1. The radius of innermost electron orbit of a hydrogen atom is 5.3 x 10^{-11}m. What is the radius of orbit in the second excited state ?

2. Find the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its.

   a. second permitted energy level to the first level, and

   b. the highest permitted energy level to the first permitted level.

3. The ground state energy of hydrogen atom is -13.6eV. What are the kinetic and potential energies of electron in this state ?

4. Two nuclei have mass numbers in the ratio 2:5. What is the ratio of their nuclear radii ?

5. The radioactive isotope D decays according to the sequence

   $$D \xrightarrow{\beta} D_1 \xrightarrow{\alpha-particles} D_2$$

   If the mass number and atomic number of D_2 are 176 and 71 respectively, what is (i) the mass number (ii) atomic number of D ?

6. Two nuclei have mass numbers in the ratio 1:2. What is the ratio of their nuclear densities ?

7. A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6M eV is split into two fragments Y and Z of mass numbers 110 and 130. The binding energy of nucleons in Y and Z is 8.5MeV per nucleon. Calculate the energy Q released per fission in MeV.

8. A radioactive nucleus 'A' undergoes a series of decays according to the following scheme:

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

9. A nucleus $^{23}_{10}Ne$ undergoes β – decay and becomes $^{23}_{11}Na$. Calculate the maximum kinetic energy of electrons emitted assuming that the daughter nucleus and anti-neutrino carry negligible kinetic energy

   mass of $^{23}_{10}Ne$=22.994466u

   mass of $^{23}_{11}Na$ = 22.989770u

   Iu = 931.5MeV/c^2

10. Calculate the energy released in MeV in the following nuclear reaction :

$$^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He + Q$$

[Mass of $^{238}_{92}U$=238.05079u, Mass of $^{234}_{90}Th$=234.043630u, Mass of $^{4}_{2}He = 4.002600u$ 1u = 931.5MeV/c^2]

11. Draw a plot of potential energy of a pair of nucleons as a function of their separation. What is the significance of negative potential energy in the graph drawn ?

12. Draw a graph showing the variation of potential energy between a pair of nucleons as a function of their separation. Indicate the regions in which the nuclear force is (i) attractive, (ii) repulsive

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

14. The sequence of the stepwise decays of radioactive nucleus is

$D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\alpha} D_4$

If the nucleon number and atomic number for D_2 are respectively 176 and 71, what are the corresponding values for D and D_4 nuclei ? Justify your answer.

15. The activity of a radioactive element drops to 1/16th of its initial value in 32 years. Find the mean life of the sample.

16. Define half-life of a radioactive substance. A radioactive substance decays to 1/32 of its initial activity in 25 days. Calculate its half – life.

17. The ground state energy of hydrogen atom is -13.6 eV. What are the kinetic and potential energies of the electron in this state ?

18. A radioactive isotope has a half-life of T years. How long will it take the activity to reduce to (a) 3.125%, (b) 1% of its original value ?

19. a. Using Bohr's second postulate of quantization of orbital angular momentum show that the circumference of the electronic in the nth orbital state in hydrogen atom is n

times the de Broglie wavelength associated with it.

b. The electron in hydrogen atom is initially in the third excited state. What is the maximum number of spectral lines which can be emitted when it finally moves to the ground state ?

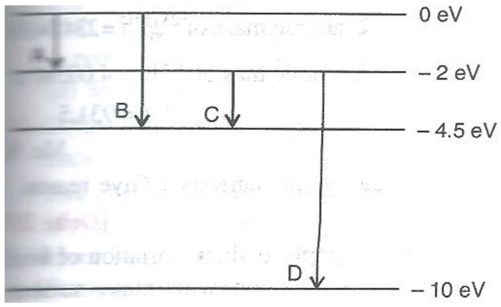
20. In a Geiger-Marsden experiment, calculate the distance of closest approach to the nucleus of Z = 80, when an α-particle of 8MeV energy impinges on it before it comes momentarily to rest and reverses its direction.

21. The ground state energy of hydrogen atom is -13.6eV. If an electron makes a transition from an energy level -0.85eV to -3.4eV, calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong ?

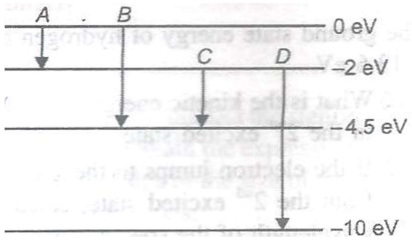
22. Using Bohr's postulates for hydrogen atom, show that the total energy (E) of the electron in the stationary stats can be expressed as the sum of kinetic energy (K_0 and potential energy (U), where K = -2U. Hence deduce the expression for the total energy in the n^{th} energy level of hydrogen atom.

23. The energy levels of a hypothetical atom are shown below. Which of the shown transitions will result in the emission of a photon of wavelength 275nm ?

Which of these transitions correspond to emission of radiation of (i) maximum and (ii) minimum wavelength ?



24a. the energy levels of an atom are as shown below. Which of them will result in the transition of a photon of wavelength 275nm ?



b. Which transition corresponds to emission of radiation of maximum wavelength ?

25. The ground state energy of hydrogen atom is -13.6eV.

i. what is the kinetic energy of an electron in the 2^{nd} excited state ?

ii. If the electron jumps to the ground state from the 2^{nd} excited state, calculate the wavelength of the spectral line emitted.

26. The ground state energy of hydrogen atom is -13.6eV.

    i. what is the potential energy of an electron in the 3rd excited state ?

    ii. If the electron jumps to the ground state from the 3rd excited state, calculate the wavelength of the photon emitted.

27. If the nucleons of a nucleus are separated far apart from each other, the sum of masses of all these nucleons is larger than the mass of nucleus. Where does this mass difference come from ?

    Calculate the energy released if ^{238}U nucleus emits an α-particle.

28. Distinguish between nuclear fission and fusion. In a fusion reaction.

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

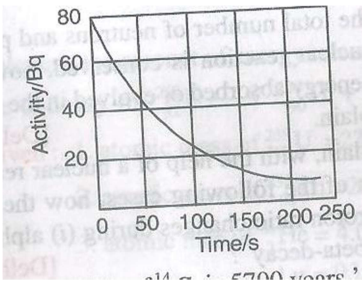
    Calculate the amount of energy in MeV released. Given m($^{2}_{1}H$)= 2.014102u; m ($^{3}_{1}H$)=3.016049u; m ($^{4}_{2}He$)=4.002603u; m_n= 1.00867u; 1u= 931.5MeV/c^2.

29. Calculate the binding energy per nucleon (in MeV)for $^{4}_{2}He$ and $^{3}_{2}He$). Comment on the difference of these binding energies and its significance in relation to α-decay of the nuclei.

30. Complete the following decay process for β-decay of phosphorus 32;

    $^{32}_{15}P \rightarrow$S+……..

    The graph shows how the activity of a radioactive nucleus changes with time using the graph, determine (i) half-life of the nucleus and (ii) its decay constant



31. a radioactive sample can decay by two different processes. The half – life for the first process is T_1 and that for the second process is T_2. Show that the effective half – life T of the nucleus is given by

$$\frac{1}{T} = \frac{1}{T_1} + \frac{1}{T_2}$$

32. The activity R of an unknown radioactive nuclide is measured at hourly intervals. The results found are tabulated as follow;

T (h)	0	1	2	3	4
R (MBq)	100	35.36	12.51	4.42	1.56

i) Plot the graph of R versus t and calculate half-life from the graph.

ii) Plot the graph of in (R/R_0) versus t and obtain the value of half-life from the graph.

33. A star converts all its hydrogen to helium, achieving 100% helium composition. It then converts the helium to carbon via the reaction $_2He^4 + {}_2He^4 + {}_2He^4 \rightarrow {}_6C^{12} + 7.27$ MeV

The mass of the star is 5.0×10^{32} kg and it generates energy at the rate of 5×10^{30} watt. How long will it take to convert al the helium to carbon at this rate ?

Ans t=1.85 x 10^8years.

34. A 1000MW 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 arise from the fission of $_{92}U^{235.}$ Ans. 15443

35. Define the binding energy of nucleus. A neutron is absorbed by a $_3Li^6$ nucleus with the subsequent emission of an α-particle. Write the corresponding nuclear reaction. Calculate the energy released in this reaction

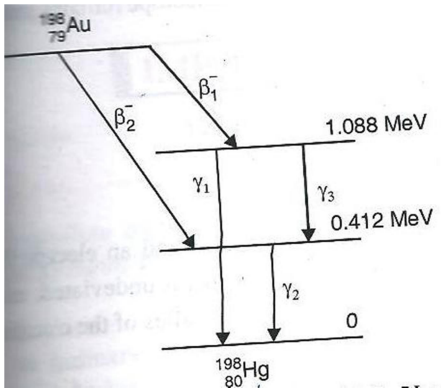
Given m($_3Li^6$)=6.015126amu

m($_0n^1$)=1.0086654amu

m($_2He^4$)=4.0026044amu and

m($_1H^3$)=3.01amu

36. Obtain the maximum kinetic energy of β-particles, and the radiation frequencies to γ-decays in the following decay scheme. You are given that : m



(^{198}Au)=197.968233u

m (^{198}Hg)=197.966760u

Ans. 0.281MeV, 0.957 MeV

37. The total energy of an electron in the first excited state of the hydrogen atom is about –3.4eV

a. What is the kinetic energy of the electron in this state ?

b. What is the potential energy of the electron in this state ?

c. Which of the answers above would change if the choice of the zero of potential energy is changed ?

38. a. What is meant by half-life of a radioactive element ?

b. The half life of a radioactive substance is 30s. Calculate

a. the decay constant, and

b. time taken for the sample to decay by 3/4th of the initial value.

39. A neutron is absorbed by a $^{6}_{3}Li$ nuclei with the subsequent emission of an alpha particle.

a. Write the corresponding nuclear reaction.

b. Calculate the energy released, in MeV, in this reaction.

Given

mass ($^{6}_{3}Li$)=6.01512126u

mass(neutron)= 1.0086654u

mass(alpha particle)=4.0026044u and

mass(triton)= 3.0100000u,

take 1u = 931MeV/c^2.

40.a. Define the activity of a radioactive nucleus and state its S.I. unit.

b. Two radioactive nuclei X and Y initially contain equal number of atoms. The half life is 1 hour and 2 hours respectively. Calculate the ratio of their rates or disintegration after two hours.