Engineering physics - I

Two marks Question with Answers

Unit-III

Thermal physics

1. **Define thermal conduction?**

Conduction is the process of transmission of heat from one point to another through substance (or some medium) without the actual motion of the particles.

2. **Mention the methods to determine thermal conductivity of good and bad conductors?**
   - Searle's method - for good conductors like metallic rod
   - Forbe's method - for determining the absolute conductivity of metals.
   - Lee's disc method - for poor conductors
   - Radial flow method - for bad conductors

3. **What is expansion joint?**

An expansion joint is an assembly designed to safety absorb the heat induced expansion or contraction of a pipeline, duct or vessel. It helps to hold parts together.

4. **Define coefficient of thermal conductivity and mention its unit?**

It is defined as the quantity of heat conducted per second normally across unit area of cross-section per unit temperature difference per unit length of the material.

Its unit is watts/metre/ kelvin ($Wm^{-1}K^{-1}$)

5. **What is meant by thermal insulation?**

Thermal insulation is defined as a material or combination of materials which resist the flow of heat. The insulation reduces the heat transfer rate/ drastically between the system and the adjacent body or the environment.

6. What is solar power?

The energy obtained from the sun, is called solar energy. Sun is the source of all energy. Sunlight contains infrared radiations in large proportion, and these infrared rays heats all objects on which they fall.

7. Derive the unit in which thermal conductivity is measured?

Thermal conductivity of material

$$K = \frac{Qx}{A(\theta_1 - \theta_2)t}$$

$$K = \frac{\text{joule} \times \text{metre}}{(\text{metre}^2) \times \text{kelvin} \times \text{second}}$$

$$= \frac{\text{joule} \times \text{metre}}{\text{second} \times \text{metre} \times \text{kelvin}}$$

$$= \frac{\text{watt}}{\text{metre} \times \text{kelvin}}$$

$$= Wm^{-1}K^{-1}$$

8. Define superficial expansion?

The coefficient of superficial expansion of a solid is the increase in area produced in unit area of the solid when the temperature is raised by 1K. it is denoted by the letter β.

9. Define coefficient of real expansion of liquid?

It is the real increase in volume of unit volume of a liquid per kelvin rise of temperature. It is denoted by γ_r.

10. Define coefficient of apparent expansion of the liquid?

It is the observed increase in volume of unit volume of the liquid per kelvin rise of temperature. It is denoted by γ_a.

11. Define coefficient of linear expansion?

The coefficient of linear expansion of a solid is the increase in length of unit length of the solid when its temperature is raised by 1K. it is denoted by the letter α.

12. Define coefficient of cubical expansion?

Coefficient of cubical expansion of a solid is the increase in volume of unit volume of a solid for 1 K rise of temperature. It is denoted by the letter γ.

13. What is the basic principle employed Lee's disc method for bad conductor?

When steady state is reached

The amount of heat conducted through the bad conductor per second = Amount of heat lost per second by the disc

14. Define radiation? And give the example?

It is the process in which heat is transmitted from one place to another place without the intermediate medium.

Ex: i) Energy from the sun.
ii) Solar water heater.

15. What do you understand by the term, "bimetallic strip" Give its use?

Bimetallic strips are made up of two thin metal strips with different coefficients of thermal expansion.

Use: It is used in water heaters as temperature controller.

16. Define oven?

An oven is a thermally insulated chamber used for heating, baking or drying of a substance and most commonly used for cooking. Kilns and furnaces are special-purpose ovens, used in pottery and metal working, respectively.

17. What are three modes of transferring heat?

- Conduction
- Convection
- Radiation

18. Define convection?

It is the process in which heat is transmitted from one place to the other directly, without the agency of any material medium.

19. What are heat exchanges?

They are devices used to transfer heat between two or more fluid streams at different temperatures.

20. Define refrigerator?

It is a machine which produces cold. It is used to remove heat from the refrigerated space and reject it to atmosphere. Hence, it maintains the temperature below the surrounding atmosphere.

21. What is thermal resistance?

The thermal resistance of a body is a measure of its opposition to the flow of heat through it. (ie.) every body posses some resistive power is termed as thermal resistance.

22. How are heat conduction and electrical conduction analogous to each other?

Sl. No	Heat conduction	Electrical conduction
1.	Heat is conducted from a point of higher temperature to a point of lower temperature.	Electricity is conducted from a point at higher potential to a point at lower potential.
2.	In metals, heat conduction is mainly due to free electrons.	In metals, electrical conduction is due to free electrons.
3.	The ability to conduct heat is measured by thermal conductivity.	The ability to conduct electricity is measured by electrical conductivity.

23. Explain why the specimen used to determine thermal conductivity of a bad conductor should have a larger area and smaller thickness?

For a bad conductor with a small thickness and large area of cross-section, the amount of heat conducted will be more.

24. What are the basic entities responsible for thermal conduction of a solid?

i. Area of cross-section (A).
ii. Time of flow (t)
iii. The temperature difference ($\theta_1 - \theta_2$)
iv. Thickness of the solid

25. Distinguish between conduction and convection?

Conduction:

It is the process in which the heat is transferred from hot end to cold end, without the actual movement of the particles.

Convection:

It is the process in which the heat is transmitted from hot end to cold end by the actual movement of the particles.

26. What is meant by thermal expansion in solid?

When a metal is heated, it will expand due to raise in temperature and when it is cooled it contracts However, an internal force will always act as to keep the metal to regain its original length/ position.

The expansion of a metal, when subjected to heat is called thermal expansion.

27. Define coefficient of thermal expansion?

The coefficient of thermal expansion can be defined as the ratio between the change in length to the original length per unit rise of temperature.

$\therefore$ the coefficient of thermal expansion, $\alpha = \frac{\Delta L}{L \Delta T}$

If $\Delta T = 1$, then $\alpha = \frac{\Delta L}{L}$

28. Define coefficient of volume expansion?

The coefficient of volume expansion (β) is defined as the ratio between the fractional change (ΔV) in volume to the original volume (V) per unit rise of temperature.

$$\therefore \beta = \frac{\Delta V}{V \Delta T}$$

If $\Delta T = 1$, $\beta = \frac{\Delta V}{V}$

29. What is meant by temperature gradient?

The rate of fall of temperature with respect to the distance is called as temperature gradient.

The negative sign indicates the fall of temperature with the increase in distance.

30. Define thermal diffusivity?

Thermal diffusivity is defined as the ratio of thermal conductivity to the thermal capacity per unit volume of the material**.**

Thermal diffusivity (h) = $\frac{\text{Thermal conductivity}}{\text{Thermal capacity}}$

31. What is the principle behind Forbe's method for determining the absolute conductivity of metals?

Under steady state conduction, the amount of heat conducted is equal to the heat radiated. Applying this conduction, the absolute thermal conductivity of metals can be calculated.

32. Why can't Lee's disc method be used for good conductors?

In Lee's disc method, the temperature difference between the upper disc and the lower disc will be used to calculate the thermal conductivity of the material.

This temperature difference will be very low for good conductors. Hence this method can't be used for good conductors.

33. What are the important properties of the thermal insulating materials?

i. The materials should be fire proof.
ii. It should hare volumetric specific heat.
iii. It should have low thermal conductivity.
iv. It should have a fibrous, granular and porous structure.

34. How will you classify thermal insulating materials?

a. Fibrous insulations (eg. Felt, wool, fur etc.)
b. Porous insulations (eg. Asbestos, aluminium foil, ebonite etc.)
c. Granular insulations (eg. Calcium silicate, sawdust & sand, etc.)

35. What is meant by Heat Exchanger? How the heat is measured using it?

A heat exchanger is a device that is used to transfer the heat between a solid and a liquid (or) between two (or) more liquid, without mixing and is used to reduce the heat produced by a device (or) machine.

Measurement:

In a heat exchanger, the driving temperature across the heat transfer surface varies with position. Therefore, the temperature difference is measured only in terms of log mean temperature difference (LMTD).

36. Mention the application of heat exchangers?

i. They are used in refrigerators.
ii. They are used in air conditioners.
iii. They are used in engines to cool the exhaust hot gases.
iv. Heat exchangers are found in radiator coils.
v. They are also used in sewage water treatment plants.

37. What do you understand by the term refrigerant? Give example?

Refrigerant is referred as the coolant. It is the liquid which absorbs the heat from the body and rejects the heat at high temperature.

Ex: liquid ammonia, chlorofluro carbon.

38. What is the principle used in domestic refrigerator?

It works on the principle of second law of thermodynamics. Ie. Heat can be made to flow from cold body to a hot body with the help of an external source.

39. Mention the application of a refrigerator?

i. It is used for preserving the food, fruits and drinks for a long duration.
ii. It is used to preserve flowers, medicines and medical drags.
iii. Refrigerator is used to manufacture ice in ice plants.
iv. It is used for producing frozen foods, ice creams, chemicals and other products.
v. In industries they are used for processing lubricants, rubber, steel etc.

40. Give the principle of solar water heater?

A solar water heater is based on the principle of converting solar energy into electrical energy and then into heat energy using solar cells.

41. Mention the application of solar power?

The solar energy can be utilized in two ways

i. Active systems
ii. Passive system

1) Active systems:

In the active systems the solar energy is directly utilized by trapping the heat from escaping through file plate collectors.

Ex: Green houses, File plate collector.

2) Passive systems:

In the passive systems, the solar is use to operate machineries such as fan, heater etc. Using photo- voltaic cells.

Ex: solar water heater, solar cookers, solar driers, furnaces etc.

42. Mention four factors to be considered for providing good thermal effect for buildings?

i. Thermal insulation.
ii. Thermal comfort.
iii. Thermal regulation.
iv. Thermal resistivity.

43. Is thermal insulation effective and beneficial? Justify your answer?

Yes, thermal insulation is effective and beneficial since it provides the following benefits.

- Reducing energy costs.
- Safety or personal working in hot appliances.
- Temperature control in processing equipment.
- Reduce noise pollution.

44. Write down the various properties of ideal refrigerants?

i. Low viscosity.
ii. Low freezing point.
iii. Low boiling point.
iv. Low heat capacity.

45. Why are the roof buildings painted white?

Black objects are good absorbers and radiators while white surfaces are poor absorbers and radiators. Therefore, houses are painted while to keep the building cool during summer.

46. A roof length 50 cm is heated at one end to 98°C, while the other end is kept at the room temperature. The area of cross- section of rod is 0.67 cm^2. The thermal conductivity of the rod is 81 w/ mk. Calculate the amount of heat conducted through the rod in 3(1/2) minutes.

Given data:

$k = 81\frac{w}{mk}$

$\theta_1 = 98℃$

$\theta_1 = 27℃$

$x = 50\ cm$

$A = 0.67\ cm^2 = 0.67 \times 10^{-4}\ m^2$

$t = 3\left(\frac{1}{2}\right)\ minutes = 210\ s$

θ =?

Formula:

$$Q = \frac{KA(\theta_1 - \theta_2)t}{x} \quad \text{Joule}$$

$$Q = \frac{81 \times 0.67 \times 10^{-4}(98-27)210}{50 \times 10^{-2}}$$

$$Q = 161.833 \quad \text{Joule}$$

47. A slab with area of $73 \times 10^{-4}\mathrm{m}^2$ through which 15J of heat is flowing through the both faces in 15 seconds and a temperature difference of 27 k is maintained. Calculate the thickness of the slab where its thermal conductivity is 0.1 w/ mk?

Given data:

$k = 0.1\frac{w}{mk}$

$\theta = 15\ \mathrm{J}$

$\theta_1 - \theta_2 = 27\ k$

$A = 73 \times 10^{-4}\ m^2$

$t = 15\ s$

x =?

Formula:

$$Q = \frac{KA(\theta_1 - \theta_2)t}{x}$$

$$\therefore \quad x = \frac{KA(\theta_1 - \theta_2)}{t}$$

$$x = \frac{0.1 \times 73 \times 10^{-4} \times 27 \times 15}{15}$$

$$x = 0.0197 \ \mathrm{m}$$