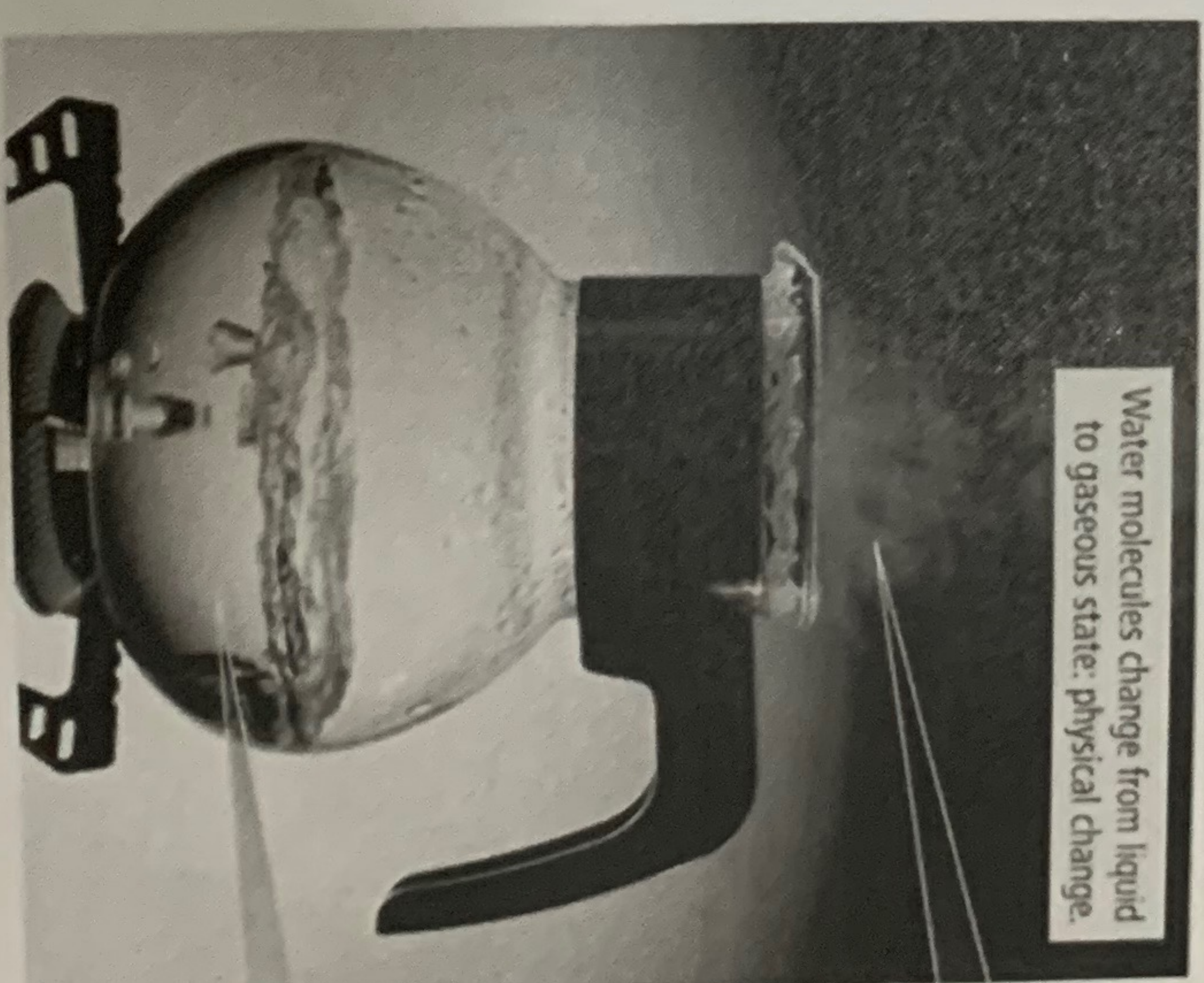
Physical Changes:

- Changes that alter only the appearance (state or shape), but NOT the chemical composition.

Example 1: when **water** (H_2O) **boils**, it changes its state from liquid to gas.

➤ The gas remains composed of water molecules H_2O , so this is a physical change.

Example 2: when a piece of paper is shredded, or a glass window is broken, only their shapes have changed, but their chemical compositions remained unchanged, so, those are physical changes.

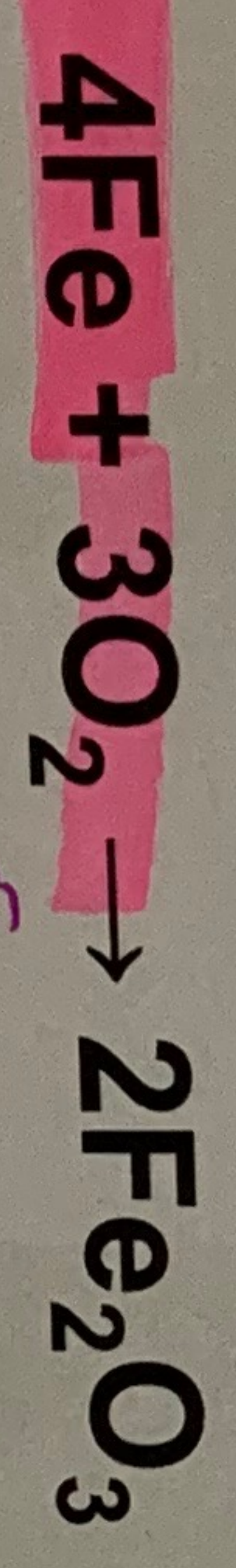


1.3 Physical and Chemical Changes & Properties

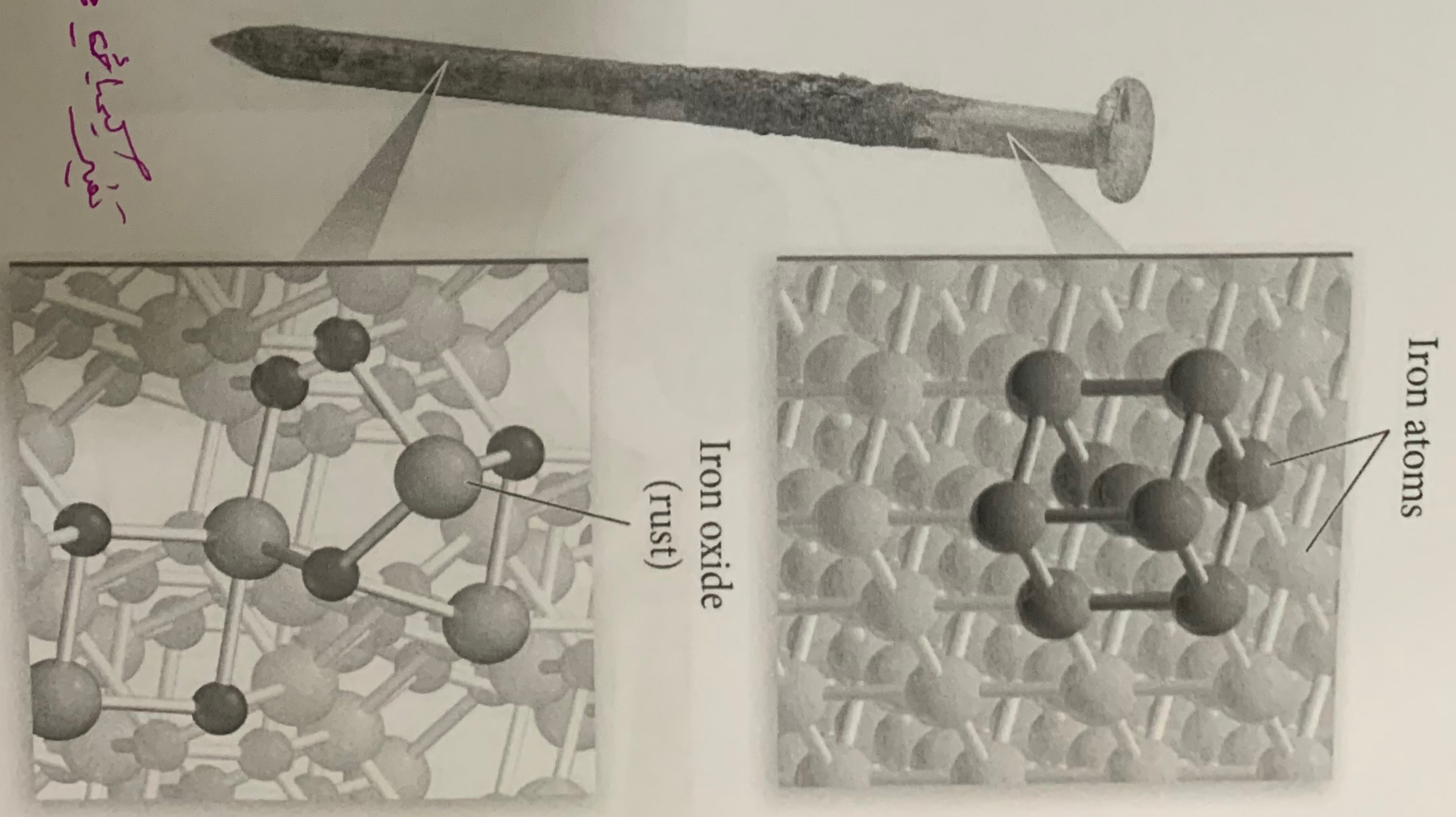
Chemical Changes:

- Changes that alter the composition of matter.
- During a chemical change, atoms rearrange, transforming the original substances into different substances.

Example 1: rusting of iron is a chemical change:



Example 2: burning of gasoline produces CO₂ + H₂O, so it's a chemical change



Evidences for Chemical Changes

دلیل کیمیائی تبدیلی

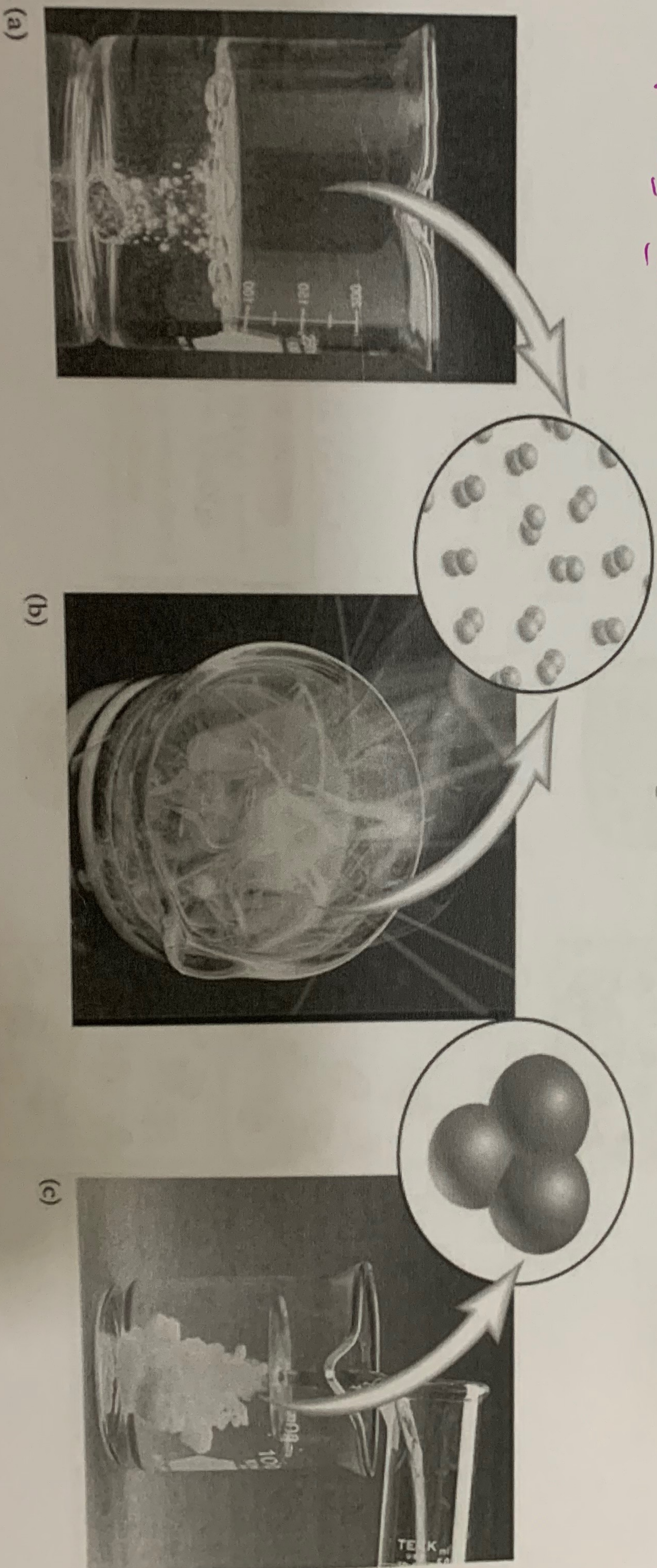
a) ^{گاز} release of a gas (bubbles) ^{تفاعلات}

b) ^{انبعاث} emission of light or heat. ^{انرژی}

c) a permanent change in color. →

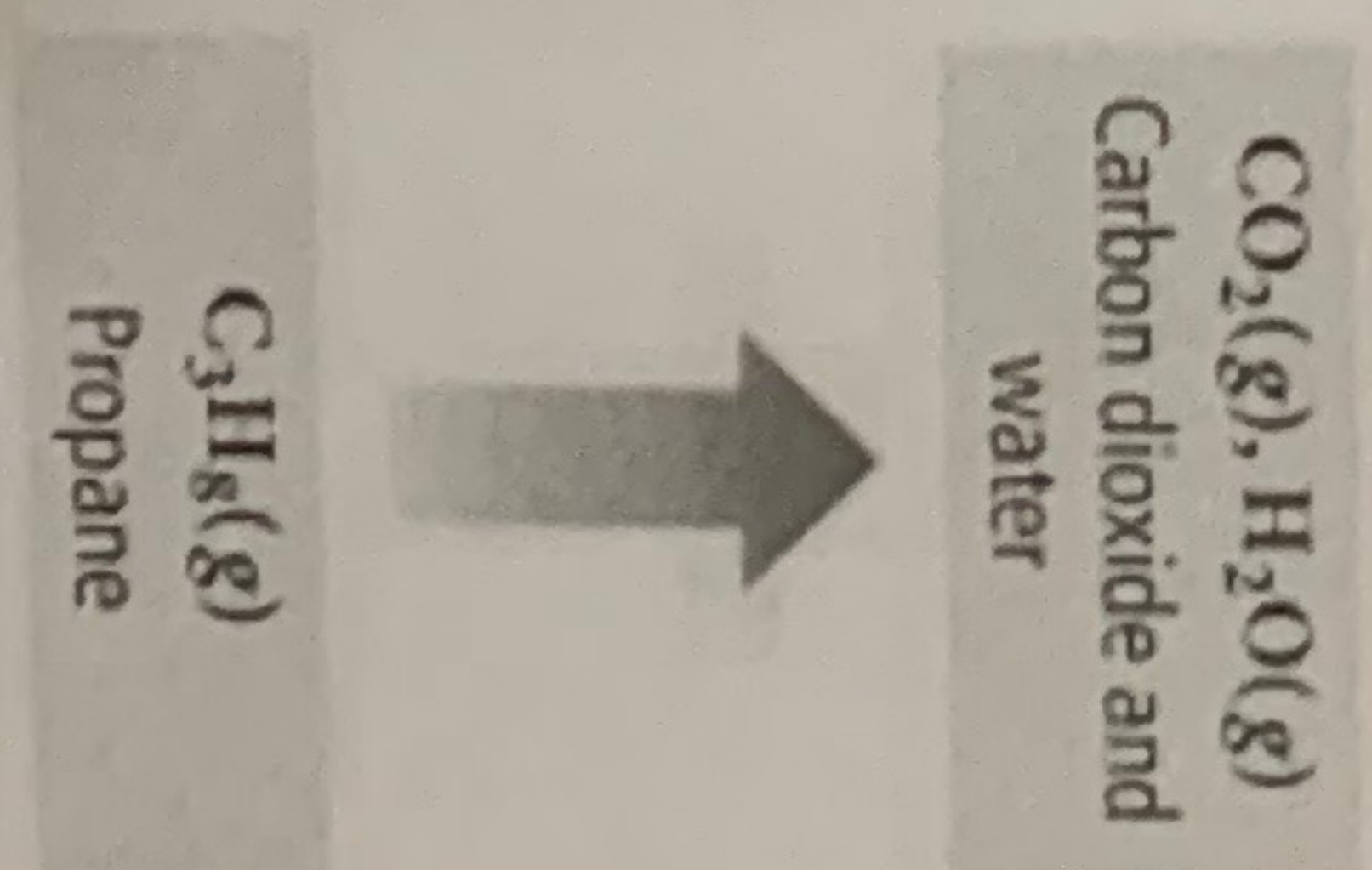
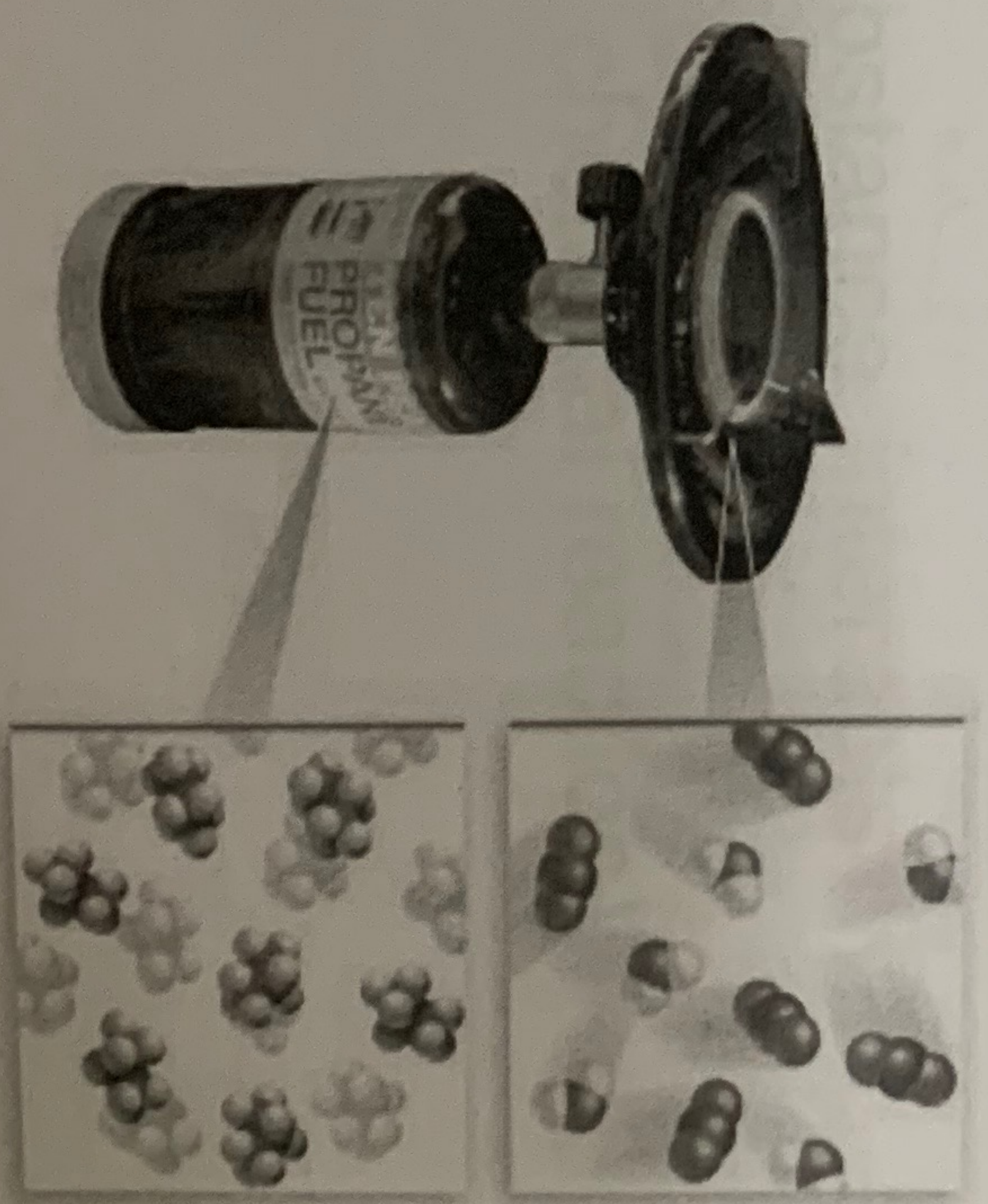
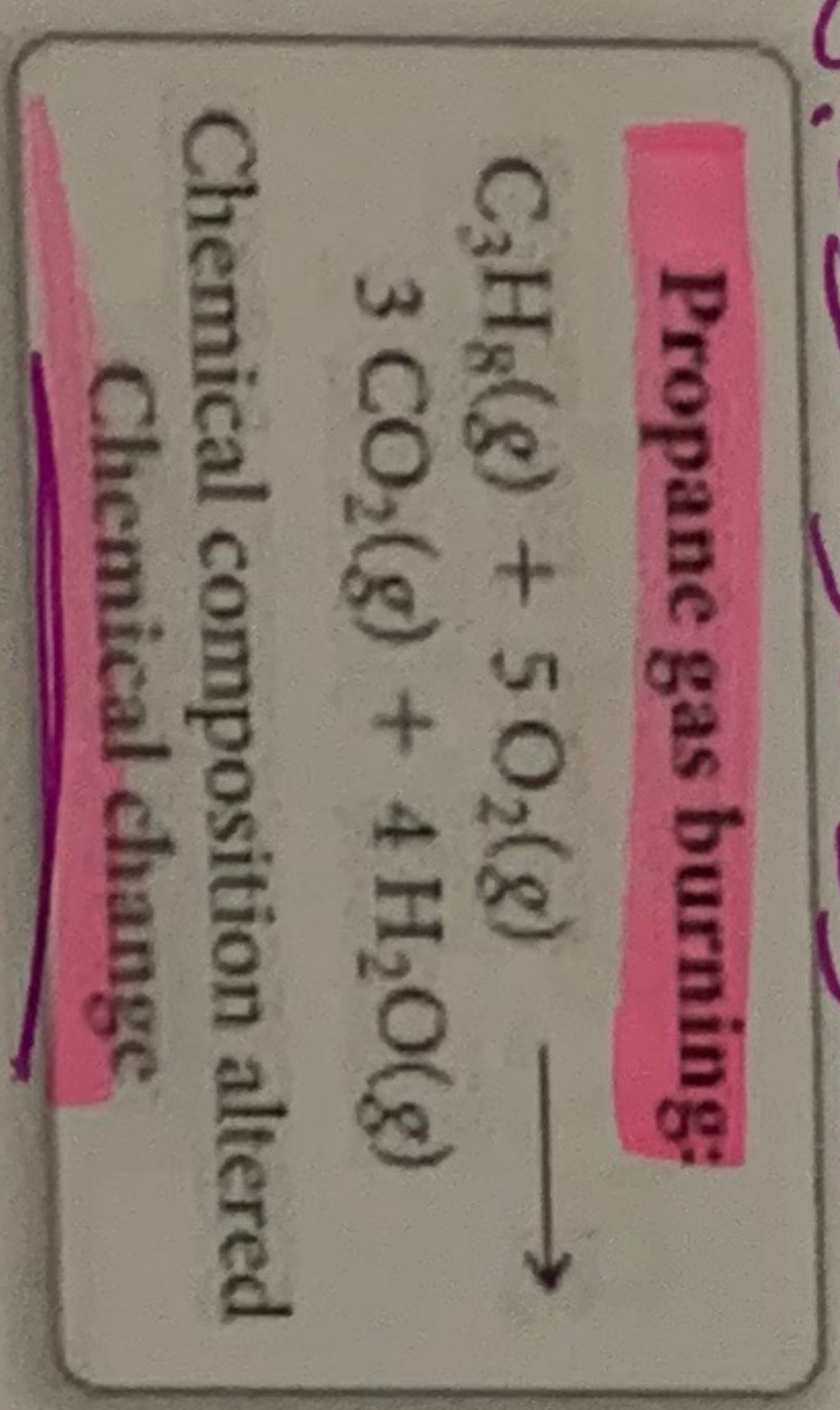
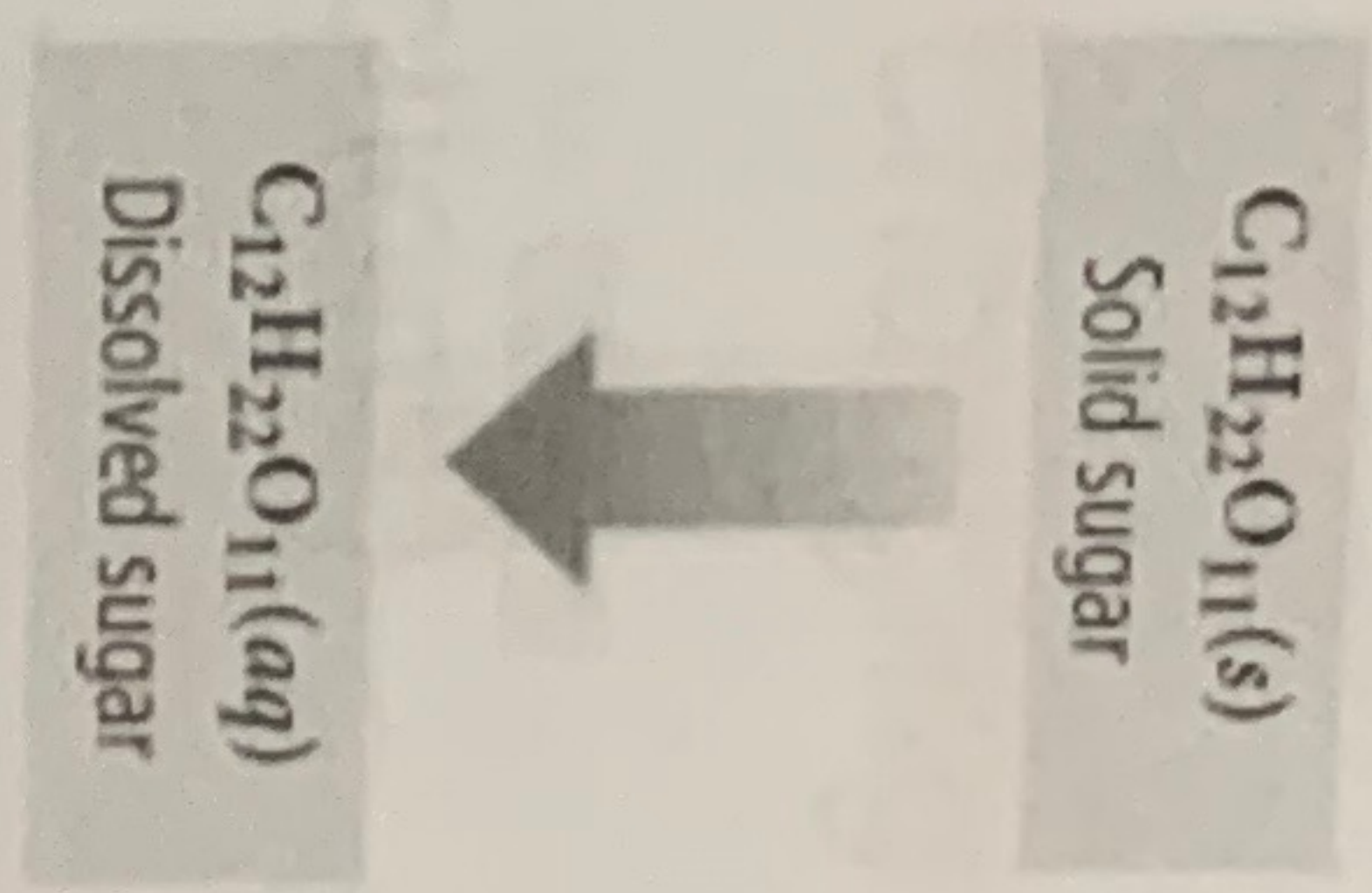
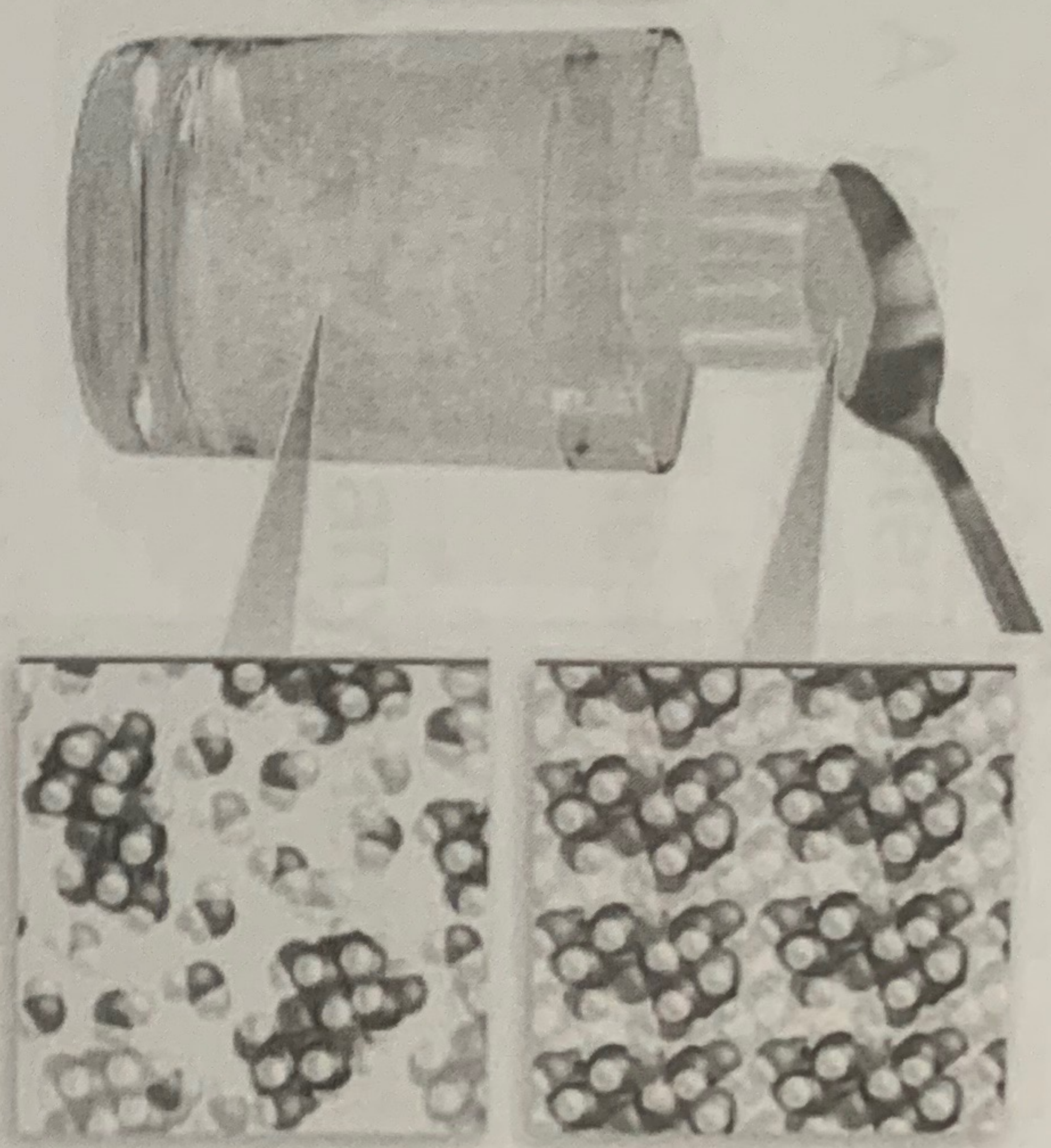
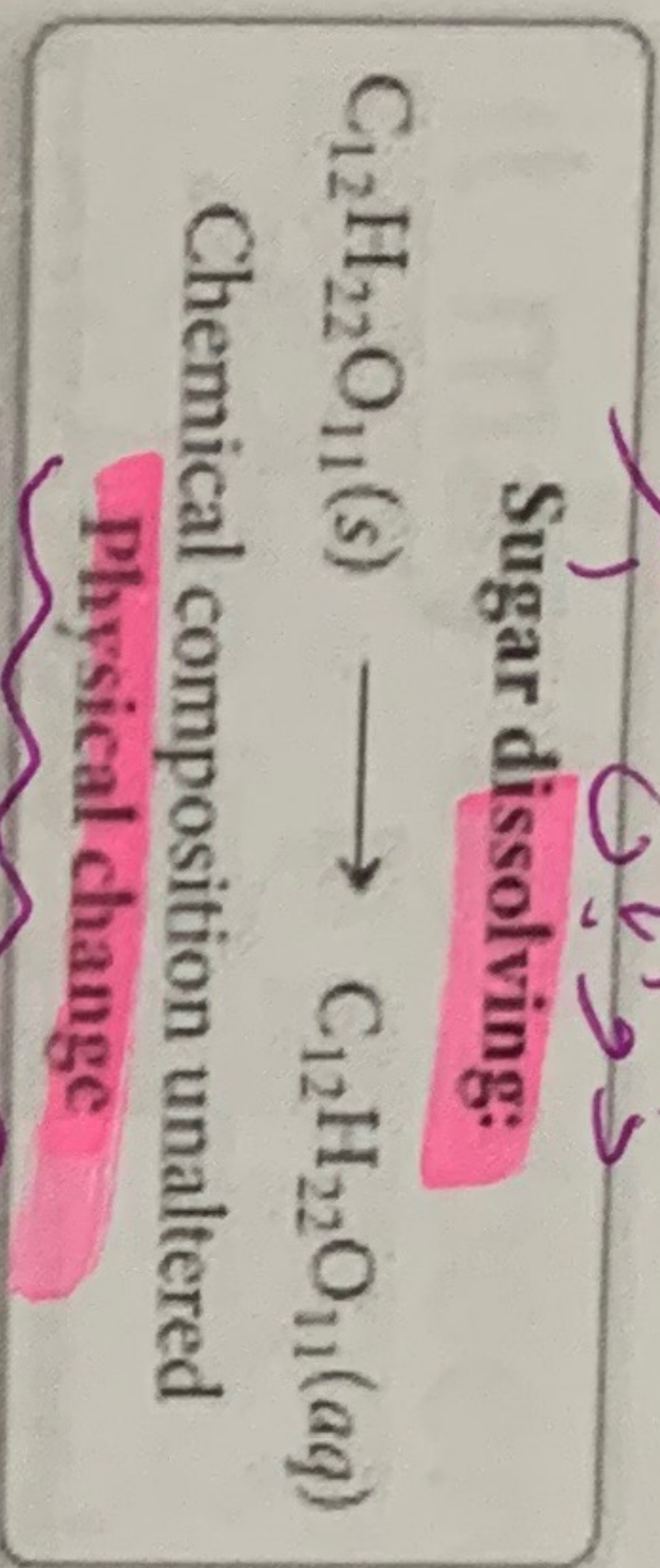
دائم رنگ بدلاؤ
← کیمیائی تبدیلی

دائم رنگ بدلاؤ



Physical and Chemical Changes: Examples

فيزيائي و كيميائي
 كيميائي (as also)



Physical and Chemical Properties of Matter

1. **Physical Properties** - A characteristic shown by a substance

الفيزيائية خواص / خاصية
 itself, it may be observed and measured without changing the
 لخصه، لا يلاحظ ولا يقيس بدون تغيير
 نفسه، لا يلاحظ ولا يقيس بدون تغيير

composition of a sample (without any chemical reactions)

تركيبه
 composition of a sample (without any chemical reactions)
 تركيبه دون تفاعل كيميائي
 تركيبه دون تفاعل كيميائي

2. **Chemical Properties** - A characteristic of a substance only

appears when the substance interacts with, or transforms into
 other substances (in a chemical reaction).
 يظهر عندما يتفاعل مع أو يتحول إلى
 مواد أخرى (في تفاعل كيميائي).

Examples on Physical Properties

➤ **Color** *لون*

➤ **Malleability** *قابلية الطرق*
مطوياً

➤ **Odor** *Smell*
رائحة

➤ **Viscosity** *اللزوجة*

➤ **Density** *كثافة*

➤ **Hardness** *الصلابة*

➤ **Melting Point** *درجة الانصهار*

➤ **Metallic Luster** *بريق معدني*

➤ **Boiling Point** *درجة الغليان*

➤ **Ductility** *قابلية السحب*
لصوت

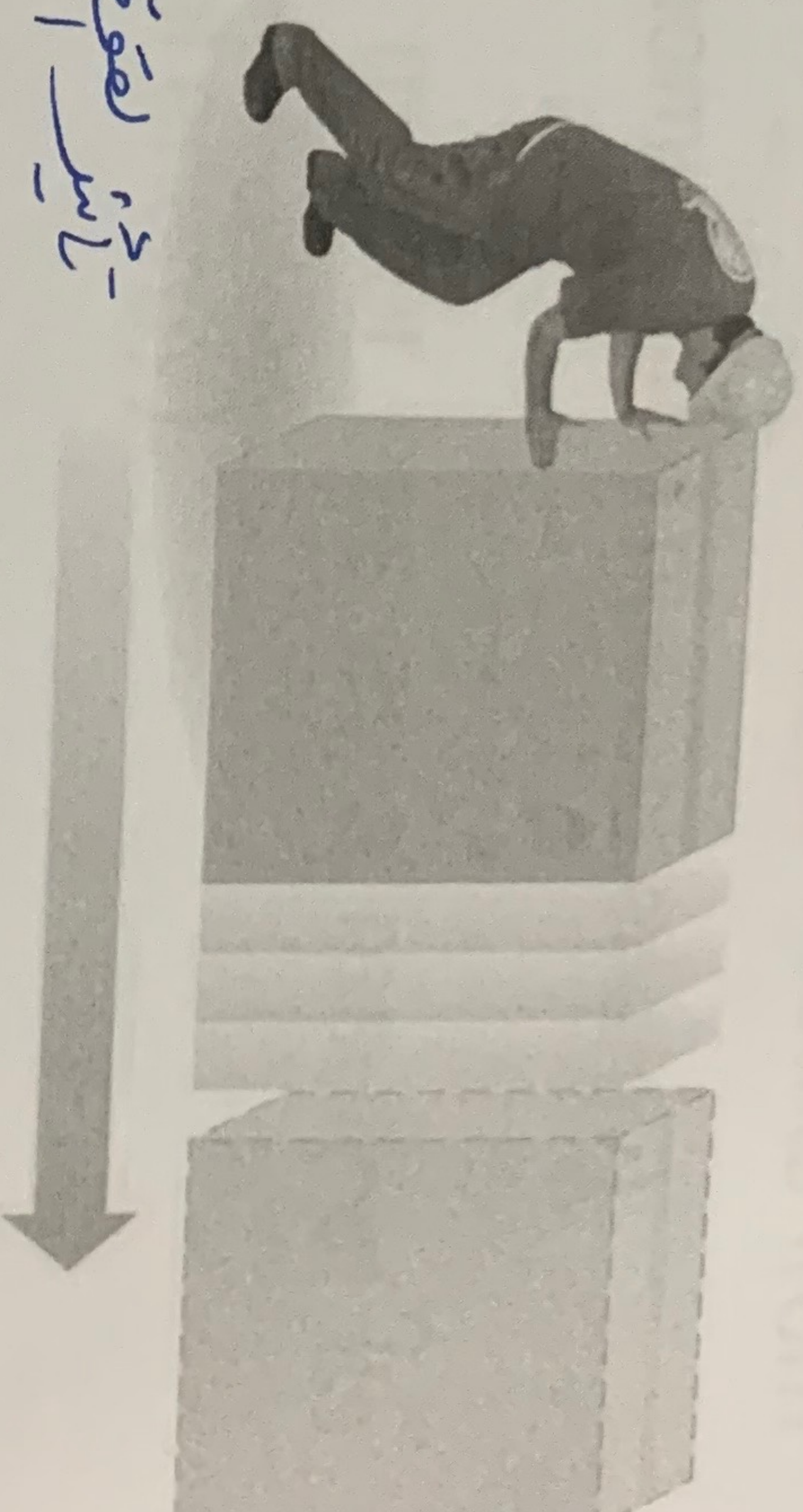
Examples on Chemical Properties

- **Reactivity** ^{تفاعل} with other chemicals
- **Acidity** ^{الحمضية} or **Basicity** ^{القاعدية}
- **Solubility** ^{ذوبانية}
- **Flammability** ^{قابلية للاشتعال}
- **Chemical stability** ^{الاستقرار الكيميائي}
- **Toxicity** ^{السمية}
- **Radioactivity** ^{النشاط الإشعاعي}

1.4 Energy: A Fundamental Part of Physical and Chemical Changes

➤ **Energy** is the **ability to do work**.
 القدرة Energy
 $W = F \times d$

➤ **Work** is defined as the action of a force through a distance.
 عمل
 القوة المسافة
 عمل = القوة × المسافة



Force acts through distance; work is done.

➤ When you push a box across the floor or pedal your bicycle across the street, you have done **work**.

عمل
 عمل = القوة × المسافة

The law of **conservation of energy**: energy can neither be created nor destroyed, but only changes from one form into another. →

لا يمكن
 أن يخلق أو
 يدمر

Potential and Kinetic Energy

➤ **Potential energy, PE:** is any form of **stored energy**; it results from position or composition (examples: chemical and nuclear energy)

طاقة الوضع
الطاقة المخزنة
الطاقة الكيميائية
الطاقة النووية
تخزين
طاقة كيميائية

➤ **Kinetic energy, KE:** is the energy matter has as a result of its motion (examples: thermal and electrical energy).

الطاقة الحركية
طاقة حركية
طاقة كهربائية

- ✓ Energy can be converted between the two types. *يمكن تحويل الطاقة بين هذين النوعين (الوضع - حركية)*
- ✓ All substances have both potential and kinetic energies, regardless to their physical states. *جميع المواد لها الطاقات المحتملة وحركية، بغض النظر عن حالتها الفيزيائية.*

✓ **Solids** have the **lowest kinetic energy**, and **gases** have the **greatest kinetic energy**. *الطاقة حركية
الطاقة حركية منخفضة
الطاقة حركية عالية*

✓ As we **increase** the **temperature** of a substance, its **kinetic energy** **increases**. *مع ازدياد درجة الحرارة، الطاقة الحركية تزداد.*

Lesson 02 in Review

مراجعة

Properties and Changes of Matter:

- The **physical properties** of matter do not involve a change in composition.
- The **chemical properties** of matter involve a change in composition.
- In a **physical change**, the **appearance** (state or shape) of matter may change, but its **composition does not**.
- In a **chemical change**, the **composition** of matter changes, and may also result in a **change in appearance**.
- All substances have both **potential** and **kinetic energies**, regardless to their **physical states**.
- Solids have the **lowest kinetic energy**, and gases have the **greatest kinetic energy**.
- As you **increase the temperature** of a substance, its **kinetic energy increases**.

Assessment

Answer the following questions:

1- Identify the following as a chemical or physical property:

- | | | |
|---------------------------------|---------------------------|--------------------------------|
| 1. blue color → Physical | 2. melting point Physical | 3. density Physical |
| 4. reacts with water → Chemical | 5. flammability Chemical | 6. hardness Physical |
| 7. Solubility Chemical | 8. boiling point Physical | 9. reacts with acid → Chemical |
| 10. luster Physical | 11. odor Physical | 12. sour taste Physical |

2- Identify the following as physical or chemical changes:

- | | |
|---|---------------------------------------|
| 1. NaCl (Table Salt) dissolves in water. Physical | 2. Sugar dissolves in water. Physical |
| 3. Ag (Silver) tarnishes. Chemical | 4. Milk sours. Chemical |
| 5. An apple is cut. Physical | 6. Wood rots. Chemical |
| 7. Heat changes H ₂ O to steam. Physical | 8. Pancakes cook. Chemical |
| 9. Baking soda reacts to vinegar. Chemical | 10. Grass grows. Chemical |
| 11. Fe (Iron) rusts. Chemical | 12. A tire is inflated. Physical |
| 13. Alcohol evaporates. Physical | 14. Food is digested. Chemical |
| 15. Ice melts. Physical | 16. Paper absorbs water. Physical |

1.5 The Units of Measurement

وحدات قياسية
Units: **standard quantities** used to **specify** measurements, they are **critical** in chemistry.
مفردات
مقاسات
الكميات
محدد
القياسات
مهم

The most common systems of units are:

1. The English system: used in the United States
الانجليزية
النظام
الولايات المتحدة

2. The Metric system: used in most of the rest of the world.
النظام
المتري
العالمية

3. The International System of Units (SI): used by scientists,
النظام
الدولي
للوحدات
العلمية
and it is based on the metric system.

Units in the Metric and SI Systems

- In the metric and SI systems, one unit is used for each type of measurement:

Measurement	Metric	SI
Length	meter (m)	meter (m)
Volume	liter (L)	cubic meter (m ³)
Mass	gram (g)	kilogram (kg)
Temperature	Celsius (°C)	Kelvin (K)
Time	second (s)	second (s)

The Meter: A Measure of Length

Length طول

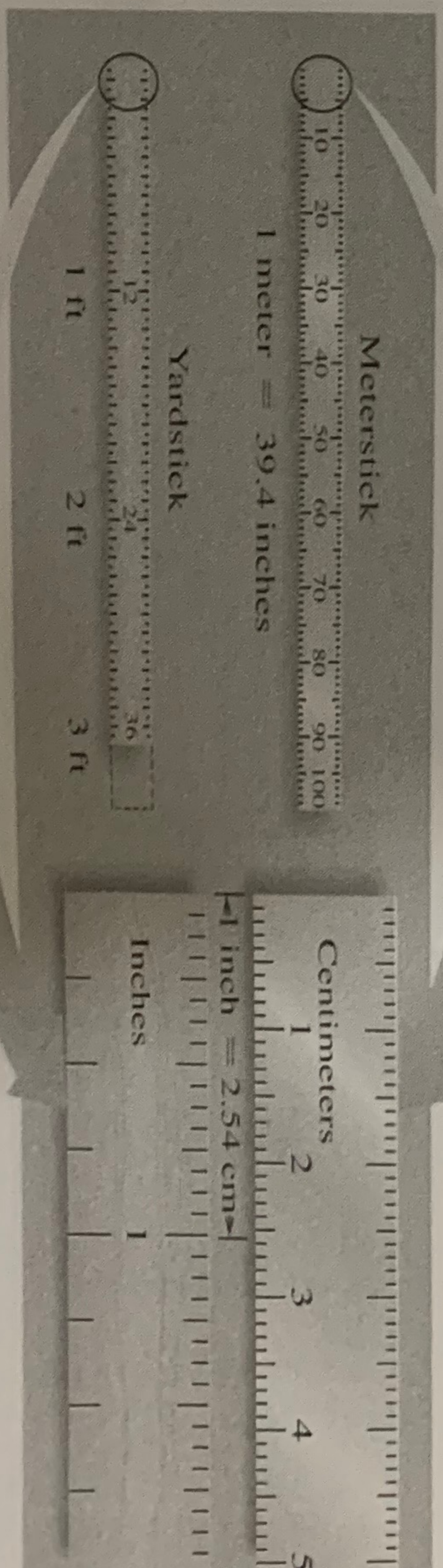
- is measured يُقاس using بِاستخدام a meter stick مسطرة.
- uses the unit meter (m) in both the metric and SI systems.
- uses centimeters سنتيمتر (cm) for smaller أصغر units وحدات of length طول.

→ مما هو مرتبط Useful relationships between the units of length:

- 2.54 cm = 1 in. 1 in = 2.54 cm
- 1 m = 100 cm
- 1 m = 39.4 in. 50 / 2.54 = 19.68

- How many (in) are there in 50 cm (1 in = 2.54 cm) 50 / 2.54 = 19.68

1 m → 1.09 yd
105 yd × 1.09 = 114.45 m



The Kilogram: A Measure of Mass

- The mass of an object is a measure of the quantity of matter within it.

- The SI unit of mass is kilogram (kg):

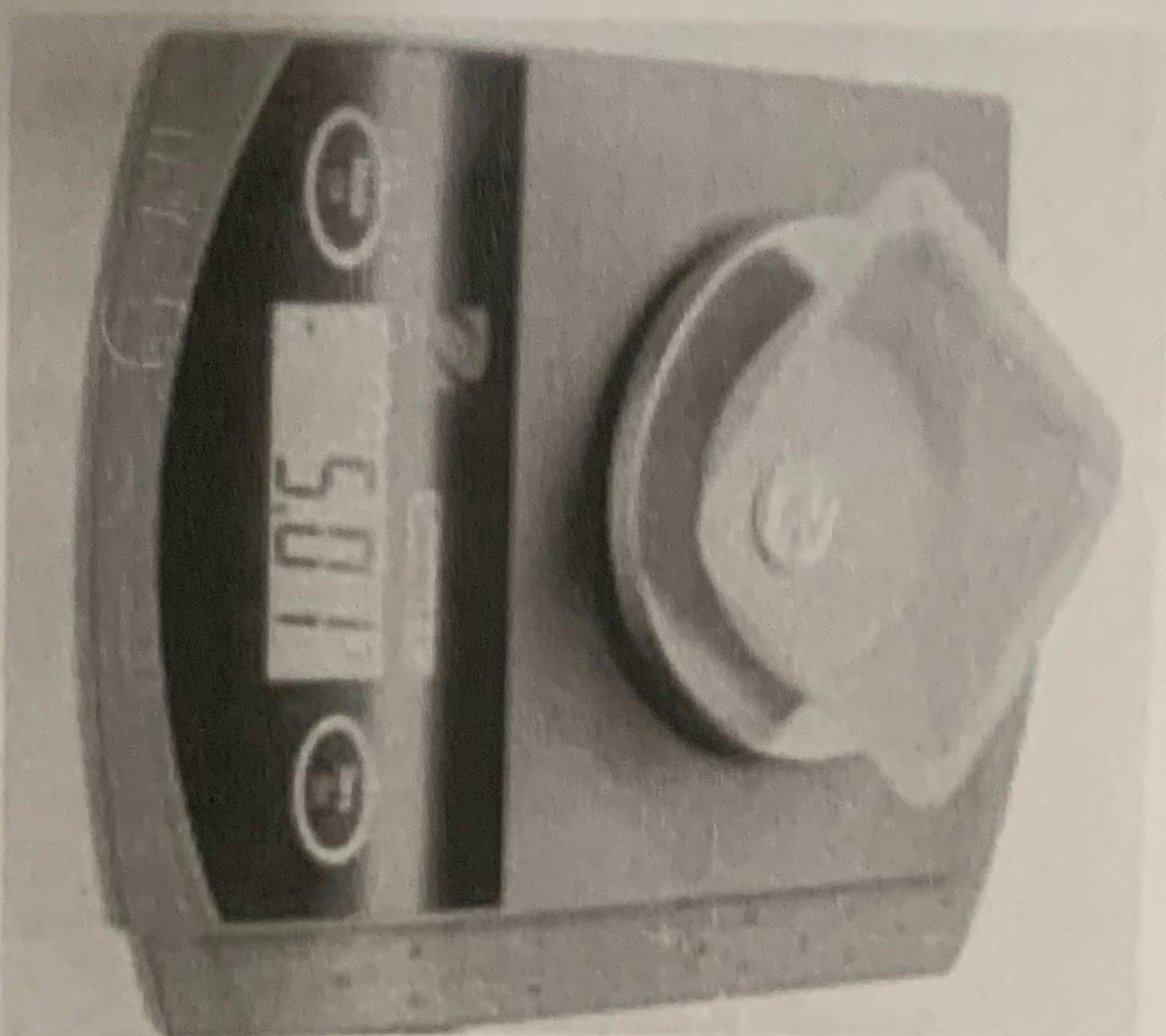
$$1 \text{ kg} = 2.21 \text{ lb (pound)}$$

- Another common unit of mass is the

gram (g):

$$1 \text{ gram is } 1/1000 \text{ kg. } = \frac{1}{1000} \text{ kg} \rightarrow 1000 \text{ g}$$

- Weight of an object is a measure of the gravitational pull on its matter.



▲ A nickel (5 cents) weighs about 5 grams.

Units of Time Measurement

Time measurement:

- uses the unit second (s) in both the metric and SI systems. →

Days, Hours, Minutes, Seconds



➤ Useful relationships between the units of time:

- 1 day = 24 h
- 1 h = 60 min
- 1 min = 60 s

۱ روزه کیلیدی = ۳۶۵ یوم
۱ ساعه کیلیدی = ۳۵۵ یوم

Units of Temperature Measurement

Common Units of Temperature:

- Fahrenheit ($^{\circ}\text{F}$) (English system) *صهر نھا ایت*

- Celsius ($^{\circ}\text{C}$) (Metric system) *سیلسیوس*

- Kelvin (K) (SI system) *کالون، کالونیک*

Boiling Point of Water:

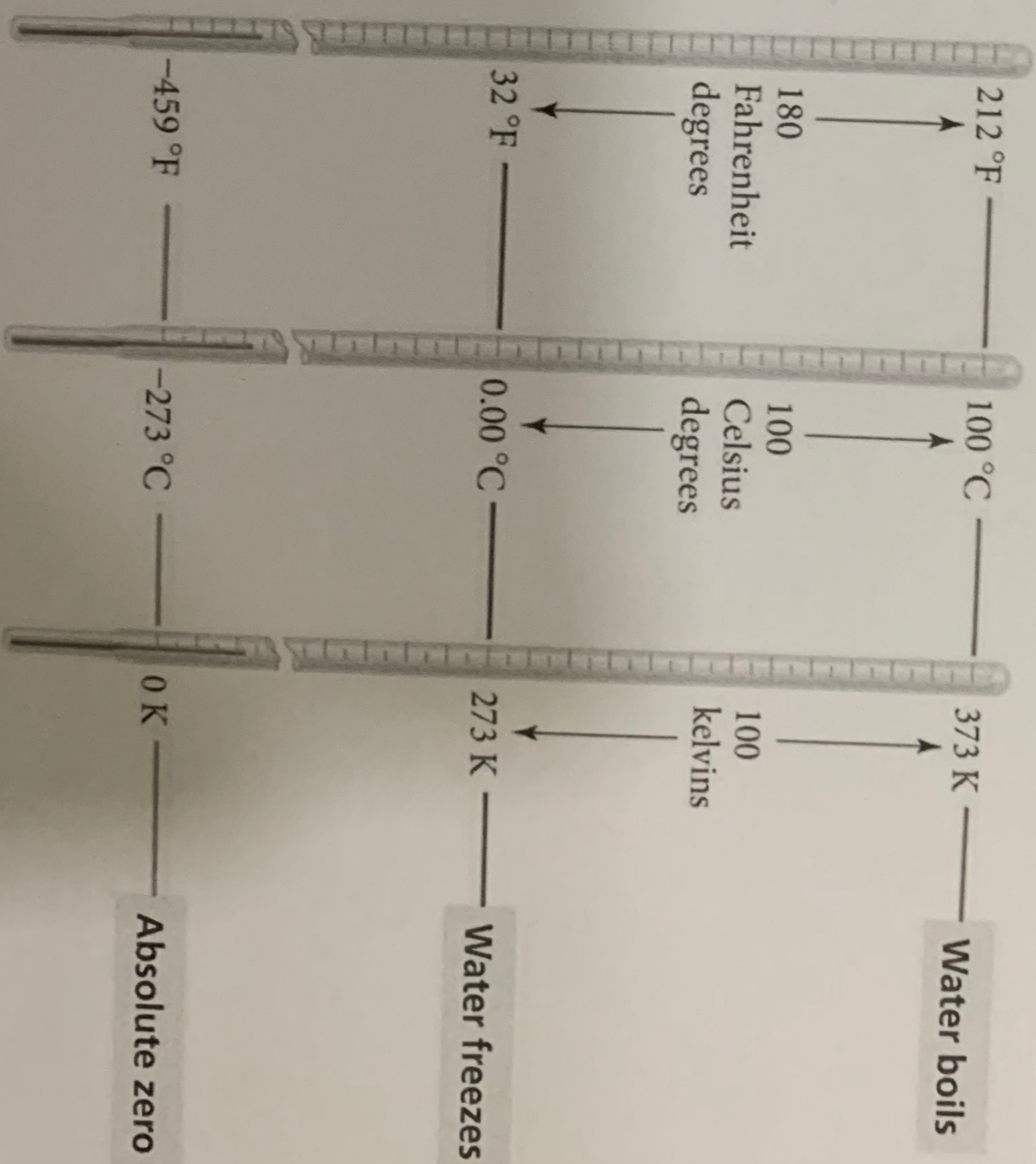
212 $^{\circ}\text{F}$, 100 $^{\circ}\text{C}$, 373.15 K

Freezing Point of Water

32 $^{\circ}\text{F}$, 0 $^{\circ}\text{C}$, 273.15 K

The absolute zero is 0 K. We can't get any colder than this!

Temperature Scales



Prefix Multipliers: Increasing The Size of The Unit

ابادائت
Prefixes that increase the size of the unit:
 حجم الوحدة

Metric and SI Prefixes

Prefix	Symbol	Numerical Value	Scientific Notation	Equality
peta	P	1 000 000 000 000 000	10^{15}	1 Pg = 10^{15} g 1 g = 10^{-15} Pg
tera	T	1 000 000 000 000	10^{12}	1 Tg = 10^{12} g 1 g = 10^{-12} Tg
giga	G	1 000 000 000	10^9	1 Gm = 10^9 m 1 m = 10^{-9} Gm
mega	M	1 000 000	10^6	1 Mg = 10^6 g 1 g = 10^{-6} Mg
kilo	k	1 000	10^3	1 km = 10^3 m 1 m = 10^{-3} km

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Prefix Multipliers: Decreasing The Size of The Unit

ابدأت
 Prefixes that decrease the size of the unit: تقل تصغر الوحدة

Metric and SI Prefixes

Prefix	Symbol	Numerical Value	Scientific Notation	Equality
Prefixes That Decrease the Size of the Unit				
deci	d	0.1	10^{-1}	1 dL = 10^{-1} L 1 L = 10 dL
centi	c	0.01	10^{-2}	1 cm = 10^{-2} m 1 m = 100 cm
milli	m	0.001	10^{-3}	1 ms = 10^{-3} s 1 s = 10^3 ms
micro	μ	0.000 001	10^{-6}	1 μ g = 10^{-6} g 1 g = 10^6 μ g
<u>nano</u>	n	0.000 000 001	<u>10^{-9}</u>	1 nm = 10^{-9} m 1 m = 10^9 nm
pico	p	0.000 000 000 001	10^{-12}	1 ps = 10^{-12} s 1 s = 10^{12} ps
femto	f	0.000 000 000 000 001	10^{-15}	1 fs = 10^{-15} s 1 s = 10^{15} fs

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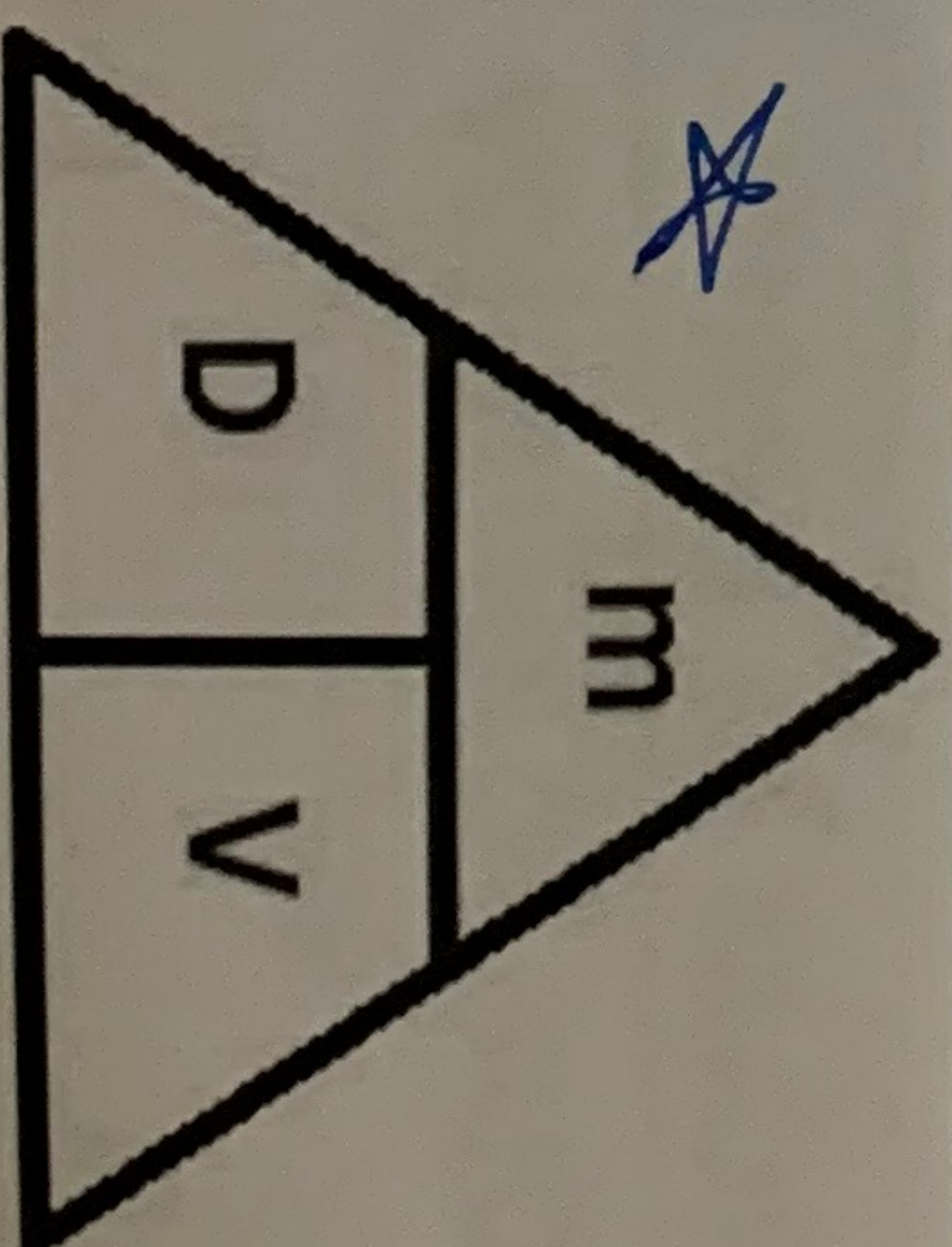
Density Of Materials

تعريف: وحدة الحجم

- Material's Density is defined as its mass per unit volume.
 - Is measured in g/L for gases.
 - Is measured in g/cm³ or g/mL for solids and liquids.
- Density Expression:

$$D = \frac{\text{mass}}{\text{Volume}} = \frac{\text{g}}{\text{mL}} \text{ or } \frac{\text{g}}{\text{cm}^3} = \text{g/cm}^3$$

Note: 1 mL = 1 cm³



D = Density
m = mass
V = volume

Density Formula

نفس الشيء

Assessment

Answer the following questions:

1- Complete the missing values:

- 100 × 517 m = 51700 km = 51700 cm = 51700 cm
- 115 s = 115000 ms = 0.115 ks
- 122 g = 122 × 10¹² pg = 122 × 10⁴ ng
- 3.35 L = 3350 mL = 3.35 × 10⁶ μL
- 157 mm → in?
 $2.5 \text{ cm} \rightarrow 1 \text{ in}$
 $2.5 \times 10^{-2} \text{ m} \rightarrow$
 $2.5 \times 10^{-2} \times 10^6 \text{ mm} \rightarrow$
 $2.5 \times 10^4 \text{ mm} \rightarrow 1 \text{ in}$
 $157 \text{ mm} \rightarrow x \text{ in}$
 $\frac{157}{2.5 \times 10^4} = 6.28 \times 10^{-8}$

2- Convert -80 °F to °C and K.

3- Perform each of the following unit conversions:

- a. 228 m to yd
- b. 2.55 kg to lb
- c. 2.41 L to qt
- d. 157 mm to in

4- A new penny has a mass of 2.49 g and a volume of 0.349 cm³, calculate its density. $\frac{2.49 \text{ g}}{0.349} = 7.15 \text{ g/cm}^3$