Tick (✔) the best answer:

a. What is the total sum of kinetic energy of all the molecules of a body called?
→ **Heat**

b. When does sea breeze occur?
→ **Day**

c. Which of the following is the SI unit of temperature?
→ **Kelvin**

d. Which of the following thermometers uses thermopile to detect the temperature of our body?
→ **Radiation thermometer**

e. The normal body temperature of a healthy person is 37 °C. What is the corresponding value in Fahrenheit scale?
→ **98.6 °F**

Answer these questions in brief:

a. What is the relationship between molecular vibration of an object and its heat?

The vibration of molecules represents their **kinetic energy**. The greater the vibration of molecules, the higher their kinetic energy. Heat is the total kinetic energy of all the vibrating molecules in a body.

Therefore, **heat of an object is directly proportional to the vibration of its molecules**.

b. Define thermal capacity. Also write its SI unit.

The thermal capacity of a body is the **amount of heat energy required to raise the temperature of the whole body by 1 °C (or 1 K)**.

Formula: Thermal Capacity = Mass × Specific Heat Capacity

SI Unit: Joule per Kelvin (J/K)

c. Temperature determines the direction of flow of heat. Explain.

Heat always flows from a **hotter body to a colder body**. The measure of hotness or coldness is given by **temperature**.Thus, the body with higher temperature loses heat and the body with lower temperature gains heat until they reach thermal equilibrium.

Hence, **temperature difference decides the direction of heat flow**.

d. What do you mean by anomalous expansion of water? Write down its one advantage.

The unusual behavior of water in which it **contracts on cooling from 100 °C to 4 °C but expands when cooled further below 4 °C** is called anomalous expansion of water.

Advantage: This property helps aquatic life to survive in cold regions because ice floats on water and insulates the water beneath, keeping it at around 4 °C.

e. A beaker is filled with water at 4 °C. No single drop can be added. What will happen if it is heated or cooled? Explain with reasons.

At 4 °C, water has its **maximum density** and minimum volume. If water is heated above 4 °C, it expands → volume increases → some water will overflow. If cooled below 4 °C, anomalous expansion occurs → water expands again → some water will overflow.

f. The specific heat capacity of water is 4200 J/kg°C. What does it mean?

It means **4200 J of heat energy is required to raise the temperature of 1 kg of water by 1 °C**.

g. What is the principle of calorimetry?

Calorimetry is based on the principle of **conservation of energy**.

The heat lost by a hot body = the heat gained by a cold body, provided there is no heat loss to surroundings.

h. How is specific heat capacity different from heat capacity?

Specific Heat Capacity: Heat required to raise the temperature of **1 kg** of a substance by 1 °C. (Unit: J/kg°C)

Heat Capacity (Thermal Capacity): Heat required to raise the temperature of the **whole body** by 1 °C. (Unit: J/K)

Difference: Specific heat is an **intensive property**, while heat capacity is an **extensive property**.

i. Why do different substances have different specific heat capacities?

Because different substances have **different molecular structures, bonding, and masses**.

This affects how much heat energy is required to raise their temperature.

Hence, each substance has its own unique specific heat capacity.

j. What is heat equation? Write down the relation between mass of an object and heat gained by it.

Heat Equation:

$Q=msdt$

Where,
Q = Heat gained or lost (J)
m = Mass of the object (kg)
s = Specific heat capacity (J/kg°C)
dt = Change in temperature (°C)

Relation: Heat gained (Q) is **directly proportional to mass (m)** of the object.

k. Define specific heat capacity. Write down the two factors that affect heat energy.

Definition: The specific heat capacity of a substance is the **amount of heat required to raise the temperature of 1 kg of the substance by 1 °C (or 1 K)**.

Factors affecting heat energy (Q = msdt):

Mass of the body (m)

Temperature change (dt)

l. What effect will be seen on the density and volume of water if it is heated from 0 °C to 10 °C? What is this type of behaviour of water called? How is this behaviour useful for aquatic life?

From 0 °C to 4 °C: Density increases, volume decreases. From 4 °C to 10 °C: Density decreases, volume increases. This behavior is called **anomalous expansion of water**.

Usefulness: It keeps the bottom water at 4 °C in winter, allowing aquatic organisms to survive.

m. When same mass of water and oil at the same temperature are allowed to cool, water cools slower than the oil. Why?

Water has a **higher specific heat capacity** (4200 J/kg°C) than oil. This means water requires more heat to change its temperature. Hence, water cools slower than oil.

n. A glass is filled with certain liquid at certain temperature such that it overflows whether heated or cooled. Suggest the name of liquid in the glass and its temperature with justification.

The liquid is **water and its** temperature is **4 °C**.

At 4 °C, water is at its maximum density and minimum volume. If heated above or cooled below 4 °C, water expands → glass overflows in both cases.

o. A large cold body may possess more heat than a small hot body. Justify with an example.

A large cold body can contain more heat than a small hot body because heat depends on the total mass and the total kinetic energy of the molecules, not

only on temperature. For example, a large bucket of water at 30 °C has more heat energy than a small cup of water at 80 °C, because the bucket contains far more molecules overall.

Distinguish between:

Difference between Specific Heat Capacity and Heat Capacity

Specific Heat Capacity	Heat Capacity
Heat required to raise the temperature of **1 kg of a substance** by 1 °C.	Heat required to raise the temperature of the **whole body** by 1 °C.
It is an **intensive property** (does not depend on mass).	It is an **extensive property** (depends on mass).
Unit: **J/kg°C**.	Unit: **J/°C or J/K**.

Difference between Heat and Temperature

Heat	Temperature
Total kinetic energy of all molecules of a body.	Average kinetic energy of the molecules of a body.
It depends on mass, specific heat, and temperature.	It does not depend on mass, only on molecular motion.
Measured in **joules (J)**.	Measured in **degree Celsius (°C), Kelvin (K), Fahrenheit (°F)**.
Heat flows from hot body to cold body.	Determines the direction of flow of heat.

Difference between Heat and Thermal Energy

Heat	Thermal Energy
Energy in transit due to temperature difference.	Internal energy stored in a body due to molecular motion.
Exists only when it is being transferred.	Exists in a body even if no transfer takes place.
It flows from one body to another.	It remains stored within the body.
Measured in joules (J).	Also measured in joules (J).

Difference between Upper and Lower Fixed Points of Thermometer

Lower Fixed Point	Upper Fixed Point
Temperature of pure melting ice at standard pressure.	Temperature of pure boiling water at standard pressure.
Taken as **0 °C**.	Taken as **100 °C**.
It is the **starting reference point** for calibration.	It is the **ending reference point** for calibration.
Represents freezing point of water.	Represents boiling point of water.

Give reasons:

a. Water is used to cool the engine of a moving vehicle because it has a high specific heat capacity and can absorb a large amount of heat without a great rise in temperature.
b. A thick glass tumbler cracks when boiling water is poured in it because the inner surface expands quickly while the outer surface remains relatively cool, creating uneven expansion and stress which causes cracks.
c. A hot water bag is used to warm body parts because water has a high specific heat capacity and can store heat for a long time and release it slowly.
d. Well water is warmer in the morning during winter season because the earth is a poor conductor of heat and the underground water retains its stored heat.
e. The temperature of an island is always moderate because the surrounding sea water absorbs heat during the day and releases it slowly at night, keeping the temperature balanced.
f. A piece of wet cloth is kept on the forehead of a patient during fever because evaporation of water from the cloth absorbs heat from the body, lowering body temperature.
g. Water pipes get burst in winter season in cold regions because water expands when it freezes, and the increased volume exerts pressure on the pipe walls until they break.
h. If a hot cup of coffee is left open, its temperature decreases due to heat loss. After some time, the temperature becomes equal to room temperature and no further cooling occurs.
i. While leaving the bed in a very cold morning, we feel cold in the room because our body is warmer than the surroundings, but after some time we feel warmer because our body adjusts and the room air gets heated locally.
j. If an iron nail is hammered many times, it becomes hot because the mechanical energy of hammering is converted into heat energy due to friction among the iron molecules.
k. Night in a desert is very cold but the day is very hot because sand has a very low specific heat capacity, so it heats up quickly during the day and cools down quickly at night.
l. An island has almost uniform climate throughout the year because of the moderating effect of the surrounding ocean water, which absorbs and releases heat slowly.

m. Water starts to freeze from the top whereas wax starts to freeze from the bottom because water has anomalous expansion, making ice lighter so it floats, while wax becomes denser on cooling and solidifies from below.
n. A clinical thermometer has a constriction just above the bulb to prevent the mercury from flowing back quickly into the bulb so that the temperature can be read after removing it from the patient.
o. Days are very hot and nights are very cold in deserts because sand has a very low specific heat capacity. It heats up quickly during the day and loses heat quickly at night.

Diagrammatic questions:

i. What special feature of water is demonstrated by the diagram?
The diagram demonstrates the anomalous expansion of water, which means water contracts when cooled from 10 °C to 4 °C but expands when cooled further below 4 °C.

ii. What change is seen in the density of water if it is heated from 0 to 4 °C?
When water is heated from 0 °C to 4 °C, its density increases because water contracts and reaches maximum density at 4 °C.

iii. What change is observed in the density if water is heated above 4 °C?
When water is heated above 4 °C, its density decreases because it expands on further heating.

iv. Explain an advantage from such behavior of water.
This behavior, called anomalous expansion, allows ice to float on water and keeps the bottom water at 4 °C in winter, providing a stable environment for aquatic life to survive.

b. An instrument for measuring the temperature of human body is shown in the photo.

i. Name the given instrument.
The given instrument is a **digital thermometer**.

ii. Name its important part that is responsible for measuring temperature.
The important part responsible for measuring temperature is the **thermistor**

iii. How is this instrument different from radiation thermometer?
A digital thermometer measures body temperature through **direct contact** using its sensor probe, while a radiation thermometer measures body temperature **without contact**, by detecting the infrared radiation emitted from the body.

iv. Write the process of measuring temperature by this instrument.
To measure temperature, the digital thermometer is switched on and its probe is placed under the tongue, in the armpit, or in the ear (depending on design). After a short time, the sensor detects the temperature, and the reading is displayed directly on the digital screen.

d. Specific heat capacities of three different substances are given.

i. Specific heat capacity of A is 130 J/kg°C. What does it mean?
It means that 130 joules of heat energy are required to raise the temperature of 1 kilogram of substance A by 1 °C.

ii. When the equal masses of all these substances are supplied with equal amount of heat, which one will have highest temperature? Give reason.
Substance A will have the highest temperature because it has the lowest specific heat capacity, meaning it requires the least amount of heat to raise its temperature.

iii. If equal masses of each of these substances is heated to 100 °C and placed over a wax slab, which one will penetrate greatest depth? Why?
Substance B will penetrate the greatest depth into the wax slab because it has the highest specific heat capacity, so it can store and release the largest amount of heat when placed on the wax.

e. Study the given table and answer the questions.

i. If each of X, Y and Z has the same temperature, which one has the maximum heat?
Substance X has the maximum heat because it has the highest specific heat capacity, meaning at the same temperature it stores more heat energy per kilogram than the others.

ii. If all of them have the same temperature and same heat, which one will have maximum mass?
Substance Y will have the maximum mass because it has the lowest specific heat capacity, so more mass is needed to store the same amount of heat at the same temperature.

iii. If you are asked to select a suitable substance among X, Y and Z for its use as an engine cooling agent of vehicles, which one will you select? Why?
I would select substance X as the cooling agent because it has the highest specific heat capacity, which allows it to absorb and carry away more heat without a large rise in temperature, making it most effective for cooling engines.