Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Third Year)

Subject: Chemistry

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Paper Title : Physical Chemistry

Unit: Unit 1- Nuclear Chemistry

Module Name: Liquid Drop Model

Module No : 09

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Notes

The liquid drop model was proposed based on some similarities of nucleus with liquid drop. The model was first proposed by **George Gamow**. It was further developed by **Niels Bohr** and **Archibald Wheeler in 1937.** This model is also known as **statistical model.** This is a very **crude** model.

Unlike Shell model, the liquid drop model does not take into account individual nucleons i.e. it considers the nucleus to be a single/ **homogenous** entity.

The Similarities/ Assumptions are as follows:

- Both the nuclei and liquid drop contain large number of particles i.e. the nucleus consists of protons and neutrons while the liquid drop contains atoms and molecules.
- Both the nuclei and liquid drop are homogenous in nature i.e. the density, charge and all other properties remain same throughout.
- The interactions of atoms/ molecules of liquid drop are with its closest neighbours similarly same condition is observed in case of nucleus where nucleons interact with nearest nucleons in immediate vicinity.

- The nuclei of atoms remain spherically symmetric due to short range nuclear forces just like the drop of a liquid which is spherical due to surface tension.
- Under extreme conditions the drop may split into number of smaller drops or smaller drops may unite to for a bigger drop which is similar to fission and fusion process in case of nucleus.
- In case of liquids, if it is supplied with thermal energy, liquid molecules get excited similarly the nucleus if bombarded with external energy then it forms compound nucleus that emits nucleons immediately and gets de-excited.

  This de-excitation process in both cases may occur by any of the following ways.

Compound nucleus	**Liquid drop**
A. By emission of radiation	A. By cooling
B. By emission of nucleon	B. By evaporation
C. By Fission	C. By breaking into small drops

- The binding energy per nucleon is proportional to mass number A of a nucleus just like the latent heat of vaporization of a liquid i.e the energy required to evaporate a certain amount of liquid is equal to its mass.

Merits of liquid drop model:

- It satisfactorily explains the behaviour of nucleus in excited states.
- It also explains nuclear fission and mechanism of nuclear reactions with low energy
- This model is used to calculate the binding energy of the nuclei and their masses.

Main drawbacks of liquid drop model:

- It is not able to explain the stability of nuclides with magic numbers.
- Being charge independent model it is not able to explain the concept of pairing i.**e**. the p- , n-n interactions which contribute to total binding energy is not taken into account.
- It is not able to calculate the nuclear spin.
- It restricts nuclides with mass between mass number 20-150 only i.e. the nuclides having mass number less than 20, most nucleons are at the surface of nucleus while those with larger mass numbers than 150 ,the electrostatic attractions and repulsions has to be considered.