

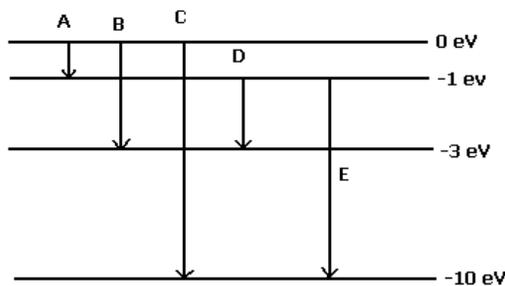
PLOT 5C, 2ND FLOOR, GANAPATI COMPLEX, SEC-13, OPP. JAIPURIA
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ATOM AND NUCLIE

1. Draw the graph showing the distribution of kinetic energy of electrons emitted during beta decay.
2. Write the nuclear decay process for β^- -decay of ${}_{15}^{32}\text{P}$.
3. Mention two reasons for nuclear fusion to occur in sun and stars.
4. State two characteristics of nuclear force. Why does the binding energy per nucleon decrease with increase in mass number for heavy nuclei like ${}^{235}\text{U}$?
5. Draw the curve showing variation of binding energy/nucleon with mass number of different nuclei. Briefly state, how nuclear fusion and nuclear fission can be explained on the basis of this graph.
6. The half life of ${}_{92}^{238}\text{U}$ against α - decay is 4.5×10^9 years. What is the activity of 1g sample of ${}_{92}^{238}\text{U}$?
7. A radioactive nucleus 'A' undergoes a series of decays according to following scheme:

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$
 The mass number and atomic number of A are 180 and 72 respectively. What are these numbers for A_4 ?
8. Compare the radii of two nuclei with mass numbers 1 and 27 respectively. **TM**
9. In the series of radioactive disintegration of Z_X first an α - particle and then a β -particle is emitted. What is the atomic number and mass number of the new nucleus formed by these successive disintegrations?
10. Give one point of difference between 'nuclear fission' and 'nuclear fusion'. Will neutron to proton ratio increase or decrease in a nucleus when (i) an electron, (ii) a positron is emitted?
11. The value of ground state energy of hydrogen atom is -13.6eV .
 a. What does the negative sign signify?
 b. How much energy is required to take an electron in this atom from the ground state to the first excited state?
12. Define 'disintegration constant' and 'mean life' of a radioactive substance. Give the unit for each.
13. Why is mass of nucleus always less than the sum of the masses of its constituents, neutrons and protons?
 If the total number of neutrons and protons in a nuclear reaction is conserved, how then is energy absorbed or evolved in the reaction? Explain.
14. Explain, with the help of a nuclear reaction in each of the following cases, how the neutron to proton ratio changes during (i) alpha decay (ii) beta- decay?
15. When a deuteron of mass 2.0141 u and negligible kinetic energy is absorbed by a lithium (${}^6_3\text{Li}$) nucleus disintegrates spontaneously into two alpha particles, each of mass 4.0026 u. calculate the energy in joules carried by each alpha particle. ($1\text{ u} = 1.66 \times 10^{-27}\text{ kg}$).
16. The sequences of stepwise decays of a radioactive nucleus is

$$D \xrightarrow{\alpha} D_1 \xrightarrow{\beta^-} D_2 \xrightarrow{\alpha} D_3$$
 If the nucleon number and atomic number for D_2 are 176 and 71 respectively, what are the corresponding values of D and D_3 ? Justify your answer in each case.
17. a. Draw a graph showing the variation of potential energy of a pair of nucleons as a function of their separation. Indicate the regions in which nuclear force is (i) attractive and (ii) repulsive.
 b. Write the two characteristic features of nuclear force which distinguish it from the Coulomb force.
18. a. Show that the decay rate 'R' of a sample of a radio nuclide is related to the number of radioactive nuclei 'N' at the same instant by the expression $R = \lambda N$.

- b. The half life of ${}^{238}_{92}\text{U}$ against α -decay is 1.5×10^{17} s. What is the activity of a sample of ${}^{238}_{92}\text{U}$ having 25×10^{20} atoms?
19. Calculate the binding energy per nucleon (in MeV) for ${}^4_2\text{He}$ and ${}^3_2\text{He}$. Comment on the difference for these binding energies and its significance in relation to α -decay of the nuclei. Given: mass of ${}^1_1\text{H} = 1.00783$ u, mass of ${}^1_0\text{n} = 1.00867$ u, mass of ${}^3_2\text{He} = 3.01664$ u, mass of ${}^4_2\text{He} = 4.00387$ u.
20. Write nuclear reaction for the following:
- α -decay of ${}^{204}_{84}\text{Po}$
 - β^- -decay of ${}^{32}_{15}\text{P}$.
 - β^+ -decay of ${}^{11}_6\text{C}$.
21. a. Draw the energy level diagram showing the emission of β - particles followed by γ -rays by a ${}^{60}_{27}\text{Co}$ nucleus.
b. Plot the distribution of kinetic energy of β - particles and state why the energy spectrum is continuous.
22. A radioactive sample contains 2.2 mg of pure ${}^{11}_6\text{C}$ which has half life period of 1224 seconds. Calculate (a) the number of atoms presents initially. (ii) The activity when $5\mu\text{g}$ of the sample will be left.
23. Group the following six nuclides into three pairs of (i) isotones (ii) isotopes (iii) isobars: ${}^{12}_6\text{C}$, ${}^3_2\text{He}$, ${}^{198}_{80}\text{Hg}$, ${}^3_1\text{H}$, ${}^{197}_{79}\text{Au}$, ${}^6_6\text{C}$.
How does the size of nucleus depend on its mass number? Hence explain why the density of nuclear matter should be independent of the size of nucleus.
24. The decay constant, for a given radionuclide, has a value of 1.386 day^{-1} . After how much time will a given sample of this radionuclide get reduced to only 6.25% of its present number?
25. The energy levels of an atom of element are shown in the following diagram. Which one of the level transitions will result in the emission of photons of wavelength 620 nm? Support your answer with mathematical calculations.



26. The half life of ${}^{14}_6\text{C}$ is 5700 years. What does it mean? Two radioactive nuclei X and Y initially contain an equal number of atoms. Their half life is 1 hour and 2 hours respectively. Calculate the ratio their rates of disintegration after two hours.
27. In a radioactive decay as follows :
- $${}^{176}_{71}\text{A} \xrightarrow{+e^0} \text{A}_1 \xrightarrow{\alpha} \text{A}_2$$
- The mass number and atomic number of A are 176 and 71 respectively, what are the mass numbers and atomic numbers of A_1 and A_2 . Which of these three elements are isobars?
28. Explain how radioactive nuclei can emit β -particles even though atomic nuclei do not contain these particles. Hence explain why the mass number of a radioactive nuclide does not change during β -decay. Use the basic law of radioactive decay, to show that radioactive nuclei follow an exponential decay law. Hence obtain a formula, for half life of a radioactive nuclide, in terms of its disintegration constant.
29. What is meant by binding energy per nucleon? The binding energies of deuteron (${}^2_1\text{H}$) and α -particle (${}^4_2\text{He}$) are 1.25 and 7.2 MeV/nucleon respectively. Which nucleus is more stable? Calculate binding energy per nucleon of ${}^{56}_{26}\text{Fe}$.
Given : $m({}^{56}_{26}\text{Fe}) = 55.934939$ amu;
m (proton) = 1.007825 amu;
m (neutron) = 1.008665 amu.