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Subject: Thermal Physics

2 Marks

THERMAL PHYSICS AND STATISTICAL MECHANICS

UNIT-I

1. **State zeroth law of thermodynamics.**

The zeroth law of thermodynamics states that if two bodies A and B are each separately in thermal equilibrium with a third body C, then A and B are also in thermal equilibrium with each other.

2. **State first law of thermodynamics.**

When a certain amount of heat Q is supplied to a system which does external work W in passing from state 1 to state 2, the amount of heat is equal to sum of the increase in the internal energy of the system and the external workdown by the system.

$$\delta U = dU + \delta W$$

Where,

δU, δW=not a perfect differentials

Du=perfect differentials.

3. **What is meant by reversible process?**

A reversible process is one which can be retraced in opposite direction by changing the external condition infinitesimally. All isothermal and adiabatic operations are reversible when carried out very slowly.

4. **What is meant by irreversible process?**

A process is said to be irreversible if it cannot be retraced back exactly in the opposite direction. During an irreversible process, heat energy is always used overcome friction. All nature process is irreversible.

5. **Define Heat engine.**

Any practical machine which converts heat in to mechanical work is called a heat engine. In their operation they absorbs heat at a higher temperature , converts part of it in to mechanic work , and reject the remaining heat at a low temperature.

6. **Define Efficiency.**

The efficiency of a heat engine is defined as the ratio of the mechanical workdown by the engine in one cycle to the heat absorbs from the high temperature source. It is denoted by η. Thus,

$$H=Q_1-Q_2/Q_1$$

Where,

Q_1 –heat absorbed from source.

Q_2-heat rejected to a sink.

7. **Write clausius clapeyron's equation?**

It is the first latent heat equation. The equation was first derived by clapeyron using Carnot's reversible cycle.

$$dP/\,dT=L/T\,(V_2-V_1)$$

Where,

L- Latent heat.

8. **Define entropy and units.**

Entropy is the quantitative measure of disorder of a system. The concept comes out of thermodynamics which deals with the transfer of heat energy with in a system.

Instead of taking about some q absolute entropy physicists generally talk about the change in entropy that takes place in a specific thermodynamics process.

$$dS=\delta Q/T$$

Units: Joule/ Kelvin

9. **State second law of thermodynamics.**

The second law of thermodynamics which clearly indicates the conditions under which heat can be converted in to work.

To making a heat flow from lower temperature body to a higher temperature body is impossible without getting an external work on the working substance.

SOURCE: At a fixed high temperature and infinity thermal capacity.

SINK: Fixed lower temperature and infinity thermal capacity.

WORKING SUBSTANCE: The perfect gas.

$$U=\sum n_i E_i=\text{Constant}$$

UNIT-2

1.Write the application of low temperature?

At a low temperature the electrical resistance of certain metals and alloys suddenly drop to zero meaning that a lot of power saving.

The electromagnetic materials made up of super conducting materials yield a better results and can work efficiently for prolonged years.

With the help of this low temperature, the refrigeration is possible without using a compressor pump.

2. Write the principle of Air conditioner.

In air conditioning the desired temperature is maintained within an enclosed space by sucking the air and made to mix with the recirculated air. When the air is 21° C with 56% relative humidity. Resulting eduidistribution of air. This is the principle behind the air conditioning.

3. Write the principle of liquefaction of gases.

When a gas is allowed from the region of constant high pressure to the region at constant low pressure adiabatically, through a porous plug, undergoing a change of temperature. This phenomenon is known as joule Thomson effect and the process is called adiabatic throttling.

The nature of gas and initial temperature determined the positive or negative the temperature change.

4. Define curies law.

The intensity of magnetic station is directly proportional to the magnetic field H and inversely proportional to temperature T of the paramagnetic substance.

$$I \propto H / T$$

$$I = C\,(H / T)$$

Where, C is a constant known as curie constant.

5. Define temperature of inversion.

The fall in temperature for a given difference of pressure decreases with the rise in initial temperature of the gas. It was found that cooling effect is decreased with the increase of initial temperature and becomes zero at a certain temperature and a temperature higher than this temperature, instead of cooling, heating was observed. This particular temperature at which the joule – Thomson effect changes sign is called the temperature of inversion Exhibits

UNIT-3

1. Define Black body.

A perfectly black body absorbs all the radiation irradiating on it irrespective of any wavelength. The nature of such a body is to emit all the radiation when heated to optimum temperature.

2. Define Stefan-Boltzmann law.

It states that the rate of emission of radiant energy by unit area of a perfectly black body is directly proportional to the fourth power of its absolute temperature.

$$R \propto T^4$$

$$R = \sigma T^4$$

$$\sigma - Stefan's constant\ ,\ \sigma = 5.67 \times 10^{-8}\ Wm^{-2}k^{-4}$$

3. Define Wien's displacement law.

From thermo dynamical considerations, when has shown that the product of the wavelength corresponding to the maximum energy and absolute temperature is constant.

$$\lambda_m \times T = constant = 0.2892 Cm.K$$

This is called Wien's displacement law.

4. Define Rayleigh-jeans law.

The energy distribution in the thermal spectrum, According to Rayleigh is give by the formula,

$$E_\lambda = 8\pi T/\lambda^4$$

Where, k-Boltzmann's constant.

5. Define Planck's law.

In 1901, Planck was able to drive a theoretical expression for the energy distribution on the basis of quantum theory of heat radiations.

$$E_\lambda = 8\pi\, hc/\lambda^5\left[e^{hY/kT} - 1\right]$$

This is known as Planck's radiation formula.

6. Define solar constant.

It is the amount of heat energy absorbed per minute by one sq.cm of a perfectly black body surface placed at a mean distance of the earth from the sun, in the absence of the atmosphere, the surface being held perpendicular to the sun 's rays. It is denoted by S.

$$S = S_0\, a^{sec\, Z}$$

Where,

S - Observed solar constant.

S_0 – True solar constant.

A - constant.

Z - Altitude of the sun

S- 1400 J$s^{-1}m^{-2}$

7. Define Pyrheliometer.

The instruments that used to measure solar constant and to find the amount of incident heat radiations.

These instruments are called as pyrheliometer.

8. Write the types of black body?

Ferry's black body.

Wien's black body.

9. Write the application of the heat radiation?

1. White clothes are preferred in summer and dark coloured clothes in winter.

When heat radiations fall on white clothes, they are reflected back. No heat is absorbed by the clothes and a person does not get heat from outside in summer. Dark clothes in winter will absorb the heat radiations falling on them and keep the body warm.

2. Hot water pipes and radiators used in rooms are painted black so that they can radiate maximum amount of heat to the room. The same pipes outside the rooms are painted white so that they do not lose to the surroundings.

3. The thermocouple junction exposed to heat is blackened to absorb maximum quantity of heat.

4. Polished reflectors are used in electric heaters to reflect maximum heat in the room.

10. Define Absorpitivity or absorptive power.

The absorptive power of a body at particular temperature and for a particular wavelength is defined as the ratio of the radiant energy absorbed per unit surface area per unit time to the total energy incident on the same area of the body in unit time wavelength range.

11. Write the properties of thermal radiation.

I. **The thermal radiation has electromagnetic wave nature and hence travels through empty space with the velocity of light.**
II. **Like light, thermal radiation travels in straight line.**
III. **Thermal radiation obeys the law of inverse square.**
IV. **It exhibits reflection refraction, interference, diffraction and polarization phenomena.**

UNIT-4

1. Define specific heat.

The specific heat of a material is defined as the quantity of required to raise the temperature of unit mass of the material through 1 degree.

Specific heat = heat capacity / mass

$$C = Q/m.\Delta T$$

2. Define constant pressure(C_p)

It is defined as the amount of heat required to raise the temperature of unit mass of a gas through 1°C, when its pressure is kept constant. It is represented by C_p and is given by

$$C_p = (\Delta Q/\Delta T)_p$$

3. Define constant volume (C_v).

It is defined as the amount of heat required to raise the temperature of unit mass of a gas through 1°C, when its volume is kept constant. It is represented by C_v and is given by

$$C_v = (\Delta Q/\Delta T)_V$$

4. Define Dulong and Petit's law.

Dulong and petit, in 1819 studied the specific heat of various elements in a solids state and enunciated a law, called Dulong and petit law. According to this law, *the product of the specific heat and the atomic weight,* i.e. atomic heat of all the elements in the solid state is a constant.

The value of this constant was fixed as 6.4 but it is taken as 6 present. The exact value is 5.96 which also agree the value derived below from the kinetic theory of matter.

5. Define heat capacity.

Different materials have different capacity to absorb heat to produce a given mass. If a material of mass m absorbs heat Q, so that its temperature rises through ΔT, *then*

$$\text{Heat capacity} = Q / \Delta T$$

6. Define Einstein's temperature.

The value v of giving good fit for a particular solid is represented by V_E is represented by V_E and is called the Einstein's frequency for that solid. Similarly θ corresponding to θ_E and is called Einstein's temperature.

$$\theta = hv/k$$

7. Define Debye's T^3 law.

At low temperature the atomic heat of solid is directly proportional to the cube of absolute temperature. This is called Debye's T^3 law.

$$C_v \ \alpha \ T^3$$

UNIT-5

1. Define macrostate.

When any particle thrown into the box, it must fall into one of the two compartments. The particles have the priori probability of going into either of them and will be ½. The possible ways in which 4 particles can be distributed in two compartments. Thus there are 5 different distributions. Each compartment rise the distribution of system of particles is known as macrostate.

2. Define microstate.

In microstate, the particles are distinguishable, the number of different possible arrangements in each compartment. Each distinct arrangement is known as the microstate of the system.

3. Define phase space.

A combination of position space and momentum space is known as phase space. The phase space has 6 dimension i.e. three position coordinates and three momentum coordinates