



Class: 9th

Subject: Physics

Chapter 7: Thermal Properties of Matter

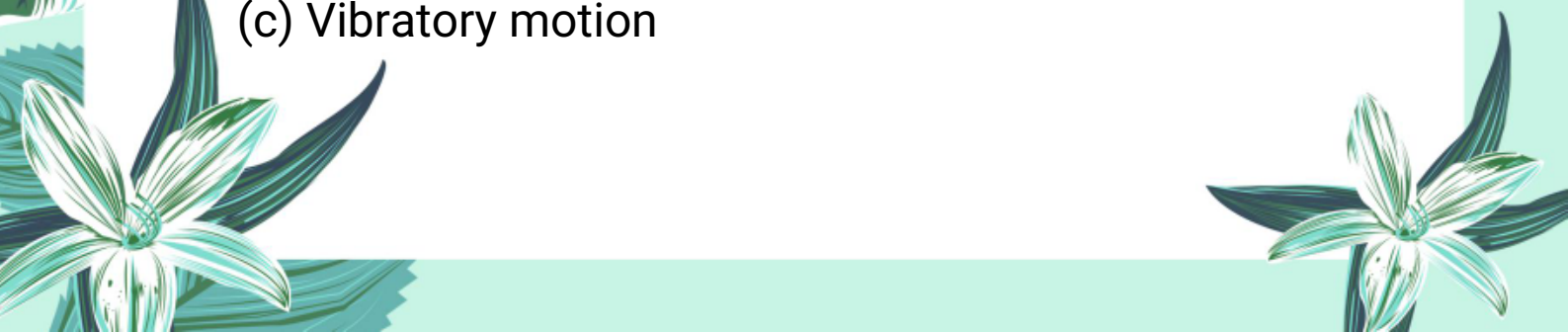


A Exercise MCQs

7.1. How do the molecules in a solid behave?

- (a) Move randomly
- (b) Vibrate about their mean positions
- (c) Rotate and vibrate randomly at their own positions
- (d) Move in a straight line from hot to cold ends

7.2. What type of motion is of the molecules in a gas?

- (a) Linear motion
 - (b) Random motion
 - (c) Vibratory motion
- 



(d) Rotatory motion

7.3. Temperature of a substance is:

(a) The total amount of heat contained in it

(b) The total number of molecules in it

(c) Degree of hotness or coldness

(d) Dependent upon the intermolecular distance

7.4. Heat is the:

(a) Total kinetic energy of the molecules

(b) The internal energy

(c) Work done by the molecules

(d) The energy in transit

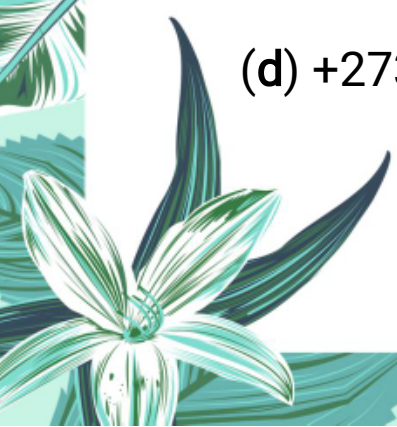
7.5. In Kelvin scale, the temperature corresponding to melting point of ice is:

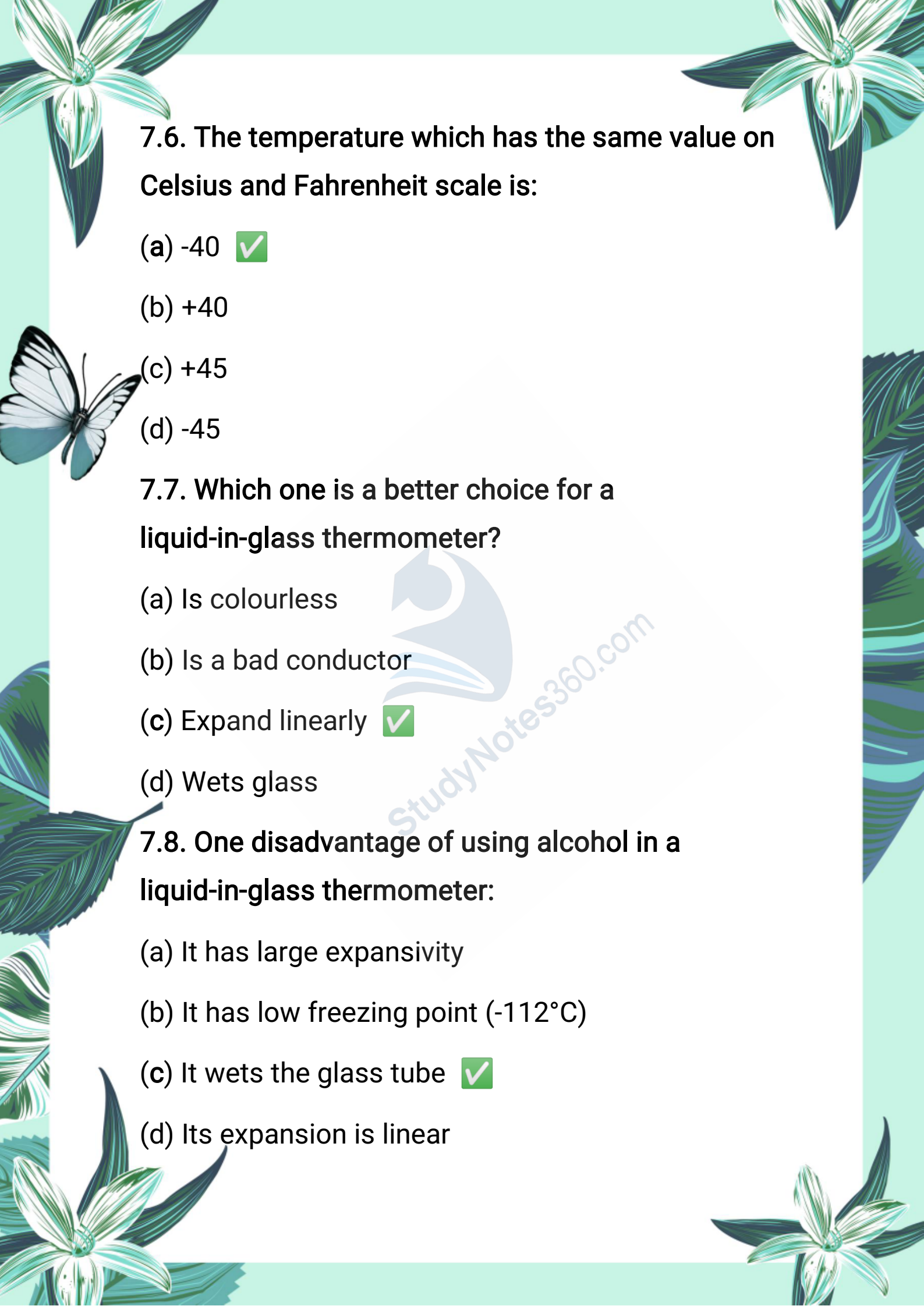
(a) Zero

(b) 32

(c) -273

(d) +273



The page features decorative illustrations of white flowers with green leaves in the corners and a butterfly on the left side. A large, faint watermark of a bird is visible in the center background.

7.6. The temperature which has the same value on Celsius and Fahrenheit scale is:

(a) -40

(b) +40

(c) +45

(d) -45

7.7. Which one is a better choice for a liquid-in-glass thermometer?

(a) Is colourless

(b) Is a bad conductor

(c) Expand linearly

(d) Wets glass

7.8. One disadvantage of using alcohol in a liquid-in-glass thermometer:

(a) It has large expansivity

(b) It has low freezing point (-112°C)

(c) It wets the glass tube

(d) Its expansion is linear



7.9. Water is not used as a thermometric liquid mainly due to:

- (a) Colourless
- (b) A bad conductor of heat
- (c) Non-linear expansion
- (d) A low boiling point (100°C)

7.10. A thermometer has a narrow capillary tube so that it:

- (a) Quickly responds to temperature changes
- (b) Can read the maximum temperature
- (c) Gives a large change for a given temperature rise
- (d) Can measure a large range of temperature

7.11. Which thermometer is most suitable for recording rapidly varying temperature?

- (a) Thermocouple thermometer
- (b) Mercury-in-glass laboratory thermometer
- (c) Alcohol-in-glass thermometer

(d) Mercury-in-glass clinical thermometer

Important MCQs:

1. The theory that explains the motion of particles in matter is called:

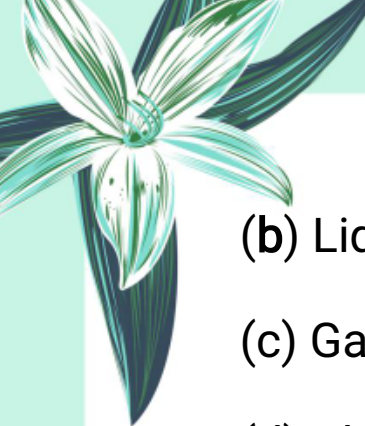
- (a) Newton's Theory
- (b) Theory of Kinetic Energy
- (c) Molecular Theory
- (d) Kinetic Molecular Theory

2. When a substance is heated, the kinetic energy of its molecules:

- (a) Decreases
- (b) Remains constant
- (c) Increases
- (d) Disappears

3. Which of the following states of matter has definite volume but no definite shape?

- (a) Solid




(b) Liquid

(c) Gas

(d) Plasma

4. Plasma is a state of matter that contains:



(a) Neutral atoms only

(b) Only molecules

(c) Positive ions and free electrons

(d) No particles

5. In which state of matter are the molecules very far apart from each other?

(a) Solid

(b) Liquid


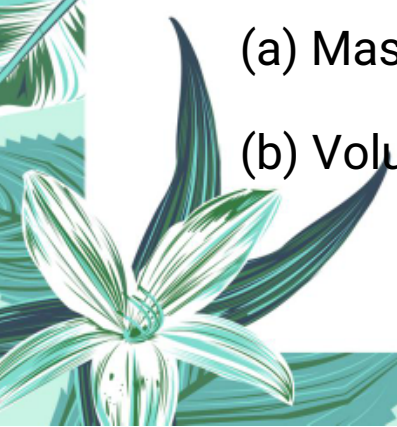
(c) Gas

(d) Plasma

6. When the temperature of a substance increases, its _____ also increases.

(a) Mass

(b) Volume





(c) Internal energy

(d) Shape

7. Heat is transferred from one object to another due to:



(a) Difference in mass

(b) Pressure difference

(c) Temperature difference

(d) Size of molecules

8. Temperature is defined as:

(a) Stored energy in an object

(b) Total energy of all molecules

(c) A quantity that determines the direction of heat flow

(d) The speed of particles

9. The sum of kinetic and potential energy of the molecules of a substance is called:

(a) Heat

(b) Pressure






(c) Temperature

(d) Internal energy

10. Which of the following is a natural example of plasma?



(a) Ice

(b) Water

(c) The Sun

(d) Glass

11. What does the Kinetic Molecular Theory state about matter?

(a) Matter is continuous and static

(b) Matter is composed of atoms at rest

(c) Matter is composed of molecules in constant motion

(d) Matter is weightless

12. Which type of motion do solid particles exhibit?

(a) Rotational motion

(b) Linear motion





(c) Circular motion

(d) Vibrational motion

13. What happens to the kinetic energy of molecules when a substance is heated?



(a) It decreases

(b) It remains unchanged

(c) It increases

(d) It disappears

14. Which state of matter has a definite volume but no definite shape?

(a) Solid

(b) Liquid

(c) Gas

(d) Plasma

15. Why does a gas have neither definite volume nor definite shape?

(a) Because its molecules are at rest

(b) Because its molecules are tightly packed





(c) Because its molecules are far apart

(d) Because it has high density

16. What is plasma?



(a) A neutral state of matter

(b) A solid with free electrons

(c) A gas with ionized particles

(d) A cold liquid

17. Which of the following is a natural source of plasma?

(a) The Moon

(b) The Sun

(c) Water

(d) Earth's crust

18. What determines the direction of heat flow?

(a) Mass

(b) Pressure

(c) Temperature


(d) Volume





19. What is internal energy?

- (a) Energy stored in the nucleus
- (b) Energy due to light
- (c) Sum of kinetic and potential energy of molecules
- (d) Energy from sound waves



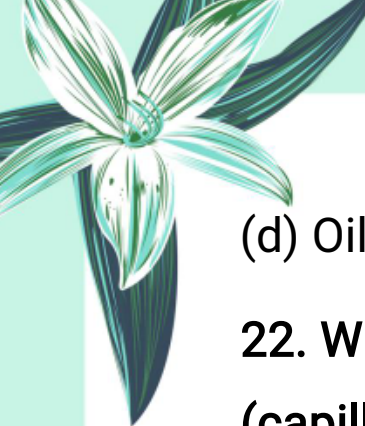
20. When heat is transferred to a substance, its internal energy:

- (a) Decreases
- (b) Remains the same
- (c) Increases
- (d) Disappears

21. Which liquid is commonly used in thermometers due to its visible silvery color and uniform expansion?

- (a) Water
- (b) Alcohol
- (c) Mercury





(d) Oil

22. What is the main reason for keeping the bore (capillary tube) of a thermometer narrow?

(a) To increase visibility

(b) To reduce cost

(c) To restrict mercury movement

(d) To detect small changes in temperature



23. What are the two fixed points used to construct a temperature scale?

(a) Boiling point of oil and freezing point of alcohol

(b) Steam point and ice point

(c) Room temperature and body temperature



(d) Melting point of mercury and freezing point of water

24. What is the range of the Fahrenheit scale?

(a) 0 to 100

(b) 32 to 212

(c) 273 to 373





(d) 100 to 180


35. Why is mercury preferred over alcohol in thermometers?

(a) It is cheaper than alcohol

(b) It evaporates quickly

(c) It sticks to glass

(d) It does not wet glass and is visible



36. What does the sensitivity of a thermometer refer to?

(a) Its ability to read high temperatures

(b) Its ability to detect small temperature changes



(c) Its ability to cool quickly

(d) Its ability to display values in Fahrenheit

37. A thermometer with scale markings at every 0.1°C is said to be:

(a) Less sensitive

(b) Highly sensitive





(c) Insensitive

(d) Inaccurate

38. What is the typical range of a clinical thermometer?



(a) -10°C to 110°C

(b) 0°C to 100°C

(c) 35°C to 45°C

(d) 0°C to 50°C

39. Mercury is suitable for long-range thermometers because it:

(a) Boils at a very low temperature

(b) Has low freezing and high boiling points

(c) Is less dense

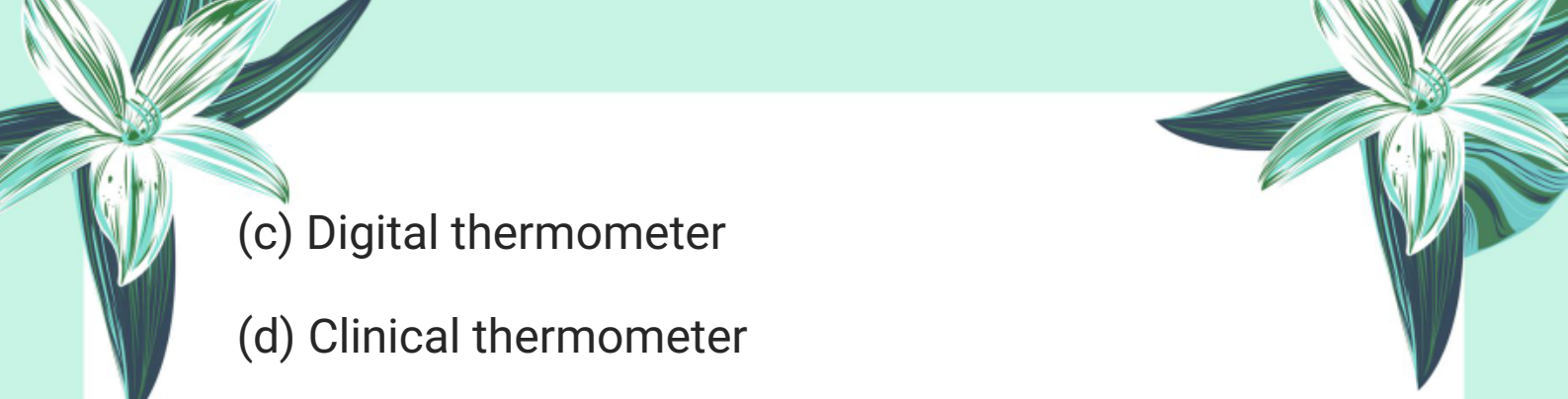
(d) Has a high specific heat

40. Which thermometer is more suitable for measuring extremely low temperatures?


(a) Alcohol thermometer

(b) Mercury thermometer




- 
- (c) Digital thermometer
 - (d) Clinical thermometer

41. Linearity in a thermometer means:

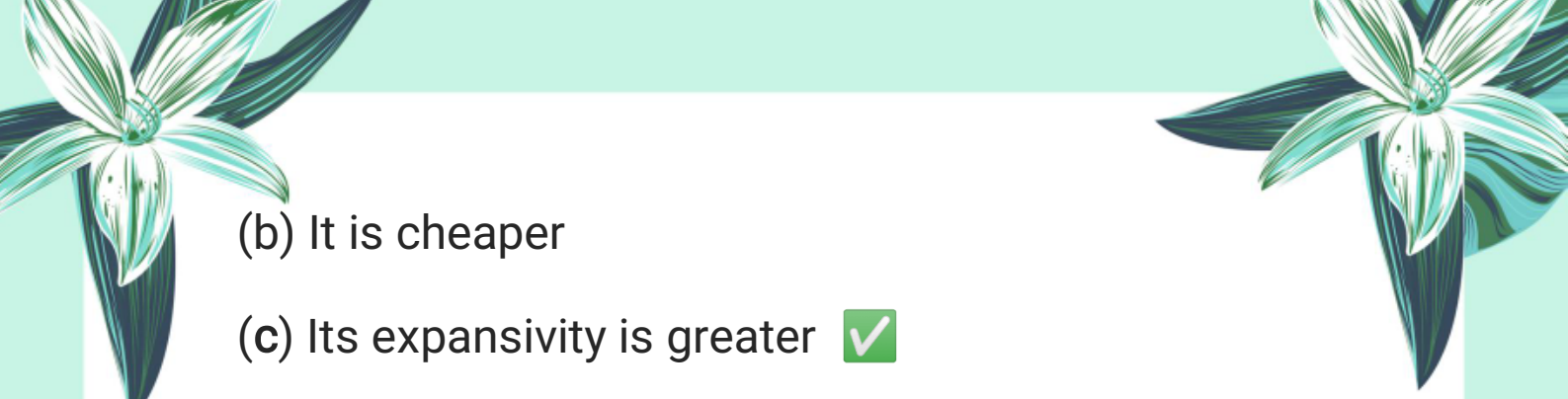
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- (a) It reads only even temperatures
 - (b) It gives different values for the same temperature
 - (c) Equal temperature changes result in equal scale readings
 - (d) It uses curved markings on the scale

42. Why is the bore (capillary tube) of a thermometer made narrow and uniform?


- 
- (a) To reduce cost
 - (b) To ensure linear and visible expansion of liquid
 - (c) To store more liquid
 - (d) To prevent mercury from freezing

43. Why is alcohol more sensitive than mercury in thermometers?


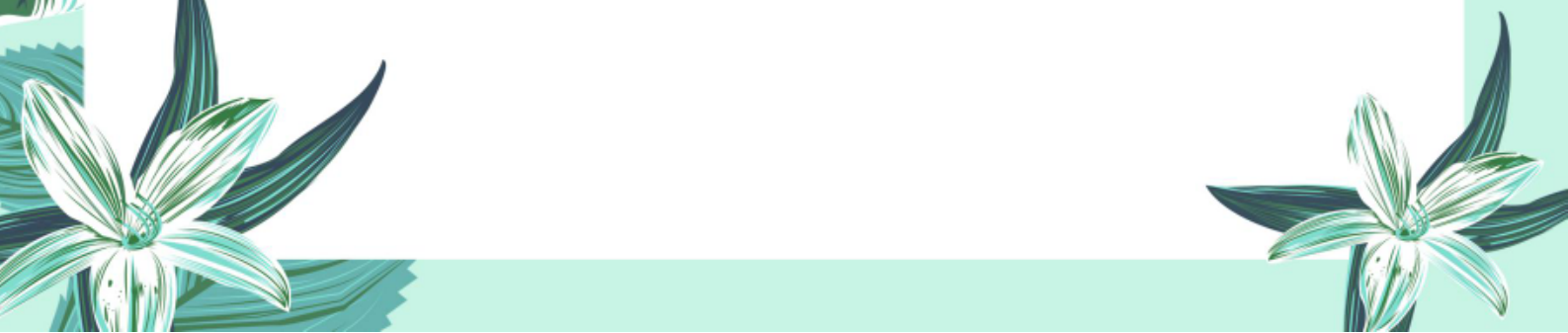
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- (a) It has higher boiling point

- 
- (b) It is cheaper
 - (c) Its expansivity is greater
 - (d) It is non-toxic

44. What property of mercury makes it respond quickly to temperature changes?

- 
- (a) Its silver color
 - (b) Its high density
 - (c) It being a good conductor of heat
 - (d) Its low cost

45. Which of the following correctly matches the property with its importance in a thermometer?

- 
- (a) Sensitivity – Wide temperature range
 - (b) Range – Ability to detect small temperature changes
 - (c) Linearity – Even spacing of scale readings
 - (d) Mercury – Suitable for very low temperatures only
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B Exercise Short Questions

7.1. Why solids have a fixed volume and shape according to particle theory of matter?

Solids have fixed volume and shape because their particles are closely packed and held tightly in fixed positions, allowing only vibrations.

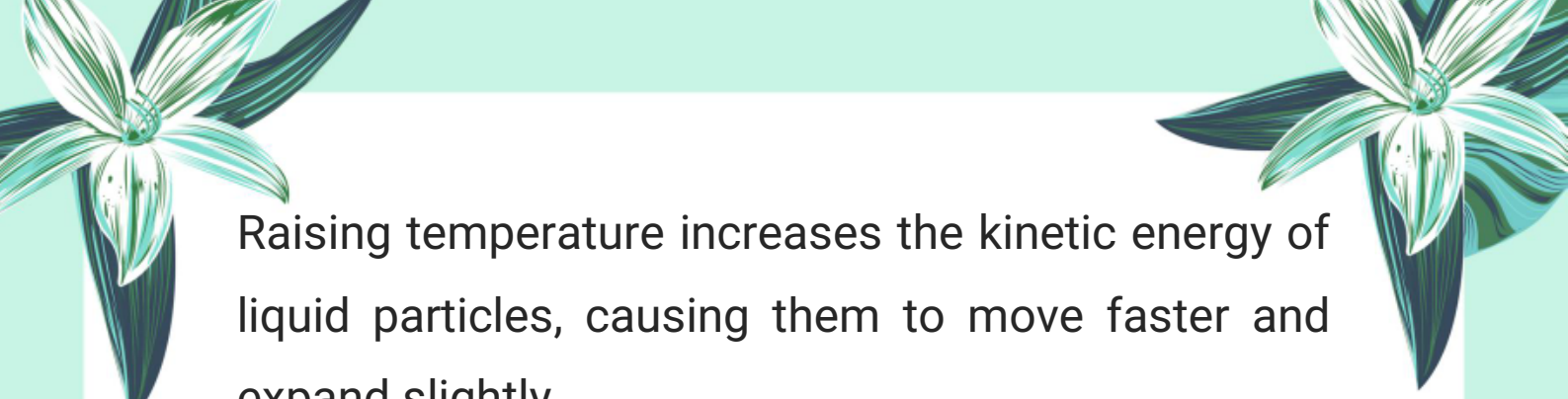
7.2. What are the reasons that gases have neither a fixed volume nor a fixed shape?

Gas particles move freely and are far apart with weak forces between them, so gases expand to fill any container and have no fixed shape or volume.

7.3. Compare the spacing of molecules in the solid, liquid and gaseous state.


In solids, particles are closely packed with little space. In liquids, particles are close but can move past each other. In gases, particles are far apart with large spaces.

7.4. What is the effect of raising the temperature of a liquid?



Raising temperature increases the kinetic energy of liquid particles, causing them to move faster and expand slightly.

7.5. What is meant by temperature of a body?



Temperature is a measure of the average kinetic energy (degree of hotness or coldness) of particles in a body.

7.6. Define heat as 'energy in transit'.

Heat is energy that flows from a hotter body to a colder body due to temperature difference.

7.7. What is meant by thermometric property of a substance? Enlist some thermometric properties.

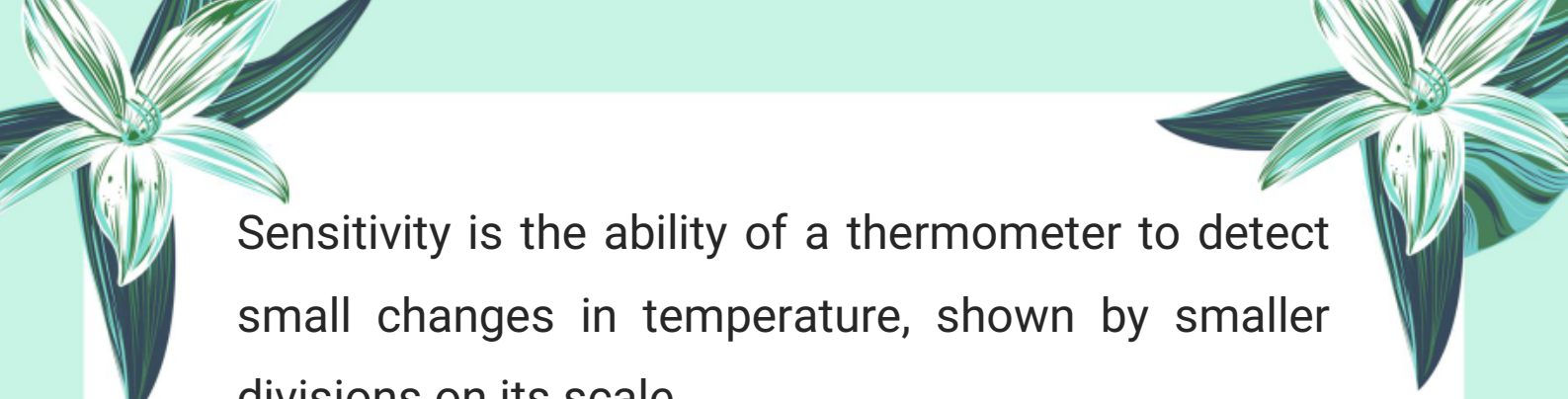
Thermometric property is a physical property that changes with temperature. **Examples:** volume expansion, electrical resistance, pressure of gas.

7.8. State the main scales used for the measurement of temperature.

The main temperature scales are Celsius ($^{\circ}\text{C}$), Fahrenheit ($^{\circ}\text{F}$), and Kelvin (K).


7.9. What is meant by sensitivity of a thermometer?





Sensitivity is the ability of a thermometer to detect small changes in temperature, shown by smaller divisions on its scale.

7.10. What do you mean by the linearity of a thermometer?



Linearity means the scale readings increase proportionally with temperature changes; equal increments in temperature show equal scale divisions.

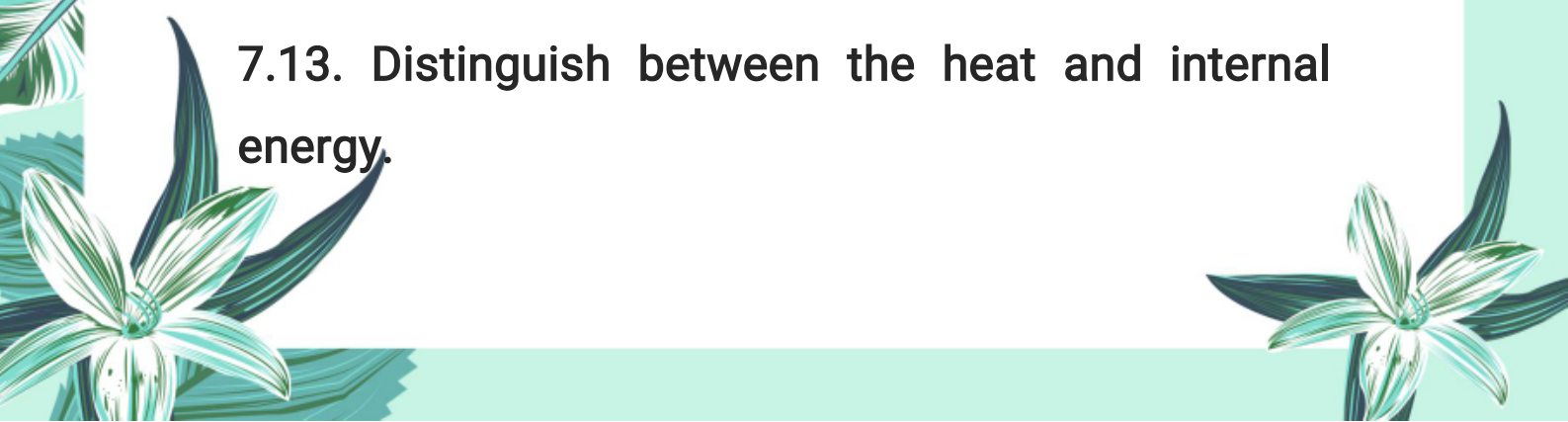
7.11. What makes the scale reading of a thermometer accurate?

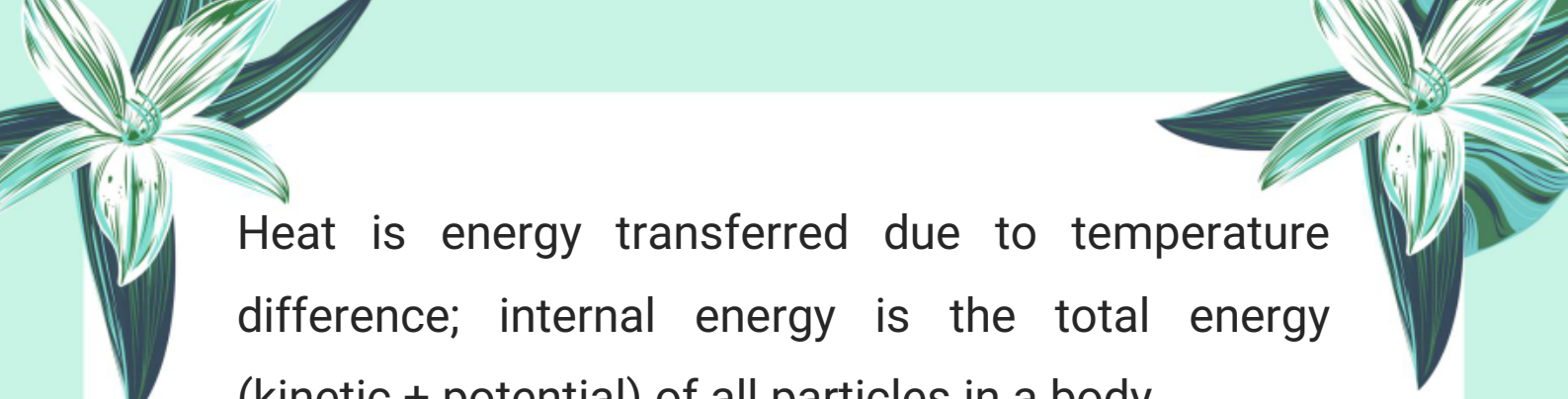
Accurate scale readings depend on uniform expansion of the liquid and evenly spaced scale marks.

7.12. What does determine the direction of heat flow?


Heat always flows from a hotter object to a colder one.

7.13. Distinguish between the heat and internal energy.





Heat is energy transferred due to temperature difference; internal energy is the total energy (kinetic + potential) of all particles in a body.



7.14. When you touch a cold surface, does cold travel from the surface to your hand or does energy travel from your hand to cold surface?

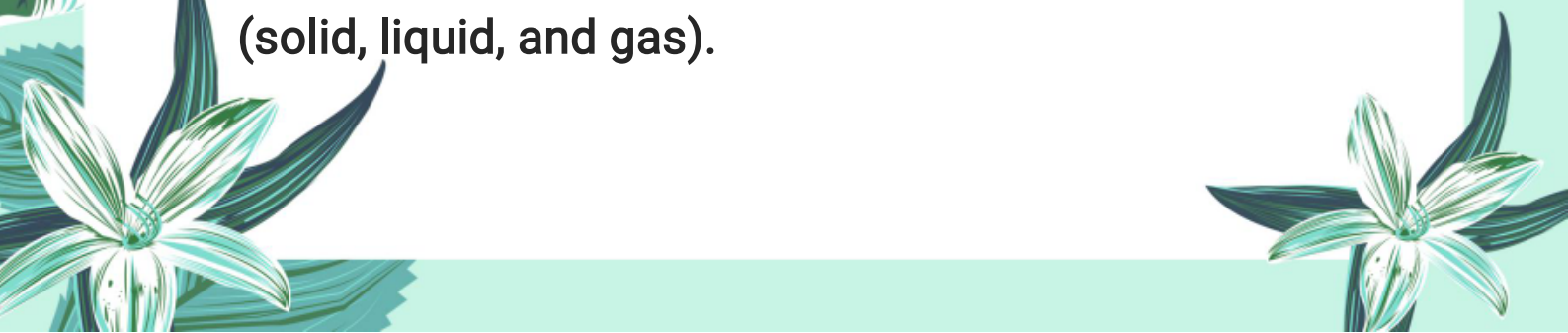
Energy travels from your warmer hand to the colder surface, making your hand feel cold.

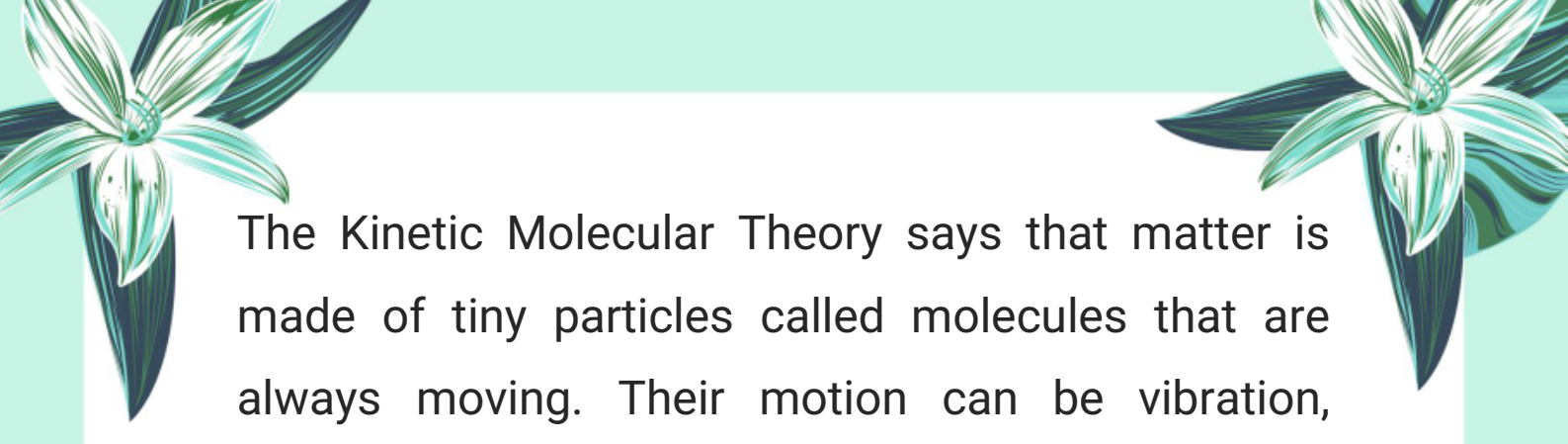
7.15. Can you feel your fever by touching your own forehead? Explain.

No, because your hand and forehead are at almost the same temperature; temperature difference is needed to feel hot or cold.

Important Long Questions:

Q1. Explain the Kinetic Molecular Theory of Matter and how it describes the three states of matter (solid, liquid, and gas).



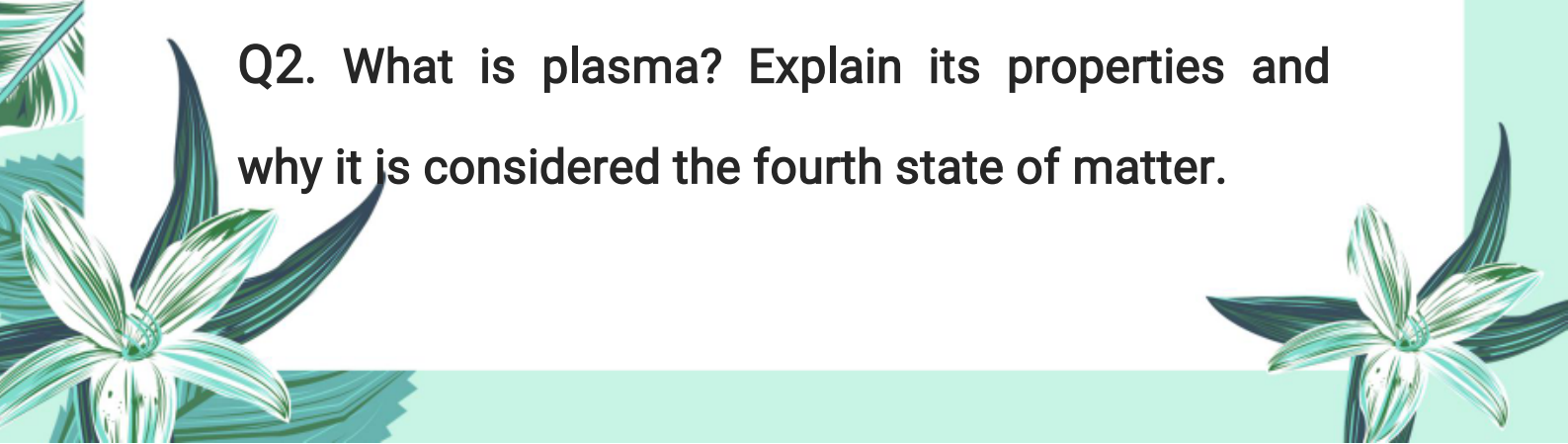


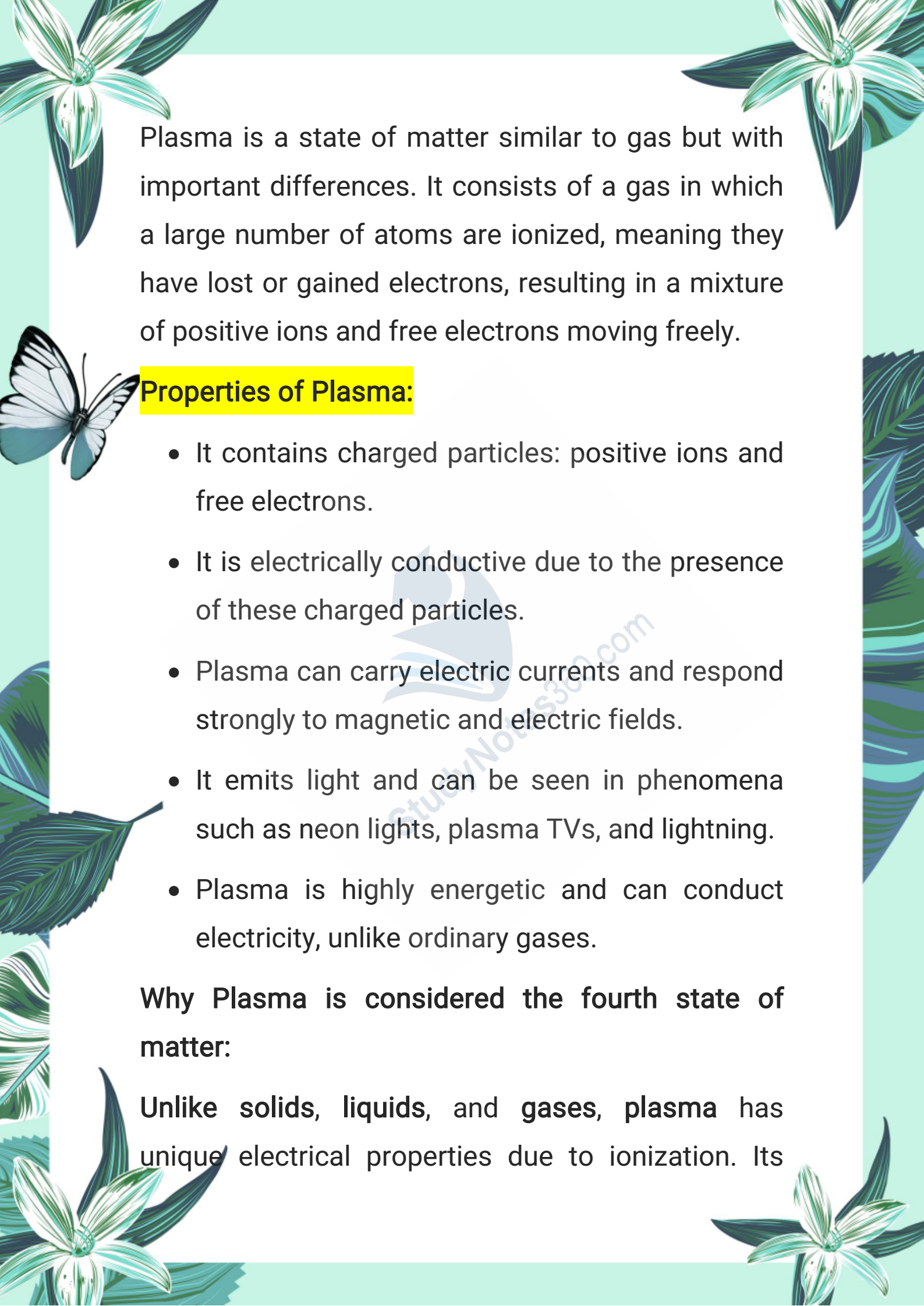
The Kinetic Molecular Theory says that matter is made of tiny particles called molecules that are always moving. Their motion can be vibration, rotation, or straight-line movement. The molecules attract each other with forces that weaken as they get farther apart.

- In **solids**, molecules are tightly packed and vibrate in fixed positions, so solids have a fixed shape and volume.
- In **liquids**, molecules are close but can slide past each other, so liquids have a fixed volume but take the shape of their container.
- In **gases**, molecules are far apart and move freely, so gases have neither fixed shape nor volume.

The theory explains how the motion and forces between molecules determine the state and properties of matter.

Q2. What is plasma? Explain its properties and why it is considered the fourth state of matter.



The page is decorated with various illustrations. In the top corners, there are stylized flowers with long, narrow petals. On the left side, there is a butterfly with white wings and black markings. The bottom corners also feature floral designs. The background is a light teal color with a subtle pattern of leaves and flowers.

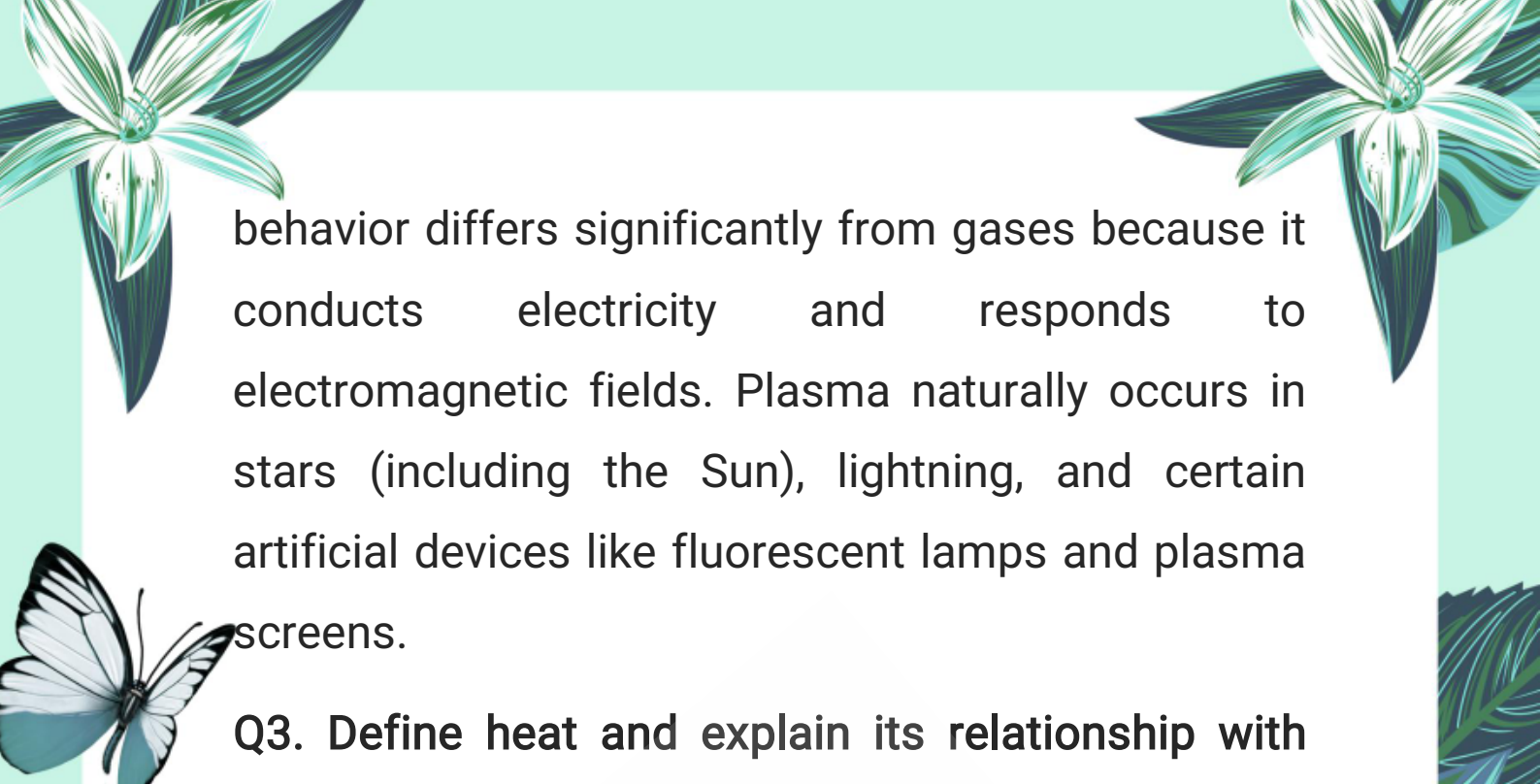
Plasma is a state of matter similar to gas but with important differences. It consists of a gas in which a large number of atoms are ionized, meaning they have lost or gained electrons, resulting in a mixture of positive ions and free electrons moving freely.

Properties of Plasma:


- It contains charged particles: positive ions and free electrons.
- It is electrically conductive due to the presence of these charged particles.
- Plasma can carry electric currents and respond strongly to magnetic and electric fields.
- It emits light and can be seen in phenomena such as neon lights, plasma TVs, and lightning.
- Plasma is highly energetic and can conduct electricity, unlike ordinary gases.

Why Plasma is considered the fourth state of matter:

Unlike solids, liquids, and gases, plasma has unique electrical properties due to ionization. Its

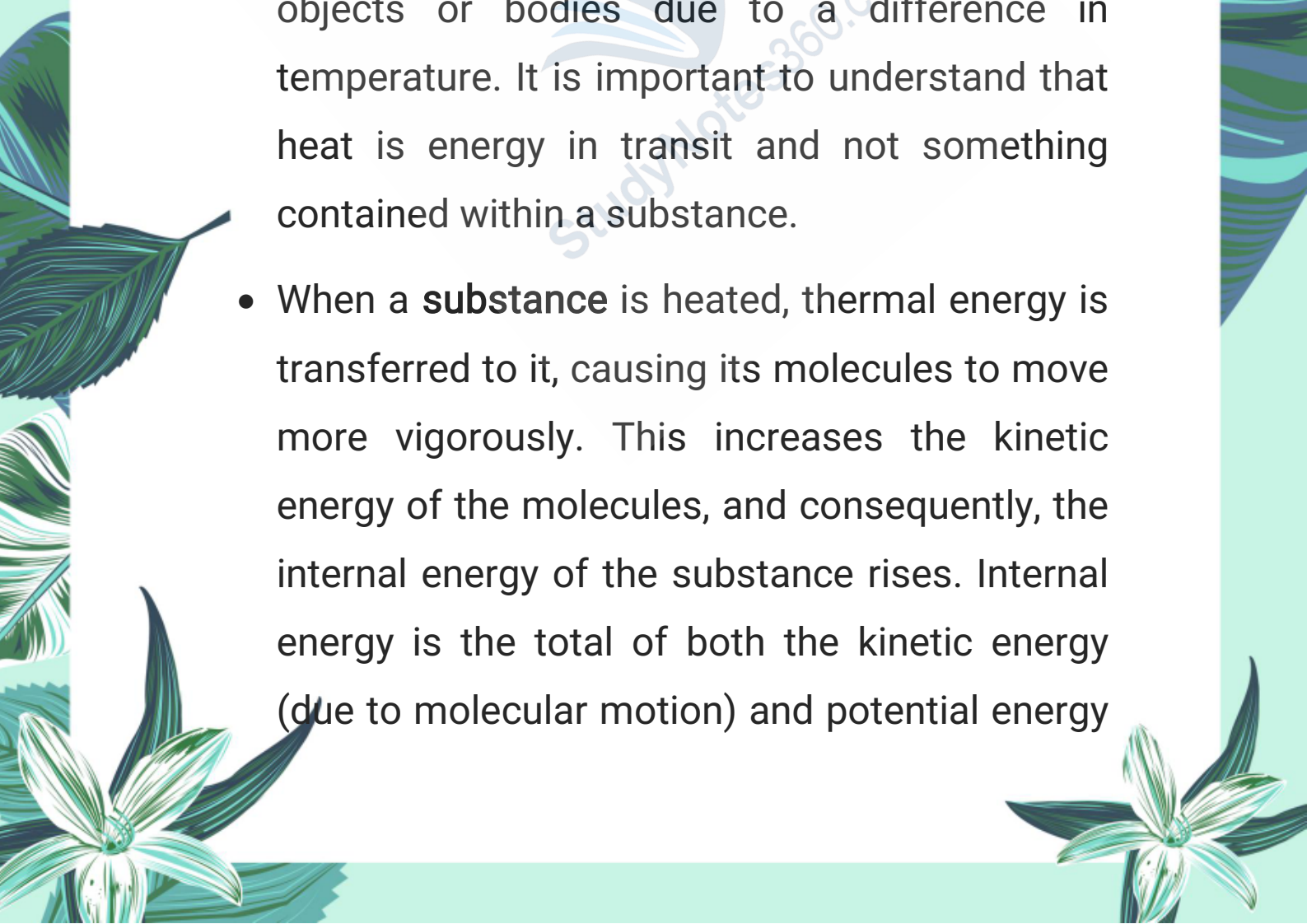


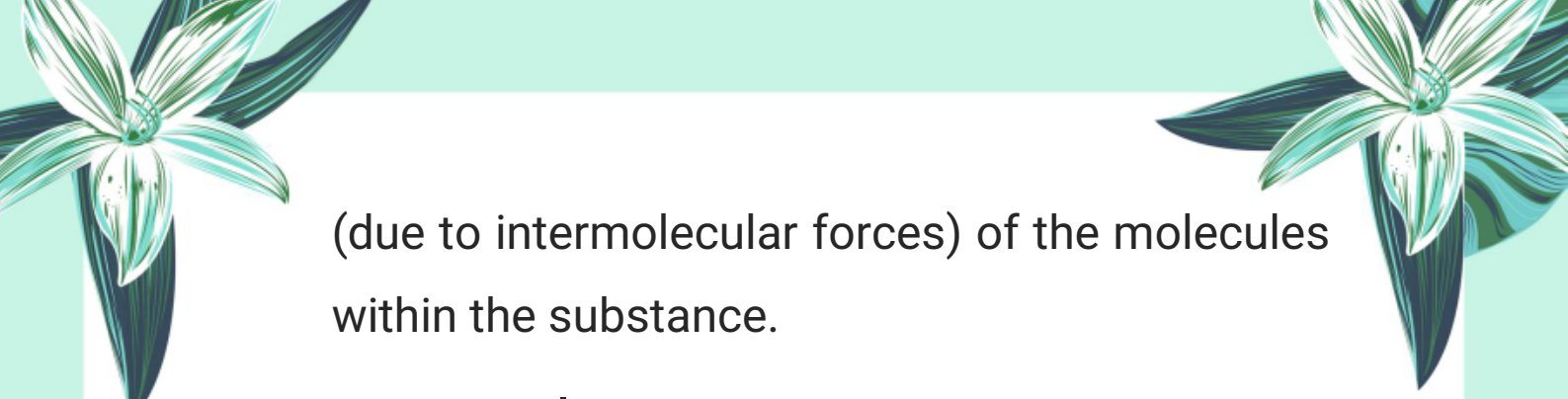
behavior differs significantly from gases because it conducts electricity and responds to electromagnetic fields. Plasma naturally occurs in stars (including the Sun), lightning, and certain artificial devices like fluorescent lamps and plasma screens.



Q3. Define heat and explain its relationship with temperature and internal energy.

Answer:

- Heat is the **energy** transferred between two objects or bodies due to a difference in temperature. It is important to understand that heat is energy in transit and not something contained within a substance.
 - When a **substance** is heated, thermal energy is transferred to it, causing its molecules to move more vigorously. This increases the kinetic energy of the molecules, and consequently, the internal energy of the substance rises. Internal energy is the total of both the kinetic energy (due to molecular motion) and potential energy
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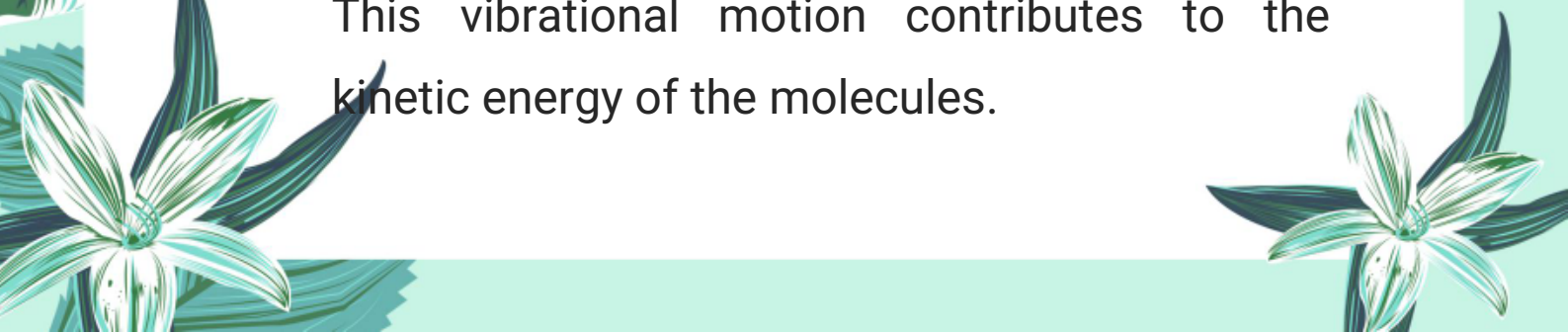


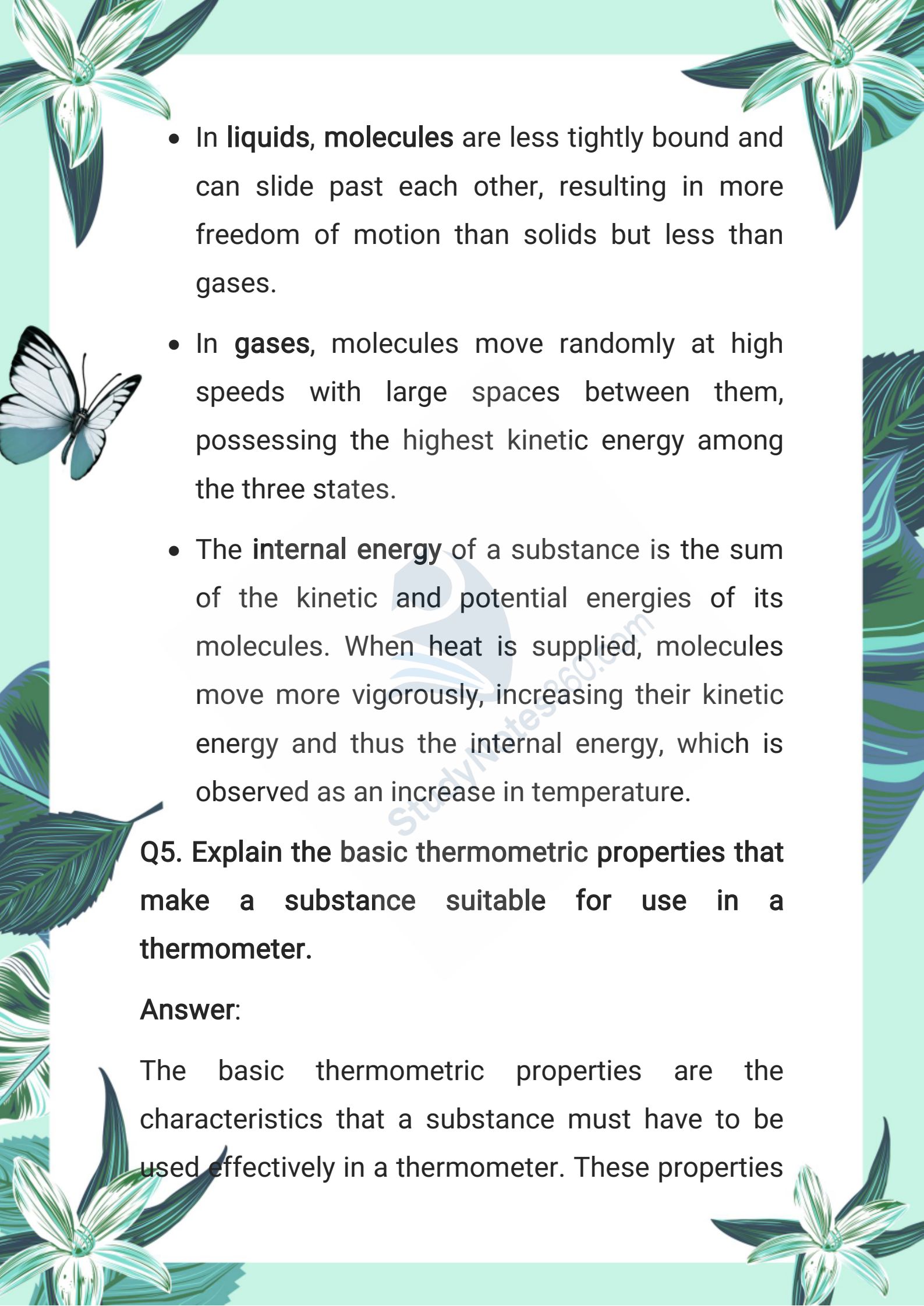
(due to intermolecular forces) of the molecules within the substance.

- As **internal energy** increases, the temperature of the substance increases. Thus, heat energy transferred to a body raises its internal energy, which is observed as a rise in temperature. It is incorrect to say a body contains heat; rather, it contains internal energy. Heat only refers to the energy transferred between bodies due to temperature difference.

Q4. Describe the molecular behavior of solids, liquids, and gases in relation to their internal energy and temperature.

Answer:



- Matter consists of molecules that are always in motion, and their movement varies depending on the state of the matter.
 - In **solids**, molecules vibrate about fixed positions due to strong intermolecular forces. This vibrational motion contributes to the kinetic energy of the molecules.
- 

- 
- In **liquids**, **molecules** are less tightly bound and can slide past each other, resulting in more freedom of motion than solids but less than gases.
 - In **gases**, molecules move randomly at high speeds with large spaces between them, possessing the highest kinetic energy among the three states.
 - The **internal energy** of a substance is the sum of the kinetic and potential energies of its molecules. When heat is supplied, molecules move more vigorously, increasing their kinetic energy and thus the internal energy, which is observed as an increase in temperature.

Q5. Explain the basic thermometric properties that make a substance suitable for use in a thermometer.


Answer:

The basic thermometric properties are the characteristics that a substance must have to be used effectively in a thermometer. These properties



ensure that the thermometer gives accurate and reliable temperature readings. The important thermometric properties are:

1. Good Conductor of Heat:



The substance should quickly absorb heat so that it can respond rapidly to changes in temperature.

2. Quick Response:

It should show a fast change in its property when the temperature changes, allowing the thermometer to give prompt readings.

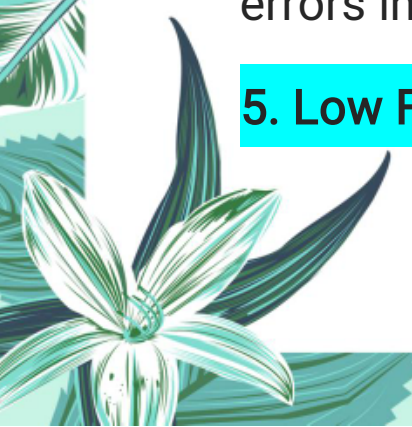
3. Uniform Thermal Expansion:

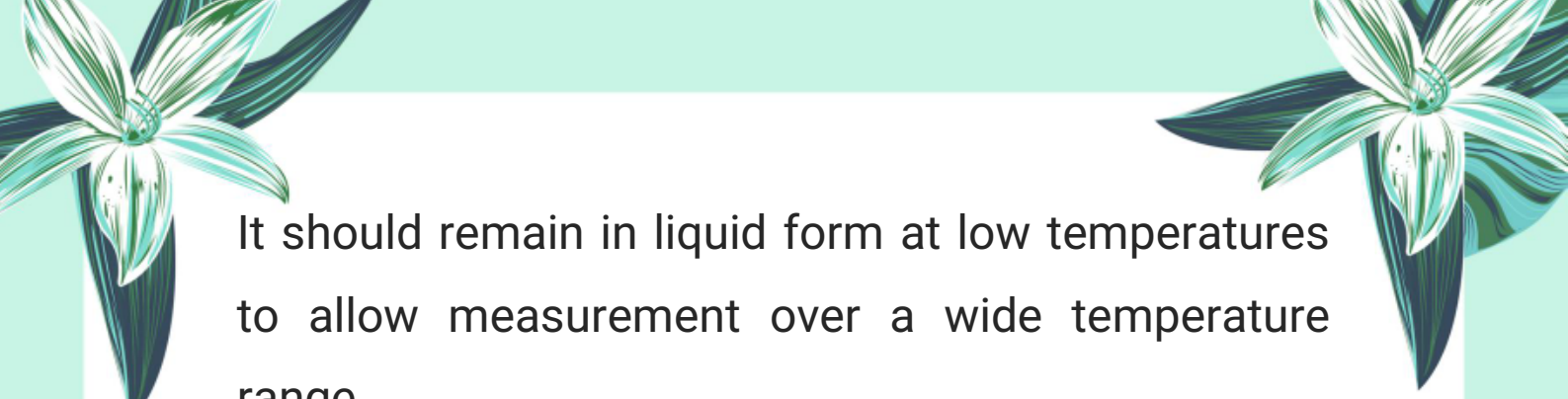
The substance should expand or contract uniformly with temperature so that the change in volume or length is proportional to the temperature change.

4. High Boiling Point:

The substance should not evaporate easily, especially at high temperatures, to avoid loss and errors in measurement.


5. Low Freezing Point:





It should remain in liquid form at low temperatures to allow measurement over a wide temperature range.

6. Large Expansivity:



The substance should have a noticeable change in volume or length with temperature changes, making it easier to measure.

7. Non-wetting to Glass:

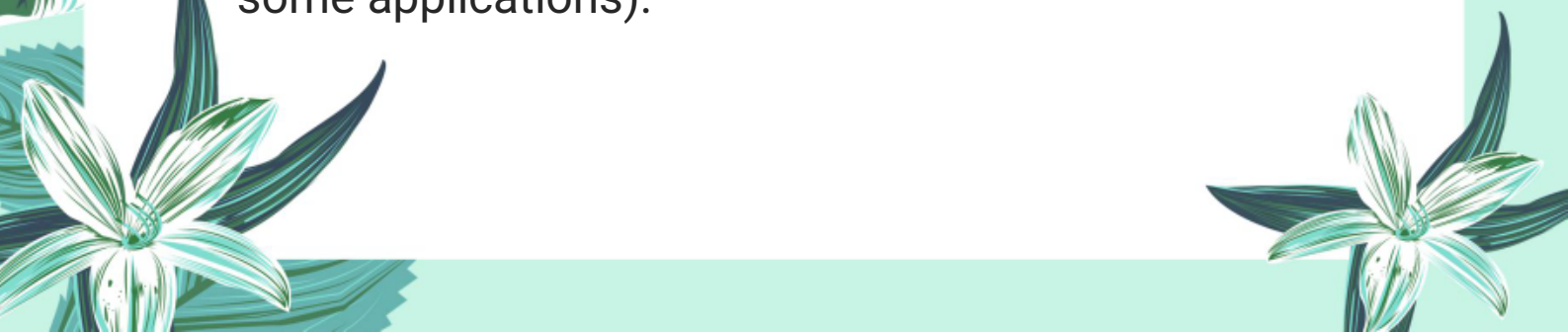
It should not stick to the walls of the glass tube to avoid inaccurate readings.

8. Visible:

The substance should be easily visible inside the thermometer, often achieved by using colored liquids like dyed alcohol or opaque liquids like mercury.

9. Non-toxic and Safe:

For practical use, the substance should not be harmful if the thermometer breaks (important for some applications).






C Constructed Response Questions


7.1. Is kinetic molecular theory of matter applicable to the plasma state of matter?

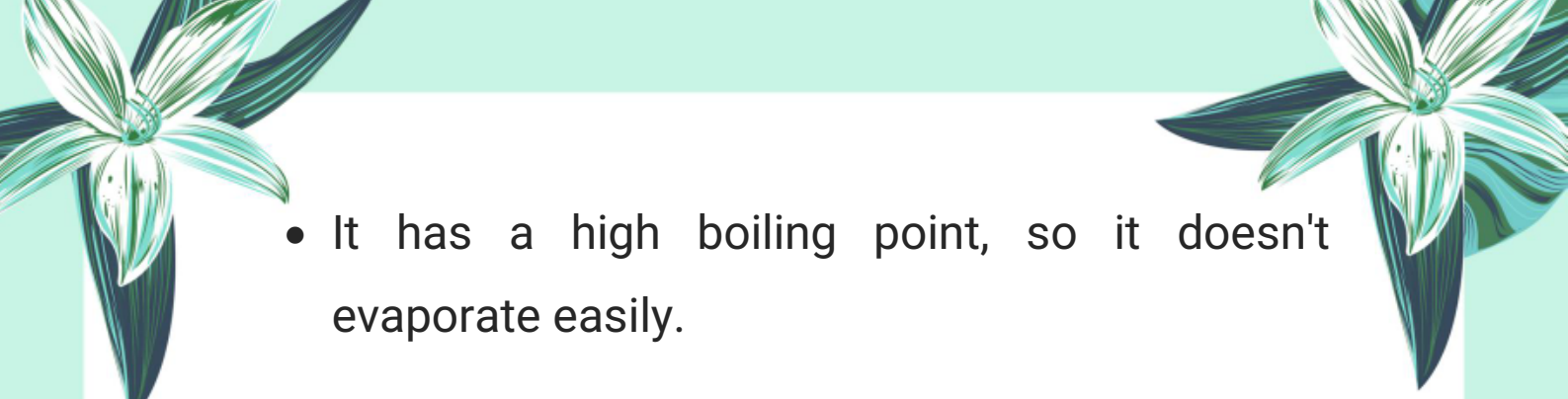
Yes, it is applicable.


- 
- Plasma consists of free-moving electrons and ions.
 - Kinetic molecular theory states that all matter is made of particles in constant motion.
 - In plasma, these particles move randomly at high speeds.
 - Therefore, the theory explains the behavior of plasma just like solids, liquids, and gases.

7.2. Why is mercury usually preferred to alcohol as a thermometric liquid?

 **Reasons for preferring mercury:**


- Mercury is visible due to its shiny silvery color.
 - It does not stick to glass, allowing accurate readings.
 - It expands uniformly with temperature.
- 

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- It has a high boiling point, so it doesn't evaporate easily.
 - Mercury gives quick response to temperature changes.

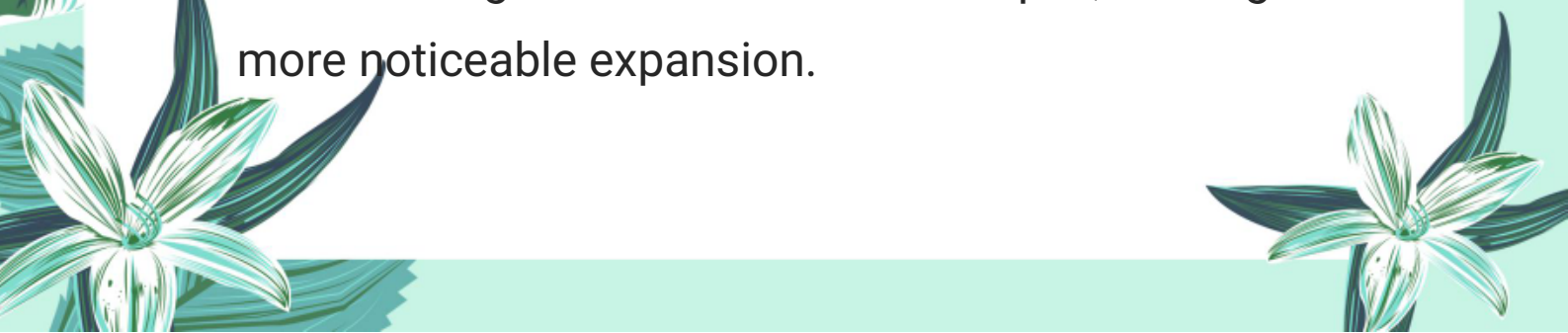


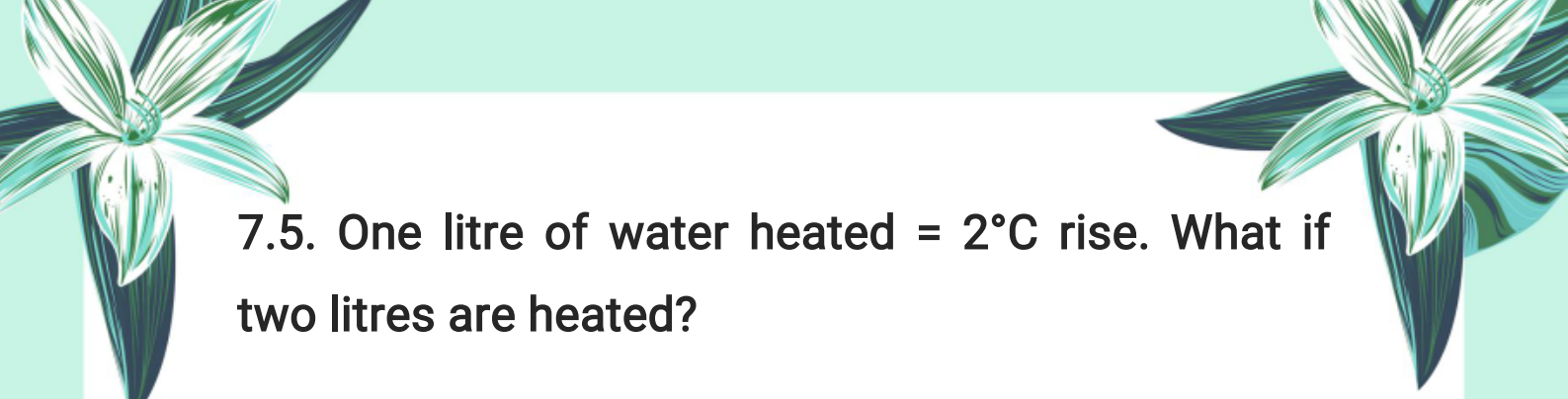
7.3. Why is water not suitable for use in thermometers? Also, guess 373 K in °C and °F.

✗ Water is not suitable because:

- It sticks to glass, causing incorrect readings.
- It evaporates at a lower temperature.
- It does not expand uniformly.
- It has a limited temperature range (0°C to 100°C).
-  373 K = 100°C = 212°F (approximate values)


7.4. Two ways to increase sensitivity of a liquid-in-glass thermometer:

1. Use a narrower capillary tube – small expansion causes larger visible rise.
 2. Use a larger bulb – holds more liquid, leading to more noticeable expansion.
- 



7.5. One litre of water heated = 2°C rise. What if two litres are heated?

- Heat is distributed over more mass.
- Temperature rise will be half.
- So, temperature rise = 1°C .

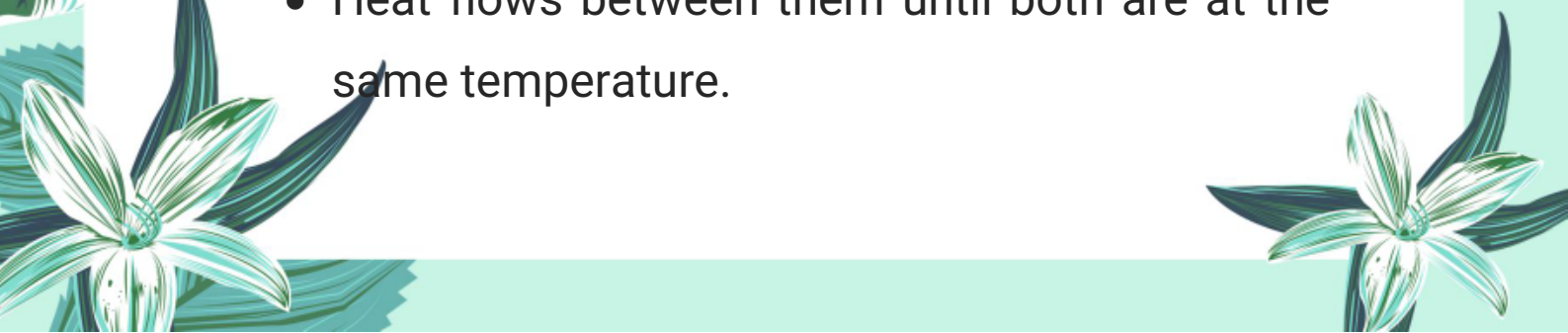


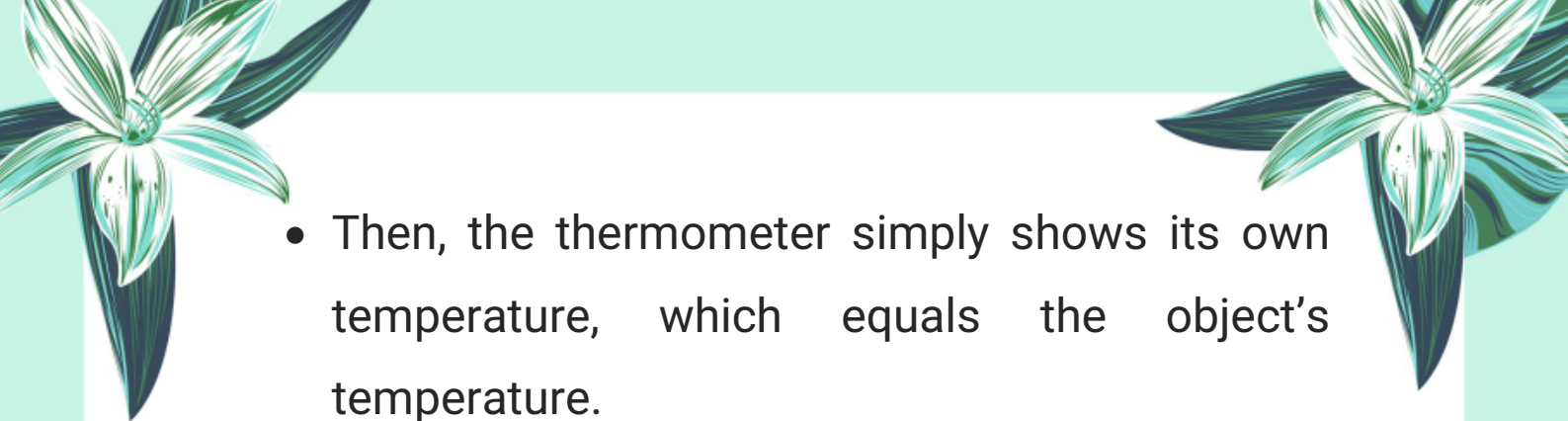
7.6. Why are there no negative numbers on the Kelvin scale?


Reasons:

- Kelvin scale starts from absolute zero (0 K).
- At 0 K, molecular motion stops.
- No temperature exists below 0 K, so negative values are not possible.
- 7.7. "A thermometer measures its own temperature" – Comment

Explanation:

- Thermometer comes into thermal equilibrium with the object.
 - Heat flows between them until both are at the same temperature.
- 

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- Then, the thermometer simply shows its own temperature, which equals the object's temperature.



7.8. In a winter night, compare the temperatures of objects like cotton, wood, plastic, metals, etc., with air temperature by touch.

 **Observation:**

- All objects are at the same temperature as the surrounding air.
- But they feel different due to their thermal conductivity:
- Metals feel colder – they conduct heat quickly away from your skin.
- Cotton, wood, plastic feel warmer – they are poor conductors, so heat is not lost quickly.

Conclusion:

All are at same temperature, but feel different because of how fast they transfer heat to/from your hand.

7.9. Which is greater: a rise of 1°C or 1°F ?





Answer:

1°C is greater than 1°F.



Conversion:

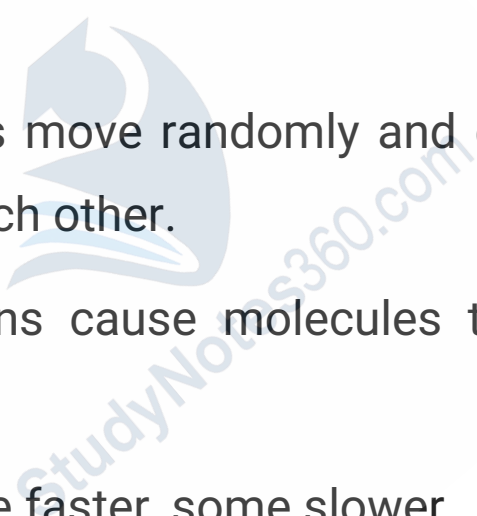
$$1^{\circ}\text{C} = 1.8^{\circ}\text{F}$$



So, temperature rises faster in Celsius scale.

7.10. Why don't all molecules in a gas move at the same speed?

Reason:

- Gas molecules move randomly and constantly collide with each other.
 - These collisions cause molecules to gain or lose energy.
 - So, some move faster, some slower.
 - Hence, molecular speeds vary – not all are equal.
- 

7.11. Does it make sense to talk about the temperature of a vacuum?

Explanation:

- Vacuum has no matter, so it has no molecules
- 



to measure motion or temperature.

- However, we can talk about the temperature of radiation in vacuum (like space).
- Example: Cosmic microwave background radiation has a temperature of about 2.7 K.

7.12. Comment: "A hot body does not contain heat."

Correct Statement:

- A body contains internal energy (sum of molecular kinetic + potential energy).
- Heat is not stored – it is energy in transfer from one body to another.
- So, saying "a body contains heat" is scientifically incorrect.

7.13. Is the Sun considered matter?

Yes, the Sun is matter.

- The Sun is made of plasma (the fourth state of matter).
- It contains charged particles – electrons and

The page is decorated with various illustrations: a large white flower with green leaves in the top left and bottom left corners, a white butterfly with black markings on its wings on the left side, and a large green leaf on the right side. The background is a light green color.

ions.

- These particles are matter in an excited state.
- The Sun also emits energy, but its physical composition is matter.

D Comprehensive Questions

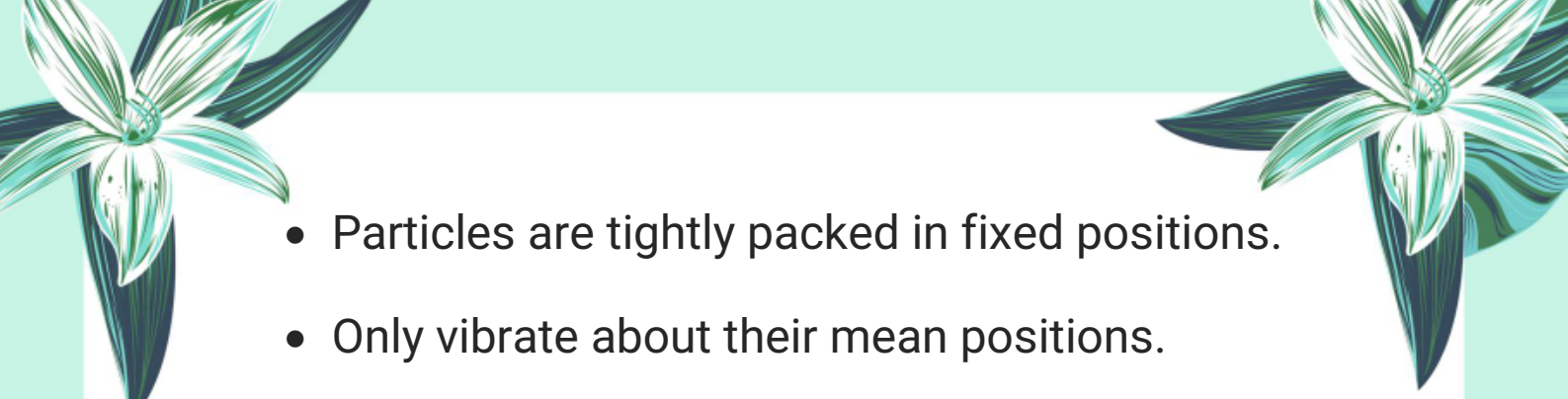
7.1. Describe the main points of particle theory of matter which differentiate solids, liquids and gases.

Main points of Particle Theory of Matter:


1. All matter is made up of tiny particles.
2. These particles are always in motion.
3. There are spaces between particles.
4. Particles attract each other with varying forces depending on the state of matter.
5. Increasing temperature increases the kinetic energy of particles.

Differences based on states of matter:

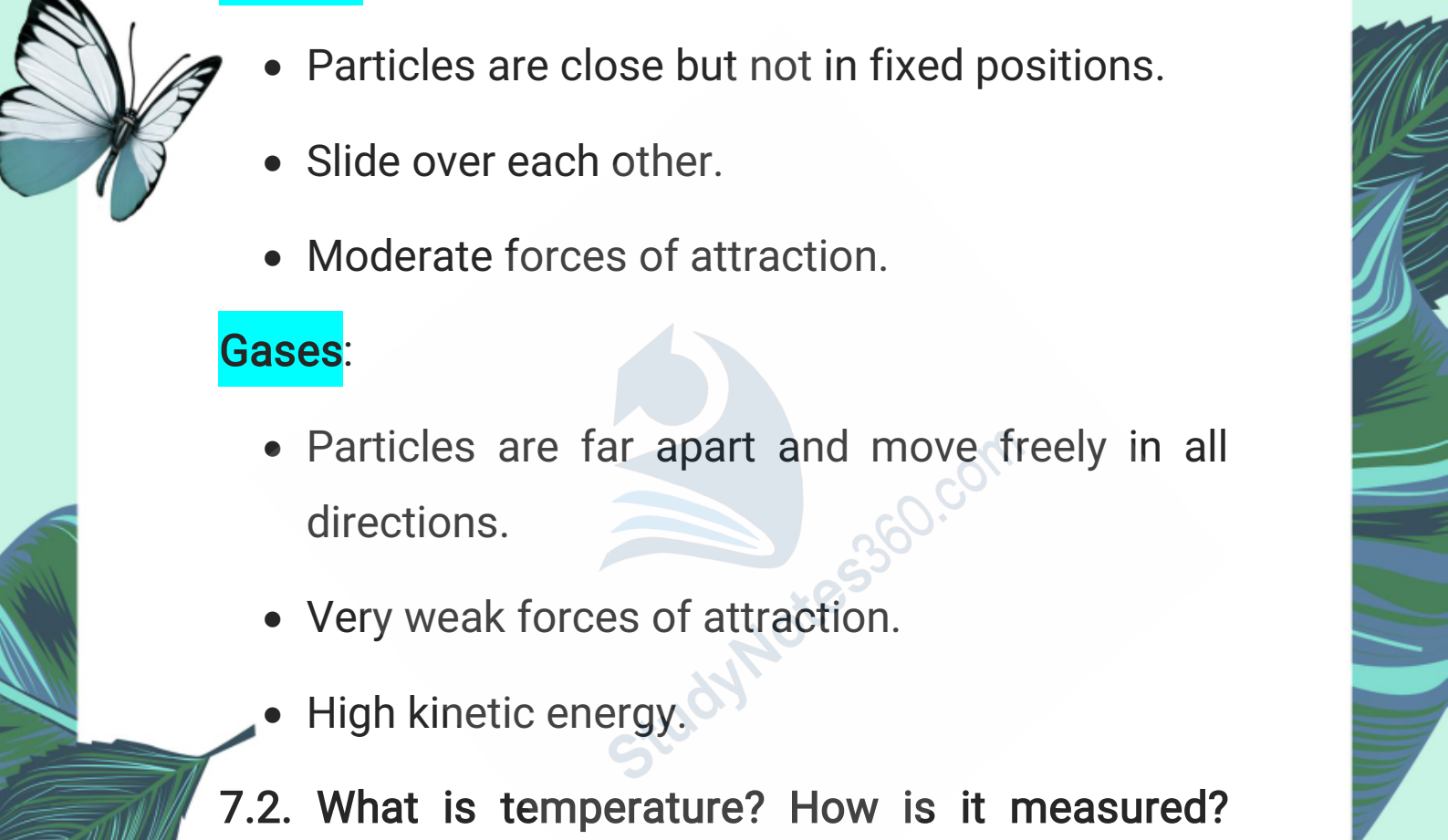
Solids:

- 
- Particles are tightly packed in fixed positions.
 - Only vibrate about their mean positions.
 - Strong forces of attraction.

Liquids:

- 
- Particles are close but not in fixed positions.
 - Slide over each other.
 - Moderate forces of attraction.

Gases:

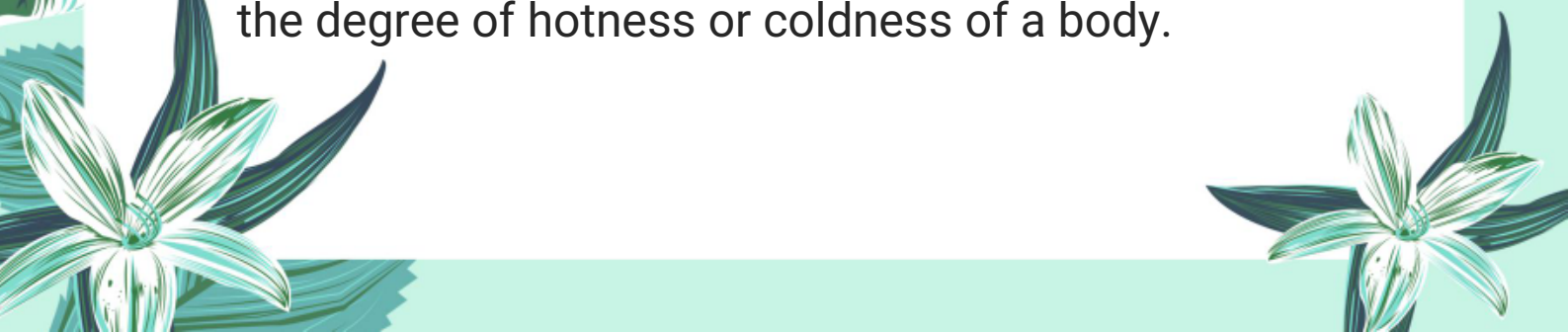
- 
- Particles are far apart and move freely in all directions.
 - Very weak forces of attraction.
 - High kinetic energy.

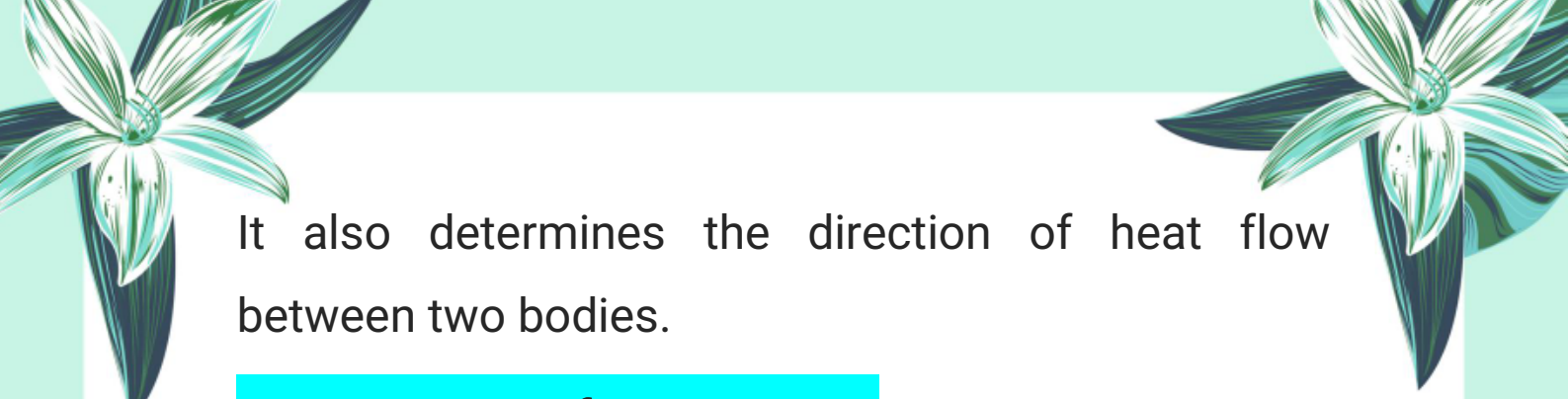
7.2. What is temperature? How is it measured?

Describe briefly the construction of a mercury-in-glass thermometer.

What is Temperature?

Temperature is a physical quantity that measures the degree of hotness or coldness of a body.





It also determines the direction of heat flow between two bodies.

Measurement of Temperature:

Temperature is measured using an instrument called a thermometer.



Construction of Mercury-in-Glass Thermometer:

1. A thin glass tube is used with a bulb at one end filled with mercury.

2. When temperature rises, mercury expands and moves up the capillary tube.

3. The scale marked on the glass stem shows the corresponding temperature.

4. Mercury is used because:

- It is a good conductor of heat.
- It does not stick to glass.
- It has a uniform expansion.
- It is visible and has a high boiling point.

7.3. Compare the three scales used for measuring temperature.





1. Celsius Scale ($^{\circ}\text{C}$):

- Lower fixed point (melting point of ice): 0°C
- Upper fixed point (boiling point of water): 100°C
- Divided into 100 equal parts.



2. Fahrenheit Scale ($^{\circ}\text{F}$):

- Lower fixed point: 32°F
- Upper fixed point: 212°F
- Divided into 180 equal parts.

3. Kelvin Scale (K):

- Absolute scale used in science.
- Lower fixed point (absolute zero): $0\text{ K} = -273^{\circ}\text{C}$
- Upper fixed point: 373 K
- $1\text{ K} = 1^{\circ}\text{C}$ (equal step size but different zero point)

7.4. What is meant by sensitivity, range, and linearity of thermometers? Explain with examples.

1. Sensitivity:


- Ability of a thermometer to detect small
- 



changes in temperature.

- More sensitive thermometers show a large expansion for a small temperature change.

2. Range:

- 
- The minimum and maximum temperatures a thermometer can measure.
 - **Example:** Clinical thermometer range is 35°C to 42°C .

3. Linearity:

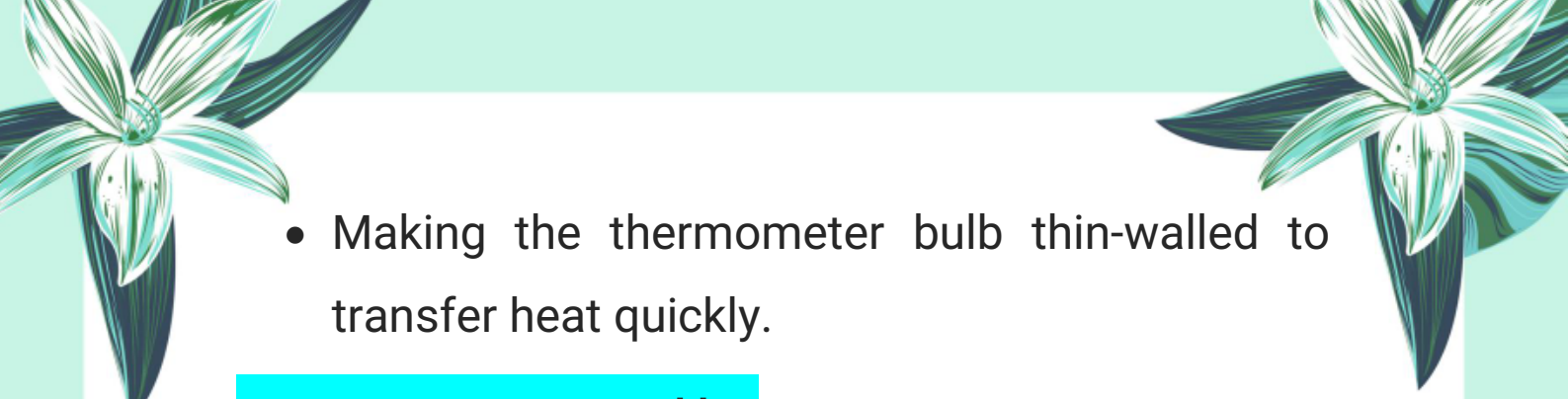
- When the liquid expands uniformly with temperature, the scale is linear.
- A linear thermometer has equally spaced temperature markings.

7.5. Explain how the parameters mentioned in question 7.4 are improved in the structure of a liquid-in-glass thermometer.


Improvement of Thermometer Design:

1. Sensitivity is improved by:

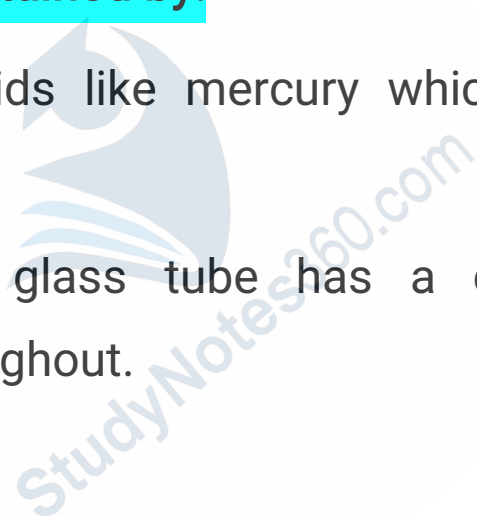
- Using a narrow bore capillary tube.
- 

- 
- Making the thermometer bulb thin-walled to transfer heat quickly.

2. Range is improved by:

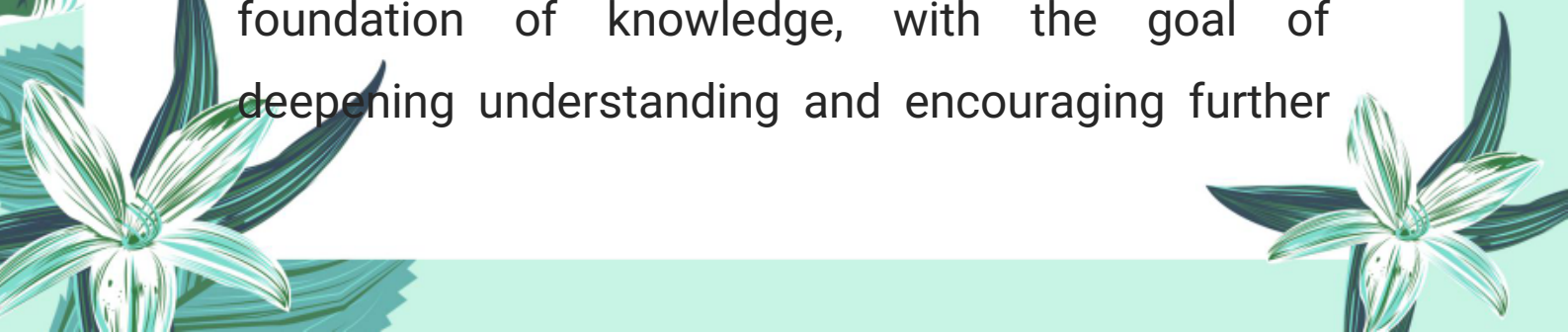
- 
- Selecting appropriate liquids like mercury (wide range) or alcohol (low temperatures).
 - Using special construction materials to withstand extreme temperatures.

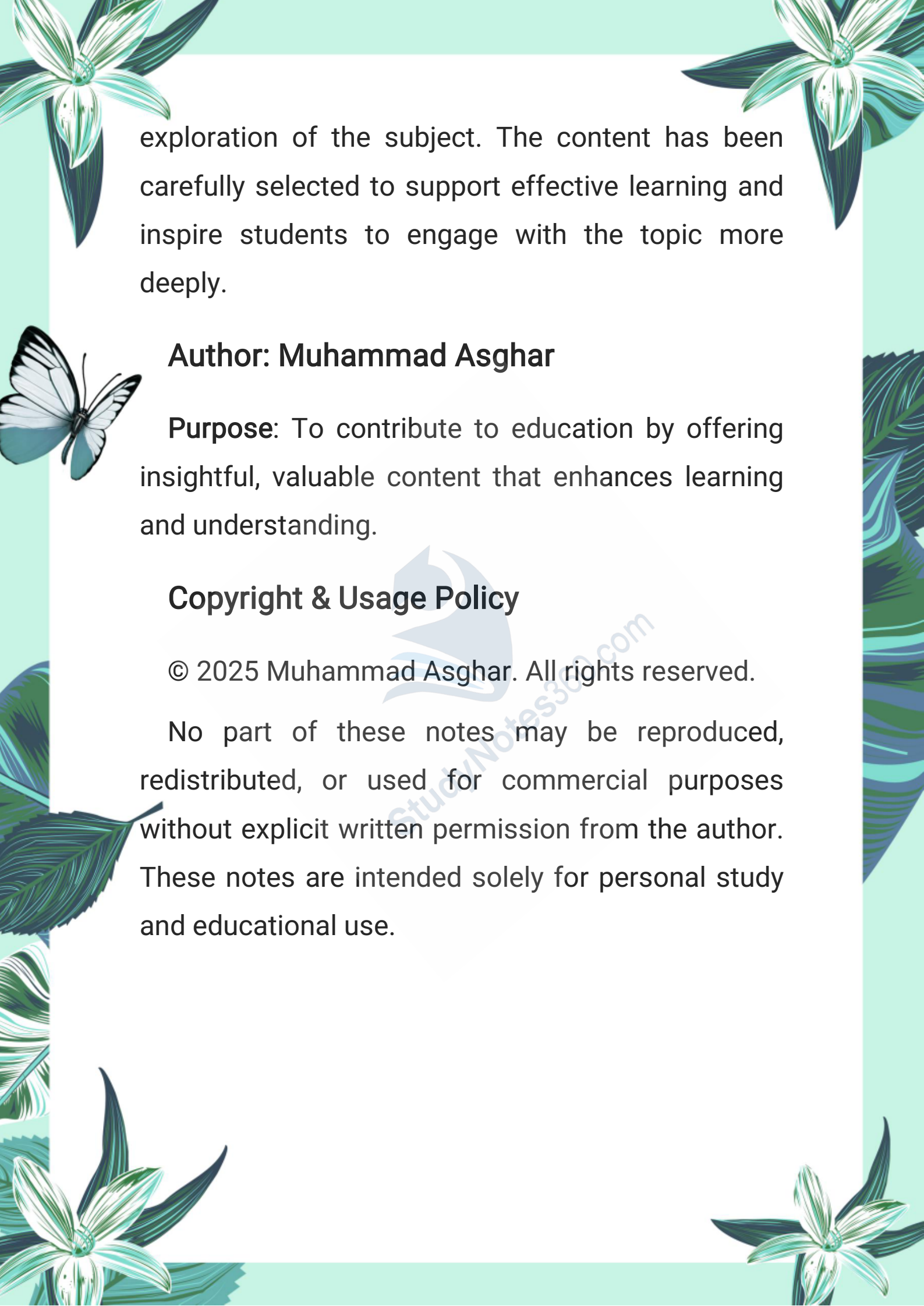
3. Linearity is maintained by:

- Choosing liquids like mercury which expand uniformly.
 - Ensuring the glass tube has a consistent diameter throughout.
- 

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further



The page is decorated with various botanical and nature-themed illustrations. In the top corners, there are stylized flowers with long, pointed petals. On the left side, a butterfly with white wings and dark markings is shown in flight. The bottom corners also feature floral designs. The background is a light, solid color, and the text is centered in a clean, sans-serif font.

exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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