# Study Circle Sessions

**Summary of topics and points**

**07/08/2015**

**Topic: Bohr's theory of Hydrogen atom**

1. Difficulties of the Rutherford model of the atom.

2. Setting up the classical equation of an electron in a circular orbit under attractive Coulomb force by the nucleus.

3. Relating speed of the electron to the radius of the orbit.

4. Classical physics has no restriction on the radius of the orbit.

5. Bohr's postulation of stationary orbits; Bohr did not explain why the electron does not radiate in stationary orbits, he only gave quantum prescription for these orbits:

Magnitude of angular momentum = $n\hbar$ (n=1, 2, 3…)

6. Using (2) and (5) for arriving at the quantization of the radius of the orbits: The radius goes like $n^2$ and inversely as Z.

7. The kinetic energy K, potential energy V and the total energy E = K+V are related very simply as 2T = -V, E = -T for a particle in Coulomb potential

8. Effect of mass of the nucleus

These points were discussed in connection with the problem on finding difference between the ground state energies of a deuterium atom and a hydrogen atom

**Topic: Schrodinger theory of hydrogen atom**

9. Ground state wave function of Hydrogen atom, most probable value of radius.

**General learning points:**

1. To emphasize scales of quantities involved and dimensional consistency of every equation.

2. To distinguish between purely mathematical steps( algebra/ calculus) and physical inputs.

3. To critically see the scope and limitations of the theory under discussion.

4. To distinguish between kinematics and dynamics.

# Study Circle Sessions

**Topics and Points**

**14/08/2015**

The topics and points of the session on 07/08/2015 were repeated because a different set of students attended the session.

**21/08/2015**

**Topic: Thermodynamics**
1. To distinguish between equilibrium in mechanics and equilibrium in thermodynamics.

2. Quasi-static, reversible and irreversible processes.

3. State variables, process variables, path dependence and path independence of quantities.

4. First law; internal energy, heat and work.

5. The basic difference between heat and work.

6. Enthalpy, its significance.

These points were discussed in the context of several problems which dealt with reversible isothermal expansion of an ideal gas, expansion against a fixed pressure, enthalpy change in fusion, etc.

**Topic: Quantum theory of hydrogen atom**
This topic discussed in earlier session was continued.

**General learning points:**
1. Understanding the conventions regarding signs of thermodynamic quantities.

2. Understanding the order of infinitesimal quantities in thermodynamics

**Topics and Points**

**28/08/2015**

**Topic : Thermodynamics**

As new students had joined, we first repeated the discussion on First Law of thermodynamics and revised the concepts of equilibrium, state variables (like U, T, S, P, V), process variables (like Q and W), quasi static and reversible processes, etc. We then turned to Second Law:

- Need for Second Law: First Law is not enough.
- Second Law gives a fundamental distinction between heat and work.
- Entropy statement of Second Law for reversible and irreversible processes
- Engine and refrigerator statements of Second Law. (Their equivalence with the entropy statement to be discussed in next few sessions of the Study Circle.)
- Entropy of the universe never decreases in any process in nature.
- Convenience variables like Helmholtz free energy (A) and Gibbs free energy (G) 'capture' the Second Law in terms of the system variable alone but at a price ( fixed T, V for A; fixed T, P for G).

Discussed an example of sudden condensation of steam into liquid water.

Did a problem on entropy change in reversible heating of an inert gas at constant pressure.

**Topic: Mechanics**

Discussed the difference in scope of mechanics and thermodynamics. As a digression, discussed the concept of frame of reference. Newton's I law of motion is not a law; it is a selection criterion to choose simple frames in nature—inertial frames.

**Topic : Quantum Mechanics**

1. Interpretation of wave-function.
2. Why is modulus squared of wave-function probability density not probability?
3. Discrete and continuous variables.
4. One-dimensional time-dependent Schrodinger equation; its solution cannot be real.
5. One-dim. time-independent Schrodinger equation.
   (3-dim. Case to be taken up next week).

<u>Mathematical methods</u>

Implicit and explicit time dependence. Partial derivatives (next week).