(2)
(4)

States of matter

Properties of States of Matter

Property	Solid	Liquid	Gas
Shape	definite	takes shape of container	takes shape of container
Volume	fixed	fixed	takes vol. of container
Compressibility	cannot be compressed	cannot be compressed	can be compressed
Ease of flow	does not flow	flows	flows

Diffusion is a result of the constant thermal motion of particles. In 1828 Robert Brown observed that pollen grains suspended in water moved about in a rapid, irregular motion. This motion has since become known as **Brownian motion**. Brownian motion is essentially diffusion of many particles. Brownian motion can also be seen as the random to and fro movement of particles.

Definition 1: *Diffusion*

Diffusion is the movement of particles from a high concentration to a low concentration.

- **Melting**

(2)

(4)

> Definition 2: *Melting point*
>
> The temperature at which a *solid* changes its phase or state to become a *liquid*. The process is called melting.

- **Evaporation**

Evaporation is the process of going from a liquid to a gas. Evaporation from a liquid's surface can happen at a wide range of temperatures. If more energy is added then bubbles of gas appear inside the liquid and this is known as boiling.

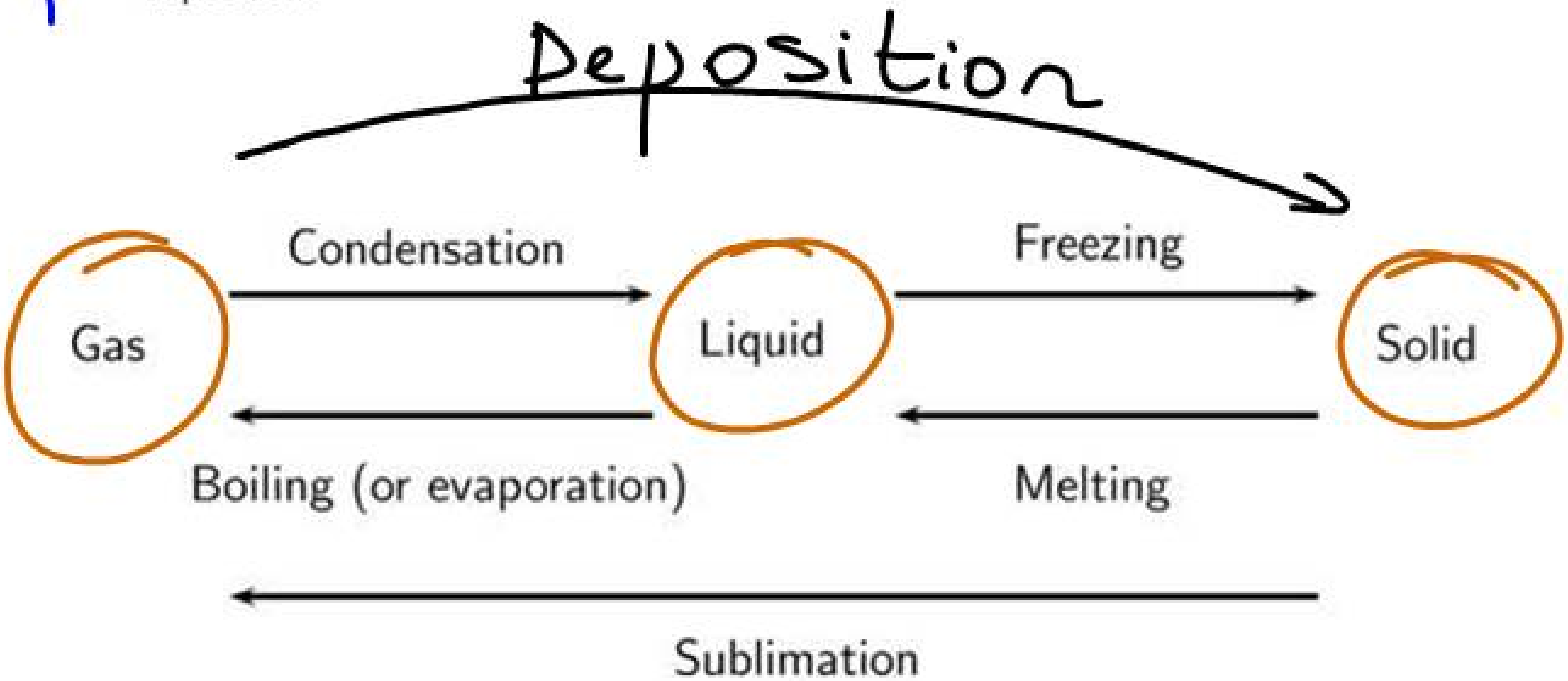
> Definition 4: *Boiling point*
>
> The temperature at which a *liquid* changes its phase to become a *gas*. The process is called evaporation

(2)

- **Condensation** is the process of going from gas to liquid.

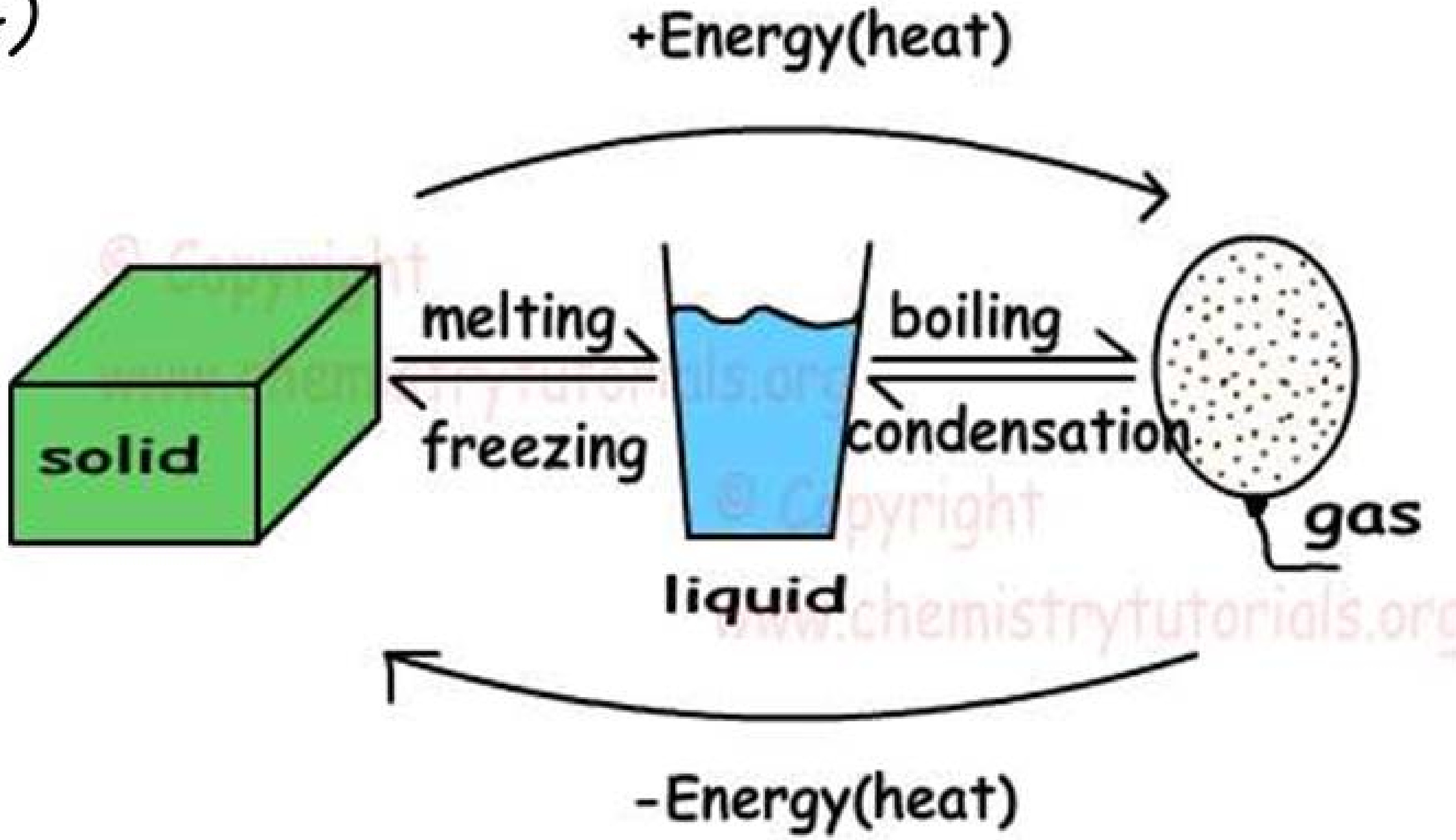
(4)

- **Sublimation** is the process of going from a solid to a gas. The reverse process is called deposition.



(2)

4


+Energy(heat)
melting
freezing
boiling
condensation
solid
liquid
gas
-Energy(heat)

Syavohw codes (4)

Energy In

(4)

Melting

evaporation

deposition

Solid

Liquid

Gas

sublimation

Freezing

condensation

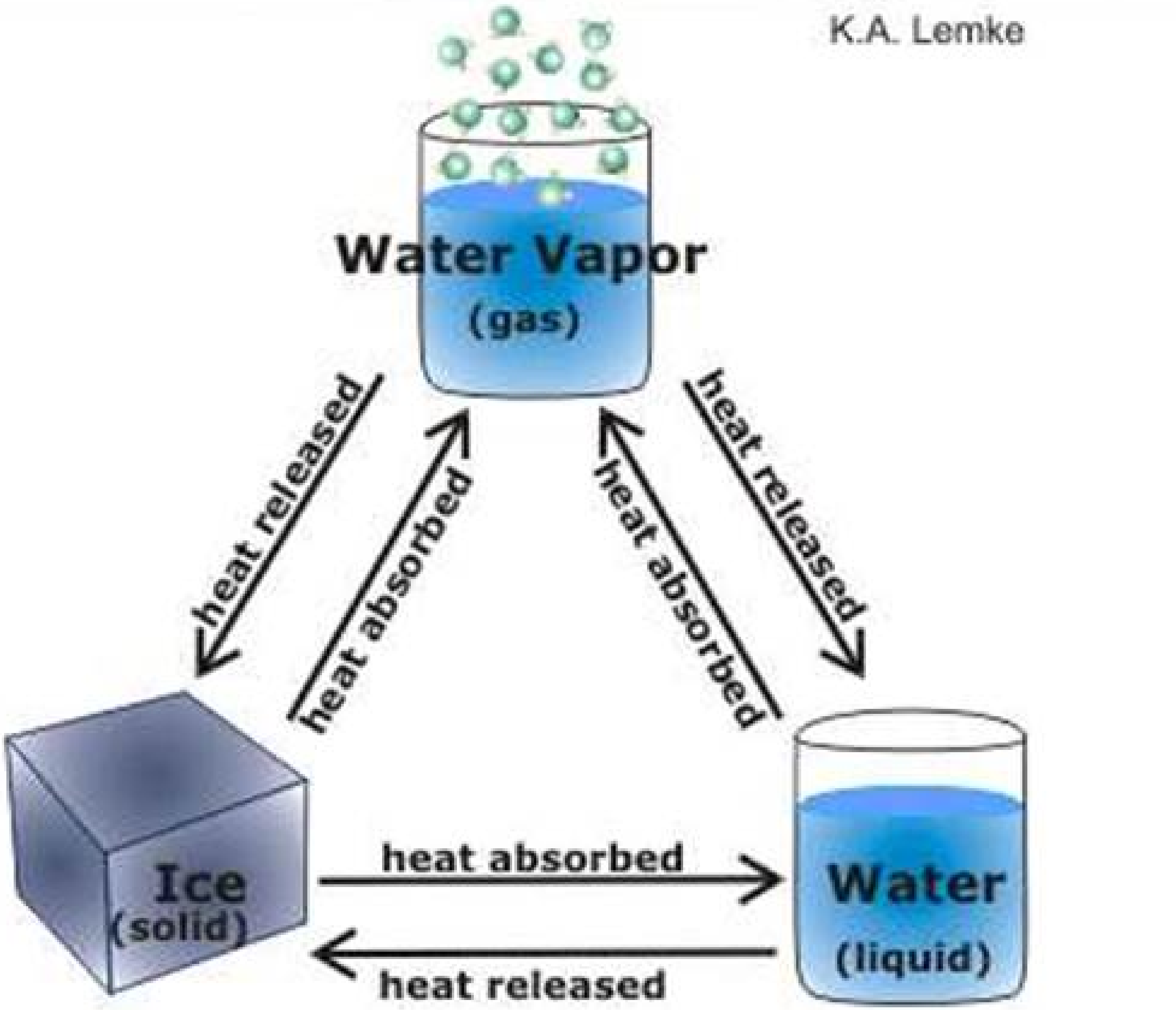
Energy Out

(2)

4

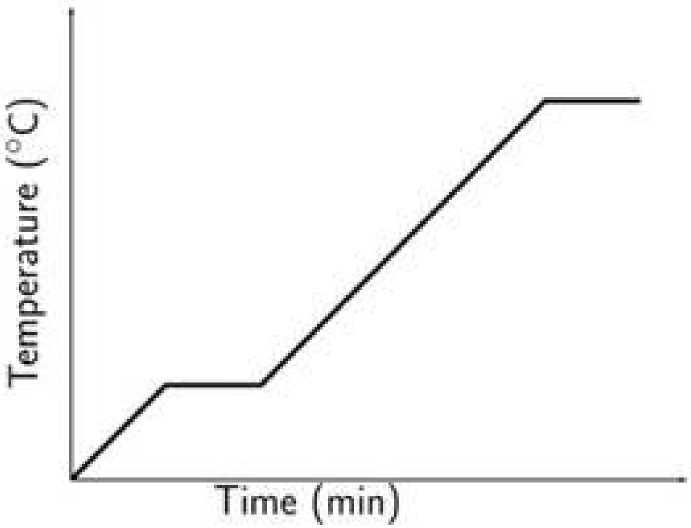
(2)

4

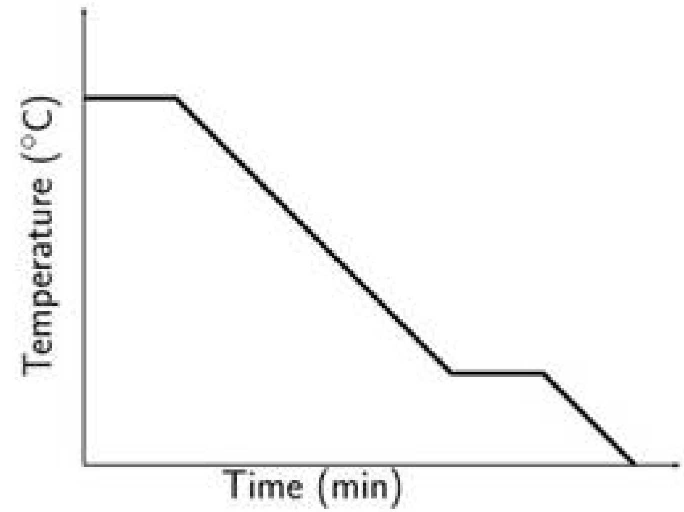

K.A. Lemke
Water Vapor
(gas)
heat released
heat absorbed
heat absorbed
heat released
Ice
(solid)
heat absorbed
heat released
Water
(liquid)

(2)

Heating curve



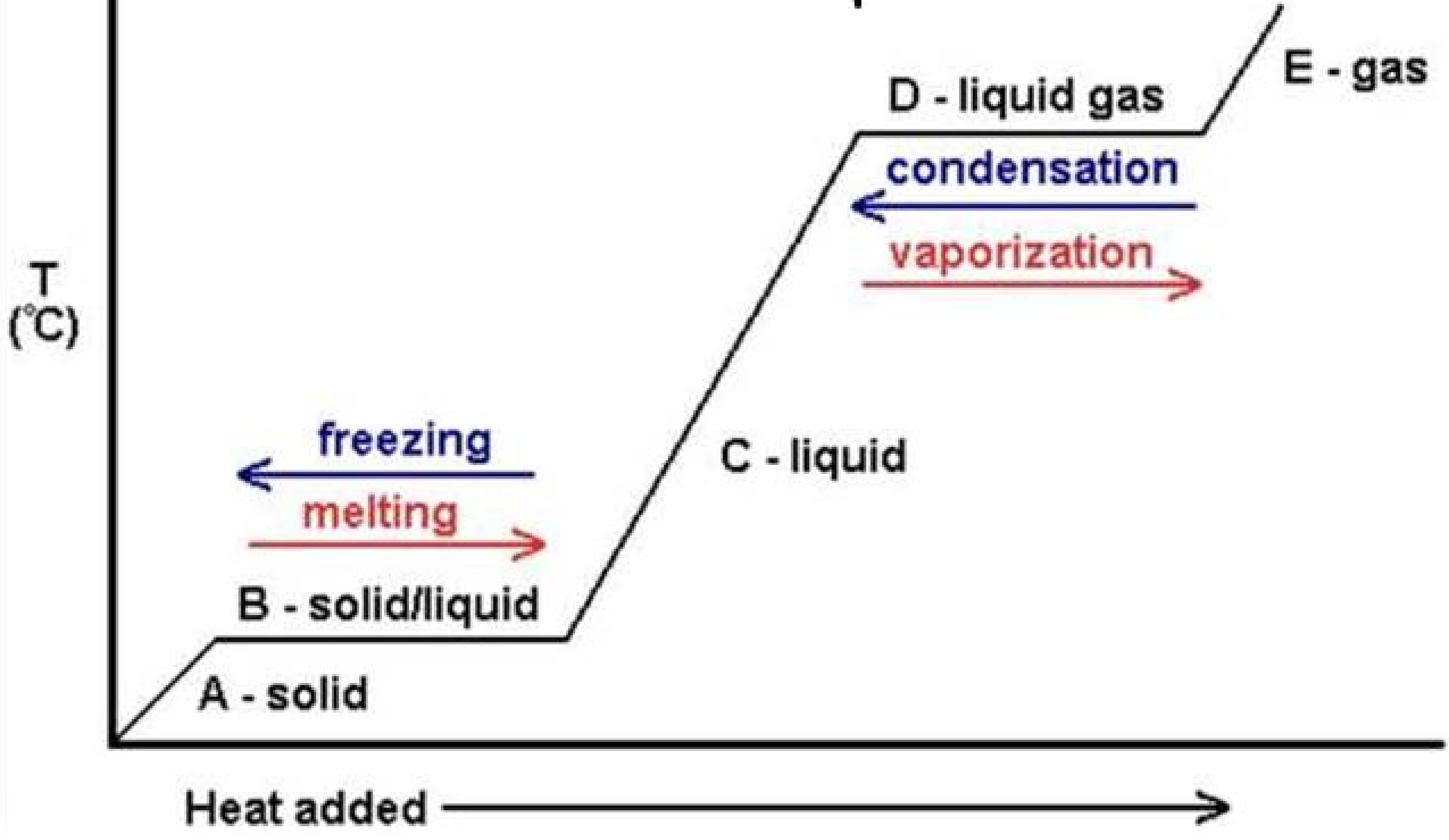
Cooling curve



(4)

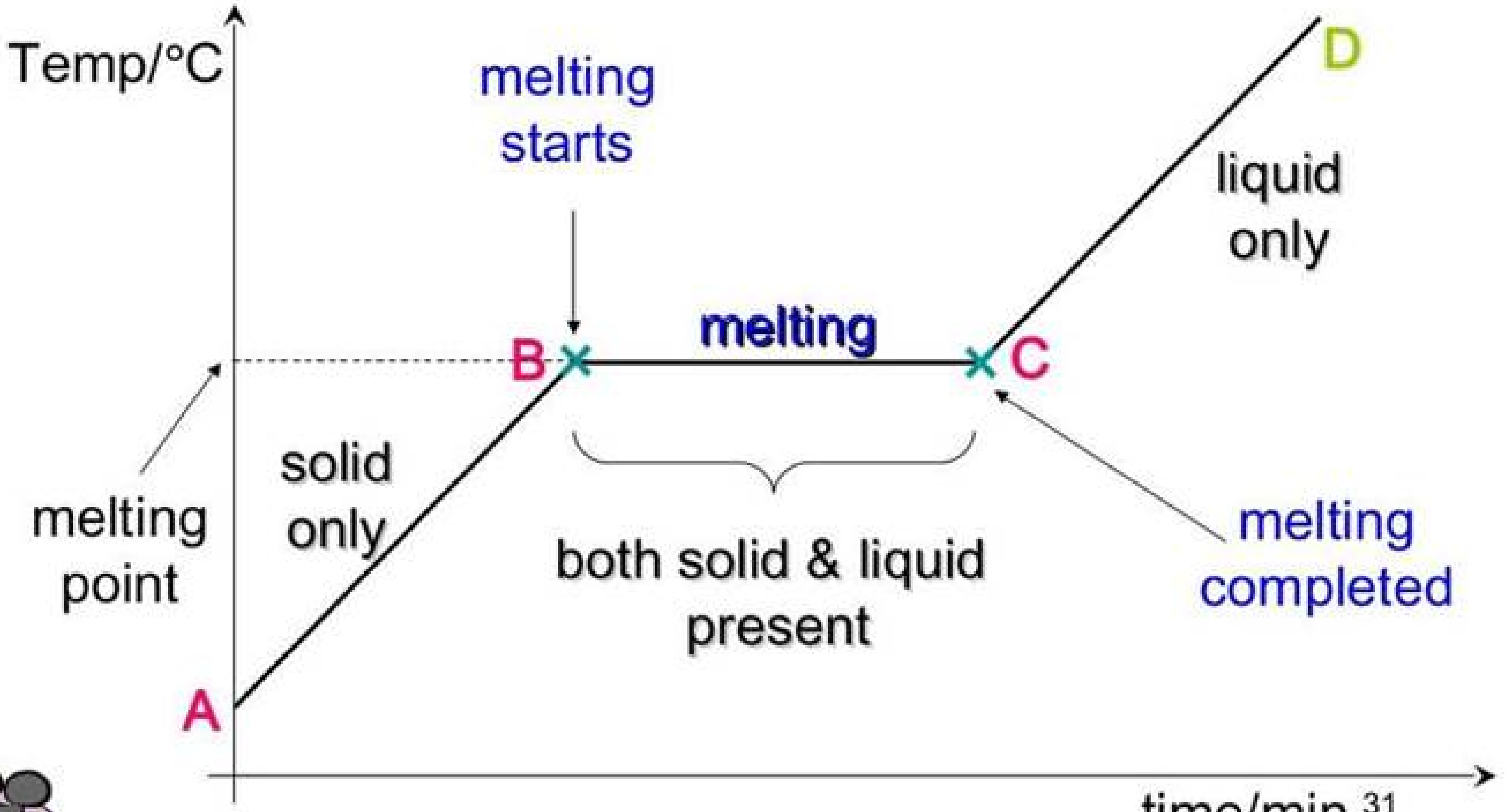
(2) Temperature: A measure of the average Kinetic Energy of the particles.

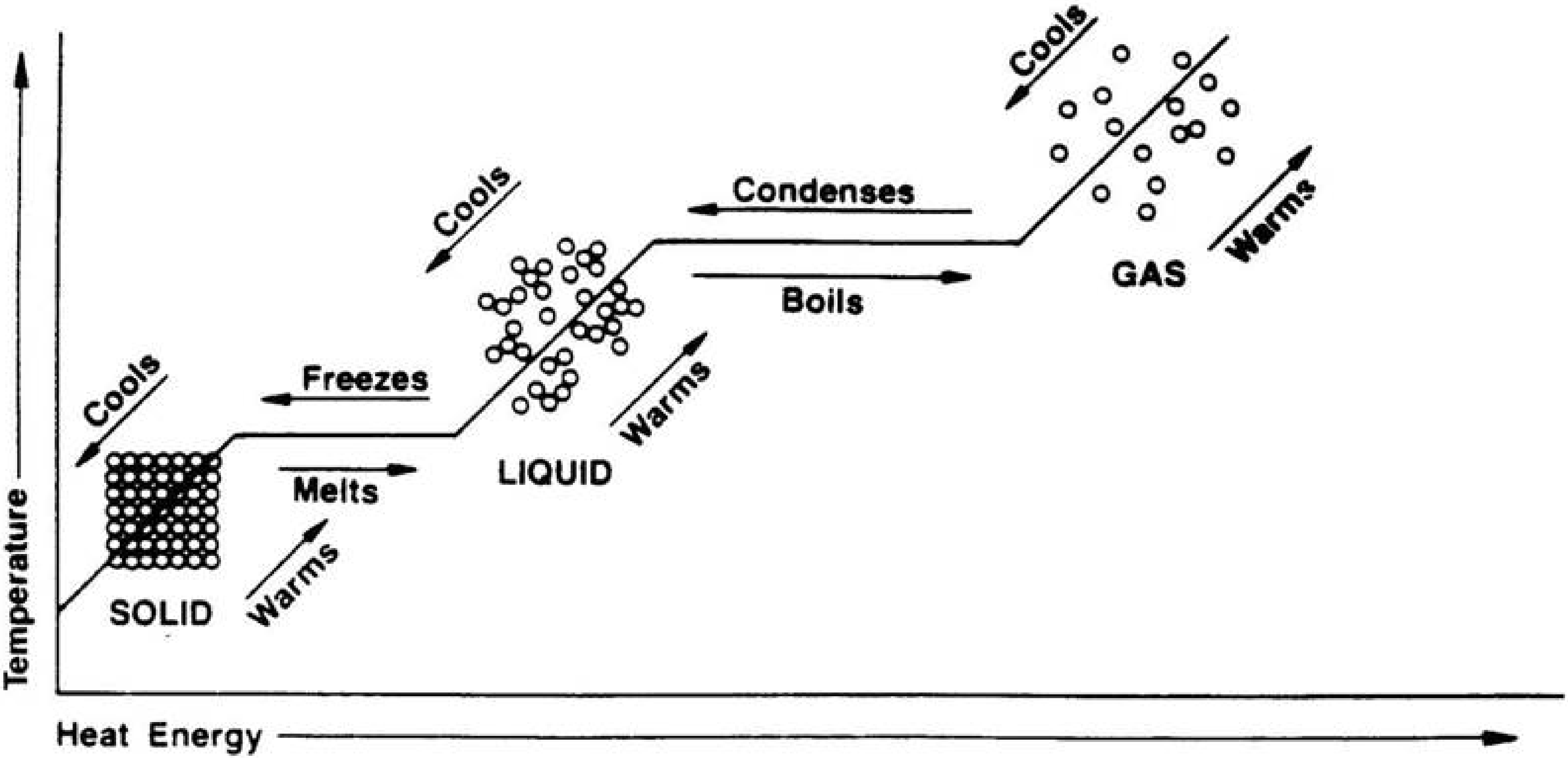
(4)

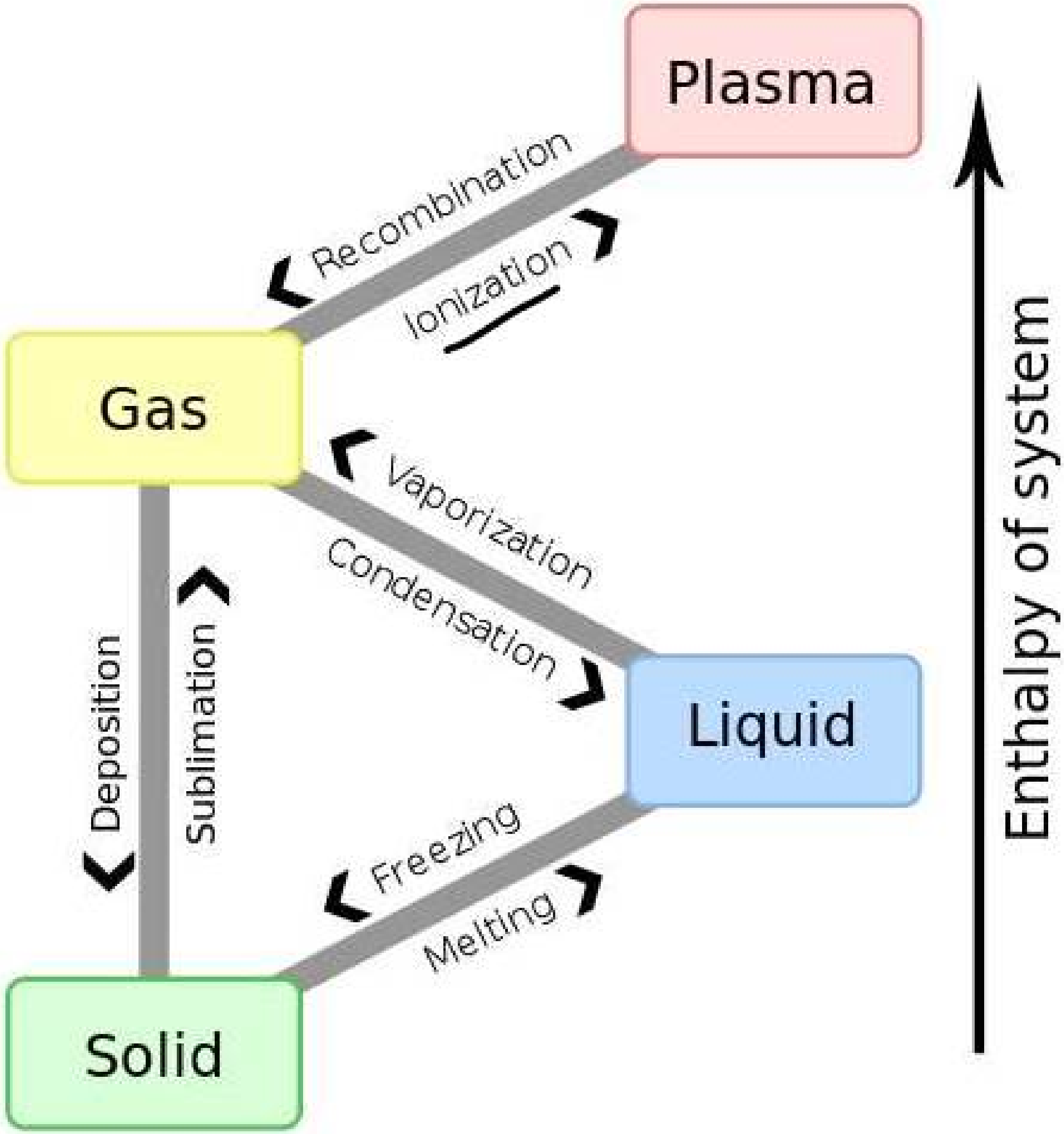


Graph of a Melting Substance

(4)




Cools
Cools
Cools
Condenses
Boils
GAS
Warms
Freezes
Melts
LIQUID
Warms
SOLID
Warms
Temperature
Heat Energy


Plasma
Gas
Liquid
Solid
Recombination
Ionization
Vaporization
Condensation
Deposition
Sublimation
Freezing
Melting
Enthalpy of system

(4) (2)

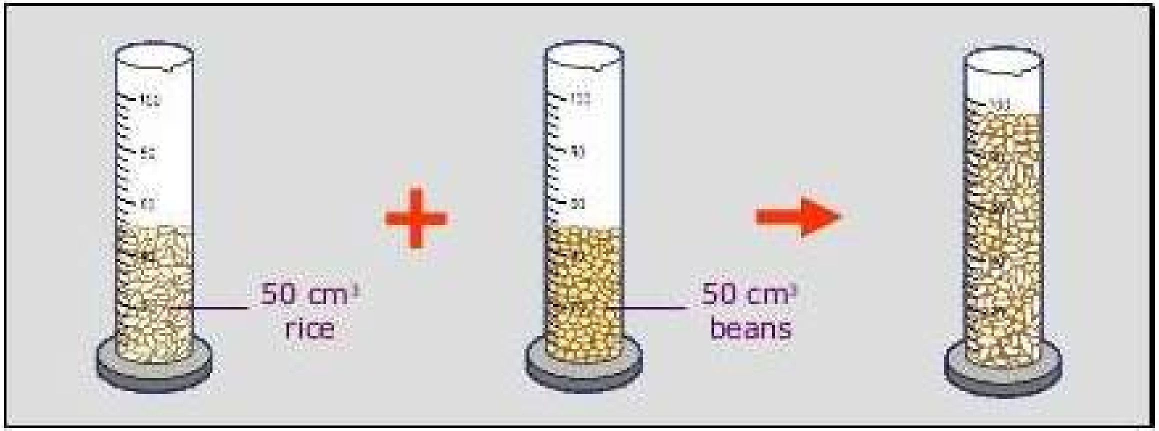
The kinetic molecular theory

Kinetic Model of Matter *
states that…

- all matter is made up of tiny particles.
- particles are always in constant random motion.
- as temperature rises, particles have higher average kinetic energy, and they move faster.

The kinetic molecular theory

Spaces between particles…



(4)
(2)

There are spaces between the particles of matter.

(4)

(2)

Kinetic Model of Matter

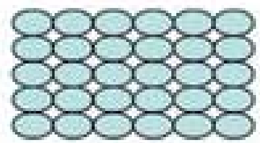
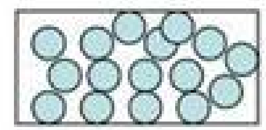
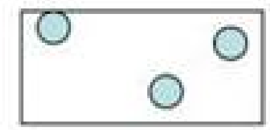
In general, solids, liquids and gases differ in terms of:

NB!!

- arrangement of particles
- movement of particles
- forces of attraction

} Energy

(2)

Properties	Solid	Liquid	Gas
Arrangement of particles	•orderly •closely packed	•disorderly •less closely packed than solid	•disorderly •very far apart
			
Attractive forces between particles	Very strong *-accounts for high density*	Strong	Very weak *-accounts for low density*
Kinetic energy of particles	very low	Low	high
Particle motion	vibrate about fixed position *-accounts for fixed shapes and volumes.*	Slide over each other *-fixed volumes but no fixed shapes*	Move about at great speeds *-no fixed shape nor volume*

(2)

Properties of solids, liquids, gases

Properties of:	Explain by:
Solid: 1. Definite volume 2. Definite shape 3. Cannot flow 4. Cannot be compressed	Particles are packed closely together and held in fixed positions Particles cannot move freely Particles packed closely together
Liquid: 1. Definite volume 2. Indefinite shape 3. Can flow 4. Cannot be compressed	Particles are packed closely together Particles are not held in fixed positions and can move freely Particles packed closely together
Gas: 1. Indefinite volume 2. Indefinite shape 3. Can flow 4. Can be compressed	Particles are far apart and not held in fixed positions Particles can move freely Particles are far apart

FORCES

(2)

What happens when a substance is heated?

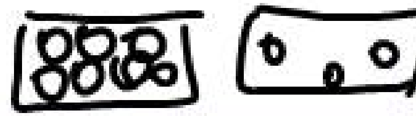
- Thermal energy is absorbed by the substance.
- Kinetic energy of the particles increase.
- Particles vibrate more or move faster.
- Frequency of collision increases. * → remember.
- Causes the particles to be further apart from each other.
- Volume increases.
- Substance expands.

What happens when a substance is cooled?

- Thermal energy is removed from the substance.
- Kinetic energy of the particles decrease.
- Particles vibrate less or move slower.
- Frequency of collision decreases.
- Causes the particles to be closer to each other.
- Volume decreases.
- Substance contracts.

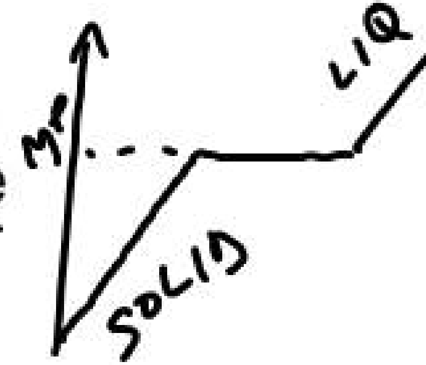
(2)

Melting — S → L



(a) On heating a solid, the particles gain thermal energy and vibrate faster.

(b) At the melting point, the particles have gained enough energy to overcome the attractive forces between them.



(c) They move away from their original positions and form a liquid.

(2)

Why does temperature remain constant during melting?

- Energy gained by the particles is used to overcome the forces of attraction between them and separate them.

HIDDEN ← LATENT HEAT

Boiling

(a) On heating a liquid, the particles gain thermal energy and move faster.

(b) At the boiling point, the particles have gained enough energy to overcome the attractive forces between them.

(c) The particles are able to escape from the liquid and form a gas.

(2)

Why does temperature remain constant during boiling?

- Energy gained by the particles is used to overcome the forces of attraction between them and separate them.

Condensation g → L

(a) When a gas is cooled, the particles lose energy and move more slowly.

(b) The attractive forces between the particles draw the particles closer together so that

↳ the gas changes into a liquid.

(c) Temperature remains constant.

Freezing L → S

(2)

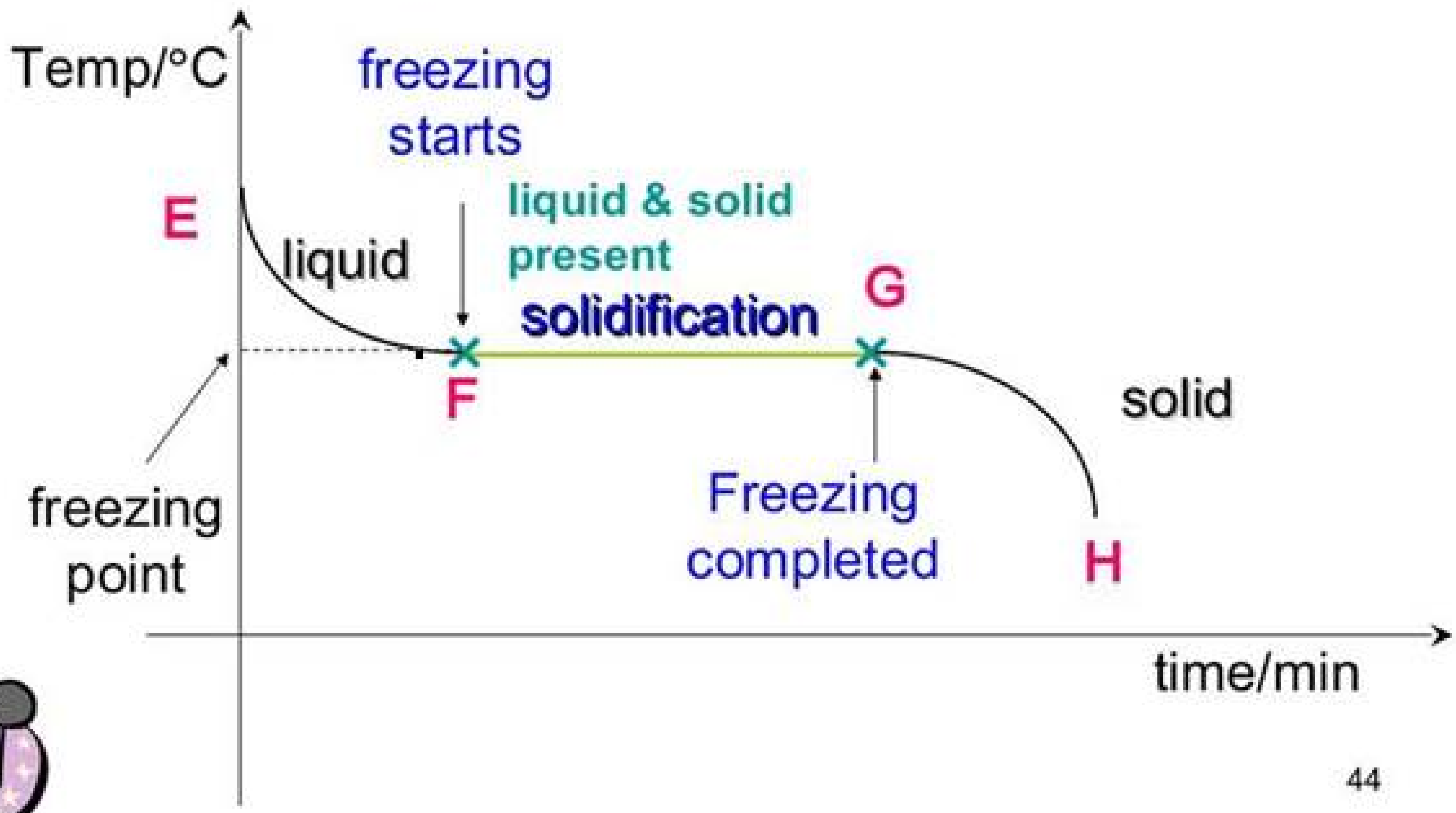
(a) When a liquid is cooled, the particles lose energy and move more slowly.

(b) At the freezing point, the attractive forces between the particles are able to stop them from moving so that the liquid changes into a solid.

(c) Temperature remains constant.

Graph of a Freezing Substance

(2)



I have learnt:

1) In the kinetic model of matter, solids, liquids and gases differ in terms of: (2)

- arrangement of particles
- movement of particles
- forces of attraction between particles.

I have learnt:

(2)

2) When a matter is heated, the average kinetic energy of the particles increases and this causes the particles to vibrate more or to move away from each other. The matter expands, not the particles.

3) During a change of state, the temperature remains constant.

End of Chapter Exercise

Problem 1:

Give one word or term for each of the following descriptions.

1. The change in phase from a solid to a gas.
2. The change in phase from liquid to gas.

Answer 1:

a) Sublimation

Problem 2:

Water has a boiling point of 100℃

1. Define boiling point.
2. What change in phase takes place when a liquid reaches its boiling point?

Answer 2:

a) The temperature at which a liquid changes its phase to become a gas.

b) Liquid to gas.

Problem 4:

Refer to the table below which gives the melting and boiling points of a number of elements and then answer the questions that follow.

Element	**Melting point (°C)**	**Boiling point (°C)**	**State at room temperature**
Copper	1083	2567	Solid
Magnesium	650	1107	Solid
Oxygen	-218.4	-183	Gas
Carbon	3500	4827	Solid
Helium	-272	-268.6	Gas
Sulphur	112.8	444.6	Solid

b) Carbon. It has the highest melting and boiling points. A high melting and boiling point indicates that a lot of energy is needed to overcome the forces holding the molecule together and so the higher the melting or boiling point, the stronger the forces.

c) Helium. It has the lowest melting and boiling points. A low melting and boiling point indicates that a small amount of energy is needed to overcome the forces holding the molecule together and so the lower the melting or boiling point, the weaker the forces.

Problem 5:

Complete the following submicroscopic diagrams to show what magnesium will look like in the solid, liquid and gas phase.