TNPSC CTSE - 2025

Diploma/ITI Level

WORK CALCULATION AND SCIENCE

Post code: 3631

Subject code: 540

Sparks Academy

Unit IV - Heat and Temperature

Heat

- Heat is a form of energy. Supplying heat to a body generally makes it hot, while removing heat makes it cold.
- Heat energy can be transformed into other forms of energy.
- It flows spontaneously from a hotter body to a cooler body.

Temperature

- Temperature is a measure of the average kinetic energy of the particles in a substance.
- It determines the direction of heat flow and is measured using scales such as Celsius (°C), Fahrenheit (°F), and Kelvin (K).
- Absolute zero (0 Kelvin) is the lowest possible temperature, where all molecular motion ceases

Unit IV - Heat and Temperature

Effects of Heat

- Change in Temperature: Heating or cooling leads to temperature changes.
- Change in Dimension: Expansion or contraction.
- Change in State: Solid to liquid, liquid to gas, etc.
- Change in Composition: Chemical transformations.
- Change in Physical and Mechanical Properties: Includes strength, malleability, etc.

Change in Electrical Conductivity: Conductivity increases or decreases based on material and temperature

Unit IV - Heat and Temperature

Difference Between Heat and Temperature

Heat	Temperature
Heat is a form of energy which causes hotness or coldness of a body	Temperature is the level of heat in a body
Heat is cause	Temperature is the effect
Heat is measured by a calorimeter	Temperature is measured by therometers, pyrometer, thermoelectric pyrometer radiation pyrometer thermocouples etc.
Its units are calorie B.T.U C.H.U etc	Its unit is degree
Heat gained or lost by a body depends on its mass, specific heat and raise or fall of temperature of the body.	Rise or fall of temperature of a body depends upon the quantity of heat gained or lost by it

Unit IV - Heat and Temperature

Boiling and Melting Points

- **Boiling point: Temperature at which a liquid changes to gas at atmospheric pressure.**
- **Melting point: Temperature at which a solid changes to a liquid.**

Material	Boiling Point (°C)	Melting Point (°C)
Iron	2862	1538
Aluminium	2519	660
Mercury	357	-39
Gold	2970	1064
Water	100	0

Measuring Instruments

1.Thermometer

Definition:

- A device used to measure temperature.

Types:

- Mercury-in-glass: Common for general use, precise and durable.
- Alcohol-based: Useful for low-temperature measurements.
- Digital: Modern, versatile, and easy to read.

Advantages of Mercury in Thermometers:

- Mercury does not wet the glass, ensuring consistent readings.
- Excellent conductor of heat, quickly attaining surrounding temperature.
- Uniform expansion makes readings accurate.
- Remains liquid over a wide temperature range but freezes at -39°C

Measuring Instruments

2.Pyrometer

Definition:

•An instrument for measuring high temperatures, typically in industrial applications.

Types:

•**Optical Pyrometer**: Measures the brightness of hot objects.

•**Radiation Pyrometer**: Measures heat radiation emitted by an object.

•**Thermoelectric Pyrometer**: Uses a thermocouple to measure temperature differences.

Applications:

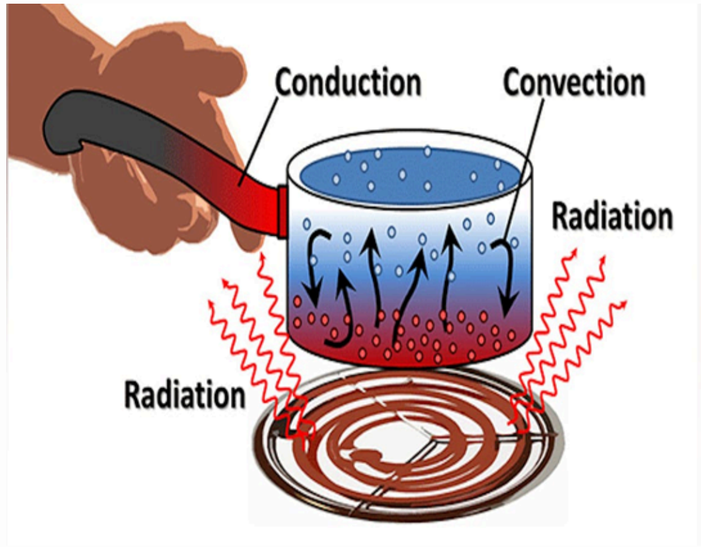
•Used in metal forging, ceramics, and other processes involving extremely high temperatures

Transmission of heat

Heat is a form of energy and is capable of doing work.

Heat flows from a hot body to a colder body or form a point of high temperature to a point of low temperature.

The greater is the temperature difference the more rapidly will be the heat flow.



Heat is transmitted in three ways

- By Conduction
- By Convection
- By Radiation

Transmission of heat

1.Conduction

Definition:

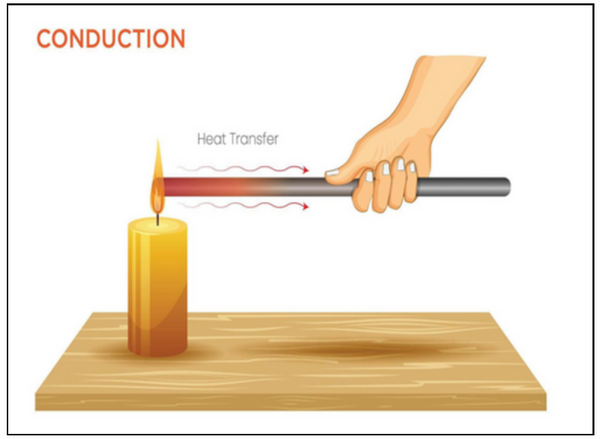
- The transfer of heat through direct contact in solids without actual movement of the material.

Mechanism:

- Heat flows from high-temperature regions to low-temperature regions within a material.
- This occurs due to the vibration of particles or free electron movement (in metals).

Examples:

- Heating one end of a metal rod, where heat travels to the other end.
- Good Conductors:
- Metals like copper, aluminum.
- Poor Conductors/Insulators:
- Materials like wood, rubber, and plastic.



Transmission of heat

2. Convection

Definition:

- Heat transfer by the actual movement of particles in fluids (liquids and gases).

Mechanism:

- Heated particles rise because they become less dense, while cooler, denser particles sink.
- This creates a circulation of heat within the fluid.

Examples:

- Boiling water where heated water rises and cooler water descends.
- Sea and land breezes.

Applications:

- Central heating systems and refrigerators.

Transmission of heat

3. Radiation

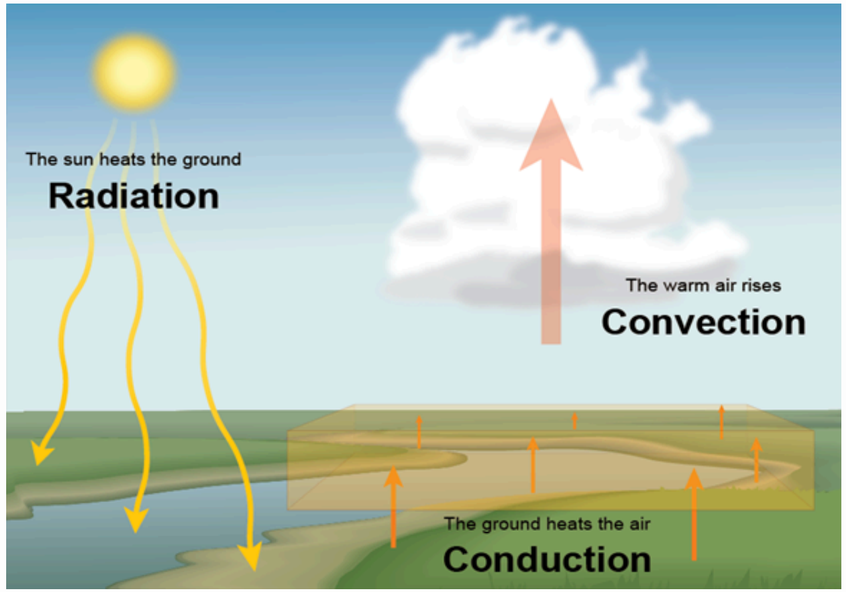
Definition

•Heat transfer through electromagnetic waves without needing a medium.

Mechanism:

•Objects emit and absorb infrared radiation based on their temperature.

•Does not require physical contact or a medium.



Examples:

•Sun’s heat reaching the Earth.

•Feeling warmth from a campfire.

Key Properties:

•Shiny and light-colored surfaces reflect radiation effectively.

•Dark and matte surfaces absorb radiation better.

1.Coefficient of Linear Expansion

The coefficient of linear expansion describes how much a material expands per unit length for a one-degree increase in temperature. It is critical in thermal design to account for the dimensional changes in materials when exposed to temperature variations.

Formula

•The linear expansion of a material can be expressed as:

$$\Delta L = \alpha L \Delta T$$

where,

ΔL :Change in length (m)

α : Coefficient of linear expansion (°C^(−1))

L : Original length (m)

ΔT: Temperature change (°C)

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Applications

- Design of Bridges and Railways: Expansion joints account for changes in length due to temperature.
- Thermometers: Utilize the expansion properties of materials.
- Pipelines: Expansion loops prevent buckling.

2.Heat Loss and Heat Gain

- The principle of heat loss and heat gain is governed by the law of conservation of energy:
- Energy cannot be created or destroyed, only transferred or transformed.
- This principle is critical in understanding heat exchange between systems, whether in insulation design, calorimetry, or thermal engineering.

Heat Transfer Equation

- The amount of heat exchanged (lost or gained) by a substance is given by:

$$Q = mc\Delta T$$

Where,

Q : Heat transferred (in joules or calories)

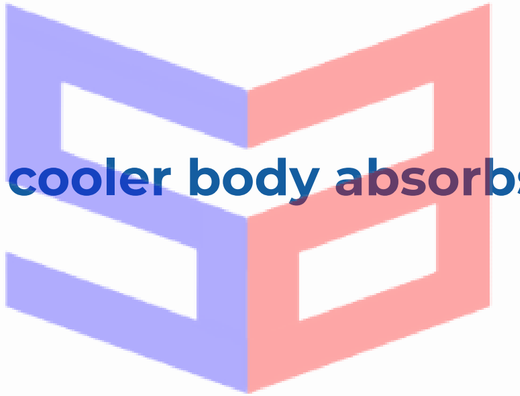
m: Mass of the substance (kg)

c: Specific heat capacity ($J/kg \cdot °C$)

ΔT : Temperature change (°C)

Applications

- Heat Loss: Occurs when a hotter body transfers energy to its surroundings or a cooler body.
- Heat Gain: Occurs when a cooler body absorbs energy from its surroundings or a hotter body.

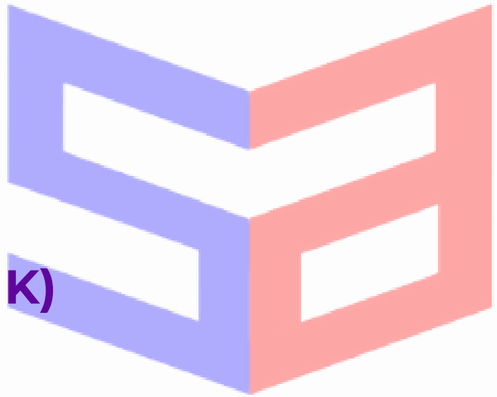


3.Thermal Conductivity (k)

Definition:

•The property of a material that quantifies the rate at which heat flows through it due to a temperature difference.

Formula: $Q = k A \Delta T / d$



Where,

•Q: Heat transfer rate (W or J/s)

•k: Thermal conductivity ($W/m \cdot K$)

•A: Cross-sectional area (m^2)

•ΔT: Temperature difference (K)

•d: Thickness of the material (m)

Good Conductors: Materials with high k, like metals (e.g., copper, aluminium).

Poor Conductors (Insulators): Materials with low k, like wood, rubber, and glass wool

4.Insulators

Definition:

- Materials that slow down or prevent the transfer of heat due to their low thermal conductivity.

Examples:

- Foam, fiberglass, cork, plastic.

Applications:

- Building insulation: Reducing heat loss in homes.
- Thermal clothing: Preventing heat loss in cold climates.
- Appliances: Maintaining temperature in refrigerators or ovens.

1.Concept of Pressure

Definition:

•Pressure is the force applied perpendicular to the surface of an object per unit area. It is a scalar quantity.

Formula:

•P=F/A

Where,

P: Pressure (N/m^2or Pascal, Pa)

F: Force (N)

A: Area (m^2)

2.Units of Pressure

Unit	Equivalent value	Common applications
Pascal (Pa)	1 N/m2	SI unit, general use.
Bar	1 bar=105 Pa	Meteorology, engineering.
Atmosphere (atm)	1 atm=101325 Pa	Atmospheric pressure reference.
Torr	1 Torr=1760 atm	Vacuum systems.
psi (pounds/in^2)	1 psi≈6894.76 Pa	Pressure in tires, hydraulic systems.

3.Types of Pressure

1.Atmospheric Pressure:

- The pressure exerted by the Earth's atmosphere at sea level.
- Standard value: 101325 Pa or 1 atm

2.Absolute Pressure:

- Total pressure measured from a perfect vacuum.
- Includes atmospheric pressure and any additional pressure.
- **Formula:**

$$P_{absolute} = P_{gauge} + P_{atmospheric}$$

3.Gauge Pressure:

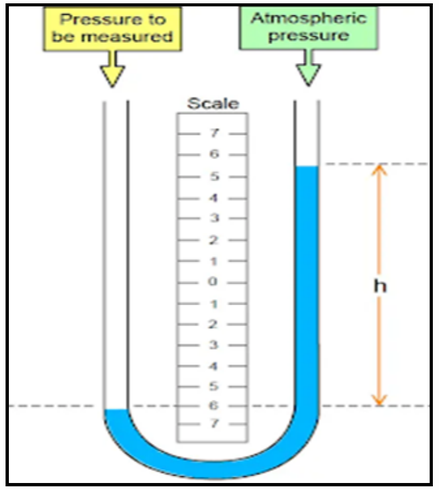
- Pressure relative to atmospheric pressure.
- Often measured with mechanical gauges.
- **Formula:**

$$P_{gauge} = P_{absolute} - P_{atmospheric}$$

4.Gauges Used to Measure Pressure

1.Manometer:

- Measures pressure using a column of liquid (e.g., mercury or water).
- Types: U-tube, inclined tube, differential manometers.



2.Bourdon Gauge:

- Common mechanical device to measure gauge pressure.
- Consists of a curved, flexible tube that straightens under pressure.

3.Barometer:

- Measures atmospheric pressure.
- Often uses mercury for high precision.

4.Digital Pressure Gauge:

- Provides electronic readings, often with high accuracy.
- Used in industrial and research applications.

Important MCQs

1. Heat is a form of which type of energy?

(வெப்பம் எந்த வகை ஆற்றலின் ஒரு வடிவம்?)

a) Kinetic Energy (தாக்கம் ஆற்றல்)

b) Potential Energy (இடத்துறை ஆற்றல்)

c) Thermal Energy (வெப்ப ஆற்றல்)

d) Electrical Energy (மின்சார ஆற்றல்)

Answer: c

Important MCQs

2. Which of the following is used to measure temperature?

(வெப்பநிலையை அளவிட பின்வருவனவற்றில் எது பயன்படுகிறது?)

a) Barometer (காற்றழுத்த அளவியல்)

b) Thermometer (வெப்பநிலை அளவியம்)

c) Pyrometer (பைரோமீட்டர்)

d) Manometer (மனோமீட்டர்)

Answer: b

Important MCQs

3. What is the SI unit of heat?

வெப்பத்தின் SI அலகு எது?

a) Joule / ஜூல்

b) Kelvin / கெல்வின்

c) Calorie / கலோரி

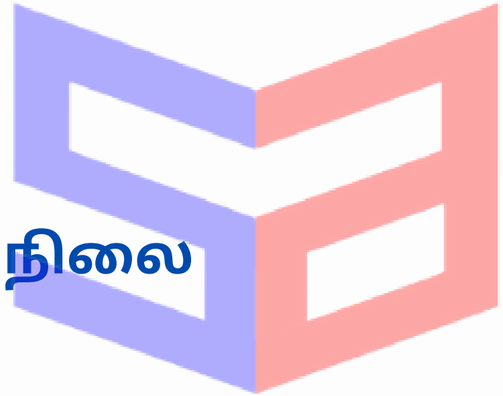
d) Celsius / செல்சியஸ்

Answer: a) Joule

Important MCQs

4.What is the average kinetic energy of particles in a substance called?

ஒரு பொருளின் மூலக்கூறுகளின் சராசரி இயக்க ஆற்றலுக்குப் பெயர்?



a) Heat / வெப்பம்

b) Temperature / வெப்பநிலை

c) Pressure / அழுத்தம்

d) Conductivity / நடத்துத்திறன்

Answer: b) Temperature

Important MCQs

5. The change in length per unit length per degree temperature change is known as:

ஒரு அளவளவில் ஒரு டிகிரி வெப்பநிலை மாற்றத்திற்கு ஏற்ப நடக்கும் நீள மாற்றம் எதைச் சொல்லுகிறது?

a) Thermal conductivity / வெப்ப நடத்துத்திறன்

b) Coefficient of linear expansion / நேரியல் விரிவடைப்பு கூட்டுத்தொகை

c) Specific heat / தனித்திறன் வெப்பம்

d) Latent heat / மறை வெப்பம்

Answer: b) Coefficient of linear expansion

Important MCQs

6.Which mode of heat transfer does not require a medium?

எந்த வெப்ப பரிமாற்ற முறைக்கு நடுநிலம் தேவைப்படாது?

a) Conduction / கடத்தல்

b) Convection / சார்ந்தல்

c) Radiation / கதிர்வீச்சு

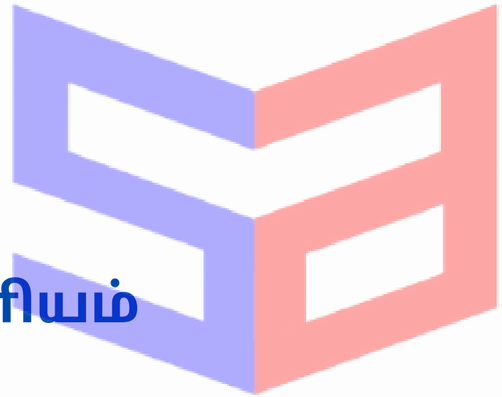
d) Diffusion / பரவல்

Answer: c) Radiation

Important MCQs

7. Which of the following materials is a good insulator?

கீழ்க்கண்ட எந்த பொருள் நல்ல உலோகரமல்லாத திரவியமாகும்?



a) Copper / செம்பு

b) Wood / மரம்

c) Aluminum / அலுமினியம்

d) Steel / எஃகு

Answer: b) Wood

Important MCQs

8. What is the standard atmospheric pressure at sea level?

கடற்கரையில் நிலையான வளிமண்டல அழுத்தம் எது?

a) 1 Pa

b) 101.3 kPa

c) 1 psi

d) 760 mmHg

Answer: b) 101.3 kPa

Important MCQs

9. A pyrometer is used to measure:

பைரோமீட்டர் எதனை அளக்க பயன்படுத்தப்படுகிறது?

a) Low temperatures / குறைந்த வெப்பநிலை

b) High temperatures / அதிக வெப்பநிலை

c) Atmospheric pressure / வளிமண்டல அழுத்தம்

d) Fluid velocity / திரவ வேகம்

Answer: b) High temperature

Important MCQs

10.The coefficient of linear expansion is expressed in:

நேரியல் விரிவு மாறிலி எந்த அலகில் வெளிப்படுத்தப்படுகிறது?

a) m

b) m/°C

c) °C^(−1)

d) J/°C

Answer: c) °C^(−1)

Important MCQs

11.Gauge pressure is the difference between:

அளவீட்டு அழுத்தம் எந்த இரண்டிற்கும் இடையிலான வேறுபாடாகும்?

a) Absolute and atmospheric pressure / முழு மற்றும் வளிமண்டல அழுத்தம்

b) Atmospheric and vacuum pressure / வளிமண்டல மற்றும் வெற்றுக்கடன் அழுத்தம்

c) Static and dynamic pressure / (நிலத்தடி மற்றும் இயக்க அழுத்தம்)

d) None of the above / (மேலே குறிப்பிடப்பட்ட எதுவும் இல்லை)

Answer: a) Absolute and atmospheric pressure

Important MCQs

12.Heat transfer in liquids occurs through:

தரவுகளில் வெப்ப பரிமாற்றம் எப்படிச் செய்யப்படுகிறது?

a) Conduction (கடத்தல்)

b) Convection (ஓழுகல்)

c) Radiation (கதிர்வீச்சு)

d) None of the above (மேலே குறிப்பிடப்பட்ட எதுவும் இல்லை)

Answer: b) Convection

Important MCQs

13. A 3 kg substance is heated, raising its temperature by 30°C. The specific heat capacity is 500J/kg°C. How much heat energy is supplied?

ஒரு 3 கிலோ பொருளின் வெப்பநிலை 30°C-ஆக உயர்த்தப்படுவதற்கான வெப்ப ஆற்றல் என்ன? சிறப்பு வெப்பத்திறன் 500J/kg°C ஆக இருக்கிறது.

a) 15,000 J

b) 45,000 J

c) 60,000 J

d) 30,000 J

Answer: b) 45,000 J

Important MCQs

14. A steel rod 3m long expands by 0.0021m when heated from 20°C to 120°C. What is the coefficient of linear expansion (α\alphaα)?

ஒரு 3 மீ நீளமுள்ள எஃகு கம்பி 20°C-இல் இருந்து 120°C-க்கு சூடுபடுத்தும்போது 0.0021m நீளமாகிறது. α\alphaα என்ன?

a)7×10−6°C^−1

b)3.5×10−5°C^−1

c)2.1×10−5°C^−1

d)1.2×10−5°C^−1

Answer: a) 7×10−6°C^−1

Important MCQs

15. A wall with an area of 8 m^2 and thickness 0.1 m has a thermal conductivity of 0.6 W/mK. If the temperature difference across the wall is 25°C, what is the heat transfer rate?

ஒரு சுவர் 8 m^2 பரப்பளவுடன் 0.1 mதடிமனாக உள்ளது மற்றும் வெப்ப இயக்கி 0.6 W/mK. வெப்பநிலை வேறுபாடு 25°C எனில், வெப்ப பரிமாற்றத்தின் அளவு என்ன?

a) 120 W

b) 1,200 W

c) 1,800 W

d) 2,000 W

Answer: b) 1,200 W

Important MCQs

16. A tank has a gauge pressure of 150 kPa, and atmospheric pressure is 101.3 kPa. What is the absolute pressure in the tank?

ஒரு தொட்டியின் அளவீட்டு அழுத்தம் 150 kPa, வளிமண்டல அழுத்தம் 101.3 kPa. தொட்டியின் முழு அழுத்தம் என்ன?

a) 51.3 kPa

b) 150 kPa

c) 251.3 kPa

d) 101.3 kPa

Answer: c) 251.3 kPa

Important MCQs

17. A rod with a cross-sectional area of 0.03 m^2, length 1.5 m, and thermal conductivity 150 W/mK has a temperature difference of 80°C between its ends. Calculate the heat transfer rate.

ஒரு கம்பி 0.03 m^2 பரப்பளவுடன் 1.5 m நீளமும் 150 W/mKவெப்ப இயக்கியும் கொண்டுள்ளது. வெப்பநிலை வேறுபாடு 80°C எனில் வெப்ப பரிமாற்றத்தின் அளவு என்ன?

a) 2,400 W

b) 3,600 W

c) 4,800 W

d) 5,000 W

Answer: b) 3,600 W

Important MCQs

18. A sealed tank contains gas at a pressure of 300 kPa. If the atmospheric pressure is 101.3 kPa, what is the gauge pressure?

ஒரு தொட்டியில் 300 kPa அழுத்தத்தில் வாயு உள்ளது. வளிமண்டல அழுத்தம் 101.3 kPa எனில், அளவீட்டு அழுத்தம் என்ன?

a) 198.7 kPa

b) 300 kPa

c) 401.3 kPa

d) 101.3 kPa

Answer: a) 198.7 kPa

Important MCQs

19. A steel plate of thickness 0.05 m, thermal conductivity 50 W/mk and area 2 m^2, has a temperature difference of 100°C. Calculate the heat transfer rate.

ஒரு 2 m^2 பரப்பளவுள்ள மற்றும் 0.05 m தடிமனுடைய எஃகு தகடு, 50 W/mK வெப்ப இயக்கியுடன் 100°C வெப்பநிலை வேறுபாட்டை வைத்துள்ளது. வெப்ப பரிமாற்றத்தின் அளவு என்ன?

a) 2,000 W

b) 20,000 W

c) 200,000 W

d) 10,000 W

Answer: b) 20,000 W

Important MCQs

20. A brass rod has a length of 5m at 25°C. When heated to 125°C, its length becomes 5.005m. Find the coefficient of linear expansion (α\alphaα).

ஒரு 5 மீ நீளமுள்ள தாமிர கம்பி 25°C-இல் இருந்து 125°C-க்கு சூடுபடுத்தப்படுகிறது. அதன் நீளம் 5.005 m-ஆக மாறுகிறது. α\alphaα-வை கணக்கிடுங்கள்.

a)1×10−5°C−1

b)2×10−6°C−1

c)2×10−5°C−1

d)1×10−6°C−1

Answer: c) 2×10−5°C−1

THANK YOU!