Chapter 7 — Thermal Properties of Matter

Constructed Response Questions (with Answers)

Class 9 Physics (New Syllabus) — Board Level

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

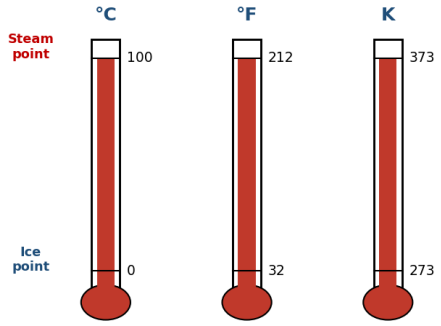
Ans: Yes, it is applicable. Plasma is a gas in which most of the atoms are ionized into positive ions and free electrons that move freely in its volume. Like the particles in the kinetic molecular theory, these ions and electrons are in continuous random motion and possess kinetic energy. Because of the free-moving charged particles, plasma can conduct electric current, so it is called the fourth state of matter.

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

Ans: Mercury is a good conductor of heat and responds quickly to temperature changes. It is opaque and silvery, so it is easily seen without colouring, does not wet the glass, and expands uniformly. It also has a low freezing point (−39°C) and a high boiling point (357°C), giving a long range. Alcohol expands more but has a low boiling point (78°C), which limits its upper range, so mercury is usually preferred.

Q 7.3. Why is water not suitable for use in thermometers? Without calculations, guess the equivalent temperature of 373 K on the Celsius and Fahrenheit scales.

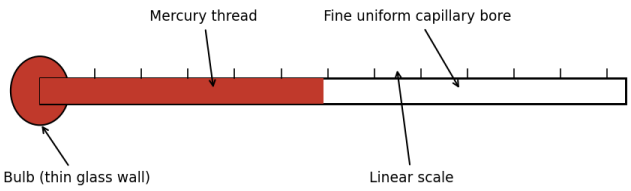
Ans: Water is unsuitable because its expansion is non-linear (it does not expand uniformly), it wets the glass, it is a bad conductor of heat, and it has a short range (freezes at 0°C, boils at 100°C). Since T = Tc + 273, 373 K equals 100°C, which is the steam point; on the Fahrenheit scale this is 212°F.



373 K = 100°C = 212°F (the steam point) on the three scales.

Q 7.4. Mention two ways in which the design of a liquid-in-glass thermometer may be altered to increase its sensitivity.

Ans: (i) Use a thermometric liquid that expands more for a given rise in temperature (large expansivity); for example, alcohol expands about six times more than mercury. (ii) Make the capillary bore narrower (thinner) so that the same expansion of liquid produces a longer movement of the thread and a bigger change in reading. Using a larger bulb (more liquid) also increases sensitivity.



Liquid-in-glass thermometer: a narrow uniform bore and thin-walled bulb increase sensitivity.

Q 7.5. One litre of water is heated by a stove and its temperature rises by 2°C. If two litres of water are heated on the same stove for the same time, what will be the rise in temperature?

Ans: The same stove in the same time supplies the same amount of heat energy. For twice the mass of water (2 litres), this same heat is shared among twice as many molecules, so the temperature rise is halved. Therefore the temperature of the 2 litres of water rises by 1°C.

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

Ans: The zero of the Kelvin scale (0 K = absolute zero = −273°C) is the lowest possible temperature in the whole universe, at which molecular motion ceases and the average kinetic energy of the molecules becomes zero. Since matter cannot be cooled below absolute zero, no temperature can be lower than 0 K, so there are no negative numbers on the Kelvin scale.

Q 7.7. Comment on the statement: "A thermometer measures its own temperature."

Ans: The statement is correct. When a thermometer is placed in contact with a body, heat flows between them until both reach the same temperature (thermal equilibrium). At that stage the thermometric liquid is at the same temperature as the body, so the scale actually shows the thermometer's own temperature — which by then equals the temperature of the body being measured.

Q 7.8. In a winter night, various objects made of cotton, wood, plastic and metal are compared with the air temperature by touching them. Comment.

Ans: All the objects that have been in the same room for a long time are in thermal equilibrium, so they are all at the same temperature — equal to the air temperature. However, they do not feel equally cold: metals feel colder than wood, plastic or cotton because metals are good conductors and draw heat away from the hand faster. The feeling of coldness depends on conduction, not on a real difference of temperature.

Q 7.9. Which is greater: an increase in temperature of 1°C or of 1°F?

Ans: An increase of 1°C is greater. For the same interval between the ice point and the steam point, the Celsius scale has 100 divisions but the Fahrenheit scale has 180 divisions. So each Celsius degree covers a larger interval; in fact 1°C = 1.8°F. Hence a rise of 1°C is greater than a rise of 1°F.

Q 7.10. Why would you not expect all the molecules in a gas to have the same speed?

Ans: In a gas the molecules move randomly and continuously collide with one another and with the walls of the container. In these collisions they constantly exchange energy, so some gain speed while others lose speed. Because of this random motion and collisions, the molecules have a range of different speeds rather than a single common speed. Temperature depends on their average kinetic energy.

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

Ans: No, it does not. Temperature is a measure of the average kinetic energy of the molecules of a substance. A perfect vacuum contains no molecules (no matter), so there are no particles whose kinetic energy could be measured. Therefore it is meaningless to talk about the temperature of a vacuum.

Q 7.12. Comment on the statement: "A hot body does not contain heat."

Ans: The statement is correct. A body does not contain heat; it contains internal energy — the sum of the kinetic and potential energies of its molecules. The word 'heat' is used only for energy in transit, i.e. energy flowing from a hotter body to a colder body due to a temperature difference. So a hot body contains internal energy, and heat is only what it transfers to a colder body.

Q 7.13. Discuss whether the Sun is matter.

Ans: Yes, the Sun is matter. The Sun and most other stars are in the plasma state, which is the fourth state of matter. Plasma is made up of ionized atoms (positive ions) and free electrons — particles that have mass and occupy space. Since it is composed of such particles, the Sun is matter in the plasma state.