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Class	9th	Chapter	07
Subject	Physics	Board	Punjab

CHAPTER 07: THERMAL PROPERTIES OF MATTER — COMPLETE SOLUTIONS

A. Multiple Choice Questions

7.1. How do the molecules in a solid behave?

- (a) Move randomly
- (b) **Vibrate about their mean positions** *(Correct)*
- (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** *(Correct)*
- (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** *(Correct)*
- (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** *(Correct)*

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

- (a) zero
- (b) 32
- (c) -273

- (d) **+273** *(Correct)*

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

- (a) **-40** *(Correct)*
- (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** *(Correct)*
- (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** *(Correct)*
- (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** *(Correct)*
- (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** *(Correct)*
- (d) can measure a large range of temperature

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

- (a) **Thermocouple thermometer** *(Correct)*
- (b) Mercury-in-glass laboratory thermometer
- (c) Alcohol-in-glass thermometer
- (d) Mercury-in-glass clinical thermometer

B. Short Answer Questions

- **7.1. Why solids have a fixed volume and shape according to particle theory of matter?**
  - **Answer:** Molecules in solids are held together by strong intermolecular forces, locking them in rigid positions where they vibrate about fixed points.
- **7.2. What are the reasons that gases have neither a fixed volume nor a fixed shape?**

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- **Answer:** Intermolecular forces in gases are extremely weak, and molecules move at high speeds in all directions, filling any available container.

- **7.3. Compare the spacing of molecules in the solid, liquid and gaseous state.**
  - **Answer:**
    - *Solids:* Tightly packed with minimum spacing.
    - *Liquids:* Slightly further apart than solids.
    - *Gases:* Very far apart with large empty spaces.
- **7.4. What is the effect of raising the temperature of a liquid?**
  - **Answer:** Thermal kinetic energy increases, molecular vibrations become more vigorous, intermolecular bonds weaken slightly, and the liquid expands.
- **7.5. What is meant by temperature of a body?**
  - **Answer:** Temperature is the physical quantity that determines the hotness or coldness of a body and the direction of heat flow.
- **7.6. Define heat as 'energy in transit'.**
  - **Answer:** Heat is not contained within a body; rather, it is thermal energy flowing spontaneously from a hotter body to a colder body due to a temperature difference.
- **7.7. What is meant by thermometric property of a substance? Enlist some thermometric properties.**
  - **Answer:** A thermometric property is any physical property that changes uniformly with temperature. *Examples:* Volume of liquid, electrical resistance, pressure of gas at constant volume.
- **7.8. State the main scales used for the measurement of temperature.**
  - **Answer:**
    1. Celsius scale (˚C)
    2. Fahrenheit scale (˚F)
    3. Kelvin absolute scale (K)
- **7.9. What is meant by sensitivity of a thermometer?**
  - **Answer:** Sensitivity is the ability of a thermometer to detect very small temperature changes, indicated by a large movement of the liquid thread per degree rise.
- **7.10. What do you mean by the linearity of a thermometer?**
  - **Answer:** Linearity means equal increments in temperature produce equal increments in the length of the thermometric liquid column.
- **7.11. What makes the scale reading of a thermometer accurate?**
  - **Answer:** Accurate calibration using fixed standard reference points such as ice point (0°C) and steam point (100°C).
- **7.12. What does determine the direction of heat flow?**

- **Answer:** The temperature difference between two bodies; heat flows spontaneously from higher to lower temperature.

- **7.13. Distinguish between the heat and internal energy.**
  - **Answer:** Internal energy is the total kinetic and potential energy of all molecules within a body. Heat is internal energy transferred between bodies due to a temperature difference.
- **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?**
  - **Answer:** Energy travels from your hand to the cold surface (heat flows from warm hand to cold object).
- **7.15. Can you feel your fever by touching your own forehead? Explain.**
  - **Answer:** No, because your hand is at approximately the same temperature as your forehead; temperature perception is relative.

C. Constructed Response Questions

- **7.1. Is kinetic molecular theory of matter applicable to the plasma state of matter? Describe briefly.**
  - **Answer:** Plasma consists of ionized gas atoms/electrons. While kinetic molecular theory applies to particle motion, electromagnetic interactions play a dominant role in plasma.
- **7.2. Why is mercury usually preferred to alcohol as a thermometric liquid?**
  - **Answer:** Mercury has a wide liquid range (−39°C to 357°C), does not wet glass, is opaque, and expands uniformly.
- **7.3. Why is water not suitable for use in thermometers? Without calculations, guess what is equivalent temperature of 373 K on Celsius and Fahrenheit scales?**
  - **Answer:** Water has non-linear expansion and wets glass. 373 Kis equivalent to 100°Cand 212°F.
- **7.4. Mention two ways in which the design of a liquid-in-glass thermometer may be altered to increase its sensitivity.**
  - **Answer:**
    1. Using a bulb with a larger volume of liquid.
    2. Using a narrower capillary tube.
- **7.5. One litre of water is heated by a stove and its temperature rises by 2°C. If two litres of water is heated on the same stove for the same time, what will be then rise in temperature?**
  - **Answer:** The temperature rise will be 1°Cbecause mass is doubled while heat supplied is constant.
- **7.6. Why are there no negative numbers on the Kelvin scale?**

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- **Answer:** Kelvin is an absolute scale where 0 Krepresents absolute zero—the point where molecular thermal motion ceases entirely.

- **7.7. Comment on the statement. 'A thermometer measures its own temperature.'**
  - **Answer:** A thermometer reaches thermal equilibrium with the object, so its reading reflects its bulb matching the object's temperature.
- **7.8. There are various objects made of cotton, wood, plastic, metals, etc. In a winter night, compare their temperatures with the air temperature by touching them with your hand.**
  - **Answer:** All objects are at thermal equilibrium with air. Metals feel colder because they conduct heat away from your hand rapidly.
- **7.9. Which is greater: an increase in temperature 1°C or one 1°F?**
  - **Answer:** An increase of 1°Cis greater because 1Celsius degree interval is equivalent to 1.8Fahrenheit degrees.
- **7.10. Why would not you expect all the molecules in a gas to have the same speed?**
  - **Answer:** Gas molecules undergo random elastic collisions, resulting in a continuous Maxwell-Boltzmann distribution of speeds.
- **7.11. Does it make sense to talk about the temperature of a vacuum?**
  - **Answer:** A true vacuum has no matter molecules, so temperature is undefined, though radiant thermal energy passing through it has a radiation temperature.
- **7.12. Comment on the statement. 'A hot body does not contain heat.'**
  - **Answer:** Heat is thermal energy in transit across a boundary. A hot body contains internal energy, not 'heat'.
- **7.13. Discuss whether the Sun is matter.**
  - **Answer:** Yes. The Sun is composed of extremely hot plasma (ionized hydrogen and helium possessing mass and volume).

D. Comprehensive Questions

- **7.1. Describe the main points of particle theory of matter which differentiate solids, liquids and gases.**
  - **Answer:** Solids have strong forces and fixed positions; liquids have moderate forces, close spacing, and flow; gases have weak forces and rapid random motion.
- **7.2. What is temperature? How is it measured? Describe briefly the construction of a mercury-in-glass thermometer.**
  - **Answer:** Temperature measures hotness/coldness. Measured with thermometers constructed from a glass bulb, narrow capillary tube, mercury, vacuum, and fixed reference points.
- **7.3. Compare the three scales used for measuring temperature.**
  - **Answer:** Celsius (0°C to 100°C), Fahrenheit (32°F to 212°F), and Kelvin (273.15 K to 373.15 K). Formulas: $C = \frac{5}{9}(F - 32)$, $K = C + 273.15$.

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- **7.4. What is meant by sensitive, range and linearity of thermometers? Explain with examples.**
  - **Answer:** Sensitivity is smallest detectable change; Range is operating limits; Linearity is uniform expansion.
- **7.5. Explain, how the parameters mentioned in question 7.4 are improved in the structure of liquid-in-glass thermometer.**
  - **Answer:** Sensitivity is improved with a large bulb and narrow capillary; range depends on liquid properties; linearity is achieved using mercury.

E. Numerical Problems

- **7.1. The temperature of a normal human body on Fahrenheit scale is 98.6°F. Convert it into Celsius scale and Kelvin scale.**
  - **Step-by-Step Solution:**
    1. Given Fahrenheit temperature $F = 98.6$°F.
    2. Convert Fahrenheit to Celsius using formula: $C = \frac{5}{9}(F - 32)$

$$C = \frac{5}{9}(98.6 - 32) = \frac{5}{9}(66.6) = 37\text{°C}$$

$$C = \frac{5}{9}(98.6 - 32) = \frac{5}{9}(66.6) = \mathbf{37}\text{°C}$$

    3. Convert Celsius to Kelvin using formula: $K = C + 273$

$$K = 37 + 273 = 310\text{ K}$$

$$K = 37 + 273 = \mathbf{310}\text{ K}$$

  - **Answer:** 37°C, 310 K
- **7.2. At what temperature Celsius and Fahrenheit thermometer reading would be the same?**
  - **Step-by-Step Solution:**
    1. Let the required temperature be x.
    2. Use the conversion relation between Celsius and Fahrenheit: $\frac{C}{5} = \frac{F-32}{9}$
    3. Substitute $C = F = x$: $\frac{x}{5} = \frac{x-32}{9}$
    4. Cross-multiply: $9x = 5(x - 32)$
    5. Expand: $9x = 5x - 160$
    6. Rearrange: $9x - 5x = -160 \Longrightarrow 4x = -160$
    7. Solve for x: $x = \frac{-160}{4} = \mathbf{-40}$
  - **Answer:** $\mathbf{-40}$°(both Celsius and Fahrenheit)
- **7.3. Convert 5°F to Celsius and Kelvin scale.**
  - **Step-by-Step Solution:**

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1. Given $F = 5°\text{F}$.
2. Convert to Celsius: $C = \frac{5}{9}(F - 32) = \frac{5}{9}(5 - 32) = \frac{5}{9}(-27) = \mathbf{-15}°\text{C}$
3. Convert to Kelvin: $K = C + 273 = -15 + 273 = \mathbf{258}$ K

- **Answer:** $-15°\text{C}$, 258 K

- **7.4. What is equivalent temperature of 25°C on Fahrenheit and Kelvin scales?**
  - **Step-by-Step Solution:**
    1. Given $C = 25°\text{C}$.
    2. Convert to Fahrenheit: $F = \frac{9}{5}C + 32 = \frac{9}{5}(25) + 32 = 45 + 32 = \mathbf{77}°\text{F}$
    3. Convert to Kelvin: $K = C + 273 = 25 + 273 = \mathbf{298}$ K
  - **Answer:** 77°F, 298 K
- **7.5. The ice and steam points on an ungraduated thermometer are found to be 192 mm apart. What temperature will be on Celsius scale if the length of mercury thread is at 67.2 mm above the ice point mark?**
  - **Step-by-Step Solution:**
    1. Given length at ice point (L_0) = 0 mm, length at steam point (L_{100}) = 192 mm.
    2. Given length at temperature $t(L_t)$ = 67.2 mmabove ice point.
    3. Use calibration formula: $C = \frac{L_t - L_0}{L_{100} - L_0} \times 100°\text{C}$
    4. Substitute values: $C = \frac{67.2 - 0}{192 - 0} \times 100 = \frac{67.2}{192} \times 100 = 0.35 \times 100 = \mathbf{35}°\text{C}$
  - **Answer:** 35°C
- **7.6. The length between the fixed point of liquid-in-glass thermometer is 20 cm. If the mercury level is 4.5 cm above the lower mark, what is the temperature on the Fahrenheit scale?**
  - **Step-by-Step Solution:**
    1. Fundamental interval ($L_{100} - L_0$) = 20 cm.
    2. Length above lower mark ($L_t - L_0$) = 4.5 cm.
    3. Calculate Celsius temperature first: $C = \frac{4.5}{20} \times 100 = 22.5°\text{C}$
    4. Convert Celsius to Fahrenheit: $F = \frac{9}{5}C + 32 = \frac{9}{5}(22.5) + 32 = 40.5 + 32 = \mathbf{72.5}°\text{F}$
  - **Answer:** 72.5°F

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