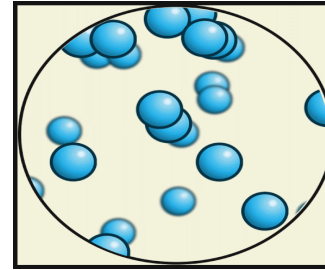


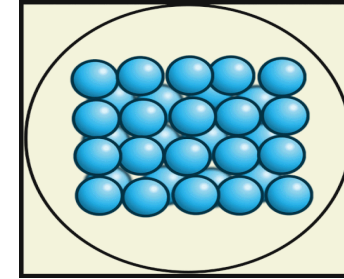
Module 1: Energy and Matter

Lesson 1: Particles in Motion

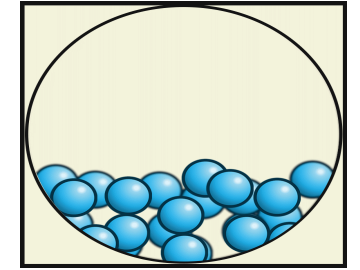
- Three states of matter :



Gas



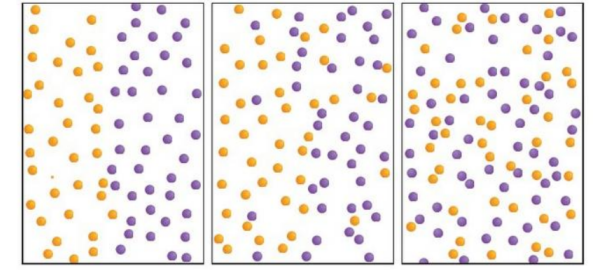
Solid



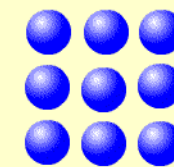
Liquid

- **Kinetic Energy** :— is the energy of motion
 - – as kinetic energy in particles increases, the speed of the particles increases.
- **Thermodynamics** — the study of the relationship between heat and energy.

- **Random motion** – movement in all directions and at different speeds

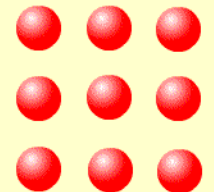


- **Diffusion** – the movement of particles from an area of higher concentration to lower concentration.
 - Particles diffuse until the concentration is the same throughout the container that is make the liquid one colour.
- **Thermal expansion** – as temperature increases (goes up), the particles move faster.
 - They collide (bump each other) and push each other apart. This makes the volume increase.
- **Thermal contraction** temperature decreases (goes down)
 - particles move less, take up less space – less volume.



All particles in a solid vibrate - even when cold.

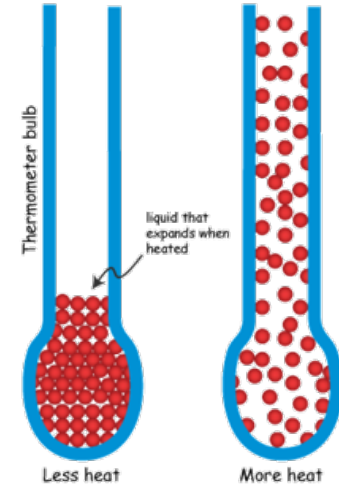
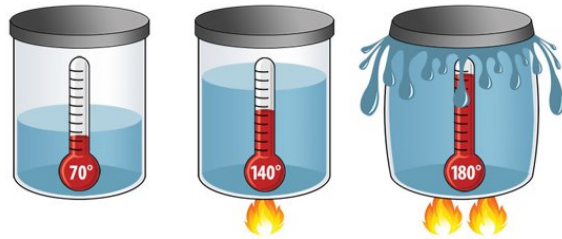
A Cyberphysics graphic 2010



At higher temperatures they vibrate faster and take up more room - expand - but the particles themselves are still the same size.

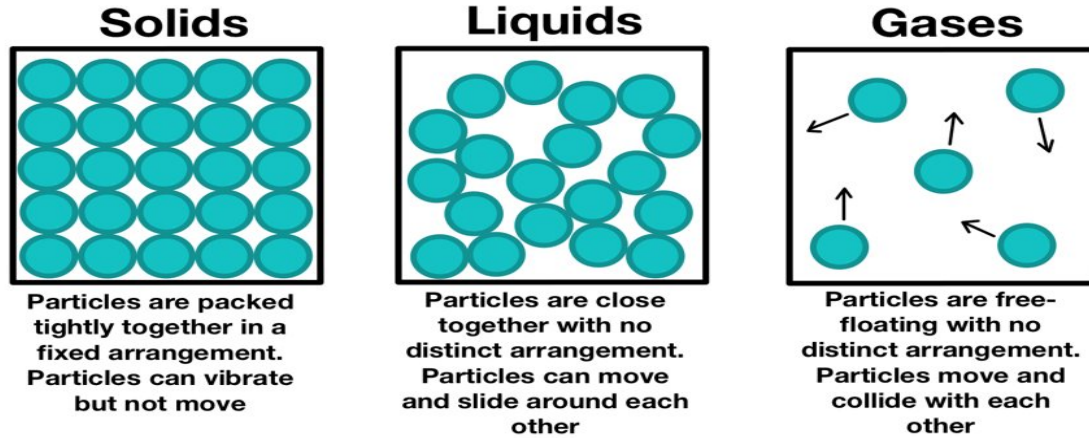
• **Temperature** is the measure of kinetic energy in particles.

- The higher the energy, the higher the temperature.
- The lower the energy, the lower the temperature.



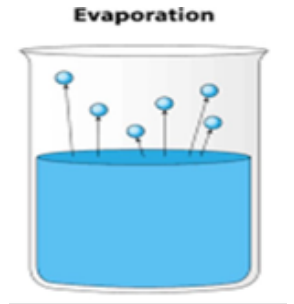
Lesson 2 : State of Matter

Particle Arrangement in Phases of Matter



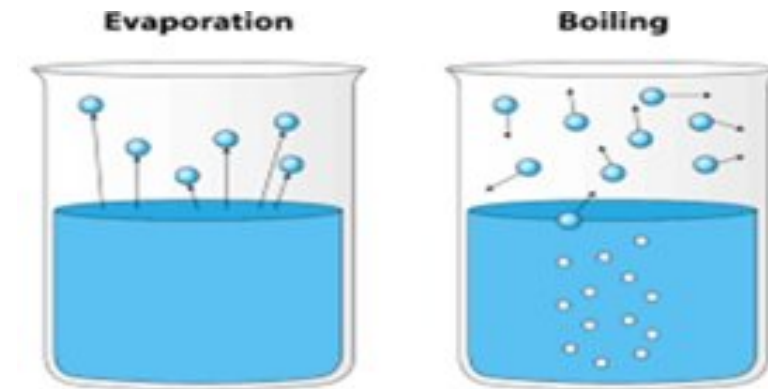
- **Condensation** (the change of a gas to a liquid)
- Lose energy (heat)

- **vaporization** (the change of a liquid to a gas)
- gaining energy (heat)



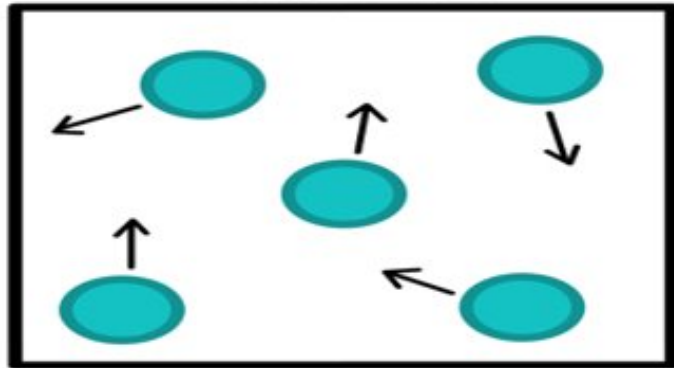
- The difference between Evaporation and boiling

Basis of Comparison	Evaporation	Boiling
Meaning	It is when the liquid or state changes into a vapour	Boiling is steaming or bubbling up under the influence of heat
Occurrence	It occurs at the surface of the liquid	Boiling occurs throughout the liquid because of the addition of a lot of heat
Temperature	Evaporations needs a little change in temperature	It requires a temperature which is greater than the boiling point



- **Potential energy** is stored energy due to the interactions between particles or objects
- The potential energy **increases** as the distance between particles **increases**

Gases



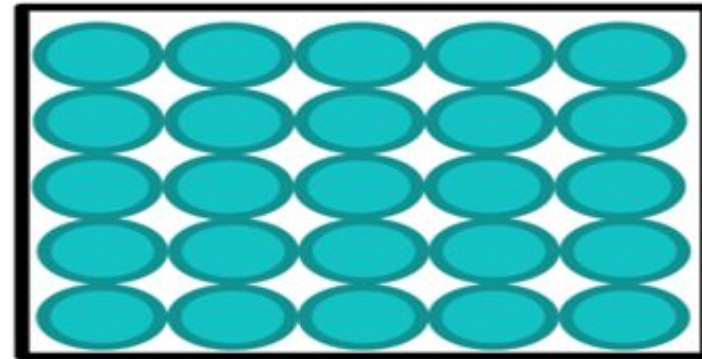
High Distance

Distance

potential energy

High potential energy

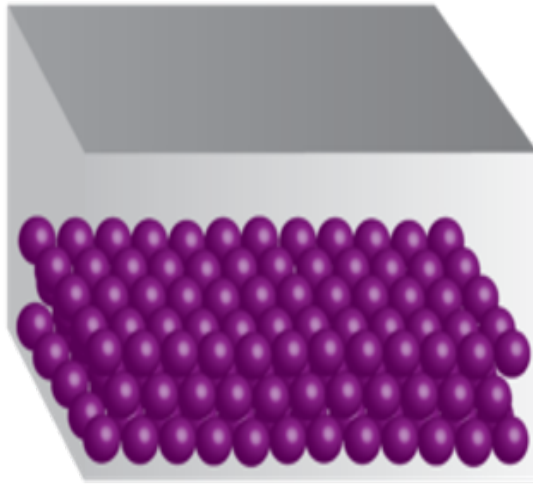
Solids



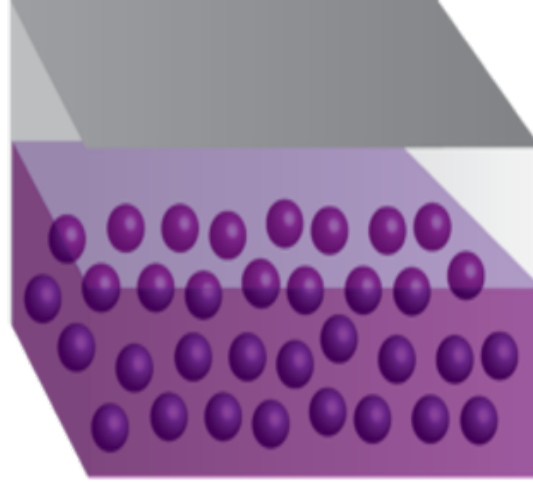
Low Distance

low potential energy

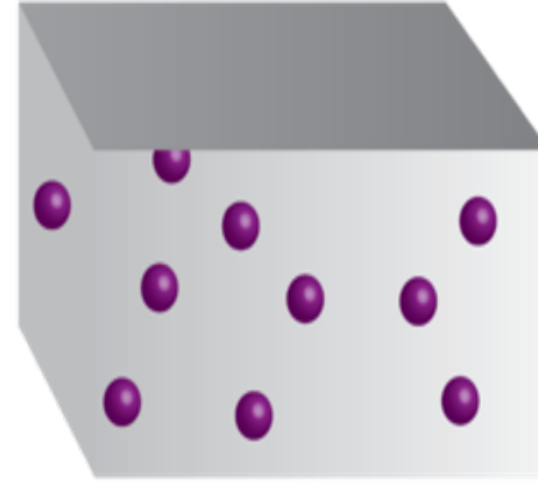
Particles attraction



Solid



Liquid



Gas





Kinetic Energy

Potential Energy

Relates to particle speed

Relates to the distance between particles/strength of attractions between particles

Measured by temperature of substance

Measured by state of matter

Increases as particle speeds increase

Increases as distance between particles increases

Decreases as particle speeds decrease

Decreases as distance between particles decreases

Increases as temperature increases

Increases as state of matter changes from solid to liquid to gas

Decreases as temperature decreases

Decreases as state of matter changes from gas to liquid to solid



THREE-DIMENSIONAL THINKING

For each example:

1. Complete the **model** of the particles.
2. Indicate how potential **energy** is changing (increasing or decreasing).
3. Indicate how the attractive forces are changing (increasing or decreasing).

A

Potential Energy = decreasing

Attractive Forces = increasing

B

Potential Energy = increasing

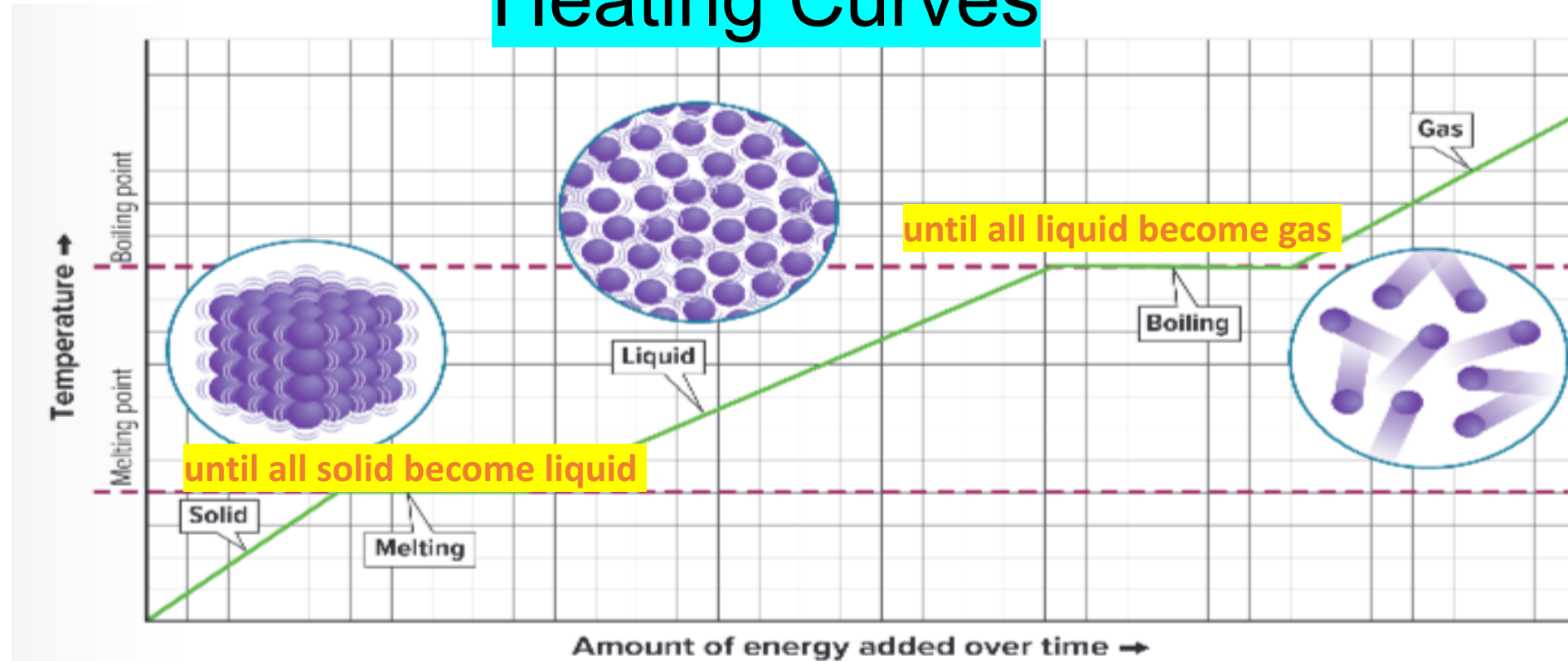
Attractive Forces = decreasing

C

Potential Energy = increasing

Attractive Forces = decreasing

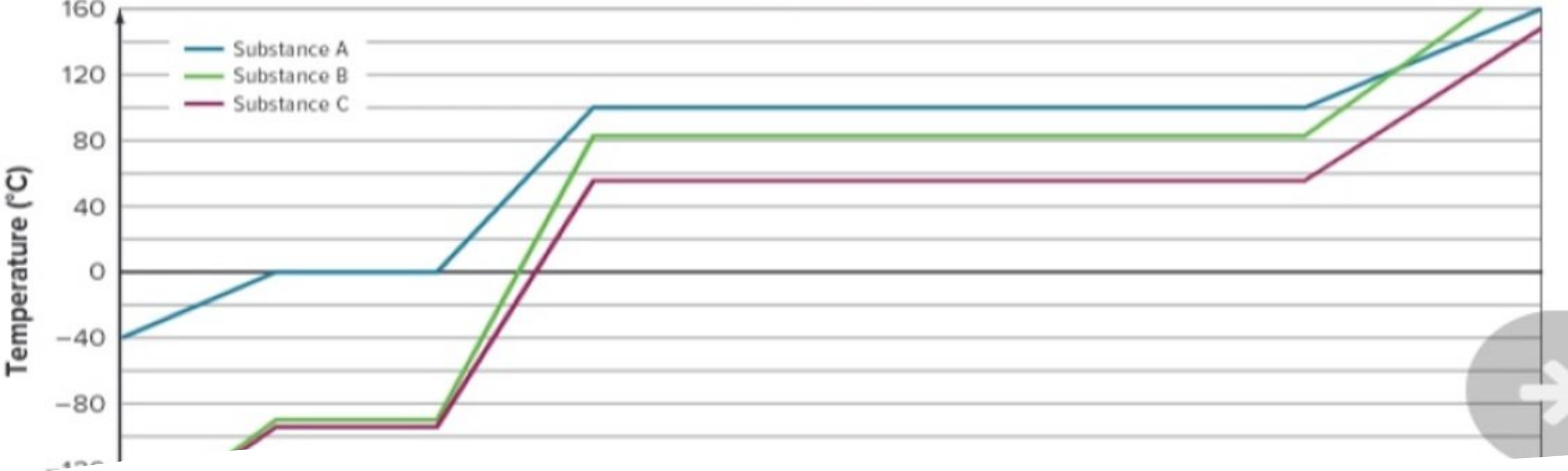
Heating Curves



Temperature increases when the state of material is not changing
kinetic energy increases -----speed of particles increases

When substance changing the state, the temperature stays the same at the melting & boiling point

Solid to liquid ----- distance between particles increases & potential energy increases
Liquid to gas-----distance between particles increases & potential energy increases



- **Particles and Melting Points**

- Different substances have different melting and boiling points .

Because the force of attraction between particles for each substance is different than the another one .

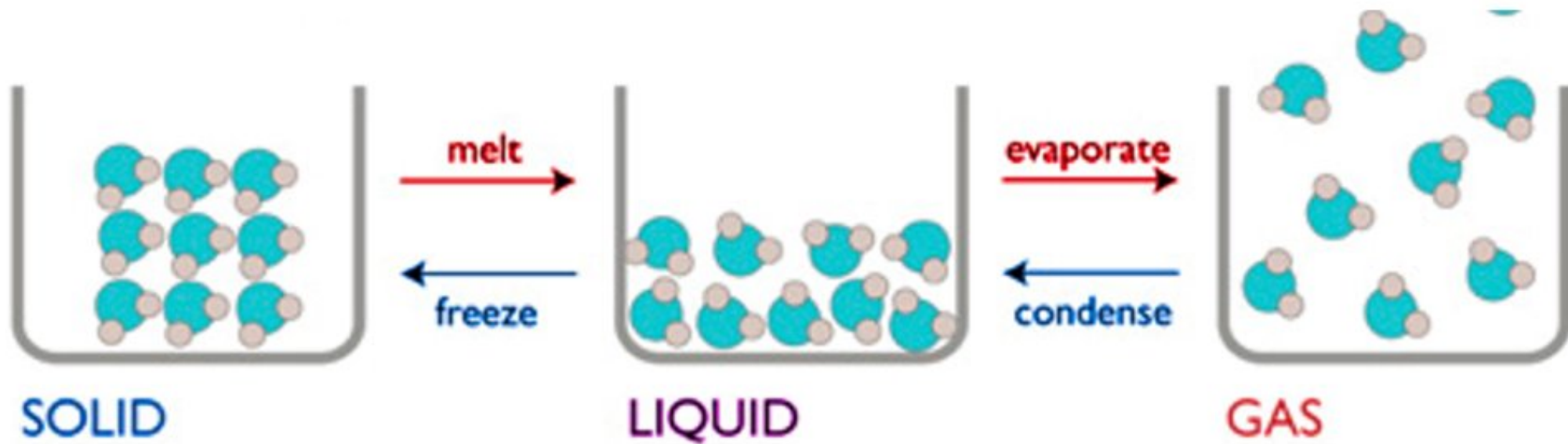
Thermal Energy: The total energy of a substance

depends on:

- The kinetic energy or the speed of the particles (measured by temperature)
- The potential energy or the arrangement of the particles (determined by state of matter)
- The total number of particles in the substance (measured by the mass of the substance)
- the type of matter that makes up the substance

Thermal energy **is not the same as temperature**. Temperature is the measure of the **average kinetic energy** of the particles.

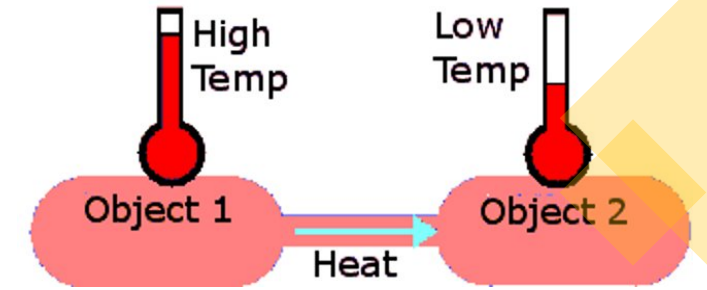
High energy (high temperature)



Low energy (low temperature)

Lesson 3: Thermal energy transfers

- Energy flows from objects or areas that have a high temperature to objects or areas that have a lower temperature.



Differentiate Systems and Energy

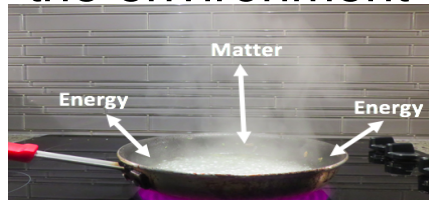
Closed system:

is a system that **does not** exchange matter or energy with the environment.



Open system:

is a system that exchanges matter or energy with the environment

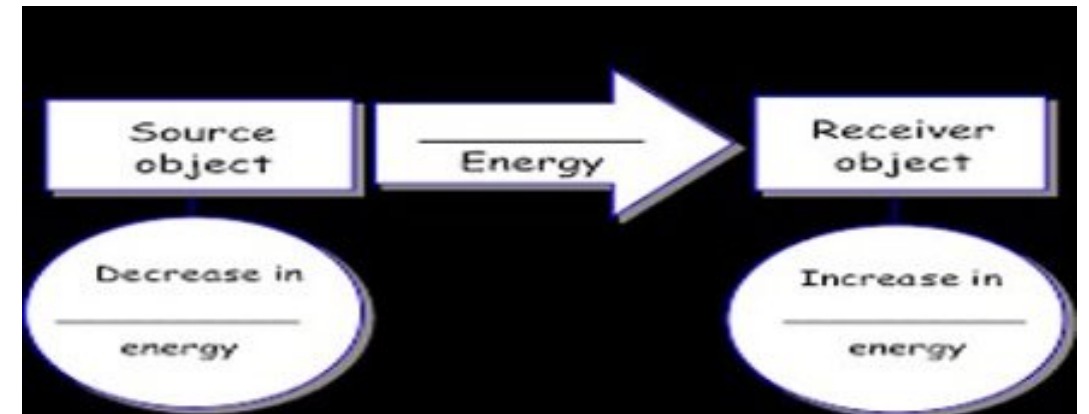


Source object:

The object that provides the energy for energy transfer

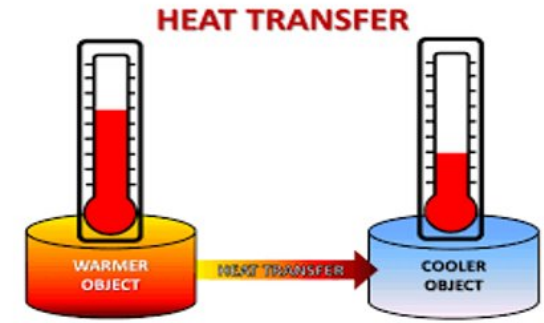
Receiver object:

The object that gains the energy from the energy transfer



• Direction of Thermal Energy Transfer

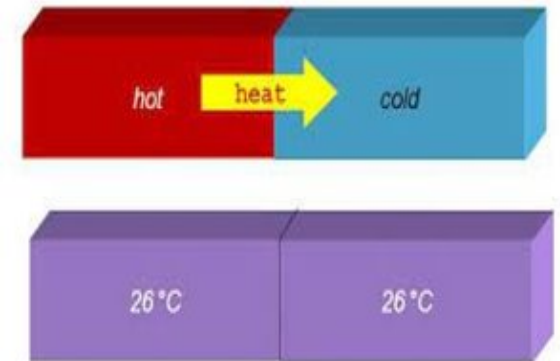
- All substances contain thermal energy .
- When **two substances contain different amounts** of thermal energy, energy can **transfer** between the substances.



- **Heat is :** The amount of thermal energy transferred from a region of higher temperature to a region of lower temperature

- **Thermal Equilibrium :** When the temperatures of materials that are in contact are the same, the materials are said to be in thermal equilibrium

After the materials reach thermal equilibrium, the particles that make up the water, the beaker, and the air continue to collide with each other. The particles transfer kinetic energy back and forth ذهاب وعودة , **but the average kinetic energy of all the particles remains the same**



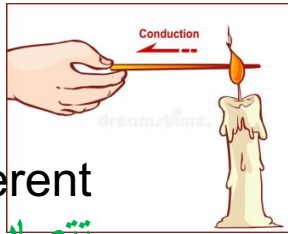
Heat Transfer

Conduction

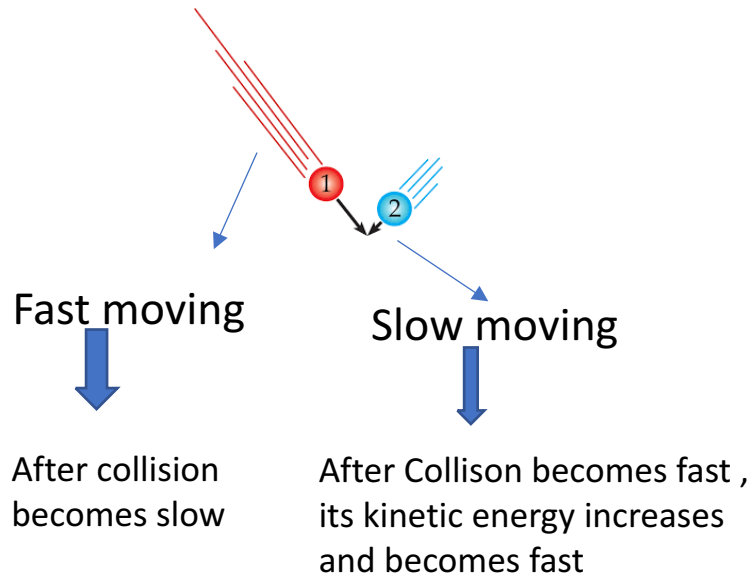
Convection

Radiation

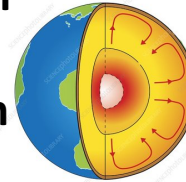
Conduction is the transfer of thermal energy between materials by the collisions of particles. (**contact**)



When particles at different temperatures **collide** تتصادم,



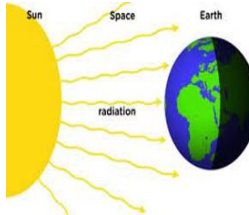
Convection is the transfer of thermal energy by the movement of particles from one part of a material to another.



Convection explains why hot air rises and cooler air sinks.

Convection occurs in liquids and gases. Convection **does not occur in solids** because the particles in solids cannot flow but vibrate only.

Radiation is the transfer of thermal energy from one material to another by electromagnetic waves



- Radiation transfer thermal energy in space.
 - radiation also can transfer thermal energy through solids such as rocks, liquids like the ocean, and gases in the atmosphere.
- A **thermogram**, is an image created by a technology that measures the radiation given off by objects.

Lesson 4: Thermal Energy Conductivity

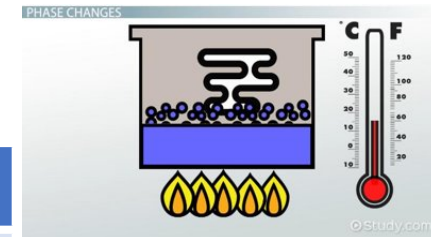
- Some materials, such as metals, conduct thermal energy easily. Other materials, such as wood or plastic, do not.
- mass affect the change in temperature of a substance, more mass-more particles-more thermal energy
- the relationship between mass and the change in temperature is inversely proportional تناسبا عكسيا
- The **grater mass** the **more thermal energy** is needed to increase temperature.
- The metal transfers thermal energy well and plastic does not transfer energy well.

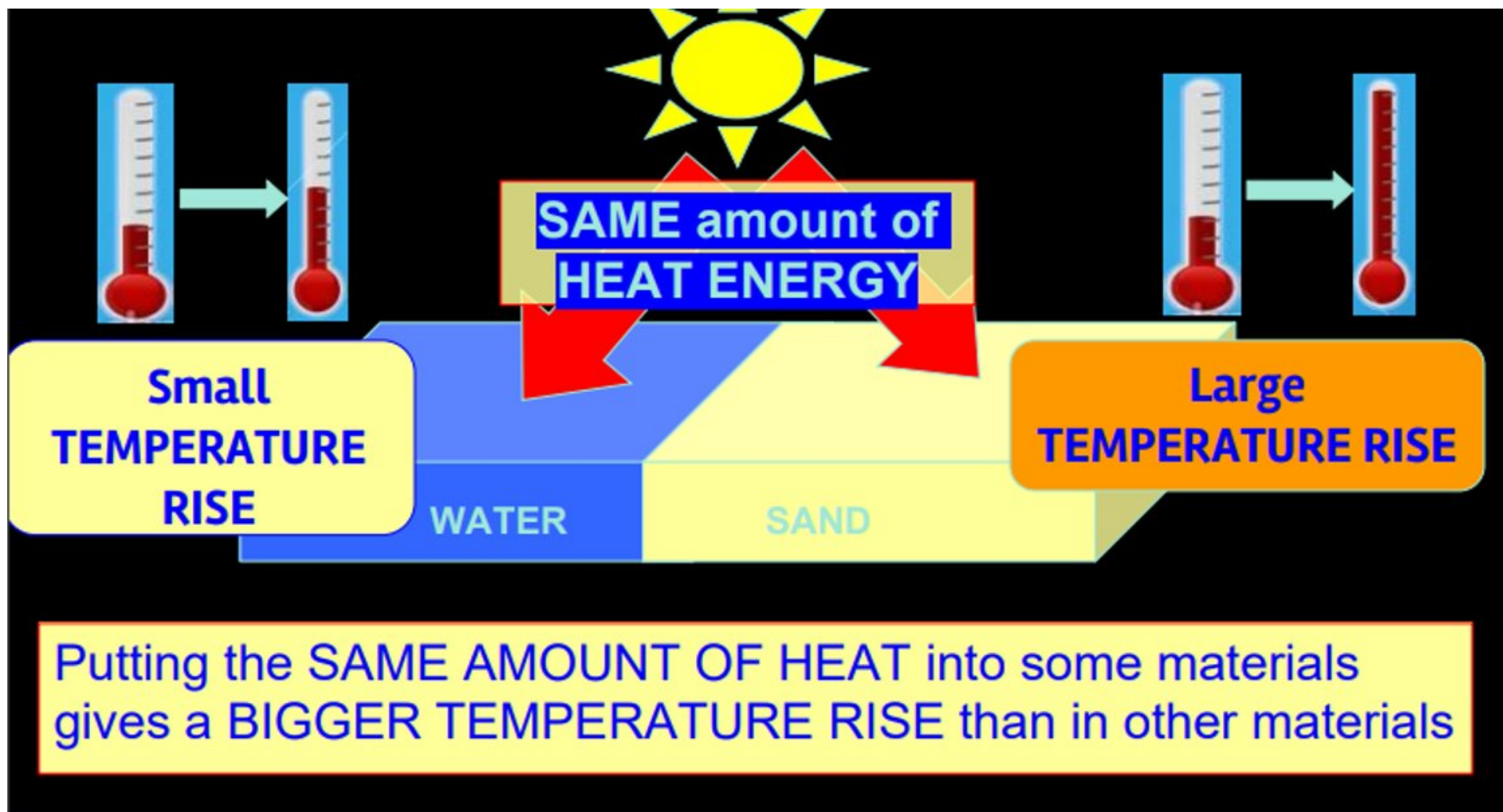


- **Specific heat** is the amount of thermal energy required to increase the temperature of 1 kg of a material by 1°C .
- **Every material has a specific heat.**

Low specific heat :requires low amount of thermal energy to be heated ,cooled down slower

High specific heat :requires high amount of thermal energy to be heated ,cooled down faster





Conductors and Insulators

- **Conductors**

- substances that conduct thermal energy well
- particles are close together
- different metals are common conductors

- **Insulators**

- substances that do not conduct thermal energy well → they delay heat transfer
- particles are far apart
- different plastics are common insulators

What are some common conductors and insulators?



Additional properties that affect thermal energy transfer

Mass

As mass increases, more thermal energy is needed to raise the temperature of the material.

Surface area

As surface area increases, more thermal energy is transferred to the environment.

Thermal Energy Transfer

Reflectivity :

decreases energy transfer while absorbance increases it.

Thickness¹:

affects the time the transfer of thermal energy through the material takes. Thick materials tend to heat and cool slowly.