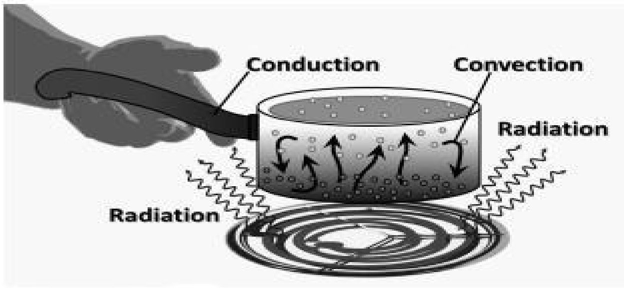
Unit-6:Heat and Thermometry	Taxonomic Level	Mark
Q.1- Explain the difference between heat and temperature. Heat is a form of energy which measures the overall kinetic energy of the molecules of a substance. Heat is measured in joule or calorie. Temperature is the measure of average kinetic energy of the molecules of a substance. It is the degree of hotness or coldness of an object. Temperature is measured in Kelvin (SI), Celsius, and Fahrenheit.	Level – 2 Understand	02
Q.2- Name the general mode of heat transfer in Solids, Liquids and gases. (a) The general mode of heat transfer in solids is conduction. (b) The general mode of heat transfer in liquids and gases is convection.	Level – 1 Remember	02
Q.3- Define Radiation. Give an example. Radiation is the method of transferring heat from one body to another without heating up the medium in between these two bodies. For example: In a microwave, the substances are heated directly without any heating medium.	Level – 1 Remember	02
Q.4- Define Coefficient of thermal conductivity and write its dimensional formula. Coefficient of thermal conductivity (K) of a substance is defined as the heat energy is flowing through the substance per unit area per unit time per its unit temperature gradient. Dimensional formula of coefficient of thermal conductivity is $[K]= [M^1 L^1 T^{-3} K^{-1}]$	Level – 1 & 2 Remember & Understand	02
Q.5- What is Coefficient of superficial expansion of a solid? The Coefficient of Superficial Expansion (β) of a solid is defined as the increase area per unit area at 0˚C, per unit rise in temperature. $\beta = \frac{A_t - A_0}{A_0 t}$ Where, A_t =Area of the solid at t˚C and A_0=Area of the solid at 0˚C	Level – 1 Remember	02
Q.6-Define Coefficient of linear expansion of a solid. The coefficient of linear expansion of a material is defined as the increase in length per unit length at 0˚C, per unit rise in temperature. $\alpha = \frac{l_t - l_0}{l_0 t}$ Where, l_0 = length of the solid at 0˚C and l_t=length of the solid at t˚C	Level – 1 Remember	02
Q7- Define coefficient of cubical expansion of a solid. The coefficient of cubical expansion of a solid is defined as the increase in volume per unit volume at 0˚C, per unit rise in temperature. $\gamma = \frac{V_t - V_0}{V_0 t}$ Where, V_o = Volume of the solid at 0˚C and V_t = Volume of the solid at t˚C	Level – 1 Remember	02

Q8- Define Mercury Thermometer and write its two uses. A mercury thermometer is a temperature measuring device that uses mercury, a liquid metal, contained in a glass tube. As the temperature rises, the mercury expands and rises in the tube, providing a visual indication of temperature on a calibrated scale. **Applications:** 1. Medical uses: Body Temperature Measurement 2. Laboratory uses: Commonly used in labs to measure temperatures during chemical reactions and experiments	Level – 1 Remember	02
Q9- Define Bimetallic Thermometer and write its two applications. A bimetallic thermometer is a temperature measuring device that consists of two different metals bonded together in a strip or coil. When the temperature changes, the differing rates of expansion of the two metals cause the strip or coil to bend. This movement is then translated into a temperature reading on a calibrated scale. **Applications:** 1. Industrial Applications: Commonly used in industrial settings to measure the temperature of gases, liquids, and solids. 2. Home Appliances: have been used in cooking appliances to measure temperatures accurately	Level – 1 & 2 Remember & Understand	02
Q10- Define Platinum Thermometer and write its two uses. A platinum thermometer is a highly precise temperature measuring device that utilizes the resistance of platinum wire to determine temperature. As the temperature changes, the electrical resistance of the platinum wire changes in a predictable manner, allowing for accurate temperature readings. **Uses:** 1. Research and Development: Have been used in various scientific research applications where precise temperature control is needed. 2. Low-Temperature Measurements: Effective for measuring extremely low temperatures in cryogenic applications	Level – 1 & 2 Remember & Understand	02
Q11-Define specific heat capacity and mention its SI unit. Specific heat capacity is the amount of heat required to raise the temperature of 1 kilogram of a substance by 1 Kelvin. Its SI unit is $Jkg^{-1}\ K^{-1}$.	Level – 1 Remember	02
Q12-Explain the difference between specific heat at constant pressure (C_p) and specific heat at **constant volume (C_v)** C_p: Specific heat at constant pressure is the amount of heat required to raise the temperature of a unit mass by a unit degree at constant pressure. C_v: Specific heat at constant volume is the amount of heat required to raise the temperature of a unit mass by a unit degree at constant volume.	Level – 1 & 2 Remember & Understand	02
Q13-Write the relations between specific heats C_p and C_v 1. $C_p/C_v=\gamma$, where γ is known as isentropic expansion factor or adiabatic index. 2. $C_p - C_v = R$, where R =universal gas constant.	Level – 1 Remember	02
Q14-Convet 77F to Celsius.	Level – 1 & 2 Remember &	02

$77F = \frac{5}{9} \times (77-32) = 25°C$	Understand	
Q15-Convet 25˚C to Fahrenheit. $25°C = (\frac{9}{5} \times 25) + 32 = 77F$	Level – 1 & 2 Remember & Understand	02
Q16-Convet 25°C to Kelvin. 25˚C= 25+273.15 = 298.15K	Level – 1 & 2 Remember & Understand	02
Unit-6:Heat and Thermometry	**Taxonomic Level**	**Mark**
Q1-Derive the relation between coefficient of linear expansion and coefficient of Superficial expansion. Consider a thin square metal plate Let l_o= length of the side of the square and A_0= Area of the square at temperature 0˚C. Upon heating the square expands and let l_t = lenght of the side of the square and A_t=area of the square at t˚C. Here, $A_0 = l_0^2$ ---------------(1) $A_t = l_t^2$ ------------------(2) We have, $\alpha = \frac{l_t - l_0}{l_0 t}$ or, $l_t - l_0 = \alpha l_0 t$ or, $l_t = \alpha l_0 t + l_0$ or, $l_t = l_0(\alpha t + 1)$----------(3) Again, we have $\beta = \frac{A_t - A_0}{A_0 t}$ or, $\beta = \frac{l_t^2 - l_0^2}{l_0^2 t}$ or, $\beta = \frac{[l_0(\alpha t+1)]^2 - l_0^2}{l_0^2 t}$ or, $\beta = \frac{l_0^2(\alpha t+1)^2 - l_0^2}{l_0^2 t}$ or, $\beta = \frac{l_0^2[(\alpha t+1)^2 - 1]}{l_0^2 t}$ or, $\beta = \frac{[(\alpha t+1)^2 - 1]}{t}$ or, $\beta = \frac{[\alpha^2 t^2 + 2\alpha t + 1 - 1]}{t}$ or, $\beta = \frac{[\alpha^2 t^2 + 2\alpha t]}{t}$ or, $\beta = \frac{t[\alpha^2 t + 2\alpha]}{t}$ or, , $\beta = \alpha^2 t + 2\alpha$ Since α is very small for Solids, hence $\alpha^2 t$ can be neglected Thus, $\boldsymbol{\beta = 2\alpha}$---------------------------------(4) **Q2-Derive the relation between Coefficient of linear expansion and cubical expansion.** Consider a metallic cube Let l_o= length of the side of the cube and V_0= Volume of the square at temperature 0˚C.	Level -2 & 3 Understand & Apply	**05**

Upon heating the cube expands and let l_t = length of the side of the cube and V_0=Volume of the cube at t°C. Here, $V_0 = l_0^3$ ---------------(1) $V_t = l_t^3$ -----------------(2) We have, $\alpha = \frac{l_t - l_0}{l_0 t}$ or, $l_t - l_0 = \alpha l_0 t$ or, $l_t = \alpha l_0 t + l_0$ or, $l_t = l_0(\alpha t + 1)$----------(3) Again, we have $\gamma = \frac{V_t - V_0}{V_0 t}$ or, $\gamma = \frac{l_t^3 - l_0^3}{l_0^3 t}$ or, $\gamma = \frac{[l_0(\alpha t+1)]^3 - l_0^3}{l_0^3 t}$ or, $\gamma = \frac{l_0^3(\alpha t+1)^3 - l_0^3}{l_0^3 t}$ or, $\gamma = \frac{l_0^3[(\alpha t+1)^3 - 1]}{l_0^3 t}$ or, $\gamma = \frac{[(\alpha t+1)^3 - 1]}{t}$ or, $\gamma = \frac{[\alpha^3 t^3 + 3\alpha^2 t^2 + 3\alpha t + 1 - 1]}{t}$ or, $\gamma = \frac{[\alpha^3 t^3 + 3\alpha^2 t^2 + 3\alpha t]}{t}$ or, $\gamma = \frac{t[\alpha^3 t^2 + 3\alpha^2 t + 3\alpha]}{t}$ or, , $\gamma = \alpha^3 t^2 + 3\alpha^2 t + 3\alpha$ Since α is very small for Solids, hence $\alpha^3 t^2$ and $3\alpha^2 t$ can be neglected Thus, $\gamma = \mathbf{3\alpha}$---------------------------------(4)	Level -2 & 3 Understand & Apply	**05**
Q3- Explain various modes of heat transfer with examples. A- There are three types of Modes of Heat Transfer such as Conduction, Convection and Radiation **Conduction:** In solids like metals, heat transfers via molecular vibrations of the molecules which are in direct contact with each other. In this case, heat is transferred without the actual movement of particles. This method of heat transfer is known as conduction. The medium is required for heat transfer in case of conduction in solids. Substances that conduct heat are known as thermal conductors. **Convection:** In fluids like water or air, the transfer of heat takes place due to the actual movement of particles from one place to another is convection. This is known as convection. The heat transfers though convection can occur in a vacuum. In both conduction and convection, heat spreads across all parts of the medium while trying to reach an equilibrium state. **Radiation:** Radiation can occur in a medium or vacuum. When heat transfers through radiation, the space in between is not heated up. This means that the spreading of heat via radiation in the form of electromagnetic waves is targeted and localized.	Level -1 & 2 Remember & Understand	**05**



: Modes of heat transfer: (a) conduction (b) convection (c) radiation

Examples: In the above figure, the transfer of heat from gas stove to bottom of the pan is an **example of radiation**. Eventual spread of heat to the middle, top and handle of the pan is an **example of conduction**. Transfer of heat from water at bottom of the pan to the water at top of the pan through movement of water molecules which carry heat from bottom to top is an **example of convection.**

Q 4. A scientist measures the temperature of a gas as 315 K. Using this information

(i) Convert the temperature to Celsius and Fahrenheit

(ii) If the gas is cooled down to 77°F, what will be its temperature in Kelvin and Celsius?

Level -1 & 2 Remember & Understand | 05

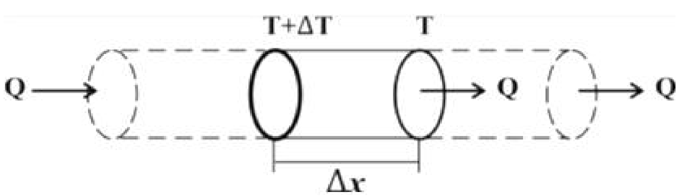
i) $\mathbf{315K} = 315 - 273.15 = \mathbf{41.85^{\circ}C}$

$\mathbf{41.85}^{\circ}\mathrm{C} = (\frac{9}{5} \times 41.85) + 32 = \mathbf{107.33F}$

ii) $\mathbf{77F} = \frac{5}{9} \times (77 - 32) = \mathbf{25^{\circ}C}$

$\mathbf{25^{\circ}C} = 25 + 273.15 = \mathbf{298.15K}$

Q5.Derive the expression for Co-efficient of Thermal Conductivity (K). Write its SI Unit & dimensional formula.



Let us consider a piece of material in the form of a bar and A is the area of cross-section of the bar and Δx is the perpendicular distance between two isothermal plane surfaces.

These two isothermal surfaces are at temperatures (T+ΔT) and T, where (T+ΔT)>T and heat flows from surface at temperature T+ΔT to the surface at temperature T.

The quantity of heat conducted between two surfaces is directly proportional to

i) the area of each surface i.e., $Q \propto A$-----------(1)

Level -1 & 2 Remember & Understand | 05

ii) the temperature gradient in direction of heat flow i.e. $Q \propto -\Delta T/\Delta x$------------(2) iii) to the time i.e. $Q \propto t$----------------(3) Combining above equations, we get **$Q = -KA\,(\Delta T/\Delta x)\cdot t$**----------------(4) This relation is mathematical expression for the basic low of heat conduction and is known as Fourier's law of heat conduction. It is also known as thermal conduction equation. Here, K is the proportionality constant and is known coefficient thermal conductivity of the material. Its value depends on the nature of material used. Thermal conductivity is the property of the material and it is the ability of the substance to transfer heat. If in equation (4), we put $A=1m^2$, $\Delta x=1m$, $\Delta T=-1K$ and $t=1sec$ then, **$Q=K$---------------------(5)** **Therefore, coefficient of thermal conductivity defined as the quantity of heat passing per unit area at a temperature drop of 1k per unit length in unit time.** ➢ SI unit of K is **J/mKs or Watt/mK** ➢ Dimensional formula of K is **$[M^1L^1T^{-3}K^{-1}]$**		