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**Book Package**

**2026**

**GATE • PSUs**

**PRODUCTION AND  
INDUSTRIAL ENGINEERING**

**Objective Practice Sets**

**General Engineering : Volume VII**

**Heat Transfer**



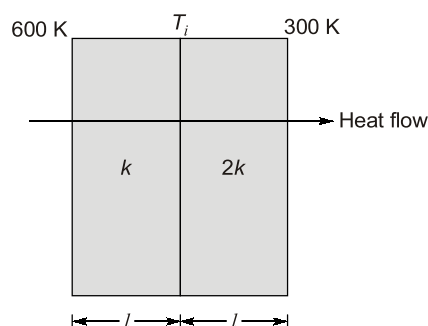
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## Heat Transfer

- Q.1** Thermal conductivity is lower for  
 (a) wood (b) air  
 (c) water at 100°C (d) steam at 1 bar
- Q.2** For a current carrying wire of 20 mm diameter exposed to air ( $h = 20 \text{ W/m}^2\text{K}$ ), maximum heat dissipation occurs when thickness of insulation ( $k = 0.5 \text{ W/mK}$ ) is  
 (a) 30 mm (b) 25 mm  
 (c) 20 mm (d) 15 mm
- Q.3** For a given heat flow and for the same thickness, the temperature drop across the material will be maximum for  
 (a) Copper (b) Steel  
 (c) Glass wool (d) Refractory brick
- Q.4** A stainless steel tube ( $k_s = 19 \text{ W/mK}$ ) of 2 cm *ID* and 5 cm *OD* is insulated with 3 cm thick asbestos ( $k_a = 0.2 \text{ W/mK}$ ). If the temperature difference between the inner most and outermost surfaces is 600°C, the heat transfer rate per unit length is  
 (a) 0.94 W/m (b) 9.44 W/m  
 (c) 944.72 W/m (d) 9447.21 W/m
- Q.5** A long glass cylinder of inner diameter = 0.03 m and outer diameter = 0.05 m carries hot fluid inside. If the thermal conductivity of glass is 1.05 W/mK, then the thermal resistance (K/W) per unit length of the cylinder is  
 (a) 0.031 (b) 0.077  
 (c) 0.17 (d) 0.34
- Q.6** A coolant fluid at 30°C flows over a heated flat plate maintained at a constant temperature of 100°C. The boundary layer temperature distribution at a given location on the plate may be approximated as  $T = 30 + 70 \exp(-y)$  where  $y$  (in m) is the distance normal to the plate and  $T$  is in °C. If thermal conductivity of the fluid is 1.0 W/mK, the local convective heat transfer coefficient (in W/m<sup>2</sup>K) at that location will be

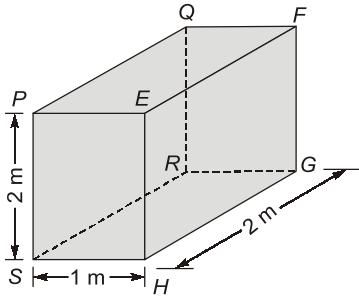
- (a) 0.2 (b) 1  
 (c) 5 (d) 10

- Q.7** Heat transfer through a composite wall is shown in figure. Both the sections of the wall have equal thickness ( $l$ ). The conductivity of one section is  $k$  and that of the other is  $2k$ . The left face of the wall is at 600 K and the right face is at 300 K.



The interface temperature  $T_i$  (in K) of the composite wall is \_\_\_\_\_.

- Q.8** Heat transfer coefficients for free convection in gases, forced convection in gases and vapours, and for boiling water lie, respectively, in the range of  
 (a) 5–15, 20–200 and 3000–50000 W/m<sup>2</sup>K  
 (b) 20–50, 200–500 and 50000–100000 W/m<sup>2</sup>K  
 (c) 50–100, 500–1000 and 100000–100000 W/m<sup>2</sup>K  
 (d) 20–100, 200–1000 and a constant 100000 Wm<sup>2</sup>
- Q.9** For the three-dimensional object shown in the figure below, five faces are insulated. The sixth face (PQRS), which is not insulated, interacts thermally with the ambient, with a convective heat transfer coefficient of 10 W/m<sup>2</sup>K. The ambient temperature is 30°C. Heat is uniformly generated inside the object at the rate of 100 W/m<sup>3</sup>. Assuming the face PQRS to be at uniform temperature, its steady state temperature is



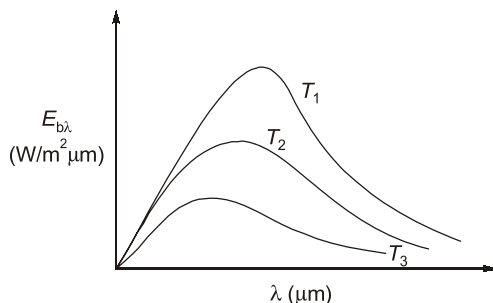
- (a) 10°C                      (b) 20°C  
(c) 30°C                      (d) 40°C

- Q.10** For a glass plate, transmissivity and reflectivity are specified as 0.86 and 0.08 respectively, the absorptivity of the glass plate is  
(a) 0.86                      (b) 0.08  
(c) 1.00                      (d) 0.06

- Q.11** A diffuse radiation surface has  
(a) Radiation intensity independent of angle  
(b) Emissive power independent of angle  
(c) Emissive power independent of wavelength  
(d) Radiation intensity independent of both angle and wavelength

- Q.12** The radiative heat transfer rate per unit area ( $\text{W/m}^2$ ) between two plane parallel gray surfaces (emissivity = 0.9) maintained at 400 K and 300 K is ( $\sigma_p$  (Stefan Boltzmann constant) =  $5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4$ )  
(a) 992                      (b) 812  
(c) 464                      (d) 567

- Q.13** The following figure was generated from experimental data relating spectral black body emissive power to wave length at the three temperatures  $T_1$ ,  $T_2$  and  $T_3$  ( $T_1 > T_2 > T_3$ ).



- The conclusion in that the measurements are  
(a) correct because the maxima in  $E_{b\lambda}$  show the correct trend  
(b) correct because Planck's law is satisfied

- (c) wrong because the Stefan Boltzmann law is not satisfied  
(d) wrong because Wien's displacement law is not satisfied.

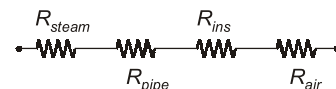
- Q.14** For an opaque surface, the absorptivity ( $\alpha$ ), transmissivity ( $\tau$ ) and reflectivity ( $\rho$ ) are related by the equation  
(a)  $\alpha + \rho = \tau$                       (b)  $\rho + \alpha + \tau = 0$   
(c)  $\alpha + \rho = 1$                       (d)  $\alpha + \rho = 0$

- Q.15** A hemispherical furnace of 1 m radius has the inner surface (emissivity,  $\epsilon = 1$ ) of its roof maintained at 800 K, while its floor ( $\epsilon = 0.5$ ) is kept at 600 K. Stefan-Boltzmann constant is  $5.668 \times 10^{-8} \text{ W/m}^2\text{K}^4$ . The net radiative heat transfer (in kW) from the roof to the floor is \_\_\_\_\_.

- Q.16** The total emissive power of a surface is  $500 \text{ W/m}^2$  at temperature  $T_1$  and  $1200 \text{ W/m}^2$  at a temperature  $T_2$ , where the temperature are in Kelvin. Assuming the emissivity of the surface to be constant, the ratio of the temperature  $T_1/T_2$  is  
(a) 0.0308                      (b) 0.416  
(c) 0.803                      (d) 0.874

- Q.17** Heat transfer takes place according to  
(a) Zeroth Law of thermodynamics  
(b) First Law of the thermodynamics  
(c) Second Law of thermodynamics  
(d) Third Law of thermodynamics

- Q.18** A pipe carrying saturated steam, is covered with a layer of insulation and exposed to ambient air. The thermal resistance are as shown in the following figure.



Which one of the following statements is correct in this regard?

- (a)  $R_{steam}$  and  $R_{pipe}$  negligible as compared to  $R_{ins}$  and  $R_{air}$   
(b)  $R_{pipe}$  and  $R_{air}$  negligible as compared to  $R_{ins}$  and  $R_{steam}$   
(c)  $R_{steam}$  and  $R_{air}$  are negligible as compared to  $R_{pipe}$  and  $R_{ins}$   
(d) No quantitative data is provided, therefore no comparison is possible.

**Answers Heat Transfer**

1. (b) 2. (d) 3. (c) 4. (c) 5. (b) 6. (b) 7. (400°C) 8. (a)  
9. (d) 10. (d) 11. (a) 12. (b) 13. (d) 14. (c) 15. (24936) 16. (c)  
17. (c) 18. (a) 19. (b) 20. (a) 21. (a) 22. (a) 23. (d) 24. (d)  
25. (c) 26. (a) 27. (b) 28. (a) 29. (d) 30. (c) 31. (d) 32. (d)  
33. (c) 34. (c) 35. (a) 36. (d) 37. (c) 38. (a) 39. (c) 40. (b)  
41. (c) 42. (c) 43. (b) 44. (a) 45. (a) 46. (a) 47. (a) 48. (d)  
49. (b) 50. (c) 51. (d) 52. (b) 53. (b) 54. (a) 55. (a) 56. (d)  
57. (c) 58. (b) 59. (c) 60. (c) 61. (c) 62. (c) 63. (b) 64. (c)  
65. (b) 66. (b) 67. (63.96) 68. (a) 69. (0.94) 70. (c) 71. (a) 72. (c)  
73. (d) 74. (0.424) 75. (-16.84) 76. (b) 77. (c) 78. (539.67) 79. (533.33) 80. (4.87)  
81. (45.45) 82. (a) 83. (a) 84. (36.23)

**Explanations Heat Transfer**

1. (b)

Material	Thermal conductivity : $k$ (W/mK)
Wood (wood fire)	0.11
Air (20°C)	0.025
Water (100°C)	0.6804
Steam (1 bar & 200°C)	0.03349

2. (d)

Given data:

$$d = 20 \text{ mm}$$

$$\therefore r = \frac{d}{2} = \frac{20}{2} = 10 \text{ mm}$$

$$h_o = 20 \text{ W/m}^2\text{K}$$

$$k = 0.5 \text{ W/mK}$$

For maximum heat dissipation,

Critical radius,

$$\begin{aligned} r_c &= \frac{k}{h} \text{ for cylinder or wire} \\ &= \frac{0.5}{20} = 0.025 \text{ m} = 25 \text{ mm} \end{aligned}$$

Thickness of insulation,

$$= r_c - r = 25 - 10 = 15 \text{ mm}$$

3. (c)

Fourier's law,

$$Q = -kA \frac{dT}{dx}$$

At constant  $Q$ ,  $A$  and  $dx$ ,

$$dT \propto \frac{1}{k}$$

Temperature drop ( $dT$ ) is inversely proportional to the thermal conductivity.

Material	Thermal conductivity : $k$ (W/mK)
Copper	385
Steel	45
Glass wool	0.0372
Refractory brick	1.50

Hence, lower the thermal conductivity, higher temperature drop. So, glass wool has minimum thermal conductivity and maximum temperature drop.

4. (c)

Given data:

$$k_s = 19 \text{ W/mK}$$

$$d_1 = 2 \text{ cm} = 0.02 \text{ m}$$

$$\therefore r_1 = \frac{d_1}{2} = \frac{0.02}{2} = 0.01 \text{ m}$$

$$d_2 = 5 \text{ cm} = 0.05 \text{ m}$$

$$\therefore r_2 = \frac{d_2}{2} = \frac{0.05}{2} = 0.025 \text{ m}$$

$$t = 3 \text{ cm} = 0.03 \text{ m}$$

$$\therefore r_3 = r_2 + t = 0.025 + 0.03$$