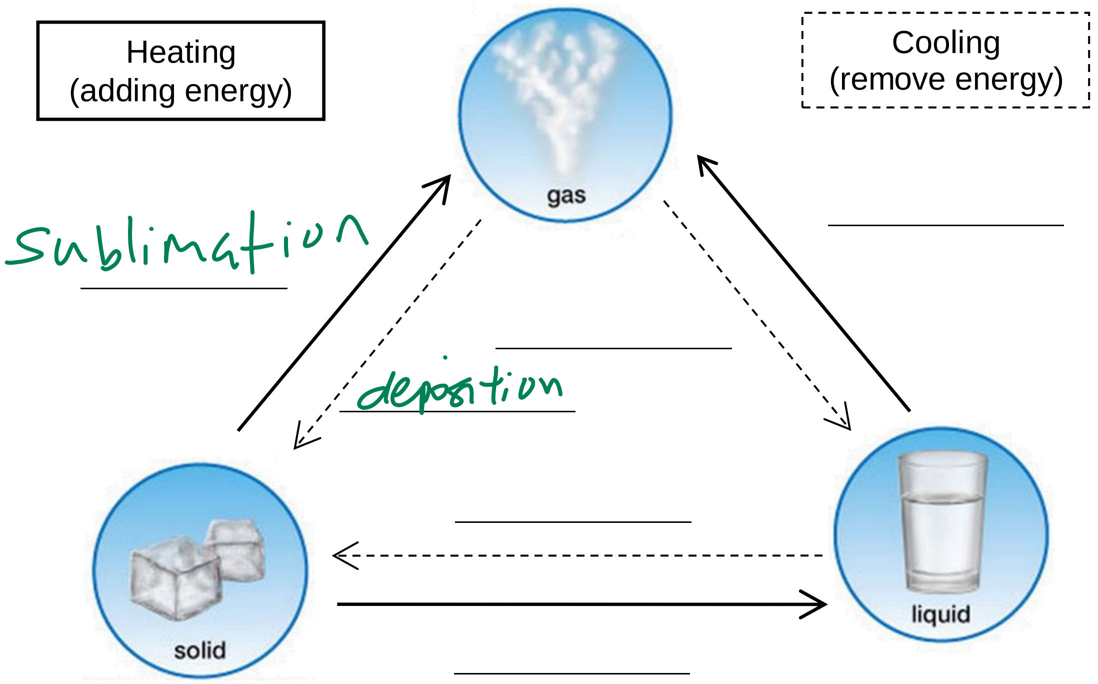
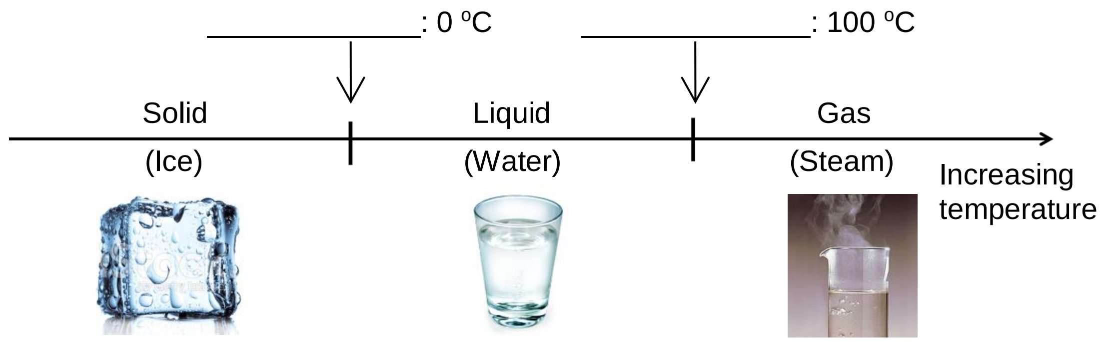
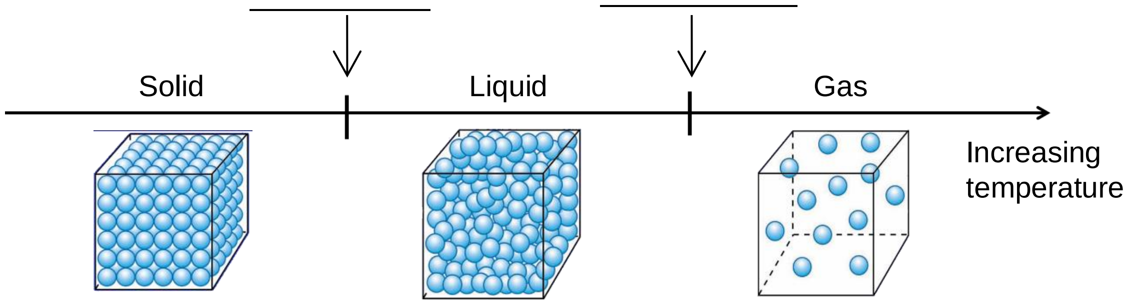
4 Changes in states of matter



How to predict changes in states of matter?
Example: Temperature line for **H_2O**:



Temperature line (in general):



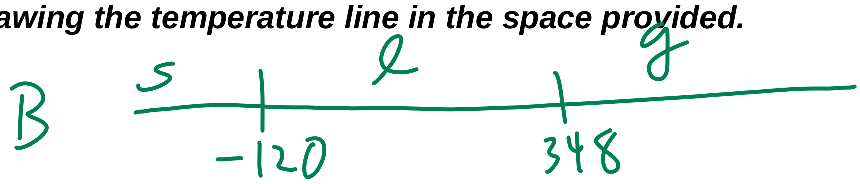
Worked example

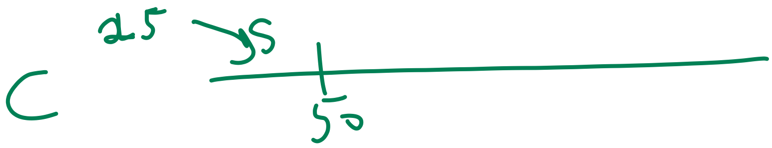
Try-it-out (1)

Given the melting and boiling points of three substances. Complete the table by writing the state of each substance at room temperature and pressure (r.t.p = 25 °C, 101.3 kPa).

Substance	Melting point (^{o}C)	Boiling point (^{o}C)	State at r.t.p
A	−24	10	Gas
B	−120	348	liquid
C	50	121	solid

Try drawing the temperature line in the space provided.



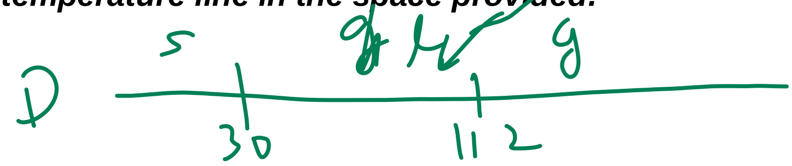


Try-it-out (2)

Given are melting and boiling points of three substances. Complete the table by writing the state of each substance at room temperature and pressure (r.t.p = 25 °C, 101.3 kPa).

Substance	Melting point (^{o}C)	Boiling point (^{o}C)	State at r.t.p
D	30	112	solid
E	−90	2	gas
F	−8	77	liquid

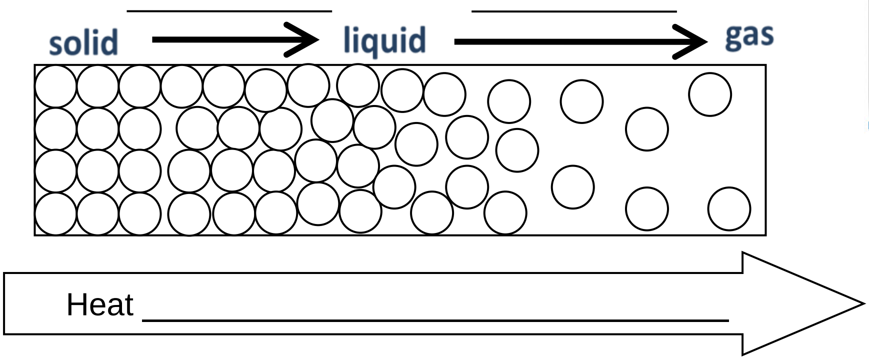
Try drawing the temperature line in the space provided.



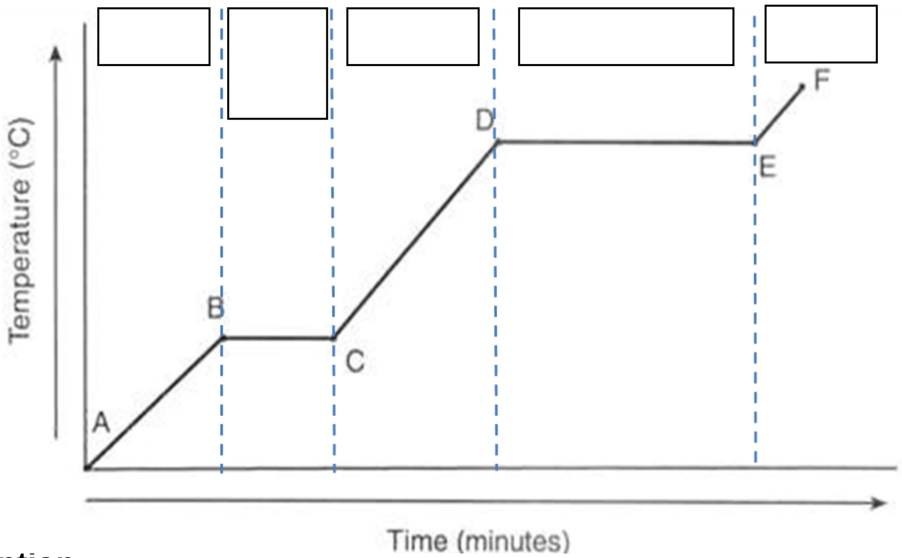
5 Using Particulate model of matter to *explain*: Changes in states of matter

a) Heating a solid

See - Think - Wonder

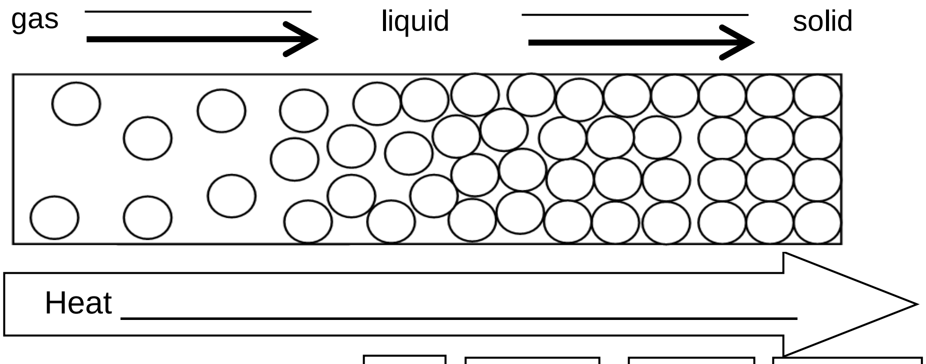


Heating curve

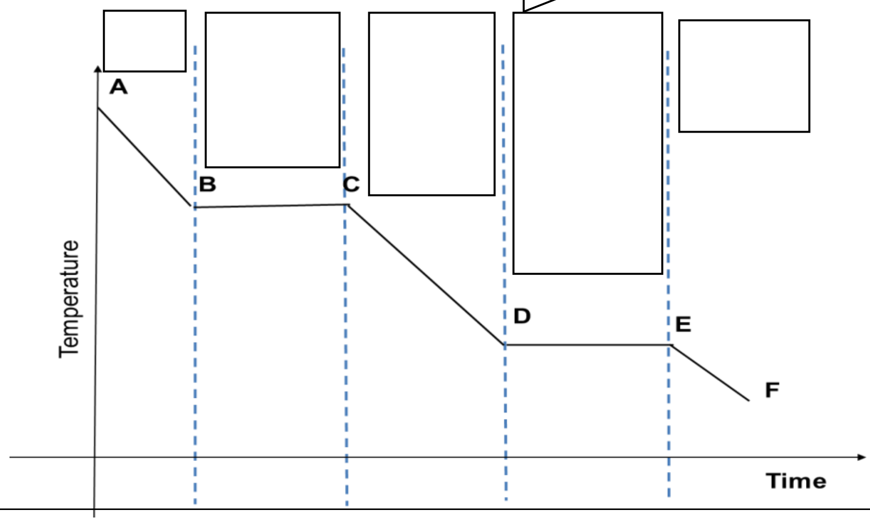


Stage	Description
AB	When solid is ***heated***, particles __________ heat energy and ______________________ at its _________________________. Heat absorbed causes _____________________________________.
BC	At ________________ of solid (change of state), heat energy ___________ is used to ____________ the strong forces of attraction between the particles. Temperature remains _______________ until the solid melts completely into a liquid at point C.
CD	When the liquid is ***heated***, particles ____________ heat energy and _________________________ more vigorously. Heat absorbed causes temperature to rise.
DE	At ____________________ of liquid (change of state), heat energy _____________ is used to ____________ the strong forces of attraction between the particles. Temperature remains __________ until the liquid boils completely into gas at point E.
EF	When the gas is further heated, particles gain heat energy and _____________________________.

b) Cooling a gas



Cooling curve



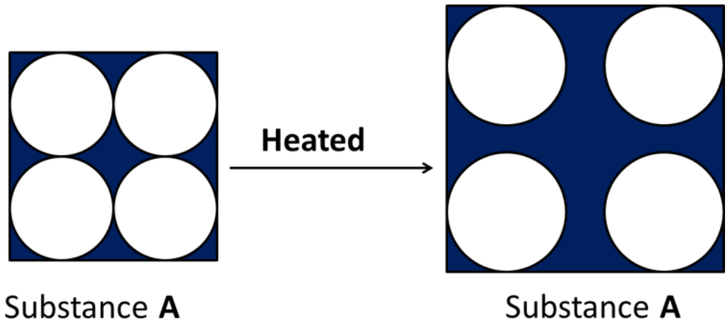
Stage	Description
AB	When the gas is ***cooled***, particles ______________ heat energy and move freely in all directions at ___________________________. Heat energy released causes temperature to fall.
BC	At _____________ point (change of state), heat energy ____________ is due to ________________ stronger forces of attraction between particles. Temperature remains _____________ until the gas condenses completely into liquid at point C.
CD	When the liquid is ________________, particles ______________ heat energy and _______________________________ more slowly. Thermal energy released causes temperature to fall.
DE	At ____________ point (change of state), heat energy _____________ is due to _______________ stronger forces of attraction between the particles. The stronger forces of attraction cause the particles to ___________________ to their _________ _____________________. Temperature remains ____________ until liquid freezes completely into solid at point E.
EF	When the solid is further cooled, particles ______________ heat energy and vibrate ____________ about their fixed positions. Thermal every released causes temperature to fall.

6 Using Particulate model of matter to *explain*: Expansion and Contraction

When heated …..

- Matter expands when it is ________________.

  ⇒ When heated, particles will __________ thermal energy, vibrate __________ vigorously and move __________ apart from one another.



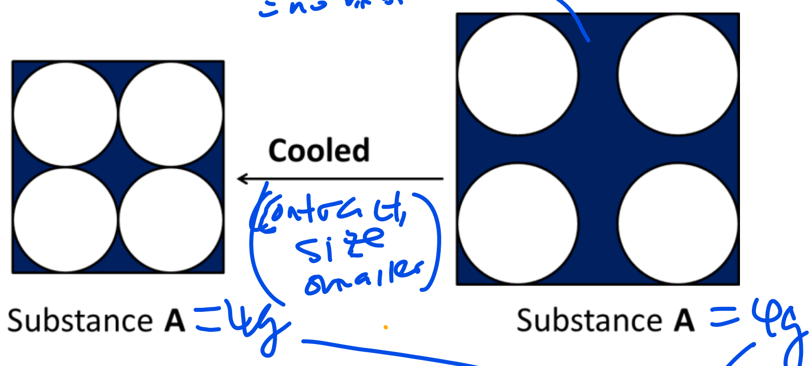
✓ Particles start to move faster
✓ Particles start to move further apart

When cooled …..

- Matter contracts when it is cooled.

  ⇒ When cooled, particles will lose thermal energy, vibrate about fixed position less vigorously and move closer to each other.

space = vacuum = no mass



✓ Particles start to move slower
✓ Particles start to move closer together

mass remains same

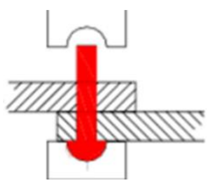
When heated or cooled, ONLY Volume and size **of matter changes:**

- Only the distance between particles increase when heated and decrease when cooled.
- Mass of matter is Conserved as size and number of particles remain the same.

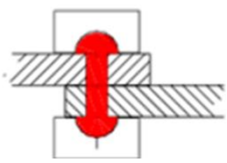
- Examples of expansion and contraction:

  a) ____________________ are placed in between slabs of concrete to prevent cracking of concrete.

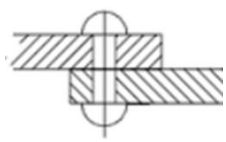
  b) ____________________ is a permanent mechanical fastener.



Metal rivet is **heated** and **expands.** It is **placed through** 2 metal plates.



The other end of the rivet is capped.



When the rivet **cools**, it **contracts** and **tightens** the two metal plates together.

7 Matter vs Particles

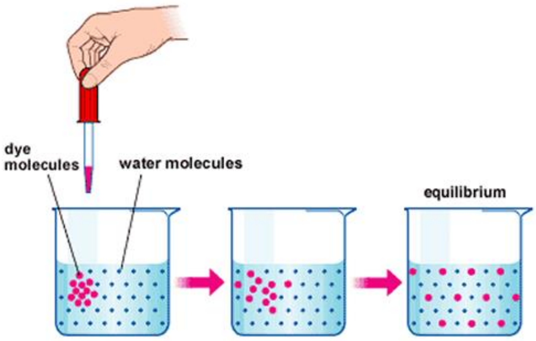
	Matter	Particles
Colour	Yes	No
Change in Temperature	Can be felt	No; but is depicted by the _______________ _______________ of particles.
Change in Size	Can be compressed or expanded	No; but is depicted by the ____________________ between the particles.

Challenge yourself!

Characteristics of Particles	**Solid**	**Liquid**	**Gas**
Forces of attraction			
Movement			
Arrangement			

8 Diffusion

A few drops of food dye is added to a beaker of water.



The dye spread throughout the beaker without stirring. Why?

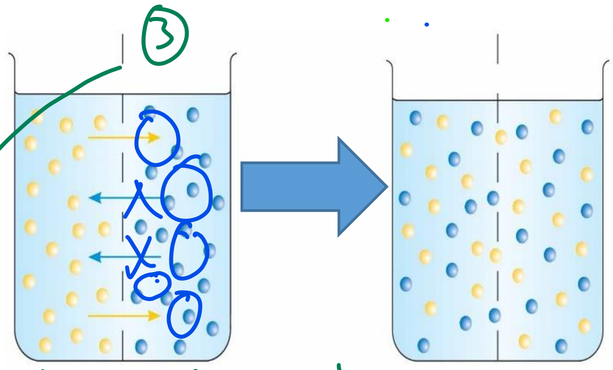
1. Initially the top of the cup has a high concentration of food dye. The food dye then moves downwards, to an area with low concentration of food dye.

Definition

- Diffusion is the ~~___~~ movement of molecules from a region of high concentration to a region of low concentration, down a concentration gradient.

high → low (natural process)

3



Diffusion can occur between:

2)
a) Solids
b) Liquids
c) Gases

all 3 states.

barrier [controls / dictates] the size of particles that can fit through pores, if too big to fit through, no diffusion for big molecules, only diffusing small ones.

The molecules will continue moving from a higher concentration to a lower concentration till equilibrium is reached (i.e. molecules are uniformly distributed).

= homogeneous ≡

Essential Takeaways

1. The Particulate Model of Matter is a simplified representation of matter composition.
2. Particulate Model of Matter is constructed to explain phenomena e.g. Melting & Boiling.
3. Particulate Model of Matter can be used to make prediction about matter and its behaviour.

Key Terms

Very small discrete particles	Movement / arrangement / distance of particles
Density and compressibility	Forces of attraction
Change of state	Melting point / boiling point
Vibrations about a fixed position	Slide past one another
Diffusion	higher concentration
lower concentration	net movement