PHYSICS

BOOKS - PRADEEP PHYSICS (HINGLISH)

ATOMS AND NUCLEI

Solved Examples

1. In the original experiment, Geiger and Marsden calculated the distance of closest approach to the gold nucleus (Z=79)- of a 7.7MeV α particle before it comes momentarily to rest and reverses its direction. What is its value?

2. A 4MeV alpha particle is scattered by 20°, when it approaches a gold nucleus. Calculate the impact parameter if Z for gold is 79.

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3. Find the wavelength of electron orbiting in the first excited state of hydrogen atom.

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4. Calculate the radius of the third Bohr orbit of hydrogen atom and the energy of electron in that orbit.

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5. In hydrogen atom, wavelength of emitted photon will be minimum in which of the following transitions?

(i) $n = 2$ to $n = 1$, (ii) $n = 6$ to $n = 5$, (iii) $n = 3$ to $n = 2$

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6. Calculate the longest and shortest wavelength in the Balmer series of hydrogen atom. Given Rydberg constant =$1.0987 \times 10^7 m^{-1}$.

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7. The velocity of electron in inner most orbit of hydrogen atom is $2.2 \times 10^6 m/s$. Use de-Broglie hypothesis to calculate radius of innermost orbit.

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8. Calculate radius of first orbit of singly ionized He atom, when radius of first orbit of hydrogen atom is 0.53Å.

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9. The energy of electron in 1st orbit of hydrogen atom is $-13.6eV$. What will be the energy of doubly ionised $._3 Li^7$ atom in the first orbit?

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10. What are the numbers of protons and neutrons in the nucleus of $._{92} U^{238}$?

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11. Obtain approximately the ratio of nuclear radii of $._{26} U^{56}$ and $._{92} U^{238}$. What is the approximately ratio of their nuclear densities?

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12. Express 150 microgram mass into equivalent energy in electron volt.

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13. Calculate mass defect, binding energy and binding energy per nucleon for a lithium nucleus $\left(._{3}Li^{7}\right)$ taking its mass =7.000000a.m.u. Mass proton=1.007825 a.m.u. and mass of neutron =1.008665 a.m.u. Take 1a.m.u. =931.5 MeV.

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14. Find the half life of U^{238}, if one gram of it emits 1.24×10^{4} α-particle per second. Avogadro's Number $= 6.023 \times 10^{23}$.

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15. The half life of Radon is 3.8 days. Calculate how much of 15 milligram of Redon will remain after 38 days.

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16. Half life on Rn^{220} is 55.5s. Calculate decay constant of this element.

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17. A radioactive isotope X has a half life of 3 seconds. At t=0, a given sample of this isotope contains 8000atom. Calculate (i) its decay constant (ii) average time (iii) the time t_1, when 1000 atoms of the isotope X remain in the sample (iv) number of decay/sec in the sample at $t = t_1 \text{ sec.}$

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18. A radioactive element decays to $1/32th$ of its initial activity in 25 decay. Calculate its half life.

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19. After a series of alpha and beta decays, $._{94}Pu^{239}$ becomes $._{82}Pb^{207}$. How many alpha and beta particles are emitted in the complete decay process?

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20. The energy released in a nuclear fission process is $4.5 \times 10^{11} J$. Where in total mass involved is one gram. Calculate the percentage of mass defect in the process.

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21. The mass defect in a nuclear fusion reaction is 0.3%. What amount of energy will be liberted in one kg fusion reaction.

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22. What is the distance of closest approach when a $5.0MeV$ proton approaches a gold nucleus?

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

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24. Calculate the impact parameter of a 5MeV alpha particle scatterd by 10° when it approaches a gold nucleus. Take Z=79 for gold.

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25. In a Geiger-Marsden experiment, calculate energy of α particle whose distance of closet approach to the nucleus of Z=79 is 2.8×10^{-14} m. How will the distance of closet approach be affected when the kinetic energy of the α-particle is doubled ?

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26. In the original experiment, Geiger and Marsden calculated the distance of closest approach to the gold nucleus (Z=79)- of a 7.7MeV α particle before it comes momentarily to rest and reverses its direction. What is its value?

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27. In a head on collision between an alpha particle and gold nucleus (Z=79), the distance of closest approach is 39.5 fermi. Calculate the energy of α-particle.

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28. What is the size of nucleus with Z=29 when an alpha particle of 12.5MeV kinetic energy retrace its path on colliding with the nucleus?

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29. Calculate the change in angular momentum of electron, when it jumps form 4th orbit to first orbit.

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30. The energy of electron in hydrogen atom is $E_n = \frac{-13.6}{n^2} eV$, Where n=1, 2,3,.......Show that (i) the electron in hydrogen atom cannot have an energy of -6.8eV. (ii) spacing between the lines (consecutive energy levels) within the given set of observed hydrogen spectrum decreases as n increases.

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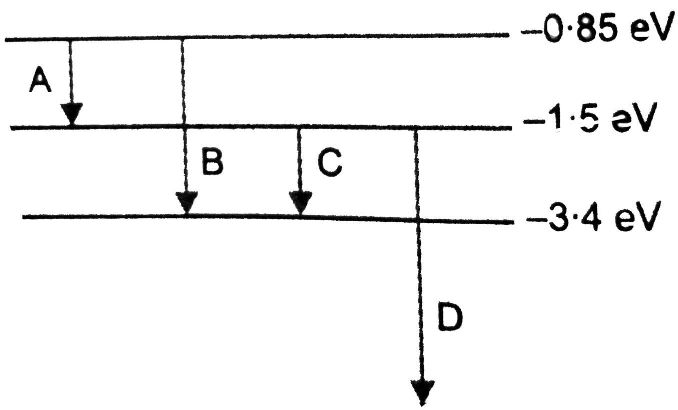
31. The energy level diagram of an element is given here. Which transition corresponds to the emission of a spectral line of wavelength 102.7nm?



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32. In the ground state of hydrogen atom, its Bohr radius is $5.3 \times 10^{-11} m$. The atom is excited such that the radius becomes $21.2 \times 10^{-11} m$. Find the value of principal quantum number and total energy of the atom in excited state.

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33. In Rutherford's nuclear model of the atom, the nucleus (radius about $10^{-15}m$) is analogous to the sum about which the electron moves in orbit (radius about $10^{-10}m$) like the earth orbits around the sun. If the dimensions of the solar system had the same proportions as those of the atom, would the earth be closer to or further away form the sun than actually it is ? The radius of earth's orbit is about is $1.5 \times 10^{11}m$. The radius of the sun is taken as $7 \times 10^{8}m$.

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34. Calculate the value of Rydberg's constant.

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35. It is found expertimentally that 13.6eV energy is required to separated a hydrogen atom into a proton and an electron. Compute the orbital radius and velocity of electron in a hydrogen atom.

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36. According to classical electromagnetic theory, calculate the initial frequency of the light emitted by the electron revolving around a proton in hydrogen atom.

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37. A 10kg satellite circles earth once every 2hr in an orbit having a radius of 8000km. Assuming that Bohr's angular momentum postulate applies to satellites just as it does to an electron in the hydrogen atom, find the quantum number of the orbit of the satellite.

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38. Using the Rydberg formula, calculate the wavelength of the first four spectral lines in the Lyman series of the hydrogen spectrum.

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39. Find the wavelength of H_α line given the value of Rydberg constant, $R = 1.1 \times 10^7 m^{-1}$.

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40. Using Bohr's formula for energy quantization, determine (i) the longest wavelength in Lymann series of hydrogen atom spectrum. (ii) the excitation energy of the n=3 level of He^+ atom. (iii) the ionization potential of the ground state of Li^{++} atom.

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41. Calculate the frequency of revolution of electron in the first Bohr orbit of hydrogen atom, if radius of first Bohr orbit is 0.5Å and velocity of electron in the first orbit is $2.24 \times 10^6 m/s$.

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42. The total energy of an electron in second excited state of hydrogen atom is -1.51eV. Calculate (i) KE of electron (ii) PE of electron in this state.

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43. Which level of the doubly ionized lithium has the same energy as the ground state energy of the hydrogen atom? Compare the orbital radii of the two levels.

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44. Which state of the triply ionized Be^{+++} has the same orbital radius as that of the ground state of hydrogen? Compare the energies of two states.

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

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46. A 12.9 eV beam of electrons is used to bombard gaseous hydrogen atom at room temperature. Upto which energy level the hydrogen atoms would be excited?

Calculate the wavelength of the first member of Paschen series and first member of Balmer series.

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47. A 12.5 eV electron beam is used to excite a gaseous hydrogen atom at room temperature. Determine the wavelengths and the corresponding series of the lines emitted.

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48. Show that the shortest wavelength lines in Lyman,Balmer and Paschen series have their wavelength in the ratio 1:4:9.

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49. A projectile of mass m, charge Z', initial speed v and impact parameter b is scattered by a heavy nucleus of charge Z. Use angular momentum and energy conservation to obtain a formula connecting the minimum distance (s) of the projectile form the nucleus to these parameters .show that for b=0, s reduces to the closest distance of approach r_0.

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50. for scattering by an inverse square law field (such as that produced by a charged nucleus in Rutherford's model), the relation between impact parameter b and the scattering angle θ is given by

$$b = \frac{Ze^2 \cot \theta / 2}{4\pi \in_0 \left(\frac{1}{2}mv^2\right)}$$

(a) What is the scattering angle for b=0?

(b) for given impact parameter, b, does the angle of deflection increase or decrease with increase in energy?

(c) What is the impact parameter at which the scattering angle is 90° for Z=79 and initial energy=10MeV?

(d) Why is it that the mass of the nucleus does not enter the formula above, but its charge does?

(e) for a given energy of the projectile, does the scattering angle increase or decrease with decrease in impact parameter?

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51. A 12.09 eV electron beam is used to bombard gaseous hydrogen at room temperature, Upto which energy level, the hydrogen atoms would be excited? Calculate the wavelengths of the second member of Lyman series and second member of Balmer series.

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52. The nuclear mass of $._{26}F^{56}$ is 55.85u. Calculate its nuclear density.

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53. The natural boron is composed of two isotopes $._{5}\beta^{10}$ and $._{5}\beta^{11}$ having masses $10.003u$ and $11.009u$ resp. Find the relative abudance of each isotope in the natural boron if atomic mass of natural boron is 10.81u.

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54. Calculate number of protons and neutrons in $._{92}U^{235}$ and the isotope $._{88}Ra^{236}$.

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55. Express 1 joule in eV. Taking 1a.m.u. $= 931 MeV$, calculate the mass of $._6 C^{12}$.

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56. The nuclear mass of $._{26} F^{56}$ is 55.85u. Calculate its nuclear density.

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57. Find the effective mass of a photon if the wavelength of radiation is 3000Å.

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58. Calculate the nuclear mass density of $._{92} U^{238}$. Given $R_0 = 1.5$ fermi and mass of each nucleon is $1.67 \times 10^{-27} kg$.

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59. The radius of $._{3}Al^{27}$ nucleus is 5 fermi. Find the radius of $._{52}Te^{125}$ nucleus.

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60. Express 1 joule in eV. Taking 1a.m.u. $= 931MeV$, calculate the mass of $._{6}C^{12}$.

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61. Calculate the binding energy per nucleon of $._{26}Fe^{56}$ nucleus. Given that mass of $._{26}Fe^{56} = 55.934939u$, mass of proton $= 1.007825u$ and mass of neutron $= 1.008665u$ and $1u = 931MeV$.

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62. Calculate the B.E./nucleon of $._{17}Cl^{35}$ nucleus. Given that of proton $= 1.007825u$, mass of neutron $= 1.008665u$, mass of $._{17}Cl^{35} = 34.980000u, 1u = 931MeV$.

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63. Calculate the binding energy per nucleon of $._{20}Ca^{40}$ nucleus. Given m $._{20}Ca^{40} = 39.962589u$, $M_p = 1.007825u$ and $M_n = 1.008665u$ and Take $1u = 931MeV$.

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

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65. Find the energy equivalent of one atomic mass unit, first in joule and then in MeV. Using this, express the mass defect of $._8 O^{16}$ in MeV $/ c^2$. Given $M_p = 1.007825u$ and $M_n = 1.008665u, m_{\text{oxy}} = 15.99053$ a.m.u. and Take $1a.m.u = 933.75 MeV / c^2$.

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66. Calculate binding energy per nucleon of $._{83} Bi^{209}$. Given that m

$(._{83} Bi^{209}) = 208.980388 amu$

$m(\text{neutron}) = 1.008665 amu$

$m(\text{proton}) = 1.007825 amu$

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67. Find mass defect, binding energy and BE/nucleon for He nuclei. Take mass of He nucleus $= 4.001509u$, $M_p = 1.007825u$ and $M_n = 1.008665u$

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68. Find the minimum energy required to separated a neutron form $._{18}Ar^{40}$. Given $M_n = 1.008665u$, mass of $._{18}Ar^{40} = 39.962383u$ and mass of $._{18}Ar^{39} = 38.964314u$.

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69. The decay constant for a given radioactive sample is 0.3465 day^{-1}. What percentage of this sample will get decayed in a period of 4 days?

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70. The half life of radium is 1500 years. After how many years will one gram of pure radium

(i) reduce to 1 centigram?

(ii) lose one milligram?

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71. A radio active substance has a half life period of 30 days. Calculate (i) time taken for $3/4$ of original number of atoms to disintegrate, (ii) time taken for $1/8$ of the original number of atoms to remain unchanged.

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72. 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?

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73. A hypothetica atom has energy levels uniformaly separated by 1.3 eV. At a temperature 2500k, what is the ratio of number of atoms in 15th excited state to the number in 13 th excited state.

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74. It is observed that only 6.25% of a given radioactive sample is left undecayed after a period of 16 days. What is the decay constant of this sample in day^{-1}?

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75. A radioactive material is reduced to $\frac{1}{16}$ of its original amount in 4 days. How much material should one being with so that $4 \times 10^{-3} kg$ of the material is left over after 6 days ?

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76. The half life of radium is 1600 years. In how many years will one gram of pure radium be reduce to one centigram?

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77. How many disintegrations per second will occur in one gram of $._{92}U^{238}$, if its half life against alpha decay is $1.42 \times 10^{17} s$?

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78. There are $4\sqrt{2} \times 10^{6}$ radioactive nuclei in a given radioactive sample. If half life of sample is 20s, how many nuclei will decay in 10seconds?

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79. The half life of $._{92}U^{238}$ against α decay is $1.5 \times 10^{17} s$. What is the activity of the sample of $._{92}U^{238}$ having 2.5×10^{21} atom?

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80. A radioactive sample contains 2.2 mg of pure $._{6}C^{11}$, which has a life period of 1224s. Calculate (i) number of atoms present initially. (ii) the activity when $5 \mu g$ of the sample will be left.

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

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82. Determine the amount of $._{84} Po^{210}$ necessary to provide a source of α particles of 5 millicurie strength. The half life of Po is 138 days.

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83. Biologically useful technetium nuclei (with atomic weight 99) have a half life of 6 hrs. A solution containing 10^{-12} g of this is injected into the bladder of a patient. Find its activity in the beginning and after one hour.

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84. The sequence of decay of radioactive nucleus is $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2 \xrightarrow{\alpha} D_3$. If nucleon number and atomic number of D_2 are 176 and 71 respectively, what are their values for D and D_3?

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85. $._{86}Rn^{222}$ is converted into $._{84}Po^{218}$ and $._{93}Np^{239}$ is converted into $._{94}Pu^{239}$. Name the particles emitted in each case and write down the corresponding equations.

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86. One Mev positron encounters one MeV electron travelling in opposite direction. What is the wavelength travelling in opposite direction. What is the wavelength of photons produced, given rest mass energy of electron or positron $= 0.512 MeV$? Take $h = 6.62 \times 10^{-34} J - s$.

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87. Complete the decay reaction $._{10} Ne^{23} \rightarrow ? + ._{-1} e^{0} + ?$

Also, find the maximum KE of electrons emitted during this decay. Given mass of $._{10} Ne^{23} = 22.994465u$. mass of $._{11} Na^{23} = 22.989768u$.

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88. The atomic mass of uranium $._{92}^{238} U$ is $23.058u$, that of throium.$_{90}^{234} Th$ is $234.0436u$ and that of an alpha particle $._{2}^{4} He$ is $4.006u$, Determine the energy released when $\alpha - decay$ converts.$_{92}^{238} U$ into $._{92}^{238} U$. int $._{90}^{234} Th$.

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89. A neutron is absorbed by a $._{3} Li^{6}$ nucleus with subsequent emission of an alpha particle. Write the corresponding nuclear reaction. Calculate the energy released in this reaction.

$m(._{3} Li^{6}) = 6.015126u, m(._{2} He^{4}) = 4.0026044u$

$m(._0 n^1) = 1.0086654u, m(._1 He^3) = 3.016049u$

Take $1u = 931 MeV$.

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90. The bombardment of Lithium with protons gives rise to the following reaction: $._3 Li^7 + ._1 H^1 \rightarrow .2_H e^4 + .2_H e^4 + Q$

The atomic masses of lithium, hydrogen and helium are : $7.016u$, $1.008u$ and $4.004u$ resp. Find the initial energy of each of α particle. Take $1a.m.u = 931 MeV$.

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91. Find the kinetic energy of the α - particle emitted in the decay $\hat{} 238Pu \rightarrow^{234} U + \alpha$. The atomic masses needed are as following:

$\hat{} 238Pu 238.04955u$

$\hat{} 234U 234.04095u$

$\hat{} 4He 4.002603u$.

Neglect any recoil of the residual nucleus.

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92. We are given the following atomic masses:

$._{92} Pu^{238} = 238.05079u,$

$._{90} Th^{234} = 234.04363u,$

$._{91} Pa^{237} = 237.05121, ._{1} H^{1} = 1.00783,$

$._{2} He^{2} = 4.00260u$

(a) Calculate the energy released during α decay of $._{92} U^{238}$,

(b) Calculate the kinetic energy of emitted α particles,

(c) show that $._{94} Pu^{238}$ cannot spontaneously emit a proton.

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93. Consider the beta decay

$\hat{} 198Au \rightarrow^{198} Hg * + B\eta^{-1} + \overrightarrow{v}.$

where $\hat{} 198Hg^{*}$ represents a mercury nucleus in an excited state at energy $1.088MeV$ above the ground state. What can be the maximum kinetic energy of the electron emitted? The atomic mass of $\hat{}\ 198Au$ is $197.968233u$ and that of $\hat{}\ 198Hg$ is $197.966760u$.

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94. A neutron is absorbed by a $._3 Li^6$ nucleus with subsequent emission of an alpha particle. Write the corresponding nuclear reaction. Calculate the energy released in this reaction.

$m(._3 Li^6) = 6.015126u, m(._2 He^4) = 4.0026044u$

$m(._0 n^1) = 1.0086654u, m(._1 He^3) = 3.016049u$

Take $1u = 931MeV$.

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95. It is estimated that the atomic bomb exploded at Hiroshima released a total energy of $7.6 \times 10^{13} J$. If on the average, 200MeV energy was released per fission, calculate

(i) the number of Uranium atoms fissioned,

(ii) the mass of Uranium used in the bomb.

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96. Calculate the energy released when three alpha particles combine to form a $\hat{\ } 12C$ nucleus. The atomic mass of $\_ 2^4 He$ is $4.002603u$.

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97. The energy released by fission of one U^{235} atom is 200 MeV. Calculate the energy released in kWh, when one gram of uranium undergoes fission.

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98. The mass defect in a nuclear fusion reaction is 0.3%. What amount of energy will be liberated in one kg fusion reaction.

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99. If $200MeV$ energy is released in the fission of a single U^{235} nucleus, the number of fissions required per second to produce 1 kilowatt power shall be (Given $1eV = 1.6 \times 10^{-19}J$).

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100. In an experiment, the activity of 1.2 mg of radioactive potassium chloride (chloride of isotope of K-40) was found to be $170s^{-1}$: Taking molar mass to be $0.075kg\text{mole}^{-1}$ find the number of $K-40$ atoms in the same and hence find the half life of $K-40$. Avogadro's number $= 6.0 \times 10^{23}\text{mole}^{-1}$

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101. The mean lives of a radioactive substance are 1620 years and 405 years for α emission and β emission respectively. Find out the time during which three fourth of a sample will decay if it is decaying both by α-emission and β-emission simultaneously. $(\log_e 4 = 1.386)$.

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102. In the chemical analysis of a rock the mass ratio of two radioactive isotopes is found to be $100:1$. The mean lives of the two isotopes are 4×10^9 years and 2×10^9 years, respectively. If it is assumed that at the time of formation the atoms of both the isotopes were in equal propotional, calculate the age of the rock. Ratio of the atomic weights of the two isotopes is $1.02:1$.

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103. For scattering of α-particles at large angles, only the nucleus of the atom is responsible, explain why?

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104. Find the ratio of the magnitude of the electric force to the grativational force acting between two protons.

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105. The K.E. of α-particle incident gold foil is doubled. How does the distance of closest approach change?

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106. Why is electron supposed to be revolving around the nucleus?

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107. Show graphically the nature of variation of radius of orbit with the principal quantum number.

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108. 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?

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109. A helium atom consists of two electrons orbiting round a nucleus of charge Z=2. But the electrons do not see the full charge Z=2 of the nucleus. Each electron sees the nucleus slightly screened by the other electron so that the effective charge Z_{eff} seen by each electron is less than 2. The ionisation potential for a He atom in its ground state is measured experimentally to be 24.46 eV. Estimate the effective charge of the nucleus as seen by each electron in the helium ground state.

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110. Explain the significance of negative energy of electron in an orbit.

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111. An electron in hydrogen atom is in the n=4 energy level. When it makes a transition to some lower energy level, to which series the wavelength of emitted photon belong?

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112. Why did Thomson atom model fail?

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113. In Rutherford's alpha ray scattering experiment, why most of alpha particles pass through almost unscattered.

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114. How is impact parameter related to the scattering angle?

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115. Can a hydrogen atom absorb a photon whose energy exceeds its binding energy?

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116. Write the relation for (i) the distance of closest approach and (ii) impact parameter.

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117. What is the value of Rydberg constant?

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118. The ground state energy of hydrogen atom is -13.6eV. What are P.E. and K.E. of electron in this state?

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119. Write an expression for Bohr's radius in hydrogen atom.

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120. Name the series of hydrogen spectrum, which has least wavelength.

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121. Out of three radiations of wavelengths $1000\text{Å}, 5000\text{Å}$ and 8000Å, which one corresponds to Lyman series?

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122. Name the spactral series of hydrogen atom, which be in infrared region.

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123. When is H_{α} line of the emission spectrum of hydgrogen atom obtained?

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124. In Bohr's theory of hydrogen atom, what is the implication of the fact that the potential energy is negative and is greater in magnitude than the kinetic energy.

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125. What is the energy possesed by an electron for $n = \infty$?

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126. What is the ground state energy of electron in case of $._3 Li^7$?

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127. What is the order of velocity of electron in a hydrogen atom in ground state?

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128. Name the series of hydrogen atom which lies in U.V. region.

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129. What is the ratio of radii of orbits corresponding to first excited state and ground state in hydrogen atom?

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130. Write an empirical relation for Paschen series of hydrogen spectrum.

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131. What is the ionisation potential of hydrogen atom?

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132. What are the values of first and second excitation potential of hydrogen atom?

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133. Define energy level. How is it represented?

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134. Which one of the series of hydrogen spectrum is in the visible region ?

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135. The wavelength of some of the spectral lines obtained in hydrogen spectrum are $1216A^{\circ}, 6463A^{\circ}$ and $9546A^{\circ}$. Which one of these wavelengths belongs to the Paschen series?

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

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137. In Rutherford scattering experiment, if a proton is taken instead of an alpha particle, then for same distance of closest approach, how much K.E. in comparison to K.E. of a particle will be required?

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138. Explain distance of closest approach and impact parameter with illustrations.

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139. What is the impact parameter for scattering of α-particle by 180°?

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140. for given impact parameter b, does the angle of deflection increase or decrease with increase in energy?

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141. In a hydrogen atom, if the electron is replaced by a particle which is 200 times heavier but has the same charge, how would its radius change?

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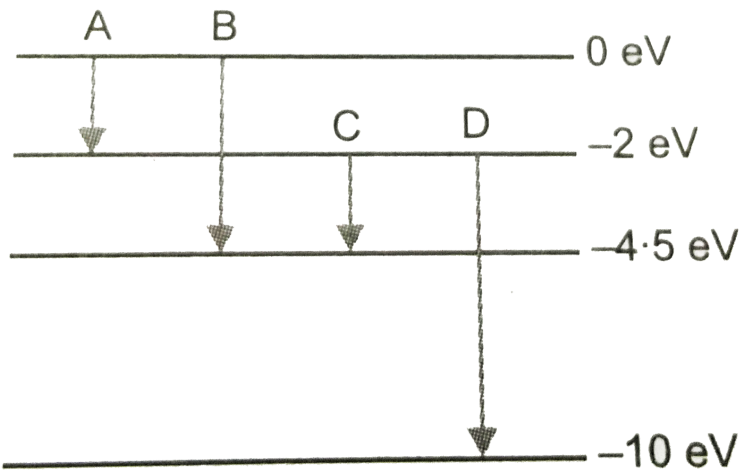
142. The energy levels of an atom are shown in fig. Which transition corresponds to emission of radiation of (i) maximum wavelength (ii) minimum wavelength?



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143. Define ionization energy. How would the ionization energy change when electron in hydrogen atom is replaced by a particle 200 times heavier than electron, but having the same charge?

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144. The groud state energy of hydrogen atom is $-13.6eV$. When its electron is in first excited state, its exciation energy is

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145. Show that d-Broglie hypothesis of matter wave supports the Bohr's concept of stationary orbit.

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146. The electron in hydrogen atom passes form the n=4 energy level to the n=1 level. What is the maximum number of photons that can be emitted? and minimum number?

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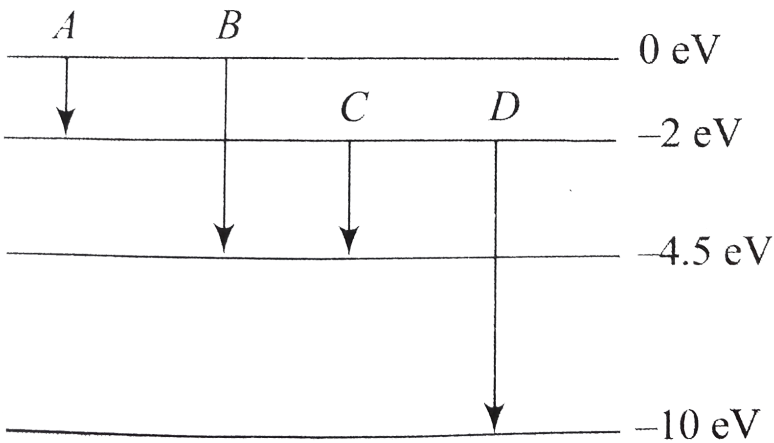
147. The energy levels of an atom are as shown in figure . Which one of those transition will result in the emission of a photon of wavelength $275nm$?



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148. The short wavelength limits of Lyman, Paschen and Balmer series in the hydrogen spectrum are denoted by λ_L, λ_P and λ_B respectively. Arrange these wavelength in increasing order.

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149. Find the ratio of energies of photons produced due to transition of electron of hydrogen atom form its (i) second permitted energy level to the first level (ii) highest permitted energy level to the first permitted level.

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150. How is impact parameter related to the scattering angle?

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151. Derive an expression for the potential energy and kinetic energy of an electron in any orbit of a hydrogen atom, according to Bohr's atomic model. How does P.E. change with increasing n?

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152. Derive Bohr's quantisation condition for angular momentum of orbiting electron in hydrogen atom using De Broglie's hypothesis.

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153. Distinguish between excitation potential and ionisation potential.

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154. Draw a schematic arrangement of the Geiger Marsden experiment. How did the scattering of α particles by a thin foil of gold provide an important way to determine an upper limit on the size of nucleus? Explain briefly.

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155. Explain distance of closest approach and impact parameter with illustrations.

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156. Why did Thomson atom model fail?

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157. Describe Rutherford atom model. What are the drawbacks of this model?

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158. Using Bohr's postulate, derive the expression for the orbital period of the electron moving in the nth orbit of hydrogen atom.

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159. Name some hydrogen like atoms. Write expression for radii of stationary orbits, speed of electrons and energy of electrons in case of such atoms.

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160. Is free neutron a stable particle ? If not, what is its mode of decay?

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161. Group the following six nuclides into three pairs of (i) isotones (ii) isotopes and (iii) isobars.

$._6 C^{12}, ._2 He^3, ._{80} Hg^{198}, ._1 H^3, ._{79} Au^{197}, ._6 C^{14}$

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162. Two nuclei have different number of protons and different number of neutrons. Can they have the same radii and same nuclear density?

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163. Select the pairs of isotopes and isotoes form the following nuclei:

$._{11} Na^{22}, ._{12} Mg^{24}, ._{11} Na^{24}, ._{10} Ne^{23}$

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164. A nucleus contains no electrons, yet it ejects them. How?

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165. A radioactive sample having N nuclei has activity R. Write down an expression for its half life in terms of R and N.

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166. Prove that the instantaneous rate of change of activity of a radioactive substance is inversely proportional to the square of half life.

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167. During alpha decay of a nucleus, how does the neutron to proton ratio change?

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168. During beta decay of a nucleus, how does the neutrons to proton ration change?

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169. We are given the following atomic masses:

$._{92}U^{238} = 238.05079u,$

$._{90}Th^{234} = 234.04363u,$

$._{91}Pa^{237} = 237.05121, ._{1}H^{1} = 1.00783,$

$._{2}He^{2} = 4.00260u$

(a) Calculate the energy released during α decay of $._{92}U^{238}$,

(b) Calculate the kinetic energy of emitted α particles,

(c) show that $._{94}U^{238}$ cannot spontaneously emit a proton.

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170. Two different radioactive elements with half lives T_1 and T_2 have N_1 and N_2 (undecayed) atoms respectively present at a given instant. Determine the ratio of their activities at this instant.

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171. In $._{92} U^{238}$ radioactive series by α decay or β decay, which one of the following can be the end product: $Pb^{206}, Pb^{207}, Pb^{208}, Pb^{209}$?

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172. What is the difference between a photon and a neutrino?

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173. Calculate the disintegration energy Q for fission of $._{42} Mo^{98}$ into two equal fragments $._{21} Sc^{49}$ by bombarding with a neutron. Given that $m(._{42} Mo^{98}) = 97.90541u, m(._{21} Sc^{49}) = 48.95002u, m_n = 1.00867u$

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174. A star converts all its hydrogen to helium, achieving 100% helium composition. It then converts the helium to carbon via the reaction

$._{2}He^{4}+._{2}He^{4}+._{2}He^{4}\rightarrow ._{6}C^{12}+7.27MeV$

The mass of the star is $5.0\times10^{32}kg$ and it generates energy at the rate of $5\times10^{30}kg$ watt. How long will it take to convert all the helium to carbon at this rate?

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175. (a) Write symbolically the process expressing the β^{+} decay of $._{11}Na^{22}$. Also write the basic nuclear process underlying this decay.

(b) Is the nucleus formed in the decay of the nucleus $._{11}Na^{22}$, an isotope or isobar?

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176. How is nuclear size related to its mass number?

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177. What is the order of nuclear density?

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178. Why is nuclear density same for all nuclei?

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179. Why are heavy nuclei usually unstable?

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180. If one a.m.u.=$1.66 \times 10^{-27} kg$, when is the mass of one atom of C^{12}?

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181. Why is density of a nucleus much more than the atomic density?

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182. How many electron potons and mass number in a nucleus of atomic number 11 and mass 24?

(i) number of electron = (ii)number of proton = (iii)number of neutrons =

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183. A nucleus of mass number A has mass defect (Δm) what is BE per nucleon of this nucleus?

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184. State two characteristic properties of nuclear forces.

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185. Compare the radii of two nuclei with mass number 1 and 27 respectively.

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186. What is the ratio of kWh to MeV?

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187. What is the ratio of volume of atom of the volume of nucleus?

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188. How many coulomb of charge is carried by 1kg of electrons?

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189. Protons and neutrons exit together in an extermely small space within the nucleus. How is this possible when protons replel each other?

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190. Write down the names and formulae of the three isotopes of hydrogen.

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191. Select the pairs of isobars and isotons form the following nuclei $._6 C^{14}, ._7 N^{13}, ._7 N^{14}, ._8 O^{16}$:

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192. Select the pairs of isotops and isotons form the following nuclei $._6 C^{12}, ._7 N^{14}, ._{15} P^{30}, ._{15} P^{31}$.

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193. Two nuclei have mass number in the ratio 1:8. What is the ratio of their nuclear radii?

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194. What do you understand by the fact that the binding energy of helium nucleus is 28.17MeV?

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195. What is one electron volt?

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196. The binding energies of deutron $\left(._1 H^2\right)$ and α-particle $\left(._2 He^4\right)$ are 1.25 and 7.2 MeV/nucleon respectively. Which nucleus is more stable?

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197. Nuclear forces are short range forces. Comment.

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

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199. Identify the nuclides X and Y in the nuclear reaction $._5 \beta^{11} + ._1 H^1 \rightarrow ._4 Be^8 + X, ._6 C^{14} \rightarrow Y + _{-1} e^0$.

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200. Out of alpha, beta and gamma radiations, which are affected by electric field and magnetic field?

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201. The decay constant of a radiaoactive sample is λ . The half life and mean life of the sample are respectively given by

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202. The mean life of a radioactive sample is T_m. What is the time in which 50% of the sample woulf get decayed ?

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203. Write the SI unit of activity of a radioactive nuclide.

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204. What is the difference between a beta particle and electron?

Watch Video Solution

205. A nucleus $._n X^M$ emits one α particle and one β-particle. What are the mass number and atomic number of the product nucleus?

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206. Which of the following is in the increasing order for penetrating power ?

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207. What is the relation between decay constant and half life of a radio active element?

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208. What are unit of activity of radioactive elements?

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209. The half life of a radioactive element A is same as mean life time of another radioactive element B.Initially, both have same number of atoms. B decays faster than A . Why?

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210. A radioactive isotope decays in the following sequence :

$$A \xrightarrow{\cdot_0 n^1} A_1 \xrightarrow{\alpha} A_2$$

If the mass number and atomic number of A_2 are 176 and 71 respectively, find the mass number and atomic number of A_1 and A. Which of the three elements are isotopes?

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211. Draw the graph showing distribution of kinetic energy of electrons emitted during beta decay.

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212. (a) Write the basic nuclear process involved in the emission of β^{+} in a symbolic form, by a radioactive nucleus.

(b) In the reaction given below:

$\cdot_{6} C^{11} \rightarrow \cdot_{y} B^{z} = x + v$

$\cdot_{6} C^{12} + \cdot_{6} C^{12} \rightarrow \cdot_{a} Ne^{20} + \cdot_{b} He^{c}$

Find the values of x,y,z and a,b,c.

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213. A nucleus $\cdot_{92} U^{235}$ undergoes alpha decay and transforms into thorium. What is mass number and charge number of nucleus produced?

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214. A uranium nucleus $U-238$ of atomic number92 emits two α-particles and two β-particles and trasnforms into a thorium nucleus. What is the mass number and atomic number of the thorium nucleus so produced?

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215. What do you mean by Q value of a nuclear reaction?

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216. In a particular fission reaction, a $._{92}U^{235}$ nucleus captures a slow neutron. The fission products are three neutrons, a $._{57}La^{142}$ nucleus and a fission product $._{Z}X^{A}$. What is the value of Z?

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

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218. What is the nuclear radius of Fe^{125}, if that of Al^{27} is 3.6 fermi.

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219. Assuming the nuclei to be spherical in shape, how does the surface area of a nucleus of mass number A_1 compare with that of a nucleus of mass number A_2?

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220. What is the effect on neutron to proton ration in a nucleus when (i) an electron, (ii) a positron is emitted?

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221. How many electron potons and mass number in a nucleus of atomic number 11 and mass 24?

(i) number of electron = (ii)number of proton = (iii)number of neutrons =

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222. Calculate the energy equivalent of 1 a.m.u. in MeV

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223. You are given two nuclei $._3 X^7$ and $._3 Y^4$. Explain giving reasons, as to which one of the two nuclei is likely to be more stable?

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224. Binding energies of $._8 O^{16}$ and $._{17} Cl^{35}$ are $127.35 MeV$ respectively. Which of the two nuclei is more stable?

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225. The natural boron is composed of two isotopes $._5 B^{10}$ and $._5 B^{11}$ having masses $10.003u$ and $11.009u$ resp. Find the relative abundance of each isotope in the natural boron if atomic mass of natural boron is 10.81u.

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226. Show that the decay rate R of a sample of radionuclide is related to the number of radioactive nuclei N at the same instant by the expression $R = \lambda N$.

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227. What $\%$ age of a given mass of a radioactive substance will be left undecayed after five half life periods?

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228. A radioactive nucleus undergoes a series of decay according to the scheme

$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\alpha} A_3^{172} \xrightarrow{\gamma} A_4.$

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229. The sequence of decay of radioactive nucleus is $D \xrightarrow{\alpha} D_1 \xrightarrow{\beta} D_2 \xrightarrow{\alpha} D_3 \xrightarrow{\alpha} D_4$

If nucleon number and atomic number of D_2 are 176 and 71 respectively, what are their value of D and D_4?

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230. Define the activity of a radionuclide. Write its SI unit. Give a plot of the activity of a radioactive species versus time.

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231. Write symbolically the nuclear β^+ decay process of $._6 C^{11}$. Is the decayed product X an isotope or isobar of $._6 C^{11}$? Given the mass values of $\left(._6 C^{11}\right) = 11.011434u$

and $m(X) = 11.009305u$. Estimate the Q value in the process.

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232. (a) What are thermal neutrons in the context of nuclear fission ?

(b) What role does a moderator play in a nuclear reactor ?

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233. A heavy nucleus X of mass number 240 and binding energy per nucleon 7.6 MeV 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.

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234. Explain with the help of a nuclear reaction in each of the following cases, how the neutron to proton ratio change during (i) α- decay (ii) β-decay.

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235. What do you understand by atomic number and mass number? Explain giving examples.

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236. Show that atomic nuclei of different elements have different sizes.

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237. Why is nuclear density same for all nuclei?

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238. Differentiate between isotope and isobars.

Watch Video Solution

239. Define atomic mass unit and electron volt. Establish a relation between them.

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240. Write the basic nuclear processes underlaying β^{+} and β^{-} decays.

Watch Video Solution

241. Why is nuclear density same for all nuclei?

Watch Video Solution

242. What do you understand by isotopes, isobars and isotons? Explain with illustrations.

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243. Explain the phenomenon of nuclear fusion with at least two examples.

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244. A 20kg satellite circles the earth 2 hour in an orbit having a radius of $8000km$. If Bohr's angular momentum postulate is applied to the satallite. Find the quantum number of the orbit of the satallite. Take $h = 6.6 \times 10^{-34} J - s$.

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245. To what series does the spectral line of atomic hydrogen belong if its wave number is equal to the difference between the wave numbers of the following two lines of the Balmer series: $486.1$and $410.2nm$? What is the wavelength of that time?

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246. There is a stream of neutrons with kinetic energy of 0.0327 eV. If half life of neutrons is 700s, what fraction of neutrons will decay before they travel a distance of 10m? Take mass of neutron =$1.675 \times 10^{-27} kg$.

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247. Energy of an electron in an excited hydrogen atom is $-3.4eV$. Its angualr momentum will be: $h = 6.626 \times 10^{-34} J - s$.

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248. The isotope of U^{238} and U^{235} occur in nature in the ratio $140:1$. Assuming that at the time of earth's formation, they were present in equal ratio, make an estimate of the age of earth. The half lives of U^{238} and U^{235} are 4.5×10^9 years and 7.13×10^8 years respectively. Given $\log_{10} 140 = 2.1461$ and $\log_{10}^2 = 0.3010$.

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249. A star initially has 10^{40} deuterons. It produces energy via the processes $._1 H^2 +_1 H^2 \rightarrow_1 H^3 + p$ and $._1 H^2 +_1 H^3 \rightarrow_2 He^4 + n$. If the average power radiated by the star is 10^{16} W, the deuteron supply of the star is exhausted in a time of the order of

(a) $10^6 s$ (b) $10^8 s$ (c) $10^{12} s$

The masses of the nuclei are as follows

$M(H^2) = 2.014$ amu, $M(n) = 1.008$ amu,

$M(p) = 1.007$ amu,$M(He^4) = 4.001$amu

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250. The wavelength of the characteristic X - ray k_{α} line emitted by a hydrogens like element is 0.32λ . The wavelength of the K_{β} line emitted by the same element will be .....

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251. The wavelength of the first line of Balmer series in hydrogen atom is 6562.8Å. Calculate ionisation potential of hydrogen and also, the wavelength of first line of Lyman series.

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252. An electron in a hydrogen atoms makes a transition form n_1 to n_2 where n_1 and n_2 are two principal quantum numbers of two states. If time period of electron in state n_1 is 8 times the time period in state n_2, find the ratio (n_2 / n_1), assuming Bohr model to be true.

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253. A stationary helium ion emits a photon corresponding to the first line of Lyman series. That photon liberates a photoelectron form a stationary hydrogen atom in ground state. Find the velocity of photoelectron. Take mass of electron $= 9.11 \times 10^{-31} kg$ and ionisation energy of hydrogen atom=13.6ev.

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254. A gas of monoatomic hydrogen is bombarded with a atream of electrons that have been accelerated from rest through a potential difference of $12.75V$. In the emission spectrum, one can observe lines of

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255. The radioactive decay rate of a radioactive element is found to be 10^3 disintegration per second at a cartain time . If the half life of the element is one second , the dacay rate after one second ..... And after three second is ......

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256. A radioactive isotope X has a half life of 3 seconds. At t=0, a given sample of this isotope contains 8000 atom. Calculate (i) its decay constant (ii) average life (iii) the time t_1, when 1000 atoms of the isotope X remain in the sample (iv) number of decay/sec in the sample at $t = t_1 \text{ sec.}$

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257. A radioavtive source in the form of a metal sphere of daimeter 10^{-3} m emits β-particles at a constant rate of 6.25×10^{10} particles per second. If the source is electrically insulated, how long will it take for its potential to rise by $1.0V$, assuming that 80% of the emitted β-particles escape the socurce?

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258. In the chemical analysis of a rock the mass ratio of two radioactive isotopes is found to be $100:1$. The mean lives of the two isotopes are 4×10^9 years and 2×10^9 years, respectively. If it is assumed that at the time of formation the atoms of both the isotopes were in equal propotional, calculate the age of the rock. Ratio of the atomic weights of the two isotopes is $1.02:1$.

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259. The mean lives of a radioactive substance are 1620 years and 405 years for α emission and β emission respectively. Find out the time during which three fourth of a sample will decay if it is decaying both by α-emission and β-emission simultaneously. $(\log_e 4 = 1.386)$.

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260. A sample contains $10^{-2} kg$ each of two substances A and B with half lives 4 sec and 8 sec respectively. Their atomic wights are in the ratio $1:2$. Find the amounts of A and B after an interval of 16 seconds.

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261. Suppose a moving hydrogen atom makes a head on inelastic collision with a stationary hydrogen atom. Before collision, both atoms are ground state and after collision, they move together. What is the minimum velocity of the moving hydrogen atom if one of the atoms is to be given the minimum excitation energy after the collisions? Take $m_H = 1.0078 amu. 1.66 \times 10^{-27} kg.$

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262. Choose the correct alternative form the clues given at the end of each statement:

(a) The size of the atom in Thomson's model is .... the atomic size in Rutherford's model (much greater than/no different form/much less than)

(b) In the ground state of ...., electrons are in stable equilibrium, while in.......... electrons always experience a net force (Thomson's model/Rutherford's model).

(c) A classical atom based on .... is doomed to collapse (Thomson's model/Rutherford's model).

(d) An atom has a nearly continous mass distribution in .... but has highly non uniform mass distribution in....... (Thomson's model/Rutherford's model).

(e) The positively charge part of the atom possesses most of the mass of the atom in .... (Rutherford's ,model /both the models).

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263. What is the shortest wavelength present in the Paschen series of spectral lines?

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264. A difference of 2.3 eV separates two energy levels in an atom. What is the frequency of radiation emitted when the atom transits form the upper level to the lower level.

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265. The ground state energy of hydrogen atom is -13.6eV. What are P.E. and K.E. of electron in this state?

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266. A hydrogen atom initially in the ground level absorbs a photon, Which excites it to n=4 level. Determine the wavelength and frequency of photon.

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267. (a) Using the Bohr's model, calculate the speed of the electron in a hydrogen atom in the n=1,2 and 3 levels. (b) Calculate the orbital period in each of these levels.

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268. The radius of innermost electron orbit of a hydrogen atom is $5.3 \times 10^{-11} m$. What are the radii of n=2 and n=3 orbits.?

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269. A $12.5eV$ electron beam is used to excite a gaseous hydrogen atom at room temperature. Determine the wavelengths and the corresponding series of the lines emitted.

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270. In accordance with the Bohr's model, find the quantum number that characterises the earth's revolution around the sun in an orbit of radius $1.5 \times 10^{11} m$ with orbital speed $3 \times 10^4 m/s$. (Mass of earth= $6.0 \times 10^{24} kg$)

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271. The gravitational attraction between electron and proton in a hydrogen atom is weaker than the coulomb attraction by a factor of about 10^{-40}. An alternative way of looking at this fact is to estimate the radius of the first Bohr orbit of a hydrogen atom if the electron and proton were bound by gravitational attraction. You will find the answer interesting.

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272. Using Bohr's theory show that when n is very large the frequency of radiation emitted by hydrogen atom due to transition of electrom from n to $(n-1)$ is equal to frequency of revolution of electron in its orbit.

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273. The total energy of an electron in the first excited state of hydrogen atom is -3.4 eV.

(a) What is kinetic energy of electron in this state?

(ii) What is potential energy of electron in this state?

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

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274. Obtain the first Bohr radius and the ground state energy of a muonic hydrogen atom (i.e., an atom in which a negatively charged muon (μ) of mass about $207m_e$ revolves around a proton).

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275. (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 11.00931u, and the atomic weight of boron is 10.81u. Find the abundaces of $._5 B^{10}$ and $._5 B^{11}$.

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276. The three stable isotopes of neon $._{10} Ne^{20}$, $._{10} Ne^{21}$ and $._{10} Ne^{22}$ have respective aboundances 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.

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277. Obtain the binding energy of a nitrogen nucleus from the following data:

$m_H = 1.00783u, m_N = 1.00867u, m\left(._7^{14} N\right) = 14.00307u$

Give your answer in units of MeV. [Remember $1u = 931.5MeV / c^2$]

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278. Obtain the binding energy of the nuclei $._{26} Fe^{56}$ and $._{83} Bi^{209}$ in units of MeV form 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 $1a.m.u931.5MeV$

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279. A given coin has a mass of 3.0 g. Calculate the nuclear energy that would be required to separated all the neutrons and protons form each other. for simplicity, assume that the coin is entirely made of $._{29}Cu^{63}$ atoms (of mass 62.92960 u).

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280. Write nuclear reaction equation for

(i) α particle of $._{88}Ra^{226}$ (ii) α decay of $._{94}Pu^{242}$ (ii) β^{-} decay of $._{15}P^{32}$ (iv) β^{-} decay of $._{83}Bi^{210}$ (v) β^{+} decay of $._{6}C^{11}$ (vi) $B\eta^{+}$ decay of $._{43}Tc^{97}$

(vii) Electron capture of $._{54}Xe^{120}$.

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281. A radioactive isotope has a life of T years. How long will it take the activity to reduce to (a) $3.125\%(b)1\%$ of its original activity?

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282. 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 $._6C^{14}$ present with the ordinary $._6C^{12}$ isotope. When the organism is dead, its interaction with the atmosphare which maintains the above equilibrium activity, ceases and its activity begins to drop. form the known half life (=5730years) of $._6C^{14}$, and the measured activity, the age of the specimen can be approximately estimated. This is the principle of $._6C^{14}$ dating used in archaeology. Suppose a spacimen form Mohenjodaro gives an activity of 9 decays per minute per gram of carbon. Estimate the approximate age of the Indus Vally Civilization.

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283. 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?

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284. The half life of $._{38}Sr^{90}$ is 28 years. What is disin. rate of 15g of this isotope?

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

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286. Find the Q value and the kinetic energy of emitted α particle in the α decay of

(a) $._{88}Ra^{226}$ (b) $._{86}Rn^{220}$. Given $m(._{88}Ra^{226}) = 226.02540u, m(._{86}Rn^{222}) = 222.01750u$

(b) $m(._{86}Rn^{220}) = 220.01137u, m(._{84}Po^{216}) = 216.00189u$ and $m._{\alpha} = 4.00260u$.

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287. The radionuclide $._6 C^{11}$ decays according to $._6 C^{11} \rightarrow ._5 B^{11} + e^+ + v$: half life =20.3min. The maximum energy of the emitted positron is $0.960 MeV$. Given the mass values

$m(._6 C^{11}) = 11.011434u, m(._6 B^{11}) = 11.009305u$

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

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288. 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,$(m(._{11}^{23} Ne) = 22.994466 amu$ and $m(._{11}^{23} Na = 22.989770 amu$. Ignore the mass of antineuttino $(\bar{v})$.

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289. 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) $._1 H^1 + ._1 H^3 \rightarrow ._1 H^2 + ._1 H^2$

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

Atomic masses are given to be

$m(._1 H^2) = 2.014102u, m(._1 H^3) = 3.016049u, m(._6 C^{12}) = 12.000000u,$

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290. 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 $m(._{26} Fe^{56}) = 55.93494u, m(._{13} Al^{28}) = 27.98191u.$

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

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292. A 1000 MW fission reactor consumes half of its fuel in 5.00y. How much $._{92}U^{235}$ did it contain initally? 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.

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293. 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 $._{1}H^{2} + ._{1}H^{2} \rightarrow ._{1}H^{3} + n + 3.17 MeV$

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294. Calculate the height of potential barrier for a head on collision of two deuterons. The effective radius of deuteron can be taken to be 2fm. Note that height of potential barrier is given by the Coulomb repulsion between two deuterons when they just touch eachother.

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295. form 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).

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

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

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297. In a periodic table, the averge 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 $._{12} Mg^{24}(23.98504u)$, $._{12} Ng^{25}(24.98584)$ 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.

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

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

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300. 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.

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301. 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:

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

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302. 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 form the date

$m(._1 H^2) = 2.014102u, m(._1 H^3) = 3.016049u$

(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?

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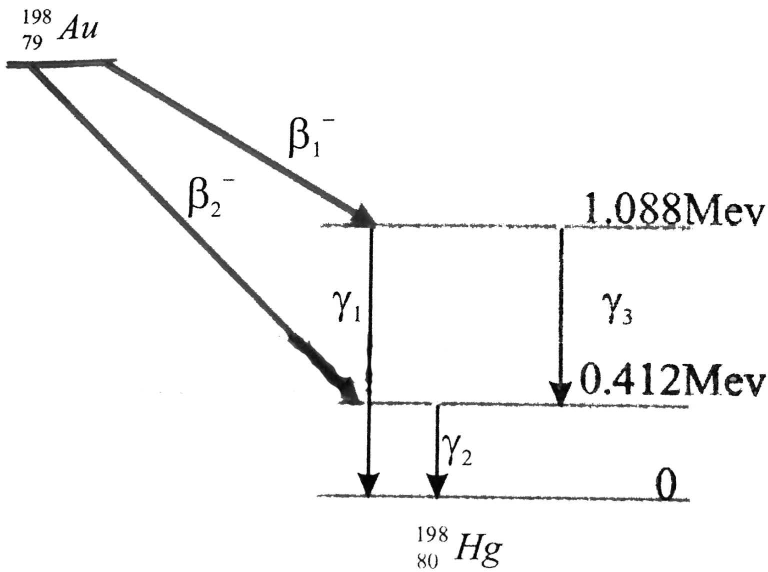
303. Obtain the maximum kinetic energy of β-particles, and the radiation frequencies of γ decays in the decay scheme shown in Fig. 14.6. You are given that $m\left(.^{198}Au\right) = 197.968233u$, $m\left(.^{198}Hg\right) = 197.966760u$



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304. 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.

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305. Suppose India has a target of producing by 2020 A.D., $2 \times 10^5 MW$ of electric power, ten percent of which is to be obtained form nuclear power plants. Suppose we are given that on an average, the efficiency of utilization (i.e., conservation to electrical energy) of thermal energy produced in a reactor is 25%. How much amount of fissionable uranium will our country need per year? Take the heat energy per fission U^{235} to be about 200MeV.

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306. The mass of a H-atm is less than the sun f the masses of a proton and electron. Why is this?

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307. Would the bohr formula for the H-atom remain unchanged if proton had a change $(+4/3)e$ and electron a change $(-3/4)e$, where $e = 1.6 \times 10^{-19} C$. Given reasons for you answer.

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308. Consider two different hydrogen atmos. The electron in each atom is in an excited state. Is it possible for the electrons to have different energies but the same orbital angular momentum according to the bohr model ?

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309. Positronium is just like a H-atom with the proton replaced by the positively charged anti-particle of the electron (called the positron which is as massive as the electron). What would be the ground state energy of positronium ?

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310. Using Bohr model, calculate the electric current created by the electron when the H-atom is in the ground state.

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311. Show that the first few frequencies of light that are emitted when electrons fall to the nth level form levels higher than n, are approximate harmonics (i.e., in the ratio 1 : 2: 3...) when $n >> 1$.

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312. What is the minimum energy that must be given to a H atom is ground state so that it can emit an $H\gamma$ line in Balmer series. If the angular momentum of the system is conserved, what would be the angular momentum of such $H\gamma$ photon ?

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313. The first four spectral lines in the Lyman series of a H-atom are $\lambda = 1218Å, 1028Å, 974.3Å$ and $951.4Å$. If instead of Hydrogen, we consider Deuterium, calculate the shift in the wavelength of these lines.

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314. A piece of wood form the ruins of an nuclei an ancient building was found to have a $.^{14}C$ activity of 12 disintegrations per minute per gram of its carbon content. The $.^{14}C$ activity of the living wood is 16 disintegrations/minute/gram. How long ago did the trees, form which the wooden sample came, die? Given half-life of $.^{14}Cis5760yers$.

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315. A nuclide 1 is said to be the mirror isobar of nuclide 2 if $A_1 = N_2$ and $Z_2 = N_1$. (a) What nuclide is a mirror isobar of $._{11}^{23}Na$? (b) Which nuclide out of the two mirror isobars has greater binding energy and why?

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316. Deuteron is a bound state of a neutron and a proton with a binding energy $B = 2.2MeV$. $A\gamma$-ray of energy E is aimed at a deuteron nucleus to try to breack it into a (neutron +proton) such that the n and p move in the direction of the incident γ-rays. If E=B, show that this can not happen. Hence, calculate how much bigger than B must E be for such a process to happen.

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317. The deuteron is bound by nuclear forces just as H-atom is made up of p and e bound by electrostatic forces. If we consider the forces between neutron and proton in deuteron as given in the form of a Coulomb potential but with an effective charge e': $F = \frac{1}{4\pi\varepsilon_0}\frac{e'^2}{r}$ estimate the value of (e' / e) given that the following binding energy of a deuteron is 2.2MeV.

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318. Nuclei with magic no. of proton Z=2,8,20,28,50,52 and magic no. of neutrons N=2,8,20,28,50,82 and 126 are found to be stable. (i) Verify this by calculating the proton separation energy S_p for $.^{120}Sn(Z=50)$ and $.^{121}Sb=(Z=51)$.

The proton separation energy for a nuclide is the minimum energy required to separated the least tightly bound proton form a nucleus of that nuclide. It is given by

$S_p=(M_{z-1,N}+M_H-M_{Z,N})c^2$.

given

$.^{119}Sn=118.9058u, .^{120}Sn=119.902199u, .^{121}Sb=120.903824u, .^{1}H=$

(ii) what does the existence of magic number indicate?

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319. A double ionised lithium atom is hydrogen like with atomic number 3

(i)Find the wavelength of the radiation to excite the electron in Li^{++} from the first to the third bohr orbit (Ionisation energy of the hydrogen atom equals $13.6eV$

(ii) How many spectral lines are observed in the emission spectrum of the above excited system ?

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320. Prove that the instantaneous rate of change of activity of a radioactive substance is inversely proportional to the square of half life.

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321. The nucleus of an atom of $._{92}Y^{235}$ initially at rest decays by emitting an α particle. The binding energy per nucleon of parent and daughter nuclei are $7.8MeV$ and $7.835MeV$ respectively and that of α particles is $7.07MeV/\text{nucleon}$. Assuming the daughter nucleus to be formed in the unexcited state and neglecting its share of energy in the reaction, calculate speed of emitted alpha particle. Take mass of α particle to be $6.68 \times 10^{-27}kg$.

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322. In an ordianary atom, as a first approximation, the motion of the nucleus can be ignored. In a positronium atom a positronreplaces the proton of hydrogen atom. The electron and positron masses are equal and , therefore , the motion of the positron cannot be ignored. One must consider the motion of both electron and positron about their center of mass. A detailed analyasis shows that formulae of Bohr's model apply to positronium atom provided that we replace m_e by what is known reduced mass is $m_e / 2$.

When system de-excites from its first excited state to ground state, the wavelngth of radiation is

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323. The radioactive decay rate of a radioactive element is found to be 10^3 disintegration per second at a cartain time . If the half life of the element is one second , the dacay rate after one second ..... And after three second is ......

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324. A radioactive sample decays with an average life of $20ms$. A capacitor of capacitance $100\mu F$ is charged to some potential and then the plates are connected through a resistance R. What should be the value of R so that the ratio of the charge on the capacitor to the activity of the radioactive sample remains constant in time?

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325. A point of γ-radiation has a half life of 30 minutes. The initial count rate, recorded by Geiger counter placed 2 m form the source is $360s^{-1}$. The distance between the counter and the source is altered. After 1.5 hours, the count rate recorded is $5s^{-5}$. what is the new distance between the counter and the source?

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326. The Coulomb barrier height for α particle emission is 30.0MeV. What is the barrier height for $._6 C^{14}$? The required data is

$m(._{88} Ra^{223}) = 223.01850u, m(._{82} Pa^{209}) = 208.98107u, m(._{86} Rn^{219}) =$

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(II) very short answer 16

1. What is the order of radius of helium atom?

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(I) Short Answer questions 1

1. Why is that mass of nucleus does not enter the formula for impact parameter but its charge does?

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Short Answer question 4

1. Enlist the main limitations of the Bohr's theory.

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(I) Conceptual Problems 1

1. Electron cannot be a part of nucleus but protons can be. Why?

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(I) Conceptual Problems 5

1. Why the mass of the nucleus is less than the sum of masses of the nucleons?

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(I) Conceptual Problems 6

1. The isotope $._{8}O^{16}$ has 8 protons, 8 neutrons and 8 electrons, while $._{4}Be^{8}$ has 4 protons, 4 neutrons and 4 electrons.Yet the ratio of their atomic masses is not exactly 2. Why?

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(I) Conceptual Problems 8

1. An electron which is emitted in beta decay comes out of the nucleus. It is not one of the atomic electron revolving around the nucleus. This fact led some scientists to conjecture that electrons are constituents of the nucleus. Later this conjecture proved to be incorrect. Try to collect some arguments which show that this conjecture is indeed incorrect.

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(I) Conceptual Problems 14

1. Name two radioactive elements which are not found in observable quantities. Why is it too?

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(I) Conceptual Problems 16

1. A free proton cannot decay into $(n + e^{+} + v)$, because such decay is not energetically allowed. Yet we observe in nature beta decay with positron emission. How do we understand the emission of positrons form nuclei?

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(I) Conceptual Problems 18

1. Four nuclei of an elements undergo fusion to form a heavier nucles, 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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(I) Conceptual Problems 21

1. What is nuclear fall out? How can it be reduced?

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(I) Conceptual Problems 22

1. Safety of nuclear reactors is an important issue. Guess some of the saftey problems that a nuclear engineer must cope within reactor design.

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(I) Conceptual Problems 23

1. Explain the concept of nuclear energy with reference to binding energy curve.

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(I) Conceptual Problems 24

1. What are delayed neutrons? Discuss their role.

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(I) Conceptual Problems 27

1. Answer the following questions:

a) Are the equations of nuclear reactions 'balanced' in the sense a chemical equation (e.g., $2H2 + O2 \rightarrow 2 H2O$) 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.

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(I) Conceptual Problems 29

1. Give reasons for

(a) Ligther elements are better moderators for a nuclear reactor than heavier elements.

(b) In a natural uranium reactor, heavy water is prefered moderator to ordinary water.

(c) Cadmium rods are provided in a reactor.

(d) Very high temperatures as those obtained in the interior of the sun are required for fusion reaction to take place.

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(I) Questions very short 10

1. Name two elementary particles which have almost infinite life time.

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(I) Questions very short 14

1. What holds nucleons together in a nucleus?

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(I) Questions very short 16

1. Name three nuclei which lie on maxima in Binding energy curve.

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(I) Questions very short 17

1. Name three nuclei which lie on minima in binding energy curve.

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(I) Questions very short 26

1. Which one is unstable among neutron, proton,electron and α-particle?

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(II) Questions very short 30

1. Why α particles have high ionising power than β rays?

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(II) Questions very short 35

1. Can radioactivity be controlled?

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(II) Questions very short 36

1. Why do alpha particles have a high ionising power?

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(II) Questions very short 40

1. γ-rays are also called electromagnetic waves. Why?

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(II) Questions very short 43

1. Consider a radioactive material of half-life 1.0 minute. If one of the nuclei decays now, the next one will decay

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(III) Questions very short 50

1. Name the process responsible for energy production in the sun.

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(III) Questions very short 51

1. Name the absorbing material used to control the reaction rate of neutrons in a nuclear reactor.

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(III) Questions very short 53

1. What is meant by critical size?

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(III) Questions very short 54

1. What is pair production?

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(III) Questions very short 55

1. What is the masss of pion plus (π^+)?

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(III) Questions very short 56

1. What is the mass of muon plus (μ^+)?

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(III) Questions very short 57

1. Is it possible that a nucleus has negative mass defect?

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(III) Questions very short 59

1. Neutrons produced in fission can be slowed down even by using ordinary water. Then, why is heavy water used for this purpose?

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(I) Questions short 5

1. Why must heavy stable nucleus contain more neutrons than protons ?

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(I) Questions short 6

1. Which property of nuclear forces is responsible for the constancy of binding energy per nucleon?

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(I) Questions short 10

1. If the nucleons bound in a nucleus are separated apart form each other, the sum of their masses is greater than the mass of the nucleus. Where does this mass difference come form? Explain briefly.

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(I) Questions short 12

1. Give the order of magnitude of nuclear mass density and average atomic mass density. Compare these densities with the typical mass density of solids, liquids and gases (at oridnary temperature and pressure).

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(II) Questions short 18

1. Why is the energy distribution of β rays continuous?

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(III) Questions short 20

1. Uranium ${}_{92}U^{238}$ is not suitable for chain reaction . Why ?

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(III) Questions short 21

1. Why is neutron so effective as a bombarding particle?

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(III) Questions short 22

1. Nuclear fission is not possible in laboratory. Why?

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(III) Questions short 23

1. A fusion reaction is much more energetic than a fission reaction. Comment.

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(III) Questions short 25

1. What is meant by critical mass in a nuclear chain reaction?

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(III) Questions short 26

1. A chain reaction dies out sometimes, why?

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(III) Questions short 27

1. Which law is violated in the following nuclear reaction? $._{0}n^{1} \rightarrow ._{1}H^{1} + ._{-1}e^{0}$?

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(III) Questions short 28

1. Explain one similarity and one dissimilarity between nuclear fission and fusion.

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(III) Questions short 31

1. (a) Draw a plot showing the variation of potential energy of a pair of nucleons as a function of their separation . Mark the regions where the nuclear force is :

(i) attractive and (ii) repulsive.

(b) In the nuclear reaction

$n + 235_{\underset{92}{U}} \rightarrow a_{\underset{54}{Xe}} + 94_{\underset{b}{Sr}} + 2n$ determine the values of a and b .

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Questions short 6

1. What is the significance of binding energy per nucleon?

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Questions short 7

1. Nature OF Nuclear Forces||Atomic Mass Unit

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Questions short 8

1. NUCLEAR STABILITY

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Questions short 9

1. State the laws of radioactive decay. Define the term 'decay constant' for a radioactive substance.

Watch Video Solution

Questions short 10

1. Define half-life period and average life. Derive relation between them.

Watch Video Solution

Questions short 11

1. Distinguish between nuclear fission and nuclear fusion.

Watch Video Solution

Questions short 12

1. Some scientists have predicted the global nuclear war on the earth would be followed by a serve nuclear winter with a devastating effect on life on earth.What might be the basis of this prediction?

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Questions short 15

1. Draw a plot of the binding energy per nucleon as a function of mass number for a large number of nuclei , $2 \leq A \leq 240$. How do you explain the constancy of binding energy per nucleon in the range $30 < A < 170$ using the property that nuclear force is short-ranged ?

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Questions short 16

1. (a) Write symbolically the β-decay process of ${}^{32}_{15}P$.

(b) Derive an expression for the average life of a radionuclide . Give its relationship with the half-life.

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Questions short 17

1. In a typical unclear reaction, e.g.

${}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + n + 3.27MeV,$

although number of nucleons is conserved is conserved, yet energy is released. How ? Explain.

(b) Show that nuclear density in a given nucleus is independent of mass number A.

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Questions Long 1

1. What is atomic nucleus? Who discovered it? What are atomic number and mass number? Explain with illustrations.

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Questions Long 5

1. Explain the term mass defect and binding energy. How are they related? Draw B.E. curve.

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Questions Long 7

1. Explain the concept of nuclear forces. Discuss their characterstic properties. Which properties distinguish them form electrostatic forces?

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Questions Long 9

1. State and explain the laws of radioactive disintergration. Hence define disintergration constant and half life peroid. Establish relation between them.

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Questions Long 10

1. State the law of radioactive decay. If N_0 is the number of radioactive nuclei in the sample at some initial time t_0, find out the relation to determine the number N present at a subsequent time.

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Questions Long 11

1. Deduce the expression, $N = N_{0e}^{-\lambda t}$, for the law of radioactive decay.

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Questions Long 12

1. State the law of redioactive decay. Plot a graph showing the number (N) of undecayed nuclei as a functin of time (t) for a given radioactive sample having half life $T_{1/2}$

Depict in the plot the number of undecayed nuclei at

(i) $t = 3T_{1/2}$ and (ii) $t = 5T_{1/2}$.

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Questions Long 13

1. What is meant by average life of a radioactive element? Derive an expression for it.

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Questions Long 17

1. What is meant by nuclear fission and nuclear chain reaction? Outline the conditions necessary for nuclear chain reaction.

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Questions Long 20

1. What do you understand by nuclear holocaust?

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Questions Long 21

1. Defferentiate between radioactive decay and nuclear fission.

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Exercise question 2

1. Suppose you are given a chance to repeat the alpha particle scattering experiment using a thin sheet of solid hydrogen in place of gold ofil (hydrogen is a solid at temperature below 14 K). What results do you expect?

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Additional Exercise 1

1. Answer the following questions, which help you understand the difference between Thomson's model and Rutherford's model better.

(a) Is the average angle of deflection of -particles by a thin gold foil predicted by Thomson's model much less, about the same, or much greater than that predicted by Rutherford's model?

(b) Is the probability of backward scattering (i.e., scattering of α-particles at angles greater than 90°) predicted by Thomson's model much less, about the same, or much greater than that predicted by Rutherford's model?

(c) Keeping other factors fixed, it is found experimentally that for small thickness t, the number of α-particles scattered at moderate angles is proportional to t. What clue does this linear dependence on t provide?

(d) In which model is it completely wrong to ignore multiple scattering for the calculation of average angle of scattering of α -particles by a thin foil?

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Additional Exercise question 4

1. Classically, an electron can be in any orbit around the nucleus of an atom. Then what determines the typical atomic size? Why is an atom not, say, thousand times bigger than its typical size? The question had greatly puzzled Bohr before he arrived at his famous model of the atom that you have learnt in the text. To simulate what he might well have done before his discovery, let us play as follows with the basic constants of nature and see if we can get a quantity with the dimensions of length that is roughly equal to the known size of an atom $\left(\sim 10^{-10}m\right)$.

(a) Construct a quantity with the dimensions of length from the fundamental constants e, m_e, and c. Determine its numerical value.

(b) You will find that the length obtained in (a) is many orders of magnitude smaller than the atomic dimensions. Further, it involves c. But energies of atoms are mostly in non-relativistic domain where c is not expected to play any role. This is what may have suggested Bohr to discard c and look for ‘something else’ to get the right atomic size. Now, the Planck’s constant h had already made its appearance elsewhere. Bohr’s great insight lay in recognising that h, m_e, and e will yield the right atomic size. Construct a quantity with the dimension of length from h, m_e, and e and confirm that its numerical value has indeed the correct order of magnitude.

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Additional Exercise question 6

1. If Bohr's qunatisation postulate (angular momentum=$nh/2\pi$) is a basic law of nature, it should be equally valid for the case of planetary motion also. Why then do never speak of quantization of orbits of planets around the sun?

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very short question 2

1. Imagine removing one electron form He^4 and He^3. Their energy levels, as worked out on the basis of bohr model will be very close. Explain why.

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2. Draw a graph showing the variation of decay rate with number of active nuclei.

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very short question 3

1. When an electron falls from a higher energy to a lower energy level, the difference in the energies appears in the forms of electromagnetic radiation. Why cannot it be emitted as other forms of energy?

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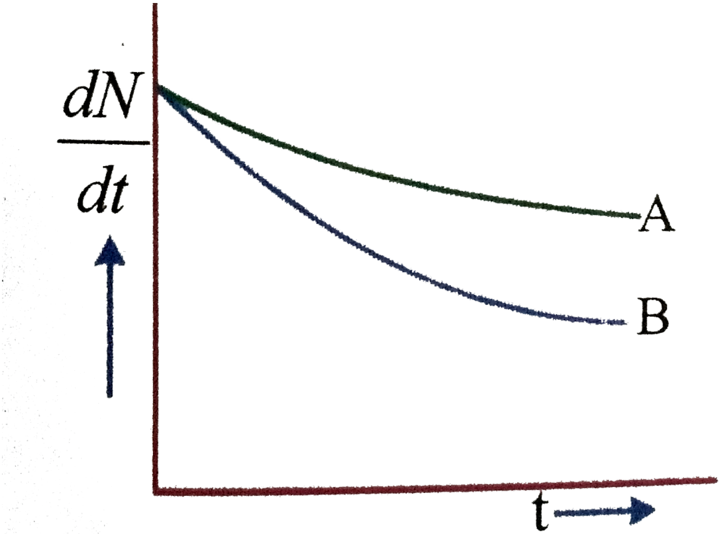
2. Which sample A or B shown in figure has shorter mean-life ?



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short question 7

1. Assume that there is no repulsive force between the electrons in an atom but the force between positive and negative charges is given by coulomb's law as usual. Under such circumstances, calculate the ground state energy of a He-atom.

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2. Consider a radioactive nucleus A which decays to a stable nucleus C through the following sequence

$A \to B \to C$

Here B is an intermediate nuclei which is also radioactive. Considering that there are N_0 atoms of A initially , plot the praph showing the variation of number of atoms of A and B versus time.

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Long question 12

1. Deutrium was discovered in 1932 by Harold Urey by measuring the small change in wavelength for a particular transition in $.^1 H$ and $.^2 H$. This is because, the wavelength of transition depend to a certain extent on the nuclear mass. If nuclear motion is taken into account, then the electrons and nucleus revolve around their common centre of mass.

Such a system is equivalent to a single particle with a reduced mass μ, revolving around the nucleus at a distance equal to the electron -nucleus separation. Here $\mu = m_e M / (m_e + M)$, where M is the nuclear mass and m_e is the electronic mass. Estimate the percentage difference in wavelength for the $1st$ line of the Lyman series in $.^1 H$ and $.^2 H$. (mass of $.^1 H$ nucleus is 1.6725×10^{-27} kg, mass of $.^2 H$ nucleus is 3.3374×10^{-27} kg, Mass of electron $= 9.109 \times 10^{-31} kg$.)

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Long question 13

1. If a proton had a radius R and the charge was uniformly distributed, calculate using Bohr theory, the ground state energy of a H-atom when (i) $R = 0.1Å$, and (ii)$R = 10Å$

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Long question 14

1. In the Angular process as atom makes a transition to a lower state without emitting a photon. The excess energy is transferred to an outer electron which may be ejected by the atom. (this is called an Augar elecrons) . Assuming the nuclesu to be massive , calculate the kinetic energy of an $n = 4$ Augar electron emitted by chromium by absorbing the energy from a $n = 2$ to $n = 1$ transition .

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2. Before the neutrino hypothesis the beta decay process was throught to be the transition.

$n \rightarrow p + \bar{e}$

If this was true show that if the neutron was at rest the proton and electron would emerge with fixed energies and calculate them. Experimentally the electron energy was found to have a large range.

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Long question 15

1. The inverse sequare law in electrostatic is $|F| = \frac{e^2}{(4\pi\varepsilon_0)r^2}$ for the force between an electron and a proton. The $\left(\frac{1}{r}\right)$ dependence of $|F|$ can be understood in quantum theo ry as being due to the fact that the particle of light (photon) is massless. If photons had a mass m_p, force would be modified to $|F| = \frac{e^2}{(4\pi\varepsilon_0)\pi^2}\left[\frac{1}{r^2} + \frac{\lambda}{r}\right]$ .exp$(-\lambda r)$ where $\lambda = \frac{m_p c}{h}$ and $h = \frac{h}{2\pi}$. Estimate the change in the gound state energy of a H-atom if m_p were 10^{-6} times the mass of the electron.

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Long question 16

1. The Bohr model for the H-atom relies on the Coulomb's law of electrostatics . Coulomb's law has not directly been varified for very short distances of the order of angstroms. Suppos-ing Coulomb's law between two oppsite charge $+q_1, -q_2$ is modified to

$$\left|\vec{F}\right| = \frac{q_1 q_2}{(4\pi\varepsilon_0)r^2}\frac{1}{r^2}, r \geq R_0$$

$$= \frac{q_1 q_2}{(4\pi\varepsilon_0)r^2}\frac{1}{R_0^2}\left(\frac{R_0}{r}\right)^{\varepsilon}, r \leq R_0$$

Calculate in such a case , the ground state enenergy of H-atom , if $\varepsilon = 0.1, R_0 = 1\text{Å}$

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Very short question 1

1. He_2^3 and He_1^3 nuclei have the same mass number. Do they have the same binding energy ?

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Very short question 4

1. Which one of the following cannot emit radiation and why ? Excited nucleus excited electron.

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Very short question 5

1. In pair annihilation an electron and a position destroy each other to produce gamma radiations . How is the momentum conserved ?

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Short question 6

1. Why do stable nuclei never have more protons than neutrons ?

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Short question 9

1. Are the nucleons fundamental particles or do they consist of still smaller perts One way to find out is to probe a nucleon just as Rutherford probed and atom . What should be the kinetic energy of an electron for it to be able to probe a nucleon? Assume the diameter of a nucleon to be approximately $10^{-15}m$.

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Long question 11

1. Sometimes a radioactive nucleus decays into a nucleus which itself is radioactive . An example is

$$.^{38}\text{ Sulphur } \xrightarrow[=2.48h]{\text{half -life}} .^{38}Cl \xrightarrow[=0.62h]{\text{half-life}} .^{38}Ar(\text{ stable})$$

Assume that we start with $1000.^{38}S$ nuclei at time t=0. the number of $.^{38}Cl$ of count zero at t=0 and will again be zero at $t=\infty$. At what value of t, would the number of counts be a maximum?

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Higher order Thinking skills 5

1. A population inversion for two energy levels is often described by assigning a negative Kelvin temperature to the system. What negative temperature would describe a system in which population of the upper energy level exceeds that of the lower by 10% and the energy difference between the two levels is 2.2 eV?

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Higher order Thinking skills 6

1. (a)If α-decays of $._{92}U^{238}$ is energetically allowed (i.e., the decay products have a total mass less than tha mass of $._{92}U^{238}$), what prevents $._{92}U^{238}$ form decaying all at once? Why is its half life so large?

(b) The α-particle faces a Coulomb barrier. A neutron being unchanged faces no such barrier. Why does the nucleus $._{92}U^{238}$ not decay spontaneously, by emitting a neutron?

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Higher order Thinking skills 7

1. The half-lives of radioactive nuclides that emit α-rays very form microsecond to billion years. What is the reason for this large variation in the life of alpha emitters?

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Higher order Thinking skills 11

1. (a) The observed decay products of a free neutron are a proton and an electron. The emitted electrons are found to have a continuous distribution of kinetic energy with a maximum of $(m_n - m_p - m_e)c^2$. Explain clearly why the presence of a continuous distribution of energy is a pointer to the existence other unobserved products in the decay.

(b) If a neutron is unstable with a half life of about 917 seconds, why don't all the neutrons of a nucleus decay eventually into protons? How can a nucleus of Z protons and (A-Z) neutrons ever remains stable, if neutrons themselves are unstable?

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Value Based Questions 1

1. Nuclear fission is the phenomenon of splitting of a heavy nucleaus into two or more ligther nuclei. Nuclear fusion is the phenomenon of fusing two or more ligther nuclei to form a single heavy nucleus. In both these processes, certain mass (Δm) disappears, which appears in the form of nuclear energy, $E = (\Delta m)c^2$. The release of energy is so sudden that it cannot be controlled. This causes havoc. Nuclear fission is the basis of the an atom bomb and nuclear fusion is the basis of a hydrogen bomb. A powerful device, called Nuclear Reactor has been developed, where in nuclear energy produced is utilised for constructive purposes.

(i) How much energy is released in the fission of one nucleus of $U(235)$ and in how much time?

(ii) Give an estimate of devastation potential of an atomic explosion.

(iii) Should we ban nuclear research in this field ? Give your views briefly.

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Value Based Questions 2

1. A nuclear reactor is a powerful device, wherein nuclear energy is utilised for peaceful purpose. It is based upon controlled nuclear chain rection. The nuclear reaction is controlled by the use of control rods (of boron or cadmium) and moderators like heavy water, graphite, etc. The whole reactor is protect with concrete walls 2 to 2.5 meter thick, so that radiation emitted during nuclear reactions may not produce harmful effects. Read the above passage and answer the following questions:

(i) Give any two merits of nuclear reactors.

(ii) What is radiactive waste?

(iii) why do people often oppose the location site of a nuclear reactor? What do you suggest?

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Value Based Questions 3

1. Einstein was the first to establish the equivalence between mass and energy. According to him, whenever a certain mass (Δm) disappears in some process, the amount of energy released is $E = (\Delta m)c^2$, where c, is velocity of light in vacuum $\left(= 3 \times 10^8 m/s\right)$. The reverse is also true, i.e., whenever energy E disappears, an equivalent mass $(\Delta m) = E/c^2$. Read the above passage and answer the following questions:

(i) What is the energy released when 1a.m.u. of mass in a nuclear reaction?

(ii) Do you want know any phenomenon in which energy materialises?

(iii) What values of life do you learn form this famous relation?

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Value Based Questions 4

1. Natural radioactivity is a spontaneous and self disruptive activity exhibated by a number of heavy elements in nature. Thus a heavy element disintegrates by itself without being forced by any external agent to do so. According to radioactive decay law, the number of atoms disintegrated per second (i.e., rate of disintegration of radioactive atoms) at any instant is directly propotional to the number of radioactive atoms actually in the sample at that instant, i.e., $-\frac{dN}{dt} \propto N$ or $R = -\frac{dN}{dt} = \lambda N$, where λ is decay constant. Read the above passage and answer the following questions:

(i) The count rate form a radioactive sample containing 10^{16} atoms is 4×10^{6} per second. What is the value of decay constant?

(ii) Name the three types of radiactive radiations. Which one of them is most penetrating?

(iii) What does radioactive decay law imply in day to day life?

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Value Based Questions 5

1. According to Bohr's theory of hydrogen atom, total energy of electron in a stationary orbit is $E = -\frac{13.6}{n^2} eV$, Where n is the number of orbit. Clearly, total energy of electron in a stationary orbit is negative, which means the electron in bound to the nucleus and is not free to leave it. An n increases, value of negative energy decreases, i.e., energy is progessively larger in the outer orbits. Read the above passage and answer the following questions:

(i) What is total energy of electron in ground state of hydrogen atom? What does it imply?

(ii) Energy required to remove an electron is smaller when atom is in any one excited state. Comment.

(ii) How is this concept translated in day to day life?

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Value Based Questions 6

1. Poonam's mother is diagnosed cancer. The attending physician told her that she has to undergo radiotherapy. While telling her the side effects of the treatement, the doctor told that her beutiful hair may fall and she may become bald. Poonam's mother refuses to get the treatment. Read the above passage and answer the following questions:

(i) What would you do if you were in Poonam's place?

(ii) What values are associated with your attitude?

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curiocity quetions 1

1. What is Bohr's correspondence principle?

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curiocity quetions 2

1. What are the basic characterstics of Lassers? Mention some of the applications.

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curiocity quetions 3

1. What does PET stand for? Where is it used?

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Exercise

1. Planck's constant has the dimension (unit) of

A. angular momentum

B. torque

C. energy

D. momentum

Answer: A

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2. What is the ground state energy of electron in case of Li^{2+} ?

A. $13.6eV$

B. $-13.6eV$

C. $30.4eV$

D. $-30.4eV$

Answer: D

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3. What is the order of velocity of electron in a hydrogen atom in ground state?

A. $10m/s$

B. $10^6 m/s$

C. $10^{-6} m/s$

D. $10^7 m/s$

Answer: B

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4. The ratio of radii of orbits correponding to first and second excited states of hydrogen atom is

A. 1

B. $1:2$

C. $2:3$

D. $4:9$

Answer: D

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5. What is the ionisation potential of hydrogen atom?

A. $-13.6eV$

B. $13.6eV$

C. $-13.6eV$

D. $13.6eV$

Answer: D

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6. Which one of the series of hydrogen spectrum is in the visible region ?

A. Lyman series

B. Balmer series

C. Paschen series

D. None of the above

Answer: B

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7. The correct relation for impact parameter, where symbols have their usual meaning is

A. $\dfrac{Ze^2 \cot \theta / 2}{(4\pi \in_0)E}$

B. $\dfrac{2Ze^2 \cot \theta}{4\pi \in_0 . E}$

C. $\dfrac{Z^2 e \cot \theta / 2}{4\pi \in_0 E}$

D. $\dfrac{(4\pi \in_0)E}{Ze^2 \cot \theta / 2}$

Answer: A

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8. The diameter of first orbit of hydrogen atom is of the order of

A. 0.5Å

B. 1Å

C. 2Å

D. 4Å

Answer: B

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9. Total energy of electron in nth stationary orbit of hydrogen atom is

A. $\frac{13.6}{n^2}\text{Joule}$

B. $\frac{13.6}{n^2}eV$

C. $-\frac{13.6}{n^2}eV$

D. $-\frac{13.6}{n^2}$Joule

Answer: C

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10. What is the value of Rydberg constant?

A. $1.097 \times 10^{-7} m$

B. $1.097 \times 10^{7} m^{-1}$

C. $1.097 \times 10^{-7} m^{-1}$

D. $1.097 \times 10^{7} m$

Answer: B

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11. A coording to Thomson model, the entire mass and positive charge of an atom are distributed............in a.............of radius.......... .

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12. The size of atomic nucleus is of the order of........... m and size of the atom is of the order of.......... .

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13. Total energy of electron in orbit of an atom is............ .This indicates that electron............ .

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14. Lyman series lies in...........region and Balmer series lies in.......... region of hydrogen spectrum.

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15. According to Bohr, angular momentum...............in hydrogen atom is...........
.

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16. The radii of stationary orbits are in the ratio............ .

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17. Orbital velocity of electron is outer orbits is............as compared to its value in............. .

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18. In the first stationary orbit of hydrogen atom, the frequency of revolution of electron is of the order of............. , and energy of electron is of order............ .

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19. Total energy of electron in outer orbits is........that in............. .

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20. An α particle of $K.E. 10^{-12} J$ exibits back scattering form a gold nucleus Z=79. What can be the maximum possible radius of the gold nucleus?

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21. A beam of α-particle of velocity $2.1 \times 10^7 m / s$ is scattered by a gold ofil (Z=79). Find the distance of closest approach of α- particle to the gold nucleus. for α-particle, $2e / m = 4.8 \times 10^7 kg^{-1}$.

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22. In a head on collision between an alpha particle and gold nucleus, the minimum distance of approach is $4 \times 10^{-14} m$. Calculate the energy of of α-particle. Take Z=79 for gold.

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23. Calculate the impact parameter of a 5MeV alpha particle scattered by 10° when it approaches a gold nucleus. Take Z=79 for gold.

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24. An alpha particle of energy 4MeV is scattered through an angle of 180° by a gold foil (Z=79). Calculate the maximum volume in which positive charge of the atom is likely to be concetrated?

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25. The number of alpha particles scattered at 60° is 100 per minute in an alpha particle scattering experiment. Calculate the number of alpha particles scattered per minute at 90°.

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26. Calculate the impact parameter of a 5 MeV particle scattered by 90°, when it approach a gold nucleus (Z=79).

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27. for scattering by an inverse square law field (such as that produced by a charged nucleus in Rutherford's model), the relation between impact parameter b and the scattering angle θ is given by

$$b = \frac{Ze^2 \cot \theta / 2}{4\pi \in_0 \left(\frac{1}{2}mv^2\right)}$$

(a) What is the scattering angle for b=0?

(b) for given impact parameter, b, does the angle of deflection increase or decrease with increase in energy?

(c) What is the impact parameter at which the scattering angle is 90° for Z=79 and initial energy=10MeV?

(d) Why is it that the mass of the nucleus does not enter the formula above, but its charge does?

(e) for a given energy of the projectile, does the scattering angle increase or decrease with decrease in impact parameter?

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28. An alpha particle having KE equal to $8.7 MeV$ is projected towards the nucleus of copper with Z=29. Calculate its distance of closest approach.

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

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30. The ground state energy of hydrogen atom is -13.6eV. If an electron makes a transition form an energy level -0.85 eV to -1.51 eV, calculate the wavelength of spectral line emitted. To which series of hydrogen spectrum does this wavelength belongs?

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31. The ground state energy of hydrogen atom is -13.6 eV (i) What are the potential energy and K.E. of electron is 3rd excited state?

(ii) If the electron jumped to the ground state form the third excited state, calculate the frequency of photon emitted.

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32. At what speed must an electron revolve around the nucleus of hydrogen atom so that it may not be pulled into the nucleus by electrostatic attraction? Given, mass of electron $= 9.1 \times 10^{-31} kg$, radius of orbit $= 0.5 \times 10^{-10} m$ and $e = 1.6 \times 10^{-19} C$.

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33. Calculate the frequency of revolution of electron in the second Bohr's orbit of radius 2.12Å. Given, $h = 6.6 \times 10^{-34} Js$, $m = 9 \times 10^{-31} kg$.

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34. Determine the radius of the first orbit of hydrogen atom. What would be the velocity and frequency of electron in this orbit? Given $h = 6.6 \times 10^{-34} Js, m = 9 \times 10^{-31} kg, e = 1.6 \times 10^{-19} C, K = 9 \times 10^{9} Nm$

.

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35. The wavelength of first members of Lyman series is $1216A^{\circ}$. Calculate the wavelength of 3rd member of Paschen series.

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36. The wavelength of K_{α} line for copper is 1.36°. Calculate the ionisation potential of a K shell electron in copper.

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37. Calculate the longest and shortest wavelength in the Balmer series of hydrogen atom. Given Rydberg constant $=1.0987 \times 10^7 m^{-1}$.

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38. Calculate longest wavelength of Paschen series. Given $R = 1.097 \times 10^7 m^{-1}$.

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39. The seond line of Balmer series has wavelength $4861Å$ The wavelength o fthe first line Balmer series is

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40. The Rydberg constant for hydrogen is $1.097 \times 10^7 m^{-1}$. Calculate the short and long wavelength limits of Lyman series.

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41. Calculate the wavelength of photon emitted when an electron jumps form 3rd orbit to 2nd orbit. Take $R = 1.097 \times 10^7 m^{-1}$. Is the photon visible ?

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42. The ionisation energy of hydrogen atom is 13.6 eV. Calculate Rydberg's constant for hydrogen.

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43. Energy of an electron in an excited hydrogen atom is $-3.4 eV$. Its angualr momentum will be: $h = 6.626 \times 10^{-34} J - s$.

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44. A hydrogen atom initially in the ground level absorbs a photon, Which excites it to n=4 level. Determine the wavelength and frequency of photon.

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45. A $12.9 eV$ beam of electrons is used to bombard gaseous hydrogen atom at room temperature. Up to which energy level the hydrogen atoms would be excited?

Calculate the wavelength of the first member of Paschen series and first member of Balmer series.

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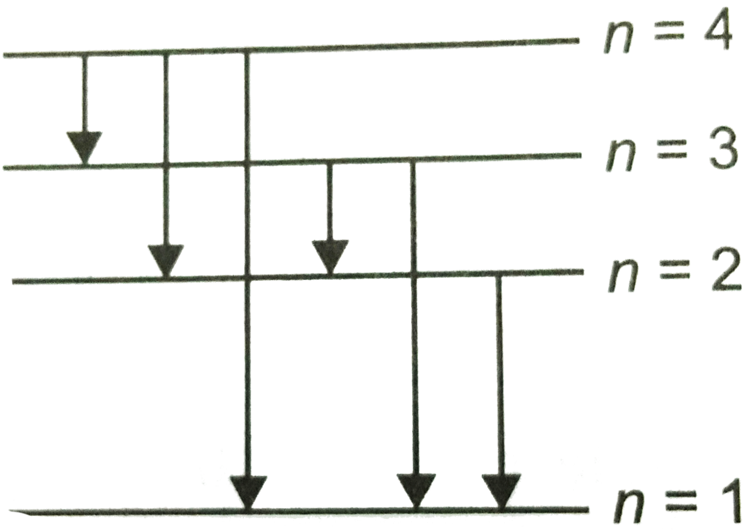
46. Fig. shows energy level diagram of hydrogen atom. Find out the transition which results in the emission of a photon of wavelength 496 nm. Which transition corresponds to emission of radiation of maximum wavelength? Justify your answer.



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47. A hydrogen atom rises form its n=1 state to the n=4 state by absorbing energy. If the potential energy of the atom in the n=1 state be -13.6 eV, then calculate

(a) potential energy in the n=4 state,

(b) energy obserbed by the atom in transition,

(c) Wavelength of the emitted radiation if the atom returns to its original state.

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48. If in nature they may not be an element for which the principle quantum number $n > 4$, then the total possible number of elements will be

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49. Which state of the triply ionized Be^{+++} has the same orbital radius as that of the ground state of hydrogen? Compare the energies of two states.

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50. What is the relation between decay constant and half life of a radio active element?

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

B. $\lambda = \frac{1}{T^2}$

C. $T = \frac{0.693}{\lambda}$

D. $\lambda = 0.693T$

Answer: C

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51. 1curei=k disintegrations/sec, where k is

A. 3.7×10^{10}

B. 3.7×10^{-10}

C. 7.3×10^{-10}

D. 7.3×10^{10}

Answer: A

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52. Which of the following is in the increasing order for penetrating power ?

A. γ, β, α

B. γ, α, β

C. α, β, γ

D. α, γ, β

Answer: C

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53. Two nuclei have mass number in the ratio 1:8. What is the ratio of their nuclear radii?

A. $1:8$

B. $8:1$

C. $1:2$

D. $2:1$

Answer: C

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54. A nucleus $._n X^M$ emits one α particle and one β-particle. What are the mass number and atomic number of the product nucleus?

A. $(m-4), n$

B. $(m-4), (n-1)$

C. $(m-3), (n+1)$

D. $(m-3), (n-1)$

Answer: B

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55. Select the pairs of isobars and isotones form the following nuclei $\cdot_6 C^{14}, \cdot_7 N^{13}, \cdot_7 N^{14}, \cdot_8 O^{16}$:

A. $\cdot_6 C^{14}, \cdot_8 O^{16}$

B. $\cdot_7 N^{14}, \cdot_7 N^{13}$

C. $\cdot_7 N^{14}, \cdot_6 O^{14}$

D. $\cdot_7 N^{14}, \cdot_8 O^{16}$

Answer: A

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56. Calculate the energy equivalent of 1 a.m.u. in MeV

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57. One electron volt is the..........when accelerated through a............ .

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58. Isotopes of an element are the atoms .... which have............ but.......... .

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59. Isobars are atoms of.........Which have same.............. But different ....

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60. Isotones are the nuclides which contain........... .

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61. Nuclear forces are the ....which hold together.............in the tiny ....

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62. Find the effective mass of a photon if the wavelength of radiation is $6 \times 10^{14} Hz$.

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63. Natural Chlorine is found to be a mixutre of two isotopes of masses 34.98 a.m.u and 36.98 a.m.u. respectively. Their relative abundances are 75.4 and 24.6% respectively. Find the composite atomic mass of natural chlorine.

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64. How many electrons protons, and neutrons are there in $12g$ of $._6 C^2$ and in $14g$ of $._6 C^{14}$?.

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65. Calculate the density of hydrogen nucleus in SI units, given $R_0 = 1.2$ fermi, mass of a proton=1.007825 a.m.u.

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66. Calculate the equivalent energy of electrons and proton at rest. Given that mass of electron $= 9.1 \times 10^{-31} kg$ and mass of proton $= 1.673 \times 10^{-27} kg.$

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67. Assuming that protons and neutrons have equal masses, calculate how many times nuclear matter is denser than water. Take mass of a nucleon $= 1.67 \times 10^{-27} kg$ and $R_0 = 1.2 \times 10^{-15} m.$

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68. If radius of the $\_(13)^{27}Al$ necleus is estimated to be 3.6 fermi then the radius of $\_(52)^{125}Te$ nucleus be nearly

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69. The nuclear radius of $._8 O^{16}$ is $3 \times 10^{-15}m$. If an atomic mass unit is $1.67 \times 10^{-27}kg$, then the nuclear density is approximately.

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70. Calculate the radius of oxygen nucleus. Take $R_0 = 1.1 \times 10^{-15}m$ and $A = 16$

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71. The binding energy of $._{10} Ne^{20}$ is 160.6 MeV. Find its atomic mass. Take mass of proton =1.007825 u and mass of neutron =1.008665 u.

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72. The binding energies of deutron $\left(._1 H^2\right)$ and α-particle $\left(._2 He^4\right)$ are 1.25 and 7.2 MeV/nucleon respectively. Which nucleus is more stable? Calculate binding energy per nucleon of $._{26} Fe^{56}$. $M\left(._{26} Fe^{56}\right)$=55.934939 a.m.u, m(proton)=1.007825 a.m.u., m(neutron) =1.008665 a.m.u.

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73. What energy is needed to split an alpha particle to piece? Given mass of α particle is 4.0039a.m.u, mass of proton=1.007825u and mass of neutron =1.008665u use $1a.\ m.\ u.\ = 931MeV$

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74. The binding energy per nucleon for $._6 C^{12} is 7.68 MeV / N$ and that for $._6 C^{13} is 7.47 MeV / N$. Calculate the energy required to remove a neutron form $._6 C^{13}$

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75. Calculate the B.E./nucleon of $._{17}Cl^{35}$ nucleus. Given that of proton $= 1.007825u$, mass of neutron $= 1.008665u$, mass of $._{17}Cl^{35} = 34.980000u$, $1u = 931 MeV$.

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76. Assuming that in a star, three alpha particle join in a single fusion reaction to form $._{6}C^{12}$ nucleus. Calculate the energy released in this reaction. Given mass of $._{2}He^{4}$ is 4.002604 a.m.u. and that of $._{6}C^{12}$ is 12 a.m.u. Take 1a.m.u. =931MeV.

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77. The sun is believed to be getting its energy form the fusion of four protons to form a helium nucleus and a pair of positrons. Calculate the release of energy per fusion in MeV. Mass of proton=1.007825 a.m.u. , mass of positron =0.000549 a.m.u., mass of helium nucleus =4.002603 a.m.u. Take 1a.m.u. =931MeV.

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78. Calculate the binding energy per nucleon in the nuclei of $._{15}P^{31}$. Given

$m(._{15}P^{31}) = 30.97376u, m(._{0}n^{1}) = 1.00865u, m(._{1}H^{1}) = 1.00782u.$

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79. The mass of a a_3^7Li nucleus is $0.042u$ less than the sum of the masses of all its nucleons. The binding energy per nucleon of $._3^7Li$ nucleus is nearly.

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80. If mass of proton =1.007825 u, mass of neutron =1.008665 u, and mass of $._3 Li^7$ is 7.01599u, and 1a.m.u. =931MeV, what is BE/nucleon of $._3 Li^7$.

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

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82. Calculate the half life periode of a radioactive substance if its activity drops to $\frac{1}{16}$ th of its initial value of 30 yr.

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83. The half life of a radioactive substance is 20s. Calculate (i) the decay constant, and (ii) time take by the sample to decay by $7/8th$ of its inital value

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84. A radioactive isotope has a half life of 5 yrs. How long will it take the activity to reduce to 3.125% ?

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85. Half life of a certain radioactive material is 100 days. After how much time the undecayed fraction of material will be 6.25%?

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86. A radioactive elements has a half life of 2500 yrs. In how many years will its mass decay by 90% of its initial mass?

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87. The half life of radioactive Radon is $3.8 days$. The time at the end of which $\frac{1}{20}th$ of the radon sample will remain undecayed is $(given \log e = 0.4343)$

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88. Half life of a sample is 20 minutes. In how much time will the acitivity of sample drop to $1/16$ of its initial value?

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89. Two nuclei P and Q have equal number of atoms at t=0. Their half lives are 3 hrs and 9 hrs respectively. Compare their rates of disintegration after 18 hours form the starts.

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90. The half life of a given radioactive nuclide is 138.6 days. What is the mean life of this nuclide? After how much time will a given sample of this nuclide get reduced to only 12.5% of its initial value?

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91. The decay constant for a radio nuclide, has a value of $1.386 day^{-1}$. After how much time will a given sample of this nuclide get reduced to only 6.25% of its present number ?

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92. The half life of a radioactive substance is 5×10^3yrs. In how many years will its activity decay to 0.2 times its initial activity? Take $\log_{10} 5 = 0.6990.$

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93. the count rate from a radioactive sample falls from 4.0×10^6per second to 1.0×10^6 per second in 20 hours.What will be the count rate 100 hours after the begnning ?

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94. A sample of radioactive material has an activity of 9×10^{12} Becquerel. The material has a half life of 80s. How long will it take for the activity to falls to 2×10^{10} Becquerel ?

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95. Biologically useful technetium nuclei (with atomic weight 99) have a half life of 6 hrs. A solution containing 10^{-12} g of this is injected into the bladder of a patient. Find its activity in the beginning and after one hour.

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96. For a given sample, the countring rate is 47.5α particle per minute. After 5 times, the count is reduced to 27α particles per minute. Find the decay constant and half life of the sample.

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97. The selling rate of a radioactive isotope is decided by its activity. What will be the second-hand rate of a oe month old $P^{32}(t_{1/2} = 14.3$ days) source if it was originally purchased for 800 rupees?

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98. One milligram of thorium emits 22α particles per minute per unit solid angle. Calculate average life of thorium. Atomic weight of Thorium is 232.

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99. A radioactive sample contains 2.2 mg of pure $._6 C^{11}$, which has a half life period of 1224s. Calculate (i) number of atoms present initially. (ii) the activity when $5\mu g$ of the sample will be left.

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100. In the case of thorium $(A = 232 \text{ and } Z = 90)$, we obtain an isotope of lead $(A = 208 \text{ and } Z = 82)$ after some radiactive disintegrations. The number of α and β particle emitted are respectively.

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101. In the final Uranium radioactive series the initial nucleus is U_{92}^{238} and the final nucleus is Pb_{82}^{206} . When Uranium neucleus decays to lead , the number of a - particle is .... And the number of β - particles emited is ......

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102. Calculate the maximum energy that a β particle can have in the following decay:

$\cdot_{8} O^{19} \rightarrow \cdot_{9} F^{19} + \cdot_{-1} e^{0} + \overline{V}$

Given,

$m(\cdot_{8} O^{19}) = 19.003576u, m(\cdot_{9} F^{19}) = 18.998403u, m(\cdot_{-1} e^{0}) = 0.000549u$

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103. When a deuteron of mass 2.0141 a.m.u and negligible K.E. is absorbed by a Lithium $(\cdot_{3} Li^{6})$ nucleus of mass 6.0155 a.m.u. the compound nucleus disintegration spontaneously into two alpha particles, each of mass 4.0026 a.m.u. Calcutate the energy carried by each α particle.

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104. Assuming that four hydrogen atom combine to form a helium atom and two positrons, each of mass 0.00549u, calculate the energy released. Given $m\left(._1 H^1\right) = 1.007825u, m\left(._2 He^4\right) = 4.002604u.$

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105. One Mev positron encounters one MeV electron travelling in opposite direction. What is the wavelength of photons produced, given rest mass energy of electron or positron $= 0.512MeV$? Take $h = 6.62 \times 10^{-34} J - s.$

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106. A deutron strikes $._8 O^{16}$ nucleus with subsequent emission of an alpha particle. Idenify the nucleus so produced.

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107. A deuteron strikes $._{5}B^{10}$ nucleus with the subsequent emission of an alpha particle. What is the atomic number, mass number and chemical name of the remaining nucelus?

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108. An isotope $._{92}U^{238}$ decays successively to form $._{90}Th^{234}$, $._{91}Pa^{234}$, $._{90}Th^{234}$, $._{90}Th^{230}$ and $._{88}Ra^{226}$. What are the radiations emitted in these five steps?

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109. Calculate the energy generated in kWh, when 100g of $._{3}Li(7)$. are converted into $._{2}He(4)$ by proton bombardment. Given mass of $._{3}Li(7) = 7.0183a.m.u$, mass of $._{2}He(4) = 4.0040a.m.u$, mass of $._{1}H(1)a \rightarrow m = 1.0081a.m.u.$

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110. Assuming that about $200 MeV$ of energy is released per fission of $._{92}U^{235}$ nuceli, the mass of U^{235} consumed per day in a fission ractor of power 1 megawatt will be approximately .

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111. The energy released by fission of one U^{235} atom is 200 MeV. Calculate the energy released in kWh, when one gram of uranium undergoes fission.

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112. When $._{92}U^{235}$ undergoes fission, 0.1% of the original mass is released into energy. How much energy is released by an atom bomb which contains 10kg of $._{92}U^{235}$?

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113. What is the power output of a $._{92}U^{235}$ reactor if it is takes 30 days to use up $2kg$ of fuel, and if each fission gives $185MeV$ of usable energy ?.

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114. The activity of a radioactive sample falls from `600 s^(-1) to 500 s^(-1) in 40 minutes. Calculate its half-life.

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115. A radioactive nucleus 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

$$\frac{1}{t} = \frac{1}{t_1} + \frac{1}{t_2}.$$

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116. Calculate packing fraction of alpha particle form the following date:

$m_\alpha = 4.0028 a.m.u.$, $m_p = 1.00758 a.m.u.$, and $m_n = 1.00897 a.m.u.$

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117. The binding energies per nucleon for deuteron ($._1H^2$) and helium ($._2He^4$) are $1.1 MeV$ and $7.0 MeV$ respectively. The energy released when two deutrons fuse to form a helium nucleus ($._2He^4$) is........

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118. M_1 and M_2 represent the masses of $._{10}Ne^{20}$ nucleus and $._{20}Ca^{40}$ nucleus respectively. State whether $M_2 = 2M_1$ or $M_2 > 2M_1$ or $M_2 < 2M_1$

Watch Video Solution

119. Calculate the energy of the following nuclear reaction:

$$._1 H^2 + ._1 H^3 \rightarrow ._2 He^4 + ._0 n^1 + Q$$

Given:

$$m(._1 H^2) = 2.014102u, m(._1 H^3) = 3.016049u, m(._2 He^4) = 4.002603u, r$$

Watch Video Solution

120. One miligram of thorium emits 22α particles per minute per unit solid anlge. Calculate average life of thorium. Atomic weight of Thorium is 232.

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121. Prove that the instantaneous rate of change of activity of a radioactive substance is inversely proportional to the square of half life.

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122. The nucleus of an atom of $._{92}Y^{235}$ initially at rest decays by emitting an α particle. The binding energy per nucleon of parent and dougther nuclei are 7.8MeV and 7.835MeV respectively and that of α particles is $7.07MeV/\text{nucleon}$. Assuming the dougther nucleus to be formed in the unexcited state and neglecting its share of energy in the reaction, calculate speed of emitted alpha particle. Take mass of α particle to be $6.68 \times 10^{-27}kg$.

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123. Find the ratio of Li^{++} ions in its ground state assuming Bohr 's model to be vaild

A. $53pm$

B. $27pm$

C. $18pm$

D. $13pm$

Answer: C

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124. Two H atoms in the ground state collide inelastically. The maximum amount by which their combined kinetic energy is reduced is

A. $10.20eV$

B. $20.40eV$

C. $13.6eV$

D. $27.2eV$

Answer: A

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125. The simple Bohr modle is not applicable to He^4 atom because

A. He^4 is an inert gas

B. He^4 has neutrons in the nucleus

C. He^4 has one more electrons

D. electrons are not subjected to central forces

Answer: C::D

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126. The gravitational force between a H-atom and another particle of mass m will be given by Newton's law: $F = G\frac{M.m}{r^2}$, where r is in km and

A. $M = m_{\text{proton}} + m_{\text{electron}}$

B. $M = M_{\text{proton}} + m_{\text{electron}} - \frac{B}{c^2}(B = 13.6eV)$

C. M is not related to the mass of the hydrogen atom

D. $M = m_{\text{proton}} + m_{\text{electron}} - \frac{|V|}{c^2}(|V|)$=magnitude of the potential energy of electron in the H-atom)

Answer: B

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

A. do not change for any type radioactivity

B. change for $\alpha \text{ and } \beta$ 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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128. $M_x \text{ and } M_y$ denote the atomic masses of the parent and the dougther nuclei respectively in a radioactive decay. The Q - value for a $\beta -$ decay is Q_1 and that for a β^+ decay is Q_2. If m_e denotes the mass of an electrons, 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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129. Heavy stable nuclei have more neutrons than protons. This is because of the fact that

A. neutrons are heavier than protons

B. electrostatic forces between protons are repulsive

C. neutrons decay into protons through beta decay

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

Answer: B

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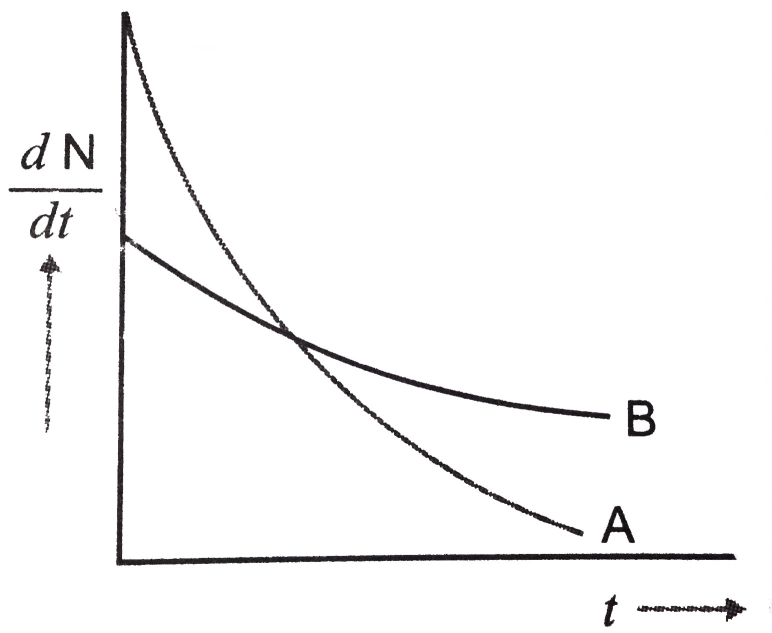
130. The variation of decay rate of two radioactive samples A and B with time is shown in fig.



Which of the following statements are true?

A. Decay constant of A is greater than that of B, hence A always decays faster than B

B. Decay constant of B is greater than that of A, but its decay rate is always smaller than that of A

C. Decay constant of A is greater than that of B, but it does not always decay faster than B

D. Decay constant of B is smaller than that of A but still its decay rate becomes equal to that of A at a later instant

Answer: C::D

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131. Consider $3rd$ orbit of He^{+} (Helium) using nonrelativistic approach the speed of electron in this orbit will be (given $K = 9 \times 10^{9}$ constant $Z = 2$ and h (Planck's constant) $= 6.6 \times 10^{-34} Js$.)

A. $1.46 \times 10^{6} m / s$

B. $0.73 \times 10^6 m / s$

C. $3 \times 10^8 m / s$

D. $2.92 \times 10^6 m / s$

Answer: A

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132. In the spectrum of hydrogen atom, the ratio of the longest wavelength in Lyman series to the longest wavelangth in the Balmer series is:

A. $\frac{5}{27}$

B. $\frac{4}{9}$

C. $\frac{9}{4}$

D. $\frac{27}{5}$

Answer: A

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133. Consider a hydrogen atom with its electron in the n^{th} orbital An electomagnetic radiation of wavelength $90nm$ is used to ionize the atom . If the kinetic energy of the ejected electron is $10.4eV$, then the value of n is (hc = 1242 eVnm)

A. 1

B. 2

C. 3

D. 4

Answer: B

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134. As an electron makes a transition from an excited state to the ground state of a hydrogen - like atom /ion

A. Its kinetic energy increases but potential energy and total energy decrease

B. Kinetic energy, potential energy and total energy decreases

C. Kinetic energy decreases, potential energy increases, potential energy increases but total energy remains same

D. Kinetic energy and total energy decreases but potential energy increases

Answer: A

Watch Video Solution

135. The electron in the hydrogen atom jumps form excited state (n=3) to its ground state (n=1) and the photons thus emitted irradiate a photosenstive material. If the work function of the material is 5.1eV, the stopping potential is estimated to be: (The energy of the electron in nth state is $E_n = -13.6/n^2 eV$)

A. $5.1V$

B. $12.1V$

C. $17.2V$

D. $7V$

Answer: D

Watch Video Solution

136. What is the diameter of $._2 Be^4$ in this ground state? Given Bohr radius of hydrogen atom is 53pm.

A. $53pm$

B. $26.5pm$

C. $1.6pm$

D. $100pm$

Answer: A

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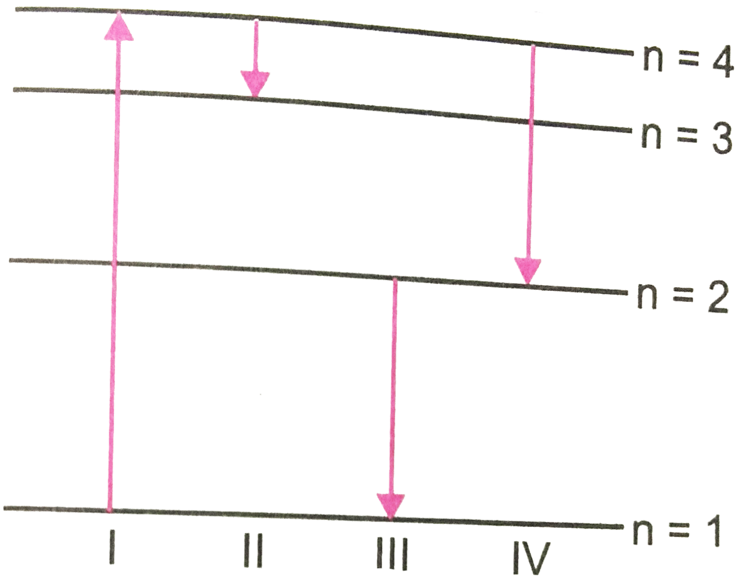
137. Shows the energy levels for an electron in a certain atom. Which transition shown represented the emission of a photon with the most energy?



A. II

B. I

C. IV

D. III

Answer: D

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138. As the electron in the Bohr orbit is hydrogen atom passes from state $n=2$ to $n=1$, the $KE(K)$ and $PE(U)$ change as

A. K four fold, U also four fold

B. K two fold, U also two fold

C. K four fold, U two fold

D. K two fold, U four fold

Answer: A

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139. A hydrogen atom ia in excited state of principal quantum number n . It emits a photon of wavelength λ when it returnesto the ground state. The value of n is

A. $\sqrt{\lambda R(\lambda R -)}$

B. $\sqrt{\frac{\lambda R}{(\lambda R - 1)}}$

C. $\sqrt{\frac{\lambda R - 1}{\lambda R}}$

D. $\sqrt{\frac{1}{\lambda R(\lambda R - 1)}}$

Answer: B

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140. When an $\alpha -$ particle of mass 'm' moving with velocity 'v' bombards on a heavy nucleus of charge 'Ze' its distance of closest approach from the nucleus depends on m as :

A. $\frac{1}{\sqrt{m}}$

B. $\frac{1}{m^2}$

C. m

D. $\frac{1}{m}$

Answer: D

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141. Suppose an electron is attracted toward the origin by a force $\frac{k}{r}$ where k is a constant and r is the distance of the electron from the origin .By applying Bohr model to this system the radius of the n^{th} orbital of the electron is found to be r_n and the kinetic energy of the electron to be T_n , Then which of the following is true ?

A. $T_n \propto \frac{1}{n^2}$

B. T_n is independent of$n, r_n, \propto n$

C. $T_n \propto \frac{1}{n}, r_n \propto n$

D. $T_n \propto \frac{1}{n}$ and $r_n \propto n^2$

Answer: B

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142. The total energy of eletcron in the ground state of hydrogen atom is $-13.6eV$. The kinetic enegry of an electron in the first excited state is

A. $6.8eV$

B. $13.6eV$

C. $1.7eV$

D. $3.4eV$

Answer: D

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143. The energy of a hydrogen atom in the ground state is $-13.6eV$. The eneergy of a He^{+} ion in the first excited state will be

A. $-13.6eV$

B. $-27.2eV$

C. $-54.4eV$

D. $-6.8eV$

Answer: A

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144. The wavelength of the first spectral line in the Balmer series of hydrogen atom is $6561A^{\circ}$. The wavelength of the second spectral line in the Balmer series of singly - ionized helium atom is

A. 1215Å

B. 1640Å

C. 2430Å

D. 4687Å

Answer: A

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145. The wavelength of the first line of Lyman series for hydrogen atom is equal to that of the second line of Balmer series for a hydrogen-like ion. The atomic number Z of hydrogen-like ion is

A. 3

B. 4

C. 1

D. 2

Answer: D

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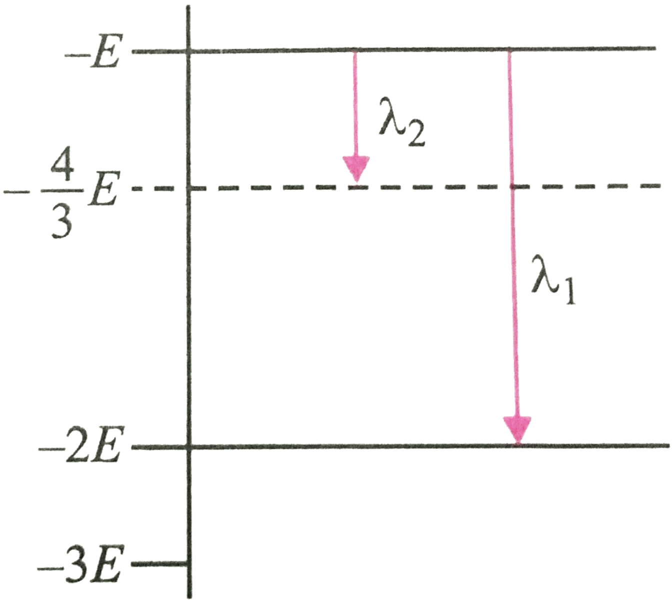
146. Some energy levels of a molecule are shown in the fig. The ratio of the wavelengths $r = \lambda_1 / \lambda_2$, is given by



A. $r = \frac{3}{4}$

B. $r = \frac{1}{3}$

C. $r = \frac{4}{3}$

D. $r = \frac{2}{3}$

Answer: B

Watch Video Solution

147. Out of the following which one is not a possible energy for a photon to be emitted by hydrogen atom according to Bohr's atomic model?

A. $1.9eV$

B. $11.1eV$

C. $13.6eV$

D. $0.65eV$

Answer: B

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148. A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r . If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization it energy will be (n is an integer)

A. $\frac{(m_1+m_2)^2 n^2 h^2}{2m_1^2 m_2^2 r^2}$

B. $\frac{n^2 h^2}{2(m_1+m_2)r^2}$

C. $\frac{2n^2 h^2}{(m_1+m_2)r^2}$

D. $\frac{(m_1+m_2)n^2 h^2}{2m_1 m_2 r^2}$

Answer: D

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149. Electron in hydrogen atom first jumps from third excited state to second excited state and then form second excited state to first excited state. The ratio of wavelength $\lambda_1 : \lambda_2$ emitted in two cases is

A. $7/5$

B. $27/20$

C. $27/5$

D. $20/7$

Answer: D

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150. An electrons of a stationary hydrogen aton passes form the fifth enegry level to the ground level. The velocity that the atom acquired as a result of photon emission will be

(m is the mass of the electron, R, Rydberg constanrt and h, Planck's constant)

A. $\frac{24hR}{25m}$

B. $\frac{25hR}{25m}$

C. $\frac{25m}{24hR}$

D. $\frac{24m}{25hR}$

Answer: A

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151. The transition form the state $n = 3$ to $n = 1$ in a hydrogen-like atom results in ultraviolet radiation. Infared radiation will be obtained in the transition from

A. $2 \rightarrow 1$

B. $3 \rightarrow 2$

C. $4 \rightarrow 2$

D. $4 \rightarrow 3$

Answer: D

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152. In a hydrogen like atom electron make transition from an energy level with quantum number n to another with quantum number $(n-1)$ if $n > > 1$, the frequency of radiation emitted is proportional to :

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

B. $\frac{1}{n^2}$

C. $\frac{1}{n^{3/2}}$

D. $\frac{1}{n^3}$

Answer: D

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153. Hydrogen atom in ground state is excited by a monochromatic radiation of $\lambda = 975\text{Å}$. Number of spectral lines in the resulting spectrum emitted will be

A. 3

B. 2

C. 6

D. 10

Answer: C

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154. Hydrogen $\left(\ _(1)H^{1}\right)$ Deuterium $\left(\ _(1)H^{2}\right)$ singly omised helium $\left(\ _(1)He^{1}\right)$ and doubly ionised lithium $\left(\ _(1)Li^{6}\right)^{++}$ all have one electron around the nucleus Consider an electron transition from $n=2 \rightarrow n=1$ if the wavelength of emitted radiartion are $\lambda_1, \lambda_2, \lambda_3,$ and λ_4, repectivelly then approximetely which one of the following is correct ?

A. $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

B. $\lambda_1 = 2\lambda_2 = 3\lambda_3 = 4\lambda_4$

C. $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$

D. $\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$

Answer: A

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155. Balmer gives an equation for wavelength of visible radition of H^{-} spectrum as $\lambda = \frac{kn^2}{n^2 - 4}$.The value of k in terms of Rydberg's constant R is

A. R

B. $4R$

C. $\frac{R}{4}$

D. $\frac{4}{R}$

Answer: D

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156. The kinetic energy of the electron in an orbit of radius r in hydrogen atom is ($e =$ electronic charge)

A. $\frac{e^2}{r}$

B. $\frac{e^2}{2r}$

C. $\frac{e^2}{r}$

D. $\frac{e^2}{2r^2}$

Answer: B

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157. Consider $3rd$ orbit of He^{+} (Helium) using nonrelativistic approach the speed of electron in this orbit will be (given $K = 9 \times 10^9$ constant $Z = 2$ and h (Planck's constant) $= 6.6 \times 10^{-34} Js$.)

A. $1.46 \times 10^6 m/s$

B. $0.73 \times 10^6 m/s$

C. $3 \times 10^8 m/s$

D. $2.92 \times 10^6 m/s$

Answer: A

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158. The ratio of wavelength of the lest line of Balmer series and the last line Lyman series is:

A. 2

B. 1

C. 4

D. 0.5

Answer: C

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159. The radiation corresponding to $3 \rightarrow 2$ transition of hydrogen atom falls on a metal surface to produce photoelectrons . These electrons are made to enter circuit a magnetic field $3 \times 10^{-4}T$ if the ratio of the largest circular path follow by these electron is `10.0 mm , the work function of the metal is close to

A. $0.8eV$

B. $2.14eV$

C. $1.8eV$

D. $1.1eV$

Answer: D

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160. if λ_{Cu} is the wavelength of K_{α}, X-ray line fo copper (atomic number 29) and λ_{Mo} is the wavelength of the K_{α} X-ray line of molybdenum (atomic number 42), then the ratio $\frac{\lambda_{Cu}}{\lambda_{Mo}}$ is close to

(a) 1.99

(b) 2.14

(c) 0.50

(d) 0.48

A. 1.99

B. 2.14

C. 0.50

D. 0.48

Answer: B

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161. An electron is an excited state of Li^{2+} ion has angular momentum $3h/2\pi$. The de Broglie wavelength of the electron in this state is $p\pi a_0(wherea_0$ is the bohr radius) The value of p is

A. 4

B. 3

C. 2

D. 1

Answer: C

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162. Given the value of Rydberg constant is $10^7 m^{-1}$, the waves number of the lest line of the Balmer series in hydrogen spectrum will be:

A. $0.5 \times 10^7 m^{-1}$

B. $0.25 \times 10^7 m^{-1}$

C. $2.5 \times 10^7 m^{-1}$

D. $0.025 \times 10^4 m^{-1}$

Answer: B

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163. A fission reaction is given by $\_(92)^{236}U \rightarrow_{54}^{140} Xe +_{38}^{94} St + x + y$, where x and y are two particle Consider $\_(92)^{236}U$ to be at rest , the kinetic energies of the products are deneted by $k_{xe} K_{st} K_s (2MeV)$ and repectively . Let the binding energy per nucleus of

_ $(92)^{236}U,^{140}_{54}Xe$ and $^{94}_{38}Stbe 7.5MeV, 8.4MeV$ and $8.5MeV$,

respectively Considering different conservation laws, the correct option (s) is (are)

A. $x = n, y = n, K_{Sr} = 129MeV, K_{Xe} = 86MeV$

B. $x = p, y = e^{-}, K_{Sr} = 129MeV, K_{Xe} = 86MeV$

C. $x = p, y = n, K_{Sr} = 129MeV, K_{Xe} = 86MeV$

D. $x = n, y = n, K_{Sr} = 86MeV, K_{Xe} = 129MeV$

Answer: A

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164. The de - Broglie wavelength of a neutron in thermal equilibrium with heavy water at a temperature $T(\text{kelvin})$ and mass m, is

A. $\lambda = \dfrac{h}{\sqrt{3mKT}}$

B. $\lambda = \dfrac{h}{\sqrt{6mKT}}$

C. $\lambda = \dfrac{h}{\sqrt{5mKT}}$

D. $\lambda = \frac{h}{\sqrt{2mKT}}$

Answer: A

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165. In the nuclear fusion reaction

$_{-}(1)^{2}H +_{1}^{3} H \rightarrow_{2}^{4} He + n$

given that the repulsive potential energy between the two nuclei is $-7.7 \times 10^{-14} J$, the temperature at which the gases must be heated the reaction is nearly

[Boltzmann's constant $k = 1.38 \times 10^{-23} J/K$]

A. $10^{7} K$

B. $10^{5} K$

C. $10^{3} K$

D. $10^{9} K$

Answer: D

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166. If M(A,Z), M_p and M_n denote the masses of the nucleus $._Z X^A$, proton and neutron respectively in units of U (where$1U = 931MeV/c^2$) and B.E. represents its B.E. in MeV, then

A. $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$

B. $M(A, Z) = ZM_p + (A - Z)M_n + BE$

C. $M(A, Z) = ZM_p + (A - Z)M_n - BE$

D. $M(A, Z) = ZM_p + (A - Z)M_n + BE/c^2$

Answer: A

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167. If a star can convert all the He nuclei completely into oxygen nuclei. The energy released per oxygen nuclei is (Mass of the helium nucleus is 4.0026 amu and mass of oxygen nucleus is 15.9994 amu)

A. $7.6 MeV$

B. $56.12 MeV$

C. $10.24 MeV$

D. $23.9 MeV$

Answer: C

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168. On bombardment of U^{235} by slow neutrons, $200 MeV$ energy is released. If the power output of atomic reactor is $1.6 MW$, then the rate of fission will be

A. 5×10^{10}

B. 5×10^{12}

C. 5×10^{4}

D. 5×10^{16}

Answer: D

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169. A nucleus $._{Z}^{A}X$ has mass represented by $M(A, Z)$. If M_p and M_p denote the mass of proton and neutron respectively and BE the binding energy (in MeV), then :

A. $B.E = [ZM_p - (A - Z)M_n - M(A, Z)]c^2$

B. $B.E = [ZM_p - AM_n - M(A, Z)]c^2$

C. $B.E = M(A, Z) - ZM_p - (A - Z)Mn$

D. $B.E = [M(A, Z) - ZM_p - (A - Z)Mn]c^2$

Answer: A

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170. In the given reaction

$$\cdot_{z} X^{A} \rightarrow \cdot_{z+1} Y^{A} \rightarrow \cdot_{z-1} K^{A-4} \rightarrow \cdot_{z-1} K^{A-4}$$

Radioactive radiations are emitted in the sequence.

A. α, β, γ

B. β, α, γ

C. γ, β, α

D. β, γ, α

Answer: B

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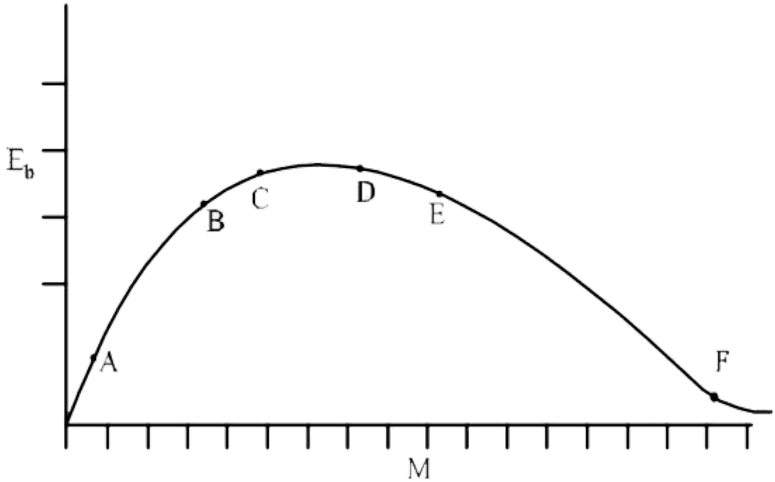
171.



The above is a plate of binding energy per nucleon E_0 against the nuclear mass M, A, B, C, D, E, F correspond to different nuclei Consider four reactions:

A. (i) and (iii)

B. (ii) and (iv)

C. (ii) and (iii)

D. (i) and (iv)

Answer: D

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172. The power obtained in a reactor using U^{235} disintegration is $100kW$. The mas decay of U^{235} per hour is

A. 10 microgram

B. 20 microgram

C. 40 microgram

D. 1 microgram

Answer: C

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173. A nucleus $._n^m X$ emits one $\alpha -$ particle and two $\beta -$ particles. The resulting nucleus is

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

B. $._n^{m-6} Z$

C. $._n^{m-4} X$

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

Answer: C

Watch Video Solution

174. Assume that a neutron breaks into a proton and an electron . The energy reased during this process is (mass of neutron $= 1.6725 \times 10^{-27} kg$ mass of proton $= 1.6725 \times 10^{-27} kg$ mass of electron $= 9 \times 10^{-31} kg)$

A. $0.506 MeV$

B. $7.10 MeV$

C. $6.39 MeV$

D. $5.4 MeV$

Answer: A

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175. If the binding energy per nucleon in $\_(3)^7 Li$ and $\_(2)^4 He$ nuclei are 5.60 MeV and 7.06MeV respectively then in the reaction

$P +_3^7 Li \rightarrow 2_2^4 He$

energy of proton must be

A. $19.6 MeV$

B. $-2.4 MeV$

C. $8.4 MeV$

D. $17.3 MeV$

Answer: D

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176. The binding energies per nucleon for a deuteron and an $\alpha -$ particle are x_1 and x_2 respectively. What will be the energy Q released in the following reaction ?

$._1 H^2 + ._1 H^2 \rightarrow ._2 He^4 + Q.$

A. $4(x_1 + x_2)$

B. $4(x_1 - x_2)$

C. $2(x_2 - x_1)$

D. $2(x_1 + x_2)$

Answer: B

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177. A nucleus of uranium decays at rest into nuclei of thorium and helium. Then :

A. The helium nucleus has less kinetic energy than the thorium nucleus

B. The helium nucleus has more kinetic energy than the thorium nucleus

C. The helium nucleus has less momentum than the thorium nucleus

D. The helium nucleus has more momentum than the thorium nucleus

Answer: B

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178. Two spherical nuclei have mass number 216 and 64 with their radii R_1 and R_2 respectively. The ratio, $\frac{R_1}{R_2}$ is equal to

A. $3:2$

B. $1:3$

C. $1:2$

D. $2:3$

Answer: A

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179. A nuclear power supplying electrical power to a villages uses a radioactive material of half life T year as the fuel . The amount of fuel at the beginning is such that the total power requirement of the village is $12.5\ \%$ of the electrical power available from the plant at that time. If the plant is able to meet the total power needs of the village for a maximum period of nT years , then the value of n is

A. 1

B. 2

C. 3

D. 4

Answer: C

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180. The isotope $\_(5)^{12}B$ having a mass $12.014u$undergoes beta - decay to $_(6)^{12}C_6^{12}C$has an excited state of the nucleus

$\left(\_ (6)^{12} C^* at 4.041 MeV\right.$ above its ground state if $\_ (5)^{12} E$ decay to $\_ (6)^{12} C^*$, the maximum kinetic energy of the β - particle in unit of MeV is $\left(1u = 931.5 MeV / c^2\right.$ where c is the speed of light in vaccuum) .

A. 9

B. 6

C. 3

D. 1

Answer: A

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

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

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

C. $t = \frac{T}{2}\frac{\log 2}{\log 1.3}$

D. $t = T\frac{\log 1.3}{\log 2}$

Answer: D

Watch Video Solution

182. For a radioactive meterial , its activity A and rate of charge of its activity R are defined as $A = -\frac{dN}{dt}$ and $R = -\frac{dA}{dt}$ where $N(t)$ is the number of nuclei at time t .Two radioactive source P (mean life τ) and Q(mean life 2τ) have the same activity at $t = 2\tau R_p$ and R_Q respectively , if $\frac{R_p}{R_Q} = \frac{n}{e}$

A. 1

B. 2

C. 3

D. 4

Answer: B

Watch Video Solution

183. A nuclear power supplying electrical power to a villages uses a radioactive material of half life T year as the fuel . The amount of fuel at the beginning is such that the total power requirement of the village is 12.5% of the electrical power available from the plant at that time. If the plant is able to meet the total power needs of the village for a maximum period of nT years , then the value of n is

A. 1

B. 2

C. 3

D. 4

Answer: C

Watch Video Solution

184. Uranium ores on the earth at the present time typically have a composition consisting of 99.3% of the isotope $._{92}U^{238}$ and 0.7% of the isotope $._{92}U^{235}$. The half-lives of these isotopes are $4.47 \times 10^9 yr$ and $7.04 \times 10^8 yr$, respectively. If these isotopes were equally abundant when the earth was formed, estimate the age of the earth.

A. $4.78 \times 10^9 yrs$

B. $5.97 \times 10^9 yrs$

C. $6.78 \times 10^7 yrs$

D. $7.29 \times 10^8 yrs$

Answer: B

Watch Video Solution

185. After how many days will $\frac{1}{20}th$ of the radio active element remain behind, if half life of the element is 6.931days

A. $23.03 days$

B. $25.12 days$

C. $29.96 days$

D. $27.12 days$

Answer: C

Watch Video Solution

186. Radioactive material 'A' has decay constant $'8\lambda'$ and material 'B' has decay constant 'lamda'. Initial they have same number of nuclei. After what time, the ratio of number of nuclei of material 'B' to that 'A' will be $\frac{1}{e}$?

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

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

C. $\frac{1}{8\lambda}$

D. $\frac{1}{9\lambda}$

Answer: B

Watch Video Solution

187. The number of beta particles emitter by radioactive sustance is twice the number of alpha particles emitter by it. The resulting daughter is an

A. isotope of parent

B. isobar of parent

C. isomer of parent

D. isotone of parent

Answer: A

Watch Video Solution

188. In a sample of radioactive material, what percentage of the initial number of active nuclei will decay during one mean life ?

A. 69.3%

B. 64%

C. 50%

D. 36%

Answer: B

Watch Video Solution

189. C^{14} has life 5700 yrs. At the end of 11400 yers, the actual amount left is

A. 0.5 times of original amount

B. 0.25 times of original amount

C. 0.125 times of original amount

D. None of the above

Answer: B

Watch Video Solution

190. Two radioactive materials have decay constant $5\lambda \& \lambda$. If initially they have same no. of nuclei. Find time when ratio of nuclei become $\left(\frac{1}{e}\right)^2$:

A. 4λ

B. 2λ

C. $\frac{1}{2\lambda}$

D. $\frac{1}{4\lambda}$

Answer: C

Watch Video Solution

191. A freshly prepared radioactive sample of half life 1 hour emits radiations that are 128 times as intense as the impossible safe limit. The minimum time after which this sample can be safely used is

A. $14hr$

B. $7hr$

C. $128hr$

D. $256hr$

Answer: B

Watch Video Solution

192. A radio isotope X with a half-life 1.4×10^9 years decays of Y 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. $1.96 \times 10^9 yr$

B. $3.92 \times 10^9 yr$

C. $4.20 \times 10^9 yr$

D. $8.40 \times 10^9 yr$

Answer: C

Watch Video Solution

193. In a radioactive material the activity at time t_1 is R_1 and at a later time t_2, it is R_1. If the decay constant of the material is λ, then

A. $R_1 = R_2(t_2 / t_1)$

B. $R_1 = R_2$

C. $R_1 = R_2 e^{-\lambda(t_1 / t_2)}$

D. $R_1 = R_2 e^{\lambda(t_1 / t_2)}$

Answer: C

Watch Video Solution

194. The intensity of gamma radiation from a given source is I

On passing through $36mm$ of lead , it is reduced to $\frac{1}{8}$. The thickness of lead which will reduce the intensity to $\frac{1}{2}$ will be

A. $12mm$

B. $18mm$

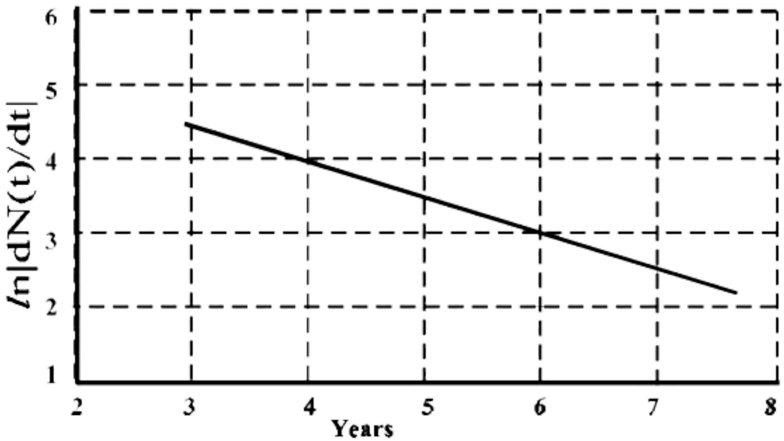
C. $9mm$

D. $6mm$

Answer: A

Watch Video Solution

195. To determine the half life of a radioactive element , a student plote a graph of in $\left|\frac{dN(t)}{dt}\right| versus t, Here \left|\frac{dN(t)}{dt}\right|$ is the rate of radioatuion decay at time t , if the number of radoactive nuclei of this element decreases by a factor of p after 4.16 year the value of p is



A. 2

B. 4

C. 6

D. 8

Answer: D

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196. A radiaoactive nucleus (initial mass number A and atomic number Z emits 3α- particles and 2 positrons The ratio of number of neutrons to that of proton in the final nucleus will be

A. $\dfrac{A-Z-4}{Z-8}$

B. $\dfrac{A-Z-12}{Z-4}$

C. $\dfrac{A-Z-4}{Z-2}$

D. $\dfrac{A-Z-8}{Z-4}$

Answer: A

Watch Video Solution

197. The activity of a radioactive sample is measures as N_0 counts per minute at $t=0$ and N_0/e counts per minute at $t=5$ min . The time (in minute) at which the activity reduces to half its value is.

A. $\log_e 2/5$

B. $\frac{5}{\log_e 2}$

C. $5 \log_{10} 2$

D. $5 \log_e 2$

Answer: D

Watch Video Solution

198. The speed of daugther nuclei is

A. $c\sqrt{\frac{2\Delta m}{M}}$

B. $c\sqrt{\frac{\Delta m}{M}}$

C. $c\sqrt{\frac{\Delta m}{M + \Delta m}}$

D. $c\frac{\Delta m}{M + \Delta m}$

Answer: A

Watch Video Solution

199. The decay constant of radio isotope is λ. If A_1 and A_2 are its activities at times t_1 and t_2 respectively, the number of nuclei which have decayed during the time $(t_1 - t_2)$

A. $A_1 t_1 - A_2 t_2$

B. $A_1 - A_2$

C. $(A_1 - A_2) / \lambda$

D. $\lambda(A_1 - A_2)$

Answer: C

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200. 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?

A. $3.2 T yr$

B. $4.6 T yr$

C. $6.6 Tyr$

D. $9.2 Tyr$

Answer: C

Watch Video Solution

201. Two samples X and Y contain equal amounts of radioactive substances. If $\frac{1}{16}th$ of a sample X and $\frac{1}{256}th$ of sample Y remain after 8h, then the ratio of half periods of X and Y is

A. $2:1$

B. $1:2$

C. $1:4$

D. $1:16$

Answer: A

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202. The activity of a freshly prepared radioactive sample is 10^{10} disintegrations per second , whose mean life is $10^{9} s$ The mass of an atom of this radioisotope is $10^{-25} kg$ The mass (in mg) of the radioactive sample is

A. 1

B. 2

C. 3

D. 4

Answer: A

Watch Video Solution

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

A. $14 min$

B. $20 min$

C. $28 min$

D. $7 min$

Answer: B

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204. 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. $150 yr$

B. $200 yr$

C. $250 yr$

D. $100 yr$

Answer: B

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205. A radioactive nucleus of mass M emits a photon of frequency v and the nucleus recoils. The recoil energy will be

A. $Mc^2 - hv$

B. $h^2v^2/2Mc^2$

C. zero

D. hv

Answer: B

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206. 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 conversation to R) is $1mm$ whereas that of Q is 2 min . 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. $3N_0$

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

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

D. $2N_0$

Answer: B

Watch Video Solution

207. 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

A. $60s$

B. $80s$

C. $20s$

D. $40s$

Answer: D

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208. The half-life of a radioactive nucleus is 50 days. 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 is

A. $30 days$

B. $50 days$

C. $60 days$

D. $15 days$

Answer: B

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209. The half-life of a radioactive isotope X is 20 years. It decays to another element Y which is stable. The two elements X and Y were found to be in the ratio of $1:7$ in a sample of a given rock. The age of the rock was estimated to be.

A. $100yr$

B. $40yr$

C. $60yr$

D. $80yr$

Answer: C

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210. For a radioactive meterial , its activity A and rate of charge of its activity R are defined as $A=-\frac{dN}{dt}$ and $R=-\frac{dA}{dt}$ where $N(t)$ is the number of nuclei at time t .Two radioactive source P (mean life τ) and Q(mean life 2τ) have the same activity at $t = 2\tau R_p$ and R_Q respectively , if $\frac{R_p}{R_Q} = \frac{n}{e}$

A. 1

B. 2

C. 3

D. 4

Answer: B

Watch Video Solution

211. Half - lives of two radioactive . Initially . The samples have equal number of nuclie After 80 minutes ,the ratio of decyed number of A and B nuclei will be

A. $1:16$

B. $4:1$

C. $1:4$

D. $5:4$

Answer: D

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212. As accident in a nuclear laboratory resulting in deposition of a certain amount of radioactive material of half life 18days inside the laboratory Tests revealed that the radiation was 64 times more than the permissible level required for save operation of the laboratory what is the minimum number of days after which the laboratory can be considered safe for use?

A. 64

B. 90

C. 108

D. 120

Answer: C

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213. The radius of the orbit of an electron in a Hydrogen - like atom is $4.5s_0$ where a_0 is the bohr radius its orbital angular momentum is $\frac{3h}{2\pi}$ it is given that is is plank constant and R is rydberg constant .The possible wavelength (s) , when the atom de- excite , is (are)

A. $\frac{9}{32R}$

B. $\frac{9}{16R}$

C. $\frac{9}{5R}$

D. $\frac{4}{3R}$

Answer: A::C

Watch Video Solution

214. Bohr's model of hydrogen atom.

A. the radius of the nth orbit is proportional to n^2

B. the total energy of the electron is nth orbit is inversely proportional to n

C. the angular momentum of electron in nth orbit is an integral multiple of $\frac{h}{2\pi}$

D. the magnitude of potential energy of the electron in any orbit is greater than its K.E.

Answer: A::C::D

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215. The electron in a hydrogen atom make a transtion $n_1 \to n_2$ where n_1 and n_2 are the priocipal quantum number of the two states . Assume the Bohr model to be valid . The time period of the electron in the initial state is eight time that in the final state . The possible values of n_1 and n_2 are

A. $n_1 = 4, n_2 = 2$

B. $n_1 = 8, n_2 = 2$

C. $n_1 = 8, n_2 = 1$

D. $n_1 = 6, n_2 = 3$

Answer: A::D

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216. The mass number of a nucleus is

A. always less than its atomic number

B. always more than its atomic number

C. sometimes equal to its atomic number

D. sometimes more than and sometimes equal to its atomic number

Answer: C::D

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217. As the mass number A increases, which of the following quantities related to a nucleus do not change?

A. mass

B. volume

C. density

D. binding energy

Answer: C

Watch Video Solution

218. During a nuclear fusion reaction,

A. A heavy nucleus breaks into two fragments by itself

B. a light nucleus bombarded by thermal neutrons breaks up

C. A heavy nucleus bombarded by thermal neutrons breaks up

D. Two light nuclei combine to give a heavier nucleus and possibly other products

Answer: D

Watch Video Solution

219. A freshly prepared radioactive source of half-life $2h$ emits radiation of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work safely with this source is

A. $6h$

B. $12h$

C. $24h$

D. $28h$

Answer: B

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220. The half-life period of a radioactive element x is same as the mean life time of another radioactive element y. Initially, both of them have the same number of atoms. Then,

(a) x and y have the same decay rate initially

(b) x and y decay at the same rate always

(c) y will decay at a faster rate than x

(d) x will decay at a faster rate than y

A. X and Y have the same decay rate intially

B. X and Y decay at the same rate always

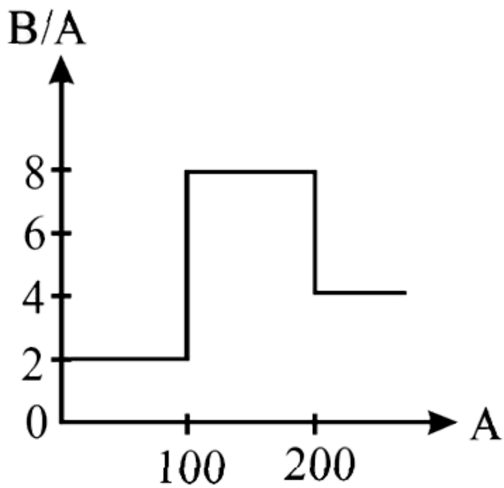
C. Y will decay at a faster rate than X

D. X will decay at a faster rate than Y

Answer: C

Watch Video Solution

221. Assume that the nuclear binding energy per nucleus(B/A) versus mass number (A) is as shown in the figure Use this plot to choose the correct (s) choice given below



A. fusion of a two nuclei with mass number lying in the range of $1 < A < 50$ will release energy

B. fusion of a two nuclei with mass number lying in the range of $51 < A < 100$ will release energy

C. fusion of a nucleus lying in the mass range of $100 < A < 200$ will release energy than broken into two equal fragments.

D. fusion of a nucleus lying in the mass range of $200 < A < 200$ will release energy than broken into two equal fragments.

Answer: B::D

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222. A star initially has 10^{40} deuterons. It produces energy via the process $_(1)H^2 +_1 H^2 + \rightarrow_1 H^3 + p$. and $_(1)H^2 +_1 H^3 + \rightarrow_2 He^4 + n$ .If the average power radiated by the state is $10^{16} W$, the deuteron supply of the star is exhausted in a time of the order of .

The masses of the nuclei are as follows:

$M(H^2) = 2.014a\mu$,

$M(p) = 1.007a\mu$, $M(n) = 1.008a\mu$, $M(He^4) = 4.001a\mu$.

A. $10^6 s$

B. $10^8 s$

C. $10^{12} s$

D. $10^{16} s$

Answer: C

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223. The nucear forces

A. are stronger, being roughly hundred times that of electromagnetic forces

B. have a short range dominant over a distance of about a few fermi

C. are central forces, independent of the spin of the nucleons

D. are independent of the nuclear charge.

Answer: A::B::D

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224. Which of the following products in a hydrogen atom are independent of the principal quantum number n? The symbols have their usual meanings

A. $v \times r$

B. En

C. Er

D. $v \times n$

Answer: C::D

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225. Let A_0 be the area enclined by the orbit in a hydrogen atom .The graph of in (A_0 / A_1) against $\ln(n)$

A. will be a circle

B. will be a monotonically increasing non-linear curve

C. will be a straight line with slope 4

D. will pass through the origin

Answer: C::D

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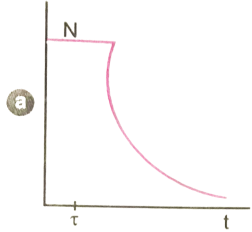
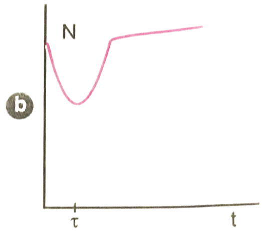
226. A radioactive sample consists of two distinct species having equal number of atoms initially. The mean life of one species is τ and that of the other is 5τ. The decay products in both cases are stable. A plot is made of the total number of radioactive nuclei as a function of time. Which of the following figure best represents the form of this plot?

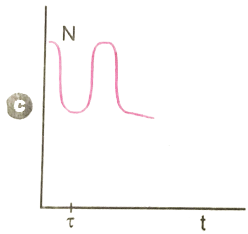
(a), (b), (c), (d)



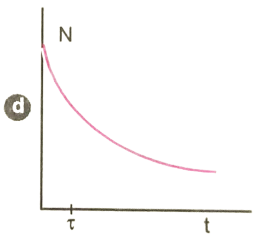
A.



B.



C.



D.

Answer: D

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227. A deutron is bombarded on $._{8}O^{16}$ nucleus and $\alpha-$ particle is emitted. The product nucleus is.

A. $._{7}N^{14}$

B. $._{7}N^{13}$

C. $._{4}Be^{9}$

D. $._{5}B^{10}$

Answer: A

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228. The heavier nuclei tend to have larger N/Z ratio because

A. coulomb forces have longer range compared to the nuclear forces

B. a neutron does not exert electric repulsion

C. a neutron is an unstable particle

D. a neutron is heavier than a proton

Answer: A::B

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229. Let m_p be the mass of a poton , M_1 the mass of a $\_(10)^{20}Ne$ nucleus and M_2 the mass of a $\_(20)^{40}Ca$ nucleus . Then

A. $M_2 = 2M_1$

B. $M_2 > 2M_1$

C. $M_2 < 2M_1$

D. $M_1 < 10(m_n + m_p)$

Answer: C::D

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230. An electron in hydrogen atom first jumps form second excited state to first excited state and then form first excited state to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be a, b and c respectively, Then

A. $a = \frac{9}{4}$

B. $b = \frac{5}{27}$

C. $c = \frac{5}{27}$

D. $c = \frac{1}{a}$

Answer: B::C::D

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231. In Bohr model of the hydrogen atom, let R,v and E represent the radius of the orbit, speed of the electron and the total energy respectively. Which of the following quantities are directly proportional to the quantum number n?

A. VR

B. RE

C. $\frac{V}{E}$

D. $\frac{R}{E}$

Answer: A::C

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232. Two deutrons each of mass m fuse to form helium resulting in release of energy E. The mass of helium formed is

A. $m + E/c^2$

B. $2m + E/c^2$

C. E/mc^2

D. $2m - E/c^2$

Answer: D

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233. In an e^{-} transition inside a hydrogen atom, orbital angular momentum may change by (h=planck constant)

A. h

B. $\frac{h}{\pi}$

C. $\frac{h}{2\pi}$

D. $\frac{h}{4\pi}$

Answer: B::C

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234. A sample of a radioactive element has a mass of $10g$ at an instant $t=0$. The approxiamte mass of this element in the sample after two mean lives is .

A. $1.35g$

B. $2.50g$

C. $3.70g$

D. $6.30g$

Answer: A

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235. Highly excited state for hydrogen - like atom (also called rydberg states) with nuclear charge Ze are defined by their principal quantum number n, where $n > > 1$ Which of the following statement is (are) true?

A. Relative change in the radii of two consecutive orbitals does not depends on Z

B. Relative change in the radii of two consecutive orbitals varies as $1/n$

C. Relative change in the Energy of two consecutive orbitals varies as $1/n^3$

D. Relative change in the angular momentum of two consecutive orbitals varies as $1/n$

Answer: A::B::D

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236. According to Thomson's model, every atom consists of a positively charged sphere of radius $10^{-10}m$ in which entire mass and positive charge of the atom are uniformly distributed. Inside the sphere, electrons are embedded like seeds in a watermelon. According Rutherford, entire positive charge and mass of the atom are concentrated in a tiny central core of the atom, which is called atomic nucleus. Size of nucleus $\approx 10^{-15}m$. The nucleus contains proton and neutrons. Negatively charged electrons revolve around the nucleus in circular orbits.

The size of atom is of the order of

A. $10^{-14}m$

B. $10^{-12}m$

C. $10^{-10}m$

D. $10^{10}m$

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237. According to Thomson's model, every atom consists of a positively charged sphere of radius $10^{-10}m$ in which entire mass and positive charge of the atom are uniformly distributed. Inside the sphere, electrons are embedded like seeds in a watermelon. According Rutherford, entire positive charge and mass of the atom are concentrated in a tiny central core of the atom, which is called atomic nucleus. Size of nucleus $\approx 10^{-15}m$. The nucleus contains proton and neutrons. Negatively charged electrons revolve around the nucleus in circular orbits.

The size of atomic nucleus is of the order of

A. $10^{-15}m$

B. $10^{-10}m$

C. $10^{14}m$

D. $10^{10}m$

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238. What is the ratio of volume of atom of the volume of nucleus?

A. 10^{15}

B. 10^{-12}

C. 10^{8}

D. 10^{-8}

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239. According to Thomson's model, every atom consists of a positively charged sphere of radius $10^{-10}m$ in which entire mass and positive charge of the atom are uniformly distributed. Inside the sphere, electrons are embedded like seeds in a watermelon. According Rutherford, entire positive charge and mass of the atom are concentrated in a tiny central core of the atom, which is called atomic nucleus. Size of nucleus $\approx 10^{-15}m$. The nucleus contains proton and neutrons. Negatively charged electrons revolve around the nucleus in circular orbits.

Large angle scattering of α-particle could not be explained by

A. Rutherford model

B. Thomson model

C. Both Rutherford model and Thomson model

D. Neither Rutherford model nor Thomson model

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240. The radioactive nuclei are unstable and emit alpha $\left(._{2}He^{4}\right)$, beta $\left(._{-1}e^{0}\right)$ and gamma $\left(._{0}\gamma^{0}\right)$ radiations to acheive states of greater stability. Rutherford and Soddy suggested the following rules governing the radioactive decay, (i) The algebric sum of charges (atomic numbers) before and after disintegration must be the same. (ii) The sum of mass numbers before and after disintegration must also be the same.

In alpha decay

A. mass number A decrease by 4 and atomic number Z increases by 2.

B. A decreases by 4 and Z decreases by 2

C. A increases by 4 and Z decreases by 2

D. A increases by 4 and Z increases by 2.

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241. The radioactive nuclei are unstable and emit alpha $\left(._{2}He^{4}\right)$, beta $\left(._{-1}e^{0}\right)$ and gamma $\left(._{0}\gamma^{0}\right)$ radiations to acheive states of greater stability. Rutherford and Soddy suggested the following rules governing the radioactive decay, (i) The algebric sum of charges (atomic numbers) before and after disintegration must be the same. (ii) The sum of mass numbers before and after disintegration must also be the same.

In beta decay

A. A remains unaffected, Z increases by 1.

B. A is unaffected, Z decreases by 1

C. A increases by 1, Z is unaffacted

D. A decreases by 1, Z is unaffected.

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242. The radioactive nuclei are unstable and emit alpha $\left(._2 He^4\right)$, beta $\left(._{-1} e^0\right)$ and gamma $\left(._0 \gamma^0\right)$ radiations to acheive states of greater stability. Rutherford and Soddy suggested the following rules governing the radioactive decay, (i) The algebric sum of charges (atomic numbers) before and after disintegration must be the same. (ii) The sum of mass numbers before and after disintegration must also be the same.

In gamma decay

A. Both A and Z increases by 1

B. Both A and Z decreases by 1

C. Neither A nor Z change

D. A is always equal to Z

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243. The radioactive nuclei are unstable and emit alpha $\left(._{2}He^{4}\right)$, beta $\left(._{-1}e^{0}\right)$ and gamma $\left(._{0}\gamma^{0}\right)$ radiations to acheive states of greater stability. Rutherford and Soddy suggested the following rules governing the radioactive decay, (i) The algebric sum of charges (atomic numbers) before and after disintegration must be the same. (ii) The sum of mass numbers before and after disintegration must also be the same.

The particle emitted in the reaction $._{90} Th^{234} \rightarrow ._{91} Pa^{234} + \ldots\ldots.$ is

A. α

B. β

C. γ

D. None of these

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244. The radioactive nuclei are unstable and emit alpha $\left(._{2} He^{4}\right)$, beta $\left(._{-1} e^{0}\right)$ and gamma $\left(._{0} \gamma^{0}\right)$ radiations to acheive states of greater stability. Rutherford and Soddy suggested the following rules governing the radioactive decay, (i) The algebric sum of charges (atomic numbers) before and after disintegration must be the same. (ii) The sum of mass numbers before and after disintegration must also be the same.

Choose the correct product of nuclear reaction: $._7 N^{14} + ._0 n^1 \rightarrow ._6 C^{14} + \ldots\ldots\ldots$

A. proton

B. neutron

C. deutron

D. electron

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245. The intensity of gamma radiation form a given source is I. On passing through 27 mm of lead, it is reduced to $I/8$. The thickness of lead which will reduce the intesity to $I/2$ will be:

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246. Starting with a sample of pure $.^{66} Cu, 7/8$ of it decays into Zn in 15 min . The corresponding half-life is.

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247. The half life of a freshly prepared radioactive sample is 2h. If the sample emits radiation of intensity, which is 16 times the permissible safe level, then the minimum time taken after which it would be possible to work safely with source is:

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248. A radioactive element $._{90} X^{238}$ decay into $._{83} Y^{222}$. The number of $\beta -$ particles emitted are.

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249. The half life of Te^{99} is 6h. The activity of Te^{99} in a patient, 36 h after receiving an injection containing this isotope is $0.125\mu ci$. What was the minimum activity of the sample injected?

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250. The radius of first Bohr ortbit is x. The de-Broglie wavelength of electron in 3rd orbit is $n\pi x$ where n=?

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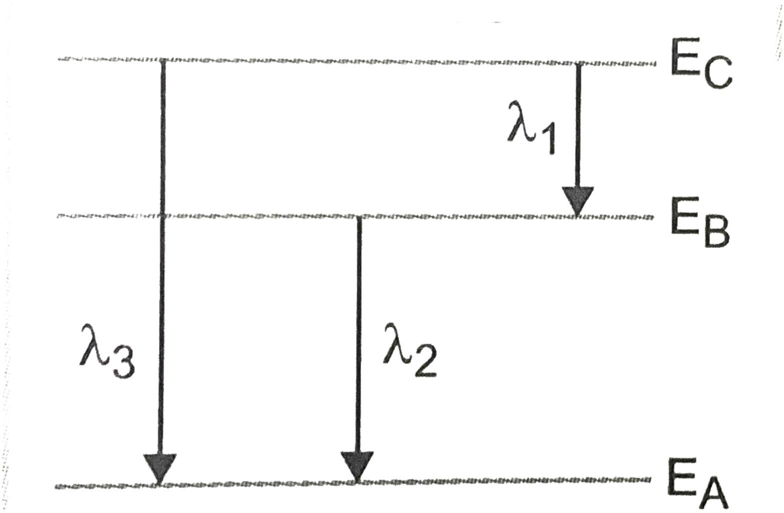
251. For an atom of an ion having single electron, the wavelengths observed are $\lambda_1 = 2units$ and $\lambda_3 = 3units$. The value of missing wavelength λ_2 is:



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252. Balmer gave an equation for wavelength of visible radiation of H-spectrum as $\lambda = \frac{kn^2}{n^2 - 4}$. The value of k in terms of Rydberg's constant R is m / R, where m is :

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253. A hydrogen atom in its ground state is irradiated by light of wavelength 970Å Taking $hc/e = 1.237 \times 10^{-6}$eV m and the ground state energy of hydrogen atom as $-13.6eV$ the number of lines present in the emmission spectrum is

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254. Assertion: Balmer series lies in visible region of electromagnetic spectrum.

Reason: Balmer means visible, hence series lies in visible region.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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255. Assertion: Lower value of binding energy per nucleon indicates greater stability.

Reason : Binding energy per nucleon of $._3 Li^7$ is greater than that of $._2 He^4$. Hence $._3 Li^7$ is less stable than $._2 He^4$.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: D

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256. Assertion : α-particle is a helium nucleus.

Reason : In α-decay, both the mass number as well as atomic number of the daugther is more than that of parent.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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257. Assertion: Isotopes of an element can be separated by using a mass spectrometer.

Reason: Separation of isotopes is possible because of difference in electron numbers of isotope.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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258. Assertion : Rydberg's constant varies with mass no. of a given element.

Reason: The 'reduced mass' of the electron is dependent on the mass of the nucleus only.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: D

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259. Assertion: In the process of nuclear fission, the fragments emit two or three neutrons as soon as they are formed and subsequently emit particles.

Reason : As the fragments contain an excess of neutrons over protons, emission of neutrons and particles bring their neutron/proton ratio the to stable values

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: A

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260. Radioactivity of 108 undecayed radioactive nuclei of half life of 50 days is equal to that of 1.2×108 number of undecayed nuclei of some material with half life of 60 days

Radioactivity is proportional to half-life.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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261. Assertion : In a radioactive disintegration, an electron is emitted by the nucleus.

Reason : Electrons are always present inside the nucleus.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: C

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262. Assertion : Fragments produced in the fission of U^{235} are active.

Reason: The fragments have abnormally high proton to neutron ratio.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: D

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263. Electron capture occurs more often than positron emission in heavy elements.

Heavy elements exhibit radioactivity.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: B

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264. Assertion : An electron and positron can annihilate each other creating a photon.

Reason: Electron and positron form a particle and anti-particle pair.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: B

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265. Assertion: Forces acting between proton-proton (f_{pp}), proton - neutron (f_{pn}) and neutron -neutron (f_{nn}) are such that $f_{pp} < f_{pn} = f_{nn}$.

Reason: Electrostatic force of repulsion between two proton reduces net nuclear forces between them.

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266. Statement -1 : Large angle scattering of alpha particles led to the discovery of atomic nucleus.

Statement -2 : Entire positive charge of atom is concentrated in the central core.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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267. Statement-1: Impact parameter for scattering of α particles by 180° is zero.

Statement-2 : Zero impact parameter means α particle tends to hit the centre of the nucleus

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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268. Statement-1: Distance of closest approach of α particle to the nucleus is always greater than the size of the nucleus.

Statement-2: Strong nuclear repulsion does not allow α particle to reach the surface of nucleus.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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269. Statement-1: Nuclei of different atom have same size

Statement-2: $R = R_0 A^{1/3}$

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: D

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270. Statement-1: Density of nuclear matter is same for all nuclei

Statement-2: Density has nothing to do with mass and size of nucleus.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: C

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271. Statement-1: $1amu. = 933MeV$

Statement-2: It follows form $E = mc^2$

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: B

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272. Statement -1: One kg of coal, on burning, produces energy $= 10^7 \text{joule.}$

Statement -2: It follows form the relation $E = mc^2$

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: C

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273. Statement-1: After ten half life lives, the amount of a radioactive element reduces to about $1/1000$ part.

Statement-2: $N = N_0\left(\frac{1}{2}\right)^n = N_0\left(\frac{1}{2}\right)^{10}$

$= \frac{N_0}{1024} \approx \frac{N_0}{1000}$

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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274. Statement-1: No law is violated in the nuclear reaction

$\cdot_0 n^1 \rightarrow \cdot_1 H^1 + \cdot_{-1} e^0$

Statement-2: Mass number and charge number, both are conserved

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: D

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275. Statement-1: Half life of tritium is 12.5 yr. The fraction of tritium that remains after 50 yr is 6.25%

Statement-2: $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n = \left(\frac{1}{2}\right)^{t/T}$

$$= \left(\frac{1}{2}\right)^{12.5/50} = \frac{1}{16} = 6.25\,\%\,.$$

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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276. This question contains Statement - 1 and Statement -2 Of the four choice given after the Statements , choose the one that best decribes the two Statements

Statement- 1:

Energy is released when heavy undergo fission or light nuclei undergo fusion and

Statement- 2:

for nuclei , Binding energy nucleon increases with increasing Z while for light nuclei it decreases with increasing Z

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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277. Statement-1:A nucleus having energy E_1 decays by β^- emission to daugther nucleus having energy E_2, but the β^- rays are emitted with a continuous energy spectrum having end point energy $(E_1 - E_2)$.

Statement-2: To conserve energy and momentum in β-decay, at least three particles must take part in the transformation.

A. Statement-1 is true, Statement-2 is true and Statement-2 is correct explanation of Statement-1.

B. Statement-1 is true, Statement-2 is true, but Statement-2 is not a correct explanation of Statement-1.

C. Statement-1 is true, but Statement-2 is false

D. Statement-1 is false, but Statement-2 is true.

Answer: A

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Fill in the blank 2

1. Alpha ray...........led of the discovery of.......... .

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Multiple choice questions 1

1. The ratio of size of a hydrogen atom to the size of its nucleus is

A. 10^5

B. 10^{-5}

C. 10^4

D. 10^{-4}

Answer: A

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Multiple choice questions 2

1. If m_e is mass of an electron, then mass of pion plus (π^+) particle is

A. $207m_e$

B. $273m_e$

C. $\frac{m_e}{207}$

D. $\frac{m_e}{273}$

Answer: B

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Multiple choice questions 3

1. Two elementary particles which have almost infinite life time are

A. electron and neutron

B. neutron and proton

C. electron and proton

D. None of the above

Answer: C

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Multiple choice questions 7

1. A radioactive element has half life of 30 seconds. If one of the nuclei decays now, the next one will decay

A. any time

B. after 30 s

C. after 60 s

D. after 30 h

Answer: A

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Fill in the blancks 3

1. Density of nuclear matter is the......... mass of........... and its............ .

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Fill in the blancks 7

1. Packing fraction of a nucleus is defined as..............per............. .

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Fill in the blancks 9

1. Radioactivity is the property by virtue of which................without being forced by............. .

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Fill in the blancks 10

1. An alpha particle is equivalent to.............or.............. .

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NCERT Multiple choice (I) questions 2

1. The binding energy of a H-atom considering an electron moving around a fixed nuclei (proton), is

$B = -\dfrac{me^4}{8n^2\varepsilon_0^2h^2}$ (m= electron mass)

If one decides to work in a frame of refrence where the electron is at rest, the proton would be movig around it. By similar arguments, the binding energy would be :

$$B = -\frac{me^4}{8n^2\varepsilon_0^2 h^2} \text{ (M = proton mass)}$$

This last expression is not correct, because

A. n would not be integral

B. Bohr-quantisation applies only to electron

C. the frame in which the electrons is at rest is not inertial

D. the motion of the proton would not be in circular orbits, even approximately.

Answer: C

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NCERT Multiple choice (I) questions 3

1. The simple Bohr model cannot be directly applied to calculate the energy levels of an atom with many electrons. This is because

A. of the electrons not being subjected to a central force

B. of the electrons colliding with each other

C. of screening effects

D. the force between the nucelus and an electron will no longer be given by Coulomb's law

Answer: A

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NCERT Multiple choice (I) questions 4

1. For he ground state , the electron int eh H-atom has an angular momentum $=h$, accord-ing to the simple Bohr model. Angular momentum is a vector ans hence there will be infi-nitely many orbits with the vector pointing in alll possible direction . In actuality , this is not true,

A. because Bohr model gives incorrect values of angular momentum

B. because only one of these would have a minimum energy

C. angular momentum must be in the direction of spin of electron

D. because electrons go around only in horizontal orbits

Answer: A

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NCERT Multiple choice (I) questions 5

1. O_2molecules consists of two oxygen atoms. In the molecules , nuclear force between the nuclei of the two atoms

A. is not important because nulear forces are short-ranged

B. is as important as electrostatic force for binding the two atoms

C. cancels the repulsive electrostatice force between the nuclei

D. is not important because oxygen nucleus have equal number of neutrons and protons

Answer: A

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2. Tritium is an isotope of hydrogen whose nucleus triton contains 2 neutrons and 1 proton . Free neutrons decay into $p + \bar{e} + \bar{n}$. If one of the neutrons in Triton decays , it would transform into He^3 nucleus. This does not happen. This is because

A. Triton energy is less than that of a He^3 nucleus

B. the electron created in the beta decay process can not remain in the nucleus

C. both the neutrons in triton have to decay simultaneously resulting in a nucleus with 3 protons, which is not a He^3 nucleus

D. because free neutrons decay due to external perturbations which is absent in a triton nucleus

Answer: A

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NCERT Multiple choice (I) questions 7

1. A set of atom in an excited state decays

A. in general to any of the states with lower energy

B. into a lower state only when excited by an external electric field

C. all together simultaneously into a lower state

D. to emit photons only when they collide

Answer: A

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2. 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 would be unbearbly high

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

Answer: B

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NCERT Multiple choice (II) questions 8

1. An ionised H-molecules consists of an electron and wo protons. The protons are seperated by a small distance of the order of angstrom. In the ground state,

A. the electron would not move in circular orbits

B. the energy would be $(2)^4$ times that of a H-atom

C. the electrons, orbit would go arround the protons

D. the molecule will soon decay in a proton and a H-atom

Answer: A::C

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NCERT Multiple choice (II) questions 9

1. Consider aiming a beam of free electrons towards free protons. When they scatter, an electron and a proton can not combine to produce a H-atom,

A. because of energy conservation

B. without simultaneously releasing energy in the form of radiation

C. because of momentum conservation

D. because of angular momentum conservation

Answer: A::B

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NCERT Multiple choice (II) questions 10

1. The bhor model for the spectra of H-atom

A. will not be applicable to hydrogen in the molecular form

B. will not be applicable as it is for a H-atom

C. is valid only at room temperature

D. predicts continuous as well as discrete spectral lines

Answer: A::B

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NCERT Multiple choice (II) questions 11

1. The balmer series for the H-atom can be ob-served

A.

B. if we measure frequencies of light emitted due to transitions between excited states and the first excited state

C. in any transition in a H-atom

D. as a sequence of frequencies with the higher frequencies getting closely packed

Answer: B::D

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NCERT Multiple choice (II) questions 12

1. Let $E = \frac{-1me^4}{8\varepsilon_0^2 n^2 h^2}$ be the energy of the n^{th} level of H-atom state and radiation of frequency $(E_2 - E_1) / h$ falls on it ,

A. it will not be absorbed at all

B. some of atoms will move to the first excited state

C. all atoms will be excited to the n=2 state

D. no atoms will make a transition to the n=3 state

Answer: B::D

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NCERT Multiple choice (I) questions 1

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

A. all the containers will have 5000 atoms of the material

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

C. the containers will in general have different numbers of the atoms of the material 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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NCERT Multiple choice (II) questions 8

1. Fusion processes, like combining two deuterons to form a He nucleus are impossible at ordinary temperature 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 ionized before fusion can take place

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

Answer: A::B

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NCERT Multiple choice (II) questions 9

1. Sample of two radioactive nuclides A and B are taken. λ_A and λ_B are the disintergration constants of A and B respectively. In which of the following cases, the two sample can simultaneously have the same decay rate at any time ?

A. Initial rate of decay of A is twice the initial rate of decay of B and $\lambda_A = \lambda_B$

B. Initial rate of decay of A is twice the initial rate of decay of B and $\lambda_A > \lambda_B$

C. Initial rate of decay of B is twice the initial rate of decay of A and

$\lambda_A > \lambda_B$

D. Initial rate of decay of B is same as the rate of decay of A at t=2h

and $\lambda_B = \lambda_A$

Answer: B::D

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(II) multiple choice question 88

1. Which of the following statements (s) is (are) correct?

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

B. The rest mass of a stable nucleus is greater than the rest masses of its separated nucleons

C. The nuclear fusion, energy is released by fusing two nuclei of medium mass. (approx. 100 am u)

D. In nuclear fission, energy is released by fragmentation of a very heavy nucleus.

Answer: A::D

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(II) multiple choice question 101

1. Which of the following assertions are correct?

A. A neutron can decay to a proton only inside a nucleus

B. A proton can change to a neutron only inside a nucleus

C. An isolated proton can change into a neutron

D. An isolated neutron can change into a proton

Answer: B::D

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Assertion- Reason type question 6

1. Assertion: If a heavy nucleus is split into two medium sized parts, each of new nucleus will have more binding energy per nucleon than original nucleus.

Reason : Joining two light nuclei together to give a single nucleus of medium size means more binding energy per necleon in new nucleus.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: B

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Assertion- Reason type question 12

1. Statement-1: An isolated radioactive atom may not decay at all whatever be its half life

Statement-2:Radioactive decay is a statistical phenomenon.

A. If both, Assertion and Reason are true and the Reason is the correct explanation of the Assertion.

B. If both, Assertion and Reason are true but Reason is not a correct explanation of the Assertion.

C. If Assertion is true but the Reason is false.

D. If both Assertion and Reason are false.

Answer: A

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