PHYSICS

NCERT - FULL MARKS PHYSICS(TAMIL)

NUCLEI

Examples

1. Given the mass of iron nucleus as $55.85u$ and $A = 56$, the nuclear density is

$(u = 1.66 \times 10^{-27} kg, r = 1.2 \times 10^{-15} m)$

Watch Video Solution

2. Calculate the energy equivalent of 1g of substance.

Watch Video Solution

3. Find the energy eqivalent of one atomic mass unit, first in Joules and then in MeV. Using this express the mass defect of ${}^{16}_{8}O$ in MeV/e^2.

Watch Video Solution

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

Watch Video Solution

5. Tritium has a half life of 12.5 years against beta decay. What fraction of a sample of pure tritium will remain undecayed after 25 years?

Watch Video Solution

6. By using the following atomic masses : $._{92}^{238}U = 238.05079u.$

$._{2}^{4}He = 4.00260u, ._{90}^{234}Th = 234.04363u.$

$._{1}^{1}H = 1.007834, ._{91}^{237}Pa = 237.065121u$ (i) Calculate the energy released during the $\alpha -$ decay of $._{92}^{238}U.$

(ii) Show that $._{92}^{238}U$ cannot spontaneously emit a proton.

Watch Video Solution

7. Answer the following questions:

a) Are the equations of nuclear reactions 'balanced' in the sense a chemical equation (e.g., 2H2 + O2 → 2 H2O) is? If not, in what sense are they balanced on both sides?

b) If both the number of protons and the number of neutrons are conserved in each nuclear reaction, in what way is mass converted into energy (or vice-versa) in a nuclear reaction?

c) A general impression exists that mass-energy interconversion takes place only in nuclear reaction and never in chemical reaction. This is strictly speaking, incorrect. Explain.

Watch Video Solution

Exercise

1. (a) Two stable isotope of $._3 Li^6$ and $._3 Li^7$ have respective abundances of 7.5% and 92.5%. These isotopes have masses 6.01512 and 7.01600 u respectively. Find the atomic weight of lithium.

(b) Boron has two stable isotopes $._5 B^{10}$ and $._5 B^{11}$. Their respective masses are 10.01294 u and 11.00931 u, and the atomic weight of boron is 10.81 u. Find the abundances of $._5 B^{10}$ and $._5 B^{11}$.

Watch Video Solution

2. The three stable isotopes of neon $._{10} Ne^{20}$, $._{10} Ne^{21}$ and $._{10} Ne^{22}$ have respective abundances of 90.51%, 0.27% and 9.22%. The atomic masses of the three isotopes are $19.99u$, $20.99u$ and $21.99u$ respectively. Obtain the average atomic mass of neon.

Watch Video Solution

3. Obtain the binding energy (in MeV. Of a nitrogen nucleus $\left(._7^{14}N\right)$, given m $\left(._7^{14}N\right) = 14.00307u.$

Watch Video Solution

4. Obtain the binding energy of the nuclei $._{26}Fe^{56}$ and $._{83}Bi^{209}$ in units of MeV from the following data: $m\left(._{26}Fe^{56}\right) = 55.934939a.m.u.$, $m = \left(._{83}Bi^{209}\right) = 208.980388amu.$ Which nucleus has greater binding energy per nucleon? Take $1a.m.u = 931.5MeV$

Watch Video Solution

5. A given coin has a mass of 3.0g. What is 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 $._{29}^{63}Cu$ atoms (of mass 62.9260 u).

Watch Video Solution

Watch Video Solution

6. Write nuclear reaction equation for

(i) α decay of $._{88}Ra^{226}$ (ii) α decay of $._{94}Pu^{242}$ (iii) β^{-} decay of $._{15}P^{32}$ (iv) β^{-} decay of $._{83}Bi^{210}$ (v) β^{+} decay of $._{6}C^{11}$ (vi) β^{+} decay of $._{43}Tc^{97}$ (vii) Electron capture of $._{54}Xe^{120}$.

Watch Video Solution

7. A radioactive isotope has a life of T years. How long will it take the activity to reduce to (a) 1% of its original activity?

Watch Video Solution

8. The normal activity of living carbon -containing matter is found to be about 15 decay per minute for every gram of carbon. This activity arises form the small proportion of radioactive $._{6}C^{14}$ present with the ordinary $._{6}C^{12}$ isotope. When the organism is dead, its interaction with the atmosphere which maintains the above equilibrium activity, ceases and its activity begins to drop. from the known half life (=5730years) of $._6 C^{14}$, and the measured activity, the age of the specimen can be approximately estimated. This is the principle of $._6 C^{14}$ dating used in archaeology. Suppose a specimen from Mohenjo - daro gives an activity of 9 decays per minute per gram of carbon. Estimate the approximate age of the Indus Valley Civilization.

Watch Video Solution

9. Obtain the amount of $.^{60} Co$ necessary to provide a radioactive source of $8.0Ci$ strength. The half-life of $.^{60} Co$ is 5.3 years?

Watch Video Solution

10. The half life of $._{38}^{90} Sr$ is 28 years. The disintegration rate of 15 mg of this isotope is of the order of

Watch Video Solution

11. Obtain approx. the ratio of the nuclear radii of the gold isotope $._{79}Au^{197}$ and silver isotope $._{47}Ag^{107}$.

Watch Video Solution

12. Find the Q-value and the kinetic energy of the emitted α-particle in the α-decya of (a) $_{88}^{226}Ra$ and (b) $_{86}^{220}Rn$.

Given $m\left(_{88}^{226}Ra\right) = 226.02540u$, $m\left(_{86}^{222}Rn\right) = 222.01750u$.

$m\left(_{86}^{220}Rn\right) = 220.01137u$, $m\left(_{84}^{216}Po\right) = 216.00189u$.

Watch Video Solution

13. The radionuclide $._6C^{11}$ decays according to $._6C^{11} \rightarrow ._5B^{11} + e^+ + v$: half life =20.3min. The maximum energy of the emitted positron is $0.960MeV$. Given the mass values

$m(._6C^{11}) = 11.011434u, m(._6B^{11}) = 11.009305u$

Calculate Q and compare it with maximum energy of positron emitted.

Watch Video Solution

14. The nucleus $._{}^{23}Ne$ deacays by β-emission into the nucleus $._{}^{23}Na$. Write down the β-decay equation and determine the maximum kinetic energy of the electrons emitted. Given,$\left(m\left(._{11}^{23}Ne\right)=22.994466amu\right.$ and $m\left(._{11}^{23}Na=22.989770amu\right.$. Ignore the mass of antineuttino $(\bar{v})$.

Watch Video Solution

15. The Q value of a nuclear reaction

A+b=C+d is defined by $Q=[m_A+m_b-m_C-m_d]c^2$ where the masses refer to the respective nuclei. Determine form the given data the Q value of the following reactions and state whether the reactions are exothermic of endothermic.

(i) $._1H^1+._1H^3\rightarrow._1H^2+._1H^2$

(ii) $._6C^{12}+._6C^{12}\rightarrow._{10}Ne^{20}+._2He^4$

Atomic masses are given to be

$m\left(._1H^2\right)=2.014102u, m\left(._1H^3\right)=3.016049u, m\left(._6C^{12}\right)=12.000000u,$

Watch Video Solution

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

Watch Video Solution

17. The fission properties of $._{84}Pu^{239}$ are very similar to those of $._{92}U^{235}$. The average energy released per fission is $180MeV$. How much energy in MeV is released if all the atoms in 1kg of pure $._{94}Pu^{239}$ undergo fission.

Watch Video Solution

18. A 1000 MW fission reactor consumes half of its fuel in 5.00y. How much $._{92}U^{235}$ did it contain initially? Assume that the reactor operates 80% of the time and that all the energy generated arises form the fission of $._{92}U^{235}$ and that this nuclide is consumed by the fission process.

Watch Video Solution

19. How long can an electric lamp of 100W be kept glowing by fusion of 2.0 kg of deuterium? The fusion reaction can be taken as $._{1}H^{2} + ._{1}H^{2} \rightarrow ._{1}H^{3} + n + 3.17MeV$

Watch Video Solution

20. Calculate the height of the potential barrier for a head on collision of two deuterons. (Hint: The height of the potential barrier is given by the Coulomb repulsion between the two deuterons when they just touch each other. Assume that they can be taken as hard spheres of radius 2.0 fm.)

Watch Video Solution

21. from the relation $R = R_0 A^{1/3}$, where R_0 is a constant and A is the mass number of a nucleus, show that the nuclear matter density is nearly constant (i.e., independent of A).

Watch Video Solution

22. For the β^+ (positron) emission from a nucleus, there is another competing process known as electron capture (electron from an inner orbit, say, the K-shell, is captured by the nucleus and a neutrino is emitted).

$e^+ + {}_Z^A X \rightarrow {}_{Z-1}^{A} Y + \upsilon$

Show that if β^+ emission is energetically allowed, electron capture is necesarily allowed but not vice - versa.

Watch Video Solution

Additional Exercises

1. In a periodic table, the average atomic mass of magnesium is given as $24.312u$. The average value is based on their relative natural abundance on earth. The three isotopes and their masses are $._{12}Mg^{24}(23.98504u)$, $._{12}Mg^{25}(24.98584)$ and $._{12}Mg^{26}(25.98259u)$. The natural abundance of $._{12}Mg^{24}$ is 78.99% by mass. Calculate the abundances of the other two isotopes.

Watch Video Solution

2. The neutron separation energy is defined to be the energy required to remove a neutron form nucleus. Obtain the neutron separation energy of the nuclei $._{20}Ca^{41}$ and $._{13}Al^{27}$ from the following data : $m(._{20}Ca^{40}) = 39.962591u$ and $m(._{20}Ca^{41}) = 40.962278u$ $m(._{13}Al^{26}) = 25.986895u$ and $m(._{13}Al^{27}) = 26.981541u$

Watch Video Solution

3. A source contains two phosphorus radionuclides $._{15}P^{35}(T_{1/2} = 14.3\text{days})$ and $._{15}P^{33}(T_{1/2} = 25.3\text{days})$. Initially, 10% of the decays come from $._{15}P^{35}$. How long one must wait until 90% do so?

Watch Video Solution

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

$._{88}Ra^{223} \rightarrow ._{82}Pb^{209} + ._{6}C^{14}, ._{88}Ra^{223} \rightarrow ._{86}Rn^{219} + ._{2}He^{4}$

(a) Calculate the Q-values for these decays and determine that both are energetically allowed.

Watch Video Solution

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

$m(._{92}U^{238}) = 238.05079u, m(._{58}Ce^{140}) = 139.90543u, m(._{34}Ru^{99}) = 98.$

Watch Video Solution

6. Consider the so called D-T reaction (deuterium-tritium fusion)

$._{1}H^{2} + ._{1}H^{3} \rightarrow ._{2}He^{4} + n$

Calculate the energy released in MeV in this reaction from the data

$m(._{1}H^{2}) = 2.014102u, m(._{1}H^{3}) = 3.016049u$

(b) Consider the radius of both deuterium and tritium to be approximately 2.0fm. what is the kinetic energy needed to overcome the Coulomb repulsion between the two nuclei? To what temperature must the gases the be heated to initiate the reaction?

Watch Video Solution

7. Obtain the maximum kinetic energy of b-particles, and the radiation frequencies of g decays in the decay scheme shown in Fig. You are given that

$m\left({}_{8}^{19}Au\right) = 197.968233u$

$m\left({}_{8}^{19}Hg\right) = 197.966760u.$

View Text Solution

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

Watch Video Solution

9. Suppose India has a target of producing by $2020AD$, $200, 000MW$ of electric power, ten percent of which was to be obtained from nuclear power plants. Suppose we are given that, on an avedrage, the efficiency of utilization(i.e conversion to electric energy) of thermal energy produced in a reactor was 25%. How much amount of fissionable uranium would our country need per year by 2020? Take the heat energy per fission of $.^{235}U$ to be about $200MeV$.

Watch Video Solution