



Attempt questions first; check the separate key afterward. Take $g = 10 \text{ m/s}^2$ where needed. Neglect air resistance unless stated.

A. Very short answers - 1 mark each

1. Distinguish heat from temperature.
2. Define coefficient of linear expansion.
3. What is anomalous expansion of water?
4. Define specific heat capacity and its SI unit.
5. Why does temperature remain constant during melting at fixed pressure?
6. State Wien's displacement law.

B. Short answers / practice - 2 marks each

7. Convert 27°C to kelvin and 68°F to degrees Celsius.
8. Why are expansion gaps provided in railway tracks?
9. Explain why a hole in a metal plate expands on heating.
10. A 2 m rod has $\alpha = 1.2 \times 10^{-5} \text{ K}^{-1}$. Find its expansion for a 50 K rise.
11. How much heat raises 0.5 kg of water from 20°C to 60°C ? Take $c = 4200 \text{ J kg}^{-1} \text{ K}^{-1}$.
12. Distinguish conduction, convection and radiation with one example each.
13. The absolute temperature of a blackbody doubles. Find the ratios of emitted power per unit area and peak wavelength.
14. Convert 100°C to kelvin.
15. Find heat capacity of 2 kg metal with $c=400 \text{ J kg}^{-1} \text{ K}^{-1}$.
16. Does a hole in a uniformly heated metal plate shrink?
17. Why does a metal spoon feel colder than wood at the same room temperature?
18. Find heat to melt 0.1 kg ice at 0°C ; $L=3.34 \times 10^5 \text{ J/kg}$.

C. Application / reasoning - 3 marks each

19. Explain why lakes freeze at the surface first and how water below can remain liquid.
20. A copper calorimeter of mass 0.1 kg contains 0.2 kg water at 20°C . A 0.1 kg metal at 100°C gives a final temperature of 25°C . Find its specific heat; c of copper = 400 and water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$.

21. Find the heat required to convert 20 g ice at 0°C into water at 50°C . Use L of fusion = $3.34 \times 10^5 \text{ J/kg}$ and c of water = $4200 \text{ J kg}^{-1} \text{ K}^{-1}$.

22. A wall of area 10 m^2 , thickness 0.2 m and conductivity $0.8 \text{ W m}^{-1} \text{ K}^{-1}$ has a 15 K temperature difference. Find steady heat flow per second.

23. Two rods expand equally for the same temperature rise. If their coefficients are in the ratio 2 : 3, find the ratio of their original lengths.

24. A blackbody's peak wavelength is $5.8 \mu\text{m}$. Find its temperature using Wien's constant $2.9 \times 10^{-3} \text{ m K}$.

25. A black surface of area 0.02 m^2 is at 400 K in surroundings at 300 K. Find net radiative loss using $\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$.

26. Sketch a heating curve from ice below 0°C to steam above 100°C at one atmosphere. Explain sloping and horizontal portions.

D. Extended practice - 5 marks each

27. Derive the relations between linear, area and volume expansion coefficients for an isotropic solid, neglecting higher-order terms.
28. Explain the principle of calorimetry. Mix 0.2 kg water at 80°C with 0.3 kg at 20°C in an insulated vessel of negligible heat capacity; find equilibrium temperature.
29. Derive the steady heat-current relation for two slabs in series. Find the interface temperature for equal thickness and area, conductivities k and $2k$, with outer faces at 100°C and 0°C respectively.
30. State and explain Stefan-Boltzmann and Wien laws. Compare total emission and peak wavelength of equal-area blackbodies at 300 K and 600 K; distinguish emission from net heat loss.

ANSWER KEY - Numerical / closed questions

7) 300.15 K (about 300 K); 20°C . 10) 1.2 mm. 11) 84000 J. 13) Power 16:1; wavelength 1:2. 14) 373.15 K. 15) 800 J/K. 16) No; it expands. 18) 33400 J. 20) $586.7 \text{ J kg}^{-1} \text{ K}^{-1}$. 21) 10880 J. 22) 600 W. 23) 3:2. 24) 500 K. 25) 19.845 W. 28) 44°C . 29) Interface 33.33°C . 30) At 600 K: 16 times emission and half peak wavelength.