**(PHYSICS)** # NUCLIE

**DPP – 2**

**CLASS – 12th**

**TOPIC – Energy Mass Equivalence & Types of Nulclear Reaction**

**Q.1** Two nuclei have mass numbers in the ratio 1:2. What is the ratio of the nuclear densities?

or

What is the ratio of the nuclear densities of two nuclei having mass numbers in the ratio 1:3?

**Q.2** All protons in an atom remain packed in a small nucleus inspite of the electrostatic repulsive force among them. Why?

Or

What holds nucleons together in a nucleus ?

**Q.3** What characteristic property of nuclear force explains the constancy of binding energy per nucleon (B.E./A) in the range of mass number A lying $30 < A < 170$ ?

**Q.4** State Einstein's mass-energy relation.

**Q.5** Define mass defect of a nucleus.

**Q.6** Define binding energy of a nucleus.

**Q.7** Draw a plot of potential energy of a pair of nucleons as a function of their separation. Write two important conclusions, which you can draw regarding the nature of nuclear forces.

**Q.8** What is mass defect? How is it related to stability of the nucleus ?

**Q.9** Why heavy stable nuclei must contain more neutrons than protons?

Or

In heavy nuclei, number of neutrons is more than number of protons. Why?

**Q.10** Explain with an example, whether the neutron to proton ratio in a nucleus increases or is decreases due to ß-decay

# SOLUTION

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**TOPIC – Energy Mass Equivalence & Types of Nulclear Reaction**

**Sol.1** Nuclear density is independent of the mass number of a nucleus. Since the two nuclei having mass numbers in the ratio 1:2 (or 1:3) have the same nuclear density, ratio of their nuclear densities is 1.

**Sol.2** Inside the nucleus, the electrostatic force of repulsion between the protons is extremely large. They are held inside the nucleus due to nuclear force between them, which is basically a strong attractive force.

**Sol.3** It is because nuclear forces are saturated forces.

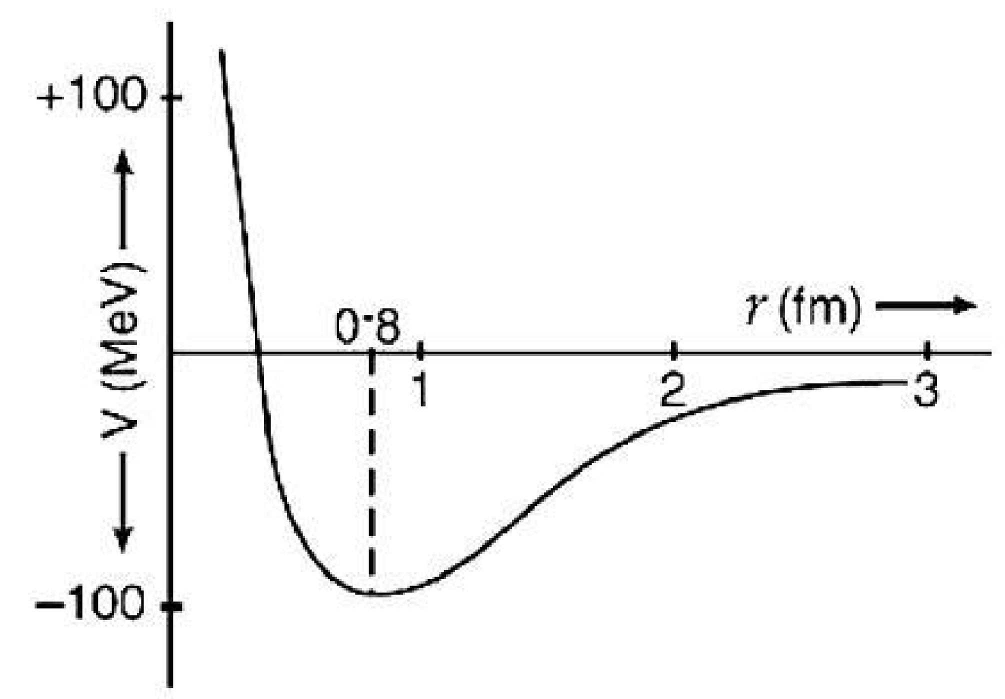
**Sol.4** In a process, when a mass m is compeletely converted into energy obtained is given by

$E = m\,c^2$

**Sol.5** The difference between the sum of the masses of the neucleons constituting a nucleus and the rest mass of the nucleus is known as mass defect.

**Sol.6** The binding energy of a nucleus is equal to the amount of work done to separate the nucleons an infinite distance apart from each other, so that they no longer interact with each other.

**Sol.7** The plot of potential energy (V) of a pair of nucleons as a function of their seperation(r) is as .




**Conclusions. 1.** At large distances between the two nucleons, the potential energy is small negative and becomes slowly more negative as the distance decreases.

Since $F = -\frac{dV}{dr}$ it implies that over the large part of the nucleus, the nuclear force between two nucleons is attractive.

2. When the distance between the nucleons is 0-8 fm, the potential energy becomes maximum negative and then, as the distance decreases further, it becomes zero and then positive. It implies that the nuclear force is zero at the distance of 0.8 fm and strong repulsive, when the distance is very small.

**Sol.8** **Mass defect**. For definition, refer to VSQ 2.25.

The stability of a nucleus depends upon the higher value of its B.E./A. Therefore, more the mass defect, more is the binding energy of the nucleus (or B.E./A) and hence more stable the nucleus will be.

**Sol.9** In heavy nuclei, the number of protons is very large. Due to this, the electrostatic force, which is a long range force, also becomes very large. To contain the nucleons inside the nucleus, the only attractive force is the nuclear force. But it is a short range force and can act only between neighbouring nucleons. A nucleus will be stable, if the number of neutrons is more than the number of protons so as to provide sufficient attractive force.

**Sol.10** $_{83}Bi^{210}$ decays into $_{84}Po^{210}$ by β - decay.

In $_{83}Bi^{210}$ nucleus, there are 83 protons and 210 - 83

i.e. 127 neutrons.

Therefore, neutron to proton ratio,

$$\frac{N_n}{N_p} = \frac{127}{83} = 1.53$$

In $_{84}P0^{210}$ nucleus, there are 84 protons and 210-84 i.e. 126 neutrons. Therefore,

$$\frac{N_n}{N_p} = \frac{126}{84} = 1.50$$

It follows that neutron to proton ratio decreases during ß-decay.