Thermal Properties of Matter

Class 11 Physics · 24 NEET MCQs with answers & explanations

Thermal Properties of Matter covers thermal expansion, calorimetry, heat transfer (conduction, convection, radiation), Newton's law of cooling, latent heat and specific heat. NEET tests calorimetry problems, linear/area/volume expansion calculations and Stefan's law — mostly numerical.

Key Thermal Concepts

Concept	Key Formula
Linear expansion	$\Delta L = \alpha L \Delta T$; α = coefficient of linear expansion
Area expansion	$\Delta A = 2\alpha A \Delta T$ ($\beta = 2\alpha$)
Volume expansion	$\Delta V = 3\alpha V \Delta T$ ($\gamma = 3\alpha$)
Calorimetry	Heat lost = Heat gained; $Q = mc\Delta T$; $Q = mL$ (phase change)
Conduction	$Q/t = KA(T_1 - T_2)/L$; K = thermal conductivity
Stefan's law	$E = \sigma A T^4$; net radiation = $\sigma A(T^4 - T_0^4)$; Wien's law: $\lambda_{max} T$ = constant

Questions

Q1. A clinical thermometer is primarily designed to measure:

(A) Temperature of boiling liquids
(B) Human body temperature
(C) Atmospheric temperature
(D) Temperature of furnaces

Q2. The fixed points used to define the Celsius scale are:

(A) Melting point and boiling point of mercury
(B) Freezing point and boiling point of alcohol
(C) Ice point and steam point of water at 1 atm
(D) Absolute zero and steam point of water

Q3. A bimetallic strip is heated uniformly. It bends toward the metal with the smaller coefficient of linear expansion because:

(A) Both metals expand by the same amount, producing no net force
(B) The metal with the larger α expands more and occupies the outer arc, forcing the strip to curve toward the metal with smaller α
(C) The strip becomes mechanically softer on heating and sags
(D) One metal melts before the other, creating asymmetric stress

Q4. Railway tracks are provided with small gaps at junctions mainly to:

(A) Reduce friction between adjacent rail sections
(B) Dampen vibration during high-speed train passage
(C) Increase mechanical strength at joints by controlled stress distribution
(D) Allow for thermal expansion during summer and prevent lateral buckling

Q5. A body of mass 2 kg and specific heat capacity 420 J kg^{-1} K^{-1} is heated from 20°C to 50°C. The heat supplied is:

(A) 12600 J
(B) 25200 J
(C) 42000 J
(D) 8400 J

Q6. Which one of the following statements is correct regarding a cavity inside a metal block when uniformly heated?

(A) The cavity contracts
(B) The cavity remains unchanged
(C) The cavity first contracts then expands
(D) The cavity expands as if filled with the same material

Q7. The rate of heat conduction through a slab is directly proportional to:

(A) Thickness of the slab
(B) Thermal conductivity of the material
(C) Inverse of temperature difference
(D) Density of the material

Q8. The phenomenon responsible for sea breeze is:

(A) Conduction
(B) Radiation
(C) Convection
(D) Thermal expansion

Q9. The SI unit of specific heat capacity is:

(A) J kg^{-1}
(B) kJ kg^{-1}
(C) J kg^{-1} K^{-1}
(D) cal g^{-1} $°C^{-1}$

Q10. Specific heat capacity is defined as the amount of heat required to raise the temperature of:

(A) 1 kg of substance by 10°C
(B) The entire body by 1°C
(C) Unit volume by 1 K
(D) Unit mass by 1 K

Q11. Which of the following remains constant during the melting of pure ice at atmospheric pressure?

(A) Mass
(B) Internal energy
(C) Temperature
(D) Volume

Q12. The SI unit of latent heat is:

(A) J m^{-3}
(B) J kg^{-1}
(C) J K^{-1}
(D) J mol^{-1}

Q13. Which of the following best defines temperature?

(A) Degree of hotness measured in calories
(B) Physical quantity determining the direction of heat flow
(C) Amount of heat contained in a body
(D) Average kinetic energy of the whole body

Q14. Heat is correctly defined as:

(A) Internal energy of a body
(B) Average kinetic energy of molecules
(C) Energy transferred because of temperature difference
(D) Energy possessed due to mass

Q15. A metal cube has side length 10 cm at 20°C. If the coefficient of linear expansion is 2×10^{-5} $°C^{-1}$, the approximate increase in volume when heated through 10°C is:

(A) 0.1 cm^3
(B) 0.3 cm^3
(C) 0.6 cm^3
(D) 1.2 cm^3

Q16. For an isotropic solid, the coefficient of cubical expansion (γ) is related to the coefficient of linear expansion (α) by:

(A) $\gamma = \alpha$
(B) $\gamma = 3\alpha$
(C) $\gamma = 2\alpha$
(D) $\gamma = \alpha/3$

Q17. The principle of calorimetry is based on:

(A) Conservation of momentum
(B) Conservation of energy
(C) Conservation of mass
(D) Newton's law of cooling

Q18. A hot iron ball is dropped into cold water inside a perfectly insulated calorimeter. At equilibrium:

(A) Only the iron loses heat
(B) Only the water gains heat
(C) Heat lost is greater than heat gained
(D) Heat lost by iron equals heat gained by water

Q19. Newton's law of cooling is a good approximation when the temperature difference between the body and surroundings is:

(A) Very large
(B) Small
(C) Zero
(D) Infinite

Q20. According to Newton's law of cooling, the rate of loss of heat from a body is directly proportional to:

(A) Mass of the body
(B) Specific heat capacity of the body
(C) Temperature difference between the body and its surroundings
(D) Surface area of the body only

Q21. Which is always true for a pure substance during a phase change at constant pressure?

(A) Internal energy remains constant
(B) Temperature remains constant
(C) Specific heat becomes zero
(D) Density remains constant

Q22. At 4°C, pure water has:

(A) Minimum volume and minimum density
(B) Maximum volume and minimum density
(C) Maximum density and minimum volume
(D) Maximum latent heat of fusion

Q23. A hot iron rod and a cold copper rod are brought into contact. Heat flows until:

(A) Both attain the same temperature
(B) Both possess equal heat
(C) Both have equal internal energy
(D) Both have equal masses

Q24. A large iceberg and a small cup of boiling water are compared. Which of the following is correct regarding their internal energy?

(A) The iceberg may have greater internal energy than the boiling water
(B) The boiling water always has greater internal energy than the iceberg
(C) Both must have equal internal energy at thermal equilibrium
(D) Internal energy depends only on temperature, not mass

Answer key

1-B	**2-C**	**3-B**	**4-D**	**5-B**	**6-D**	**7-B**	**8-C**
9-C	**10-D**	**11-C**	**12-B**	**13-B**	**14-C**	**15-C**	**16-B**
17-B	**18-D**	**19-B**	**20-C**	**21-B**	**22-C**	**23-A**	**24-A**

Answers with explanations

Q1 — Answer: (B) Human body temperature
A clinical thermometer has a calibrated range of 35°C to 42°C, designed exclusively for body temperature. Its constriction prevents mercury from falling back after the reading is taken, unlike a laboratory thermometer.

Q2 — Answer: (C) Ice point and steam point of water at 1 atm
The Celsius scale uses two fixed points: the ice point (0°C, equilibrium of ice and water at 1 atm) and steam point (100°C, boiling point of water at 1 atm). Option D is wrong: absolute zero is not a fixed point of the Celsius scale.

Q3 — Answer: (B) The metal with the larger α expands more and occupies the outer arc, forcing the strip to curve toward the metal with smaller α
The metal with larger α extends more and must form the outer (longer) arc. The metal with smaller α forms the inner (shorter) arc. The strip therefore bends toward the low-α metal. Students most commonly choose the trap: "bends toward larger α."

Q4 — Answer: (D) Allow for thermal expansion during summer and prevent lateral buckling
Without expansion gaps, rails heated in summer develop large compressive thermal stress (= YαΔT) with no room to expand, causing lateral buckling. The gap provides exactly the relief needed.

Q5 — Answer: (B) 25200 J
Q = mcΔT = 2 × 420 × 30 = 25200 J. Option A uses ΔT = 15 (half the correct value). Option D uses mass = 1 kg by error.

Q6 — Answer: (D) The cavity expands as if filled with the same material
Every linear dimension, including cavities, expands on heating. Option A is the most common wrong answer — students assume empty space cannot expand.

Q7 — Answer: (B) Thermal conductivity of the material
From Fourier's law H = kAΔT/L, heat flow rate is directly proportional to k (thermal conductivity). Option A is wrong — H is inversely proportional to thickness L. Option C inverts the correct relationship for ΔT.

Q8 — Answer: (C) Convection
Land heats faster than sea during the day, so air above land rises. Cooler sea air moves in to replace it — this bulk fluid motion is convection. Option A (conduction) requires direct contact with no bulk motion; Option B (radiation) requires no medium.

Q9 — Answer: (C) J kg^{-1} K^{-1}
Specific heat capacity = heat per unit mass per unit temperature rise. SI unit = J kg^{-1} K^{-1}. Option A omits K^{-1}. Option D is CGS unit, not SI. Option B uses kJ, a non-standard SI prefix form.

Q10 — Answer: (D) Unit mass by 1 K
Specific heat capacity is defined per unit mass per unit temperature rise (1 K). Option B defines heat capacity (not specific). Option C incorrectly uses unit volume — specific heat is per unit mass, not volume.

Q11 — Answer: (C) Temperature
Heat supplied becomes latent heat of fusion, breaking intermolecular bonds without increasing kinetic energy — so temperature stays fixed at 0°C. Internal energy increases and volume changes slightly during melting.

Q12 — Answer: (B) J kg^{-1}
Latent heat is heat per unit mass during a phase change — SI unit is J kg^{-1}. Option C (J K^{-1}) is heat capacity; Option A (J m^{-3}) is energy density; Option D (J mol^{-1}) is molar latent heat — a different quantity.

Q13 — Answer: (B) Physical quantity determining the direction of heat flow
Temperature is an intensive state variable that determines the direction of spontaneous heat flow. Option A is wrong as calories measure heat, not temperature. Option C confuses temperature with heat content.

Q14 — Answer: (C) Energy transferred because of temperature difference
Heat is energy in transit due to a temperature difference; it is not stored in a body. Option A confuses heat with internal energy, a classic NEET distractor.

Q15 — Answer: (C) 0.6 cm^3
γ = 3α = 6×10^{-5} $°C^{-1}$. V = 1000 cm^3. ΔV = γVΔT = 6×10^{-5} × 1000 × 10 = 0.6 cm^3. Option D arises from using γ = 6α instead of 3α — a common factor-of-2 error.

Q16 — Answer: (B) γ = 3α
For isotropic solids expanding equally in all three dimensions, γ ≈ 3α for small ΔT. Option C is β = 2α (superficial expansion), a common confusion. Option A conflates linear and volumetric coefficients.

Q17 — Answer: (B) Conservation of energy
In an isolated system, total energy is conserved. Heat lost by the hot body equals heat gained by the cold body — a direct application of the First Law of Thermodynamics.

Q18 — Answer: (D) Heat lost by iron equals heat gained by water
In a perfectly insulated calorimeter, no heat escapes to surroundings. By conservation of energy, heat lost by iron equals heat gained by water until both reach the same final temperature.

Q19 — Answer: (B) Small
Newton's law $dT/dt \propto (T-Ts)$ is valid only for small ΔT (typically under 30–40°C), where Stefan's T^4 law linearises. At large ΔT, radiation dominates non-linearly and the simple proportionality fails.

Q20 — Answer: (C) Temperature difference between the body and its surroundings
Newton's law states $dQ/dt \propto (T-Ts)$. The driving quantity is excess temperature above surroundings. Mass and specific heat affect how temperature changes per unit heat lost, not the rate of heat loss directly.

Q21 — Answer: (B) Temperature remains constant
During phase change, supplied heat increases intermolecular potential energy, not kinetic energy. Temperature stays constant throughout. Trap: students confuse constant temperature with constant internal energy — internal energy increases as PE rises.

Q22 — Answer: (C) Maximum density and minimum volume
Water contracts anomalously on cooling from 4°C to 0°C. At 4°C its density is maximum (~1000 kg/m^3), so the volume of a given mass is minimum. Options A and B pair the wrong extremes, and latent heat of fusion is not related to 4°C.

Q23 — Answer: (A) Both attain the same temperature
Thermal equilibrium is reached when both bodies attain the same temperature, not equal heat or internal energy. Internal energy depends on mass and composition, not temperature alone.

Q24 — Answer: (A) The iceberg may have greater internal energy than the boiling water
Internal energy depends on mass, temperature, and state. A massive iceberg at 0°C can have greater total internal energy than a small cup of boiling water. Option B wrongly assumes temperature alone decides internal energy.

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