احجز مكانك واستعد للامتحان بثقة كاملة

ملزمة الفيزياء الفصل الثاني
Inspire 12 متقدم لعام 2026

MR.MOHAMAD

تنويه:

تم إنشاء هذه الملزمة لمساعدتك، ولكن المرجع الرئيسي هو الكتاب، وسيكون هناك ملف إضافي للأمثلة.

لحجز مقعدك قم بالتواصل معنا

اضغط هنا: 0566410429

NOLOGIA™

للتواصل والحجز

انضم للقناة

احصل على شرح الملزمة كاملة

بـ199 درهم فقط

لحجز مقعدك قم بالتواصل معنا

اضغط هنا: 0566410429

Module (11): Thermal Energy

	Lesson Title	Page
11-1	Temperature, Heat, and Thermal Energy	4
11-2	Changes of State and The Thermodynamics	20

MR.MOHAMAD

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429

NOLOGIA™ 0566410429

Module (11): Thermal Energy

01 First Lesson:
Temperature, Heat, and Thermal Energy

MR.MOHAMAD

لا تتردد في التواصل معنا
قم بمسح رمز الـQR

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429

Why Do Different Parts of a Pan Show Different Colors?

This thermal image reveals the invisible world of heat. The different colors represent different temperatures. But what *_is_* temperature, really? And how does this thermal energy move through the pan?

MR.MOHAMAD

An Introduction to Thermal Energy

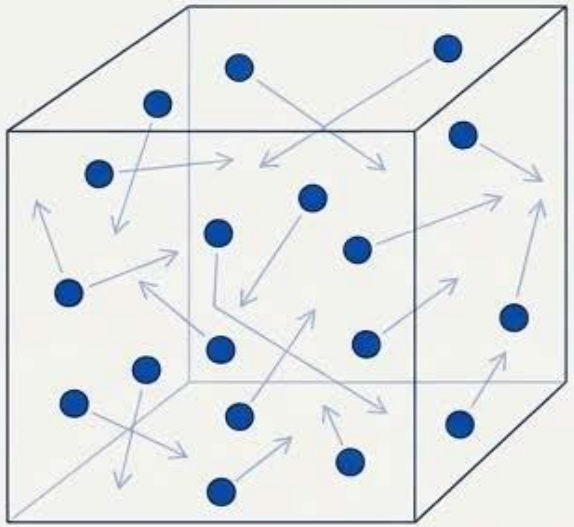
Grade 12 Advanced Physics

NOLOGIA™

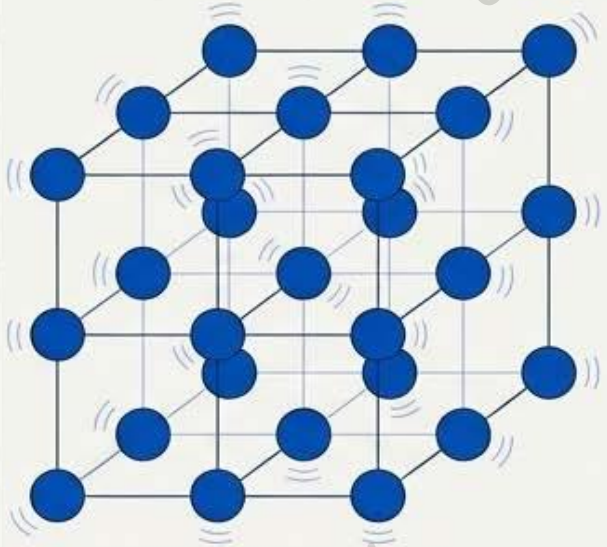
للتواصل على الرقم: 0566410429

Everything is Moving: The Microscopic World of Heat

Every material is made of microscopic particles—atoms and molecules—that are in constant, random motion. This motion gives them kinetic energy.



In gases and liquids, particles move and collide freely, transferring energy.



In solids, atoms are held in place but still have kinetic energy as they vibrate.

The temperature of an object is a measure of the *average* kinetic energy of its constituent particles. Hotter objects have particles that are, on average, moving or vibrating faster.

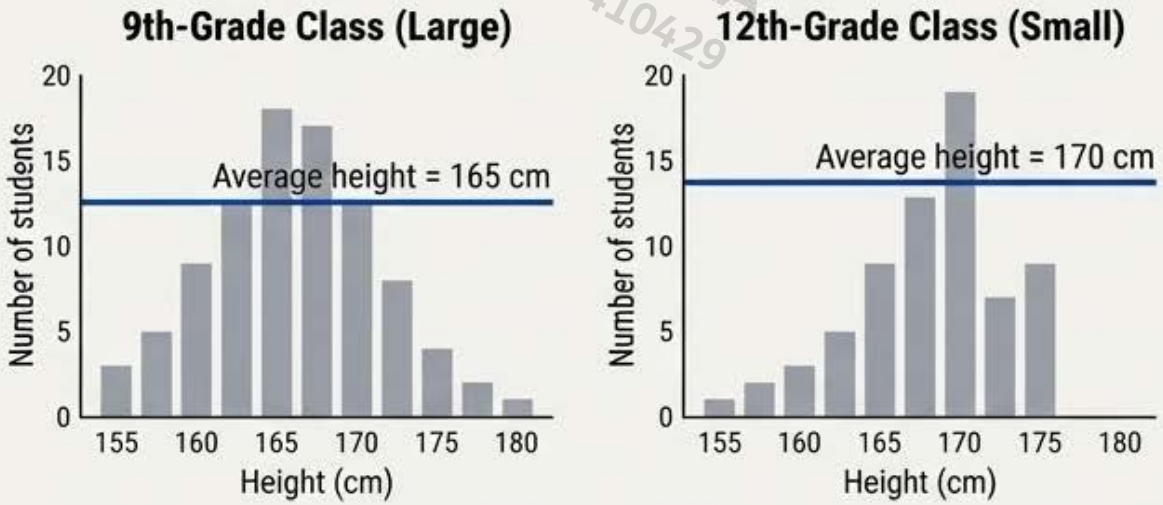
NOLOGIA™

للتواصل على الرقم: 0566410429

Temperature vs. Thermal Energy: What's the Difference?

Temperature is the average, but Thermal Energy is the total.

The Analogy

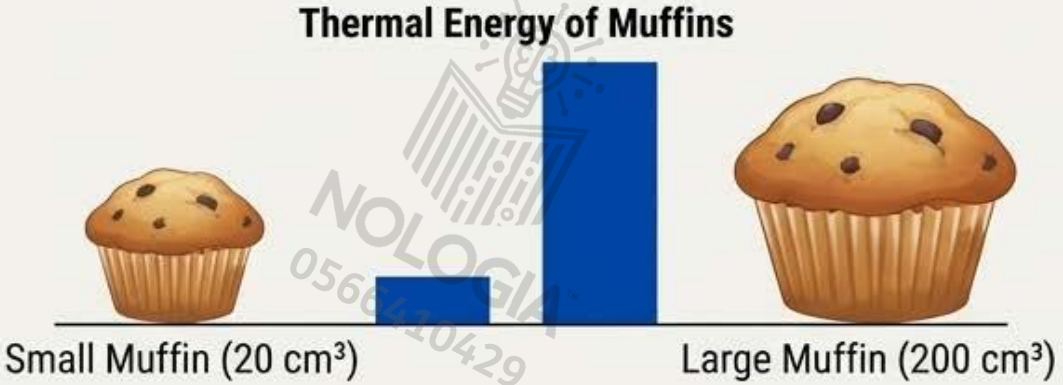


Think of particle energy like student height.

- The *average* height of a 12th-grade class is greater than the average height of a 9th-grade class. This is like **Temperature.**

However, a very large 9th-grade class could have a greater *total* height (sum of all heights) than a very small 12th-grade class. This is like **Thermal Energy.**

The Practical Example



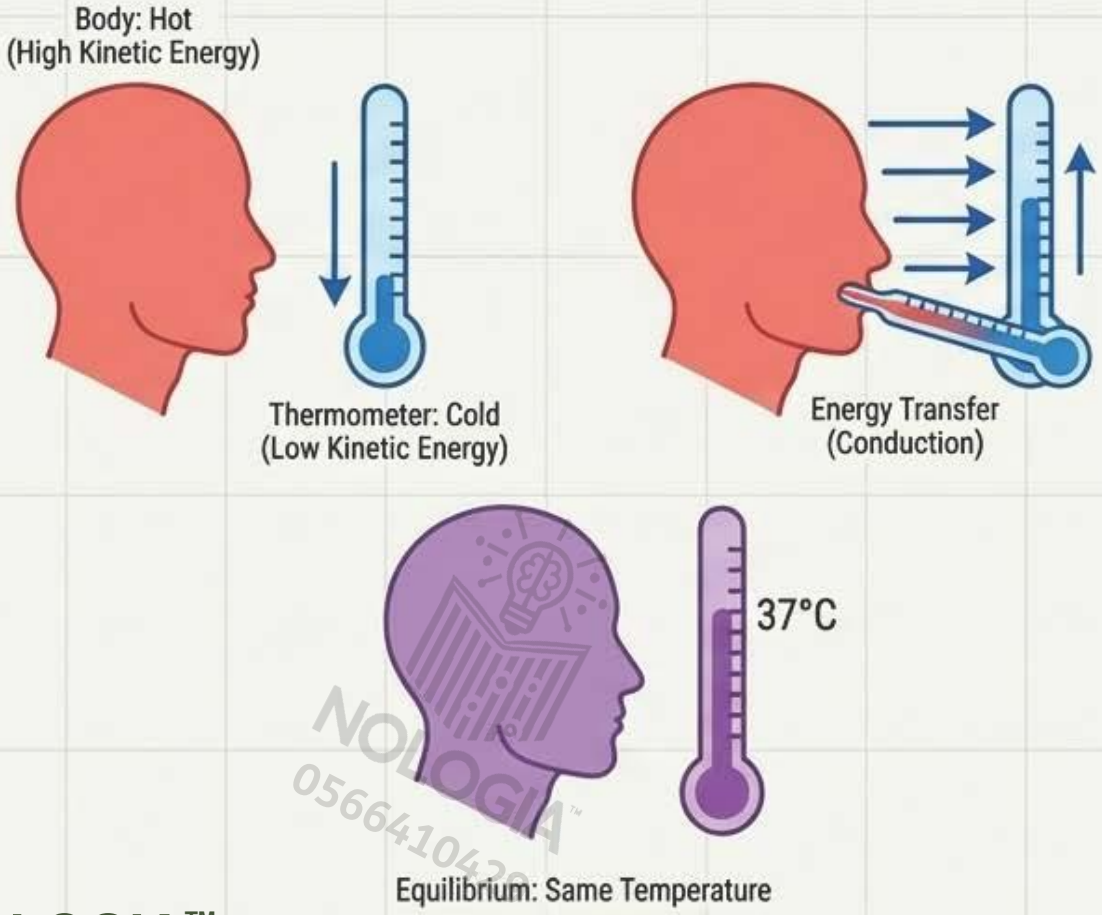
The Practical Example

Two muffins can be at the same temperature (same average particle energy), but the larger muffin has more particles, so it has more total thermal energy.

NOLOGIA™
0566410429
للتواصل على الرقم: 0566410429

Reaching a Balance: Thermal Equilibrium

Thermal Equilibrium is the state where two objects in contact have reached the same temperature, and there is no longer a net transfer of thermal energy between them.



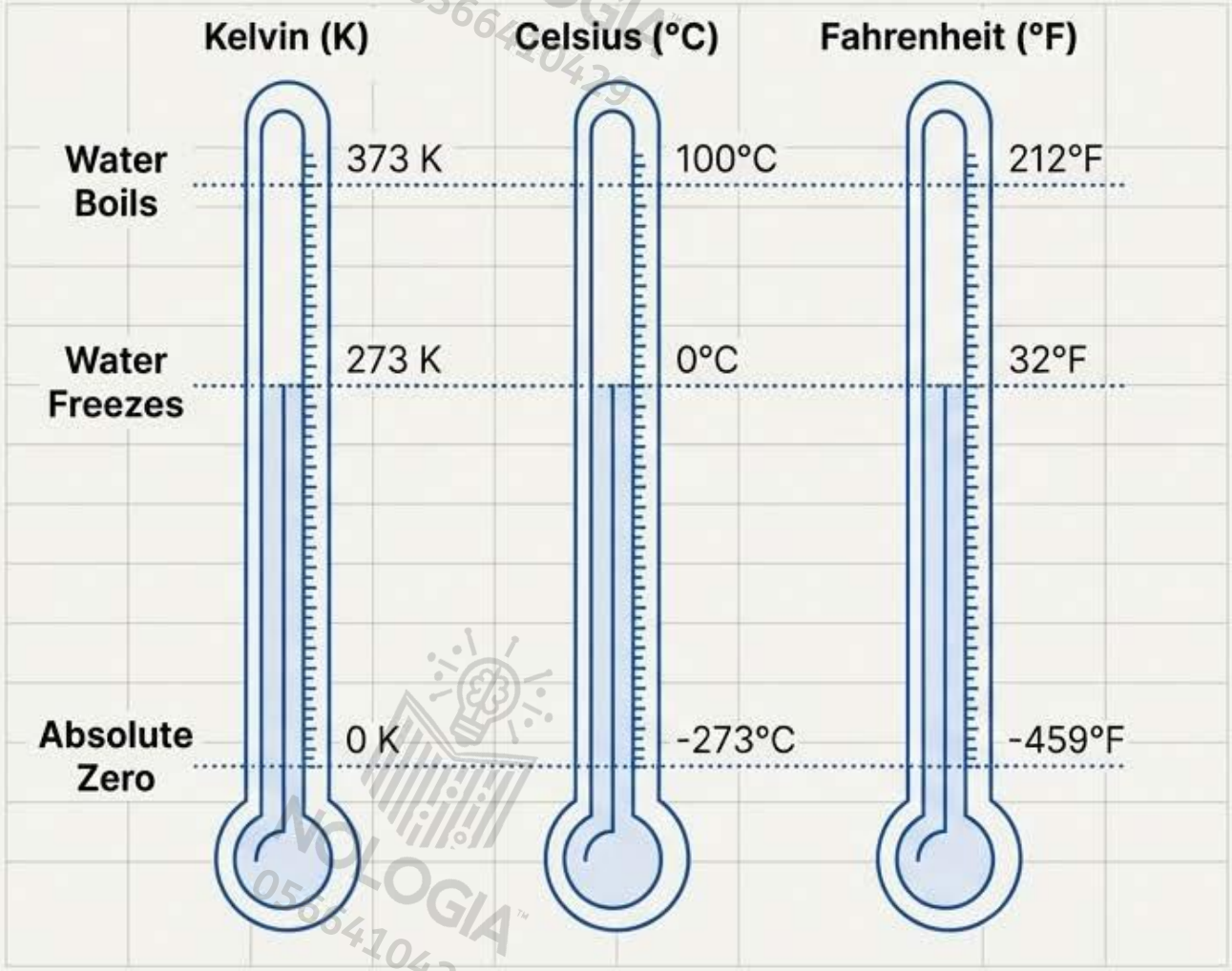
How it Works:

1. **Initial State:** Your body is hotter than a cold thermometer. The particles in your body have a higher average kinetic energy.
2. **Contact:** When you place the thermometer in your mouth, the faster-moving particles in your body collide with the slower-moving particles of the thermometer.
3. **Energy Transfer (Heat):** Energy is transferred from your body to the thermometer. This process is called **conduction.**
4. **Equilibrium:** The transfer continues until the rate of energy transfer from your body to the thermometer equals the rate of transfer from the thermometer to your body. They are now at the same temperature.

NOLOGIA™

للتواصل على الرقم: 0566410429

Measuring Temperature: Celsius, Fahrenheit, and Kelvin



- **Celsius (°C):** Used globally for most day-to-day measurements. Defined by water's freezing (0°C) and boiling (100°C) points.
- **Fahrenheit (°F):** Primarily used in the United States.
- **Kelvin (K):** The SI unit for temperature. It is an absolute scale, meaning 0 K (absolute zero) is the point where particles have minimal kinetic energy. It has no negative values.

Essential Conversion

Formula: $T_K = T_C + 273$

Note: Because each interval on the Kelvin scale is equal to one Celsius degree, the *change* in temperature (ΔT) is the same on both scales.

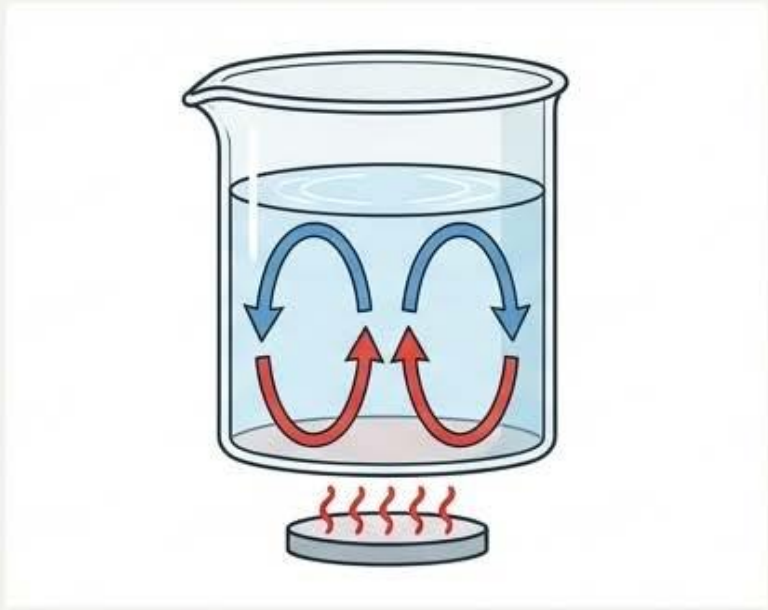
The Journey of Heat: How Thermal Energy is Transferred

Heat (Q) is the transfer of thermal energy that occurs spontaneously from a hotter object to a colder object.



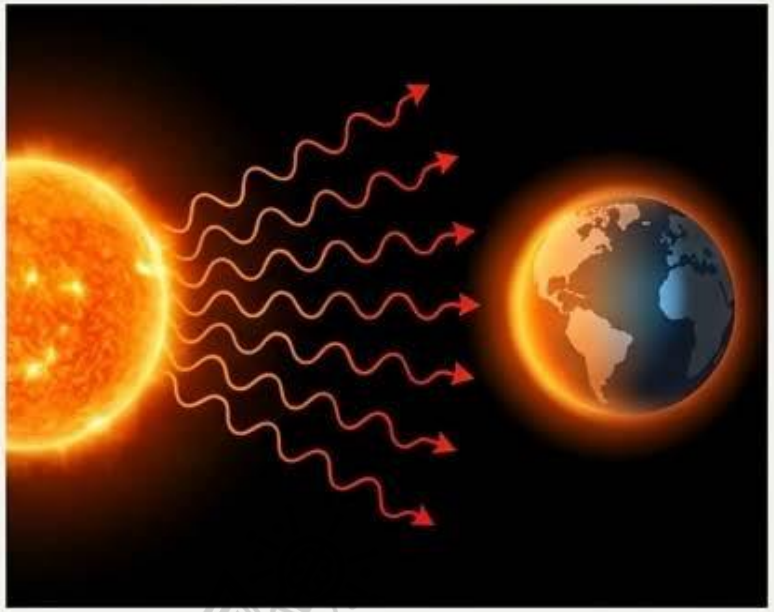
CONDUCTION

Transfer through direct contact.



CONVECTION

Transfer through the movement of fluids (liquids or gases).



RADIATION

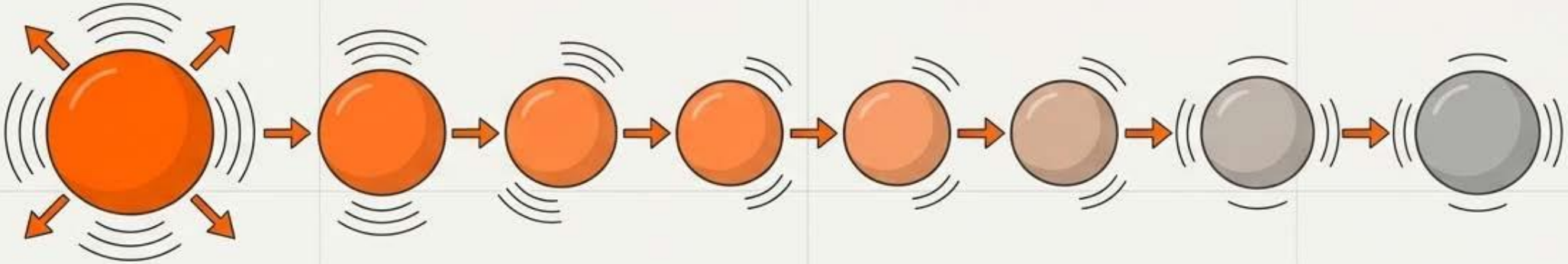
Transfer by electromagnetic waves.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Transfer by Touch: Conduction

Conduction occurs when particles of an object collide with their neighbors, transferring kinetic energy without the particles themselves changing position. It is the primary method of heat transfer in solids.



Real-World Examples



Good Conductors

Good Conductors (Metals): Why does the metal handle of a spoon in hot soup get hot? Metals like copper, iron, and aluminum have free electrons that transfer energy quickly.

Poor Conductors

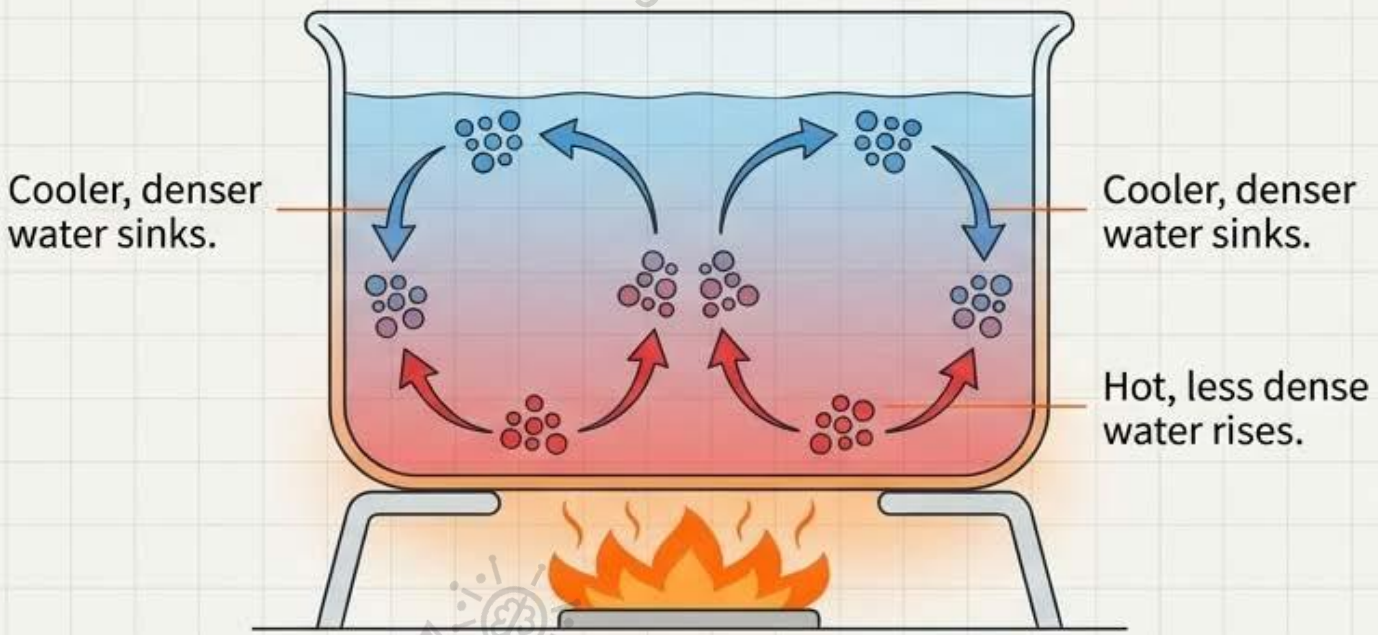
Poor Conductors (Insulators): Why are cooking pan handles made of plastic or wood? These materials are insulators; their particles don't transfer energy easily, keeping the handle cool.



NOLOGIA 0566410429

Transfer by Flow: Convection

Convection is the transfer of thermal energy in a fluid (a liquid or gas) by the movement of the fluid itself. Hotter, less dense fluid rises, and cooler, denser fluid sinks, creating a **convection current.**



1. Water at the bottom is heated by conduction from the pot.
2. It expands, becomes less dense, and rises.
3. Cooler, denser water from the top sinks to take its place, gets heated, and rises. This cycle heats the entire pot.

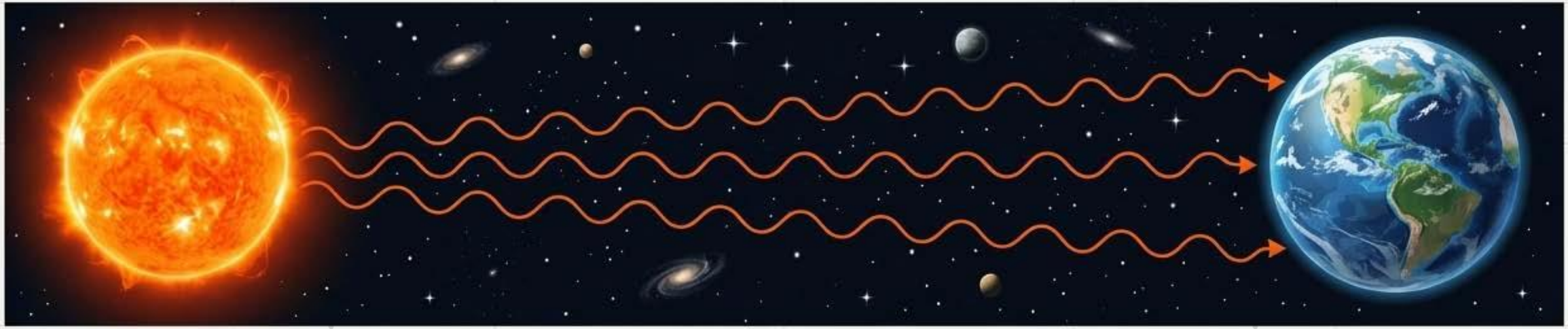
Large-Scale Example:
Thunderstorms and large-scale atmospheric winds are caused by convection. Warm air rises, cools, and then sinks, driving weather patterns.

NOLOGIA™
0566410429
للتواصل على الرقم: 0566410429

Transfer Through Space: Radiation

Radiation is the transfer of energy by electromagnetic waves. Unlike conduction or convection, radiation does not require a medium (matter) to travel through.

All objects with a temperature above absolute zero (0 K) emit thermal radiation.



The Sun is 150 million km away. Its energy reaches us as electromagnetic waves, traveling through the vacuum of space. When these waves are absorbed by objects on Earth, their energy is converted into thermal energy.



Everyday Example

You can feel the heat from a campfire or a hot stove element even from a distance, without touching it. This is radiant heat.

A Material's Character: Specific Heat (c)



On a bright summer day, why does the sand on a beach become scorching hot while the ocean water stays cool, even though both receive the same amount of solar radiation?

The Answer: Specific Heat (c) is the amount of energy required to raise the temperature of 1 kg of a substance by 1 K (or 1°C). Think of it as **thermal inertia** or **resistance to temperature change**.
High Specific Heat (like Water): Requires a lot of energy to change its temperature. It heats up slowly and cools down slowly.
Low Specific Heat (like Sand/Metals): Requires little energy to change its temperature. It heats up quickly and cools down quickly.

Table 1: Specific Heat of Common Substances

Material	Specific Heat (J/kg·K)	Material	Specific Heat (J/kg·K)
Aluminum	**897**	Lead	130
Brass	376	Methanol	2450
Carbon	710	Silver	235
Copper	385	**Water**	**4180**
Glass	**840**	Water Vapor	2020
Ice	2060	Zinc	388
Iron	450		

للتواصل على الرقم: 0566410429

Calculating Heat Transfer

$$Q = m\,c\,\Delta T$$
$$Q = m\,c\,(T_f - T_i)$$

Q

—— **Heat** transferred.

- Measured in **Joules (J)**.
- *Q* is positive if the object gains heat (gets warmer).
- *Q* is negative if the object loses heat (gets cooler).

m

—— **Mass** of the substance.

- Measured in **kilograms (kg)**.

c

—— **Specific Heat** of the substance.

- Measured in **Joules per kilogram-Kelvin (J/kg·K)**.

ΔT

—— **Change in Temperature** ($T_{final} - T_{initial}$).

- Measured in **Kelvin (K)** or **degrees Celsius (°C)**. (The change is the same for both).

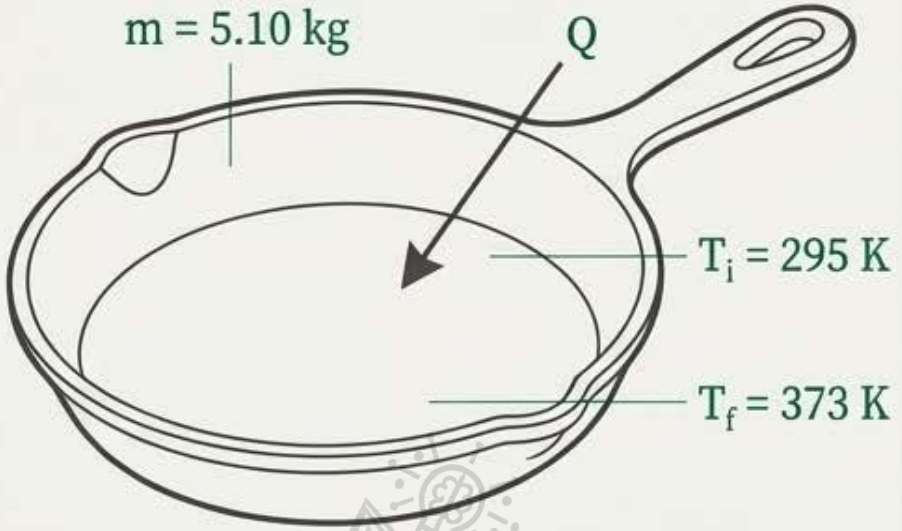
NOLOGIA™ 0566410429

Worked Example: Heating a Cast-Iron Skillet

Problem Statement:
How much heat is transferred to a 5.10 kg cast-iron skillet when its temperature is raised from 295 K to 373 K? The specific heat of iron is 450 J/kg·K.

Step 1: Analyze and List Knowns

- Mass (m) = 5.10 kg
- Specific Heat (c) = 450 J/kg·K
- Initial Temp (T_i) = 295 K
- Final Temp (T_f) = 373 K
- Unknown: Heat (Q) = ?



Step 2: State the Formula

$Q = mc(T_f - T_i)$

Step 3: Substitute and Solve

$Q = (5.10\ kg)(450\ J/kg \cdot K)(373\ K - 295\ K)$

$Q = (5.10\ kg)(450\ J/kg \cdot K)(78\ K)$

$Q = 179{,}010\ J$ or $1.8 \times 10^5\ J$

Step 4: Evaluate the Answer

The units are in Joules, the correct unit for energy. The sign is positive, which makes sense because the skillet was heated.

NOLOGIA 0566410429

The Calorimeter: Measuring Heat in a Closed System

What is a Calorimeter?
A device that measures changes in thermal energy. It's an insulated container that isolates a system, preventing heat from entering or leaving.

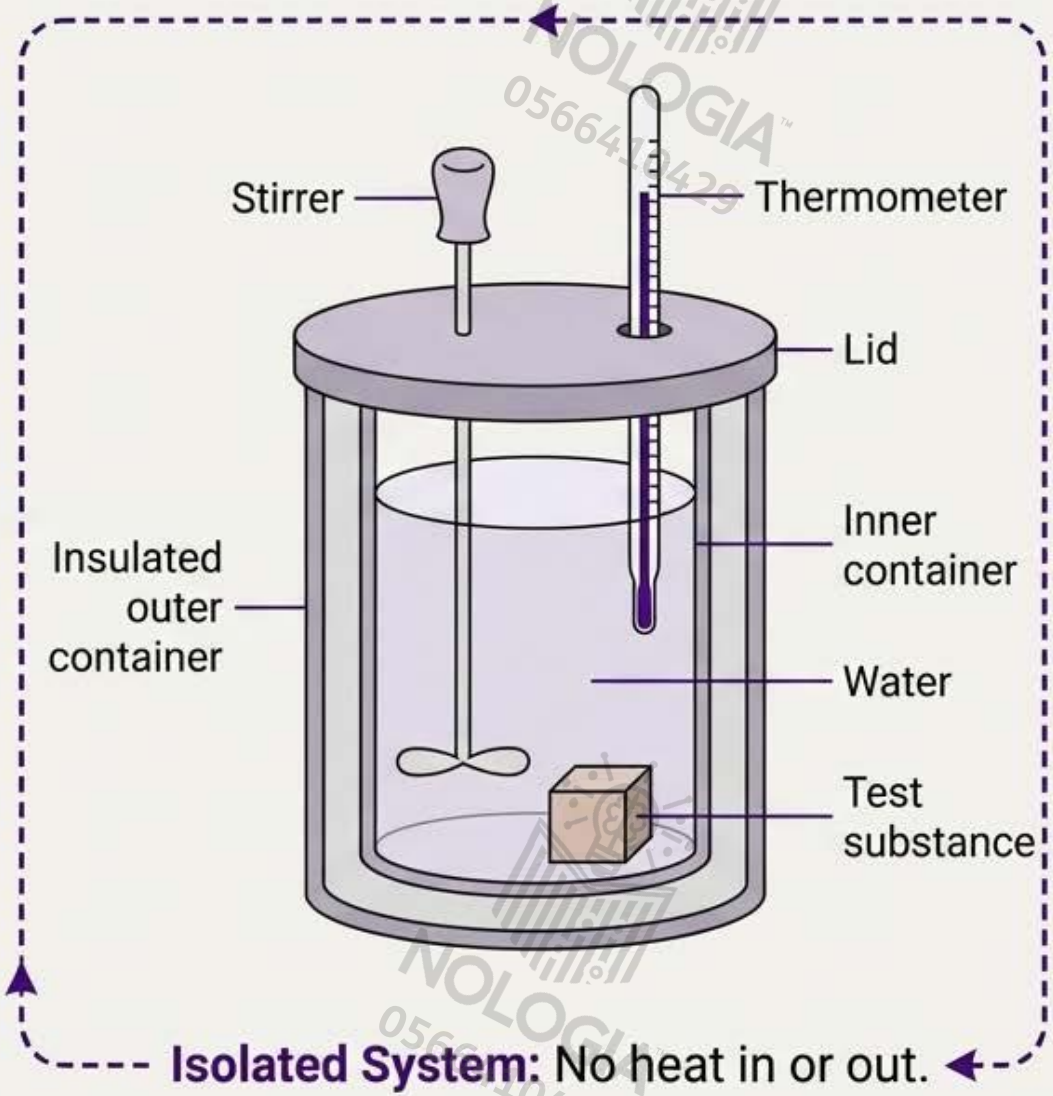
The Principle of Energy Conservation:
* In an isolated system, the total energy change is zero ($\Delta E_A + \Delta E_B = 0$).
* This means the heat lost by the hot object is equal to the heat gained by the cold object.

Core Equation:
Heat Lost = - Heat Gained

$$Q_{lost} = -Q_{gained}$$

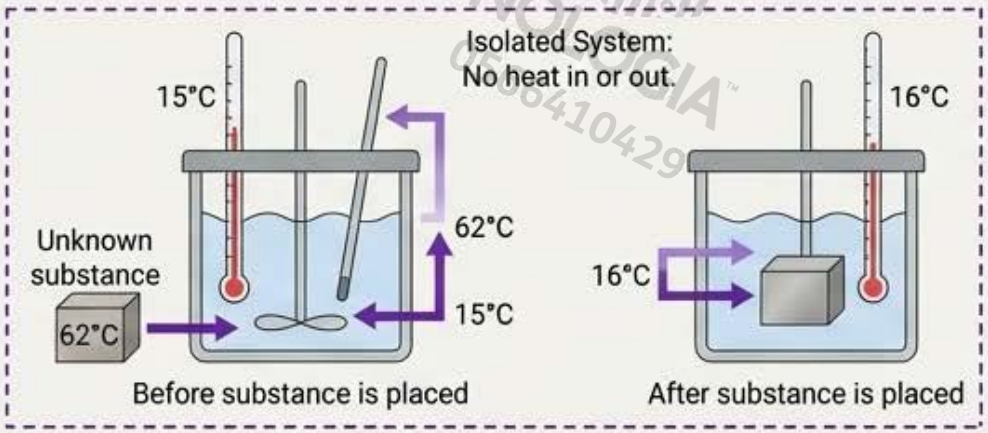
$$m_A c_A \Delta T_A = - m_B c_B \Delta T_B$$

Application
By measuring the masses and temperature changes of a known substance (like water) and an unknown substance, we can use this principle to calculate the unknown's specific heat.



Worked Example: Finding an Unknown Specific Heat

Problem Statement: A 0.10 kg block of an unknown substance at 62°C is placed in a calorimeter containing 0.50 kg of water at 15°C. The system reaches a final equilibrium temperature of 16°C. What is the specific heat of the unknown substance? (c_{water} = 4180 J/kg·K)



Step 1: Analyze and List Knowns

Object A (Unknown):
$m_A = 0.10$ kg
$T_{iA} = 62°C$
$T_f = 16°C$

Object B (Water):
$m_B = 0.50$ kg
$T_{iB} = 15°C$, $T_f = 16°C$
$c_B = 4180$ J/kg·K

Unknown:
$c_A = ?$

Step 2: State the Formula

$$m_A c_A (T_f - T_{iA}) = -m_B c_B (T_f - T_{iB})$$

Rearrange to solve for c_A:

$$c_A = \frac{-m_B c_B (T_f - T_{iB})}{[m_A (T_f - T_{iA})]}$$

Step 3: Substitute and Solve

$$c_A = -\frac{(0.50\text{ kg})(4180\text{ J/kg·°C})(16°C - 15°C)}{[(0.10\text{ kg})(16°C - 62°C)]}$$

$$c_A = -\frac{(2090)}{-4.6}$$

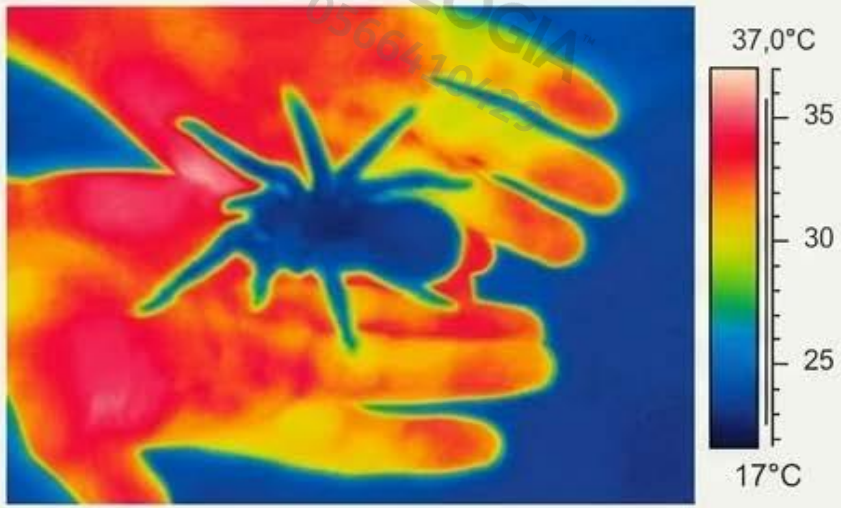
$$c_A = 454\text{ J/kg·°C}$$

Step 4: Evaluate the Answer

The value is 454 J/kg·K. Comparing this to our table of specific heats, this substance is likely iron (c = 450 J/kg·K).

Thermal Energy in the Real World

Application in Biology



Animals use thermal principles to survive.

- **Cold-blooded animals** (like the spider) depend on external sources for heat; their body temperature matches their surroundings.
- **Warm-blooded animals** (like humans) regulate their internal body temperature (e.g., 37°C) through metabolic processes like shivering (to generate heat) and sweating (to lose heat via evaporation).

Module Summary: Key Concepts & Formulas

- **Temperature:** A measure of average kinetic energy of particles.
- **Thermal Energy:** The total kinetic energy of all particles in an object.
- **Heat (Q):** The transfer of thermal energy from hot to cold.
- **Conduction:** Heat transfer by direct contact.
- **Convection:** Heat transfer by fluid movement.
- **Radiation:** Heat transfer by electromagnetic waves.
- **Specific Heat (c):** A material's resistance to temperature change.

Key Formula 1: $Q = m\,c\,\Delta T$

Key Formula 2: $TK = TC + 273$

Key Principle (Calorimetry): $Q_{lost} = -Q_{gained}$

NOLOGIA™ 0566410429

Module (11): Thermal Energy

02 Second Lesson:
Changes of State and The Thermodynamics

MR.MOHAMAD

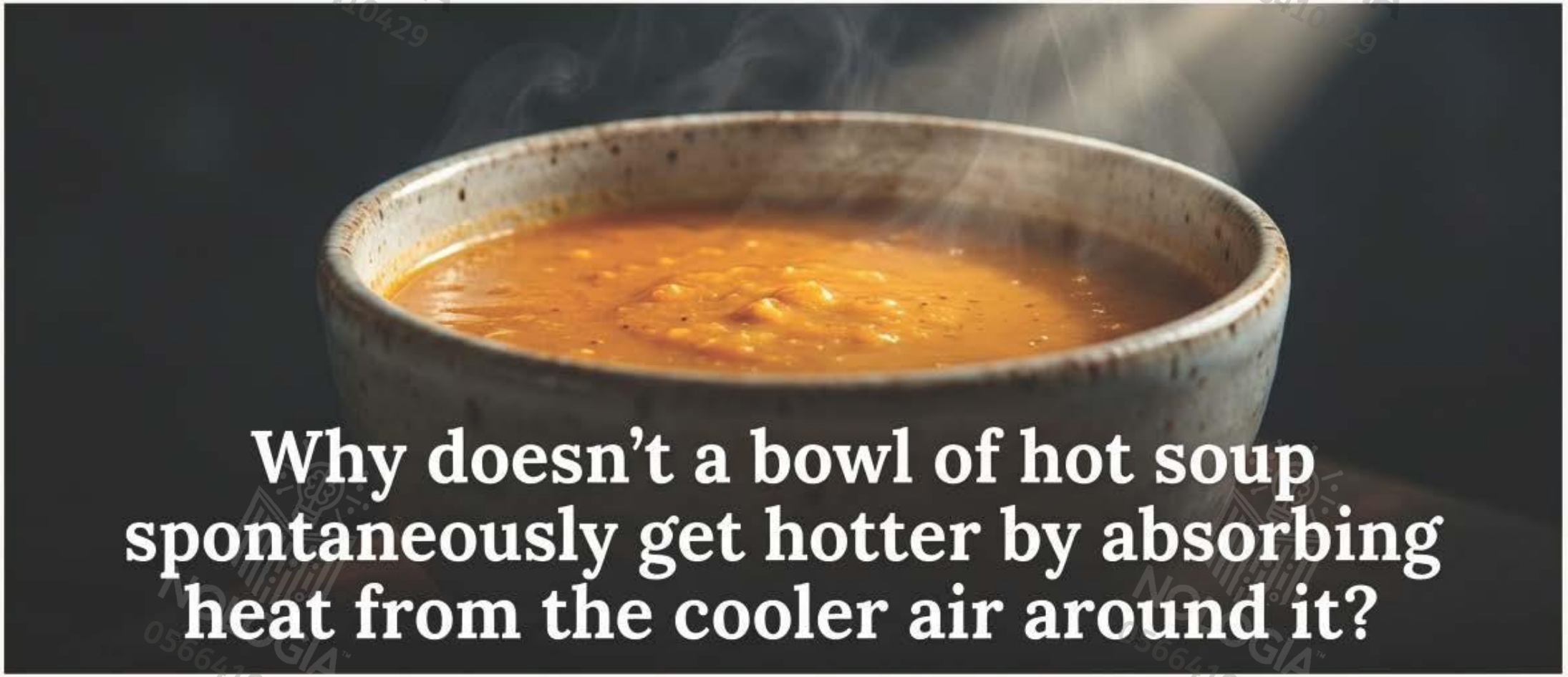
لا تتردد في التواصل معنا
قم بمسح رمز الـQR

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429

The Arrow of Time: A Thermodynamics Masterclass

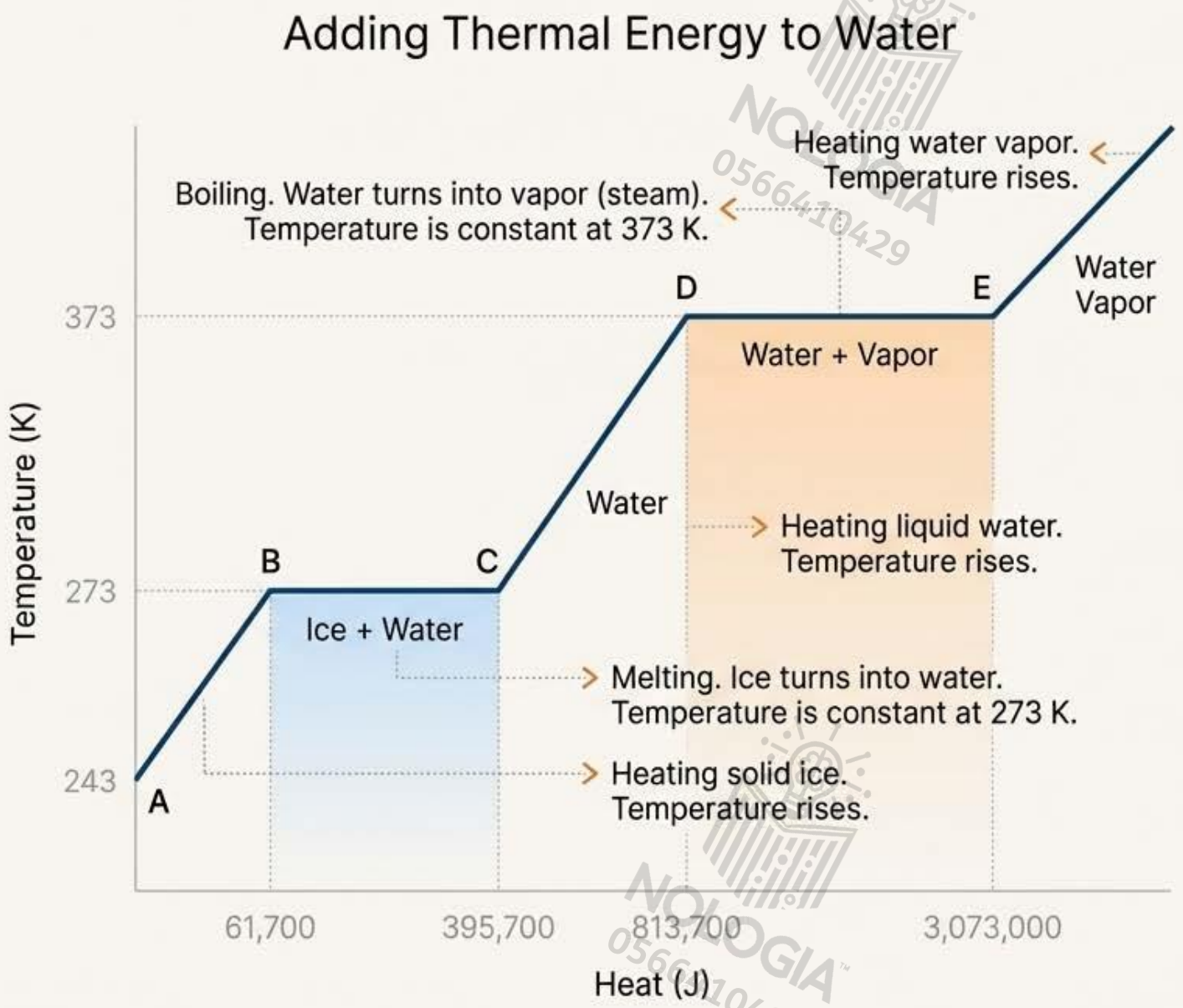
by Mr. Mohamad



NOLOGIA™ 0566410429

The Journey of Water: Mapping Temperature vs. Added Energy

Key Idea: To understand our soup, we first need to understand how substances like water change state when thermal energy is added. This graph shows what happens to 1.0 kg of ice as it's **heated from 243 K** to beyond **373 K**.



NOLOGIA 0566410429

The Hidden Energy of Phase Changes

Key Question: Why does the temperature stop rising at melting (B-C) and boiling (D-E)?

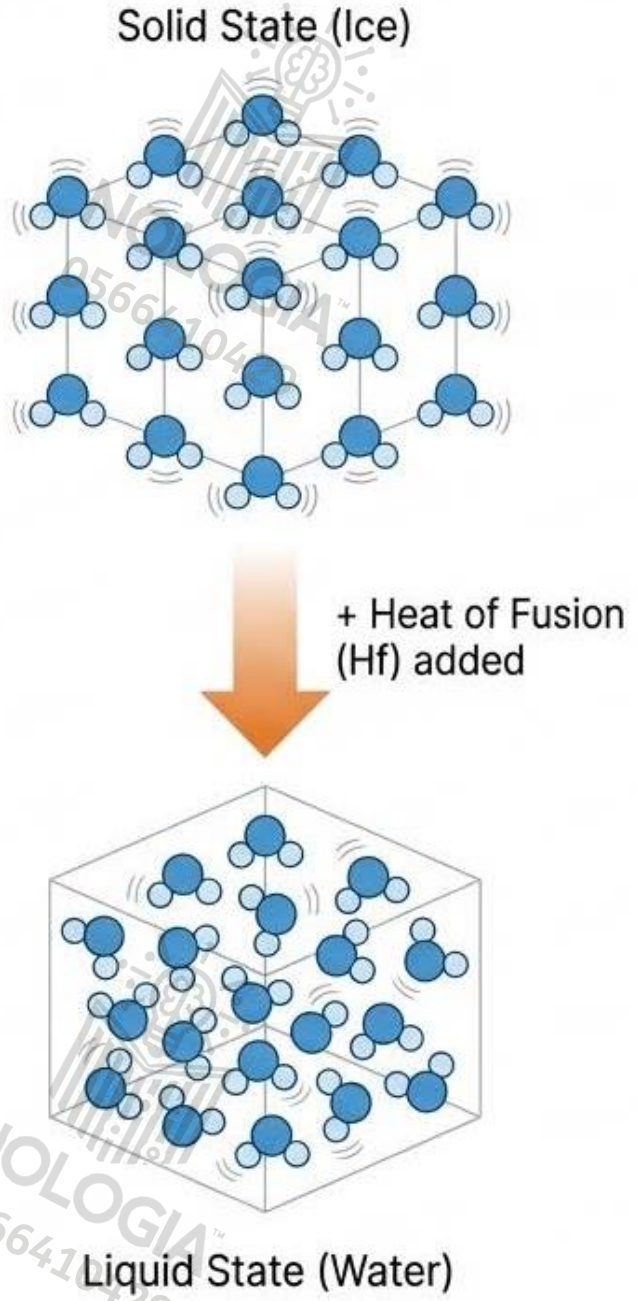
During a phase change, the added thermal energy is used to change the potential energy of the molecules, giving them more freedom to move. It doesn't increase their average kinetic energy, which is what we measure as temperature.

Key Terminology

Heat of Fusion (Hf): The amount of energy needed to melt 1 kg of a substance from solid to liquid at its melting point. For example, the thermal energy from the warmer air that causes a snowman to melt.



Heat of Vaporization (Hv): The amount of energy needed to vaporize 1 kg of a substance from liquid to gas at its boiling point.



للتواصل على الرقم: 0566410429

Calculating the Energy of Transformation

Formula Spotlight 1: Melting a Solid

$$Q = mH_f$$

Q: Heat required (Joules)
m: mass of the substance (kg)
H_f: heat of fusion (J/kg)

Formula Spotlight 2: Vaporizing a Liquid

$$Q = mH_v$$

Q: Heat required (Joules)
m: mass of the substance (kg)
Hv: heat of vaporization (J/kg)

For freezing or condensation, the same amount of energy is *removed* from the substance ($Q = -mH_f$ or $Q = -mH_v$).

Heats of Fusion and Vaporization

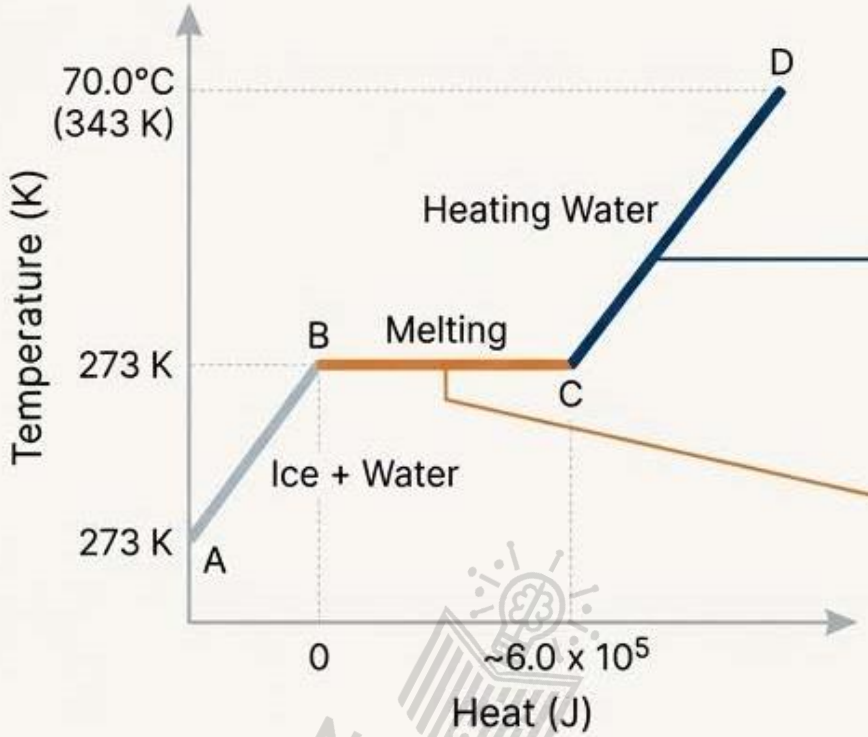
Material	Heat of Fusion H_f (J/kg)	Heat of Vaporization H_v (J/kg)
Water	3.34×10^5	2.26×10^6
Copper	2.05×10^5	5.07×10^6
Lead	2.04×10^4	8.64×10^5

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Masterclass Example: Making Hot Cocoa

Problem Statement: You need to melt 1.50 kg of snow at 0.0°C and heat it to 70.0°C to make hot cocoa. How much heat will you need?



Step 1: Melt the Snow (Segment B-C)

$Q_{melt} = mH_f$

$Q_{melt} = (1.50\ kg)(3.34 \times 10^5\ J/kg) = 5.01 \times 10^5\ J$

Step 2: Heat the Water (Segment C-D)

$Q_{heat} = mc\Delta T$

$Q_{heat} = (1.50\ kg)(4180\ J/kg{\cdot}K)(70.0\ K) = 4.39 \times 10^5\ J$

Step 3: Find the Total Heat

$Q_{total} = Q_{melt} + Q_{heat}$

$Q_{total} = 5.01 \times 10^5\ J + 4.39 \times 10^5\ J = 9.40 \times 10^5\ J$

Conclusion: You need to add 940 kJ of energy.

NOLOGIA 0566410429

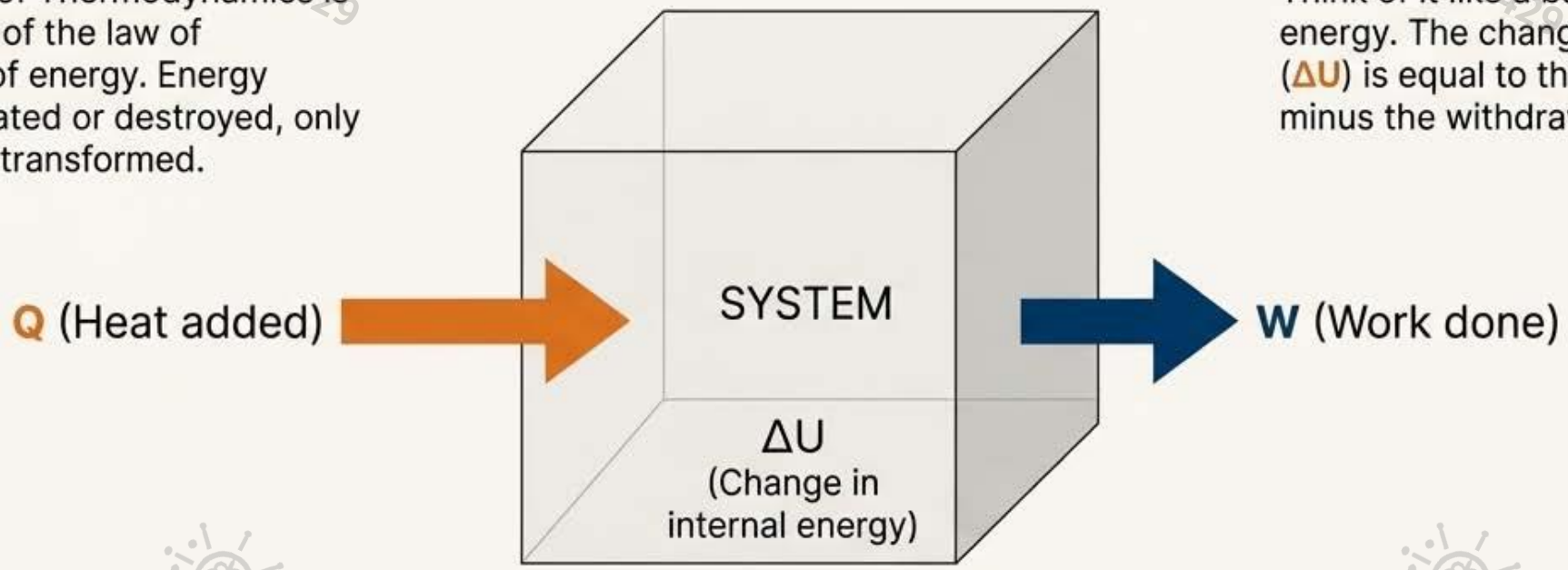
The First Law: Energy's Golden Rule

Core Concept

The First Law of Thermodynamics is a restatement of the law of conservation of energy. Energy cannot be created or destroyed, only transferred or transformed.

Analogy

Think of it like a bank account for energy. The change in your account (**ΔU**) is equal to the deposits (**Q**) minus the withdrawals (**W**).



$$\Delta U = Q - W$$

ΔU: Change in the system's internal energy
Q: Heat added *to* the system
W: Work done *by* the system

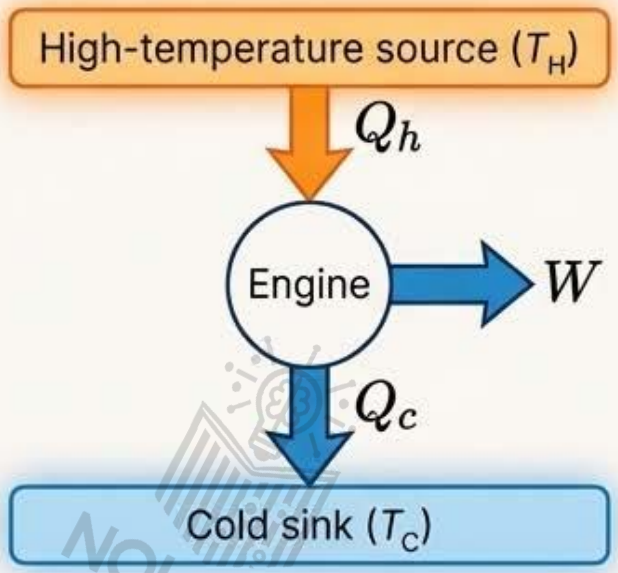
NOLOGIA 0566410429

Putting Energy to Work: The Heat Engine

Definition

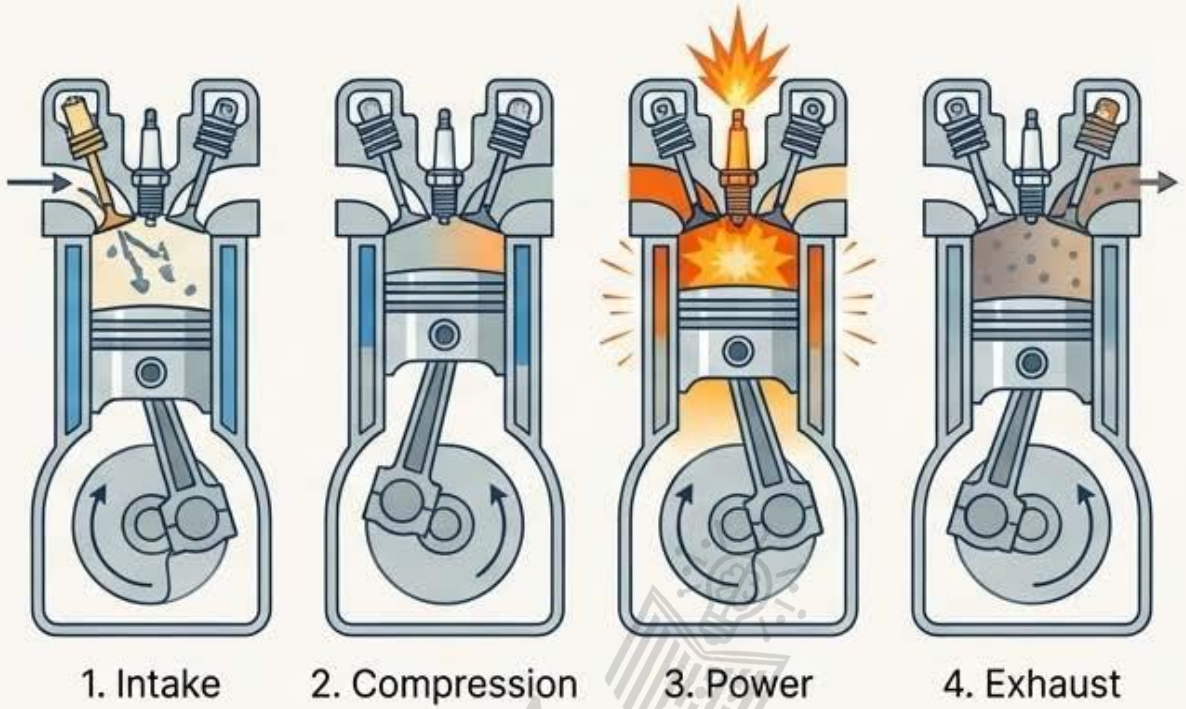
A heat engine is a device that continuously converts thermal energy into mechanical energy.

How it Works (Energy Flow Diagram)



$$Q_h = W + Q_c$$

Practical Example: The Internal Combustion Engine



The hot, expanding gases from ignited fuel push a piston down, doing work that ultimately propels the car.

NOLOGIA 0566410429

The Inescapable Reality of Waste Heat

Key Question

Can we build a 100% efficient engine that turns all Qh into W?

No. All heat engines generate waste heat (Qc). The engine must release this excess heat to the environment to continue operating. The thermal energy of the working substance does not return to its initial state after one cycle.

Efficiency

- A typical gasoline engine has an efficiency of less than 30%.
- Even the most advanced automobile engines are less than 50% efficient.

Implication

A significant amount of energy from fuel is transferred to the surroundings as thermal energy, not useful work. This is a fundamental constraint.



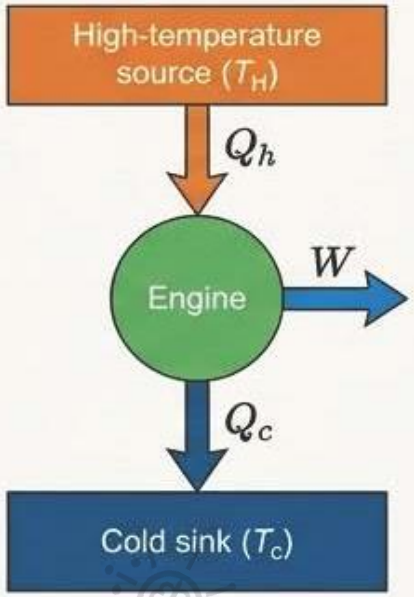
NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Reversing the Flow: Refrigerators and Heat Pumps

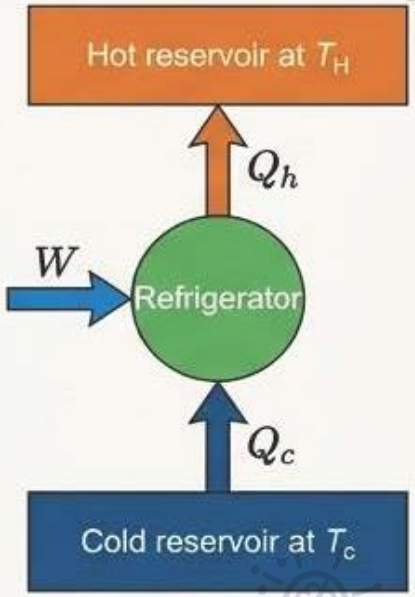
A refrigerator is a heat engine operating in reverse. It uses external **work** to move thermal energy from a cold object to a warmer one.

Heat Engine (Spontaneous Flow)



$$Q_h = W + Q_c$$

Refrigerator (Non-spontaneous Flow)



$$Q_h = W + Q_c$$

Heat Pumps

A device that can act as a heater in winter (pumping heat from the cold outside air into the house) or an air conditioner in summer (pumping heat from the house to the hot outside air).

NOLOGIA™

للتواصل على الرقم: 0566410429

A Missing Piece of the Puzzle



Recap

The First Law says energy is conserved. $\Delta U = Q - W$.

A Paradox

According to the First Law, the following should be possible:

- A cup of lukewarm water spontaneously separating into hot water and ice cubes.
- A broken glass reassembling itself.
- A car using the heat from the road to power itself.
- Our Soup: The heat from the cool room air could flow into the hot soup, making it even hotter.

The Problem

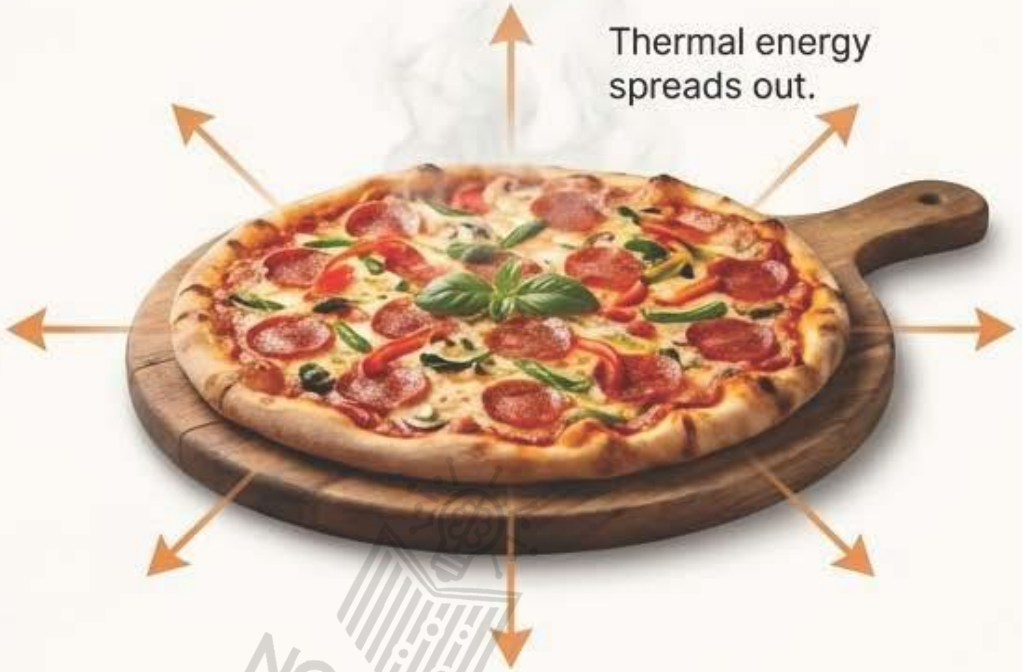
In all these cases, energy would be conserved. Yet, we never see them happen. The First Law tells us *what's possible* in terms of energy accounting, but not *which direction* a process will naturally go.

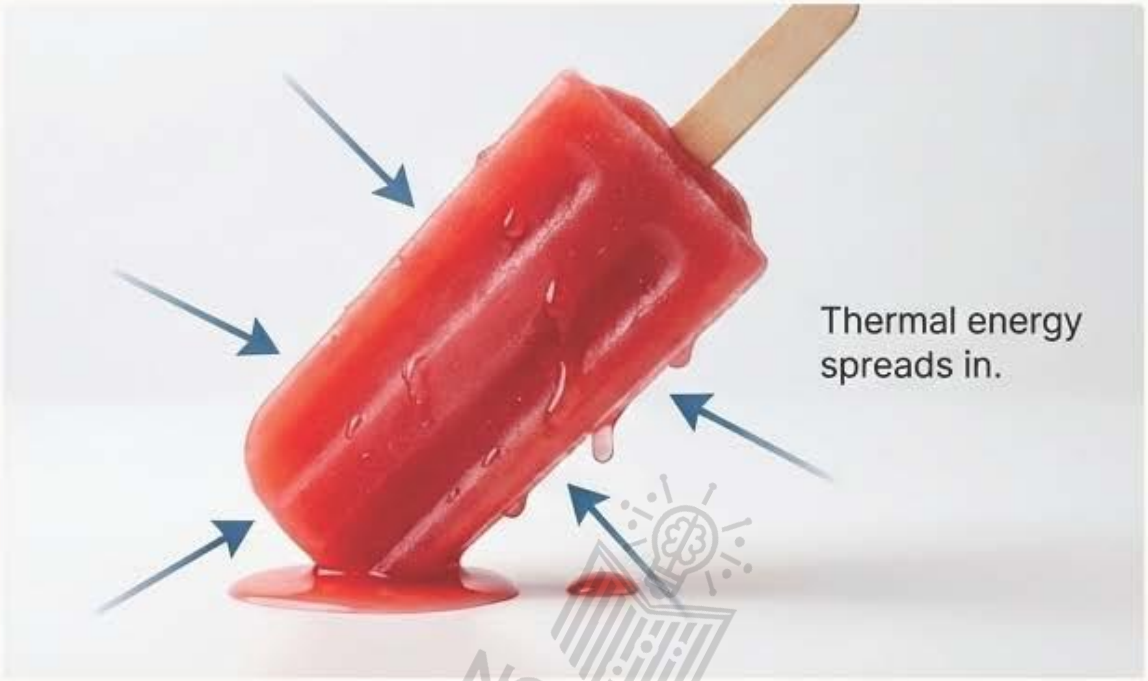
NOLOGIA 0566410429

The Second Law: Nature's One-Way Street

The Rule: The Second Law of Thermodyn**amics** states that in an uncontrolled system, thermal energy spontaneously flows from a warmer object to a cooler object. It never spontaneously flows from cold to hot.

Core Idea: Energy doesn't just exist; it spreads out. This dispersal of energy is a natural, irreversible process.





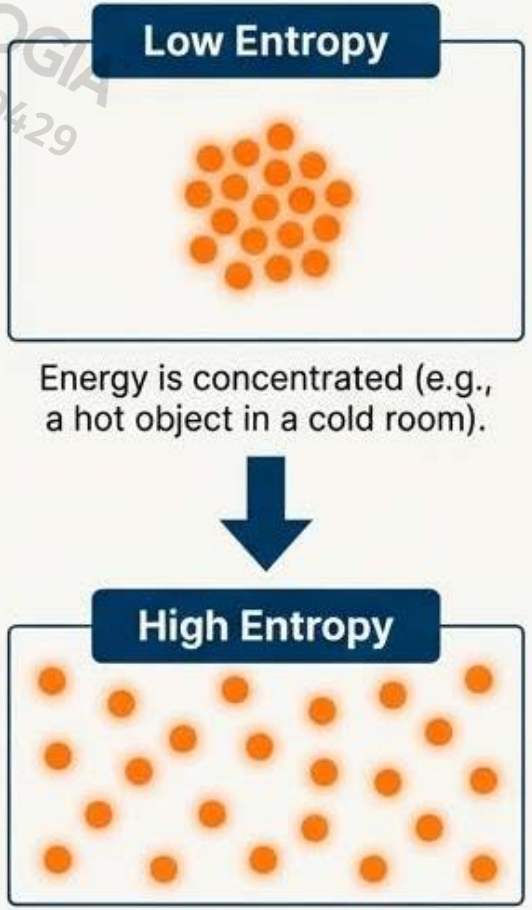
Conclusion: This law explains why hot things cool down and cold things warm up. It defines the "arrow of time" for thermal processes.

NOLOGIA™

للتواصل على الرقم: 0566410429

Entropy: The Measure of Dispersal

Entropy (S) is the measure of the **dispersal of thermal energy**. It's a way to quantify how spread out or "disordered" a system's energy is.



The Second Law, Restated

The total entropy of the universe (an isolated system) always increases or stays the same for any process. Natural processes always proceed in a direction that increases total entropy.

Formula Spotlight

$$\Delta S = \frac{Q}{T}$$

ΔS: Change in entropy (J/K)

Q: Thermal energy transferred

T: Temperature in Kelvin at which the transfer occurs

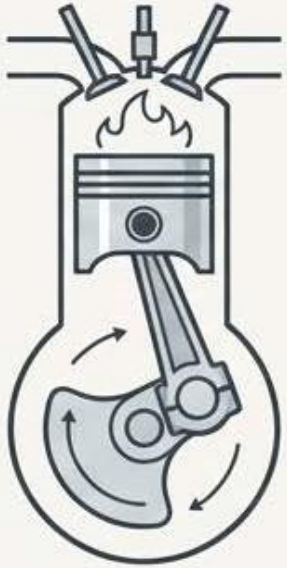
NOLOGIA 0566410429

Entropy and the "Energy Crisis"

The Paradox: If energy is always conserved (First Law), how can we have an energy crisis?

The Answer: The crisis is not about the *amount* of energy, but its *quality* or *availability*.







Low Entropy Start

The chemical energy in petroleum is highly ordered and concentrated.

High Entropy End

This energy is transformed into the dispersed, disordered thermal energy of exhaust gases and a heated engine block.

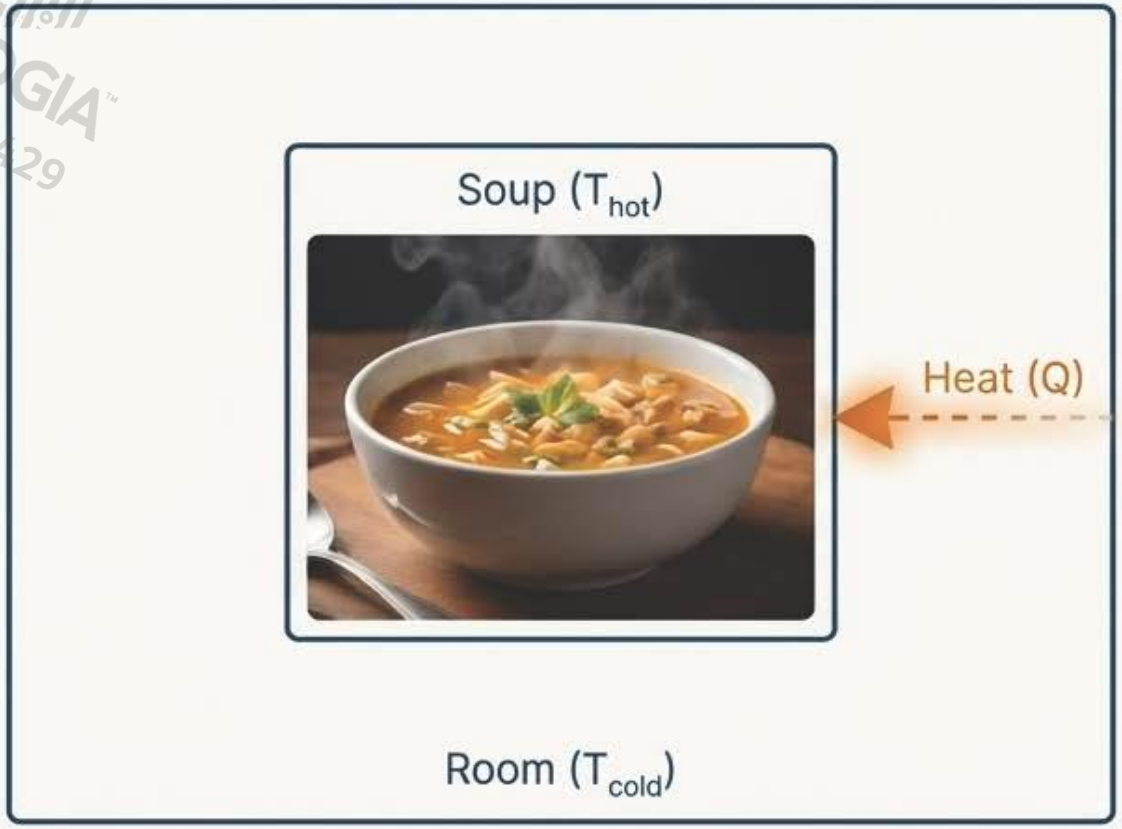
Conclusion: The total energy is the same, but it has spread out into a less useful form. The increase in entropy represents a loss of available energy to do work.

للتواصل على الرقم: 0566410429

The Mystery of the Soup: Solved

The Question Revisited

Why doesn't a bowl of hot soup spontaneously get hotter by absorbing heat from the cooler room?



The Answer, Step-by-Step

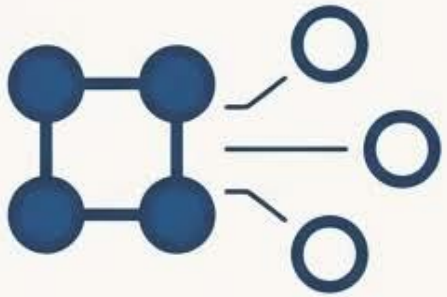
1. For the soup to get hotter, thermal energy (Q) would have to spontaneously flow from the cooler room (T_{cold}) to the hotter soup (T_{hot}).
2. The room's entropy would decrease by $\Delta S_{room} = -Q / T_{cold}$.
3. The soup's entropy would increase by $\Delta S_{soup} = +Q / T_{hot}$.
4. Because $T_{cold} < T_{hot}$, the magnitude of the room's entropy decrease would be larger than the soup's entropy increase.
5. Therefore, the total entropy of the universe ($\Delta S_{room} + \Delta S_{soup}$) would decrease.

The Verdict:

A decrease in total entropy violates the Second Law of Thermodynamics, a fundamental and unbreakable rule of the universe. The soup cools down because that is the only process that increases the universe's total entropy.

NOLOGIA 0566410429

Three Laws to Rule All Energy



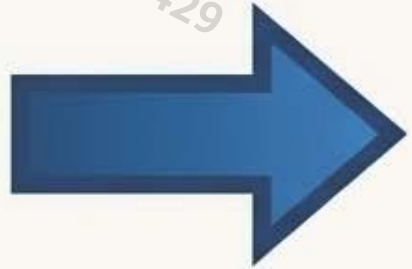
Phase Changes

Energy is required not just to change temperature, but to change state (**Q=mHf**, **Q=mHv**). This energy is "hidden" as it doesn't raise the temperature.



The First Law

Energy is accounted for. It cannot be created or destroyed (**ΔU = Q - W**). This is the law of conservation.



The Second Law

Energy has a natural direction of flow—from hot to cold, from order to disorder. This is the law of increasing entropy (**ΔS_universe > 0**). It is why the past is diiferent from the future.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Module (12): States of Matter

	Lesson Title	Page
12-1	Properties of Fluids	37
12-2	Forces within Liquids	53
12-4	Solids	68

MR.MOHAMAD

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429

لا تتردد في التواصل معنا
قم بمسح رمز الـQR

Module (12): States of Matter

01 First Lesson:
Properties of Fluids

MR.MOHAMAD

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429

The Physics of Fluids: Pressure, Properties, and the Gas Laws

A Comprehensive Study Guide for Advanced Physics

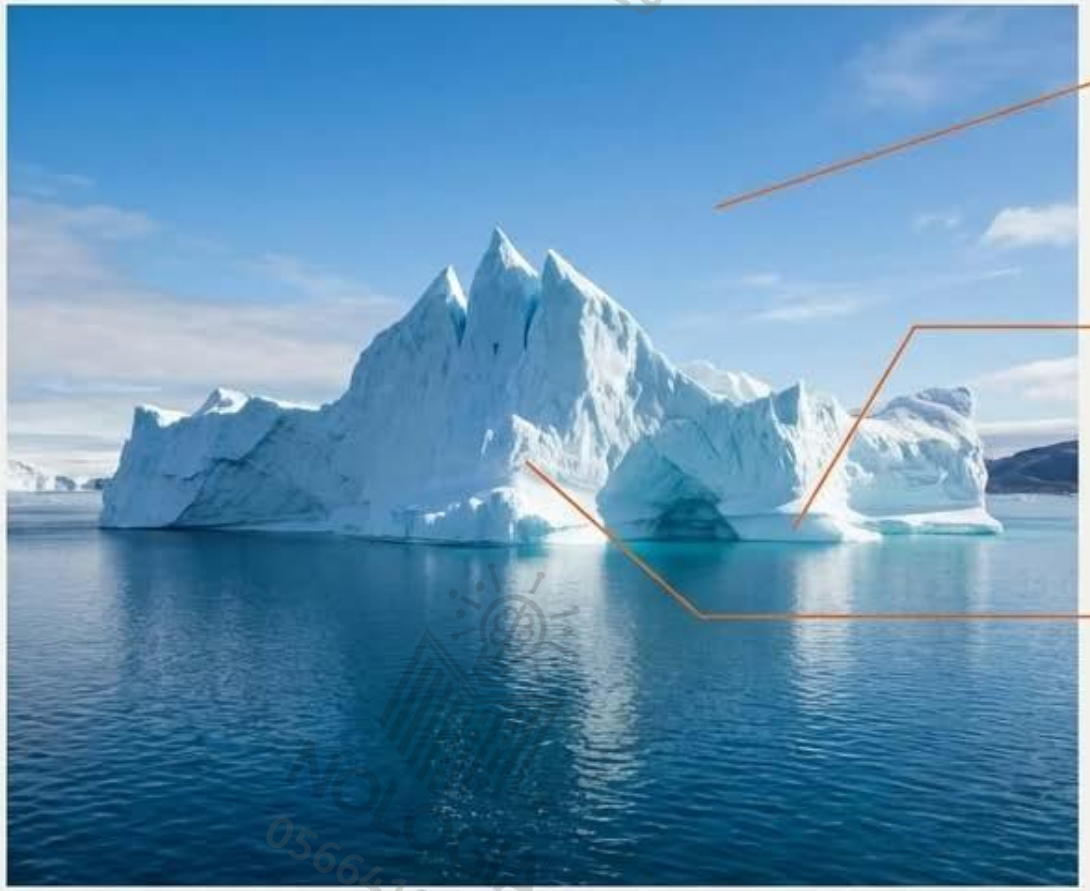
Prepared for mr.mohamad

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

What Defines a Fluid?

Fluids are materials that can flow and have no definite shape of their own.



Gases

Have no definite shape or volume, expanding to fill any container they occupy.
(Example: Air in a room).

Liquids

Take the shape of their container but have a definite volume and form a flat upper surface.
(Example: Water in a glass).

Solids

In contrast, have a definite shape and volume.
(Example: Ice).

Both liquids and gases are classified as fluids.

NOLOGIA 0566410429

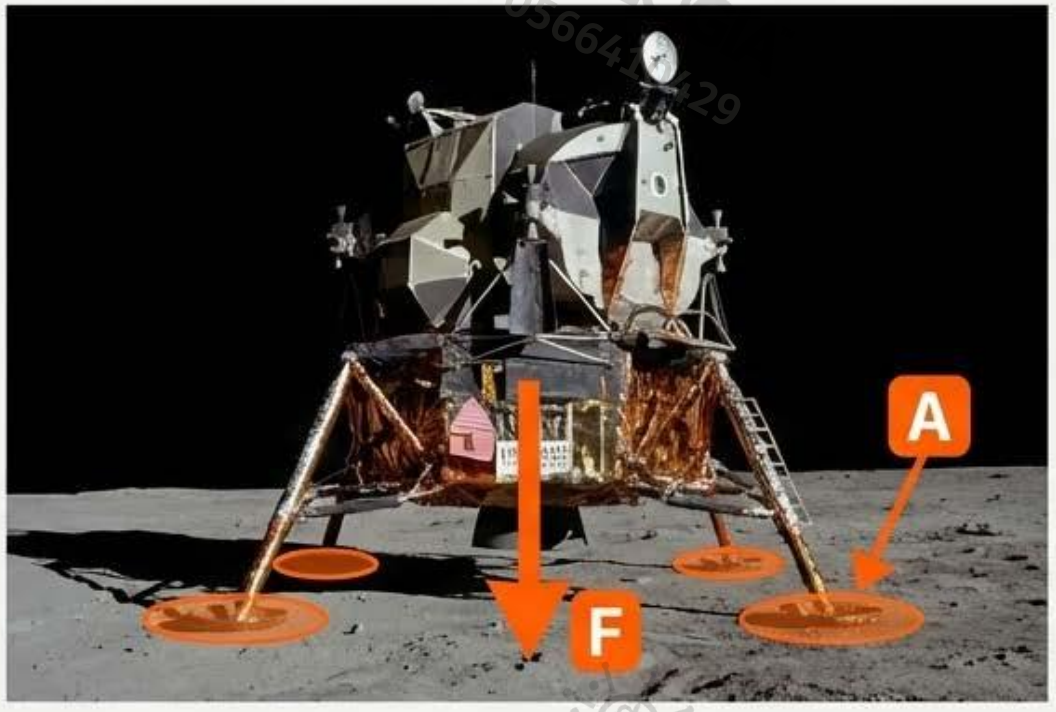
Pressure: The Perpendicular Force on a Surface

Pressure is defined as the **perpendicular** component of the force exerted on a surface, divided by the area of that surface.

$$P = \frac{F}{A}$$

- **P:** Pressure, measured in Pascals (Pa). 1 Pa = 1 N/m^2.
- **F:** Perpendicular Force, measured in Newtons (N).
- **A:** Surface Area, measured in square meters (m^2).

Pressure is a scalar quantity.



Practical Example: The Lunar Module

Both the astronaut and the landing module exert pressure on the Moon's surface. The wide pads of the module distribute its large weight (force) over a large area to prevent it from sinking into the lunar soil.

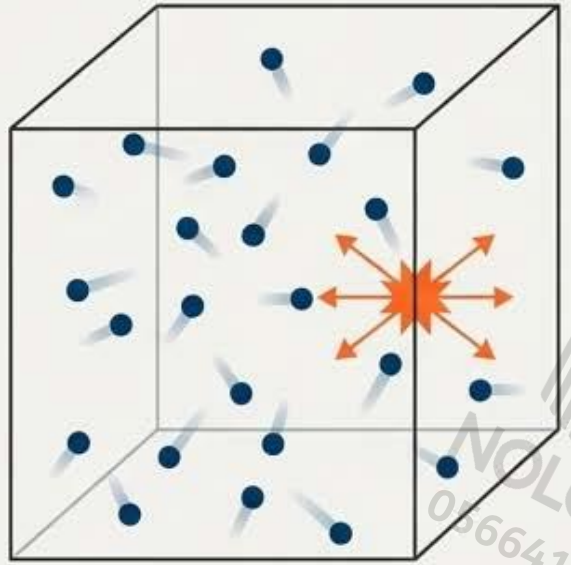
NOLOGIA™
للتواصل على الرقم: 0566410429

The Scale of Pressure in Our Universe

- **The center of Earth** | 4×10^{8} kPa
- **The deepest ocean trench** | 1.1×10^{5} kPa
- **Standard atmosphere** | 1.01325×10^{2} kPa
- **Air pressure on top of Mt. Everest** | 3×10^{1} kPa
- **Blood pressure** | 1.6×10^{1} kPa
- **The best vacuum** | 1×10^{-10} kPa

Focus on Atmospheric Pressure

At sea level, gases of the atmosphere exert a force in all directions of approximately 10 N on every square centimeter of surface area. This is about 101 kPa.



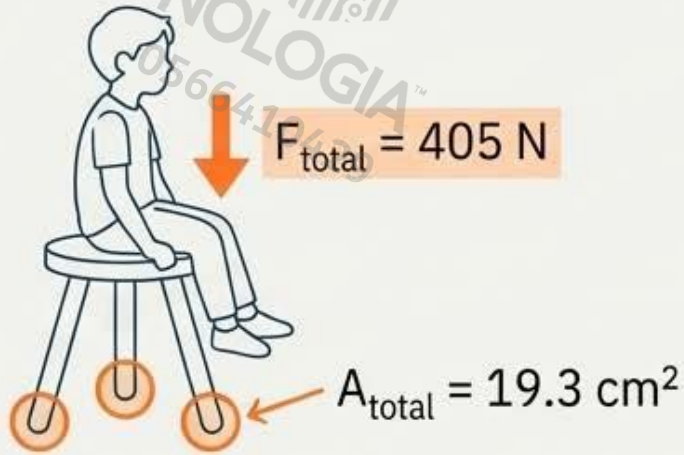
Microscopic Origin: Explained by the kinetic-molecular theory. Billions of gas particles are in random, high-speed motion, colliding elastically with surfaces. The impulse exerted by these countless collisions results in gas pressure.

NOLOGIA™

للتواصل على الرقم: 0566410429

Masterclass: Calculating Pressure

The Challenge: A child weighing 364 N sits on a three-legged stool weighing 41 N. The total bottom surface area of the stool's legs is 19.3 cm^2. What is the average pressure the child and stool exert on the ground?



Step 1: Analyze and Sketch the Problem

- **Knowns:**
- F_{child} = 364 N
- F_{stool} = 41 N
- A_{total} = 19.3 cm^2

Find Total Force:

$F_{total} = F_{child} + F_{stool} = 364\ N + 41\ N = 405\ N$

Step 2: Solve for the Unknown

Formula: $P = F / A$

Crucial Step - Unit Conversion:

Convert area from cm^2 to m^2.

$19.3\ cm^2 \times (1\ m / 100\ cm)^2 = 0.00193\ m^2$

Calculation: $P = 405\ N / 0.00193\ m^2$

$P \approx 2.10 \times 10^5$ Pa (or 210 kPa)

NOLOGIA™

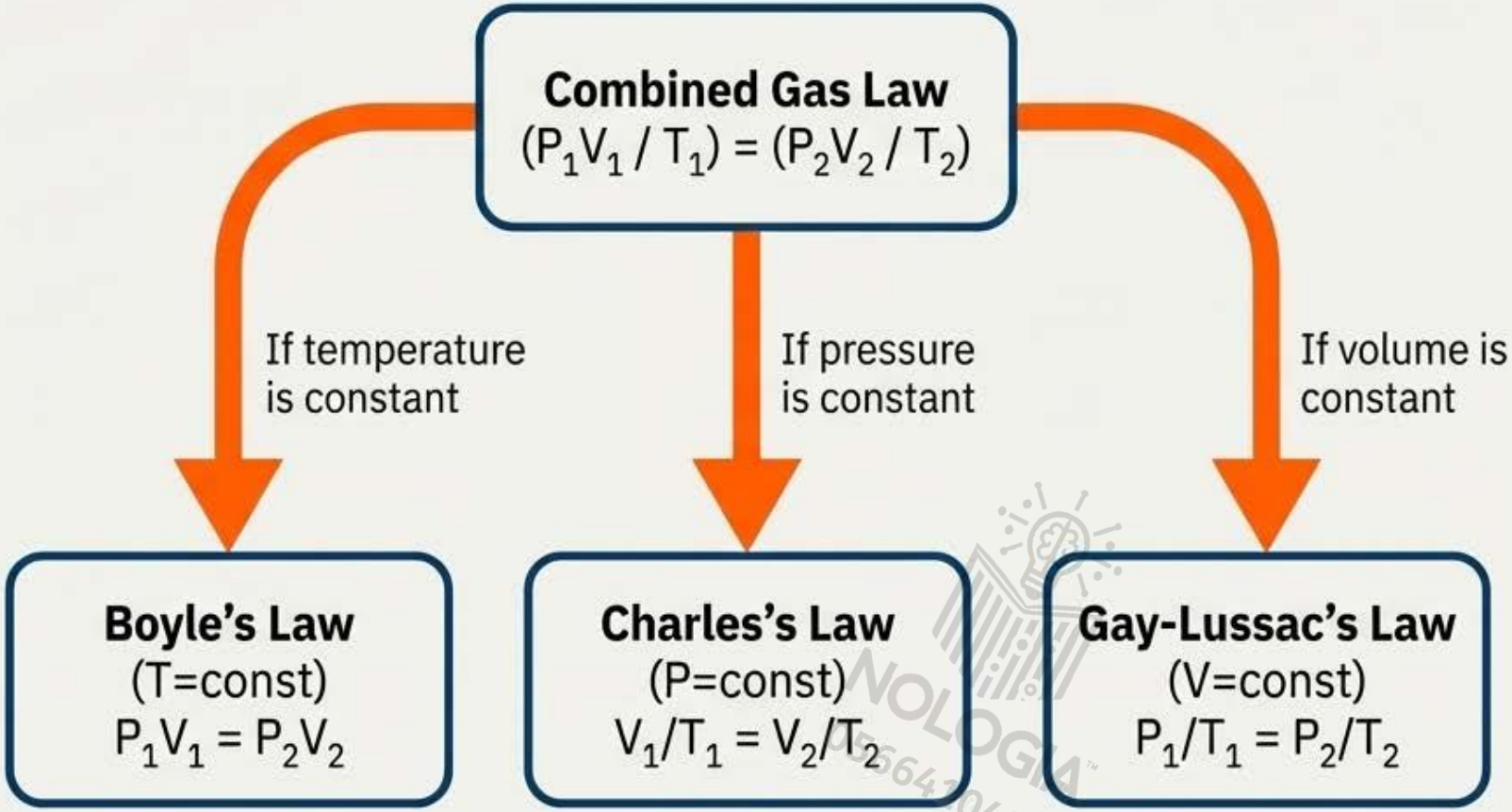
للتواصل على الرقم: 0566410429

The Gas Laws: Predicting the Behavior of Gases

The properties of a gas—pressure (P), volume (V), and temperature (T)—are not independent. The Gas Laws are a set of equations that describe the relationships between them for a fixed amount of gas.

The Key Relationships We Will Explore:

- **Boyle's Law**: The relationship between Pressure and Volume (at constant Temperature).
- **Charles's Law**: The relationship between Volume and Temperature (at constant Pressure).
- **The Combined Gas Law**: The master equation linking all three variables.
- **The Ideal Gas Law**: An equation of state for a hypothetical 'ideal gas."



Boyle's Law: As Pressure Increases, Volume Decreases

The Law

For a fixed amount of gas at a constant temperature, the product of the pressure and volume is a constant.

$$P_1V_1 = P_2V_2$$

Relationship

Pressure and Volume are *inversely* proportional.



Practical Application: Scuba Diving



The air in a diver's tank is under high pressure, allowing a large amount of air (volume) to be compressed into a small tank. As the diver ascends and the external water pressure decreases, the regulator releases air, which expands in volume before the diver inhales it.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Charles's Law: As Temperature Increases, Volume Increases

The Theory

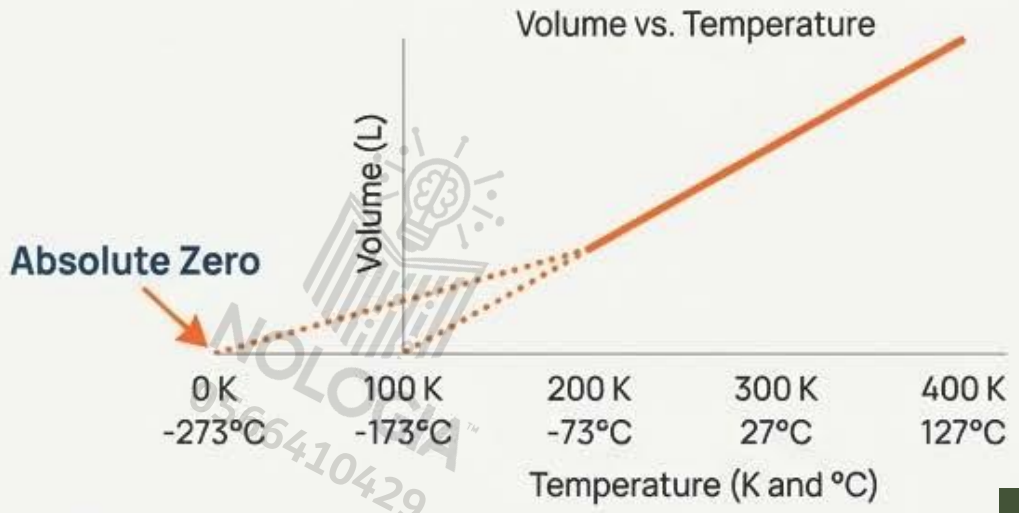
The Law

For a fixed amount of gas at a constant pressure, the volume is directly proportional to its Kelvin temperature.

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

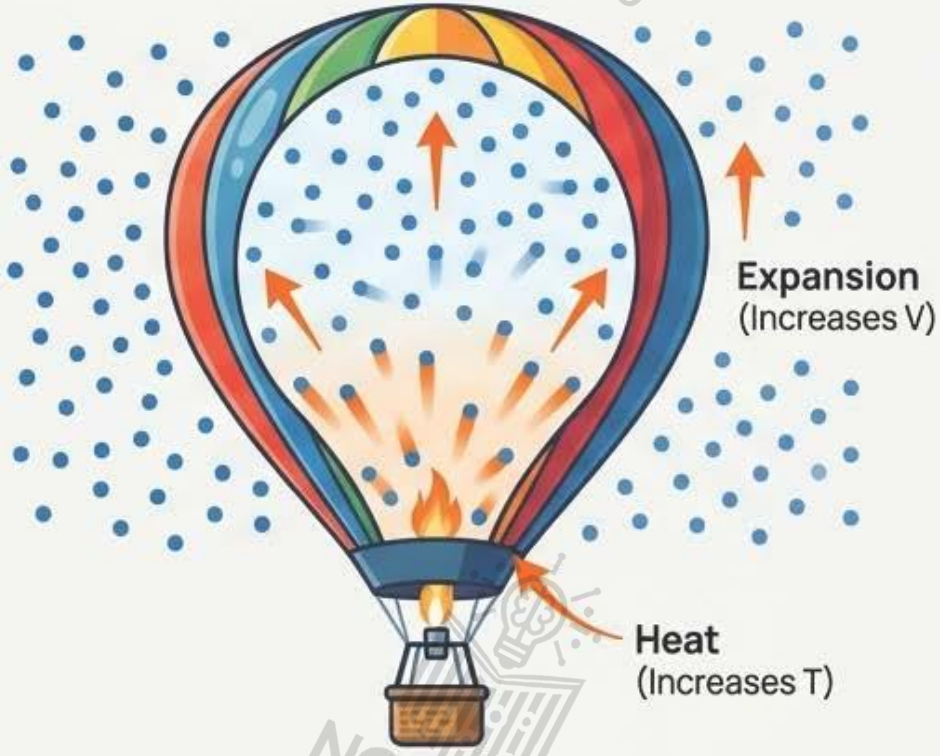
Critical Concept: Absolute Temperature

This relationship only works when temperature is measured in Kelvin (K).



The Application

Practical Application: Hot Air Balloons



Heating the air inside a balloon (increasing T) causes it to expand (increasing V). This makes the air inside less dense than the cooler air outside, generating lift and causing the balloon to rise.

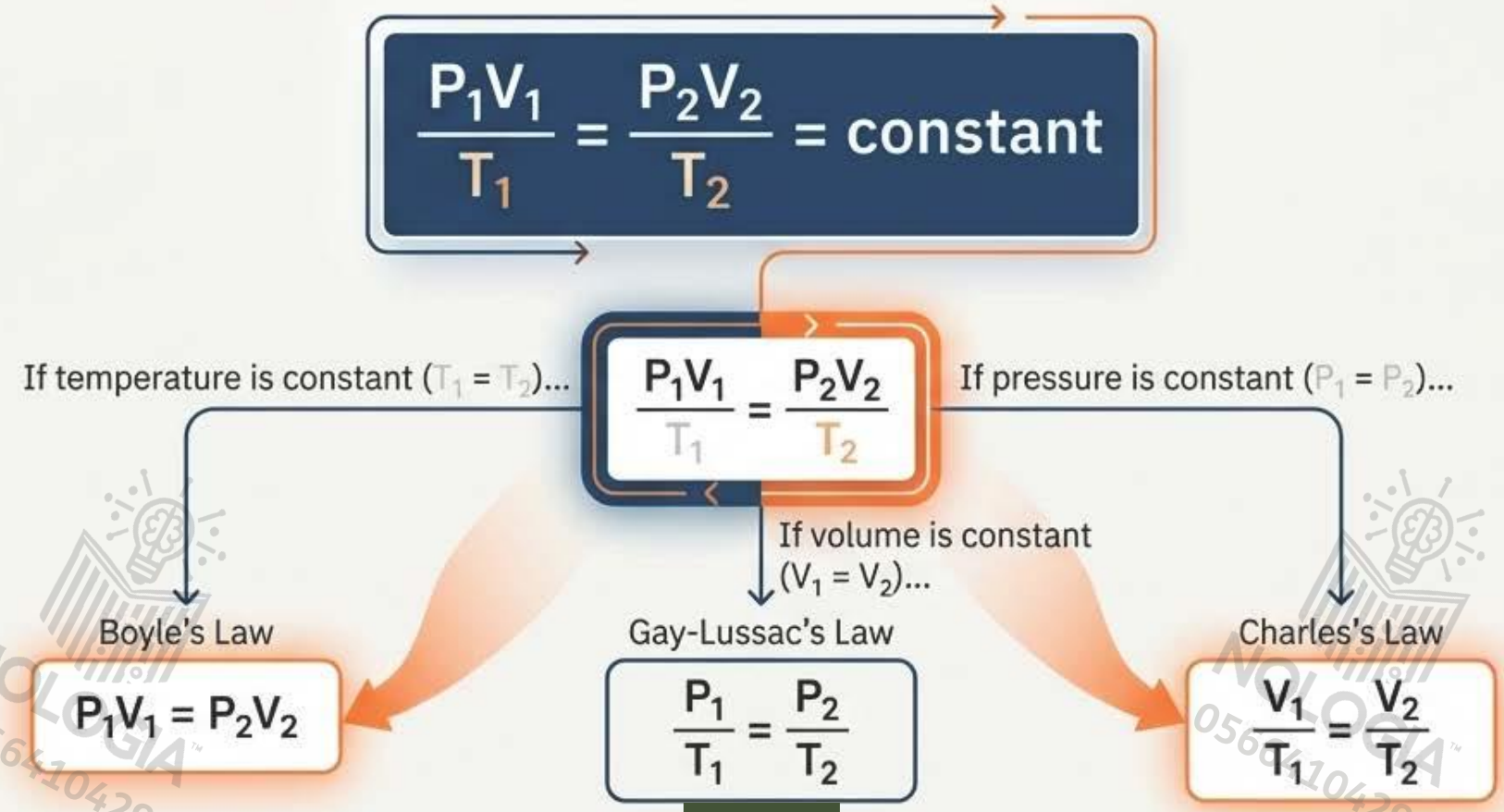
NOLOGIA™
0566410429

للتواصل على الرقم: 0566410429

The Combined Gas Law: Unifying P, V, and T

This single law combines Boyle's Law and Charles's Law, relating pressure, volume, and temperature for a fixed amount of an ideal gas.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} = \text{constant}$$



NOLOGIA 0566410429

The Ideal Gas Law: The Equation of State

The Ideal Gas Law relates the pressure, volume, and temperature of a gas to the number of particles (moles) it contains. It describes the state of the gas at a single point in time.

$$PV = nRT$$



P

Pressure (in Pascals, Pa)



V

Volume (in cubic meters, m^3)



n

Number of moles of gas. (1 mole = 6.022×10^{23} particles, Avogadro's number).



R

The Ideal Gas Constant (8.31 J/(mol·K)).



T

Absolute Temperature (in Kelvin, K).

What is an 'Ideal Gas'?

A theoretical model where gas particles have no volume and no intermolecular attractive forces. Real gases behave like ideal gases under conditions of low pressure and high temperature.

Masterclass: Applying the Gas Laws

The Challenge: A 20.0-L sample of argon gas is at 273 K and atmospheric pressure (101.3 kPa). The temperature is lowered to 120 K, and the pressure is increased to 145 kPa.

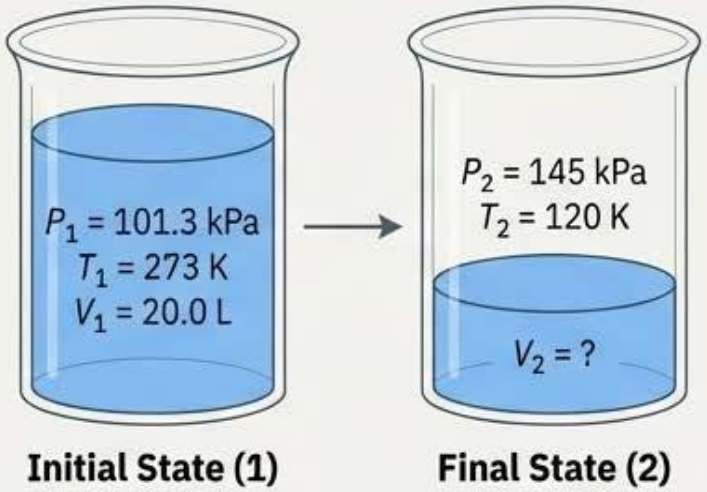
a. What is the new volume of the argon sample?
b. Find the number of moles of argon in the sample.

Part A Solution (Using the Combined Gas Law)

$$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1}$$

$$V_2 = \frac{101.3\ \text{kPa} \times 20.0\ \text{L} \times 120\ \text{K}}{145\ \text{kPa} \times 273\ \text{K}}$$

$V_2 = 6.1\ \text{L}$



Part B Solution (Using the Ideal Gas Law)

$$n = \frac{PV}{RT}$$

$$n = \frac{101.3 \times 10^3\ \text{Pa} \times 0.0200\ \text{m}^3}{8.31\ \text{J/(mol·K)} \times 273\ \text{K}}$$

$n = 0.893\ \text{mol}$

للتواصل على الرقم: 0566410429

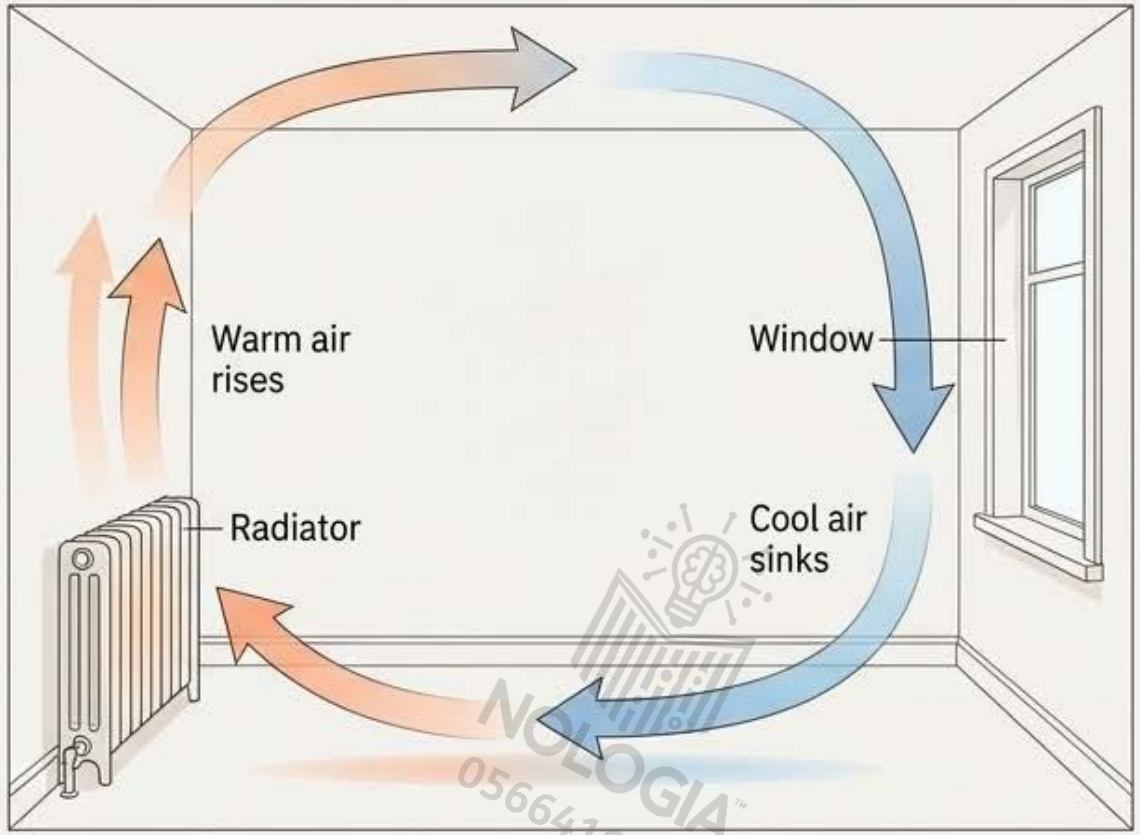
Thermal Expansion and Convection Currents

Core Concept: Thermal expansion is the tendency of matter to change in volume in response to a change in temperature. In fluids, this leads to convection.

The Process of Convection:

1. A fluid (like air or water) near a heat source gets **warmer**.
2. As it warms, it **expands** and becomes **less dense**.
3. The warmer, less dense fluid **rises**.
4. Cooler, denser fluid from above sinks to take its place, gets heated, and rises.
5. This creates a continuous circulation called a **convection current**.

Real-World Example: Heating a room. Air near a radiator is heated, becomes less dense, and rises. Cooler, denser air near the ceiling sinks, creating a circulation that distributes heat throughout the room.



NOLOGIA™
0566410429
للتواصل على الرقم: 0566410429

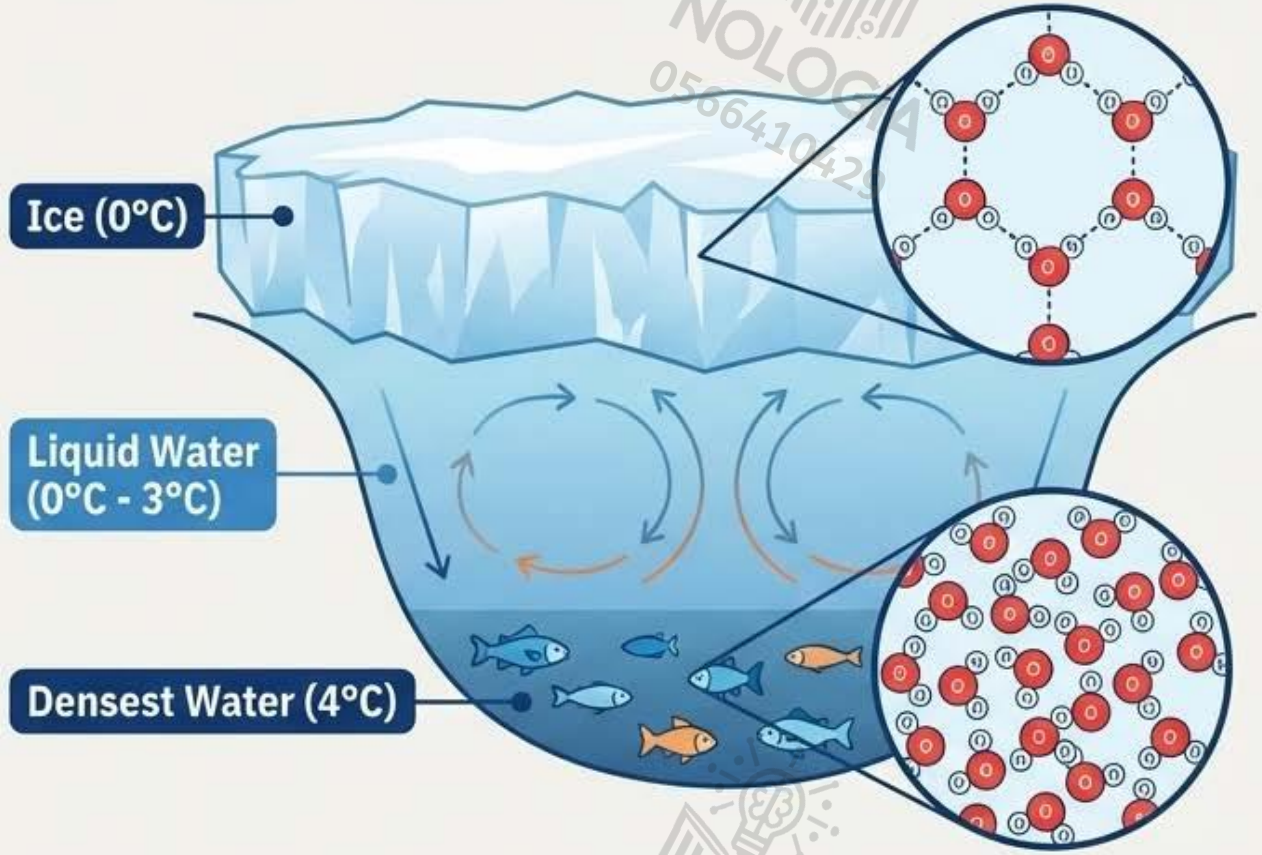
The Unique Anomaly of Water: Why Ice Floats

The Rule: Most liquids become denser as they get colder.

The Exception: Water behaves differently. As it cools, it contracts and becomes denser until it reaches **4°C**.

Below 4°C: As water cools from 4°C to 0°C, the hydrogen bonds between molecules begin to form a rigid, open crystalline structure. This structure takes up more volume.

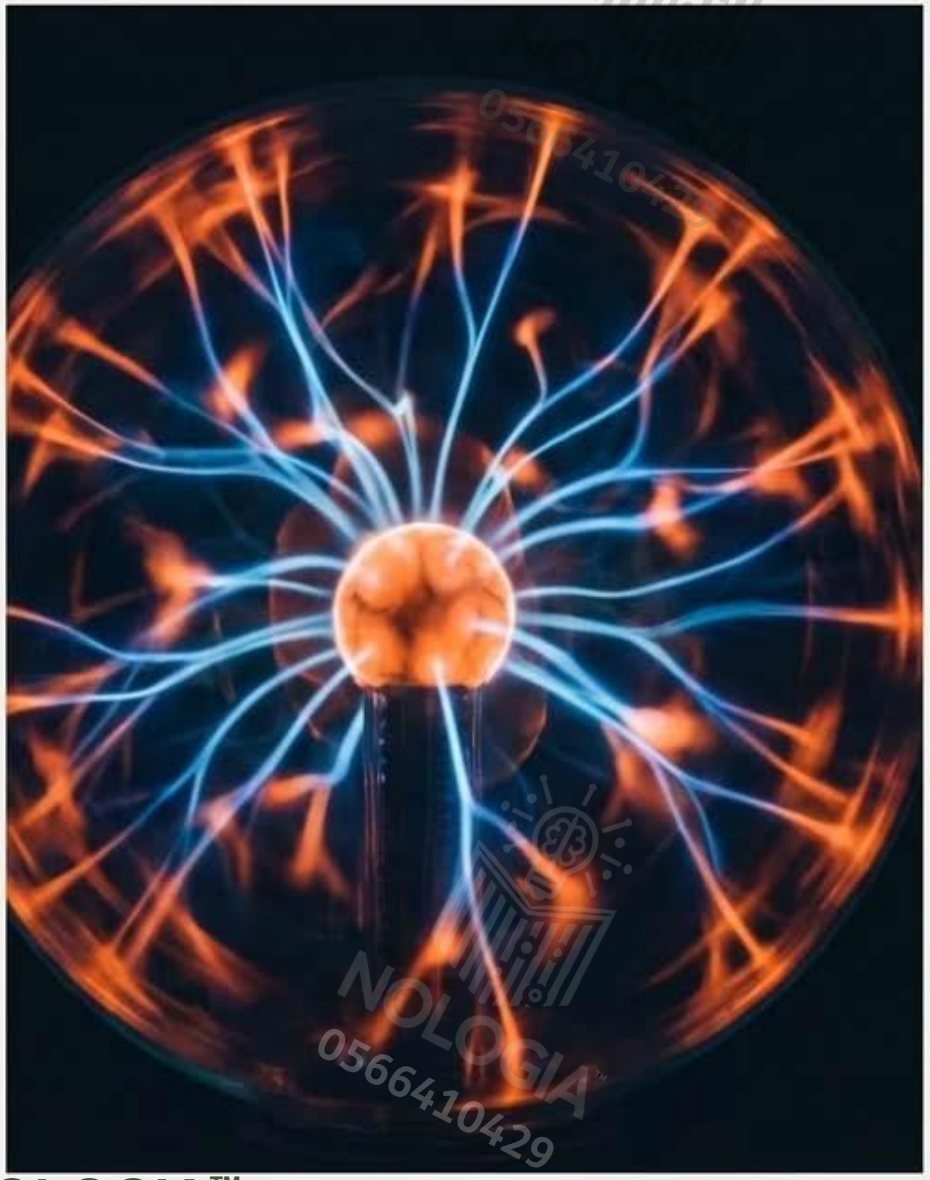
The Result: Ice (solid water at 0°C) is less dense than liquid water at 4°C.



Real-World Significance: This unique property is vital to our environment. In winter, lakes freeze from the top down. The layer of ice insulates the water below, allowing aquatic life to survive in the liquid water underneath.

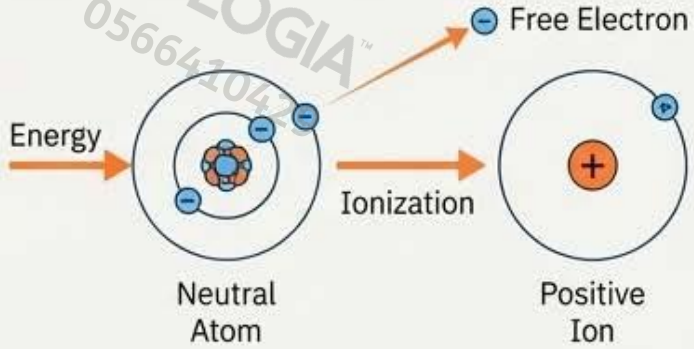
NOLOGIA 0566410429

Plasma: The Electrified Fourth State of Matter



What is Plasma?

If you continue to heat a gas, the collisions between particles become so violent they knock electrons off the atoms. The result is an ionized gas of free-moving, positively charged ions and negatively charged electrons.



Key Properties:

- Considered a distinct state of matter.
- Can conduct electric current (unlike gases).
- Is the most common state of matter in the universe.

Examples of Plasma:

- **Cosmic**: Stars consist mostly of plasma.
- **Natural**: Lightning bolts are columns of plasma.
- **Technological**: The glowing gas in neon signs and fluorescent lights.

NOLOGIA™
0566410429

للتواصل على الرقم: 0566410429

Comprehensive Reference: Key Concepts & Equations

Section 1: Core Definitions

- **Fluid:** A substance that can flow and takes the shape of its container (liquids and gases).
- **Pressure:** The perpendicular force exerted per unit area (P = F/A). Unit: Pascal (Pa).
- **Plasma:** An ionized gas consisting of positive ions and free electrons.
- **Convection:** Heat transfer in a fluid through the circulation of warmer, less dense fluid rising and cooler, denser fluid sinking.

Section 2: The Gas Law Equations

Boyle's Law:

$P_1V_1 = P_2V_2$ (T is constant)

Charles's Law:

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (P is constant, T in Kelvin)

Combined Gas Law:

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ (T in Kelvin)

Ideal Gas Law:

$PV = nRT$ (P in Pa, V in m^3, T in Kelvin, R = 8.31)

NOLOGIA 0566410429

NOLOGIA™ 0566410429

Module (12): States of Matter

02 Second Lesson: Forces within Liquids

MR.MOHAMAD

لا تتردد في التواصل معنا
قم بمسح رمز الـQR

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429



NOLOGIA™
0566410429
للتواصل على الرقم: 0566410429

Have You Ever Wondered...



...why some insects can walk on water?



...why raindrops form perfect spheres?



...how a paper towel can pull water upwards, against gravity?

The answers lie in a constant battle between two powerful, invisible forces. Let's meet them.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Meet the Two Forces: Cohesion & Adhesion

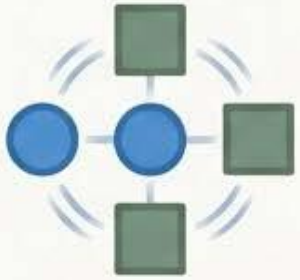
COHESION



The force of attraction between **like** particles. It's how molecules of the same substance stick together.

Think of it as 'team spirit' for molecules.

ADHESION



The force of attraction between particles of **different** substances. It's how a substance sticks to another surface.

Think of it as 'friendship' between different types of molecules.

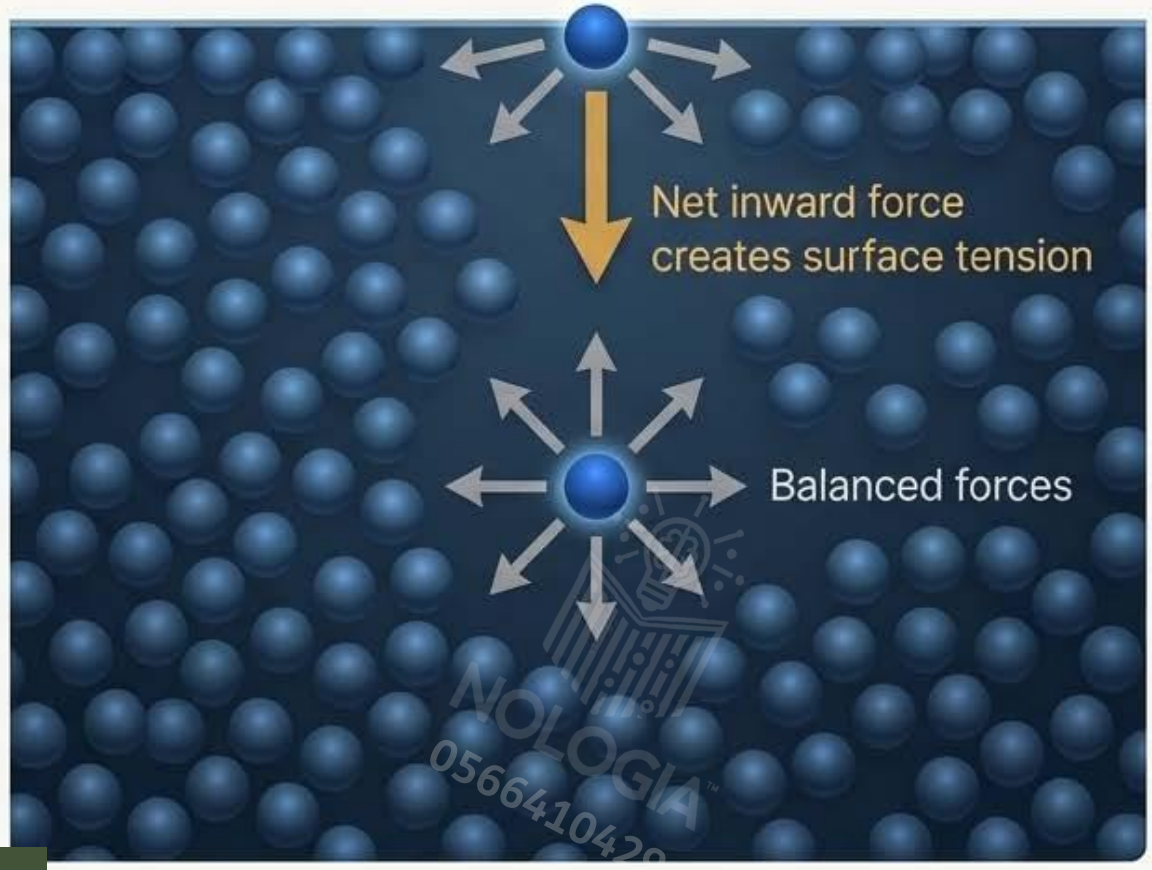
NOLOGIA 0566410429

The Power of Cohesion: Creating a "Liquid Skin"

Core Concept: Cohesive forces are the forces of attraction that like particles exert on one another. Inside a liquid, each particle is pulled equally in all directions by its neighbors.

The Surface Difference: But at the surface, particles are only pulled by the particles below and to the sides. This creates a net inward force.

Key Result: This net inward force pulls the surface molecules tightly together, causing the surface layer to behave like a "tightly stretched sheet." We call this Surface Tension.



NOLOGIA 0566410429

Cohesion in Action: Examples of Surface Tension



The Water Strider

The cohesive forces in the water are strong enough to create a surface layer that can support the weight of very light objects, like the water strider. The insect's legs dimple the surface but do not break it.



The Floating Needle

Even though steel is much denser than water, a needle can float if placed carefully. Surface tension distributes its weight over a large enough area to prevent it from sinking.



The Spherical Droplet

Cohesion pulls water molecules inward, minimizing the surface area for a given volume. The shape with the least surface area is a sphere. This is why water beads into droplets.

NOLOGIA 0566410429

Cohesion's Other Effect: Viscosity (A Fluid's Resistance to Flow)

Viscosity is the measure of a fluid's internal friction. It's caused by the cohesive forces between molecules and collisions between them. In simple terms, it's a liquid's "thickness."



Low Viscosity. Water has relatively weak cohesive forces, so it flows easily.



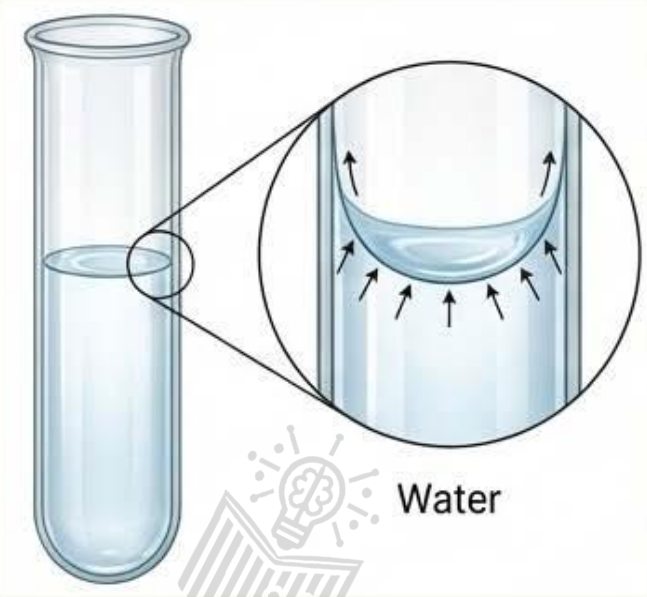
High Viscosity. Stronger cohesive forces cause honey to resist flow.

Practical Application: Motor oil is a high-viscosity fluid designed to flow slowly over engine parts, coating them to reduce friction and wear.

The Great Debate: When Cohesion and Adhesion Compete

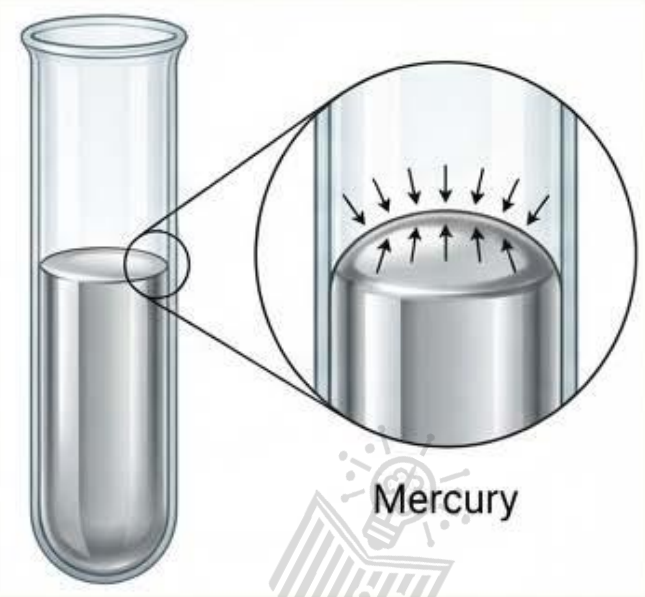
What happens when a liquid touches a different substance, like the glass walls of a container? The answer depends on which force is stronger.

Adhesion Wins



The adhesive forces between water molecules and the glass particles are stronger than the cohesive forces between the water molecules themselves. Water “climbs” the glass walls.

Cohesion Wins



The cohesive forces between mercury atoms are much stronger than the adhesive forces between the mercury and the glass. The liquid pulls itself inward, away from the glass.

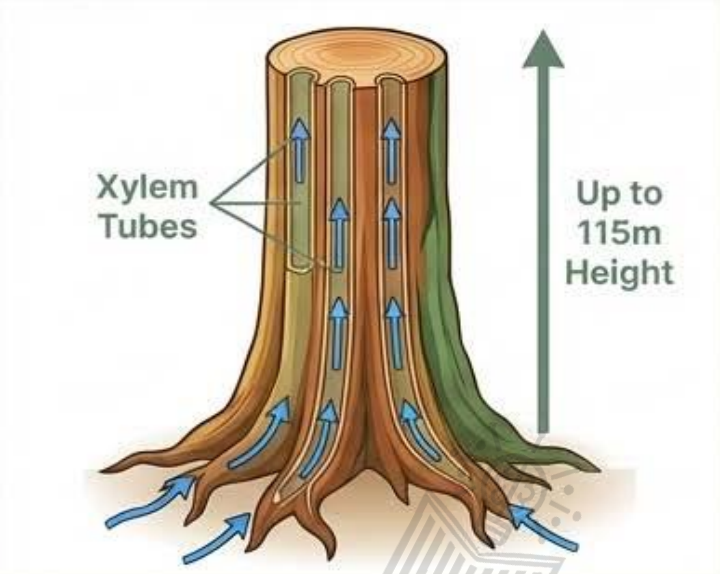
NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Adhesion in Action: The Gravity-Defying Climb of Capillarity

When adhesion is stronger than cohesion in a narrow tube, the liquid will be pulled upward against gravity. This is called **Capillary Action**. The narrower the tube, the higher the liquid rises.

Plants & Trees



This is how giant trees, like the 115m tall Sequoia, pull water from the ground all the way to their highest leaves.

Paper Towels



The narrow spaces between the fibers in a paper towel act as capillary tubes, pulling the liquid up.

Candle Wicks



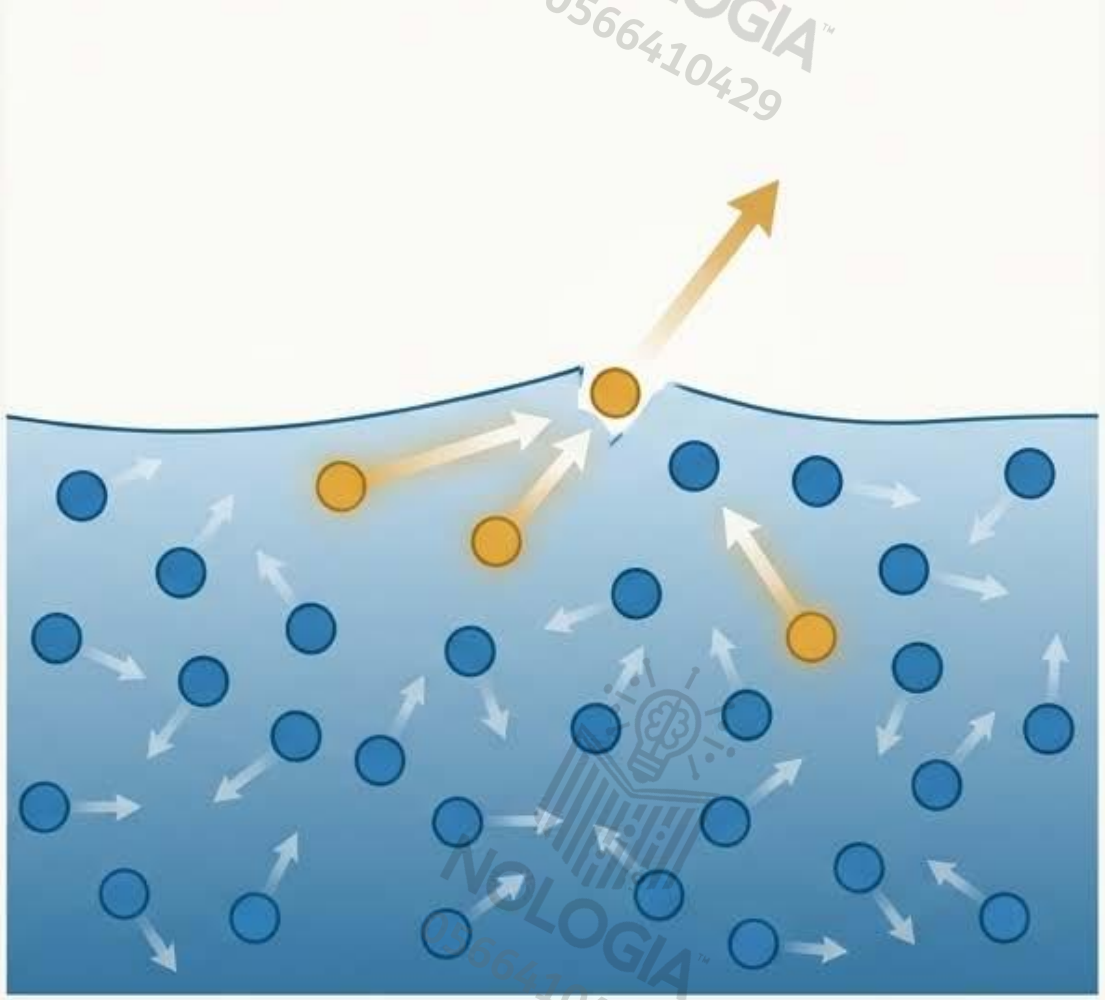
Capillary action draws molten wax up the wick to the flame, providing a continuous source of fuel.

Shifting States Part 1: The Great Escape (Evaporation)

Evaporation is the process where a liquid turns into a gas. It occurs only at the surface.

The Mechanism: A Race of Energy

Particles in a liquid are moving at random speeds. Only the fastest-moving particles—those with the highest kinetic energy—have enough power to break through the cohesive forces at the surface and escape into the air.



NOLOGIA™

للتواصل على الرقم: 0566410429

The Consequence of Evaporation: Nature's Air Conditioner

Core Concept: Evaporative Cooling

When the fastest, highest-energy particles escape during evaporation, the average kinetic energy of the remaining particles decreases. Since temperature is a measure of average kinetic energy, the remaining liquid gets cooler.

Sweating



Sweating

Your body perspires when it's hot. As the sweat evaporates from your skin, it carries heat away, cooling you down.

Rubbing Alcohol



Rubbing Alcohol

Alcohol evaporates very quickly because it has weak cohesive forces. This is why it feels intensely cold when applied to the skin.

The Humidity Factor



The Humidity Factor

On a humid day, the air is already full of water vapor, making it harder for sweat to evaporate. This is why you feel warmer and stickier.

NOLOGIA™ 0566410429

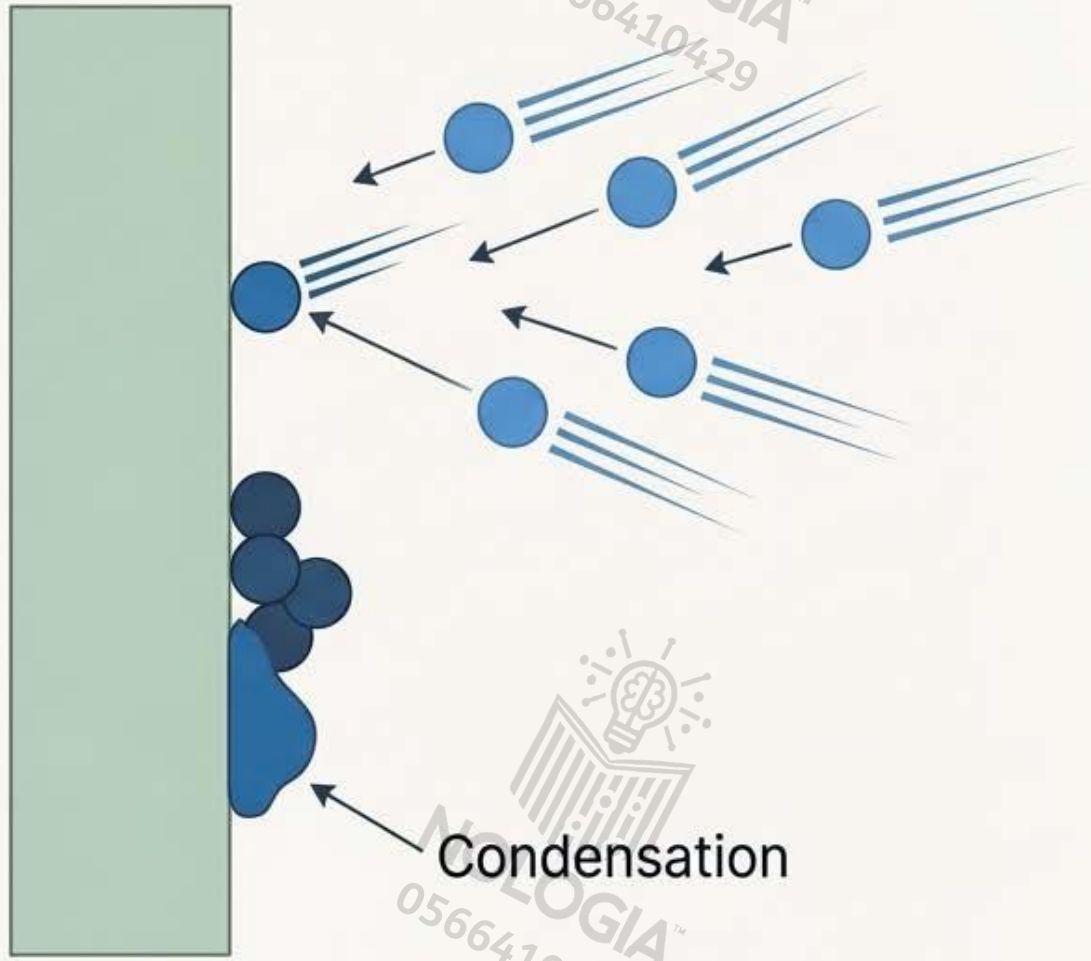
للتواصل على الرقم: 0566410429

Shifting States Part 2: The Return Journey (Condensation)

Condensation is the opposite of evaporation. It's the process where a gas turns back into a liquid.

The Mechanism: Losing Energy

This happens when gas particles in the air lose kinetic energy, usually by coming into contact with a cold surface. As they slow down, the cohesive forces become strong enough to pull the particles back together into a liquid.



NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Condensation in Action: From Invisible Gas to Visible Water



The Cold Glass

On a humid day, water vapor in the air cools when it touches the cold surface of the glass, turning back into liquid water. The glass isn't leaking!



Clouds and Fog

Clouds and fog are simply tiny liquid water droplets. They form when warm, moist air rises and cools, causing the water vapor to condense around tiny dust particles in the air.



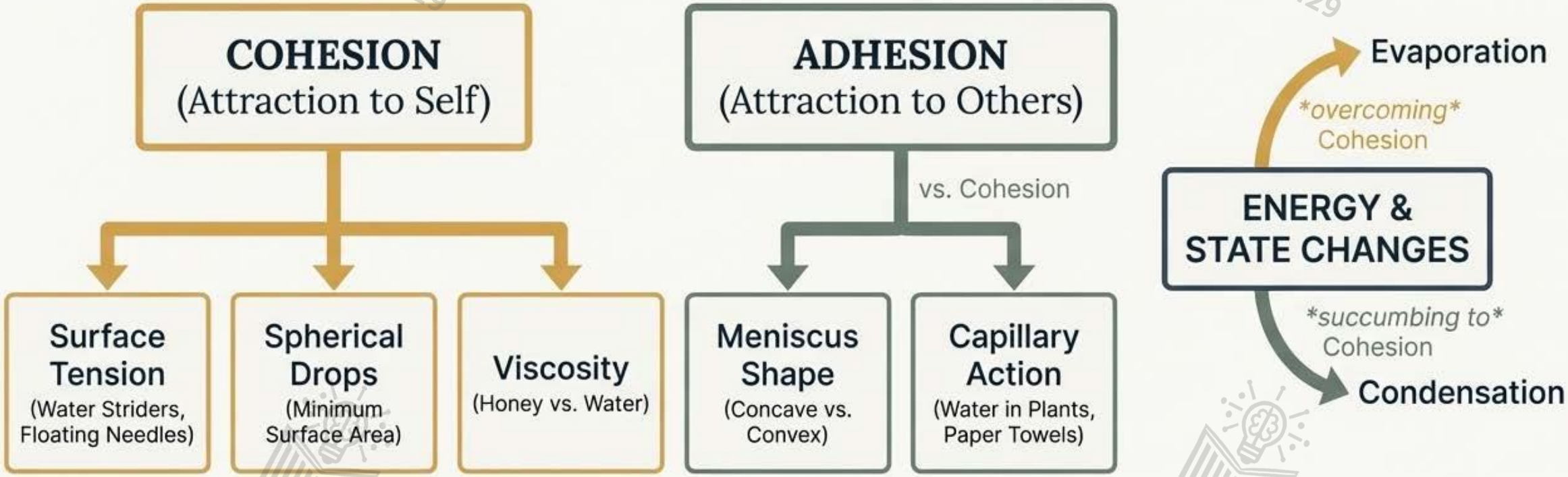
The Soda Can "Mist"

When you open a carbonated drink, the sudden drop in pressure causes the gas inside to expand and cool rapidly. This chills the surrounding water vapor, causing it to instantly condense into a tiny fog cloud.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

The Full Picture: How Two Forces Rule the World of Liquids



From the shape of a raindrop to the weather itself, nearly every behavior of a liquid can be understood by asking: "Is it cohesion, adhesion, or a battle between the two?"

NOLOGIA™

للتواصل على الرقم: 0566410429

Apply Your Knowledge: You are the Physicist



Question: You spill a glass of water. Explain, using the terms **cohesion** and **adhesion**, why a paper towel is so effective at cleaning it up.

Answer hint: Capillary action due to strong adhesion between water and paper fibers.



Question: After a hot shower, the mirror is covered in a layer of fog. What is this 'fog,' and what physics principle explains its formation?

Answer hint: It's liquid water formed by condensation of water vapor on the cooler mirror surface.



Question: If you place a drop of water and a drop of honey on a tilted plate, the water runs down much faster. Which liquid has stronger **cohesive forces** (called), and what is the resulting property called?

Answer hint: Honey has stronger cohesion, leading to higher viscosity.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

NOLOGIA™ 0566410429

Module (12): States of Matter

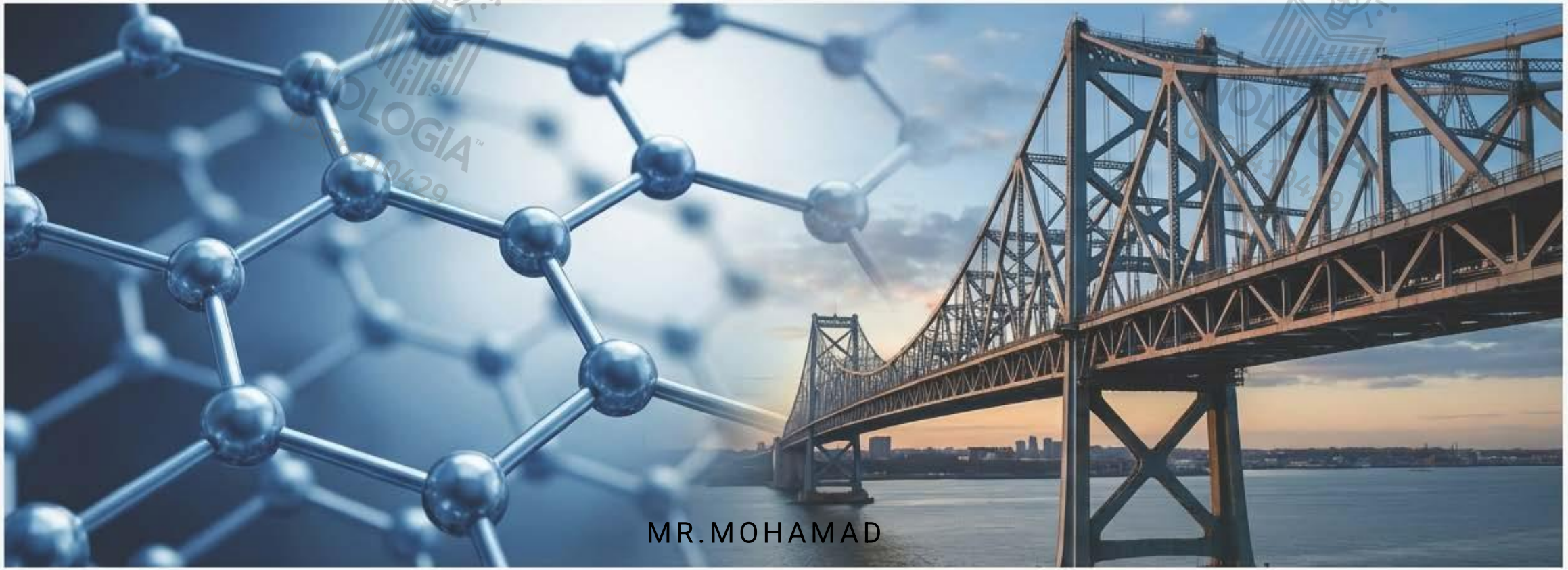
04 Fourth Lesson: Solids

MR.MOHAMAD

لا تتردد في التواصل معنا
قم بمسح رمز الـQR

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

للتواصل على الرقم: 0566410429



Mastering Solids & Thermal Expansion

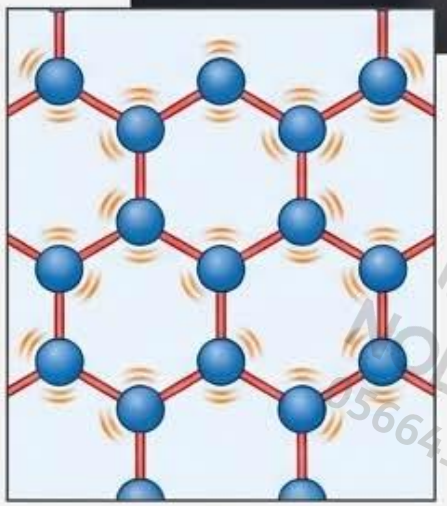
A Comprehensive Guide for Advanced Physics

NOLOGIA™ 0566410429

What Truly Defines a Solid?

SOLIDS



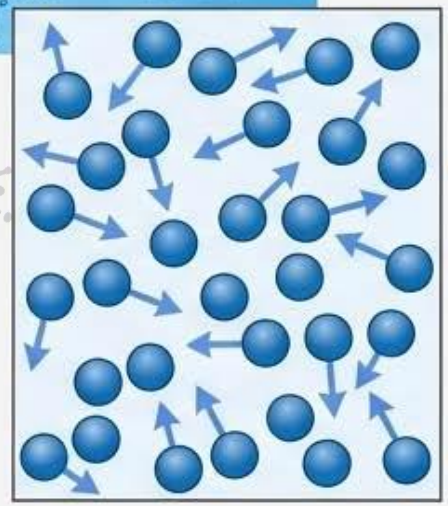


- Particles are locked into a fixed pattern, vibrating around fixed points.
- Strong cohesive forces maintain a definite shape and volume.
- They are stiff, can be cut, and retain their shape.

FLUIDS

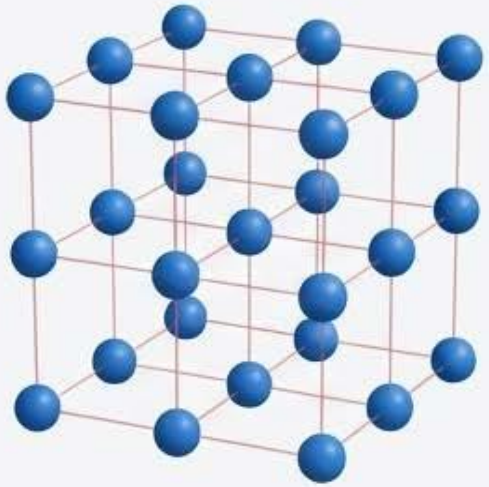


- Particles can move past one another.
- Cohesive forces are weaker, allowing them to flow.
- They take the shape of their container and do not retain their shape.



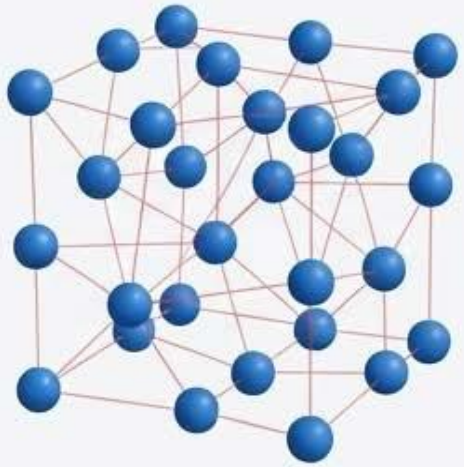
للتواصل على الرقم: 0566410429

A Tale of Two Structures: Crystalline vs. Amorphous



Crystalline Solids

Particles are arranged in an orderly, geometric, and repeating pattern.



Amorphous Solids

Particles have no regular crystal structure; the arrangement is disordered.



Salt (NaCl)



Diamond



Ice



Quartz



Glass



Butter



Wax



Plastic

للتواصل على الرقم: 0566410429

How Solids Respond to Force

Elasticity

The ability of a solid to return to its original form after external forces are removed.



The bow stores and releases energy, returning to its shape.

Malleability

The ability to be flattened or shaped into thin sheets without breaking.



Gold is highly malleable, allowing it to be hammered into extremely thin sheets.

Ductility

The ability to be pulled into thin strands of wire.



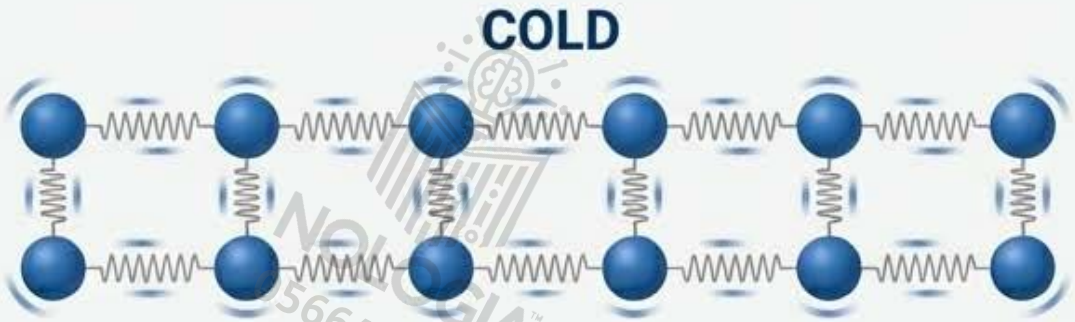
Copper's ductility makes it essential for electronics.

NOLOGIA 0566410429

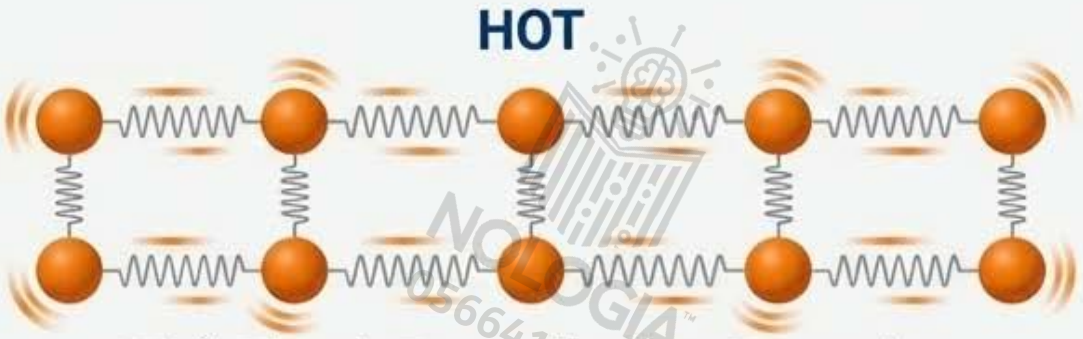
The Unseen Force of Temperature



What do a buckling railway track and a cracking sidewalk have in common? **Thermal Expansion.**



Low Kinetic Energy.



High Kinetic Energy leads to Expansion.

NOLOGIA™

للتواصل على الرقم: 0566410429

Engineering in Action: Taming Expansion



A 100-meter section of a steel bridge can expand by several centimeters in the summer heat. Without room to move, the immense force would cause the bridge to buckle and break.

Engineers include **expansion joints**—purpose-built gaps that allow materials to safely expand and contract with temperature changes.

More Examples

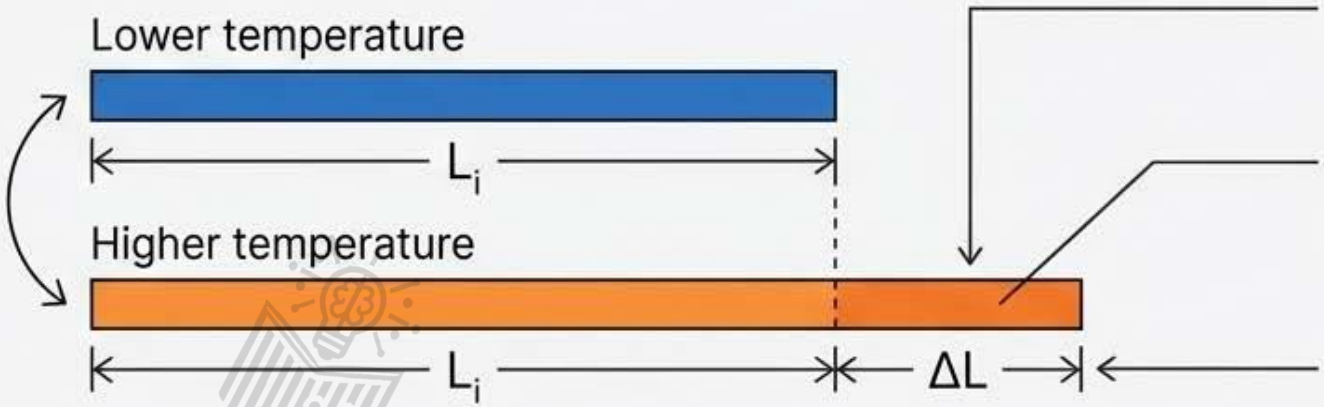






Predicting Change in One Dimension: Linear Expansion

$$\Delta L = \alpha L_i \Delta T$$



ΔL: **Change in Length.** The amount the material grows.

α: **Coefficient of Linear Expansion.** A property unique to each material that describes how much it expands.

L_i: **Initial Length.** How long the object was to begin with.

ΔT: **Change in Temperature.** The temperature difference that drives the expansion.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Worked Example: Calculating a Material's Property

A metal bar 1.60 m long at 21°C is heated to 84°C. It expands by 1.7 mm. What is the coefficient of linear expansion (α) for this material?

ANALYZE AND LIST GIVENS

$L_i = 1.60\ \text{m}$

$\Delta L = 1.7\ \text{mm} = 1.7 \times 10^{-3}\ \text{m}$

$T_i = 21°\text{C}$

$T_f = 84°\text{C}$

$\Delta T = T_f - T_i = 63°\text{C}$

Unknown = α

REARRANGE AND SOLVE

$$\Delta L = \alpha L_i \Delta T$$

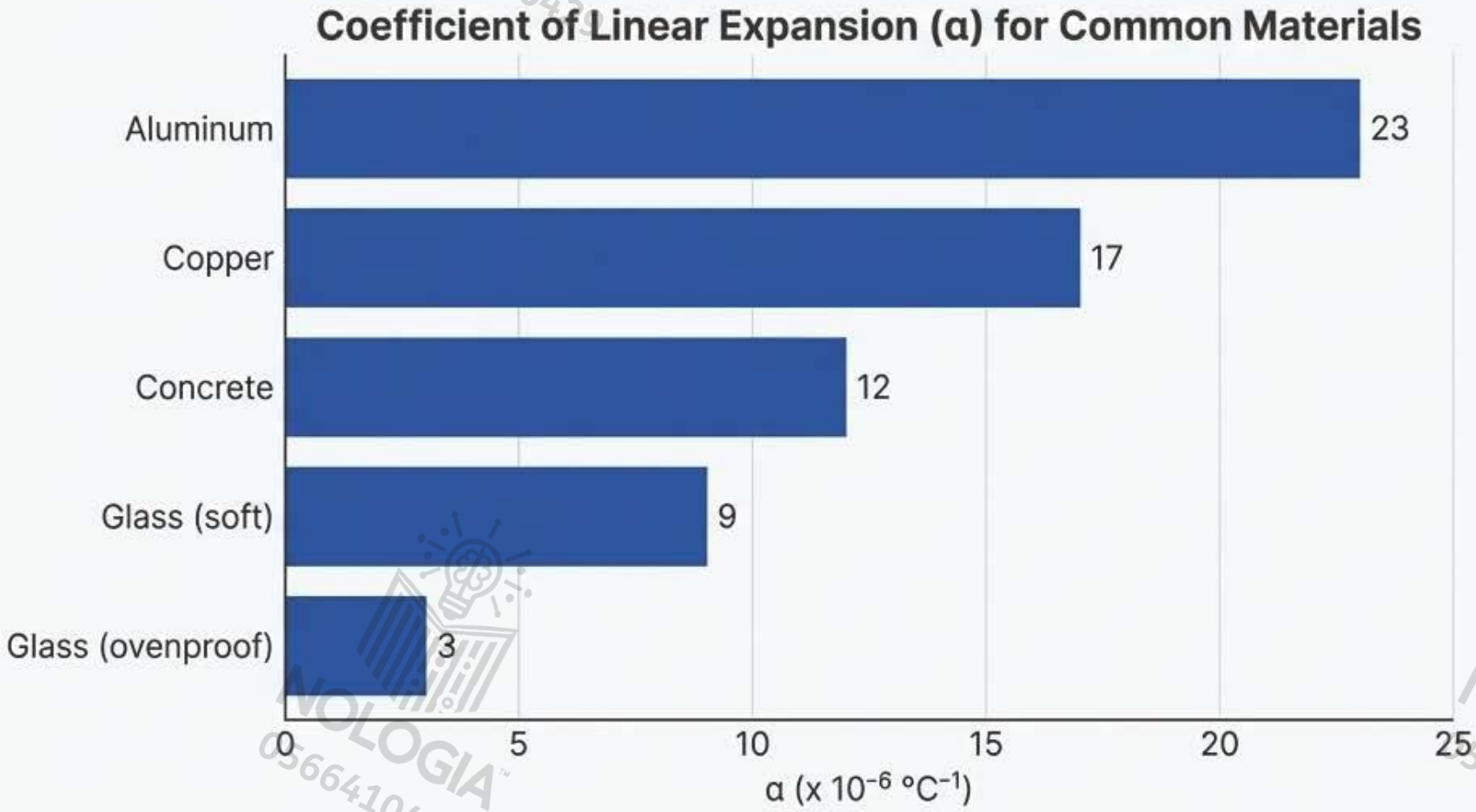
$$\alpha = \frac{\Delta L}{L_i \Delta T} \qquad \alpha = \frac{1.7 \times 10^{-3}\ \text{m}}{1.60\ \text{m} \cdot 63°\text{C}}$$

CALCULATE AND EVALUATE

Final Answer: $\alpha = 1.7 \times 10^{-5}\ °\text{C}^{-1}$

Evaluation Note: This value is consistent with the accepted coefficient for copper, as seen in reference tables.

The Material Matters: A Comparison of Expansion Coefficients

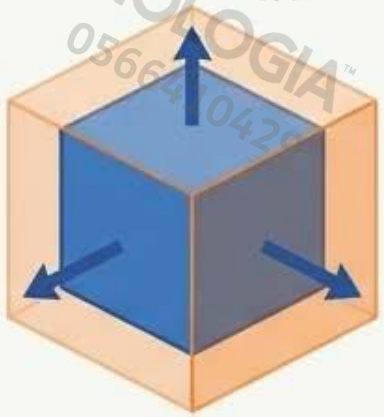


**Notice: Aluminum expands nearly twice as much as Concrete for the same temperature change. This is why engineers must account for these differences when combining materials in a structure.

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Beyond Length: Expanding in All Three Dimensions



$$\Delta V = \beta V_i \Delta T$$

ΔV: Change in Volume
β: Coefficient of Volume Expansion
V_i: Initial Volume
ΔT: Change in Temperature

For most solids, expansion is the same in all directions. Therefore, the coefficient of volume expansion (β) is approximately three times the linear coefficient ($\beta \approx 3\alpha$).

Practical Demonstration

At room temperature.



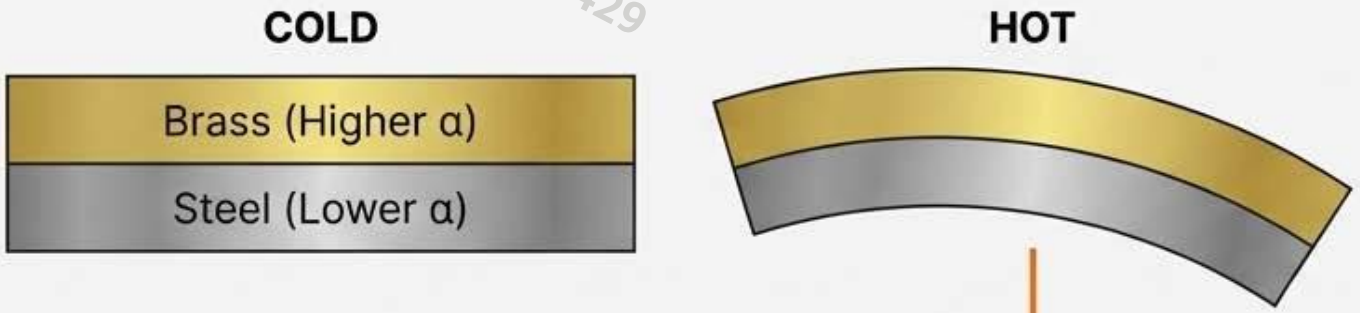
After heating.



NOLOGIA 0566410429

Clever Application: The Bimetallic Strip

How It Works



When heated, brass expands more than steel. Because they are bonded together, this difference in expansion forces the strip to curve.

Real-World Use

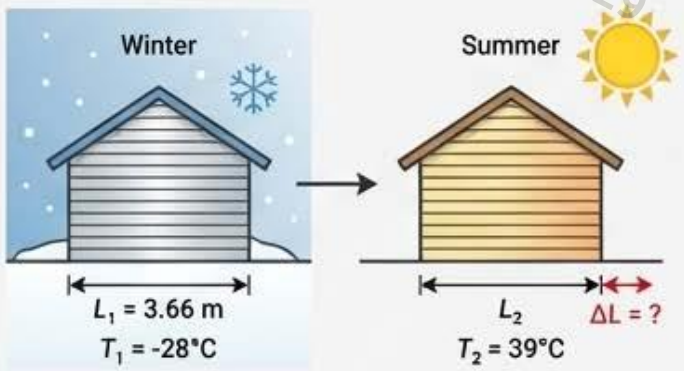


This simple principle acts as an automatic switch. In a thermostat, the bending strip makes or breaks an electrical contact to turn a heater on or off, maintaining a constant temperature.

NOLOGIA™
0566410429

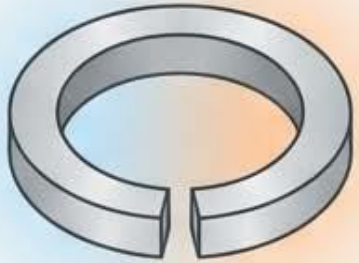
للتواصل على الرقم: 0566410429

Test Your Understanding: You Be the Engineer



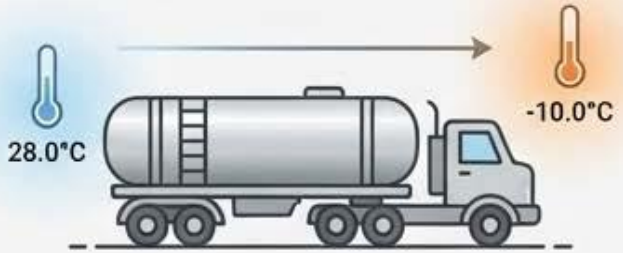
1. Linear Expansion

A piece of aluminum house siding is 3.66 m long on a day when the temperature is -28°C. How much longer is it on a hot summer day at 39°C? (α for aluminum is 23×10^{-6} °C^{-1}).



2. Conceptual Thinking

A solid metal ring has a small gap in it. If the ring is heated uniformly, will the gap become wider or narrower? Explain your answer.



3. Volume Expansion

A tanker truck takes on a load of 45,725 L of gasoline in Houston where the temperature is 28.0°C. The truck delivers its load in Minneapolis, where the temperature is -10.0°C. How many liters of gasoline does the truck deliver? (β for gasoline is 950×10^{-6} °C^{-1}).

NOLOGIA™
0566410429

للتواصل على الرقم: 0566410429

The Engineer's Approach: Step-by-Step Solutions

Solution 1: House Siding

$$\Delta L = \alpha L_i \Delta T$$

$\Delta L = (23 \times 10^{-6}\ °C^{-1})(3.66\ m)$
$(39°C - (-28°C))$

$\Delta L = (23 \times 10^{-6})(3.66)(67) =$
$0.0056\ m$

The siding is 5.6 mm longer.

Solution 2: The Ring

The gap will become **wider**. Heating the ring causes it to expand in all dimensions as if it were a solid disk. Every linear dimension, including the circumference and the gap, increases proportionally.

Solution 3: Gasoline Tanker

$$\Delta V = \beta V_i \Delta T$$

$\Delta V = (950 \times 10^{-6}\ °C^{-1})(45{,}725\ L)$
$(-10.0°C - 28.0°C)$

$\Delta V = (950 \times 10^{-6})(45{,}725)(-38.0)$
$= -1650\ L$

$V_f = 45{,}725\ L - 1650\ L = 44{,}075\ L$

The truck delivers 44,075 L of gasoline.

NOLOGIA 0566410429

The Challenge Problem: Test Your Mastery

A steel ruler is marked in millimeters so that it is perfectly accurate at 30.0°C. What percentage error would the ruler show when measuring a length at -30.0°C? (α for steel is 12 x 10^{-6} $°C^{-1}$)

**Hint: Think about what has happened to the ruler itself. If the ruler shrinks, what happens to the distance between its millimeter markings?*

NOLOGIA™ 0566410429

للتواصل على الرقم: 0566410429

Your Guide to Solids & Thermal Expansion: A Summary

The microscopic structure and particle motion of solids determine their real-world macroscopic properties, from elasticity to thermal expansion.

Key Concepts Reviewed

- **Solids:** Crystalline (ordered) vs. Amorphous (disordered).
- **Properties:** Elasticity, Malleability, Ductility.

Key Skills Mastered

- You can now calculate linear expansion: $\Delta L = \alpha L_i \Delta T$
- You can now calculate volume expansion: $\Delta V = \beta V_i \Delta T$

Mr. Mohamad: Look at the world around you—from the sidewalk beneath your feet to the thermostat on your wall. You now understand the hidden physics that shaped it. Well done.

NOLOGIA 0566410429

ختاماً، نسأل اللّه أن يوفقكم، وأن
تكون هذه الملزمة قد حققت
الفائدة المرجوة ♥

MR.MOHAMAD

لا تتردد في التواصل معنا
قم بمسح رمز الـQR

NOLOGIA™

لحجز مقعدك قم بالتواصل معنا
اضغط هنا: 0566410429

NOLOGIA™ 0566410429