CHAPTER 12

Thermodynamics

TRY YOURSELF ANSWERS

1. A thermodynamic process in which the system returns to its initial state after undergoing a series of changes, is called a cyclic process.

2. Zeroth law of thermodynamics gives the definition of temperature.

3. The quantities like pressure (P), volume (V) and temperature (T) which describe the behaviour of a thermodynamic system are called thermodynamic variables.

4. In chemical equilibrium, there is a uniform chemical composition throughout the system and surrounding. The system does not undergo any spontaneous change in its internal structure due to chemical reaction, diffusion etc.

5. Internal energy of a system is defined as the energy possessed by the system due to molecular motion and molecular configuration. The energy due to molecular motion is called internal kinetic energy and that due to molecular configuration is called internal potential energy.

6. First law of thermodynamics defines internal energy.

7. (i) First law does not indicate the direction of heat transfer.

(ii) It does not indicate as to why the whole of heat energy cannot be converted into work continuously.

8. Using first law of thermodynamics, we can calculate increase in internal energy of a liquid in the process of boiling. In boiling, a liquid changes into vapour at constant temperature and pressure. Work done in expansion, $\Delta W = P\Delta V = P(V_g - V_\ell)$

Heat absorbed by the liquid in boiling process, $\Delta Q = mL$

According to first law of thermodynamics, $\Delta Q = \Delta U + \Delta W$

or $\Delta U = \Delta Q - \Delta W$ or $\Delta U = mL - P(V_g - V_\ell)$

where m is the mass of liquid at its boiling point and L is the latent heat of vapourisation of the liquid.

9. The two principal specific heats of a gas

(i) Specific heat at constant volume (C_V)

(ii) Specific heat at constant pressure (C_P)

10. The difference between the two principal specific heats is equal to the amount of heat equivalent to the work performed by the gas during expansion at constant pressure.

11. Given that, $C_P - C_V = 4000$ J Kg^{-1} °C^{-1}

and $\dfrac{C_P}{C_V} = 1.6$ or $C_P = 1.6\,C_V$

$\therefore$ $1.6\,C_V - C_V = 4000$ or $0.6\,C_V = 4000$

or $C_V = \dfrac{4000}{0.6} = 6666.67$ J Kg^{-1} °C^{-1}

$C_P = C_V + 4000$ J Kg^{-1} °C^{-1}

$\therefore$ $C_P = 10666.66$ J Kg^{-1} °C^{-1}

12. In isothermal prcoess, T = constant or $\Delta T = 0$

Specific heat, $s = \dfrac{\Delta Q}{m\Delta T} = \infty$

Therefore, specific heat of a gas during isothermal process is infinite.

13. The adiabatic relation between pressure P and Temperature T of an ideal gas is

$P^{1-\gamma}T^{\gamma} = K$ = constant

where γ is the ratio of specific heats at constant pressure and at constant volume.

14. Work done in an isothermal process

$$W = nRT\ln\left(\frac{V_2}{V_1}\right)$$

Here, $n = 1$, $T = 600$ K, $V_1 = V$ and $V_2 = 3V$

$$\therefore \quad W = 1\times R\times 500\ln\left(\frac{3V}{V}\right) = 600R\ln 3$$

15. (i) Reversible process : Slow compression and expansion of a spring without setting up oscillations.

(ii) Irreversible process : Sudden compression or expansion and rapid evaporational condensation.

16. (i) The process should be infinitely slow.

(ii) The system should be free from dissipative forces.