PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

ATOMIC NUCLEUS

Numerical Examples

1. In any nuclear reaction $\frac{1}{1000}$ part of the mass of a particular substance is converted into energy. If 1 g of that substance takes part in a nuclear reaction then determine the energy evolved in kilowatt-hour

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2. If a metal's mass could be completely converted into energy, calculate how much of this metal would be required as fuel for a power plant in a year. This power plant, let us suppose, generates 200 MW on an average.

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3. For a nucleus which is nearly spherical in shape $r = r_0 A^{\frac{1}{3}}$, where r is the radius and A is the mass number and r_0 is a constant of value 1.2×10^{-15} m.

If the mass of the neutrons and protons are equal and equal to 1.67×10^{-27} kg, prove that density of the nucleus is 2.3×10^{14} times the density of water.

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4. How many α and β-particles are emitted when U-238 changes to Pb-206 due to radioactivity. Atomic numbers of U-238 and Pb-206 are 92 and 82 respectively.

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5. ${}_{92}U^{238}$ decays by emitting successively 8 α-particles and 8 β-particles. Determine the mass number and atomic number of the new element and express it in symbol.

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6. ${}_{86}A^{222} \rightarrow {}_{84}B^{210}$. Determine how many α-particles and β-particles have been emitted in the above reaction.

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7. The half-life of a radioactive substance is 1 y. After 2 y, what will the amount of the substance that will be disintegrated?

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8. In 8000 y, a radioactive substance reduces a $\frac{1}{32}$th part of its initial amount. Determine its half-life.

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9. A radioactive material reduces to $\frac{1}{8}$th of its initial amount in 18000 y. Find its half-life period.

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10. An accident in a laboratory deposits some amount of radioactive material of half-life 20d on the floor and the walls. Testing reveals that the level of radiation is 32 times the maximum permissible level. After how many days will it be safe to use the room?

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11. Half-life of thorium is 1.5×10^{10} y. How much time is needed for 20% of thorium to disintegrate ?

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12. Half-life of radium is 1500 y. In how many years will 1 g of pure radium reduce by 1 mg ?

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13. State the law of radioactive decay. 3/4th of a radioactive sample decays in 3/4 s. What is the half-life of the sample?

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14. A radioactive isotope X with half-life 1.5×10^9 y decays into a stable nucleus Y. A rock sample contains both elements X and Y in ratio 1:15. Find the age of the rock .

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15. Po^{210} has half-life of 140 d. In 1g Po^{210} how many disintegration will take place every second ? [Avogadro's number = 6.023×10^{23}]

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16. A radioactive sample of half-life 30 d contains 10^{12} particles at an instant of time. Find the activity of the sample.

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17. How much $._{84}Po^{210}$ of half-life 138 days is required to produce a source of α-radiation of intensity 5 mCl (millicurie) ?

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18. A 280 days old radioactive shows an activity of 6000 dps, 140 days later it's activity becomes 3000 dps. What was its initial activity ?

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19. Complete the following nuclear reaction : $._{13}Al^{27} + ._2He^4 \rightarrow ._{15}P^{30} + ?$

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20. Complete the following nuclear reaction : $._7N^{14} + ._2He^4 \rightarrow ._8O^{17} + ?$

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21. Identify the missing particle in the following two reactions (I). ${}_9F^{19} + {}_1H^1 \rightarrow {}_8O^{16}$ + ?

(II). ${}_{12}Mg^{25} + ? \rightarrow {}_{11}Na^{22} + {}_2He^4$

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22. When ${}_4Be^9$ is hit by α-particles a neutron is emitted resulting in the formation of a new element. Identify the element and write the complete reaction equation.

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23. When an aluminium nucleus $\left(._{13} Al^{27}\right)$ is hit by a proton a new element is formed with the emission of α-particle. (ii)Write the complete equation of reaction , (ii)Identify the new element and (iii)Determine the number of neutrons and protons in the nucleus .

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24. On collision with neutron , $._{13} Al^{27}$ changes to radiosodium $._{11} Na^{24}$ and emits a particle. $._{11} Na^{24}$, In its turn emits a particle and is transmitted to $._{12} Mg^{24}$. Write the two nuclear equations and identify the particles .

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25. A nucleus disintegrated into two nuclei and their velocities are in the ratio of 2:1. What will be the ratio of their size ?

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26. In the nuclear reaction $X(n, \alpha)_3 Li^7$, identify X.

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27. The kinetic energy of a slow moving neutron is 0.04 eV. What fraction of the speed of light is the speed of this neutron ? At what temperature will the average kinetic energy of a gas molecule to equal to the energy of this neutron ? [mass of neutron : 1.675×10^{-27} kg , Boltzmann constant, $k_B = 1.38 \times 10^{-23} J.K^{-1}$]

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28. In a typical nuclear fission reaction, it was found that there was a loss of mass of 0.2150 u. How much

energy in MeV will be released from the reaction ? ($c = 3 \times 10^8 ms^{-1}$)

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29. In a piece of ancient wood C-14 and C-12 in this wood at present is $\frac{1}{8}$ part of their ratio in the ancient wood. Half-life of C^{14} is 5570 y. What is the age of the wood ?

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Section Related Questions

1. What do you mean by mass-energy equivalence ?

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2. What do you mean by the law of conservation of mass energy ?

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3. What do you mean by rest mass of a body ?

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4. What are the characteristics of nuclear force ?

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5. What are the constituents of the atomic nucleus?

What do you mean by nucleon?

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6. What is nuclear force ?

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7. What are isotopes ?

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8. Define atomic weight and atomic number of an element

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9. What is unified atomic mass unit ? Determine the equivalent energy of 1 u in MeV unit.

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10. Define binding energy of nucleus . What is its source ?

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11. What is meant by mass defect of a nucleus ? How it it related to the binding energy of the nucleus ?

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12. What do you mean by mass excess ? Give examples .

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13. How can nuclear density be calculated ?

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14. Write down the relation between radius of nucleus and mass number .

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15. Define radioactivity

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16. What are radioactive rays ?

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17. Write down three properties of beta rays .

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18. What is the constituent of an α -particle ?

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19. Describe briefly about the generation of α-rays and its principle properties .

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20. What are the differences between cathode rays and β - rays ?

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21. What are the basic differences between X-rays and γ - rays ?

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22. Mention two properties of each of the radioactive rays emitted from a radioactive substance.

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23. State clearly the differences between α, β and γ - rays.

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24. State the differences between α and β - particles in respect of their charges , masses and ionisation

powers .

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25. Compare X-rays and γ-rays .

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26. Mention the similarities between cathode rays and beta rays .

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27. If a radioactive element emits -

(i) α-particle and

(ii) β-particle, then how its mass number and atomic number will change?

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28. What do you mean by conservation of mass number and atomic number ? Show that from it two displacement laws of α and β -decay can be obtained from these conservation laws .

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29. What is disintegration energy ?

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30. Establish the relation between decay constant and half-life .

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31. What do you mean by half-life of a radioactive substance ?

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32. Write down the law of radioactive decay .

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33. Write down the law of radioactive decay and explain it with curve . Define half-life of a radioactive substance

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34. What is mean life of radioactive substance ? Show its relation with half-life .

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35. Half-life of a radioactive element is $T_{1/2}$ and its average life is τ. Write down the relation between them.

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36. What do you mean by 'activity' of a radioactive sample ?

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37. In which properites , the activity of a radioactive sample depends ?

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38. Define 1 curie

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39. What is artificial radioactivity ? Illustrate the matter

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40. What do you mean by artificial transmutation ? Give examples .

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41. Explain the phenomenon of artificial transmutation with example .

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42. Give two examples of artificial transmutation by α-rays.

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43. What do you mean by radioisotopes ?

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44. What do you mean by nuclear fission ?

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45. Explain nuclear fission with a suitable nuclear reaction.

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46. Explain how energy is released as a result of nuclear fission.

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47. Give two examples of moderator .

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48. What is the main principle of atom bomb ?

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49. What do you mean by nuclear fusion ?

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50. Explain how the sun and the other stars generate energy.

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51. Explain why a nuclear fission is to be performed about a nuclear fusion.

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52. Discuss two important applications of radioisotopes .

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53. Write short notes on : Radio isotopes and their uses.

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54. What do you know about carbon dating ?

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Hots Question

1. The density of uranium nucleus is approximately , $m_p = 1.67 \times 10^{-27}$ kg .

A. $10^{20} kg.\, m^{-3}$

B. $10^{17} kg.\, m^{-3}$

C. $10^{14} kg.\, m^{-3}$

D. $10^{11} kg.\, m^{-3}$

Answer: B

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2. There is no electron in nucleus then how does β-emission take place from the nucleus ?

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3. The nucleus of a radioactive element emits an α-particle and then emits 2 β-particles subsequently . Prove that the product (daughter nucleus) is actually an isotope of the original elements .

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4. What is meant by the statement that the half-life of radium is 1622 years ?

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5. What will be the change in the ratio of neutrons to protons of a nucleus if

(i) a β-particle is emitted,

(ii) a positron is emitted and

(iii) a γ-ray photon is emitted?

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6. Energy evolved during nuclear fission can be used for the welfare of mankind' - discuss briefly .

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7. Why is neutron used as an ideal particle for bombarding the nucleus of elements in a nuclear reaction ?

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8. What is difference between chemical reaction and nuclear reaction ?

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9. What effect will be noticed when a source of α-particles is introduced in a changed gold leaf electroscope ?

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10. Electromagnetic waves are emitted from an atom in excited state and γ -rays are emitted during radioactive disintegration. What are the similarities and dissimilarities between them ?

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11. Is mass defect always positive or negative ?

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12. Write two characteristic features of nuclear force which distinguish it from the Coulomb force.

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13. A mixture consists of two radioactive materials A_1 and A_2 with half-lives of $20s$ and $10s$ respectively. Initially the mixture has $40g$ of A_1 and $160g$ of a_2. The

amount the two in the mixture will become equal after

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14. The half -life of a radioactive nucleus is 50 days. What is the time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and the time t_1 when $\frac{1}{3}$ of it had decayed ?

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Ncert Textbook Questions

1. Obtain the binding energy of the nuclei $._{26}^{56}Fe$ and $._{83}^{209}Bi$ in units of MeV from the following data .

m_H=1.007825 u, m_n=1.008665 u

$m\left(._{26}^{56}Fe\right) = 55.934939u$ $m\left(._{83}^{209}Bi\right)$ = 208.980388 u

Which nucleus has greater binding energy per nucleon ?

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2. A given coin has a mass of 3.0 g . Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other . For

simplicity assume that the coin is entirely made of $._{29}^{63}C$ atoms (of mass 62.92960 u). The masses of protons and neutrons are 1.00783 u and 1.00867 u respectively.

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3. The half-life of $._{38}^{90}Sr$ is 28 years . What is the disintegration rate of 15 mg of this isotope ?

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4. Find Q-value and kinetic energy of the emitted α-particle in the α-decay of (a). $_{88}^{222}Ra$ and (b). $_{86}^{220}Rn$.

Given , $m\left(.^{226}_{86}Ra\right)$ = 226.02540 u, $m\left(.^{222}_{26}Rn\right)$ = 222.01750 u, $m\left(.^{220}_{86}Rn\right)$ = 220.01137 u, $m\left(.^{216}_{84}Po\right)$ = 216.00189 u , $m\left(.^{4}_{2}He\right)$ =4.00260 u

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5. The radionuclide $.^{11}_{6}C$ decays according to $.^{11}_{6}C \rightarrow .^{11}_{5}B + e^{+} + v$. $T_{1/2}$ = 20.3 min. The maximum energy of emitted positron is 0.960 MeV. Calculate Q and compare it with the maximum energy of the positron emitted. Given : $m\left(.^{11}_{6}C\right)$ =11.01143 u, $m\left(.^{11}_{5}B\right)$ =11.009305 u, m_e = 0.000548 u

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6. The Q-value of a nuclear reaction A + b $\rightarrow$ C + d is defined by $Q = [m_A + m_b - m_C - m_d]c^2$, where the masses refer to nuclear rest masses . Determine from the given data whether the following reactions are exothermic or endothermic .

(a). $._1^1 H + ._1^3 H \rightarrow ._1^2 H._1^2$, (b)

$._6^{12} C + ._6^{12} C \rightarrow ._{10}^{20} Ne + ._2^4 He$

Atomic masses are given to be $m\left(._1^1 H\right)$ = 1.007825 u, $m\left(._1^2 H\right)$ = 2.014102 u , $m\left(._1^3 H\right)$ =3.016049 u, $m\left(._1^{12} C\right)$ =12.000000 u, $m\left(._{10}^{20} Ne\right)$ =19.992439 u, $m\left(._2^4 He\right)$ =4.002603 u

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7. Is the fission of a ${}_{26}^{56}Fe$ nucleus into two equal fragments , ${}_{13}^{28}Al$ energetically possible ? Argue by working out Q of the process. Given , $m\left({}_{26}^{56}Fe\right)$ = 55.93494 u and $m\left({}_{13}^{28}Al\right)$ = 27.98191 u

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8. The fission properties of ${}_{94}^{239}Pu$ are very similar to those of ${}_{92}^{235}U$. The average energy released per fission is 180 MeV . How much energy, in MeV , is released if all the atoms in 1 kg of pure ${}_{94}^{239}Pu$ undergo fission ?

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9. A 1000 MW fission reactor consumes half of its fuel in 5 y. How much $._{92}^{235}U$ did it contain initially ? Assume that the reactor was active 80% of the time and all the energy generated arises from the fission of $._{92}^{235}U$ and that this nuclide is consumed by the fission process.

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10. How long an electric lamp of 100 W can be kept glowing by fusion of 2.0 kg of deuterium ? The fusion reaction can be taken as $._{1}^{2}H + ._{1}^{2}H \rightarrow ._{2}^{3}He + n + 3.2MeV$

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11. A source contains two phosphorus radionuclei $._{15}^{32}P\left(T_{1/2}=14.3d\right)$ and $._{15}^{33}P\left(T_{1/2}=25.3d\right)$. Initially, 10% of the decay come from $._{15}^{33}P$. How long one must wait until 90% comes from it?

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12. Under certain circumstances , a nucleus can decay by emitting a particle more massive than an α-particle. Consider the following decay processes.

(a). $._{88}^{223}Ra \rightarrow ._{82}^{209}Pb + ._{6}^{14}C$,

(b). $._{88}^{223}Ra \rightarrow ._{86}^{219}Rn + ._{2}^{4}He$

Calculate the Q-values for these two decays and determine that both are energetically possible.

$m\left(.^{223}_{88}Ra\right) = 223.01850u$, $m\left(.^{209}_{82}Pb\right)$=208.98107 u, $m\left(.^{219}_{86}Rn\right)$ = 219.00948 u, $m\left(.^{14}_{6}C\right)$ = 14.00324 u and $m\left(.^{4}_{2}He\right)$ =4.00260 u

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13. Consider the fission of $.^{238}_{92}U$ by fast neutrons. In one fission event , no neutrons are emitted and the final stable end products, after the beta decay of the primary fragments , are $.^{140}_{58}Ce$ and $.^{99}_{44}Ru$. Calculate Q for this fission process.

Given , $m\left(.^{238}_{92}U\right) = 238.05079u$, $m\left(.^{140}_{58}Ce\right)$ =

139.90543 u

$m\left(.^{99}_{44}Ru\right)$ = 98.90594 u, m_n=1.008667 u

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14. Suppose India had a target of producing by 2020 AD, 200,000 MW of electric power , 10% of which was to be obtained from nuclear power plant. Suppose we are given that, on an average, the efficiency of utilisation (i.e., conversion to electric energy) of thermal energy produced in a reactor was 25% . How much amount of fissionable uranium did our country need per year by 2020 ? Take the heat per fission of

$.^{235}U$ to be about 200 MeV. Avogadro's number $= 6.023 \times 10^{-23} mol^{-1}$.

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15. Calculate the compare the energy released by (a) fusion of 1.0 kg of hydrogen deep within the sun and (b) the fission of 1.0 kg of $.^{235}U$ in a fission reactor.

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Ncert Exemplar Question

1. Suppose we consider a large number of containers each containing initially 10000 atoms of radioactive material with a half-life of 1 year. After 1 year,

(A) All containers will have 5000 atoms

(B) All the containers will contain the same number of atoms but that number will only be approximately 5000.

(C) The containers will in general have different numbers of the atoms but their average will be close to 5000.

(D) None of the containers can have more than 5000 atoms.

A. all containers will have 5000 atoms

B. all the containers will contain the same number of atoms but that number will only be approximately 5000

C. the containers will in general have different members of the atoms but their average will be close to 5000

D. none of the containers can have more than 5000 atoms

Answer: c

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2. When a nucleus in an atom undergoes a radioactive decay, the electronic energy levels of the atom -

(A) Do no change for any type of radioactivity.

(B) Change for α and β -radioactivity but not for γ-radioactivity.

(C) Change for α-radioactivity but not for others.

(D) Change for β-radioactivity but not for others.

A. do no change for any type of radioactivity

B. change for α and β -radioactivity but not for γ-radioactivity

C. change for α-radioactivity but not for others

D. change for β-radioactivity but not for others

Answer: b

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3. M_x and M_y denote the atomic masses of the parent and the daughter nuclei respectively in a radioactive decay. The Q-value for a β^- - decay is Q_1 and that for a β^+ - decay is Q_2. If m_e denotes the mass of an electron , then which of the following statements is correct ?

A. $Q_1 = (M_x - M_y)c^2$ and

$Q_2 = (M_x - M_y - 2m_e)c^2$

B. $Q_1 = (M_x - M_y)c^2$ and $Q_2 = (M_x - M_y)c^2$

C. $Q_1 = (M_x - M_y - 2m_e)c^2$ and

$Q_2 = (M_x - M_y + 2m_e)c^2$

D. $Q_1 = (M_x - M_y + 2m_e)c^2$ and

$Q_2 = (M_x - M_y + 2m_e)c^2$

Answer: a

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4. Heavy and stable nuclei have more neutrons than protons . This is because of the fact that

A. neutrons are heavier than protons

B. electrostatic force between protons are repulsive

C. neutrons decay into protons through β-decay

D. nuclear forces between neutrons are weaker than that between protons

Answer: b

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5. In a nuclear reactor , moderators slow down the neutrons which come out in a fission process. The moderator used have light nuclei. Heavy nuclei will not serve the purpose because,

A. They will break up

B. elastic collision of neutrons with heavy nuclei will not slow them down

C. the net weight of the reactor woud be unbearably high

D. substances with heavy nuclei do not occur in liquid or gaseous state at room temperature .

Answer: b

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6. Fusion processes , like combining two deuterons to form a He nucleus are impossible at ordinary temperatures and pressure . The reasons for this can be traced to the fact

A. nuclear forces have short range

B. nuclei are positively charged

C. the original nuclei must be completely ionised before fusion can take place

D. the original nuclei must break up before combining with each other .

Answer: a,b

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Exercise

1. The approximate value of the density of uranium nucleus $\left(m_p = 1.67 \times 10^{-27} kg\right)$ is

A. $10^{20} kg.\, m^{-3}$

B. $10^{17} kg.\, m^{-3}$

C. $10^{14} kg.\, m^{-3}$

D. $10^{11} kg.\, m^{-3}$

Answer: B

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2. Which of the following is correct ?

A. The rest mass of a stable nucleus is less than the sum of the rest masses of the isolated nucleons

B. The rest mass of a stable nucleus is more than the sum of the rest masses of the isolated nucleons

C. In nuclear fusion, energy is emitted due to combination of two nuclei of comparable masses (100 u approx)

D. In nuclear fission , no energy is released due to fragmentation of a very heavy nucleus .

Answer: A

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3. During emission of a negative β - particle

A. an electron from the atom is emitted

B. an electron already present inside the nucleus is emitted

C. an electron is emitted due to disintegration of a neutron inside of nucleus.

D. a part of nuclear binding energy is converted into an electron .

Answer: C

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4. Which of the following statements is correct ?

A. β-rays and cathode rays are of identical nature

B. γ-rays are a steam of high energetic neutrons

C. α-particles are singly charged helium atoms

D. The masses of a proton and that of a neutron are exactly equal

Answer: A

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5. A radioactive nucleus of mass number A, initially at rest, emits an α -particle with a speed v. The recoil speed of the daughter nucleus will be

A. $\frac{2v}{A-4}$

B. $\frac{2v}{A+4}$

C. $\frac{4v}{A-4}$

D. $\frac{4v}{A+4}$

Answer: C

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6. An excited Ne^{22} nucleus is disintegrated into an unknown nucleus and two α-particles . This unknown nucleus is

A. nitrogen

B. carbon

C. boron

D. oxygen

Answer: B

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7. The half-life of I^{131} is 8d. If a sample of I^{131} is taken at time t=0, then it can be said that

(A) No nuclear disintegration will occur before t=4 d.

(B) No nuclear disintegration will occur before t=8 d.

(C) all nuclei will be disintegrated in t=16 d.

(D) A definite nucleus may be disintegrated at any time after t=0.

A. no nuclear disintegration will occur before t=4 d

B. no nuclear disintegration will occur before t=8 d

C. all nuclei will be disintegrated in t=16 d

D. a definite nucleus may be disintegrated at any time after t=0

Answer: D

8. In a freshly prepared radioactive sample the rate of radiation is 64 times greater than the safe limit. If its half -life be 2 h then using this sample experiments can be performed with safely after

A. 6 h

B. 12 h

C. 24 h

D. 128 h

Answer: B

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9. The mean life of a radioactive element is 13 days. Initially a sample contains 1 g of this element . The mass of the element will be 0.5 g after a time of

A. 13 days

B. 18.75 days

C. 9 days

D. 6.5 days

Answer: C

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10. The half-life of At^{215} is 100 μs.The time taken for the radioactivity of a sample of the element to decay $\frac{1}{16}$th of its initial value is

A. $400\mu s$

B. $6.3\mu s$

C. $40\mu s$

D. $300\mu s$

Answer: A

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11. The half-life of a radioactive substance is 20 min. The approximate time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$rd of its has decayed and time t_1 when $\frac{1}{3}$rd of it had decayed is -

(A) 14 min

(B) 20 min

(C) 28 min

(D) 7 min

A. 14 min

B. 20 min

C. 28 min

D. 7 min

Answer: B

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12. The half-life of a radioactive isotope X is 50 years . It decays to another element Y which is stable . The two elements X and Y were found to be in the ratio of

1:15 in a sample of a given rock. The age of the rock was estimated to be

A. 150 years

B. 200 years

C. 250 years

D. 100 years

Answer: B

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13. A nucleus ${}_{n}^{m}X$ emits one α particle and two β^{-} particles .The resulting nucleus is

A. ${}^{m-6}_{n-4}Z$

B. ${}^{m-6}_{n}Z$

C. ${}^{m-4}_{n}X$

D. ${}^{m-4}_{n-2}Y$

Answer: C

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14. Two radioactive nuclei P and Q in a given sample decay into a stable nucleus R. At time t=0, number of P species are $4N_0$ and that of Q are N_0. Half-life of P (for conversion to R) is 1 min whereas that of Q is 2min.

Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be

A. $2N_0$

B. $3N_0$

C. $\frac{9N_0}{2}$

D. $\frac{5N_0}{2}$

Answer: C

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15. Of the following equations which one is the probable nuclear fusion reaction ?

A. ${}_{5}C^{13} + {}_{1}H^{1} \rightarrow {}_{6}C^{14}$ + 4.3 MeV

B. ${}_{6}C^{12} + {}_{1}H^{1} \rightarrow {}_{7}N^{13}$ +2MeV

C. ${}_{7}N^{14} + {}_{1}H^{1} \rightarrow {}_{8}O^{15}$

D.

${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{54}Xe^{140} + {}_{38}Sr^{94} + {}_{0}n^{1} + \gamma$

+ 200 MeV

Answer: B

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16. In the nuclear reaction $._{7}^{14}N + X \rightarrow ._{6}^{14}C + ._{1}^{1}H$ the X will be

A. $._{-1}^{0}e$

B. $._{1}^{1}H$

C. $._{1}^{2}H$

D. $._{0}^{1}n$

Answer: D

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17. Fast moving neutrons are retarded

A. by using lead obstacle

B. by passing through water

C. after colliding elastically with heavy nuclei

D. by strong electric fields.

Answer: B

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18. In nuclear fusion,

A. a heavy nucleus breaks into two intermediate nuclei and few high particles

B. a light nucleus breaks due to collision with a thermal neutrons

C. a heavy nucleus breaks due to collision with a thermal neutron

D. two or more light nuclei combine into a heavier nucleus and a few light particles

Answer: C

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19. $4._1 H^1 \rightarrow ._2 He^4 + 2e^+ +$ 26 MeV : this is an equation of

A. β-decay

B. γ-decay

C. fusion

D. fission

Answer: C

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20. The power obtained in a reactor using U^{235} disintegration is 1000 kW. The mass decay of U^{235} per hour is

A. $10\mu g$

B. $20\mu g$

C. $40\mu g$

D. $1\mu g$

Answer: C

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21. What is the relation between unified atomic mass unit (u) and electron unit ?

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22. The mass of a proton or a neutron is nearly 1.67×10^{-24} g . What is its equivalent energy in MeV ?

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23. What is the order of magnitude of the density of nuclear matter ?

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24. What is the difference in the structures of Cl^{35} and Cl^{37} nuclei?

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25. What is the relation between the atomic number (Z) and the mass number (A) of two isobars?

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26. What is the difference in the properties of the two carbon isotopes C^{12} and C^{14} in the context of radioactivity ?

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27. What is the approximate ratio of the penetrating power of α, β and γ-rays ?

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28. What is the relation between half-life and decay constant of a radioactive isotope ?

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29. When a β-particle is emitted from the radioactive isotope ${}_{15}P^{32}$, it is converted into ${}_{16}S^{32}$ / Write down the required transformation equation

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30. When an α - particle is emitted from a uranium nucleus (atomic no. 92, mass number 238), a new nucleus is formed. From this nucleus a β-particle is also emitted. Wha will be the atomic number and mass number of the final nucleus ?

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31. What are the atomic number and the mass number of the plutonium isotope produced due to two

successive β-decays of the isotope $._{92}U^{239}$ of uranium ?

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32. Which fundamental particle was first discovered from artificial transmutation ?

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33. $._1H^2 + ._1H^3 \rightarrow ._2He^4 +$ ____

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34. Write down the decay scheme of a free neutron

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35. $._1H^1 + ._1H^1 + ._1H^1 + ._1H^1 \rightarrow ._2He^4 + 2$ _____ .

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36. What are thermal neutrons ? Why are neutrons considered as ideal particles for nuclear fission ?

Watch Video Solution

37. What are the basic differences between natural and artificial radioactivity ?

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38. $._1H^2 + ._1H^2 \rightarrow ._2He^4 + Q$. In this reaction the masses of deuterium and helium atoms are 2.0141 u and 4.0024 u respectively. What is this process called, and what is the energy released Q , in MeV

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39. What are the similarities and dissimilarities of the nuclei of two isobars C^{14} and N^{14}?

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40. An artificial radioisotope $._{15}P^{31}$ can be prepared by disintegrating $._{13}Al^{27}$ nucleus with alpha particles. Later on it emits a positron and is converted into $._{14}Si^{31}$ nucleus. Write down the transition equations.

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41. From the nucleus of a Polonium atom $._{84}Po^{218}$, an α-particle and two β-particles are emitted successively due to radioactive disintegration. What will be the nuclei produced in these steps ?

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42. In a radioactive disintegration a nucleus emits an α-particle first and then two β-particles. Show that the final nucleus thus formed is the isotope of the first.

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43. Mass of a proton or a neutron is approximately 939 MeV, but unified atomic mass unit is approximately 931 MeV. What is the reason of this difference ?

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44. Half-life of radium is 1622 years'- what do you mean by this statement ?

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45. Positively charged protons and neutral neutrons are packed inside the atomic nucleus. But protons, though similarly charged, do not repel each other. How do you account for this phenomenon?

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46. Complete the nuclear reaction and explain the result thus obtained : ${}_7N^{14} + {}_2He^4 \rightarrow$ .....

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47. Explain why nuclear fission should precede nuclear fusion ?

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48. Nuclear force is charge independent -what do you mean by this statement ?

Watch Video Solution

49. Atomic nuclei do not contain any electrons, yet electrons come out of them in β-decay. Explain how it is possible .

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50. Nuclear fission, as a source of energy, can be used for the benefit of mankind'- discuss in short .

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51. I unified atomic mass unit is equivalent to 931.2 MeV of energy. What is the meaning of this

equivalence ?

Watch Video Solution

52. What is the basic difference in the use of 'radio-carbon clock' and 'uranium clock' ?

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53. Complete the following equations :

$_{\cdot 88}Ra^{226} \rightarrow {}_{\cdot 86}Rn^{222} +$ ____

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54. Complete the following nuclear equations :

$$._4Be^9 + ._2He^4 \rightarrow _{\_} \quad _{-+} \; ._0n^1$$

Watch Video Solution

55. Complete the following nuclear equations :

$$._7N^{14} + ._0N^1 \rightarrow _{\_} \quad _{-+} \; ._1H^1$$

Watch Video Solution

56. Complete the following nuclear equations :

$$._6C^{14} \rightarrow _{\_} \quad _{\_} \; + \; ._{-1}\beta^0$$

Watch Video Solution

57. Complete the following nuclear equations :

$$._{13}Al^{27} +_{\_}{}^{\_} \rightarrow ._{14}Si^{28} + ._{-1}\beta^{0}$$

Watch Video Solution

58. Complete the following nuclear equations :

$$._{92}U^{235} + ._{0}n^{1} \rightarrow ._{56}Ba^{141} + ._{36}Kr^{92} +_{\_}{}^{\_} ._{0}n^{1}$$

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59. A radioactive nucleus X decays as follows :

$$A \xrightarrow{\beta^+} A_1 \xrightarrow{\alpha} A_2$$

If the mass number and atomic number of A_2 are 176

and 71 respectively, what are the mass numbers and the atomic numbers of A_1 and A? Which of these three elements are isobars?

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60. The mass of a proton is 1.00816 u and that of a neutron is 1.00902 u. If the mass of a deuterium nucleus $\left({}_1H^2\right)$ is 2.01479 u, then what will be the binding energy of this nucleus ? (1 u = 931.2 MeV)

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61. At a given time, 25% of the nuclei present in a sample is radioactive. After 10 s that amount reduces to 12.5%. After what time from the beginning, 0.78% of the nuclei present in the sample would be radioactive?

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62. The masses of a proton and a neutron are 1.0073 u and 1.0087 u , respectively. If the mass of an O^{16} nucleus is 15.990525 u, then find out its binding energy per nuclear .

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63. If 1 u = 1.66×10^{-27} kg and average radius of a nucleus is 1.2×10^{-15} m, then determine the radius and density of a Ra^{226} nucleus.

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64. The rate of disintegration of a radioactive element at any instant is 10^3 dps. If the half-life of that element is 1 second, then what is its rate of disintegration after 1 second and after 3 second?

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65. The half-life of a radioactive element is 8 d . If the initial mass of the element be 1 g then what amount of it will be disintegrated in 24 d ?

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66. The half-life of a radioactive element is 1600 y. What part of the element will remain after 6400 y ?

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67. The half-life of a radioactive element is 3 min. If the initial mass of the element be 1 g then after what time 0.0625 g of the element remains intact?

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68. Initial mass of a radioactive element is 1 g. If 0.25 g of the element remains intact after 6 min then determine the half-life of the element .

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69. The half-life of a radioactive element is 1600 y. After what time 10% of that element present in any radioactive sample will disintegrate?

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70. One-fourth part of a radioactive element is disintegrated in 664 y. Determine the half-life of the element .

Watch Video Solution

71. The half-life of U^{238} is 4.5×10^9 y. In any radioactive sample if 1 g. of that element remains present then determine the activity of the sample in curie unit.

(Avogadro number = 6.023×10^{23}).

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72. The activity of 1 g. of a sample of Po^{210} is 4442 Ci. Determine the half-life of the element. (Avogadro's number = 6.023×10^{23})

Watch Video Solution

73. The half-life of an isotope of carbon is 6000 y. In how many years the amount this isotope in a sample will be $\frac{1}{8}$th part of its initial amount?

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74. The half-life of a radioactive element is 2h. If its initial mass be 5 g., then determine the residual mass of the element after 10 h.

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75. The half-life of Radon is 3.8 d. After how many days $\frac{1}{20}$ part of some amount of Radon will remain intact?

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76. If a radioactive substance disintegrates by 20% in 5d, then what part of the initial mass of the substance

will remain intact after 15 d?

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77. Radioactive isotope Th^{232} (Z = 90) emits six α-particles and four β-particles successively. What will be the mass number and atomic number of the isotope thus produced? Identify the element.

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78. The half-life of a radio-isotope is 3 min. What fraction of the number of these isotopes in a sample would remain intact after 15 min ?

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79. One -fourth of the amount of a radioactive element decays is 2490 years . Find out the half-life of this element .

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80. The half-life of Radium-226 is 1600 years. What will be the activity of a sample containing 1 mg of this element. Given, Avogadro number = $6.023 \times 10^{23}. mol^{-1}$.

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81. The activity of 1 g of Pb^{210} is 77.4 curie. Find its half life. Given, Avogadro number = $6.023 \times 10^{23} mol^{-1}$, and 1 curie = 3.7×10^{10} decay per second.

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82. A radioactive isotope has a half-life of T years. How long will it take for the activity to reduce to 3.125% of its original value?

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83. The nuclei P and Q have equal number of atoms at t = 0. Their half-lives are 3 hr and 9 hr respectively. Compare their rates of disintegration after 8 hour from the start.

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84. The half-life of $._{92}^{238}U$ undergoing α-decay is 4.5×10^9 year. What is the activity of 1 g. sample of $._{92}^{238}U$?

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85. The binding energies of deuterium $\left(._1 H^2\right)$ and helium $\left(._2 He^4\right)$ per nucleon are 1.1 MeV and 7.0 MeV respectively . When a helium nucleus $\left(._2 He^4\right)$ is formed by fusion of two deuterium nuclei then how much energy will be evolved ?

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Entrance Corner

1. Statement I: Negative charges are never emitted from the nucleus of an atom.

Statement II: Nucleus of an atom is constituted only

of protons and neutrons.

(A) Statement I is true, statement II is true, statement II is a correct explanation for statement I.

(B) Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

(C) Statement I is true, statement II is false.

(D) Statement I is false, statement II is true.

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I

B. Statement I is true , statement II is true , statement II is not a correct explanation for

statement I

C. Statement I is true , statement II is false

D. Statement I is false, statement II is true .

Answer: D

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2. Statement 1: Mass of O^{16} nucleus is less than the sum of masses of 9 protons and 8 neutrons.

Statement 2: Some internal energy is needed to keept the protons and neutrons bound in the nucleus.

(A) Statement 1 is true, Statement 2 is true. Statement

2 is not a correct explanation for statement 1.

(B) Statement 1 is true, Statement 2 is true. Statement 2 is a correct explanation for statement 1.

(C) Statement 1 is true, Statement 2 is false.

(D) Statement 1 is false, Statement 2 is true.

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I

B. Statement I is true , statement II is true , statement II is not a correct explanation for statement I

C. Statement I is true , statement II is false

D. Statement I is false, statement II is true .

Answer: A

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3. Statement I: At any specific instant, the activity of radium-226 is less than Polonium-210 for equal mass of sample because the half-life of radium and that of polonium are 1600 y and 140 d respectively.

Statement II: The activity of a radioactive sample is proportional to its decay constant.

(A) Statement I is true, statement II is true, statement

II is a correct explanation for statement I.

(B) Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

(C) Statement I is true, statement II is false.

(D) Statement I is false, statement II is true.

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I

B. Statement I is true , statement II is true , statement II is not a correct explanation for statement I

C. Statement I is true , statement II is false

D. Statement I is false, statement II is true .

Answer: A

4. Statement I:Some energy is released when a heavy nucleus disintegrate into two nuclei of moderate size. Statement II: The more the mass number of the nucleus , more is the binding energy for each proton or neutron

A. Statement I is true , statement II is true , statement II is a correct explanation for

statement I

B. Statement I is true , statement II is true , statement II is not a correct explanation for statement I

C. Statement I is true , statement II is false

D. Statement I is false, statement II is true .

Answer: C

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5. Statement I: No natural radioisotope can emit positron.

Statement II: Some artifically transmuted isotopes show radioactivity - some of these may emit positrons.

(A) Statement I is true, statement II is true, statement II is a correct explanation for statement I.

(B) Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

(C) Statement I is true , statement II is false.

(D) Statement I is false, statement II is true.

A. Statement I is true , statement II is true , statement II is a correct explanation for statement I

B. Statement I is true , statement II is true , statement II is not a correct explanation for statement I

C. Statement I is true , statement II is false

D. Statement I is false, statement II is true .

Answer: C

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6. Statement 1: The greater the decay constant of a radioactive element, the smaller is its half-life.

Statement 2: An element, although radioactive, can

last longer, if its decay with time is slow.

(A) Statement 1 is correct, Statement 2 is correct. But, Statement 2 is not the correct explanation of Statement 1.

(B) Statement 1 is correct, Statement 2 is correct. Statement 2 is the correct explanation of Statement 1.

(C) Statement 1 is correct, Statement 2 is incorrect.

(D) Statement 1 is incorrect, Statement 2 is correct.

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7. A radioactive isotope X^A becomes Y^{A-4} after decay. Which of the following radioactive emissions

are not possible in this case?

(A) α

(B) β

(C) meson

(D) positron

A. α

B. β

C. meson

D. positron

Answer: B::C::D

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8. A radioactive isotope X^A becomes Y^A after disintegration which of the following radioactive emissions are not possible in the case?

(A) α

(B) β

(C) meson

(D) positron

A. α

B. β

C. meson

D. positron

Answer: A::D

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9. In case of a radioactive element which of the following relations are not correct where, λ = decay constant, T = half life and τ = mean life?

(A) $\tau = \frac{1}{\lambda}$

(B) $\tau = \frac{0.693}{\lambda}$

(C) $\tau = 0.6T$

(D) $\tau = \frac{T}{0.693}$

A. $\tau = \frac{1}{\lambda}$

B. $\tau = \frac{0.693}{\lambda}$

C. $\tau = 0.6T$

D. $\tau = \frac{T}{0.693}$

Answer: b,c

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10. When α-rays and β-rays are compared as radioactive radiation, it is found that -

(A) Deflection of β-particles in electric or magnetic field is comparatively larger.

(B) Penetration power of β-particles is more.

(C) Ionisation power of β -particles is more.

(D) Velocity of β -particles is more.

A. deflection of β-particles in electric or magnetic field is comparatively larger

B. penetration power of β-particles is more

C. ionisation power of β -particles is more

D. velocity of β -particles is more

Answer: a,c

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11. Ratio of mass number of two nuclei is 1:8, then -

(A) ratio of diameter = 1:4

(B) ratio of diameter = 1:2

(C) ratio of volume = 1:8

(D) ratio of volume : 1:4

A. ratio of diameter = 1:4

B. ratio of diameter = 1:2

C. ratio of volume = 1:8

D. ratio of volume : 1:4

Answer: a,b,d

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12. In any nuclear reaction -

(A) The total number of protons and neutrons remains same before and after the reaction.

(B) Increase or decrease in the number of protons is equal to the decrease or increase in the number of neutrons.

(C) Kinetic energy of the incident particle is approximately 8 MeV or its equivalent.

(D) Some energy is released if total mass is reduced.

A. the total number of protons and neutrons remains same before and after the reaction

B. increase or decrease in the number of protons is equal to the decrease or increase in the number of neutrons

C. kinetic energy of the incident particle is approximately 8 MeV or its equivalent

D. some energy is released if total mass is reduced.

Answer: a, d

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13. The initial number of radioactive atoms in a radioactive sample is N_0. If after time t the number of becomes N, then $N = N_0 e^{-\lambda t}$, where λ is known as the decay constant of the element. The time in which the number of radioactive atoms becomes half of its initial number is called the half-life (T) of the element. The time in which the number of atoms falls to 1/e times of its initial number is the mean life (τ) of the element. The product λN is the activity (A) of the radioactive sample when the number of atoms is N. The SI unit of activity is bequerel (Bq)' where 1 Bq = 1 decay.s^{-1},

The half-life of Iodine-131 is 8d. Its decay constant (in SI) is -

(A) 10^{-6}

(B) 1.45×10^{-6}

(C) 2×10^{-6}

(D) 2.9×10^{-6}

A. 10^{-6}

B. 1.45×10^{-6}

C. 2×10^{-6}

D. 2.9×10^{-6}

Answer: (A)

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14. The initial number of radioactive atoms in a radioactive sample is N_0. If after time t the number of becomes N, then $N = N_0 e^{-\lambda t}$, where λ is known as the decay constant of the element. The time in which the number of radioactive atoms becomes half of its initial number is called the half-life (T) of the element. The time in which the number of atoms falls to 1/e times of its initial number is the mean life (τ) of the element. The product λN is the activity (A) of the radioactive sample when the number of atoms is N. The SI unit of activity is bequerel (Bq)' where 1 Bq = 1 decay.s^{-1}.

The half-life of Iodine-131 is 8 d. Its mean life (in SI) is -

(A) 4.79×10^5 s.

(B) 6.912×10^5 s.

(C) 9.974×10^5 s.

(D) 22.96×10^5 s.

A. 4.79×10^5

B. 6.912×10^5

C. 9.974×10^5

D. 22.96×10^5

Answer: c

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15. The initial number of radioactive atoms in a radioactive sample is N_0. If after time t the number of becomes N, then $N = N_0 e^{-\lambda t}$, where λ is known as the decay constant of the element. The time in which the number of radioactive atoms becomes half of its initial number is called the half-life (T) of the element. The time in which the number of atoms falls to 1/e times of its initial number is the mean life (τ) of the element. The product λN is the activity (A) of the radioactive sample when the number of atoms is N. The SI unit of activity is bequerel (Bq)' where 1 Bq = 1 decay.s^{-1}.

The half-life of Iodine-131 is 8 d. What is the activity (in

Bq) of 1 g of Iodine?

(A) 2.3×10^{15}

(B) 4.6×10^{15}

(C) 6.9×10^{15}

(D) 9.2×10^{15}

A. 2.3×10^{15}

B. 4.6×10^{15}

C. 6.9×10^{15}

D. 9.2×10^{15}

Answer: (B)

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16. The initial number of radioactive atoms in a radioactive sample is N_0. If after time t the number of becomes N, then $N = N_0 e^{-\lambda t}$, where λ is known as the decay constant of the element. The time in which the number of radioactive atoms becomes half of its initial number is called the half-life (T) of the element. The time in which the number of atoms falls to 1/e times of its initial number is the mean life (τ) of the element. The product λN is the activity (A) of the radioactive sample when the number of atoms is N. The SI unit of activity is bequerel (Bq)' where 1 Bq= 1 decay. s^{-1}.

After how many days the activity of Iodine-131 will be $\frac{1}{16}$th of its initial value. [The half-life of Iodine-131 is 8 d.]

(A) 24 d

(B) 32 d

(C) 40 d

(D) 48 d

A. 24d

B. 32 d

C. 40 d

D. 48 d

Answer: b

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17. The initial number of radioactive atoms in a radioactive sample is N_0. If after time t the number of becomes N, then $N = N_0 e^{-\lambda t}$, where λ is known as the decay constant of the element. The time in which the number of radioactive atoms becomes half of its initial number is called the half-life (T) of the element. The time in which the number of atoms falls to 1/e times of its initial number is the mean life (τ) of the element. The product λN is the activity (A) of the radioactive sample when the number of atoms is N.

The SI unit of activity is bequerel (Bq)' where 1 Bq = 1 decay.s^{-1}, and Avogadro's number, $N = 6.023 \times 10^{23}$

What is the ratio of activity of same amount of sodium-24 to that of iodine-131? [half life of sodium-24 is 15h.]

(A) 1/70

(B) 1/7

(C) 7

(D) 70

A. $\frac{1}{70}$

B. $\frac{1}{7}$

C. 7

D. 70

Answer: (D)

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18. What is the ratio of radius of aluminium-27 nucleus to that of a proton ?

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19. What is the value of k in the following nuclear reaction ?

$U^{235} + n \rightarrow Ba^{141} + Kr^{92} + 3x^{k}$ (n is the symbol of neutron)

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20. The half-life of iodine-131 is 8d. In how many days its activity will be $\frac{1}{\sqrt{2}}$ part of its initial value ?

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21. Radioisotope carbon-14 is a β-emitter. What is the atomic number of the daughter element ?

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22. The amount of radium in a radioactive sample is 16 g. What amount of radium will remain in the same after 4800 y if the half-life of radium is 1600 y ?

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23. The equation of a nuclear fusion: 4 protons $\rightarrow$ X +2 positrons .What is the mass number of X ?

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24. The equation of a nuclear fusion : 2 deuteron $\rightarrow$ X +1 neutron

What is the atomic number of X ? (deuteron is the nucleus of deuterium or heavy hydrogen)

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Examination Archive

1. State radioactive decay law , write down the relation between radius of the nucleus and mass number of an atom.What is isotone ? Give an example .

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2. Draw the variation of binding energy per nucleon with mass number of atoms and indicate the stable and unstable regions on the diagram.

View Text Solution

3. Define binding energy and mass defect of a necleus . What is the relation between the binding energy and mass defect of a nucleus ?

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4. Write down the equation of β-decay . Why is the detection of neutrinos difficult ?

Watch Video Solution

5. Why is nuclear fusion reaction called a thermonuclear reaction ?

Watch Video Solution

6. In a nuclear decay, a nucleus emits one α-particle and then two β-particles one after another . Show

that the final nucleus is an isotope of the former nucleus .

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7. A radioactive element emits 2 α-particles and 3 β-particles . The values of atomic number (Z) and mass number (A) of the new element will be -

(A) (A+5), (Z-1)

(B) (A-5), (Z+1)

(C) (A-8), (Z-1)

(D) (A-8), (Z+1)

A. (A+5),(Z-1)

B. (A-5),(Z+1)

C. (A-8),(Z-1)

D. (A-8),(Z+1)

Answer: c

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8. Draw the curve showing the variation of binding energy per nucleon as a function of mass number A. Explain the stability of the nucleus from the curve .

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9. $R = R_0 A^{1/3}$ (R_0 = constant, A = Mass Number), R = radius of nucleus. Taking the relation show that of nuclear density does not depend on mass number A.

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10. What is meant by activity of a radioactive substance? Write its SI unit.

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11. Half-life of a radioactive substance is 30 days. Number of atoms in the substance is 10^{12}. How many disintegration of atoms per second does occur?

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12. For the radioactive nuclei that undergo either α or β decay, which one of the following cannot occur?

(A) Isobar of original nucleus if produced

(B) Isotope of the original nucleus is produced

(C) Nuclei with higher atomic number than that of the original nucleus is produced.

(D) Nuclei with lower atomic number than that of the original nucleus is produced.

A. Isobar of original nucleus if produced

B. isotope of the original nucleus is produced

C. Nuclei with higher atomic number than that of the original nucleus is produced .

D. Nuclei with lower atomic number than that of the original nucleus is produced

Answer: B

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13. Radon-222 has a half-life of 3.8 days. If one starts with 0.064 kg of Radon-222 the quantity of Radon-222 left after 19 days will be -

(A) 0.002 kg.

(B) 0.062 kg.

(C) 0.032 kg.

(D) 0.024 kg.

A. 0.002 kg

B. 0.062 kg

C. 0.032 kg

D. 0.024 kg

Answer: A

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14. If the half-life of a radioactive nucleus is 3 days, nearly what fraction of the initial number of nuclei will decay on the 3rd day? (Given, $3\sqrt{0.25} \approx 0.63$).

A. 0.63

B. 0.37

C. 0.5

D. 0.13

Answer: D

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15. Half-lives of two radioactive elements A and B are 20 minutes and 40 minutes, respectively. Initially, the samples have equal number of nuclei. After 80 minutes, the ratio of decayed numbers of A and B nuclei will be -

(A) $1:16$

(B) $4:1$

(C) $1:4$

(D) $5:4$

A. $1:16$

B. $4:1$

C. $1:4$

D. $5:4$

Answer: D

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16. A radioactive nucleus A with a half-life T, decays into a nucleus B. At t=0, there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by -

(A) $t = \frac{T}{2}\frac{\log 2}{\log 1.3}$

(B) $t = T\frac{\log 1.3}{\log 2}$

(C) $t = T\log(1.3)$

(D) $t = \dfrac{T}{\log(1.3)}$

A. $t = \dfrac{T}{2}\dfrac{\log 2}{\log 1.3}$

B. $t = T\dfrac{\log 1.3}{\log 2}$

C. $t = T\log(1.3)$

D. $t = \dfrac{T}{\log(1.3)}$

Answer: B

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17. The binding energy per nucleon of ${}_{3}^{7}Li$ and ${}_{2}^{4}He$ nuclei are 5.60 MeV and 7.06 MeV respectively. In the

nuclear reaction $._3^7 Li + ._1^1 H \rightarrow 2._2^4 He + Q$, the value of energy Q released is

A. 19.6 MeV

B. -2.4 MeV

C. 8.4 MeV

D. 17.3 MeV

Answer: D

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18. A radioisotope Y with half-life 1.4×10^9 years decays to X which is stable. A sample of the rock from

a cave was found to contain X and Y in the ratio $1:7$.

The age of the rock is -

(A) 1.96 × 10^9 years.

(B) 3.92 × 10^9 years.

(C) 4.20 × 10^9 years.

(D) 8.40 × 10^9 years.

A. 1.96×10^9 years

B. 3.92×10^9 years

C. 4.20×10^9 years

D. 8.40×10^9 years

Answer: C

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19. If radius of the ${}_{13}^{27}Al$ nucleus is taken to be R_{Al} , then the radius of ${}_{53}^{125}Te$ nucleus is nearly

A. $\left(\frac{53}{13}\right)^{1/3} R_{\mathrm{Al}}$

B. $\frac{5}{3} R_{\mathrm{Al}}$

C. $\frac{3}{5} R_{\mathrm{Al}}$

D. $\left(\frac{13}{53}\right)^{1/3} R_{\mathrm{Al}}$

Answer: B

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20. The energy liberated per nuclear fission is 200 MeV. If 10^{20} fissions occur per second the amount of power produced will be

A. 2×10^{22} W

B. 32×10^{8} W

C. 16×10^{8} W

D. 5×10^{11} W

Answer: B

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21. For a radioactive material , half-life is 10 minutes . If initially there are 600 number of nuclei , the time taken (in minutes) for the disintegration of 450 nuclei is

A. 3

B. 10

C. 20

D. 15

Answer: C

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1. Draw a plot of potential energy of a pair of nucleons as a function of their separations. Mark the regions where the nuclear force is (i)attactive and (ii)repulsive . Write any two characteristic features of nuclear forces.

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2. Define the activity of a given radioactive substance. Write its SI unit.

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3. Draw the plot of binding energy per nucleon (B.E./A) as a function of mass number A. Write two important conclusions that can drawn regarding the nature of nuclear force.

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4. Use this graph to explain the release of energy in both the processes of nuclear fusion and fission

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5. Write the basic nuclear process of neutron undergoing β-decay . Why is the detection of neutrons found very difficult ?

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6. Why is it found experimentally difficult to detect neutrinos in nuclear β-decay ?

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7. Define the Activity of a radioactive sample. Write its S.I. unit. A radioactive sample has activity of 10000

disintegrations per second (dps) after 20 hours. After next 10 hours its Activity reduces to 5000 dps. Find out its half-life and initial activity.

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8. Derive the mathematical expression for law of radiactive decay for a sample of a radiactive nucleus .

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9. How is the mean life of a given radiaoactive nucleus related to the decay constant ?

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10. A radioactive nucleus 'A' undergoes a series of decays as given below:

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4.$$

The mass number and atomic number of A_2 are 176 and 71 respectively. Determine the mass and atomic numbers of A_4 and A.

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11. Write the basic nuclear processes underlying β^+ and β^- decays.

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12. Four nuclei of an element undergo fusion to form a heavier nucleus , with release of energy . Which of the two - the parent or the daughter nucleus - would have higher binding energy per nucleon ?

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13. Explain the processes of nuclear fission and nuclear fusion by using the plot of binding energy per nucleon (BE/A) versus the mass number A

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14. A radioactive isotope has a half-life of 10 years. How long will it take for the activity to reduce to 3.125% ?

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