

Rajasthan RVUNL

Mechanical Engineering

Heat Transfer and
Refrigeration
& Air Conditioning

Top 100+
Most Expected Questions



4. The relationship $\lambda_{\max}T = \text{constant}$, between the temperature of a black body and the wavelength at which maximum value of monochromatic emissive power occurs is known as _____.
- A. Planck's law
B. Kirchhoff's law
C. Lambert's law
D. Wein's law

Ans. D

Sol. This is the Wien's law. From the spectral distribution of black body emissive power, it is apparent that the wavelength associated with a maximum rate of emission depends upon the absolute temperature of the radiating surface.

5. The unit of Stefan Boltzmann constant is_____.
- A. $\text{W/cm}^2\text{K}^2$
B. W^2/cmK^4
C. $\text{W/cm}^2\text{K}^3$
D. $\text{W/cm}^2\text{K}^4$

Ans. D

Sol. The Stefan–Boltzmann constant (also Stefan's constant), a physical constant denoted by the Greek letter σ (sigma), is the constant of proportionality in the Stefan–Boltzmann law: "the total intensity radiated over all wavelengths increases as the temperature increases", of a black body which is proportional to the fourth power of the thermodynamic temperature. Its unit is $\text{W/cm}^2\text{K}^4$.

6. Lumped system analysis of transient heat conduction situations is valid when the Biot number is
- A. Very small
B. Very large
C. Approximately one
D. Cannot say unless the Fourier number is also known

Ans. A

Sol. Lumped system analysis of transient heat conduction situations is applicable when $Bi < 0.1$.

7. Heat transfer takes place according to which law?
- A. Newton's law of cooling
B. Second law of thermodynamics
C. Newton's second law of motion
D. First law of thermodynamics

Ans. B

Sol. By Fourier's law of conduction,

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

Negative sign shows that heat always flow in the direction of decreasing temp. i.e. to satisfy clausius statement of Second law of thermodynamic's.

8. Consider the following statements and choose the correct statements _____?

1. Fins should be attached on the side where heat transfer coefficient is small.
2. Effective new of fins depend on thermal conductivity only.
3. Fins must have small thick new for better heat dissipation.

- A. Only 1 and 2 B. Only 2 and 3
C. Only 1 and 3 D. 1, 2 and 3

Ans. C

Sol. Fins should be attached to side where heat transfer coefficient are small, and fins must have small thickens to accommodate a greater number of fins and have adequate between the fins for better heat dissipation.

9. Heat transfer takes place in liquids and gases is essentially due to

- A. Radiation B. Conduction
C. Convection D. Conduction as well as convection

Ans. C

Sol. Convection is a process by which thermal energy is transferred between solid and fluid flowing through it.

10. Total incident radiation on a surface from all directions per unit time, per unit area of surface is known as

- A. Radiosity B. Black body radiation
C. Irradiation D. Total radiation

Ans. C

Sol. Total incident radiation on a surface from all directions per unit time, per unit area of surface is known as irradiation.

11. As the wave length Increases, the monochromatic emissivity of the grey body

- A. Increase B. Decrease
C. Independent of wavelength D. First increase then decrease

Ans. C

Sol. Grey surface is that surface in which monochromatic emissivity is independent of wavelength

12. In order to achieve maximum heat dissipation, the fin should be designed in such a way that :

- A. It should have maximum lateral surface at the root side of the fin
B. It should have maximum lateral surface towards the tip side of the fin
C. It should have maximum lateral surface near the centre of the fin
D. It should have minimum lateral surface near the centre of the fin

Ans. A

Sol. Fin should be designed so that base surface is maximum

The more the heat transfer influx through the base area, higher will be heat dissipation.

13. A lane slab of 10 cm thickness generates heat. It is observed that the temperature drop between the centre and its surface to be 60°C . If thickness is increased to 200 mm, the temperature difference will be _____ $^{\circ}\text{C}$.
- A. 140 B. 210
C. 240 D. 340

Ans. C

Sol. $T_{\max} = T_1 + \frac{q_g L^2}{8K}$

$$\Delta T = T_{\max} - T_1 = \frac{q_g L^2}{8K}$$

$$\text{So, } \frac{\Delta T_1}{\Delta T_2} = \left(\frac{L_1}{L_2} \right)^2$$

$$\therefore \Delta T_2 = \Delta T_1 \left(\frac{L_2}{L_1} \right)^2$$

$$\Rightarrow \Delta T_2 = 60 \times \left(\frac{200}{100} \right)^2 = 240^\circ \text{C}$$

14. Match **List-I (process)** with **List-II (predominant parameter associated with the process)** and select the correct answer using the codes given below:

List-I:

- (A). Mass transfer
(B). Forced convection
(C). Free convection
(D). Transient conduction

List-II:

- (1). Reynolds number
- (2). Sherwood number
- (3). Mach number
- (4). Biot number
- (5). Grashoff number

- A. A-1, B-2, C-3, D-4
- C. A-3, B-4, C-5, D-1

- B. A-2, B-1, C-5, D-4
- D. A-2, B-1, C-5, D-3

Ans. B

Sol.

Process	Predominant parameter associated with it
Mass transfer	Sherwood number
Forced Convection	Reynolds number
Free Convection	Grashoff number
Transient Conduction	Biot Number

15. The time constant of a thermocouple is _____.
 A. the time taken to attain the final temperature to be measured
 B. the time taken to attain 50% of the value of initial temperature difference
 C. the time taken to attain 63.2% of the value of initial temperature difference
 D. determined by the time taken to reach 100°C from 0°C

Ans. C

Sol. Time constant of a thermocouple is the time taken to attain 63.2% of the value of initial temperature difference.

16. A long fin of 5 cm diameter, made of aluminum ($k = 237 \text{ W/m}^\circ\text{C}$) is attached to a surface maintained at 100°C. Air flows over the surface at temperature 20°C with heat transfer coefficient of 10 W/m²C. If the fin can be assumed as infinitely long, its effectiveness is close to
 A. 43 B. 36
 C. 29 D. 14

Ans. A

Sol. Given,

Diameter of the fin, $d = 5 \text{ cm}$

Conductivity of fin material, $k = 237 \text{ W/m}^\circ\text{C}$

Base Temperature, $T_0 = 100^\circ\text{C}$

Air temperature, $T_\infty = 20^\circ\text{C}$

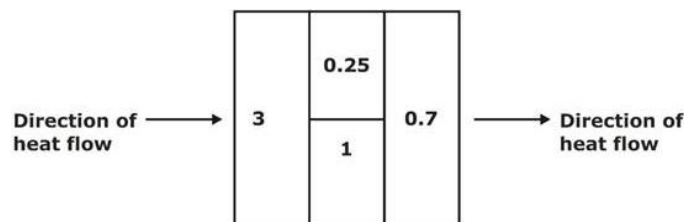
Heat transfer coefficient, $h = 10 \text{ W/m}^2\text{C}$

For infinitely long fin,

$$\varepsilon = \frac{\sqrt{hpkA_c} (T_0 - T_\infty)}{hA_c (T_0 - T_\infty)} = \sqrt{\frac{pk}{hA_c}}$$

$$\varepsilon = \sqrt{\frac{\pi \times d \times k}{h \times \frac{\pi}{4} \times d^2}} = \sqrt{\frac{4k}{hd}} = \sqrt{\frac{4 \times 237}{10 \times 0.05}} = 43.54$$

17. A composite wall is made of four different materials of construction as shown in figure. The resistance (in kW) of each sections of the wall is indicated in the diagram.



The overall resistance (K/W) of the composite wall in the direction of heat flow is ____.

- A. 3.9 B. 4.0
 C. 4.2 D. 4.5

21. The number of radiation shield screens in case of radiation heat transfer to reduce the radiation heat exchange by 80% is _____.
- A. 1
B. 2
C. 3
D. 4

Ans. D

Sol. Radiation heat transfer with 'n' shield screens:

$$(Q)_{n\text{- shields}} = \left(\frac{1}{n+1} \right) (Q)_{\text{without shields}}$$

$$\text{Given: } Q_{\text{with shields}} = (1 - 0.80) Q_{\text{without shields}}$$

$$0.20 \times Q_{\text{without shields}} = \left(\frac{1}{n+1} \right) Q_{\text{without shields}}$$

On solving: $n = 4$

22. Two radiating surface $A_1 = 6 \text{ m}^2$ and $A_2 = 4 \text{ m}^2$ have shape factor $F_{12} = 0.1$. Then the shape factor F_{21} will be
- A. 0.12
B. 0.18
C. 0.15
D. 0.10

Ans. C

Sol. Given,

$$A_1 = 6 \text{ m}^2, A_2 = 4 \text{ m}^2 \text{ and shape factor } F_{12} = 0.1$$

we know that,

$$A_1 F_{12} = A_2 F_{21}.$$

$$6 \times 0.1 = 4 \times F_{21}$$

$$F_{21} = 0.15$$

23. A steam tube with inside and outside heat transfer coefficient $8 \text{ W/m}^2\text{K}$ and $25 \text{ W/m}^2\text{K}$. Overall heat transfer coefficient in ($\text{W/m}^2\text{K}$) is. [Assume tube to be thin].
- A. 0.165
B. 6.06
C. 12.12
D. 0.0825

Ans. B

Sol. For thin tube $r_2 = r_1$ Hence conduction Resistance is zero.

$$U = \frac{1}{\frac{1}{h_1} + \frac{1}{h_2}}$$

$$U = \frac{1}{\frac{1}{8} + \frac{1}{25}}$$

$$U = 6.06 \text{ W/m}^2\text{K}.$$

24. After expansion from a gas turbine, the hot exhaust gases are used to heat the compressed air from a compressor with the help of a counter flow heat exchanger of 0.8 effectiveness. What is the number of transfer units of the heat exchanger?
- A. 2
B. 4
C. 8
D. 16

Ans. B

Sol. Given,

Effectiveness of counter flow heat exchanger = 0.8

$$\text{Effectiveness, } \varepsilon = \frac{NTU}{1 + NTU} = 0.8 \Rightarrow NTU = 4$$

25. In a two-fluid heat exchanger, the inlet and outlet temperature of the hot fluid are 65°C and 40°C respectively. For the cold fluid, these are 15°C and 42°C. The heat exchanger is a:
- A. Parallel flow heat exchanger
 - B. Counter flow heat exchanger
 - C. Heat exchange device where both parallel flow and counter flow operations are possible
 - D. None of the above

Ans. B

Sol. here, Outlet temperature of cold fluid is higher than the outlet temperature of hot fluid which can only possible in counter flow heat exchanger,so it is a counter flow heat exchanger.

26. Automobile radiator is a heat exchanger of _____ type.
- | | |
|-----------------|------------------|
| A. Counter flow | B. Parallel flow |
| C. Cross flow | D. Regenerator |

Ans. C

Sol. A tube bundle carries a heating or cooling fluid (either gas or liquid), normally perpendicular to a gas flow which passes over the tubes and allows heat to be transferred between the fluids.

27. If Prandtl number is 0.064 and friction coefficient is 0.64, Stanton number will be equal to ____.
- A. 5
B. 4
C. 2
D. 0.8

Ans. C

Sol. Given,

Prandtl number = 0.064

friction coefficient = 0.64

$$\frac{C_{ix}}{2} = St_x \times (Pr)^{2/3}$$

$$\frac{0.64}{2} = St_x \times (0.064)^{2/3} \Rightarrow St_x = 2$$

28. For a diffused body, emissivity is given as 0.5 and emissive power of the black body is given as 20W/m^2 . Calculate the intensity of radiation of body? (in W/m^2)
- A. 3.18
B. 6.36
C. 2.12
D. 0.15

Ans. A

Sol. Emissive Power of body $E_b = \text{emissivity} \times \text{Emissive Power of Black body}$

$$E_b = 0.5 \times 20 = 10 \text{ W/m}^2$$

Now, Intensity, $I = \frac{E_b}{\pi} = \frac{10}{\pi} = 3.18 \text{ W / m}^2$

29. There is a thermal insulation of thermal conductivity 0.67 W/m-K applied to a hollow spherical container. The convective heat transfer coefficient at the outer surface of insulation is $20 \text{ W/m}^2\text{K}$. The critical radius of insulation will be _____.
- A. 0.67 m B. 0.067 m
- C. 0.0335 m D. 6.7 m

Ans. B

Sol. Thermal conductivity: $K = 0.67 \text{ W/m-K}$

Heat transfer coefficient: $h = 20 \text{ W/m}^2\text{K}$

Critical radius of insulation of sphere:

$$r_{\text{critical}} = \frac{2k_{\text{ins}}}{h}$$

$$r_{\text{critical}} = \frac{2 \times 0.67}{20} = 0.067\text{m}$$

So, the correct option is (b)

30. 60% of incident radiant energy on the surface of a thermal body in thermal equilibrium is reflected back. If the transmissivity of the body is 0.2, then the emissivity of the surface is
- A. 0.60
B. 0.40
C. 0.20
D. 0.80

Ans. C

Sol. For a body in thermal equilibrium,

Emissivity = Absorptivity

$$\text{Absorptivity} + \text{Reflectivity} + \text{Transmissivity} = 1$$
$$\text{Absorptivity} = 1 - \text{Reflectivity} - \text{Transmissivity}$$
$$\text{Absorptivity} = 1 - 0.60 - 0.20 = 0.20$$

Absorptivity = Emissivity = 0.20

31. Which of the following is an application of fins in heat transfer?
- A. Cooling coils and condenser coils in refrigerators and ACs
 - B. Economisers for steam power plants
 - C. IC engines and air compressors
 - D. All of the above

Ans. D

Sol. Fins are the extended surface protruding from a surface or body and they are meant for increasing the heat transfer rate between the surface and the surrounding fluid by increasing heat transfer area.

Application of fins in heat transfer are IC engines and air compressors, economizers for steam power plants and Cooling coils and condenser coils in refrigerators and ACs.

32. The minimum number of view factors required to be known initially to calculate all possible view factors for a 6 surface asymmetric enclosure are:

- A. 36
B. 15
C. 6
D. 30

Ans. B

Sol. View factors that need to be evaluated directly for n surfaces = $\frac{n}{2}C$

$$\frac{6}{2}C = \frac{6 \times 5}{2} = 15$$

33. With increase in temperature, thermal conductivity of air _____.

- A. Increases
B. Decreases
C. Remains the same
D. None of these

Ans. A

Sol. As the temperature of air increases average kinetic energy of the molecules increases, thus the average speed of molecules increases, thus the collision rate of the molecules increases. In air the thermal (kinetic energy of molecules) energy between the molecules is transported when they collide. So if the collision rate is more the rate of transportation of thermal energy between the molecules is more. Thus the conductivity of air increases with temperature.

34. Which one of the following configurations has the highest fin effectiveness?

- A. Thin, closely spaced fins
B. Thin, widely spaced fins
C. Thick, widely spaced fins
D. Thick, closely spaced fins

Ans. A

Sol. Fin effectiveness, $\epsilon = \frac{\text{heat transfer with fin}}{\text{heat transfer without fin}}$

i.e., for so long fin

$$\epsilon = \sqrt{\frac{Pk}{hA}} P \uparrow \& A \downarrow$$

And this is highest with thin closely spaced fins.

35. A plane wall of thickness 50 cm having thermal conductivity 17.5 W/m°C. temperature at right and left surface are 10°C and 150°C. determine the heat flux through the wall?

- A. 875 W/m²
B. 1400 W/m²
C. 2575 W/m²
D. 4900 W/m²

Ans. D

Sol. Given,

Thickness of wall = 50cm

Thermal conductivity, $k = 17.5/\text{m}^\circ\text{C}$

Temperature at right phase $T_2 = 10^\circ\text{C}$

Temperature at left phase $T_1 = 150^\circ\text{C}$

$$Q = kA \frac{T_1 - T_2}{x} = 17.5 \times 1 \times \frac{150 - 10}{50 \times 10^{-2}}$$

$$Q = 4900\text{W} / \text{m}^2$$

36. For Laminar flow, the convective heat transfer coefficient is Proportion to

A. x

B. $x^{1/2}$

C. $x^{-1/2}$

D. $x^{-1/5}$

Ans. C

Sol. $Nu = 0.332 (Re)^{1/2} (Pr)^{1/3}$

$$\frac{hx}{k} = 0.332 \left(\frac{\rho \vee x}{\mu} \right)^{1/2} (Pr)^{1/3}$$

$$h \propto x^{-1/2}$$

37. Lowest possible temperature to which water can be cooled in any cooling tower is

A. Wet bulb temperature incoming air

B. Dry bulb temperature incoming air

C. Due point temperature

D. Ambient temperature

Ans. A

Sol. Lowest possible temperature to which water can be cooled in any cooling tower wet bulb temperature of incoming air to cooling tower.

38. The local heat transfer coefficient (in $\text{W}/\text{m}^2\text{K}$) at a point is given as $h_x = 15.6x$. The average heat transfer coefficient for a length of 8 m is :

A. 62.4

B. 78

C. 19.5

D. 10

Ans. A

Sol. The average heat transfer coefficient is given by :

$$h_{\text{avg}} = \frac{1}{L} \int_0^L h_x dx$$

$$= \frac{1}{8} \int_0^8 15.6x dx$$

$$= \frac{15.6}{8} \times \frac{64}{2}$$

$$h_{\text{avg}} = 62.4\text{W} / \text{m}^2\text{K}$$

39. Ideal shape of fin is

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- A. Trapezoidal
C. Rectangular
- B. Parabolic
D. circular

Ans. B

Sol. Ideal shape of fin is parabolic but due to design constraints trapezoidal shape is used in practical application.

40. The temperature of solid surface changes from 27 °C to 627 °C. The emissive power changes would then confirm to the ratio _____.

- A. 6:1
C. 81:1
- B. 9:1
D. 27:1

Ans. C

Sol. The Emissive power of a body is given by:

$$E = \varepsilon A \sigma T^4$$

Where:

A = heat transfer surface area of the body

ε = emissivity of the body

σ = Boltzman constant

Thus, when temp. changes from 27 °C to 627 °C

$$T_2 = 627 + 273 = 900 \text{ K}$$

$$T_1 = 27 + 273 = 300 \text{ K}$$

$$\frac{E_2}{E_1} = \left(\frac{T_2}{T_1} \right)^4$$

$$\frac{E_2}{E_1} = \left(\frac{900}{300} \right)^4 = 81$$

41. Most metals are good conductor of heat because of
- A. Transport of energy
B. Free electrons and frequent collision of atoms
C. Lattice defects
D. Capacity to absorb energy

Ans. B

Sol. In metals. heat is conducted due to presence of free electron around 70% & molecular vibration around 30%.

42. Air enters a counter-flow heat exchanger at 70 °C and leaves at 40 °C. Water enters at 30 °C and eaves at 50 °C. The LMTD in deg. C is

- A. 5.65
C. 19.52
- B. 14.43
D. 20.17

Ans. B

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45. The unit of thermal diffusivity is
 A. $\text{m}^2/\text{hr-K}$ B. $\text{kcal}/\text{m}^2\text{-hr}$
 C. m^2/hr D. $\text{m}/\text{hr-K}$

Ans. C

Sol. The quantity $\alpha = k/\rho c$ is called thermal diffusivity.

$$\alpha = \frac{K}{\rho C} = \frac{\frac{W}{m-K}}{\frac{\text{kg}}{\text{m}^3} \times \frac{J}{\text{kg-K}}} = \frac{\frac{J}{s} - m^2}{J} = \frac{m^2}{s} = \frac{m^2}{hr}$$

46. A steel plate of thermal conductivity 50 W/mK and thickness 10 cm passes a heat flux by conduction of 25 KW/m^2 . If the temperature of hot surface of the plate is 100°C , then what is the temperature of cooler surface of the plate?
 A. 30°C B. 40°C
 C. 50°C D. None of these

Ans. C

Sol. Applying Fourier law of conduction

$$Q = KA \frac{dT}{dx}$$

$$25 \times 10^3 \times 0.1 = 50 \times (100 - T_{\text{cooler}})$$

$$T_{\text{cooler}} = 50^\circ\text{C}$$

47. What is the correct arrangement of silver, mild steel, copper and aluminium in decreasing order of thermal conductivity at room temperature?
 A. silver, copper, aluminium, mild steel B. aluminium, mild steel, copper, silver
 C. mild steel, aluminium, copper, silver D. copper, silver, aluminium, mild steel

Ans. A

Sol. Correct order of thermal conductivity in decreasing order :
 Silver > copper > aluminium > mild steel

48. Thermal Resistance of Radial Conduction through hollow cylinder is:

A. $\frac{2\pi kL}{\ln(r_2/r_1)}$

B. $\frac{\ln(r_2/r_1)}{2\pi L}$

C. $\frac{\ln(r_2/r_1)}{2\pi kL}$

D. $2\pi kL \times \ln\left(\frac{r_2}{r_1}\right)$

Ans. C

Sol. Formula for heat transfer through a hollow cylinder is,

$$Q = \frac{2\pi kL(T_1 - T_2)}{\ln(r_2/r_1)} \dots\dots\dots(i)$$

$$Q = \frac{\Delta T}{R} \dots\dots\dots(ii)$$

Comparing (i) & (ii)

$$R = \frac{\ln(r_2/r_1)}{2\pi kL}$$

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52. The material having least thermal conductivity _____.

A. Glass wood

B. Asbestos

C. Freon-12

D. Air

Ans. C

Sol.

Material	Conductivity
Air	0.024
Glass wood	0.075
Freon-12	0.0083
Asbestos	0.2

53. For the same inlet and outlet temperatures of hot and cold fluids, the Log Mean Temperature Difference (LMTD) is

A. greater for parallel flow heat exchanger than for counter flow heat exchanger

B. greater for counter flow heat exchanger than for parallel flow heat exchanger

C. same for both parallel and counter flow heat exchangers

D. dependent on the properties of the fluids

Ans. B

Sol. Log Mean Temperature Difference (LMTD) is greater for counter flow heat exchanger than for parallel flow heat exchanger

54. Prandtl Number of Mercury is_____.

A. Very low

B. Very high

C. Equal to that of water

D. Equal to 1

Ans. A

Sol.

$$\text{Prandtl Number } Pr = \frac{\nu}{\alpha} = \frac{\mu C_p}{k}$$

Since conductivity of Mercury is very high thus the value of Prandtl Number for mercury is very low

Prandtl Number of Mercury ≈ 0.025

Prandtl Number of water $\approx 2 - 8$

Prandtl Number of air ≈ 0.65 to 71

55. Nusselt is the ratio of _____.

A. Convection resistance offered by fluid to conduction resistance offered by fluid

B. Convection resistance offered by fluid to conduction resistance offered by solid body

C. Conduction resistance offered by solid to convection resistance offered by fluid

D. conduction resistance offered by fluid to convection resistance offered by fluid

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Ans. D

Sol. Nusselt Number = $\frac{hD}{k_f}$

Where k_f = conductivity of fluid

h = heat transfer coefficient of fluid

D = Characteristic length

$$Nu = \left(\frac{D}{k_f} \right) \times \frac{1}{1/h} = \left(\frac{D}{k_f \times A} \right) \times \left(\frac{1}{\left(\frac{1}{hA} \right)} \right)$$

$$Nu = \frac{\left(\frac{D}{k_b A} \right)}{(1/hA)}$$

$$Nu = \frac{\text{Conductive resistance offered by fluid}}{\text{Convective resistance offered by fluid}}$$

56. Three metal walls of the same thickness and cross sectional area have thermal conductivities k , $2k$ and $3k$ respectively. The temperature drop across the walls (for same heat transfer) will be in the ratio

A. 3:1.5:1

B. 1:1:1

C. 1:2:3

D. Given data is insufficient

Ans. A

Sol. Given,

As, $\delta_1 = \delta_2 = \delta_3$ and cross sectional areas are same i.e. temperature drop varies inversely with thermal conductivity.

$$\text{Thus, } \Delta T_1 : \Delta T_2 : \Delta T_3 = \frac{1}{K} : \frac{1}{2K} : \frac{1}{3K}$$

$$\Delta T_1 : \Delta T_2 : \Delta T_3 = 6 : 3 : 2$$

$$\Rightarrow 3 : 1 : 5 : 1$$

57. A wooden slab having thickness 5cm has its inner and outer surface temperatures at 40°C and 20°C respectively. The heat flux from the slab is 40 W/m². The thermal conductivity of wood is :

A. 0.8 W/m-K

B. 0.25 W/m-K

C. 0.1 W/m-K

D. 0.18 W/m-K

Ans. C

Sol. The heat transfer through the wood is given by Fourier's law

$$Q = k \frac{T_1 - T_2}{L}$$

$$40 = k \frac{40 - 20}{0.05}$$

$$k = 0.1 \text{ W/m K}$$

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58. The effect of forced convection can be neglected if

A. $\frac{Gr_L}{Re_L^2} \gg 1$

B. $\frac{Gr_L}{Re_L^2} = 1$

C. $\frac{Gr_L}{Re_L^2} \ll 1$

D. $\frac{Gr_L}{Re_L^2} = 0$

Ans. A

Sol.

When $\frac{Gr_L}{Re_L^2} = 1$, effect of both free and forced convection should be considered.

When $\frac{Gr_L}{Re_L^2} \gg 1$, effect of forced convection neglected

When $\frac{Gr_L}{Re_L^2} \ll 1$, effect of free convection neglected

59. If conductive Heat transfer is taking place radially in a hollow cylinder then temperature distribution is

A. Parabolic

B. Linear

C. Logarithmic

D. Elliptical

Ans. C

Sol. In hollow cylinder temperature distribution is logarithmic.

If conduction takes place in radial direction then temperature at any point in the cylinder can be expressed as a function of radius only.

60. On a heat transfer surface, fins are provided to

A. Increase turbulence in flow for enhancing heat transfer

B. Increase temperature gradient so as to enhance heat transfer

C. Pressure drop of the fluid should be minimized

D. Surface area is maximum to promote the rate of heat transfer

Ans. D

Sol. Fins are provided to a heat exchanger surface to augment the heat transfer by increasing the surface area exposed to the surroundings.

61. The overall heat transfer coefficient is 500. During the operation the tube surfaces get covered by soot, and the overall heat transfer coefficient is 250. Thus it leads to a factor having a value.

A. 1

B. 0.015

C. 0.006

D. 0.002

Ans. D

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Sol. It leads to fouling, and fouling factor is to be determined

It is given by,

$$\text{Fouling factor} = \frac{1}{U_{\text{dirty}}} - \frac{1}{U_{\text{clean}}}$$
$$= \frac{1}{250} - \frac{1}{500}$$

$$\text{Fouling factor} = 0.002$$

62. In a shell and tube heat exchanger, baffles are provided on the shell side to _____.

- A. Prevents Sagging
- B. Improve heat transfer
- C. Provide support for tubes
- D. All options are correct

Ans. D

Sol. Baffles are an integral part of the shell and tube heat exchanger design. A baffle is designed to support tube bundles and direct the flow of fluids for maximum efficiency.

63. The temperature of a surface with 0.2 m^2 area is 17°C . Calculate the wavelength corresponding to maximum monochromatic emissive power

- A. 20 micrometers
- B. 30 micrometers
- C. 10 micrometers
- D. 40 micrometers

Ans. C

Sol. According to wein's law

$$\lambda_m T = 2898 \text{ } \mu\text{mk}$$

$$\lambda_m = \frac{2898}{290} = 9.99 \text{ micrometer} \approx 10$$

64. In a balanced counter flow heat exchanger where heat capacities of both fluids are same, the temperature profiles of the two fluids are:

- A. Non-linear and parallel
- B. Linear and parallel
- C. Linear and non-parallel
- D. Non-linear and non-parallel

Ans. B

Sol. In a balance counter flow heat exchanger,

$$\Delta T_{\text{LMTD}} = \Delta T_1 = \Delta T_2$$

Hence, the profile is linear and parallel

65. A metal rod of 2 cm diameter has a conductivity of 50 W/mk which is to be insulated with an insulating material of conductivity 0.2 W/mk . If the convective heat transfer coefficient with the ambient atmosphere is $10 \text{ W/m}^2\text{k}$ the critical thickness of insulation will be

- A. 1 cm
- B. 2 cm
- C. 7 cm
- D. 8 cm

Ans. A

Sol. Given,

$$k_{\text{insulation}} = 0.2 \text{ W/m-K}, \quad k_{\text{metal}} = 50 \text{ W/m-K}$$

$$D = 2 \text{ cm}, \quad r = 1 \text{ cm}$$

$$h_o = 10 \text{ W/m}^2\text{K}$$

For cylinder

$$\text{Critical radius of insulation, } r_c = k/h_o = 0.2 / 10 = 2 \text{ cm}$$

$$\text{Critical thickness of insulation} = r_c - r = 2 - 1 = 1 \text{ cm}$$

66. In forced convection, the surface heat transfer coefficient from a heated flat plate is a function of Where Re is Reynolds number, Pr is Prandtl number and Gr is Grash of number.

A. Re and Gr

B. Pr and Gr

C. Re and Pr

D. Re, Gr and Pr

Ans. C

Sol. Nusselt no. in case of forced convection is a function of Reynolds no. and Prandtl no.

$$Nu = f(Re, Pr)$$

67. The Biot number can be thought of as the ratio of _____.

A. The conduction thermal resistance to the convective thermal resistance

B. The convective thermal resistance to the conduction thermal resistance

C. The thermal energy storage capacity to the conduction thermal resistance.

D. The thermal energy storage capacity to the convection thermal resistance.

Ans. A

Sol. The Biot number can be thought of as the ratio of the conduction thermal resistance to the convective thermal resistance.

$$Bi = \frac{hL_c}{K_{\text{solid}}} = \frac{\frac{L_c}{K_{\text{solid}}A}}{\frac{1}{hA}} = \frac{\text{Internal Conduction thermal resistance}}{\text{Convection thermal resistance}}$$

68. In regenerator type heat exchanger, heat transfer takes place by

A. direct mixing of hot and cold fluids

B. a complete separation between hot and cold fluids

C. flow of hot and cold fluids alternately over a surface

D. generation of heat again and again

Ans. C

Sol. Regenerator type of heat exchanger where heat from the hot fluid is intermittently stored in a thermal storage medium before it is transferred to the cold fluid. Hence (C) is correct.

69. Heisler chart shows the temperature time history of a solid in a transient heat conduction as a function of:

- A. Fourier number and Biot number
- B. Fourier number and reciprocal of Biot number
- C. Reciprocal of Fourier number and Biot number
- D. Reciprocal of Fourier number and reciprocal of Biot number

Ans. B

Sol. Heisler chart shows the temperature time history of a solid in a transient heat conduction as a function of Fourier number and reciprocal of Biot number.

70. The inner radius of a hollow sphere is increased by twice and outer radius is increase by four times. What will be the ratio of Initial to final geometric radius?

- A. 2.828
- B. 0.3535
- C. 2.885
- D. 0.3465

Ans. B

Sol. Initial Geometric radius of sphere = $\sqrt{r_1 r_2}$

Final Geometric radius of sphere = $\sqrt{4r_1 \times 2r_2} = 2.828 \sqrt{r_1 r_2}$

Ratio of initial to final = $1/2.828 = 0.3535$

71. In a heat exchanger, the hot fluid enters at 220°C and leaves at 180°C and cold fluid enters at 60°C and leaves at 150°C . Then find the heat capacity ratio _____.

- A. 2.25
- B. 0.5
- C. 0.44
- D. 1

Ans. C

Sol. Given,

Inlet temperature of hot fluid = 220°C

Exit temperature of hot fluid = 180°C

Inlet temperature of cold fluid = 60°C

Exit temperature of cold fluid = 150°C

The heat capacity ratio, R is defined as

$$R = \frac{c_{\min}}{c_{\max}} = \frac{\dot{m}_c c_c}{\dot{m}_h c_h} = \frac{T_{h_1} - T_{h_2}}{T_{c_2} - T_{c_1}}$$

$$R = \frac{220 - 180}{150 - 60} = 0.44$$

72. Which one is true for an opaque body?

- A. Transmissivity is zero
- B. Reflectivity is zero
- C. Absorptivity is zero
- D. Reflectivity is unity

Ans. A

Sol. For the opaque body, sum of absorptivity and reflectivity is unity.

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73. A hollow sphere is constructed of aluminum, $k = 200 \text{ W/m}\cdot\text{K}$ with an inner diameter of 5 cm and an outer diameter of 10 cm. The inside temperature is 200°C and the outer temperature is 100°C . Calculate the heat transfer.
- A. 36.13 kW B. 15.31 kW
C. 25.13 kW D. 12.57kW

Ans. D

Sol. Given:

$$d_i = 5 \text{ cm} = r_i = 0.025 \text{ m},$$

$$d_0 = 10 \text{ cm} = r_0 = 0.05 \text{ m},$$

$T_i = 200^\circ\text{C},$

$$T_0 = 100^\circ\text{C},$$

$k = 200 \text{ W/m-k}$

$$Q = 4\pi k r_o r_i \frac{T_1 - T_2}{r_o - r_i}$$

$$Q = 4\pi \times 200 \times 0.025 \times 0.05 \frac{200 - 100}{0.025}$$

$$Q = 12556.37$$

$$Q = 12.57 \text{ kW}$$

74. What is the Biot No. of steel slab of dimensions $3\text{cm} \times 3\text{cm} \times 9\text{cm}$. Use: $h = 60\text{W/m}^2\text{K}$, $k = 50\text{W/m-K}$
- A. 0.0077 B. 0.025
- C. 0.0068 D. 0.049

Ans. A

Sol. Since Biot Number is given by:

$$Bi = \frac{hL_c}{K_{solid}}$$

Where:

L_C : Characteristic length

Characteristic length:

$$L_c = \frac{\text{Vol.}}{\text{surface area}} = \frac{L_1 L_2 L_3}{2(L_1 L_2 + L_2 L_3 + L_3 L_1)}$$

$$L_c = 6.43 \times 10^{-3} \text{m}$$

Biot Number:

$$Bi = \frac{hL_c}{K_{solid}} = \frac{60 \times 6.43 \times 10^{-3}}{50}$$

$$= 0.0077$$

75. Which of the following is not true for the analysis of heat flow in the composite wall?
- A. The contact between adjacent layers is perfect
 - B. At the interface there is no fall of temperature
 - C. At the interface the temperature is continuous, although there is discontinuity in temperature gradient
 - D. The temperature at inner surface is same as outer surface

Ans. D

Sol. In a composite or multilayer wall, the analysis of heat flow is made on the following assumption:

The contact between adjacent layers is perfect

At the interface there is no fall of temperature

At the interface the temperature is continuous, although there is discontinuity in temperature gradient

76. Fourier's law of heat conduction is applicable only for
- A. One dimensional cases only
 - B. Two dimensional cases only
 - C. Three dimensional cases only
 - D. Regular surfaces having non-uniform temperature gradients

Ans. A

Sol. **Assumptions of Fourier equation:**

Steady state heat conduction.

One directional heat flow.

Bounding surfaces are isothermal in character that is constant and uniform temperatures are maintained at the two faces.

Isotropic and homogeneous material and thermal conductivity 'k' is constant.

Constant temperature gradient and linear temperature profile.

No internal heat generation.

77. For constant heat flux , what is the Nusselt number in the developed flow?
- A. 4.36
 - B. 3.66
 - C. 1.23
 - D. 6.66

Ans. A

Sol. For constant wall temperature heat transfer coefficient is 3.66 and for constant heat flux it is 4.36.

78. Which of the following is true for a black body?
- A. $\alpha = 1$
 - B. $\rho = 0$
 - C. $\tau = 0$
 - D. All of the above

Ans. D

Sol. Absorptivity(α) is the fraction of incident radiation absorbed.

Reflectivity(ρ) is the fraction of incident radiation reflected.

Transmissivity (τ) is the fraction of incident radiation transmitted.

for a black body,

$$\rho = 0, \tau = 0 \text{ \& } \alpha = 1$$

So the correct option is (d).

79. The temperature profile of fluid in laminar tube flow (forced convection) with constant heat flux along length of tube is.

A. Exponential

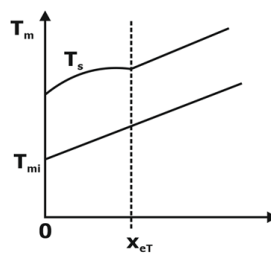
B. linear

C. logarithmic

D. Hyperbola

Ans. B

Sol. The temperature profile of fluid in laminar tube flow [forced convection] subjected to constant heat flux is linear.



80. At thermal equilibrium _____.

A. reflectivity will become zero

B. Absorptivity is lesser than emissivity

C. Absorptivity is equal to emissivity

D. Sum of absorptivity and emissivity is unity

Ans. C

Sol. As per the kirchoff law, At thermal equilibrium, absorptivity is equal to emissivity.

81. A cross flow type air heater has an area of 50 m². The overall heat transfer coefficient is 100 W/m² K and heat capacity of both hot and cold stream is 1000 W/ K. The value of NTU is

A. 1000

B. 500

C. 5

D. 0.2

Ans. C

Sol. Number of transfer units is given by:

$$NTU = \frac{UA}{C_{min}}$$

$$NTU = \frac{100 \times 50}{1000}$$

$$NTU = 5$$

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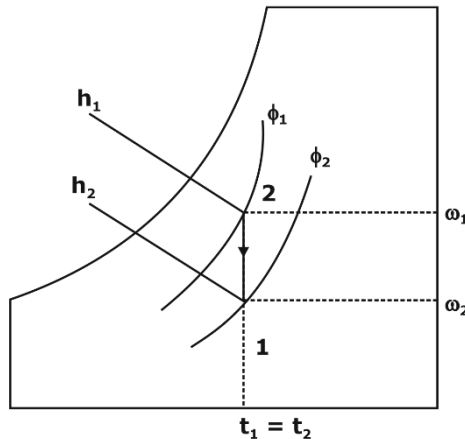
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1. On a Psychrometric chart, what does a vertical downward line represent _____?
- A. Adiabatic saturation B. Sensible cooling
C. Dehumidification D. Humidification

Ans. C

Sol.



Process 2-1 shows the dehumidification process. It is a process of decreasing the specific humidity at the constant dry bulb temperature.

2. In the vapour compression refrigeration cycle _____.
- A. dry compression is always preferred
B. wet compression is always preferred
C. may be dry or wet depending upon the refrigerant
D. mixer of dry and wet compression is preferred

Ans. A

Sol. There is a problem with wet compression because chances of liquid refrigerant being trapped in the head of cylinder which may damage the cylinder head and liquid refrigerant may wash away the lubricating oil from the walls, so wear rate increases.

3. Sling psychrometer is used to measure _____
- A. Dry bulb and Wet bulb temperature B. Wet bulb temperature
C. Dry bulb temperature D. Dew point temperature

Ans. A

Sol. A sling psychrometer is an instrument that measures the relative humidity and dew point in an area. A sling psychrometer has two thermometers: a wet bulb and a dry bulb. The wet bulb has a cotton wick over the bulb of the thermometer, which is moistened with room temperature water.

4. During which component of vapour compression refrigeration system, the enthalpy remains constant:
- A. Evaporator B. Compressor
C. Throttle valve D. Condenser

Ans. C

Sol. Throttling is the process in which enthalpy remains constant.

In vapour compression refrigeration cycle, enthalpy remains constant when refrigerent isthrottled from high pressure to low Pressure.

5. In which of the following refrigeration cycle, does the waste heat gets effectively used?

- A. Vapor compression cycle
- B. Vapor absorption cycle
- C. Air refrigeration cycle
- D. Vapor expansion cycle

Ans. B

Sol. Consider the following statement regarding VARS

VARS is a heat operating device that works on low-grade energy.

It is used extensively where waste heat is available.

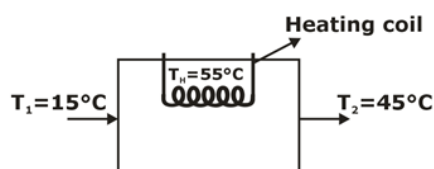
6. Air at 15°C DBT, 60% of relative humidity is heated to 45°C using an electric heater. The surface temp. of the coil is 55°C. Then what will be contact factor of heating coil.

- A. 0.25
- B. 0.5
- C. 0.75
- D. 0.66

Ans. C

Sol. Contact factor = efficiency(η) of coil

$$= \frac{T_2 - T_1}{T_H - T_1} = \frac{45 - 15}{55 - 15} = \frac{30}{40} = 0.75$$



7. If barometer pressure is 1 bar and partial pressure of air is 0.92 bar. Find the relative humidity, if saturation pressure of water vapour at same dry bulb temperature is 0.1 bar.

- A. 70 %
- B. 75%
- C. 80 %
- D. 85 %

Ans. C

Sol. Given,

Barometer pressure, $P = 1$ bar

Partial pressure of air, $P_a = 0.92$ bar

Saturation pressure of water vapour, $P_{vs} = 0.1$ bar

$$\text{Relative humidity, } \phi = \frac{P_v}{P_{vs}}$$

$$P = P_v + P_a \Rightarrow 1 = P_v + 0.92$$

$$P_v = 0.08 \text{ bar}$$

$$\phi = \frac{0.08}{0.1} = 0.8 = 80\%$$

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Ans. C

Sol. Let The amount of heat rejected by condenser= Q_1

We know, $Q_1 = W + Q_2$

where Q_2 = Refrigerating effect

Here, $Q_2 = \text{COP} \times W = 4 \times 40 = 160 \text{ kW}$

Therefore, $Q_1 = 160 + 40 = 200 \text{ kW}$

13. In the air cycle refrigeration system _____.

- A. Only sensible heat transfer processes occurs
- B. Only latent heat transfer processes occurs
- C. Both sensible and latent heat transfer processes occur
- D. No heat transfer takes place

Ans. A

Sol. In the air cycle refrigeration, the air is a working fluid and air does not undergo phase change, so there is only sensible heat transfer processes takes place.

14. In a vapour absorption refrigerator, the temperatures of evaporator and ambient air are 10°C and 30°C , respectively. For obtaining COP of 2 for this system, the temperature of the generator is to be nearly

- A. 90°C
- B. 85°C
- C. 80°C
- D. 75°C

Ans. C

Sol.

Ambient temp = $30^\circ\text{C} = 303 \text{ K}$

Evaporator temp = $10^\circ\text{C} = 283 \text{ K}$

Cop of system = $\eta_{\text{gen}} \times \text{COP}_{\text{Eva}} = 2$

$$\left(1 - \frac{303}{T_G}\right) \left(\frac{283}{303 - 283}\right) = 2$$

$T_G = 353\text{K} = 79.8^\circ\text{C} \approx 80^\circ\text{C}$ Ans

15. Match the following $\Rightarrow 1 - 2 - 3 - 4$: _____ -

List - A

- 1. R -12
- 2. Ammonia
- 3. R-22
- 4. R-11

List - B

- A. Industrial system
- B. Air conditioning
- C. Centrifugal compressor
- D. Food freezer

A. B - A - D - C

B. C - B - D - A

C. B - C - A - D

D. C - A - D - B

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Ans. A

Sol. Below shown is the application area of various refrigerator.

R - 12 \Rightarrow Air condition

Ammonia \Rightarrow Industrial system

R-22 \Rightarrow Food freezer

R-11 \Rightarrow Centrifugal compressor

16. The COP of a refrigerator working on a reversed Carnot cycle is 5. The ratio of the highest absolute temperature to the lowest absolute temperature would be

A. 1.25

B. 1.3

C. 1.4

D. 1.2

Ans. D

Sol.

$$\text{COP} = \frac{T_L}{T_H - T_L}$$

$$5 = \frac{T_L}{T_H - T_L}$$

$$0.2 = \frac{T_H}{T_L} - 1$$

$$\frac{T_H}{T_L} = 1.2$$

17. Sub cooling is beneficial as it:

1. Increases specific refrigeration effect

2. Decreases work of compression

3. Ensures liquid entry into expansion device

4. All of the above

A. 1 and 2

B. 2 and 3

C. 1 and 3

D. 4

Ans. C

Sol. Subcooling is beneficial as it increases the refrigeration effect by reducing the throttling loss at no additional specific work input. Also subcooling ensures that only liquid enters into the throttling device leading to its efficient operation.

18. In Water lithium bromide vapour absorption cycle, lithium bromide is used as

A. Refrigerant

B. Absorbent

C. Cooling substance

D. Lubricant

Ans. B

Sol. In a water-lithium bromide vapor absorption refrigeration system, water is used as the refrigerant while lithium bromide (Li Br) is used as the absorbent.

In the absorber, the lithium bromide absorbs the water refrigerant, creating a solution of water and lithium bromide.

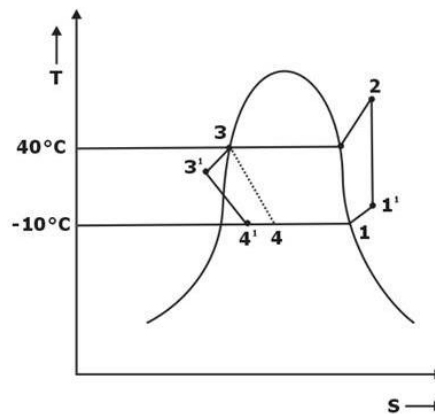
19. Out of the following refrigerant shown below, which of the following has the maximum ozone depletion potential in the stratosphere?

- | | |
|--------------------|-------------------|
| A. Ammonia | B. Carbon Dioxide |
| C. Sulphur dioxide | D. Chlorine |

Ans. D

Sol. Chlorine has the maximum ozone depletion potential in the stratosphere among all the above refrigerants. Hence it is a banned in refrigerant, and seldomly used worldwide.

20. In R-12 Vapor Compression refrigeration system an ideal heat exchanger is used such that refrigerant gets superheated before the entry to compressor and gets sub-cooled after leaving from condenser as shown in the below T-S diagram



$$h_1 = 183.2 \text{ KJ/Kg}$$

$$h_{1'} = 192.53 \text{ KJ/Kg}$$

$$h_2 = 220.3 \text{ KJ/Kg}$$

$$h_3 = 74.59 \text{ KJ/Kg}$$

Find COP of refrigeration sytem _____

- | | |
|---------|---------|
| A. 4.25 | B. 6.87 |
| C. 8.85 | D. 3.67 |

Ans. A

Sol. As heat exchanger just transfers heat from 1 – 1'to 3 – 3'

$$\text{Therefore } (h_{1'} - h_1) = (h_3 - h_{3'})$$

$$192.53 - 183.2 = 74.59 - h_{3'}$$

$$h_{3'} = 65.26 \text{ KJ/Kg}$$

As 3' – 4' is isenthalpic process so, $h_{3'} = h_{4'}$

$$\text{COP} = \frac{\text{Re figeration effect}}{\text{Compressor Work}} = \frac{(h_1 - h_{4'})}{(h_2 - h_{1'})}$$

$$\text{COP} = \frac{(183.2 - 65.26)}{(220.3 - 192.53)} = 4.25$$

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21. A reversible heat engine is operating between a source at T_1 and a sink at T_2 . What will be the effect on efficiency if T_2 decreases?
- A. Decreases
B. Increases
C. Remains constant
D. None of the above

Ans. B

Sol. The efficiency of a reversible heat engine is operating between a source at T_1 and a sink at T_2 is given by,

$$\eta = \text{Work done} / \text{Heat supplied}$$

$$\eta_{\text{rev}} = (T_1 - T_2) / T_1$$

$$\eta_{\text{rev}} = 1 - (T_2 / T_1)$$

From the above equation, as T_2 decreases the efficiency increases and tends towards 100%.

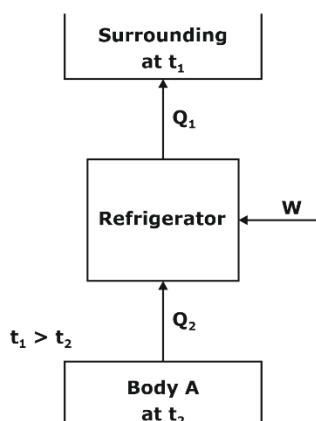
22. The COP of heat pump and COP of refrigerator are related as
- A. $[\text{COP}]_{\text{H.P.}} = 1 + [\text{COP}]_{\text{ref}}$
B. $[\text{COP}]_{\text{H.P.}} = 1 - [\text{COP}]_{\text{ref}}$
C. $[\text{COP}]_{\text{H.P.}} = [\text{COP}]_{\text{ref}}$
D. None of the above

Ans. A

Sol. The COP of a device, operating in a cycle is given by,

$$[\text{COP}] = \text{Desired effect} / \text{Work input}$$

In refrigerator,



The desired effect is to maintain temperature of the body A lower than the surroundings temperature.

Therefore, A refrigerator is a device, which operates in a cycle and maintains the temperature of a particular body lower than the surrounding temperature.

$$[\text{COP}]_{\text{ref}} = \text{Desired effect} / \text{Work input}$$

$$[\text{COP}]_{\text{ref}} = Q_2 / W$$

And in heat pump,

The desired effect is to maintain temperature of the body B more than the surrounding temperature.

Therefore, $[COP]_{H.P.} = \text{Desired effect} / \text{Work input}$

$$[\text{COP}]_{\text{H.P.}} = Q_1 / W$$

and the work input is given by,

$$W = Q_1 - Q_2$$

From the equations of $[\text{COP}]_{\text{ref}}$ and $[\text{COP}]_{\text{H}}$

$$[\text{COP}]_{\text{H.P.}} = 1 + [\text{COP}]_{\text{ref}}$$

23. Which of the following statements are TRUE?

1. During sensible cooling of air, both dry bulb and wet bulb temperatures decrease
 2. During sensible cooling of air, dry bulb temperature decreases but wet bulb temperature remains constant
 3. During sensible cooling of air, dry and wet bulb temperatures decrease but dew point temperature remains constant
 4. During sensible cooling of air, dry bulb, wet bulb and dew point temperatures decrease
- A. 1 and 2 B. 2 and 4
C. 1 and 3 D. 3 and 4

Ans. C

Sol. During this process, the moisture content of air remains constant but its temperature decreases as it flows over a cooling coil. For moisture content to remain constant, the surface of the cooling coil should be dry and its surface temperature should be greater than the dew point temperature of air. If the cooling coil is 100% effective, then the exit temperature of air will be equal to the coil temperature.

24. Consider an ideal VCRS (Vapor compression refrigeration cycle), for which the enthalpy of refrigerant before and after the evaporator are 75 kJ/kg and 180 kJ/kg respectively. Determine the refrigerant flow for each ton of refrigeration required:

- A. 1 kg/min B. 2 kg/min
C. 3 kg/min D. 4 kg/min

Ans. B

Sol. By definition, $1 \text{ TR} = 3.5 \text{ kW} = 210 \text{ kJ/min}$

Now Heat addition through Evaporator is

$$\dot{Q} = \dot{m}(h_1 - h_4)$$

$$210 = \dot{m}(180 - 75)$$

$$\dot{m} = \frac{210}{105} = 2 \text{ kg / min}$$

25. In a triple fluid vapour absorption refrigeration system, the hydrogen gas is used to _____.
A. Improve system performance
B. Reduce the partial pressure of refrigerant in evaporator
C. Circulate the refrigerant
D. Provide a vapour seal

Ans. B

Sol. The "ammonia" is used as a refrigerant because it possesses most of the desirable properties.

Hydrogen is called a carrier gas and the main function H_2 is to reduce the partial pressure of the NH_3 gas to increase the rate of evaporation (the lighter the gas, faster is the evaporation) of the liquid ammonia in the evaporator.

The "water" is used as a solvent because it has the ability to absorb ammonia readily.

26. What is the bypass factor of 3 coils if the bypass factor of single coil is 0.7?
A. 0.21
B. 0.7
C. 0.343
D. 0.49

Ans. C

Sol. By pass factor of n coils = X^n , X is by pass factor of single coil.

By pass factor of 3 coil = $0.7^3 = 0.343$

27. One ton of refrigeration (TR) is equal to
A. 3.5 W
B. 210 KJ
C. 1000 Kg of refrigerant
D. 3.5 KJ/sec

Ans. D

Sol. A ton of refrigeration, also called a refrigeration ton, is a unit of power used in some countries to describe the heat-extraction capacity of refrigeration and air conditioning equipment.

It is defined as the rate of heat transfer that results in the freezing of 1 ton of pure water into ice at 0°C in 24 hours

$1 \text{ TR} = 3.5 \text{ KW} = 3.5 \text{ KJ/sec}$ or 210 KJ/min or 50 Kcal/min

28. Air refrigeration is preferably used in aircrafts because
A. it uses air that is available in plenty in the atmosphere
B. it has high COP
C. its weight per ton of refrigeration is low
D. it is cheaper

Ans. C

Sol. Air cycle machines are lighter weight and more efficient in aircraft, because they do not need a separate compressor unit. They take their compressed air from the engine bleed air.

29. The following data refer to a vapour compression refrigerator:

Enthalpy at compressor inlet = 1200 kJ/kg

Enthalpy at compressor outlet = 1400 kJ/kg

Enthalpy at condenser outlet = 200 kJ/kg

The COP of the refrigerator is

A. 7

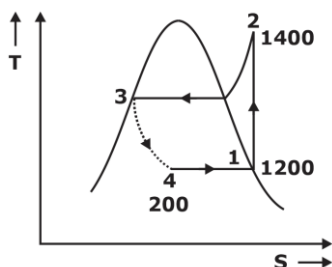
B. 6

C. 5

D. 4

Ans. C

Sol.



As from the vapor compressor cycle

$$\text{COP} = \frac{h_1 - h_4}{h_2 - h_1}$$

$$\text{COP} = \frac{1200 - 200}{1400 - 1200}$$

$$= 5$$

30. During a psychometric process, the latent heat added is 20 kJ/s and the sensible heat added is 30 kJ/s. Determine the Sensible heat factor:

A. 0.3

B. 0.6

C. 0.6777

D. 1.5

Ans. B

Sol. By definition, Sensible heat factor = $\frac{\text{Sensible Heat}}{\text{Total Heat}}$

$$\text{Therefore, S.H.F} = \frac{\text{S.H.}}{\text{S.H.} + \text{L.H.}}$$

$$= \frac{30}{20 + 30} = \frac{30}{50}$$

$$= 0.6$$

31. In a vapour absorption refrigeration system, the COP of the system is 0.3. If the heat extracted from the refrigerated space is 15 kW, then heat received by generator, if the efficiency of generator is 80 %.

A. 50 kW

B. 66.67 kW

C. 72.5 kW

D. 62.5 kW

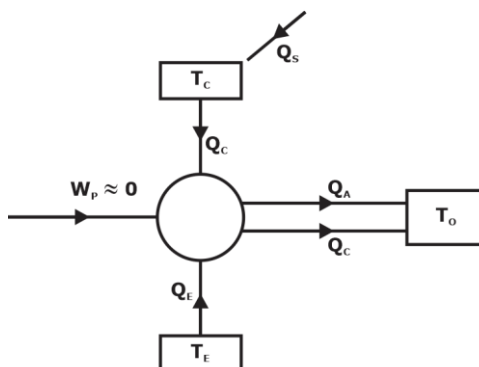
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Ans. D

Sol.



Given $COP = 0.3$ $Q_E = 15 \text{ kW}$

$$COP = \frac{Q_E}{Q_G} = 0.3 = \frac{15}{Q_G} = Q_G = 50 \text{ kW}$$

$$\frac{Q_G}{Q_S} = \eta_{\text{Generator}} \Rightarrow \frac{50}{Q_S} = 0.80$$

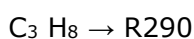
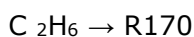
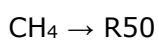
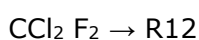
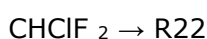
$$Q_S = 62.5$$

32. Which of the following is not true for Designation of Refrigerants?

- A. $\text{CHClF}_2 \rightarrow \text{R33}$
- B. $\text{CCl}_2 \text{F}_2 \rightarrow \text{R12}$
- C. $\text{CH}_4 \rightarrow \text{R50}$
- D. $\text{C}_3 \text{H}_8 \rightarrow \text{R290}$

Ans. A

Sol. **Equation:**



33. A Bell – Coleman air refrigeration cycle works as a reversed

- A. Stirling Cycle
- B. Otto Cycle
- C. Diesel Cycle
- D. Brayton Cycle

Ans. D

Sol. A Bell – Coleman air refrigeration cycle works as a reversed Brayton Cycle.

A Reverse Brayton cycle achieves a cooling effect by reversing the gas turbine.

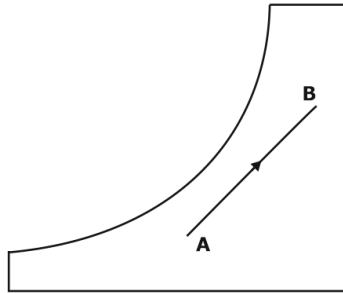
So the correct option is (d).

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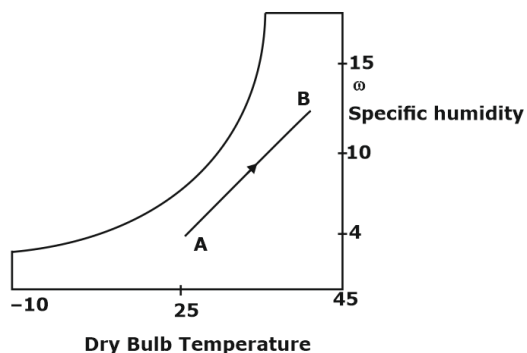
34. What does the curve AB represent in the following Psychrometric Chart?



- A. Sensible heating and dehumidification
- B. Sensible cooling and dehumidification
- C. Sensible heating and humidification
- D. Sensible cooling and humidification

Ans. C

Sol.



Therefore from the chart it is clear that AB represents sensible heating and humidification.

So, the correct option is (c).

35. In cold storage plant, the refrigerant used is

- A. R-11
- B. R22
- C. NH_3
- D. Air

Ans. C

Sol. Some refrigerent and their applications

R-11 used in central conditioning,

R-22 window air conditioner,

NH_3 - used in cold storage plant,

Air is used in aircraft refrigeration

36. The un-desirable property of a refrigerant is

- A. Non-toxic
- B. Non-flammable
- C. Non-explosive
- D. high boiling point

Ans. D

Sol. • Desirable properties of a refrigerant is:

- Low boiling point
- high critical temperature
- high latent heat of vaporization
- Non-toxic
- Non-flammable
- Low viscosity
- Low freezing point

37. Where is an air refrigeration cycle generally employed?

- | | |
|---------------------------|-----------------------------|
| A. Domestic refrigerators | B. Commercial refrigerators |
| C. Air-conditioning | D. Gas liquefaction |

Ans. D

Sol. Air refrigeration cycle is used widely for gas liquefaction.

It also combine with multi-stages to achieve desire liquefaction.

38. Decrease in evaporator pressure of VCRS results

- | | |
|-------------------------------------|---------------------------|
| A. Increase in refrigeration effect | B. Increase in work input |
| C. Increase in COP | D. Can't say |

Ans. B

Sol. Effect of decrease in evaporator pressure of VCRS results,

Decrease in R.E.

Increase in work input

Decrease in COP

Decrease in volumetric efficiency
