Explanations

1. (a) The binding energy of a nucleus is the energy required to take its nucleus away from one another. It is generally expressed as binding energy per nucleon. It is a measure of the stability of the nucleus. Higher the binding energy per nucleon, more stable is the nucleus.

2. (d) Given reaction is ${}^{14}_{7}\mathrm{N} + X \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}p$

   From the reaction we can see that

   $$A = 1$$

   and

   $$Z = 0$$

   Thus, the given particle is ${}^{1}_{0}n$.

3. (a) We have to consider binding energy per nucleon curve. Where, we can find that iron (Fe) is having maximum binding energy per nucleon.

4. (a) Nuclear density is given by $\rho = \dfrac{m}{\frac{4}{3}\pi R_0^3}$

   It is not related with mass number.

5. (b) Copper nucleus has a radius of the order of 10^{-14} m.

6. (b) The binding energy of nucleus is the energy released in formation of nucleus by combining its constituent particles i.e. nucleons. In other words, it is that external energy which is required to isolate the nucleons of the nucleus from each other.

7. (*b*) The elements high on the binding energy (BE) *versus* mass number plot are very tightly bound and hence they are stable and the elements those are lower on this plot, are less tightly bonds and hence, they are unstable.
Since, helium nucleus shows a peak on this plot, so it is very stable.

8. (a) The nucleus of the lightest atom of hydrogen, which has a relative abundances of 99.985% is called the proton.

Thus, we can conclude that ratio of the mass of nucleus of H-atom and the proton is approximately 1.

9. (b) Before the advent of special theory of relativity, it was presented that mass and energy were conserved separately in a reaction.

However, Einstein showed that mass is a another form of energy and one can convert mass-energy into other forms of energy, say kinetic energy and *vice-versa*.

10. (a) Since, nuclear force does not depend on the electric charge.

So, nuclear force between neutron-neutron, proton-neutron and proton-proton is approximately the same.

11. (a) The constancy of the binding energy per nucleon in the range $30 < A < 170$ is a consequence of the fact that the nuclear force is short ranged in nature.

12. (a) Neutrinos are neutral particles with very small mass compared to electrons. They interact very weakly with matter.
Therefore, they are very difficult to detect, since they can even penetrate the large quantity of matter (earth) without any interaction.

13. (i) (c) Neutrino is massless and chargeless particle.

(ii) (a) Since, the nuclei of protium, deuterium and tritium are isotopes of hydrogen, they must contain only one proton each. But the masses of the nuclei of protium, deuterium and tritium are in the ratio of 1 : 2 : 3, because of presence of neutral matter in deuterium and tritium nuclei.

(iii) (d) $\text{Density} = \dfrac{\text{Mass}}{\text{Volume}} = \dfrac{mA}{\frac{4}{3}\pi R_0^3 A} = \dfrac{3m}{4\pi R_0^3}$

As, $m = m_P = m_N$
$= 23 \times 10^{17}\ \text{kgm}^{-3}$,
which is a constant.

(iv) (a) $R = R_0 A^{1/3}$

$$\log R = \log R_0 + \frac{1}{3}\log A$$

On comparing the above equation of straight line; $y = mx + c$. So, the graph between $\log A$ and $\log R$ is a straight line also.

(v) (b) For nucleus X, $A_X = 3$

For nucleus Y, $A_Y = 81$

$$\therefore \quad \frac{R_X}{R_Y} = \left(\frac{A_X}{A_Y}\right)^{1/3} = \left(\frac{3}{81}\right)^{1/3}$$
$$= \left(\frac{1}{3}\right)^{(1/3)\times 3} = \frac{1}{3}$$