

Thermal Properties of Matter — CBSE Pattern Test 2

Class 11 Physics · 90 minutes · 40 marks · Sections A–D with answer key · Narayan Gurukul Academy

Test 2 — CBSE Pattern (90 minutes, 40 marks)

Class 11 Physics · Thermal Properties of Matter · Narayan Gurukul Academy (ClassApna)

General Instructions: (1) This paper has four sections — Section A (1×10), Section B (2×4), Section C (3×4) and Section D (5×2) — total 40 marks. Time allowed: 90 minutes.

(2) All questions are compulsory. No overall choice is given; internal choice, where allowed, is clearly marked.

(3) For MCQ questions choose the single correct option; for VSA answers write a single line.

(4) Take $g = 10 \text{ m/s}^2$. All symbols carry their usual meaning. Use of a calculator is not permitted.

Section A — MCQ & VSA ($10 \times 1 = 10$ marks)

1. The heat needed to raise the temperature of mass m by ΔT with specific heat c is

(A) $Q = mc\Delta T$

(B) $Q = mc/\Delta T$

(C) $Q = c\Delta T/m$

(D) $Q = m\Delta T/c$

2. The SI unit of specific heat is

(A) $\text{J kg}^{-1} \text{K}^{-1}$

(B) J kg^{-1}

(C) J K^{-1}

(D) $\text{W m}^{-1} \text{K}^{-1}$

3. The substance with an unusually high specific heat is

(A) water

(B) copper

(C) glass

(D) wood

4. In the method of mixtures, the heat lost by the hotter bodies

(A) equals the heat gained by the colder ones

(B) is greater than the heat gained

(C) is lost to the surroundings always

(D) cannot be compared

5. During a change of state at constant pressure, the temperature of the substance

(A) remains constant

(B) increases steadily

(C) decreases

(D) first rises then falls

6. The heat required to melt unit mass of a solid is its

(A) latent heat of fusion

(B) latent heat of vaporisation

(C) specific heat

(D) thermal capacity

7. The latent heat of vaporisation of water is approximately

(A) $2.26 \times 10^6 \text{ J kg}^{-1}$

(B) $3.34 \times 10^5 \text{ J kg}^{-1}$

(C) $4.18 \times 10^3 \text{ J kg}^{-1}$

(D) $1.01 \times 10^5 \text{ J kg}^{-1}$

8. Perspiration cools the body because

(A) sweat evaporates, absorbing latent heat from the skin

(B) sweat is cold

(C) sweat conducts heat away

(D) the skin reflects radiation

9. Which mode of heat transfer can operate in a vacuum?

10. Define a black body.

Section B — Short Answer I ($4 \times 2 = 8$ marks)

11. How much heat is needed to convert 100 g of ice at 0°C to water at 0°C ? ($L_f = 3.34 \times 10^5 \text{ J kg}^{-1}$)

12. How much heat is needed to raise the temperature of 200 g of water from 25°C to 75°C ? ($c = 4.18 \times 10^3 \text{ J/kg K}$)

13. 5 kg of water at 60°C is mixed with 5 kg of water at 20°C . Find the final temperature assuming no heat loss.

14. A body cools from 80°C to 70°C in 5 minutes when the room is at 20°C . Estimate how long it takes to cool from 70°C to 60°C using Newton's law of cooling.

Section C — Short Answer II ($4 \times 3 = 12$ marks)

15. A window pane is 1 cm thick, 1 m $\times$ 1 m in area, with a temperature difference of 20°C between its faces. Find the heat conducted per second. ($k_{\text{glass}} = 0.8 \text{ W m}^{-1} \text{ K}^{-1}$)

16. A copper rod of length 1 m is heated from 20°C to 100°C . If the coefficient of linear expansion is $1.7 \times 10^{-5} \text{ K}^{-1}$, find the increase in length.

17. Calculate the heat required to convert 100 g of ice at 0°C to water at 0°C and then raise it to 20°C . ($L_f = 3.34 \times 10^5 \text{ J kg}^{-1}$, $c_{\text{water}} = 4200 \text{ J kg}^{-1} \text{ K}^{-1}$)

18. A black-body sphere of radius 5 cm at 1000 K radiates energy. Find the rate of energy radiated. ($\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$)

Section D — Long Answers ($2 \times 5 = 10$ marks)

19. A copper calorimeter of mass 100 g contains 150 g of water at 25°C . Steam at 100°C is passed until the temperature reaches 30°C . Find the mass of steam condensed. ($L = 2.26 \times 10^6 \text{ J/kg}$, $c = 4180 \text{ J/kg K}$)

20. State and explain the law of thermal conduction (Fourier's law) and derive the heat-current formula for a rod of length l and area A . Also state Stefan's law of black-body radiation and explain Newton's law of cooling as its consequence.

Answer Key (Marking Scheme)

Q1 — (A) $Q = mc\Delta T$. Q2 — (A) $\text{J kg}^{-1} \text{ K}^{-1}$. Q3 — (A) water. Q4 — (A) equals the heat gained by the colder ones.

Q5 — (A) remains constant. Q6 — (A) latent heat of fusion. Q7 — (A) $2.26 \times 10^6 \text{ J kg}^{-1}$. Q8 — (A) evaporation absorbs latent heat.

Q9 — Radiation (electromagnetic waves need no medium).

Q10 — A body that absorbs all radiation incident on it and emits perfectly (an ideal absorber and emitter).

Q11 — $Q = mL_f = 0.1 \times 3.34 \times 10^5 = 3.34 \times 10^4 \text{ J}$.

Q12 — $Q = mc\Delta T = 0.2 \times 4180 \times 50 \approx 4.18 \times 10^4 \text{ J}$.

Q13 — Heat lost = heat gained: $5 \times (60 - T) = 5 \times (T - 20)$ $\Rightarrow T = 40^\circ\text{C}$.

Q14 — $t \approx 5 \times 55/45 \approx 6.1 \text{ min}$ (avg excess 55 in first fall, 45 in second).

Q15 — $H = kA\Delta T/l = 0.8 \times 1 \times 20/0.01 = 1600 \text{ W}$.

Q16 — $\Delta l = \alpha l \Delta T = 1.7 \times 10^{-5} \times 1 \times 80 = 1.36 \times 10^{-3} \text{ m} = 1.36 \text{ mm}$.

Q17 — Melt: $3.34 \times 10^4 \text{ J}$; warm: $0.1 \times 4200 \times 20 = 8400 \text{ J}$; total $\approx 4.18 \times 10^4 \text{ J}$.

Q18 — $A = 4\pi \times 0.05^2 \approx 0.0314 \text{ m}^2$; $P = \sigma AT^4 \approx 1.78 \times 10^3 \text{ W}$.

Q19 — Heat to bring vessel + water $25 \rightarrow 30^\circ\text{C} = (0.1 + 0.15) \times 4180 \times 5 = 5225 \text{ J}$. Steam condensing at 100°C then cooling to 30°C releases $m(2.26 \times 10^6 + 4180 \times 70) = m \times 2.55 \times 10^6$. $m \approx 2.0 \times 10^{-3} \text{ kg} \approx 2 \text{ g}$.

Q20 — $H = kA(\theta_1 - \theta_2)/l$ (Fourier). Stefan: $E = \sigma eAT^4$, for a black body $e = 1$. Newton's law $d\theta/dt \propto (\theta - \theta_0)$ follows for small temperature excesses from $dE = 4\sigma eAT^3 dT$: the rate is set by the T^4 law evaluated near the surrounding temperature.