CBSE Class 9 Science
Revision Notes
CHAPTER – 1
Matter in our Surroundings

- Anything that occupies space and has mass and is felt by senses is called matter.
- According to indian ancient philosphor, matter is the form of five basic elements (the Panchtatva) – air , earth ,fire , sky and water.

Characteristics of particles of matter

- Made of tiny particles.
- Vacant spaces exist between particles.
- Particles are in continuous motion.
- Particles are held together by forces of attraction.

States of Matter
Basis of Classification of Types

- Based upon particle arrangement
- Based upon energy of particles
- Based upon distance between particles

Five states of matter

1. Solid
2. Liquid
3. Gas
4. Plasma
5. Bose-Einstein condensate

(I) SOLID

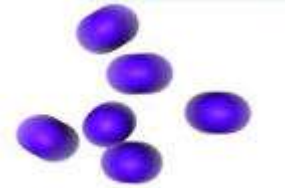
- Fixed mass, volume and shape
- Inter-particle distances are least.
- Incompressible.
- High density and do not diffuse

- Inter particle forces of attraction are strongest.
- Constituent particles are very closely packed.

(II) LIQUID

- Not fixed shape but fixed volume and mass.
- Inter particle distances are larger than solid.
- Almost incompressible.
- Density is lower than solids and can diffuse.
- Inter particle forces of attraction are weaker than solids .
- Constituent particles are less closely packed.

(III) GAS



- Neither fixed shape nor fixed volume.
- Inter particle distances are largest.
- Highly compressible.
- Density is least and diffuse.
- Inter particle forces of attraction are weakest.
- Constituent particles are free to move about.

(IV) PLASMA (NON-EVALUATIVE)

- A plasma is an ionized gas.
- A plasma is a very good conductor of electricity and is affected by magnetic fields.
- Plasma, like gases have an indefinite shape and an indefinite volume. Ex. Ionized gas

(v) BOSE-EINSTEIN CONDENSATE (non –evaluative)

- A **BEC** is a state of matter that can arise at very low temperatures.
- The scientists who worked with the Bose-Einstein condensate received a Nobel Prize for their work in 1995.

- The BEC is all about molecules that are really close to each other (even closer than atoms in a solid).

Microscopic Explanation for Properties of Solids

- Solids have a definite shape and a definite volume because the particles are locked into place
- Solids do not flow easily because the particles cannot move/slide past one another
- Solids are not easily compressible because there is little free space between particles

Microscopic Explanation for Properties of Liquids

- Liquids are not easily compressible and have a definite volume because there is little free space between particles.
- Liquids flow easily because the particles can move/slide past one another.
- Liquids flow easily because the particles can move/slide past one another.

Microscopic Explanation for Properties of Gases

- Gases are easily compressible because there is a great deal of free space between particles
- Gases flow very easily because the particles randomly move past one another.
- Gases have an indefinite shape and an indefinite volume because the particles can move past one another (non –evaluative)

Microscopic Explanation for Properties of Plasmas

- Plasmas have an indefinite shape and an indefinite volume because the particles can move past one another.
- Plasmas are easily compressible because there is a great deal of free space between particles.
- Plasmas are good conductors of electricity &are affected by magnetic fields because they are composed of lens.

Microscopic Explanation for Properties of BEC

- Particles are less energetic than solids because Exist at very low temperature.
- Particles are literally indistinguishable because they are locked into same space .

- BEC shows super fluidity because Particles can flow without friction.

1. **Interchange in states of matter**

Water can exist in three states of matter –

- Solid, as ice,
- Liquid, as the familiar water, and
- Gas, as water vapour.

Sublimation : The changing of solid directly into vapours on heating & vapours into solid on cooling. Ex. Ammonium chloride, camphor & iodine.

(a) Effect of change in temperature

The temperature effect on heating a solid varies depending on the nature of the solid & the conditions required in bringing the change.

- On increasing the temperature of solids, the kinetic energy of the particles increases which overcomes the forces of attraction between the particles thereby solid melts and is converted to a liquid.
- The temperature at which a solid melts to become a liquid at the atmospheric pressure is called its melting point.
- The melting point of ice is 273.16 K.
- The process of melting, that is, change of solid state into liquid state is also known as fusion.

(b) Effect of Change of Pressure

- Increasing or decreasing the pressure can change the state of matter. Applying pressure and reducing temperature can liquefy gases.
- Solid carbon dioxide (CO_2CO2) is stored under high pressure. Solid CO_2CO2 gets converted directly to gaseous state on decrease of pressure to 1 atmosphere without coming into liquid state. This is the reason that solid carbon dioxide is also known as dry ice.

Latent Heat :

The hidden heat which breaks the force of attraction between the ***molecules during*** change of state.

Fusion Heat energy required to change 1kg of solid into liquid.

Vaporisation Heat energy required to change 1kg of liquid to gas at atmospheric pressure at its boiling point

Thus, we can say that pressure and temperature determine the state of a substance, whether it will be solid, liquid or gas.

4. Evaporation & Boiling

- Particles of matter are always moving and are never at rest.
- At a given temperature in any gas, liquid or solid, there are particles with different amounts of kinetic energy.
- In the case of liquids, a small fraction of particles at the surface, having higher kinetic energy, is able to break away from the forces of attraction of other particles and gets converted into vapour .
- This phenomenon of change of a liquid into vapours at any temperature below its boiling point is called evaporation.

Factors Affecting Evaporation

- The rate of evaporation increases with an increase of surface area.
- With the increase of temperature, more number of particles get enough kinetic energy to go into the vapour state.
- Humidity is the amount of water vapour present in air. The air around us cannot hold more than a definite amount of water vapour at a given temperature. If the amount of water in air is already high, the rate of evaporation decreases.
- Wind speed : the higher the wind speed , the more evaporation.

Evaporation cause cooling.

- The particles of liquid absorb energy from the surrounding to regain the energy lost during evaporation,

Evaporation Vs Boiling

- Boiling is a bulk phenomenon. Particles from the bulk (whole) of the liquid change into vapour state.
- Evaporation is a surface phenomenon. Particles from the surface gain enough energy to overcome the forces of attraction present in the liquid and change into the vapour state.

5. Kelvin & Celsius Scale

- Kelvin is the SI unit of temperature, $0^\circ C$ = 273.16 K we take $0^\circ C$ = 273 K.
- SI unit of temperature is Kelvin. $T(K) = T(^0C) + 273$ T(K)=T(0C)+273
- Kelvin scale of temperature has always positive sign , hence regarded as better scale than Celsius.

- Atmosphere (atm) is a unit of measuring pressure exerted by a gas. The SI unit of pressure is Pascal (Pa):
- 1 atmosphere = 1.01 × (10 to the power 5) Pa. The pressure of air in atmosphere is called atmospheric pressure. The atmospheric pressure at sea level is 1 atmosphere, and is taken as the normal atmospheric pressure.

You are expected to know

- Particle nature of matter.
- All five states of matter & their behaviour
- enter conversion of states of matter
- Latent heat
- Conversion between Kelvin scale & Celsius scale

Intext Exercise 1

Question 1:

Which of the following are matter?
Chair, air, love, smell, hate, almonds, thought, cold, cold drink, smell of perfume.

Solution 1:

Anything that occupies space and has mass is called matter. Matter can exist in three physical states—solid, liquid, and gaseous.
Chair and almond are forms of matter in the solid state.
Cold drink is a liquid state of matter.
Air and smell of perfume are gaseous states of matter.
Note: The sense of smell is not matter. However, the smell or odour of a substance is classified as matter. The smell of any substance (say, perfume) is the gaseous form of that substance which our olfactory system can detect (even at very low concentrations). Hence, smell of perfume is matter.

Question 2:

Give reasons for the following observation:
The smell of hot sizzling food reaches you several metres away, but to get the smell from cold food you have to go close.

Solution 2:

Solids diffuse at a very slow rate. But, if the temperature of the solid is increased, then the rate of diffusion of the solid particles into air increases. This is due to an increase in the kinetic energy of solid particles. Hence, the smell of hot sizzling food reaches us even at a distance, but to get the smell from cold food we have to go close.

Question 3:

A diver is able to cut through water in a swimming pool. Which property of matter does this observation show?

Solution 3:

The ability of a diver to cut through water in a swimming pool shows that matter is made up of particles.

Question 4:

What are the characteristics of particles of matter?

Solution 4:

The characteristics of particles of matter are:
(i) Particles of matter have spaces between them.
(ii) Particles of matter are in continuous motion.
(iii) Particles of mater attract each other.

Intext Exercise 2

Question 1:

The mass per unit volume of a substance is called density (density = mass/volume). Arrange the following in order of increasing density − air, exhaust from chimney, honey, water, chalk, cotton, and iron.

Solution 1:

The given substances in the increasing order of their densities can be represented as:
Air < Exhaust from chimney < Cotton < Water < Honey < Chalk < Iron

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Question 2:

(a) Tabulate the differences in the characteristics of states of matter.
(b) Comment upon the following: rigidity, compressibility, fluidity, filling a gas container, shape, kinetic energy, and density.

Solution 2:

(a) The differences in the characteristics of states of matter are given in the following table.

S. No.	Solid state	Liquid state	Gaseous state
1.	Definite shape and volume.	No definite shape. Liquids attain the shape of the vessel in which they are kept.	Gases have neither a definite shape nor a definite volume.
2.	Incompressible	Compressible to a small extent.	Highly compressible
3.	The intermolecular distance is least	The intermolecular distance is greater	The intermolecular distance is maximum
4.	These particles attract each other very strongly.	The force of attraction between liquid particles is less than solid particles.	The force of attraction is least between gaseous particles.
5.	Particles of solid cannot move freely.	These particles move freely.	Gaseous particles are in a continuous, random motion.

(b) Rigidity can be expressed as the tendency of matter to resist a change in shape.
Compressibility is the ability to be reduced to a lower volume when force is applied.
Fluidity is the ability to flow.
By filling a gas container we mean the attainment of shape of the container by gas.
Shape defines a definite boundary.
Kinetic energy is the energy possessed by a particle due to its motion.

$K.E. = \frac{1}{2}mv^2$ m= mass of the particle, v= velocity of the particle

Density is mass per unit volume.

Question 3:

Give reasons:

(a) A gas fills completely the vessel in which it is kept.

(b) A gas exerts pressure on the walls of the container.

(c) A wooden table should be called a solid.

(d) We can easily move our hand in air, but to do the same through a solid block of wood, we need a karate expert.

Solution 3:

(a) There is little attraction between particles of gas. Thus, gas particles move freely in all directions. Therefore, gas completely fills the vessel in which it is kept.

(b) The gas particles are in random motion due to weak intermolecular force of attraction. These gaseous molecules continuously collide among themselves and they hit the walls of the container with a greater force.

Therefore, gas exerts pressure on the walls of the container.

(c) A wooden table has a definite shape and volume. It is very rigid and cannot be compressed i.e., it has the characteristics of a solid. Hence, a wooden table should be called a solid.

(d) Particles of air have large spaces between them. On the other hand, wood has little space between its particles. Also, it is rigid. For this reason, we can easily move our hands in air, but to do the same through a solid block of wood, we need a karate expert.

Question 4:

Liquids generally have lower density as compared to solids. But you must have observed that ice floats on water. Find out why.

Solution 4:

The mass per unit volume of a substance is called density (density = mass/volume).

As the volume of a substance increases, its density decreases.

Though ice is a solid, it has large number of empty spaces between its particles.

These spaces are larger as compared to the spaces present between the particles of water.

Thus, the volume of ice is greater than that of water. Hence, the density of ice is less than that of water. A substance with lower density than water can float on water. Therefore, ice floats on water.

Intext Exercise 3

Question 1:

Convert the following temperature to Celsius scale:

(a) 300 K

(b) 573 K

Solution 1:

(a) 300 K = (300 − 273)°C
= 27°C
(b)573 K = (573 − 273)°C
= 300°C

Question 2:
What is the physical state of water at:
(a) 250°C
(b) 100°C

Solution 2:
(a) Water at 250°C exists in gaseous state.
(b) At 100°C, water can exist in both liquid and gaseous form. At this temperature, after getting the heat equal to the latent heat of vaporization, water starts changing from liquid state to gaseous state.

Question 3:
For any substance, why does the temperature remain constant during the change of state?

Solution 3:
During a change of state, the temperature remains constant. This is because all the heat supplied to increase the temperature is utilised in changing the state by overcoming the forces of attraction between the particles. Therefore, this heat does not contribute in increasing the temperature of the substance.

Question 4:
Suggest a method to liquefy atmospheric gases.

Solution 4:
By applying pressure and reducing the temperature, atmospheric gases can be liquefied.

Intext Exercise 4

Question 1:
Why does a desert cooler cool better on a hot dry day?

Solution 1:
When a liquid evaporates, the particles of the liquid absorb energy from the surroundings to compensate the loss of energy during evaporation. This makes the surroundings cool.
In a desert cooler, the water inside it is made to evaporate. This leads to absorption of energy from the surroundings, thereby cooling the surroundings. Again, we know that evaporation depends on the amount of water vapour present in air (humidity). If the amount of water vapour present in air is less, then evaporation is more. On a hot dry day, the amount of water

vapour present in air is less. Thus, water present inside the desert cooler evaporates more, thereby cooling the surroundings more. That is why a desert cooler cools better on a hot dry day.

Question 2:

How does water kept in an earthen pot (matka) become cool during summers?

Solution 2:

There are some pores in an earthen pot through which the liquid inside the pot evaporates. This evaporation makes the water inside the pot cool. In this way, water kept in an earthen pot becomes cool during summers.

Question 3:

Why does our palm feel cold when we put some acetone or petrol or perfume on it?

Solution 3:

Organic compounds are covalently bonded and are volatile in nature. When we put some acetone or petrol or perfume on our palm, it evaporates. During evaporation, particles of the liquid absorb energy from the surrounding or the surface of the palm to compensate for the loss of energy, making the surroundings cool. Hence, our palm feels cold when we put some acetone or petrol or perfume on it.

Question 4:

Why are we able to sip hot tea or milk faster from a saucer than a cup?

Solution 4:

A liquid has a larger surface area in a saucer than in a cup. Thus, it evaporates faster and cools faster in a saucer than in a cup. For this reason, we are able to sip hot tea or milk faster from a saucer than a cup.

Question 5:

What type of clothes should we wear in summers?

Solution 5:

We should wear cotton clothes in summers. During summers, we sweat more. On the other hand, cotton is a good absorber of water. Thus, it absorbs sweat from our body and exposes the liquid to the atmosphere, making evaporation faster. During this evaporation, particles on the surface of the liquid gain energy from our body surface, making the body cool.

NCERT Exercise

Question 1:

Convert the following temperatures to Celsius scale.

(a) 300 K

(b) 573 K

Solution 1:

Kelvin is an SI unit of temperature, where 0°C = 273.16 K (approximately 273 K)

(a) 300 K = (300 − 273) °C

= 27 °C

(b) 573 K = (573 − 273) °C

= 300 °C

Question 2:

Convert the following temperatures to Kelvin scale.

(a) 25°C

(b) 373°C

Solution 2:

Kelvin is an SI unit of temperature, where 0°C = 273.16 K (approximately 273 K)

(a) 25 °C = (25 + 273) K

= 298 K

(b) 373 °C = (373 + 273) K

= 646 K

Question 3:

Give reason for the following observations.

(a) Naphthalene balls disappear with time without leaving any solid.

(b) We can get the smell of perfume sitting several metres away.

Solution 3:

(a) Naphthalene undergoes sublimation easily i.e., the change of state of naphthalene from solid to gas takes place easily. Thus, naphthalene balls disappear with time without leaving any solid.

(b) Gaseous particles possess high speed and large spaces between them. Particles of perfume diffuse into these gaseous particles at a very fast rate and reach our nostrils. This enables us to smell the perfume from a distance.

Question 4:

Arrange the following substances in increasing order of forces of attraction between particles − water, sugar, oxygen.

Solution 4:

Sugar is a solid; the forces of attraction between the particles of sugar are strong.

Water is a liquid; the forces of attraction here are weaker than sugar. Oxygen is a gas; the forces of attraction are the weakest in gases.

Thus, the increasing order of forces of attraction between the particles of water, sugar and oxygen is Oxygen < Water < Sugar

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Question 5:

What is the physical state of water at
(a) 25°C
(b) 0°C
(c) 100°C

Solution 5:

(a) Water at 25°C is present in the liquid state.
(b) At 0 °C, water can exist as both solid and liquid. At this temperature, after getting the heat equal to the latent heat of fusion, the solid form of water i.e., ice starts changing into its liquid form i.e., water.
(c) At 100 °C, water can exist as both liquid and gas. At this temperature, after getting the heat equal to the latent heat of vaporization, water starts changing from its liquid state to its gaseous state, i.e., water vapours.

Question 6:

Give two reasons to justify–
(a) water at room temperature is a liquid.
(b) an iron almirah is a solid at room temperature.

Solution 6:

(a) At room temperature (25 °C), water is a liquid because it has the following characteristic of liquid:
(i) At room temperature, water has no shape but has a fixed volume that is, it occupies the shape of the container in which it is kept.
(ii) At room temperature, water flows.
(b) An iron almirah is a solid at room temperature (25 °C) because:
(i) it has a definite shape and volume like a solid at room temperature.
(ii) it is rigid as solid at room temperature.

Question 7:

Why is ice at 273 K more effective in cooling than water at the same temperature?

Solution 7:

Ice at 273 K has less energy than water (although both are at the same temperature). Water possesses the additional latent heat of fusion. Hence, at 273 K, ice is more effective in cooling than water.

Question 8:

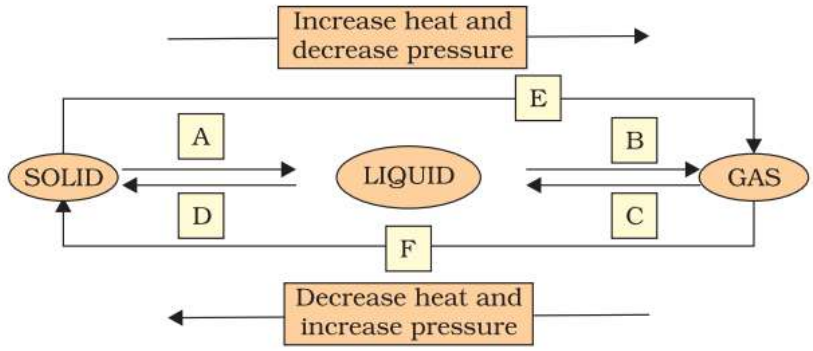
What produces more severe burns, boiling water or steam?

Solution 8:

Steam has more energy than boiling water. It possesses the additional latent heat of vaporization. Therefore, burns produced by steam are more severe than those produced by boiling water.

Question 9:

Name A, B, C, D, E and F in the following diagram showing change in its state.



Solution 9: