Class Test Solution (HMT) 11-04-2019

Answer key

1.	(c)	9.	(a)	17.	(d)	25.	(a)	33.	(d)
2.	(a)	10.	(d)	18.	(a)	26.	(c)	34.	(b)
3.	(c)	11.	(c)	19.	(b)	27.	(d)	35.	(c)
4.	(a)	12.	(a)	20.	(d)	28.	(d)	36.	(c)
5.	(b)	13.	(a)	21.	(b)	29.	(d)	37.	(d)
6.	(d)	14.	(a)	22.	(b)	30.	(c)	38.	(a)
7.	(d)	15.	(b)	23.	(c)	31.	(b)	39.	(c)
8.	(a)	16.	(a)	24.	(c)	32.	(a)	40.	(a)

1. (c)

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

$$\frac{Q\,dx}{A} = -k\,dT$$

$\therefore$ kdT = constant or $dT \propto \frac{1}{k}$

Which one has minimum thermal conductivity that will give maximum temperature drop.

2. (a)

Heat loss by hot body = Heat gain by cold body

$m_h c_{ph}\ (t_h - t_f) = m_c c_{pc}(t_f - t_c)$

or $1 \times 0.4 \times (60 - t_f) = 1 \times 4.2 \times (t_f - 20)$

or $t_f = 13.5°C$

3. (c)

4. (a)

$$Q = kA\frac{dT}{dx} = 0.5 \times 1 \times \frac{60}{0.25} W = 120$$

5. (b)

Thermal diffusivity (a) = $\frac{k}{\rho c_p}$;

$\therefore$ $\alpha \propto k$

6. (d)

7. (d) $Q = -KA\frac{dT}{dx}$; $(ML2T^{-3}) = K(L^2)\frac{(\theta)}{(L)}$

$\Rightarrow ML^2T^{-3} = K(L)(\theta)$

$$\Rightarrow K = \frac{ML^2T^{-3}}{L\theta} = \left[MLT^{-3}\theta^{-1}\right]$$

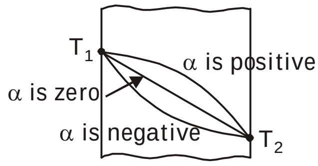
8. (a)

$$\frac{K_1A(\Delta T_1)}{dx} = \frac{K_2A(\Delta T_2)}{dx}$$

$$\Rightarrow K_1(\Delta T_1) = K_2(\Delta T_2)$$

$$\Rightarrow \frac{\Delta T_1}{\Delta T_2} = \frac{K_2}{K_1} = \frac{2}{3}$$

9. (a)



For the shape of temperature profile

$K = k_0(1 + \alpha T)$

10. (d)

For two insulating layers,

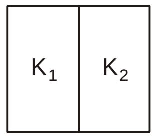
$$\frac{Q}{A} = \frac{t_1 - t_2}{\frac{\Delta x_1}{k_1} + \frac{\Delta x_2}{k_2}}$$

$$= \frac{1000 - 120}{\frac{0.3}{3} + \frac{0.3}{0.3}} = \frac{880}{1.1} = 800$$

Four outer casing, $\frac{Q}{A} = \frac{120 - 40}{1/h}$,

or $h = \frac{800}{80} = 10\ W/m^2K$

11. (c)



$L_1 = L_2$

$$\frac{1}{K_{eq}} = \frac{1}{2}\left(\frac{1}{K_1} + \frac{1}{K_2}\right)$$

$$K_{eq} = \frac{2K_1K_2}{K_1 + K_2}$$

12. (a)

13. (a)

14. (a)

15. (b)

16. (a)

17. (d)

18. (a)

The effectiveness of a fin can also be characterized as

$$\varepsilon_f = \frac{q_f}{q} = \frac{q_f}{hA_c(T_b - T_\infty)}$$

$$= \frac{(T_b - T_\infty)/R_{t,f}}{(T_b - T_\infty)/R_{t,h}} = \frac{R_{t,h}}{R_{t,f}}$$

It is a ratio of the thermal resistance due to convection to the thermal resistance of a fin. In order to enhance heat transfer, the fin's resistance should be lower than that of the resistance due only to convection.

19. (b) Effectiveness (ε_{fin})

$$\varepsilon_{fin} = \frac{Q_{\text{with fin}}}{Q_{\text{without fin}}} = \sqrt{\frac{kP}{hA_{cs}}} = \sqrt{\frac{hPkA_{cs}(t_o - t_a)}{hA_{cs}(t_o - t_a)}}$$

If the ratio $\frac{P}{A_{cs}}$ is $\uparrow \varepsilon_{fin} \uparrow$

20. (d)

21. (b)

22. (b)

23. (c)

24. (c)

25. (a)

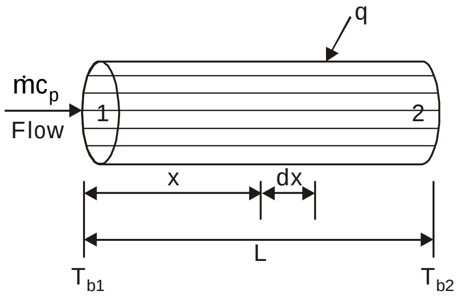
26. (c)

27. (d) $Q = (h_1 A\Delta T + h_2 A\Delta T + h_3 A\Delta T)$

$$Q = h_{av} \times 6A\Delta T \;;$$

$$\therefore \quad h_{av} = \frac{h_1 + h_2 + 4h_3}{6}$$

28. (d) Bulk temperature



$$Q = \dot{m}c_p(T_{b2} - T_{b1})$$

$$dQ = \dot{m}c_p dT_b = h\{2\pi r\, dr(T_w - T_b)\}$$

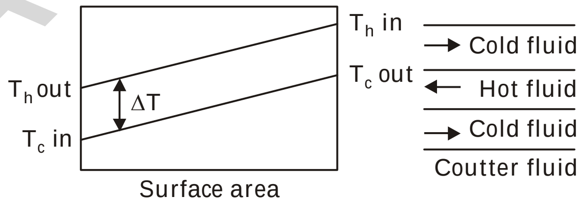
- The bulk temperature represents energy average or 'mixing cup' conditions.
- The total energy 'exchange' in a tube flow can be expressed in terms of a bulk temperature difference.

29. (d) $Gr_x = \frac{\beta g \Delta T x^3}{v^2}$

30. (c)

31. (b)

32. (a)

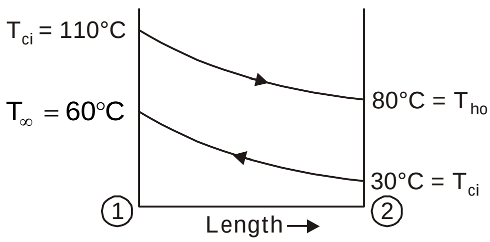


33. (d)

34. (b)

35. (c)

36. (c)



$\theta_1 = \theta_2 = 50°$

$\theta_1 = \theta_2 = 50° \theta_1 = T_{hi} = T_\infty$

= 110 – 60 = 50°C

$\theta_2 = T_{ho} = T_{ci}$ = 80 – 30 = 50°C

37. (d) Overall coefficient of heat transfer U W/m²K is expressed as $\frac{1}{U} = \frac{1}{h_i} + \frac{\Delta x}{k} + \frac{1}{h_o}$

$= \frac{1}{25} + \frac{0.15}{0.15} + \frac{1}{25} = \frac{27}{25}$. So, $U = \frac{25}{27}$ which is closer to the heat transfer coefficient based on the bricks alone.

38. (a)

39. (c) $\in = \dfrac{1 - e^{-NTU\left(1+\frac{C_{min}}{C_{max}}\right)}}{1 + \frac{C_{min}}{C_{max}}}$ = 1 – e^{-NTU}

For Parallerl flow [As boiler and condenser $\frac{C_{min}}{C_{max}} \to 0$]

$= \dfrac{1 - e^{-NTU\left(1+\frac{C_{min}}{C_{max}}\right)}}{1 + \frac{C_{min}}{C_{max}} e^{-NTU\left(1+\frac{C_{min}}{C_{max}}\right)}}$ = 1 – e^{-NTU} for

Counter flow

40. (a) In this case the effectiveness of the heat exchanger $(\varepsilon) = \frac{NTU}{1 + NTU}$