Chapter One / Home works

Q1/ State the number of neutrons, protons and the amount of charge in each of the following nuclei; $_3^7$Li , $_{10}^{22}$Ne , $_{40}^{94}$Zr , $^{180}_{72}$Hf.

Q2/ Calculate the density of nuclear matter in units of: tons/ mm^3, nucleons / fm^3.

Q3/ Calculate the distance of closet approach of alpha particle of kinetic energy 25 MeV from uranium $^{235}_{92}$U in head collision and which is scattered at angle 180^o.

Q4/ A beam of α –particles (kinetic energy 5.3 MeV) from $_{84}^{214}$Po, of intensity 10^4 particles / sec is incident normally on a gold foil of density 19.3 g /cm^3 and 10^{-5} cm thick. What is the number of scattered particles per second per unit area at angle 60^o, at a distance of 10 cm from the foil?

Q5/ What nuclei have radius equal to one-half the radius of **$_{92}^{236}$U** nucleus**?**

Q6/ calculate the nuclear radius of $^{107}_{47}$Ag, $_{92}^{235}$U nucleus in ferme meter (fm) and meters.

Q7/ Calculate the nuclear matter density of the ^{12}C nucleus in units of Kg / m^3.

Chapter Two / Home works

Q1/ Calculate the total binding energy and the average binding energy per nucleon for $_8^{16}$O nucleus.
Given that: M($_8^{16}$O) =15.9949 amu , M($^1_1$H) =1.007825 amu , M($_0^1$n) =1.008665 amu

Q2 /Calculate the separation energy of proton from $_8^{16}$O nucleus. given that:
M($_8^{16}$O) =15.9949 amu , M($_7^{15}$N) =15.0001 amu , M($^1_1$H) =1.007825 amu

Q3/ Calculate the separation energy of neutron from $_8^{16}$O nucleus, given that:
M($_8^{16}$O) =15.9949 amu , M($_8^{15}$O) = 15.003 amu , M(n) = 1.008665 amu

Q4/ Calculate the value of: **(a)** mass defect for uranium **$_{92}^{235}$U.** **(b)** the mass excess for **$_{92}^{235}$U.**

Q5/ Show that for a nucleus ^A_ZX: the separation energy of neutron is ;

$$S_n = B.E_{tot}(A,Z) - B.E_{tot}(A-1,Z)$$

Q6/ Calculate the binding energy and average binding energy per nucleon for then nucleus of $_{92}^{235}$U and $_2^4$He .

Q7/ Calculate the separation energy of the neutron and proton from $_{26}^{57}$Fe.

Q8/ The binding energy of neon isotope $_{10}^{20}$Ne is 160.647 MeV. Find its atomic mass.

Q9/Find the mass defect and mass excess of $_2^4$He nucleus.

Q10 / Show that 1 amu unit is equivalent to 931.48 MeV .

Q11/ Calculate the rest mass energy of proton in joule and MeV units.

Q12 / Show that for a nucleus ${}^{A}_{Z}X$, the separation energy of neutron S_n is:

S_n = B.E(A ,Z) – B.E(A-1,Z) .

Constants

Mass of hydrogen atom M_H = 1.007825 amu

Mass of neutron M_n = 1.008665 amu

Mass of ${}_{92}^{235}U$ atom=235.0439 amu

Mass of helium atom M(${}_{2}^{4}He$) = 4.002603 amu

Mass of iron atom M (${}_{26}^{57}Fe$) = 56.935396 amu

Mass of iron atom M (${}_{26}^{56}Fe$) = 55.934939 amu

Mass of Manganese atom M (${}_{25}^{56}Mn$) = 55.938907 amu

1 atomic mass unit (1 amu) =1.66×10^{-27} Kg.

Chapter Three / Home works

Q1/ Calculate the value of nuclear magneton (μ_N) in units of $J\,T^{-1}$ and $eV\,T^{-1}$, where (T) is tesla .

Q2/ Calculate the total binding energy of ${}_{13}^{27}Al$ nucleus from the semi-empirical binding energy formula .

Q3/According to single particle model (shell model), what is the spin and parity of the ground state of ${}_{19}^{39}K$ nucleus.

Q4/ Calculate the repulsive potential energy due to coulomb force among the protons of ${}^{235}_{92}U$ nucleus.

Q5 / Calculate the binding energy of ${}_{4}^{9}Be$ nucleus from semi –empirical binding energy formula .

Q6 / Calculate the mass of ${}_{4}^{9}Be$ nucleus from the semi –empirical mass formula.

Q7 / from semi-empirical binding energy formula derive an expression for the average binding energy for a nucleus with mass number **A** and atomic number **Z**.

Q8/ According to the shell model, what is the expected spin and parity of the ground state of ; ${}_{20}^{40}Ca$, ${}_{21}^{43}Ca$ nuclei.

Chapter Four/ Homework's

Q1 / The half-life of ${}^{226}Ra$ is 1620 years, Calculate;

a) The decay constant of ${}^{226}Ra$ in units of sec^{-1}

b) The number of radioactive atoms in 1g of ${}^{226}Ra$.

c) The activity of 1g of ${}^{226}Ra$.

Q2/ One milligram of polonium-210 (^{210}Po), half-life 138.3 days , is allowed to decay for 1Year ,what is its activity at the end of that time ?

Q3//

As an example, consider a piece of wood, weighing 50 g, which has an activity of 320 disintegrations/minute from ^{14}C. The corresponding activity in a living plant is 12 disintegrations/minute/gm, and we wish to determine the age of the wood. (The half-life of ^{14}C is $t_{\frac{1}{2}} = 5730$ yr, and $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$.) We are given that the initial and current activities are

$$\mathcal{A}(t=0) = 12/\text{min/gm},$$
$$\mathcal{A}(t) = \frac{320}{50}/\text{min/gm}.$$

From the definition of activity, we can relate the activities at our two times as follows

$$\mathcal{A}(t) = \left|\frac{dN}{dt}\right| = \lambda N(t) = \lambda N_0 e^{-\lambda t} = \mathcal{A}(t=0)e^{-\lambda t}.$$

Therefore, we obtain

$$\lambda t = \ln \frac{\mathcal{A}(t=0)}{\mathcal{A}(t)},$$

$$\text{or} \quad t = \frac{1}{\lambda} \ln\left(\frac{12 \times 50}{320}\right) \approx \frac{5730\text{yr}}{0.693} \times 0.626$$
$$\approx 5170 \text{ years.}$$

In other words, the piece of wood is about 5170 years old. Recently, carbon dating techniques have greatly improved through the use of nuclear mass

Q 4/ calculate the mean life-time for ^{210}Po nucleus

Q5/ The half-life of radioactive ^{60}Co is 5.26 years. What is the activity of a 1g sample of ^{60}Co in units of curie, and its activity after 5.26 Years?

Q6/ The half –life of radon 222 (^{222}Rn) is 3.85 days. How long it take for 60 percent (60%) of a sample of radon (^{222}Rn) to decay?

Q7 / Derive an expression for the relation between lifetime (τ) and half-life time $t_{1/2}$.

Q8/ The activity of a certain radio nuclide decreases to 15 percent of its original value in 10 days .Find its half-life .

Q9/ The activity of 20 g of ^{232}Th is 2.18 μci .Calculate the disintegration constant and the half-life of ^{232}Th .

Chapter Five/ HOME WORKS

Q1/ $^{240}_{94}P$ decays with a half-life of 6760 years by emitting two groups of alpha particles, with energy 5.17 MeV and 5.12 MeV.

a) What are the decay energy (disintegration energy)?

b) Calculate the recoil kinetic energy of the daughter nucleus.

Q2/ Show that a radioactive isotope $_{29}^{64}Cu$ satisfied the conditions for decaying by β^-, β^+ and electron capture processes .

Q3/ Calculate the maximum kinetic energy of electron, T_e(max) , and positron , T_{e+} ,in the $\beta^- - decay$, and β^+-decay of $_{29}^{64}Cu$.

Q4/ What is the most predominate multipole transition in the $2^+ \rightarrow 2^+$ gamma transition ?

Q5/ ^{137}Cs decays by β^-- emission ,as shown in the figure .When the nucleus left in excited state, its decay to the ground state via gamma transition .What are the energies between of the beta

Chapter Six / HOME WORKS

Q1/ Complete each of the following nuclear reactions;

$_3^6Li$ (? , n) $_4^7Be$, $_{15}^{31}$ P (d , ?) $_{15}^{32}$ P , $^{115}_{49}In$ (n , ?) $^{116}_{49}In$, $_{13}^{27}$ Al (? , P)$_{15}^{30}$ P

Q2/ Find the Q-value of the reaction ^9Be (α, n)^{12}C. Given that:

M(^9Be) =9.015 amu , M (α) =4.00387 amu , M (n) =1.00898 amu , M (^{12}C) = 12.003 amu

Q3 / The Q-value for a given reaction ^{19} F (n, p)^{19}O is -3.9 MeV, and the energy of incident neutron 10 MeV. What is the energy of the emitted protons that are observed at angle 90^0 to the direction of the incident neutrons?

Q4/ In question3, the Q-value of the reaction -3.9 MeV, what is the threshold energy? Given the atomic mass of M (^{19}F)= 18.9984 amu .

Q5 / What thickness of ^{27}Al is need to reduce the intensity of an incident beam of 0.025 eV neutrons to one tenth of its initial intensity? The density of aluminum is 2.7 g/cm^3, atomic weight 26.98 and its cross section for 0.025 eV neutron is 0.23 b.

Chapter Seven / HOME WORKS

Q1/ Calculate the amount of energy available (in MeV and Joules) if one gram of ^{235}U is completely fission. The energy release of fission of 1 atom of ^{235}U (energy per fission) is 235 MeV/ fission.

Q2/ Show that the complete fission of 1 g of ^{235}U would produce energy at amount of 2.27x10^4 KW.h.

Q3/ Calculate the amount of energy release in the fusion reaction;

$$_1^1H + _1^1H \rightarrow _1^2H + e^+ + v$$