Case Study - 4

We have seen that the internal energy U of a system can change through two modes of energy
Transfer heat and work. Let

ΔQ = Heat supplied to the system by the surroundings
ΔW = Work done by the system on the surroundings
ΔU = Change in internal energy of the system

The general principle of conservation of energy then implies that

$$\Delta Q = \Delta U + \Delta W$$

i.e. the energy (ΔQ) supplied to the system goes in partly to increase the internal energy of the system (ΔU) and the rest in work on the environment (ΔW) is known as the First Law of Thermodynamics. It is simply the general law of conservation of energy applied to any system in which the energy transfer from or to the surroundings is taken into account. Suppose an amount of heat ΔQ supplied to a substance changes its temperature from T to $T + \Delta T$. We define heat capacity of a substance to be $S=\frac{\Delta Q}{\Delta T}$. s is known as the specific heat capacity of the substance To define a constant characteristic of the substance and independent of its amount, we divide s by the mass of the substance m in kg

$s= \frac{S}{m} = \frac{1}{m}\frac{\Delta Q}{\Delta T}$ s is known as the specific heat capacity of the substance. It depends on the nature of the substance and its temperature. The unit of specific heat capacity is J kg^{-1} K^{-1}.

1. First law of thermodynamics is based on?

a. Conservation of energy
b. Conservation of mass
c. Conservation of momentum
d. Conservation of work

2. $\Delta U=0$ means that the process is isothermal. True or False?

a. True
b. False
c. None of these

3. Heat given to the gas in isothermal condition is used to

a. Increase temperature
b. Increase internal energy of system
c. Do external work

d. None of these

4. **Define specific heat capacity of substance. Give its SI unit**

5. **State First law of thermodynamics**

Answer key – 4

1. a
2. a
3. c

4. specific heat capacity of substance is the ratio of heat capacity of substance by the mass of the substance m in kg

   $s = \frac{S}{m} = \frac{1}{m}\frac{\Delta Q}{\Delta T}$

   s is known as the specific heat capacity of the substance.
   It depends on the nature of the substance and its temperature. The unit of specific heat capacity is J kg^{-1} K^{-1}.

5. First law of thermodynamics is similar to law of conservation of energy. the energy (ΔQ) supplied to the system goes in partly to increase the internal energy of the system (ΔU) and the rest in work on the environment (ΔW) is known as the First Law of Thermodynamics. Let

   ΔQ = Heat supplied to the system by the surroundings
   ΔW = Work done by the system on the surroundings
   ΔU = Change in internal energy of the system
   The general principle of conservation of energy then implies that

   $\Delta Q = \Delta U + \Delta W$

   i.e. the energy (ΔQ) supplied to the system goes in partly to increase the internal energy of the system (ΔU) and the rest in work on the environment (ΔW).

Case Study - 5

For an ideal gas, the equation of state is the ideal gas relation P V = μRT. For a fixed amount of the gas i.e. given μ, there are thus, only two independent variables, say P and V or T and V. The pressure-volume curve for a fixed temperature is called an isotherm. The thermodynamic state variables are of two kinds: extensive and intensive. Extensive variables indicate the 'size' of the system. Intensive variables such as pressure and temperature do not. To decide which variable is extensive and which intensive, think of a relevant system in equilibrium, and imagine that it is divided into two equal parts. The variables that remain unchanged for each part are Intensive. The variables whose values get halved in each part are extensive. It is easily seen, for example, that internal energy U, volume V, total mass M are extensive variables. Pressure P, temperature T, and density r are intensive variables. Now we focus on thermodynamic processes.

Quasistatic process: the process which is infinitely slow is called quasi static process. The system changes its variables (P, T, V) so slowly that it remains in thermal and mechanical equilibrium with its surroundings throughout.

Isothermal process: A process in which the temperature of the system is kept fixed throughout is called an isothermal process.

In isobaric processes the pressure is constant while in isochoric processes the volume is constant. Finally, if the system is insulated from the surroundings and no heat flows between the system and the surroundings, the process is adiabatic.

1. **Pressure is**
   a. Intensive variable
   b. extensive variable
   c. none of these

2. **volume is**
   a. Intensive variable
   b. extensive variable
   c. none of these

3. **Define quasi static process**

4. **Define an isothermal process**

5. **Define isobaric and isochoric processes**

Answer key - 5

1. A

2. B

3. The process which is infinitely slow is called quasi static process. The system changes its variables so slowly that it remains in thermal and mechanical equilibrium with its surroundings throughout.

4. A process in which the temperature of the system is kept fixed throughout is called an isothermal process.

5. Process in which the pressure of system is constant is called isobaric process and process in which volume is constant is called isochoric process.