MADE EASY PUBLICATIONS

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CONTENTS

MECHANICAL ENGINEERING

Objective Practice Sets

Heat Transfer

1 CHAPTER
Introduction and Basic Concepts

MCQ and NAT Questions

Q.1 Heat transmission is directly linked with the transport of medium itself, i.e., there is actual or bulk motion of heated particles during
(a) conduction only
(b) convection only
(c) radiation only
(d) conduction as well as radiation

Q.2 Choose the correct statement
(a) Thermal conductivity for metals decreases with increase in temperature
(b) Thermal conductivity for gases and insulating material decreases with increase in temperature
(c) Thermal conductivity is not a function of temperature
(d) Thermal conductivity increases with increase in temperature irrespective of material

Q.3 Arrange the following substance in increasing order of thermal conductivity.
1. Copper 2. Aluminium
3. Water 4. Air
Which one of the following sequence is correct?
(a) 4-3-2-1 (b) 4-3-1-2
(c) 3-4-2-1 (d) 3-4-1-2

Q.4 The inner surface of a plane brick wall is at 50°C and the outer surface is at 25°C. The rate of heat transfer per m^2 of the surface area of the wall, which is 220 mm thick is (the thermal conductivity of the bricks is 0.51 W/m K).
(a) 20.65 W/m^2 (b) 32.75 W/m^2
(c) 47.62 W/m^2 (d) 57.95 W/m^2

Q.5 All the three modes of heat transmission are involved in
(a) melting of ice
(b) cooling of a small metal casting in a quenching bath
(c) heat flow through the walls of a refrigerator
(d) automobile engine equipped with a thermo-syphon cooling system

Q.6 For a composite wall made of three layers, of three layers, A, B and C of different material wall thickness and temperature difference across the wall faces of layer A, B and C are 20cm and 100°C, 15cm and 180°C, 25cm and 100°C respectively. Which one of the following is correct? (assume area of each layer is same).
(a) Layer A has highest thermal conductivity (k)
(b) Layer B has highest thermal conductivity (k)
(c) Layer C has highest thermal conductivity (k)
(d) All layers have equal thermal conductivity.

Q.7 The heat conducted through a wall of thickness δ is given by

$$Q = -kA\frac{dT}{dx} = -kA\left(\frac{T_2 - T_1}{\delta}\right)$$

which amongst the following is not a correct statement?
(a) the term (δ/kA) is called thermal resistance
(b) the term (kA/δ) is called thermal conductance
(c) the factor (Q/A) is called thermal loading
(d) the temperature gradient (dT/dx) is positive

Q.8 Heat conduction in gases is due to
(a) electromagnetic waves
(b) motion of electrons
(c) mixing motion of the different layers of the gas
(d) elastic impact of molecules

Q.9 Thermal diffusivity is
(a) a dimensionless parameter
(b) function of temperature
(c) a physical property of the material
(d) none of these

Q.10 Your finger sticks to an ice tray just taken from the refrigerator, Which factor has more effect on this phenomenon?
(a) The inside temperature of the freezer (Suppose it's working properly)
(b) The humidity of the air

Q.21 Which of the following statements is/are correct?
(a) Thermal conductivity is a thermophysical property of a material.
(b) Heat conduction occurs in gases by molecular momentum transfer.
(c) With increase in temperature thermal conductivity of gases decreases.
(d) Liquids are better conductors of heat than gases.

Q.22 Which of the following statements is/are correct about a black body?
(a) A black body is considered as an ideal emitter.
(b) A black body is considered as a perfect absorber.
(c) A black body is considered as non-diffusive in nature.
(d) Snow and Ice are also considered as black body.

Q.23 Which of the following statements is/are correct?
(a) In free convection heat transfer the motion of the fluid occurs naturally due to buoyancy forces.
(b) Radiation heat transfer does not require any material medium for its propagation.
(c) All bodies at all temperature emit thermal radiation except the body at 0 K.
(d) Radiation heat transfer dominates over conduction and convection when the temperature difference is sufficiently large.

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Answers Introduction and Basic Concepts

1. (b)	2. (a)	3. (a)	4. (d)	5. (d)	6. (c)	7. (d)	8. (d)
9. (c)	10. (d)	11. (a)	12. (a)	13. (d)	14. (c)	15. (d)	16. (a)
17. (b)	18. (d)	19. (a)	20. (a, c, d)	21. (a, b, d)	22. (a, b, d)	23. (a, b, c, d)	

Explanations Introduction and Basic Concepts

1. (b)

Actual movement of particles of the medium is present in convection only.

2. (a)

For gases thermal conductivity increases with increase in temperature and decrease with increase in molecular weight.

3. (a)

Substance	k(w/m-K)
Copper	386
Aluminium	175.6
Water	0.51
Air	0.022

4. (d)

$$q = k\frac{\Delta T}{\Delta x} = \frac{0.51\times 25}{0.22} = 57.95\ \text{W/m}^2$$

5. (d)

In syphon cooling system all modes conduction, convection and radiation takes place. Since it has high temperatures therefore radiation heat transfer is also significant.

6. (c)

$$\because\ Q = \frac{k_1A_1\Delta t_1}{L_1} = \frac{k_2A_2\Delta t_2}{L_2} = \frac{k_3A_3\Delta t_3}{L_3}$$

$$\therefore\ A_1 = A_2 = A_3 = A$$

$$\therefore\ Q = \frac{k_1\,.\,\Delta t_1}{L_1} = \frac{k_2\,.\,\Delta t_2}{L_2} = \frac{k_3\,.\,\Delta t_3}{L_3}$$

$$\therefore\ Q = \frac{k_1(100)}{20} = \frac{k_2(180)}{15} = \frac{k_3(100)}{25}$$

$$\therefore\ 5k_1 = 12k_2 = 4k_3$$

$$\therefore\ \boxed{k_3 > k_1 > k_2}$$

7. (d)

$\frac{\delta}{kA}$ in thermal resistance

$\frac{Q}{A}$ in thermal loading

9 CHAPTER

Radiation Heat Transfer

MCQ and NAT Questions

Q.1 Which of the following relation is correct?

(a) $E = \dfrac{I}{\pi}$ (b) $E = \pi I$

(c) $E = \pi^2 I$ (d) $E = \dfrac{I}{\pi^2}$

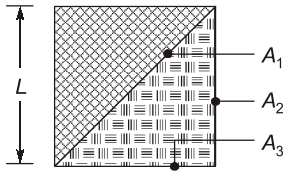
Symbols have usual meaning

Q.2 Solar radiations is incident over an opaque body at a rate of 600 W/m^2. If the reflectivity of body is 0.4, the part of radiation absorbed is

(a) 90 W/m^2 (b) 180 W/m^2

(c) 270 W/m^2 (d) 360 W/m^2

Q.3 For the given figure



The value of F_{21} is

(a) 1 (b) 0.5

(c) 0.71 (d) 0.62

Q.4 If ε is the emissivity of surfaces and shields and n is the number of shields introduced between the two surfaces, then overall emissivity is given by

(a) n/ε (b) $n\varepsilon$

(c) $1/(2n-\varepsilon)$ (d) $\varepsilon/[(n+1)(2-\varepsilon)]$

Q.5 A spherical aluminium shell of inside diameter 2 m is evacuated and used as a radiation test chamber. If the inner surface is coated with carbon black and maintained at 600K, the irradiation on a small test surface placed inside the chamber (Stefan Boltzmann constant)

$\sigma = 5.67 \times 10^{-8}$ W/m^{2}K^4

(a) 1000 W/m^2 (b) 3400 W/m^2

(c) 5680 W/m^2 (d) 7384 W/m^2

Q.6 Two large parallel grey plates with a small gap, exchange radiation at the rate of 1000 W/m^2 when their emissivities are 0.5 each. By coating one plate, its emissivity is reduced to 0.25. Temperatures remain unchanged. The new rate of heat exchange shall become

(a) 500 W/m^2 (b) 600 W/m^2

(c) 700 W/m^2 (d) 800 W/m^2

Q.7 A pipe carrying steam having an OD of 20 cm lump in a large room and is exposed to air at a temp of 30°C. The pipe surface temp is 400°C. The emissivity of pipe surface is 0.8, the loss of heat to surroundings per metre length of pipe due to thermal radiation is

(a) 3.6 kw/m (b) 4.6 kw/m

(c) 5.6 kw/m (d) 6.6 kw/m

Q.8 If pipe in above problem is enclosed in a 40 cm diameter brick conduit of emissivity 0.91; the equivalent emissivity of the system is

(a) 0.67 (b) 0.72

(c) 0.77 (d) 0.82

Q.9 Consider the problem No (35 and 36), the decrease in heat loss is, when 40 cm diameter brick conduit encloses the pipe,

(a) 2.05% (b) 3.57%

(c) 4.99% (d) 5.62%

Q.10 Emissivities of two large parallel plates maintained at 800°C and 300°C are 0.3 and 0.5. Net radiant heat exchange /m^2 for plates is

(a) 12.46 kW/m^2 (b) 15.94 kW/m^2

(c) 27.37 kW/m^2 (d) 35.27 kW/m^2

Q.11 The net radiation from the surface of two parallel having emissivity 0.7 maintained between two temperature is to be reduced by 85 times by using some screens of emissivity 0.05 in between the plates.

No. of screens are

(a) 2 (b) 3

(c) 4 (d) 5

(d) Highly polished metallic shields having good reflectivity are generally used in the furnaces to increase radiation heat exchange.

Q.65 Which of the following statements is/are correct?

(a) The total thermal radiation incident upon a surface per unit time and per unit area is known as radiosity (J).

(b) The total thermal radiation leaving a surface per unit time and per unit area is known as irradiation (G).

(c) Net radiation heat exchange between the surface and all of its surroundings in the (J-G) A.

(d) Net radiation heat exchange between the surface and all of its surroundings is $\in [E_b - G]A$.

Q.66 Which of the following statements is/are correct with respect to radiation shields placed between two infinitely large planes exchanging heat with each other?

(a) To reduce the radiation heat exchange by a very good% by keeping the shield, the shield must have high emissivity.

(b) Each shield kept between the planes bring 2 surface resistances and 1 space resistance.

(c) Each shield kept between the planes bring 2 space resistances and 1 surface resistance.

(d) If there are 'n' number of shields being kept between the planes there would be total $(2n + 2)$ surface resistances and $(n + 1)$ space resistances in the entire radiation network drawn with n-shields.

Q.67 A spherical ball of 10 cm diameter and 300 K temperature is placed inside a large spherical furnace at 600 K. 20% of the energy emitted by the furnace reaches the spherical ball and we can assume all the surfaces as black. Which of the following is/are correct?

(a) Diameter of the spherical furnace will be 0.2236 m.

(b) Net heat exchange between the two surfaces is 43.285 W.

(c) Shape factor of spherical furnace with respect to itself will be 0.64.

(d) Magnitude of net heat exchange between the two surfaces will be 216.426 W.

Q.68 The overall heat transfer coefficient due to convection and radiation for a steam main at 325°C running in a large room at 30°C is 28.46 W/m^{2}K. The emissivity of the pipe surface is 0.8. Which of the following is/are correct?

(a) Heat lost by radiation is 5418.33 W/m^2.

(b) Heat transfer coefficient due to convection is 18.367 W/m^{2}K.

(c) Heat transfer coefficient due to radiation is 18.367 W/m^{2}K.

(d) Total heat lost is 7295.64 W/m^{2}K.

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Answers — Radiation Heat Transfer

1. (b)	2. (d)	3. (c)	4. (d)	5. (d)	6. (b)	7. (c)
8. (c)	9. (b)	10. (b)	11. (c)	12. (d)	13. (b)	14. (d)
15. (c)	16. (d)	17. (c)	18. (c)	19. (c)	20. (d)	21. (d)
22. (b)	23. (c)	24. (b)	25. (c)	26. (a)	27. (d)	28. (d)
29. (a)	30. (b)	31. (c)	32. (a)	33. (d)	34. (a)	35. (b)
36. (b)	37. (a)	38. (c)	39. (c)	40. (b)	41. (c)	42. (3543.75)
43. (0.60)	44. (406.25)	45. (32.17)	46. (16.54)	47. (813.31)	48. (2756)	49. (4920)
50. (5)	51. (1200)	52. (64)	53. (16.93)	54. (0.44)	55. (7500)	56. (c)
57. (d)	58. (a)	59. (b)	60. (d)	61. (a, c)	62. (a, b, c)	63. (a, c)
64. (a, b, c)	65. (c, d)	66. (b, d)	67. (a, d)	68. (a, c)		