

1. **Sol. (c)**

Coefficient of performance

$$K = \frac{T_2}{T_1 - T_2} = \frac{273}{303 - 273} = \frac{273}{30} = 9$$

2. **Sol. (b)**

In a refrigerator, the heat dissipated in the atmosphere is more than that taken from the cooling chamber, therefore the room is heated if the door of a refrigerator is kept open.

3. **Sol. (d)**

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{400}{500} = \frac{1}{5}$$

$$\because \eta = \frac{W}{Q} \Rightarrow \frac{1}{5} = \frac{W}{Q}$$

$$\Rightarrow W = \frac{Q}{5} = \frac{6}{5} \times 10^4 = 1.2 \times 10^4 \text{ J}$$

4. **Sol. (c)**

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{(273+69)}{(273+411)} = 0.5$$

$$\Rightarrow \text{Work done} = \eta \times Q = 0.5 \times 1000 = 500 \text{ J}$$

5. **Sol. (b)**

$$\because \eta = 1 - \frac{T_2}{T_1} = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

Where Q_1 = heat absorbed, Q_2 = heat rejected

$$\Rightarrow 1 - \frac{T/3}{T} = \frac{W}{Q_1} \Rightarrow \frac{2}{3} = \frac{W}{Q_1} = \frac{Q_1 - Q_2}{Q_1}$$

$$\Rightarrow \frac{2}{3} = 1 - \frac{Q_2}{Q_1} \Rightarrow \frac{Q_2}{Q_1} = \frac{1}{3} \Rightarrow Q_2 = \frac{Q_1}{3} = \frac{Q}{3}$$

6. **Sol. (c)**

$$\eta = 1 - \frac{T_2}{T_1} \Rightarrow \frac{25}{100} = 1 - \frac{300}{T_1} \Rightarrow \frac{1}{4} = 1 - \frac{300}{T_1}$$

$$T_1 = 400 \text{ K} = 127^\circ \text{C}$$

7. **Sol. (a)**

$$\eta = 1 - \frac{T_2}{T_1} = \frac{T_1 - T_2}{T_1} \Rightarrow \eta_1 = \frac{(473 - 273)}{473} = \frac{200}{473}$$

$$\text{and } \eta_2 = \frac{273 - 73}{273} = \frac{200}{273}$$

$$\text{So required ratio } \frac{\eta_1}{\eta_2} = \frac{273}{473} = 0.577$$

8. **Sol. (a)**

$$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{(273+123)}{(273+27)} = 1 - \frac{150}{300} = \frac{1}{2} = 50\%$$

9. **Sol. (b)**

$$\text{In first case, } (\eta_1) = 1 - \frac{500}{800} = \frac{3}{8}$$

$$\text{and in second case, } (\eta_2) = 1 - \frac{600}{x}$$

$$\text{Since } \eta_1 = \eta_2, \text{ therefore } \frac{3}{8} = 1 - \frac{600}{x}$$

$$\text{or } \frac{600}{x} = 1 - \frac{3}{8} = \frac{5}{8} \text{ or } x = \frac{600 \times 8}{5} = 960 \text{ K}$$

10. **Sol. (a)**

$$\eta_{\text{max}} = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{400} = \frac{1}{4} = 25\%$$

So 26% efficiency is impossible

11. **Sol. (b)**

$$\text{In first case } \eta_1 = 1 - \frac{T_2}{T_1} = 1 - \frac{(273+0)}{(273+200)} = \frac{200}{473}$$

$$\text{In second case } \eta_2 = 1 - \frac{(273-200)}{(273+0)} = \frac{200}{273}$$

$$\Rightarrow \frac{\eta_1}{\eta_2} = \frac{1}{\left(\frac{473}{273}\right)} = 1:1.73$$

12. **Sol. (b)**

$$\eta = 1 - \frac{T_2}{T_1} \Rightarrow \frac{1}{2} = 1 - \frac{500}{T_1} \Rightarrow \frac{500}{T_1} = \frac{1}{2} \quad \dots (i)$$

$$\frac{60}{100} = 1 - \frac{T_2'}{T_1} \Rightarrow \frac{T_2'}{T_1} = \frac{2}{5} \quad \dots (ii)$$

$$\text{Dividing equation (i) by (ii), } \frac{500}{T_2'} = \frac{5}{4} \Rightarrow T_2' = 400 \text{ K}$$

13. **Sol. (b)**

$$\eta = 1 - \frac{T_2}{T_1} = \frac{W}{Q} \Rightarrow W = \left(1 - \frac{T_1}{T_2}\right) Q = \left\{1 - \frac{(273+27)}{(273+627)}\right\}$$

$$\Rightarrow W = \left(1 - \frac{300}{900}\right) \times 3 \times 10^6 = 2 \times 10^6 \times 4.2 \text{ J} = 8.4 \times 10^6 \text{ J}$$

14. **Sol. (c)**

Coefficient of performance

$$K = \frac{T_2}{T_1 - T_2} \Rightarrow 5 = \frac{(273-13)}{T_1 - (273-13)} = \frac{260}{T_1 - 260}$$

$$\Rightarrow 5T_1 - 1300 = 260 \Rightarrow 5T_1 = 1560$$

$$\Rightarrow T_1 = 312 \text{ K} \rightarrow 39^\circ\text{C}$$

15. Sol. (a)

$$\begin{aligned} \text{Coefficient of performance } K &= \frac{T_2}{T_1 - T_2} \\ &= \frac{(273 - 23)}{(273 + 27) - (273 - 23)} = \frac{250}{300 - 250} = \frac{250}{20} = 5 \end{aligned}$$

16. Sol. (c)

$$\begin{aligned} \eta &= \frac{T_1 - T_2}{T_1} = \frac{W}{Q} \Rightarrow W = \frac{Q(T_1 - T_2)}{T_1} \\ &= \frac{6 \times 10^4 [(227 + 273) - (273 + 127)]}{(227 + 273)} \\ &= \frac{6 \times 10^4 \times 100}{500} = 1.2 \times 10^4 \text{ cal} \end{aligned}$$

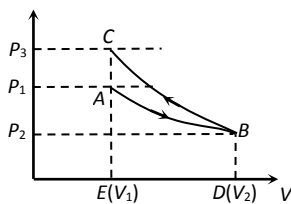
17. Sol. (c)

From graph it is clear that $P_3 > P_1$.

Since area under adiabatic process (BCED) is greater than that of isothermal process (ABDE).

Therefore net work done

$$W = W_i + (-W_A) \because W_A > W_i \Rightarrow W < 0$$



18. Sol. (a)

According to given Vander Waal's equation

$$P = \frac{nRT}{V - n\beta} - \frac{cn^2}{V^2}$$

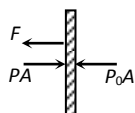
Work done,

$$\begin{aligned} W &= \int_{V_1}^{V_2} PdV = nRT \int_{V_1}^{V_2} \frac{dV}{V - n\beta} - cn^2 \int_{V_1}^{V_2} \frac{dV}{V^2} \\ &= nRT [\log_e(V - n\beta)]_{V_1}^{V_2} + cn^2 \left[\frac{1}{V} \right]_{V_1}^{V_2} \\ &= nRT \log_e \frac{V_2 - n\beta}{V_1 - n\beta} + cn^2 \left(\frac{V_1 - V_2}{V_1 V_2} \right) \end{aligned}$$

19. Sol. (b)

Volume of the gas is constant $V = \text{constant} \therefore P \propto T$
i.e., pressure will be doubled if temperature is doubled

$$\therefore P = 2P_0$$



Now let F be the tension in the wire.

Then, equilibrium of any one piston gives

$$F = (P - P_0)A = (2P_0 - P_0)A = P_0A$$

20. Sol. (c)

$$PV^\gamma = K \text{ or } P\gamma V^{\gamma-1}dV + dP \cdot V^\gamma = 0$$

$$\text{or } \frac{dP}{P} = -\gamma \frac{dV}{V} \text{ or } \frac{dP}{P} \times 100 = -\gamma \left(\frac{dV}{V} \times 100 \right)$$

$$= -1.4 \times 5 = -7\%$$

21. Sol. (c)

Area enclosed between a and f is maximum. So work done in closed cycles follows a and f is maximum.

22. Sol. (a)

Initial and final states are same in all the process.

Hence $\Delta U = 0$; in each case.

By FLOT; $\Delta Q = \Delta W = \text{Area enclosed by curve with volume axis.}$

$$\therefore (\text{Area})_1 < (\text{Area})_2 < (\text{Area})_3 \Rightarrow Q_1 < Q_2 < Q_3$$

23. Sol. (a)

For an isothermal process $PV = \text{constant}$

$$\Rightarrow PdV + VdP = 0 \Rightarrow -\frac{1}{V} \left(\frac{dV}{dP} \right) = \frac{1}{P}$$

$$\text{So, } \beta = \frac{1}{P}$$

\therefore graph will be rectangular hyperbola.

24. Sol. (b)

In adiabatic process, slope of PV -graph.

$$\frac{dP}{dV} = -\gamma \frac{P}{V} \Rightarrow |\text{Slope}| \propto \gamma$$

From the given graph $(\text{Slope})_2 > (\text{Slope})_1 \Rightarrow \gamma_2 > \gamma_1$

Therefore 1 should correspond to O_2 ($\gamma = 1.4$) and 2 should correspond to He ($\gamma = 1.66$)

25. Sol. (c)

As we know that slope of isothermal and adiabatic curves are always negative and slope of adiabatic curve is always greater than that of isothermal curve

26. Sol. (d)

Process CD is isochoric as volume is constant, Process DA is isothermal as temperature constant and Process AB is isobaric as pressure is constant.

27. Sol. (b)

The cyclic process 1 is clockwise where as process 2 is anticlockwise. Clockwise area represents

positive work and anticlockwise area represents negative work. Since negative area (2) > positive area (1), hence net work done is negative.

28. Sol. (c)

Process AB is isochoric, $\therefore W_{AB} = P \Delta V = 0$

Process BC is isothermal $\therefore W_{BC} = RT_2 \cdot \ln\left(\frac{V_2}{V_1}\right)$

Process CA is isobaric

$\therefore W_{CA} = -P \Delta V = -R \Delta T = -R(T_1 - T_2) = R(T_2 - T_1)$

(Negative sign is taken because of compression)

29. Sol. (a)

AB is isobaric process, BC is isothermal process, CD is isometric process and DA is isothermal process

These process are correctly represented by graph (a).

30. Sol. (c)

Work done by the gas (as cyclic process is clockwise) $\therefore \Delta W = \text{Area } ABCD$

So from the first law of thermodynamics ΔQ (net heat absorbed) = $\Delta W = \text{Area } ABCD$

As change in internal energy in cycle $\Delta U = 0$.

31. Sol. (c)

From the given VT diagram,

In process AB, $V \propto T \Rightarrow$ Pressure is constant (As quantity of the gas remains same)

In process BC, $V = \text{Constant}$ and in process CA, $T = \text{constant}$

\therefore These processes are correctly represented on PV diagram by graph (c).

32. Sol. (d)

$\Delta Q = \Delta U + \Delta W$; ΔU does not depend upon path.

$\therefore \Delta W_A > \Delta W_B \Rightarrow \Delta Q_A > \Delta Q_B$

33. Sol. (c)

In a cyclic, $\Delta U = 0$

From FLOT, $\Delta Q = \Delta U + \Delta W = 0 + \Delta W = \text{Area of}$

closed curve $\Rightarrow \Delta Q = \pi r^2 \pi \left(\frac{20}{2}\right)^2 kP_a \times \text{litre}$

$= 100 \pi \times 10^3 \times 10^{-3} J = 100 \pi J$

34. Sol. (d)

In all given cases, process is cyclic and in cyclic process $\Delta U = 0$.

35. Sol. (b)

In cyclic process $\Delta Q = \text{Work done} = \text{Area inside the closed curve.}$

Treat the circle as an ellipse of area

$$= \frac{\pi}{4} (P_2 - P_1)(V_2 - V_1)$$

$$\Rightarrow \Delta Q = \frac{\pi}{4} \{(150 - 50) \times 10^3\} = \frac{\pi}{2} J$$

36. Sol. (d)

$$W_{BCOB} = - \text{Area of triangle } BCO = - \frac{P_0 V_0}{2}$$

$$W_{AODA} = + \text{Area of triangle } AOD = + \frac{P_0 V_0}{2}$$

37. Sol. (c)

Work done = Area of curve enclosed

$$= 2V \times 2P = 4PV$$

38. Sol. (b)

Work done = Area enclosed by indicator diagram

$$= \frac{1}{2} \times (3V - V)(4P - P) = 3PV$$

39. Sol. (d)

ΔU , remains same for both path

For path *iaf*: $\Delta U = \Delta Q - \Delta W = 50 - 20 = 30 J$.

For path *fi*: $\Delta U = -30 J$ and $\Delta W = -13 J$

$$\Rightarrow \Delta Q = -30 - 13 = -43 J.$$

40. Sol. (a)

$\Delta E_{\text{int}} = 0$, for a complete cycle and for given cycle work done is negative, so from first law of thermodynamics Q will be negative i.e. $Q < 0$.

41. Sol. (d)

W = Area bonded by the indicator diagram with V-axis)

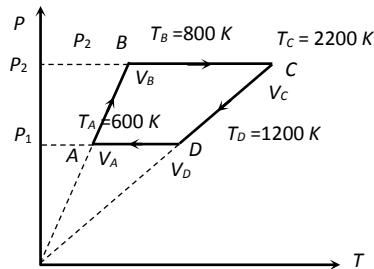
$$= \frac{1}{2} (P_A + P_B)(V_B - V_A)$$

42. Sol. (c)

Processes A to B and C to D are parts of straight line graphs of the form $y = mx$

$$\text{Also } P = \frac{\mu R}{V} T \quad (\mu = 6)$$

$\Rightarrow P \propto T$. So volume remains constant for the graphs AB and CD



So no work is done during processes for A to B and C to D i.e., $W_{AB} = W_{CD} = 0$ and $W_{BC} = P_2(V_C - V_B) = \mu R(T_C - T_B)$

$$= 6R(2200 - 800) = 6R \times 1400 \text{ J}$$

$$\text{Also } W_{DA} = P_1(V_A - V_D) = \mu R(T_A - T_D)$$

$$= 6R(600 - 1200) = -6R \times 600 \text{ J}$$

Hence work done in complete cycle

$$W = W_{AB} + W_{BC} + W_{CD} + W_{DA}$$

$$= 0 + 6R \times 1400 + 0 - 6R \times 600$$

$$= 6R \times 900 = 6 \times 8.3 \times 800 \approx 40 \text{ kJ}$$

43. Sol. (d)

Adiabatic curves are more steeper than isothermal curves.

44. Sol. (d)

During process A to B, pressure and volume both are decreasing. Therefore, temperature and hence, internal energy of the gas will decrease ($T \propto PV$) or $\Delta U_{A \rightarrow B}$ = negative. Further $\Delta W_{A \rightarrow B}$ is also negative as the volume of the gas is decreasing. Thus $\Delta Q_{A \rightarrow B}$ is negative.

In process B to C pressure of the gas is constant while volume is increasing. Hence temperature should increase or $\Delta U_{B \rightarrow C}$ = positive. During C to A volume is constant while pressure is increasing. Therefore, temperature and hence, internal energy of the gas should increase or $\Delta U_{C \rightarrow A}$ = positive.

During process CAB volume of the gas is decreasing. Hence, work done by the gas is negative.

45. Sol. (b)

$$\left(\frac{Q}{t}\right)_1 = \frac{K_1 A_1 (\theta_1 - \theta_2)}{l} \quad \text{and} \quad \left(\frac{Q}{t}\right)_2 = \frac{K_2 A_2 (\theta_1 - \theta_2)}{l}$$

$$\text{given } \left(\frac{Q}{t}\right)_1 = \left(\frac{Q}{t}\right)_2 \Rightarrow K_1 A_1 = K_2 A_2$$

46. Sol. (d)

$$\text{In variable state } \frac{Q}{t} \propto K \quad \text{and} \quad \frac{Q}{t} \propto \frac{1}{\rho c} \Rightarrow \frac{Q}{t} \propto \frac{K}{\rho c}$$

(K = thermal conductivity, ρ = density, c = specific heat)

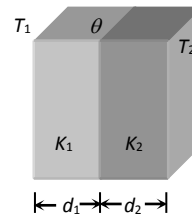
47. Sol. (c)

$$\frac{Q}{t} = \frac{KA(\Delta\theta)}{l} \Rightarrow 50 = \frac{5 \times 20 \text{ K}}{0.4} \Rightarrow K = \frac{1}{5} = 0.2$$

48. Sol. (a)

When a piece of glass is heated, due to low thermal conductivity it does not conduct heat fast. Hence unequal expansion of it's layers crack the glass.

49. Sol. (a)



In series both walls have same rate of heat flow.

Therefore

$$\frac{dQ}{dt} = \frac{K_1 A (T_1 - \theta)}{d_1} = \frac{K_2 A (\theta - T_2)}{d_2}$$

$$\Rightarrow K_1 d_2 (T_1 - \theta) = K_2 d_1 (\theta - T_2)$$

$$\Rightarrow \theta = \frac{K_1 d_2 T_1 + K_2 d_1 T_2}{K_1 d_2 + K_2 d_1}$$

50. Sol. (a)

$$\text{Temperature of interface } \theta = \frac{K_1 \theta_1 + K_2 \theta_2}{K_1 + K_2}$$

$$\left(\because \frac{K_1}{K_2} = \frac{1}{4} \Rightarrow \text{If } K_1 = K \text{ then } K_2 = 4K\right)$$

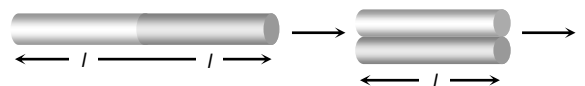
$$\Rightarrow \theta = \frac{K \times 0 + 4K \times 100}{5K} = 80^\circ \text{C}$$

51. Sol. (b)

$$\frac{\theta_1 - \theta_2}{l} = 80 \Rightarrow \frac{30 - \theta_2}{0.5} = 80 \Rightarrow \theta_2 = -10^\circ \text{C}$$

52. Sol. (d)

Let the heat transferred be Q.



When rods are joined end to end. Heat transferred by each rod = $Q = \frac{KA\Delta\theta}{l} \times 12$ (i)

When rods are joined lengthwise, $Q = \frac{KA\Delta\theta}{2l} t$ (ii)

From equation (i) and (ii) we get $t = 48 \text{ s}$

53. Sol. (d)

$$\frac{Q}{t} = \frac{KA\Delta\theta}{l} \Rightarrow \frac{K_A}{K_B} = \frac{A_B}{A_A} = \left(\frac{r_B}{r_A}\right)^2 = \frac{1}{4} \Rightarrow K_A = \frac{K_B}{4}$$

54. Sol. (b)

Thermal conductivity of composite plate

$$K_{eq} = \frac{2K_1K_2}{K_1+K_2} = \frac{2 \times 2 \times 3}{2+3} = \frac{12}{5} = 2.4$$

55. Sol. (c)

$$\frac{Q}{At} = K \frac{\Delta\theta}{l} \Rightarrow K \frac{\Delta\theta}{l} = \text{constant} \Rightarrow \frac{\Delta\theta}{l} \propto \frac{1}{K}$$

Hence, if $K_c > K_m > K_g$, then

$$\left(\frac{\Delta\theta}{l}\right)_c < \left(\frac{\Delta\theta}{l}\right)_m < \left(\frac{\Delta\theta}{l}\right)_g \Rightarrow X_c < X_m < X_g$$

because higher K implies lower value of the temperature gradient.

56. Sol. (b)

$$\text{In series } R_{eq} = R_1 + R_2 \Rightarrow \frac{2l}{K_{eq}A} = \frac{l}{K_1A} + \frac{l}{K_2A}$$

$$\Rightarrow \frac{2}{K_{eq}} = \frac{1}{K_1} + \frac{1}{K_2} \Rightarrow K_{eq} = \frac{2K_1K_2}{K_1+K_2}$$

57. Sol. (d)

$$Q = \frac{KA(\Delta\theta)t}{l}$$

$\therefore Q$ and $\Delta\theta$ are same for both spheres hence

$$K \propto \frac{l}{At} \propto \frac{l}{r^2t} \Rightarrow \frac{K_{larger}}{K_{smaller}} = \frac{l_l}{l_s} \times \left(\frac{r_s}{r_l}\right)^2 \times \frac{t_s}{t_l}. \text{ It is given that}$$

$$r_l = 2r_s, l_l = \frac{1}{4}l_s \text{ and } t_l = 25 \text{ min, } t_s = 16 \text{ min.}$$

$$\Rightarrow \frac{K_{larger}}{K_{smaller}} = \left(\frac{1}{4}\right) \left(\frac{1}{2}\right)^2 \times \frac{16}{25} = \frac{1}{25}$$

58. Sol. (b)

$$\text{Temperature gradient} = \frac{100-20}{20} = 4^\circ\text{C/cm}$$

$$\text{temperature at centre} = 100 - 4 \times 10 = 60^\circ\text{C}$$

59. Sol. (c)

Temperature of interface

$$\theta = \frac{K_1\theta_1l_2 + K_2\theta_2l_1}{K_1l_2 + K_2l_1}$$

$$= \frac{K \times 0 \times 2 + 3K \times 100 \times 1}{K \times 2 + 3K \times 1}$$

$$= \frac{300K}{5K} = 60^\circ\text{C}$$

60. Sol. (b)

$$\frac{Q}{t} = \frac{KA(\theta_1 - \theta_2)}{l} = \frac{100 \times 100 \times 10^{-4}(100-0)}{1}$$

$$\Rightarrow \frac{Q}{t} = 100 \text{ Joule / sec} = 6 \times 10^3 \text{ Joule / min}$$

61. Sol. (a)

Thermal resistance of Cu is lesser than the thermal resistance of steel. Hence only in option (a) thermal resistance is minimum so heat current is maximum.

62. Sol. (c)

Let θ be temperature middle point C and in series rate of heat flow is same

$$\Rightarrow K(2A)(100 - \theta) = KA(\theta - 70)$$

$$\Rightarrow 200 - 2\theta = \theta - 70 \Rightarrow 3\theta = 270 \Rightarrow \theta = 90^\circ\text{C}$$

63. Sol. (b)

Because of uneven surfaces of mountains, most of it's parts remain under shadow. So, most of the mountains. Land is not heated up by sun rays. Besides this, sun rays fall slanting on the mountains and are spread over a larger area. So, the heat received by the mountains top per unit area is less and they are less heated compared to planes (Foot).

64. Sol. (c)

Radiation is the fastest mode of heat transfer.

65. Sol. (d)

The polished surface reflects all the radiation.

66. Sol. (c)

Heat radiations are electromagnetic waves of high wavelength.

67. Sol. (d)

Every body at all time, at all temperatures emits radiation (except at $T = 0$). The radiation emitted by the human body is in the infra-red region.

68. Sol. (c)

69. Sol. (c)

Good absorbers are always good emitters of heat.

70. Sol. (a)

A perfectly black body is a good absorber of radiations falls on it. So it's absorptive power is 1.

71. Sol. (a)

For a black body emissivity = absorptive power.

72. Sol. (c)

According to Kirchoff's law, the ratio of emissive power to absorptive power is same for all bodies is equal to the emissive power of a perfectly black body i.e.,

$$\left(\frac{e}{a}\right)_{body} = E_{\text{Black body}} \quad \text{For a particular wave length}$$

$$\left(\frac{e_{\lambda}}{a_{\lambda}}\right)_{body} = (E_{\lambda})_{\text{Black body}} \Rightarrow e_{\lambda} = a_{\lambda} E_{\lambda}$$

73. Sol. (b)

$$\text{Absorption power} = \frac{\text{Heat absorbed}}{\text{Total heat given}}$$

74. Sol. (a)

Red and green colours are complementary to each other. When red glass is heated it absorbs green light strongly, hence according to Kirchoff's law, the emissive power of red glass should be maximum for green light. That's why when this heated red glass is taken in dark room it strongly emits green light and looks greenish.

75. Sol. (c)

When light incident on pin hole, enters into the box and suffers successive reflection at the inner wall. At each reflection some energy is absorbed. Hence the ray once it enters the box can never come out and pin hole acts like a perfect black body.

76. Sol. (c)

According to Wein's law, $\lambda_m T = \text{constant}$

$$\lambda_r > \lambda_y > \lambda_b \Rightarrow T_r < T_y < T_b \quad \text{or} \quad T_A < T_C < T_B$$

77. Sol. (d)

$$\lambda_m T = \text{constant} \Rightarrow \frac{T_1}{T_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{10^{-4}}{0.5 \times 10^{-5}} = 200.$$

78. Sol. (c)

According to Wein's displacement law.

79. Sol. (d)

$$\lambda_{m_1} T_1 = \lambda_{m_2} T_2 \Rightarrow \lambda_{m_2} = \frac{\lambda_{m_1} T_1}{T_2} = 4.08 \times \frac{700}{1400} = 2.04 \text{ m}$$

80. Sol. (c)

$$\lambda_{m_1} T_1 = \lambda_{m_2} T_2 \Rightarrow \lambda_{m_2} = \frac{\lambda_{m_1} T_1}{T_2} = \frac{14 \times 200}{1000} = 2.8 \mu\text{m}$$

