PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

ATOM

Numerical Examples

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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19. Complete the following nuclear reaction : $._{13}Al^{27} + ._{2}He^{4} \rightarrow ._{15}P^{30}$ + ?

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20. Complete the following nuclear reaction : $._{7}N^{14} + ._{2}He^{4} \rightarrow ._{8}O^{17}$ + ?

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21. Identify the missing particle in the following two reactions (I) $._{9}F^{19} + ._{1}H^{1} \rightarrow ._{8}O^{16}$ + ?

(II)$._{12}Mg^{25} + ? \rightarrow ._{11}Na^{22} + ._{2}He^{4}$

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22. When $._{4}Be^{9}$ is hit by α-particles a neutron is emitted resulting in the formation of a new element. Identify the element and write the complete reaction equation.

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

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

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

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26. In the nuclear reaction $X(n, \alpha)_3Li^7$, identify X.

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

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28. In a typical nuclear fission reaction, it was found that there was a loss of mass of 0.2150 u. How much energy in MeV will be released from the reaction ? $(c = 3 \times 10^8 ms^{-1})$

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

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Section Related Questions

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

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

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

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4. What are the characteristics of nuclear force ?

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5. What are the constituents of the atomic nucleus? What do you mean by nucleon?

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6. What is nuclear force ?

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7. What are isotopes ?

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8. Define atomic weight and atomic number of an element

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

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

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

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

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13. How can nuclear density be calculated ?

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

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15. Define radioactivity

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16. What are radioactive rays ?

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17. Write down three properties of beta rays .

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

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

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

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

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

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

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

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25. Compare X-rays and γ-rays .

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

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27. If a radioactive element emits -

(i) α-particle and

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

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

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29. What is disintegration energy ?

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

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

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32. Write down the law of radioactive decay .

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33. Write down the law of radioactive decay and explain it with curve .

Define half-life of a radioactive substance

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

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

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

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

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38. Define 1 curie

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39. What is artificial radioactivity ? Illustrate the matter

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

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41. Explain the phenomenon of artificial transmutation with example .

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

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43. What do you mean by radioisotopes ?

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44. What do you mean by nuclear fission ?

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45. Explain nuclear fission with a suitable nuclear reaction.

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

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47. Give two examples of moderator .

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48. What is the main principle of atom bomb ?

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49. What do you mean by nuclear fusion ?

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

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

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52. Discuss two important applications of radioisotopes .

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

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54. What do you know about carbon dating ?

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55. Discuss briefly the main inferences made by Rutheford from his α - particle scattering experiment.

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56. Explain the origin of spectral lines of hydrogen from Bohr's postulates.

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57. State the postulates of Bohr's model of hydrogen atom .

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58. Explain the origin of Balmer series .

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59. With the help of Balmer's relation, show how the wavelengths of the spectral lines of hydrogen can be determined.

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60. State Bohr postulates related to atomic model .

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61. Establish Bohr's quantum condition from de Broglie 's hypothesis.

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62. Mention two defects of Bohr's theory .

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63. According to Bohr's theory mention the expressions of the following parameters for hydrogen atom:

(i) radius of Bohr orbit, (ii) velocity of electron ,

(iii) orbital frequency of electron, (iv) angular momentum of electron, (v) kinetic energy of electron (iv) potential energy of electron.

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64. In which state does an atom emit (i) line spectrum, (ii) band spectrum ?

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65. (i) For an atom of an element having atomic number Z, find the expression of the following parameter in SI unit :

(a) radius of the n-th Bohr orbit (r_n)

(b) Velocity of the electron in n-th orbit (v_n)

(c) Total energy of the electron in n-th orbit (E_n)

Given , $\in_0$ =permittivity of free space, m=mass of electron, e= charge of electron and h =Planck's constnat)

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66. Show that in Bohr's model radii of electron orbits increase as n^2 , where n is the quantum number of the orbit.

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67. What do you mean by hard and soft X-ray ?

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68. Energy of X-ray is greater than that of visible light . Explain.

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69. Write down three important properties of X -rays.

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70. Write down four important uses of X-rays.

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71. What is the nature of soft X-rays and hard X-rays ?

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72. Write down Moseley's law . Describe the importance of Moseley's work.

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Hots Question

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

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

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

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

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

Answer: B

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

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

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

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

(i) a β-particle is emitted,

(ii) a positron is emitted and

(iii) a γ-ray photon is emitted?

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

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

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

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

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

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11. Is mass defect always positive or negative ?

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

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

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

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Ncert Textbook Questions

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

m_H=1.007825 u, m_n=1.008665 u

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

Which nucleus has greater binding energy per nucleon ?

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2. A given coin has a mass of 3.0 g . Calculate the nuclear energy that would be required to separate all the neutrons and protons from each other . For simplicity assume that the coin is entirely made of $._{29}^{63} C$ atoms (of mass 62.92960 u). The masses of protons and neutrons are 1.00783 u and 1.00867 u respectively.

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

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4. Find Q-value and kinetic energy of the emitted α-particle in the α-decay of (a).$_{88}^{222}Ra$ and (b).$_{86}^{220}Rn$. Given , $m\left(._{86}^{226}Ra\right)$ = 226.02540 u, $m\left(._{26}^{222}Rn\right)$ = 222.01750 u, $m\left(._{86}^{220}Rn\right)$ = 220.01137 u, $m\left(._{84}^{216}Po\right)$ = 216.00189 u , $m\left(._{2}^{4}He\right)$ =4.00260 u

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

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

(a).$_1^1 H + ._1^3 H \rightarrow ._1^2 H._1^2$, (b).$_6^{12} C + ._6^{12} C \rightarrow ._{10}^{20} Ne + ._2^4 He$

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

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

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

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

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10. How long an electric lamp of 100 W can be kept glowing by fusion of 2.0 kg of deuterium ? The fusion reaction can be taken as $._1^2H + ._1^2H \rightarrow ._2^3He + n + 3.2MeV$

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

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

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

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

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

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

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

Given , $m\left(._{92}^{238} U\right) = 238.05079u, m\left(._{58}^{140} Ce\right)$ = 139.90543 u

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

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14. Suppose India had a target of producing by 2020 AD, 200,000 MW of electric power , 10% of which was to be obtained from nuclear power plant. Suppose we are given that, on an average, the efficiency of utilisation (i.e., conversion to electric energy) of thermal energy produced in a reactor was 25% . How much amount of fissionable uranium did our country need per year by 2020 ? Take the heat per fission of $.^{235} U$ to be about 200 MeV. Avogadro's number $= 6.023 \times 10^{-23} mol^{-1}$.

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

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Ncert Exemplar Question

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

(A) All containers will have 5000 atoms

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

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

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

A. all containers will have 5000 atoms

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

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

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

Answer: c

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

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

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

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

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

A. do no change for any type of radioactivity

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

C. change for α-radioactivity but not for others

D. change for β-radioactivity but not for others

Answer: b

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

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

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

C. $Q_1 = (M_x - M_y - 2m_e)c^2$ and $Q_2 = (M_x - M_y + 2m_e)c^2$

D. $Q_1 = (M_x - M_y + 2m_e)c^2$ and $Q_2 = (M_x - M_y + 2m_e)c^2$

Answer: a

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

A. neutrons are heavier than protons

B. electrostatic force between protons are repulsive

C. neutrons decay into protons through β-decay

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

Answer: b

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

A. They will break up

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

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

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

Answer: b

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

A. nuclear forces have short range

B. nuclei are positively charged

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

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

.

Answer: a,b

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Exercise

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

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

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

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

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

Answer: B

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2. Which of the following is correct ?

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

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

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

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

Answer: A

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3. During emission of a negative β - particle

A. an electron from the atom is emitted

B. an electron already present inside the nucleus is emitted

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

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

Answer: C

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4. Which of the following statements is correct ?

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

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

C. α-particles are singly charged helium atoms

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

Answer: A

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

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

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

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

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

Answer: C

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

A. nitrogen

B. carbon

C. boron

D. oxygen

Answer: B

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

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

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

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

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

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

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

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

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

Answer: D

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

A. 6 h

B. 12 h

C. 24 h

D. 128 h

Answer: B

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

A. 13 days

B. 18.75 days

C. 9 days

D. 6.5 days

Answer: C

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

A. $400 \mu s$

B. $6.3 \mu s$

C. $40 \mu s$

D. $300 \mu s$

Answer: A

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

(A) 14 min

(B) 20 min

(C) 28 min

(D) 7 min

A. 14 min

B. 20 min

C. 28 min

D. 7 min

Answer: B

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12. The half-life of a radioactive isotope X is 50 years . It decays to another element Y which is stable . The two elements X and Y were found to be in the ratio of 1:15 in a sample of a given rock. The age of the rock was estimated to be

A. 150 years

B. 200 years

C. 250 years

D. 100 years

Answer: B

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

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

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

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

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

Answer: C

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14. Two radioactive nuclei P and Q in a given sample decay into a stable nucleus R. At time t=0, number of P species are $4N_0$ and that of Q are N_0. Half-life of P (for conversion to R) is 1 min whereas that of Q is 2min. Initially there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be

A. $2N_0$

B. $3N_0$

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

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

Answer: C

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

A. $._5 C^{13} + ._1 H^1 \rightarrow ._6 C^{14}$ + 4.3 MeV

B. $._6 C^{12} + ._1 H^1 \rightarrow ._7 N^{13}$ +2MeV

C. $._7 N^{14} + ._1 H^1 \rightarrow ._8 O^{15}$

D. $._{92} U^{235} + ._0 n^1 \rightarrow ._{54} Xe^{140} + ._{38} Sr^{94} + ._0 n^1 + \gamma$ + 200 MeV

Answer: B

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16. In the nuclear reaction $._7^{14} N + X \rightarrow ._6^{14} C + ._1^1 H$ the X will be

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

B. $._1^1 H$

C. $._1^2 H$

D. $._0^1 n$

Answer: D

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17. Fast moving neutrons are retarded

A. by using lead obstacle

B. by passing through water

C. after colliding elastically with heavy nuclei

D. by strong electric fields.

Answer: B

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18. In nuclear fusion,

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

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

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

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

Answer: C

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

A. β-decay

B. γ-decay

C. fusion

D. fission

Answer: C

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

A. $10\mu g$

B. $20\mu g$

C. $40\mu g$

D. $1\mu g$

Answer: C

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

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

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

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

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

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

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

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

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

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

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31. What are the atomic number and the mass number of the plutonium isotope produced due to two successive β-decays of the isotope $._{92}U^{239}$ of uranium ?

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

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

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34. Write down the decay scheme of a free neutron

Watch Video Solution

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

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

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

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38. $._1 H^2 + ._1 H^2 \rightarrow ._2 He^4 + Q$. In this reaction the masses of deuterium and helium atoms are 2.0141 u and 4.0024 u respectively. What is this process called, and what is the energy released Q , in MeV

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

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

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

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

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

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

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

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46. Complete the nuclear reaction and explain the result thus obtained :

$._{7}N^{14} + ._{2}He^{4} \rightarrow$ ....

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47. Explain why nuclear fission should precede nuclear fusion ?

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

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

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

Watch Video Solution

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

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

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53. Complete the following equations :

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

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54. Complete the following nuclear equations :

$\cdot_{4} Be^{9} + \cdot_{2} He^{4} \rightarrow _{-} \quad _{-+} \cdot_{0} n^{1}$

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55. Complete the following nuclear equations :

$\cdot_{7} N^{14} + \cdot_{0} N^{1} \rightarrow _{-} \quad _{-+} \cdot_{1} H^{1}$

Watch Video Solution

56. Complete the following nuclear equations :

$\cdot_{6} C^{14} \rightarrow_{-} \ \_ + \cdot_{-1} \beta^{0}$

Watch Video Solution

57. Complete the following nuclear equations :

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

Watch Video Solution

58. Complete the following nuclear equations :

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

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59. A radioactive nucleus X decays as follows :

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

If the mass number and atomic number of A_2 are 176 and 71 respectively, what are the mass numbers and the atomic numbers of A_1 and A? Which of these three elements are isobars?

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60. The mass of a proton is 1.00816 u and that of a neutron is 1.00902 u. If the mass of a deuterium nucleus $\left(._1 H^2\right)$ is 2.01479 u, then what will be the binding energy of this nucleus ? (1 u = 931.2 MeV)

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

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

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

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

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

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

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

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

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

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

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

(Avogadro number = 6.023×10^{23}).

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

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

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

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

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76. If a radioactive substance disintegrates by 20% in 5d, then what part of the initial mass of the substance will remain intact after 15 d?

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

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

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

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

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

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

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

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

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85. The binding energies of deuterium $\left(._{1} H^{2}\right)$ and helium $\left(._{2} He^{4}\right)$ per nucleon are 1.1 MeV and 7.0 MeV respectively . When a helium nucleus $\left(._{2} He^{4}\right)$ is formed by fusion of two deuterium nuclei then how much energy will be evolved ?

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Entrance Corner

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

Statement II: Nucleus of an atom is constituted only of protons and neutrons.

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

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

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

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

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

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

C. Statement I is true , statement II is false

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

Answer: D

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

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

(A) Statement 1 is true, Statement 2 is true. Statement 2 is not a correct explanation for statement 1.

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

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

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

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

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

C. Statement I is true , statement II is false

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

Answer: A

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

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

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

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

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

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

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

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

C. Statement I is true , statement II is false

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

Answer: A

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4. Statement I:Some energy is released when a heavy nucleus disintegrate into two nuclei of moderate size.

Statement II: The more the mass number of the nucleus , more is the binding energy for each proton or neutron

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

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

C. Statement I is true , statement II is false

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

Answer: C

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

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

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

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

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

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

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

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

C. Statement I is true , statement II is false

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

Answer: C

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

Statement 2: An element, although radioactive, can last longer, if its decay with time is slow.

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

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

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

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

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7. A radioactive isotope X^A becomes Y^{A-4} after decay. Which of the following radioactive emissions are not possible in this case?

(A) α

(B) β

(C) meson

(D) positron

A. α

B. β

C. meson

D. positron

Answer: B::C::D

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

(A) α

(B) β

(C) meson

(D) positron

A. α

B. β

C. meson

D. positron

Answer: A::D

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

(A) $\tau = \frac{1}{\lambda}$
(B) $\tau = \frac{0.693}{\lambda}$
(C) $\tau = 0.6T$
(D) $\tau = \frac{T}{0.693}$

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

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

C. $\tau = 0.6T$

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

Answer: b,c

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

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

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

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

(D) Velocity of β -particles is more.

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

B. penetration power of β-particles is more

C. ionisation power of β -particles is more

D. velocity of β -particles is more

Answer: a,c

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

(A) ratio of diameter = 1:4

(B) ratio of diameter = 1:2

(C) ratio of volume = 1:8

(D) ratio of volume : 1:4

A. ratio of diameter = 1:4

B. ratio of diameter = 1:2

C. ratio of volume = 1:8

D. ratio of volume : 1:4

Answer: a,b,d

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12. In any nuclear reaction -

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

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

number of neutrons.

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

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

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

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

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

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

Answer: a, d

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

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

(A) 10^{-6}

(B) 1.45×10^{-6}

(C) 2×10^{-6}

(D) 2.9×10^{-6}

A. 10^{-6}

B. 1.45×10^{-6}

C. 2×10^{-6}

D. 2.9×10^{-6}

Answer: (A)

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

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

(A) 4.79×10^5 s.

(B) 6.912×10^5 s.

(C) 9.974×10^5 s.

(D) 22.96×10^5 s.

A. 4.79×10^5

B. 6.912×10^5

C. 9.974×10^5

D. 22.96×10^5

Answer: c

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

The half-life of Iodine-131 is 8 d. What is the activity (in Bq) of 1 g of Iodine?

(A) 2.3×10^{15}

(B) 4.6×10^{15}

(C) 6.9×10^{15}

(D) 9.2×10^{15}

A. 2.3×10^{15}

B. 4.6×10^{15}

C. 6.9×10^{15}

D. 9.2×10^{15}

Answer: (B)

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

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

(A) 24 d

(B) 32 d

(C) 40 d

(D) 48 d

A. 24d

B. 32 d

C. 40 d

D. 48 d

Answer: b

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

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

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

(A) 1/70

(B) 1/7

(C) 7

(D) 70

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

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

C. 7

D. 70

Answer: (D)

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

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

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

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

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

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

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

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

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

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Examination Archive

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

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

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

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

Watch Video Solution

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

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6. In a nuclear decay, a nucleus emits one α-particle and then two β-particles one after another . Show that the final nucleus is an isotope of the former nucleus .

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

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

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

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

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

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

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

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

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

Answer: c

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

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

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

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

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

(A) Isobar of original nucleus if produced

(B) Isotope of the original nucleus is produced

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

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

A. Isobar of original nucleus if produced

B. isotope of the original nucleus is produced

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

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

Answer: B

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

(A) 0.002 kg.

(B) 0.062 kg.

(C) 0.032 kg.

(D) 0.024 kg.

A. 0.002 kg

B. 0.062 kg

C. 0.032 kg

D. 0.024 kg

Answer: A

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

A. 0.63

B. 0.37

C. 0.5

D. 0.13

Answer: D

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

(A) $1:16$

(B) $4:1$

(C) $1:4$

(D) $5:4$

A. $1:16$

B. $4:1$

C. $1:4$

D. $5:4$

Answer: D

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

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

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

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

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

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

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

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

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

Answer: B

17. The binding energy per nucleon of $._3^7 Li$ and $._2^4 He$ nuclei are 5.60 MeV and 7.06 MeV respectively. In the nuclear reaction $._3^7 Li + ._1^1 H \rightarrow 2._2^4 He + Q$, the value of energy Q released is

A. 19.6 MeV

B. -2.4 MeV

C. 8.4 MeV

D. 17.3 MeV

Answer: D

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18. A radioisotope Y with half-life 1.4×10^9 years decays to X which is stable. A sample of the rock from a cave was found to contain X and Y in the ratio $1:7$. The age of the rock is -

(A) 1.96 × 10^9 years.

(B) 3.92 × 10^9 years.

(C) 4.20 × 10^9 years.

(D) 8.40 × 10^9 years.

A. 1.96×10^9 years

B. 3.92×10^9 years

C. 4.20×10^9 years

D. 8.40×10^9 years

Answer: C

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

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

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

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

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

Answer: B

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

A. 2×10^{22} W

B. 32×10^{8} W

C. 16×10^{8} W

D. 5×10^{11} W

Answer: B

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

A. 3

B. 10

C. 20

D. 15

Answer: C

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

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

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

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

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

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

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7. Define the Activity of a radioactive sample. Write its S.I. unit. A radioactive sample has activity of 10000 disintegrations per second (dps) after 20 hours. After next 10 hours its Activity reduces to 5000 dps. Find out its half-life and initial activity.

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

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

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

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

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

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

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

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

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

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15. Using de Broglie's hypothesis , explain with the help of a suitable diagram , Bohr's second postulate of quantisation of energy levels in a hydrogen atom.

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

what are the kinetic and potential energies of the electron in this state ?

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17. How are X-rays produced ?

Watch Video Solution

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

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19. Using Bohr's postulates, derive the expression for the frequency of radiation emitted when electron in hydrogen atom undrgoes transition from higher energy state (quantum number n_i) to the lower state (n_f). When electron in hydrogen atom jumps from energy state $n_i = 4$ to $n_f = 3, 2, 1$, identify the spectral series to which the emission lines belong.

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20. Using Rutherford model of atom , derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron ?

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21. Using Bohr's postulates of the atomic model, derive the expression for radius of n-th electron orbit. Hence obtain the expression for Bohr's radius.

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22. Given the value of ground state energy of hydrogen atom as -13.6 eV. Find out its kinetic and potential energy in the ground and second excited states.

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23. When is k_{α} line in the emission spectrum of hydrogen atom obtained ? Calculate the frequency of the photon emitted during this transition.

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24. Calculate the wavalength of radiation emitted when electron in a hydrogen atom jumps from $n = \infty$ to n=1 .

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25. Define the distance of closest approach. An α-particle of kinetic energy K is bombarded on a thin gold foil. The distance of the closest approach is r. What will be the distance of closest approach for an $alpah$-particle of double the kinetic energy ?

View Text Solution

26. Write two important of Rutheroford nuclear model of the atom. .

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27. Find out the wavelength of the electron orbiting in the ground state of hydrogen atom.

Watch Video Solution

28. A 12.75 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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29. The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 Å. Calculate the short wavelength limit for Balmer series of the hydrogen spectrum.

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30. The ground state energy of hydrogen atom is -13.6 eV . If an electron makes a transition from an energy level -1.51 eV to -3.4 eV, calculate the wavelength of the spectrum line emitted and name the series of hydrogen spectrum to which it belongs.

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31. State Bohr's postulate to define stable orbits in hydrogen atom . How does de Broglie's hypothesis explain the stability of these orbits ?

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32. A hydrogen atom initially in the ground state absorbs a photon which excites it to the n=4 level. Estimate the frequency of the photon.

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Example

1. If the value of Rydberg constant of hydrogen is $109737 cm^{-1}$, determine the longest and the shortest wavelength of the Balmer series.

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2. As a result of collision with an electron of 20 eV energy, a hydrogen atom is excited to the higher energy state and the electron is scattered with a reduced velocity. Subsequecntly a photon with wavelength 1216 Å is emitted from the hydrogen atom . Determine the velocity of the electron after collision.

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3. Light from a discharge tube containing hydrogen atoms is incident on the surface of a piece of sodium . The maximum kinetic energy of the photoelectrons emitted from sodium is 0.73 eV. The work function of sodium is 1.82 eV .

Find (i) the energy of photons responsible for the photoelectric emission,

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4. Light from a discharge tube containing hydrogen atoms is incident on the surface of a piece of sodium . The maximum kinetic energy of the photoelectrons emitted from sodium is 0.73 eV. The work function of sodium is 1.82 eV .

(ii) The quantum numbers of the two orbits in the hydrogen atom involved in emission of photons and

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5. Light from a discharge tube containing hydrogen atoms is incident on the surface of a piece of sodium . The maximum kinetic energy of the photoelectrons emitted from sodium is 0.73 eV. The work function of sodium is 1.82 eV .

(iii) the change in angular momentum of the electron of hydrogen atom in the orbits.

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6. When ultraviolet light of wavelengths 800 Å and 700 Å are incident on the hydrogen atom at ground state electrons are emitted with energies 1.8 eV and 4 eV, respectively. Determine the value of Planck's constant.

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7. In absorbing 10.2 eV energy, the electron of a hydrogen atom jumps from its initial orbit to next higher energy orbit . As the electron returning to the former orbit, a photon is emitted. What is the wavelength of this photon ?

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8. Hydrogen atom in its ground state, is excited by means of monochromatic radiation of wavelength 975 Å . How many different lines are possible in the resulting spectrum ? Calculate the longest wavelength amongst them. Given, ionisation energy of hydrogen atom is 13.6 eV.

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9. If a stream of electrons of kinetic energy 36 keV is bombarded on a molybdenum target, what will be the frequency of the emitted X -ray ?

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10. What minimum terminal potential difference of a Coolidge tube should be maintained to produce X -ray of wavelength 0.8 Å ?

$[h = 6.62 \times 10^{-34} J \cdot s, e = 1.60 \times 10^{-19} C, c = 3 \times 10^{8} m \cdot s^{-1}]$

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Higher Order Thinking Skill Hots Questions

1. Electron of a hydrogen atom revolves in 3rd orbit.

Find the angular momentum of the electron.

$(h = 6.6 \times 10^{-27} erg \cdot s)$

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2. In a hydrogen atom, how many times is the radius of fourth orbit compared to that in the second orbit?

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3. In a hydrogen atom, how many times is the speed of the electron in the fourth orbit compared to that in the second orbit ?

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4. How many times does the electron revolve in the first Bohr orbit of hydrogen atom per second ?

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5. In a hydrogen atom, how many times is the energy of the electron in the fourth orbit compared to that in the second orbit ?

Watch Video Solution

6. In the Bohr of the hydrogen atom, what is the ratio of the kinetic energy to the total energy of the electron in any quantum state ?

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7. The electron in a hydrogen atom is excited to the n -th excited state. How many possible spectral lines can it emit in transtion to the ground state ?

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8. Explain why the spectrum of hydrogen contains a number of lines although a hydrogen atom has only one electron.

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9. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principal quantum numbers of the two states. According to the Bohr model , the time period of revolution of electron in initial state is 8 times that in the final state. Which are possible values of n_1 and n_2?

A $4, 2,$ B $8, 2,$ C $8, 1,$D $6, 3.$

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10. An electron in a hydrogen -like atom is in an excited state. It has a total energy of -3.4 eV. Calculate the kinetic energy of the electron.

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11. As per Bohr model , the minimum energy (in eV) required to remove an electron from the ground state of $Li^{2+} ion(Z = 3)$ is : A) 1.51 B) 13.6 C) 40.8 D) 122.4 - which one is correct?

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12. The spectrum of sodium atom resembles the spectrum of hydrogen atom. In which way is this statement correct ?

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13. What is the significance of negative energy of electron in its orbit ?

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14. Determine the ratios of time periods of an electron in Bohr orbits of a hydrogen atom.

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15. Determine the ratios of

(ii) orbital frequencies of an electron in Bohr orbits of a hydrogen atom.

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16. The wavelength of the K_{α} line of X-ray of an element having atomic number Z=11 is λ. For which atomic number will the wavelength of that line be 4λ ?

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17. On which power of the principal quantum number (n) of the orbit, will the magnetic moment (μ) of an electron revolving in the Bohr orbit of an atom be directly proportional ?

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18. Three ascending energy states of an atom are A,B,C. The wavelengths of emitted radiations due to transition from C to B and from B to A are λ_1 and λ_2 respectively. What will be the wavelength of emitted radiation due to transition from C to A ?

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19. What are meant by excitation potential and ionisation potential ?

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20. Find the wavelength of electromagnetic waves of frequency 5×10^{19} Hz in free space. Where is this type of wave used ?

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21. Show that the energy of first excited state of He^{+} atom is equal to the energy of electron in the first orbit of hydrogen atom.

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22. Show that the speed of electron in the second orbit of He^{+} atom is equal to the speed of electron in the first orbit of hydrogen atom.

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Ncert Textbook Questions With Answer Hint

1. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. What series of wavelengths will be emitted ?

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2. Obtain an expression for the frequency of radiation emitted when a hydrogen atom de-exites from level n to level (n-1) . For large n, show that frequency equals the classical frequency of revolution of the electron in the orbit.

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3. The total energy of an electron in the first excited state of the hydrogen atom is about -3.4 eV . In this state

(a) what is the kinetic energy of the electron ?

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4. The total energy of an electron in the first excited state of the hydrogen atom is about -3.4 eV . In this state

(b) what is the potential energy of the electron ?

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5. If Bohr 's quantisation 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 we never speak of quantisation of planets around the sun?

View Text Solution

6. Obtain the first Bohr radius and the ground state energy of a muonic hydrogen atom (I.e ., an atom in which negatively charged muon (μ^{-}) of mass about $207m_e$ orbits around a proton).

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Ncert Exemplar Questions With Answer Hint Multiple Options Correct

1. The binding energy of a H atom, considering an electron moving around a fixed nuclei (proton), is

$$B = \frac{me^4}{8n^2 \in_0^2 h^2} (m = \text{mass of electron})$$

if one decides to work in a frame of refrence where the electron is at rest , the proton would be moving around it. By similar arguments , the binding energy would be

$$B = \frac{Me^4}{8n^2 \in_0^2 h^2} (M = \text{mass of proton})$$

This last expression is not correct because

A. n would not be integral

B. Bohr's quantisation applies only to electrons

C. the frame in which the electron 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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2. 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 subjects to a central force

B. of the electrons colliding with each other

C. of screening effects

D. the force between the nucleus and an electron will no longer be given by Colomb's law

Answer: A

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3. O_2 molecules consist of two oxygen atoms. In the molecule, nuclear force between the nuclei of the two atoms

A. is not important because nuclear forces are short-ranged

B. is as important as electrostatic force for binding the two atoms

C. cancels the repulsive electrostatic force between the nuclei

D. is not important because oxygen nucleus have equal number of neutrons and protons

Answer: A

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4. For the Ground state , the electron in the H atom has an angular momentum = h, according to the simple Bohr model . Angualar momentum is a vector pointing in all possible directions . Actually , it 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 electons

D. because electrons go around only in horizotal orbits

Answer: A

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

A. 10.20 eV

B. 20.40 eV

C. 13.6 eV

D. 27.2 eV

Answer: A

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6. An ionised H molecule consists of an electron and two protons . The protons are separated 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 , orbits would go around the protons

D. the molecule soon decay in a proton and a neutron

Answer: A::C

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7. Consider aiming a beam of free electrons towards free protons. When they scatter, an electron and a proton connot 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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8. The Bohr model for the spectra of a H atom

A. will not be applicable to hydrogen in the molecular form

B. will not be applicable as it is for a He atom

C. is valid only at room temperature

D. predicts continuous as well as discrete spectral lines.

Answer: A::B

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9. The simple Bohr model 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 electron

D. electrons are not subject to central forces

Answer: C::D

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10. The Balmer series for the H atom can be observed

A. if we measure the frequencies of light emitted when an excited atom falls to the ground state

B. if we measure the frequencies of light emitted due to transition 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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Exercise Multiple Choice Questions

1. According to Rutherford's atomic model, which of the following is correct ?

A. atom is stable

B. majority of space in an atom is empty

C. E=hf

D. none of these

Answer: B

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2. Which of the was used in Rutherford's experiment ?

A. aluminum foil

B. platinum foil

C. silver foil

D. gold foil

Answer: D

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3. What is the velocity of the electron in the first Bohr orbit of hydrogen atom ?

A. $3 \times 10^8 m \cdot s^{-1}$

B. $2.19 \times 10^6 m \cdot s^{-1}$

C. $3 \times 10^7 m \cdot s^{-1}$

D. $2.19 \times 10^7 m \cdot s^{-1}$

Answer: B

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4. How many times will the electron in the first Bohr orbit of hydrogen atom revolve in 1 s ?

A. 6.58×10^{15}

B. 4.13×10^{16}

C. 1.64×10^{15}

D. 4.13×10^{15}

Answer: A

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5. The total energy of an electron in the ground state , of hydrogen atom is

A. zero

B. 13.6 eV

C. $-13.6eV$

D. $-13.6J$

Answer: C

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6. What is the minimum energy (in eV) necessary to liberate an electron from the ground state of a Li^{++} (Z=3), according to Bohr's theory ?

A. 1.51

B. 13.6

C. 40.8

D. 122.4

Answer: D

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7. Electron in a hydrogen atom undergoes transition from n_1 to n_2 , where n_1 and n_2 are the principal quantum numbers of two given states. According to Bohr's theory , if the time period of the electron in the initial state be eight times that in the final state , the possible values of n_1 and n_2 will be, respectively

A. 4 and 2

B. 8 and 2

C. 8 and 1

D. 6 and 4

Answer: A

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8. Atomic number of Helium is 2. what is the energy of the ground state of Hulium ion having single positive charge ?

A. $-13.6eV$

B. $-54.4eV$

C. $-40.8eV$

D. $-122.4eV$

Answer: B

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9. Ionisation potential of an atom is 24.6 V . How much energy is required to ionise it ?

A. 24.6 eV

B. 2.46 eV

C. 246 eV

D. 0.246 eV

Answer: A

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10. In Bohr's model of hydrogen atom ,

A. radius of n-th orbit is directly proportional to n^2

B. total energy of electron in the n-th orbit is inversely proportional to n

C. angular momentum of electron in any orbit is an intergral multiple of h

D. the potential energy of an electron in any orbit is more than its kinetic energy

Answer: A

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11. Ground state energy of hydrogen atom is -13.6 eV . If the electron in this atom jumps from the fourth level to the second level, what will be the wavelength of the emitted radiation ?

A. 2918 Å

B. 1824 Å

C. 4863 Å

D. 3824 Å

Answer: C

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12. The electron in a hydrogen atom has been excited to the n -th state. What is the maximum number of spectral lines that may be emitted by the atom when the electron transits to the ground state ?

A. $\frac{1}{6}n(n-1)(n-2)$

B. n

C. n(n-1)

D. $\frac{1}{2}n(n-1)$

Answer: D

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13. If the electron in a hydrogen atom is raised to the third orbit, how many photons of different energies may be emitted ?

A. 1

B. 2

C. 3

D. 4

Answer: C

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14. According to Bohr's model , the ratio of the energies of the electron in the first orbit of hydrogen atom and He^{+} atom is

A. $1:2$

B. $4:1$

C. $1:4$

D. $1:9$

Answer: C

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15. The quantised physical quantity of an atomic electron, according to Bohr' s model , is

A. linear velocity

B. angular velocity

C. linear momentum

D. angular momentum

Answer: C

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16. An one -electron atom has an energy of -3.4 eV. The kinetic energy of the electron is

A. $-3.4eV$

B. $3.4eV$

C. $-6.8eV$

D. 6.8 eV

Answer: B

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17. An one -electron atom has an energy of -3.4 eV. The potential energy of the electron is

A. $-3.4eV$

B. $3.4eV$

C. $-6.8eV$

D. 6.8 eV

Answer: C

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18. An electron is in the third orbit of a hydrogen atom. If h $= 6.6 \times 10^{-34} J \cdot s$, its orbital angular momentum is

A. $1.98 \times 10^{-33} j \cdot s$

B. $2.2 \times 10^{-34} J \cdot s$

C. $3.15 \times 10^{-34} J \cdot s$

D. $1.05 \times 10^{-34} J \cdot s$

Answer: C

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19. The ratio between the radii of the fourth and the second electron orbits of a hydrogen atom is

A. $2:1$

B. $4:1$

C. $8:1$

D. $16:1$

Answer: B

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20. The ratio between the electron velocities in the second and in the third orbits of a hydrogen atom is

A. $4:9$

B. $2:3$

C. $3:2$

D. $9:4$

Answer: C

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21. The ratio between the electron revolution fraquencies in the first and in the second orbits of an hydrogen atom is

A. $8:1$

B. $4:1$

C. $2:1$

D. $1:4$

Answer: A

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22. In an inelastic collision an electron excites as hydrogen atom from its ground state to a M -shell state. A second electron collides instantaneously with the excited hydrogen atom in the M-state and ionizes it. At least how much energy the second electron transfers to the atom in the M-state ?

A. $+3.4eV$

B. $+1.51eV$

C. $-3.4eV$

D. $-1.51eV$

Answer: B

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23. Energy required for the electron excitation in Li^{2+} from the first to the Bohr orbit is

A. 36.3 eV

B. 108.8 eV

C. 122.4 eV

D. 12.1 eV

Answer: B

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24. 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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25. An electron in the hydrogen atom jumps from excited state n to the Ground state . The wavelength so emitted illuminates a photosensitive material having work function 2.75 eV. If the stopping potential of the photoelectron is 10 V, then the value of n is

A. 2

B. 3

C. 4

D. 5

Answer: C

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26. 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. 0.65 eV

B. 1.9 eV

C. 11.1 eV

D. 13.6 eV

Answer: C

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27. The wavelength λ and the frequency f of a particular X- ray spectral line varies with the atomic number Z of the target element. In this event , Z is nearly proportional to

A. λ

B. $\sqrt{\lambda}$

C. f

D. $\sqrt{f}$

Answer: D

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28. The ratio of the wavelength of K_{β} and K_{α} spectral lines of hydrogen is

A. $8:27$

B. $16:27$

C. $27:32$

D. $9:16$

Answer: C

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Exercise Very Short Answer Type Questions

1. What is the order of magnitude of the ratio between the volume of an atom and that of its nucleus ?

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2. The nucleus contains the entire ...... charge and nearly the entire.......of an atom. Fill in the blanks

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3. In Rutherford's experiment , which particle is reponsible for the low angle scattering of α-particles ?

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4. Total energy of the electron in the first Bohr orbit of hydrogen atom is -13.6 eV . What are the kinetic and potential energies of the electron ?

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5. Energy of electron in the first excited state of hydrongen atom is -3.4 eV . What is the kinetic energy of this electron ?

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Watch Video Solution

6. What is the ratio of the areas of the first and the second orbits of an hydrogen atom?

Watch Video Solution

7. What is the approximate diameter of a hydrogen atom ?

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8. Energy in the ground state of hydrogen atom is -13.6 eV . What are the energies of its second and third excited states ?

Watch Video Solution

9. If the radius of the first Bohr orbit is r, what would be the radius of the second ?

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10. What is Bohr's quantum condition for the angular momentum of electron in a hydrogen atom ?

Watch Video Solution

11. According to Bohr's model ,what is the ratio between the kinetic energy and the total energy of an electron in its n th quantum state ?

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12. The electron energy in the first Bohr orbit of hydrogen atom is -13.6 eV . What will be the energy of the photon emitted due to electron transition from the second to the first orbit of that atom ?

Watch Video Solution

13. What is the electron velocity in the second orbit of hydrogen atom ?

Watch Video Solution

14. The ionisation energy of a hydrogen atom is 13.6 eV. Estimate the energy required to excite it from its ground state to the next state.

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15. An energy of 13.6 eV is needed to ionise a hydrogen atom. How much energy is to be supplied to the atom to liberate an electron from its n=2 state ?

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16. The radius of the first electron orbit of a hydrogen atom is 5.3×10^{-11}m. what is the radius of its second orbit ?

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Watch Video Solution

17. The total energy of an electron in the first excited state of hydrogen atom is -3.4 eV . What is the potential energy of the electron in this state ?

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18. Name the different types of X- ray spectrum.

Watch Video Solution

19. What is the general name of the spectral line emitted due of transition of an electron from second orbit to first orbit of an atom ?

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20. An electron beam hits a target to produce continuous X-ray spectrum. If E be the kinetic energy of each electron in the beam , what would be the lowest wavelength of the emitted X-rays ?

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21. At which value of the atomic Z of the target element, does Moseley's $\sqrt{f} - Z$ plot of X-rays intersect the Z-axis ?

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Exercise Short Answer Type Questions I

1. Why can the spectral lines of hydrogen atom not be explained by Rutherford's atomic model ?

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2. What is the advantage of using gold rather than other metals in Rutherford's alpha particle scattering experiment ?

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3. In Rutherford experiment ,very few of the alpha particles scatter through large angles. Why ?

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4. What do you mean by energy levels of a hydrogen atom ?

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5. In what sense the spectrum of sodium atom resembles that of hydrogen atom ?

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6. Total energy of any electron bound inside an atom is negative . Why ?

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7. Kinetic energy of an electron decreases with the increases of distance of its orbit from the nucleus. But the total energy increases. Explain why.

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8. A hydrogen atom contains only one electron. But the spectrum of hydrogen atom has many lines . Why ?

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Exercise Short Answer Type Questions Ii

1. The wavelength of a continuous X-ray spectrum cannot be less than a certain value . Explain why.

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2. The electron velocity in the first excited state of a hydrogen atom is v . When it emits a photon, it comes to the ground state and the electron velocity becomes 2v . Justify this increase in electron velocity even if some energy has been taken away by the emitted photon.

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Problem Set I

1. If the principal quantum number of an energy state be n , the energy of a hydrogen atom, $E = -\frac{13.6}{n^2} eV$. Due to transition of electron from n=3 to n=2 level, what will be the energy of the photon emitted ?

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2. If the electron in a hydrogen atom jumps from the second excited state to its ground state, the wavelength of the emitted radiation becomes 1026 Å . Determine the value of Rydberg constant from this data.

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3. Wavelength of a spectral line found in the atomic spectrum of hydrogen is 4861 Å . Between which two quantum states does the transition of electron occur to generate this line ?

Rydberg constant =$1.097 \times 10^7 m^{-1}$.

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4. The difference of energy between the third quantum state and the ground state of hydrogen atom is 12.1 eV . Determine the energy of the ground state.

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5. Radius of the Bohr orbit of hydrogen atom is 0.53 Å . What will be the velocity of the electron in the second quantum state? Given, mass of electron =$9.1 \times 10^{-31} kg$ and $e = 1.6 \times 10^{-19} C$.

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6. If the longest wavelength of Balmer series in the atomic spectrum of hydrogen be 6563 Å , what are the next two consecutive wavelength in that series ?

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7. If radius of the 1 st Bohr orbit of hydrogen atom be 0.53 Å , determine the ground state energy (in eV) of the atom . Given e= $1.6 \times 10^{-19} C$ and $\dfrac{1}{4\pi \in_0} = 9 \times 10^9 N \cdot m^2 \cdot C^{-2}$

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8. In an excited state, the energy of the electron of a hydrogen atom is -0.54 eV. Determine the angular momentum of the electron in this state from Bohr's theory .

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9. Calculate the maximum and minimum wavelengths of Lyman series of hydrogen . R $= 1.097 \times 10^7 m^{-1}$.

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10. If the binding energy of the electron in a hydrogen atom is 13.6 eV, what will be the energy required to remove the electron from the first excited state of Li^{++} ?

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11. The radiation , emitted due to transition of hydrogen atom from the second excited state to ground state, is incident of the surface of sodium metal. The maximum kinetic energy of the emitted photoelectrons is 10.27 eV. What is the work function of sodium? Given, ionisation energy of hydrogen =13.59 eV.

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12. When ultraviolet rays of wavelength 620 Å is incident on a hydrogen atom in the ground state, its electron is emitted with a velocity of $1.5 \times 10^6 m \cdot s^{-1}$. What is the ionisation energy of hydrogen ? Given , h= $6.625 \times 10^{-34} J \cdot s$, mass of electron = $9.1 \times 10^{-31} kg, c = 3 \times 10^8 m \cdot s^{-1}$ and $1eV = 1.6 \times 10^{-19} J$.

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13. The ground state energy of a hydrogen atom is -13.6 eV . The charge of an electron is -1.6×10^{-19}C. Find out the first Bohr radius.

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14. The Rydberg constant for hydrogen is $109737 cm^{-1}$. Find out the lowest wavelength among the spectral lines of Balmer series.

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15. The wavelength of the first member of Balmer series is 6560 Å . Calculate the wavelength of the second member of Lyman series.

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16. If a stream of electrons having kinetic energy 36 keV be incident on a molybdenum target, what will be the cut-off wavelength of the emitted X-ray ?

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17. If 50 kV potential difference is applied across a Coolidge tube, what will be the maximum frequency of X-ray emitted from the tube? $h = 6.6 \times 10^{-34} J \cdot s, e = 1.6 \times 10^{-19} C.$

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18. What should be the minimum value of potential difference to be applied across a Coolidge tube for production of X-rays of wavelength 0.8 Å ?

$h = 6.62 \times 10^{-34} J \cdot s, e = 1.6 \times 10^{-19} C$

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19. Estimate the kinetic energy of electron that hit the target in a Coolidge tube and produce X-ray of wavelength 1 Å . Given $h = 6.62 \times 10^{-34} J \cdot s, c = 3 \times 10^{8} m \cdot s^{-1}.$

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20. In case of hydrogen atom, calculate the wavelength of K_{α} line. Given energy of hydrogen atom in ground state $= -13.6eV, h = 6.63 \times 10^{-34} j \cdot s.$

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Problem Set Ii

1. If the value of Rydberg constant is $1.097 \times 10^{7} m^{-1}$, what will be the wavelengths of the emitted radiations in case of the following transitions in a hydrogen atom ?

(i) From n=5 to n=2

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2. If the value of Rydberg constant is $1.097 \times 10^{7} m^{-1}$, what will be the wavelengths of the emitted radiations in case of the following transitions in a hydrogen atom ?

(ii) From n=5 to n=1

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3. If the value of Rydberg constant is $1.097 \times 10^7 m^{-1}$, what will be the wavelengths of the emitted radiations in case of the following transitions in a hydrogen atom ?

(iii) From n=5 to n=3

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4. If the value of Rydberg constant is $1.097 \times 10^7 m^{-1}$, what will be the wavelengths of the emitted radiations in case of the following transitions in a hydrogen atom ?

(iv) From n=∞ to n=1

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Problem Set Ii Hots Numerical Problems

1. Angular momentum of an electron in an orbit hydrogen atom is $4.2 \times 10^{-34} J \cdot s$. What is the energy of that electron in that orbit? Given mass of an electron = $9.1 \times 10^{-31} kg, e = 1.6 \times 10^{-19} C, 1eV = 1.6 \times 10^{-19} erg.$

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2. Hydrogen atoms in the ground state are excited by means of radiation of wavelength 1026 Å. Find out the wavelength of radiation that this excited atoms can emit when they come back to ground state. Given, $h = 6.625 \times 10^{-34} J \cdot s, c = 3 \times 10^8 m \cdot s^{-1}, 1eV = 1.6 \times 10^{-19} J$ ionisation energy of hydrogen = 13.62 eV.

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3. Among the photoelectrons, emitted due to incidence of light of frequency f on a metal surface , only the electrons having the highest kinetic energy can ionise a hydrogen atom. If this experment is performed with light of frequency $\frac{5}{6}f$, the photoelectron having the highest kinetic energy can excite a hydrogen atom and from this excited hydrogen atom a photon of wavelength 1215 Å is emitted . Determine the (i) work function of the metal and

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4. Among the photoelectrons, emitted due to incidence of light of frequency f on a metal surface , only the electrons having the highest kinetic energy can ionise a hydrogen atom. If this experment is performed with light of frequency $\frac{5}{6}f$, the photoelectron having the highest kinetic energy can excite a hydrogen atom and from this excited hydrogen atom a photon of wavelength 1215 Å is emitted . Determine the

(ii) value of f. Given

$h = 6.625 \times 10^{-34} \cdot s, c = 3 \times 10^8 \cdot s^{-1}, 1eV = 1.6 \times 10^{-19} J,$

ionisation energy of hydrogen =13.62 eV.

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

(i) potential energy in n=4 state

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

(ii) energy absorbed by the atom in transition

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

wavelength of emitted radiation if the atom returns to its original state

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8. The ionisation potential of hydrogen atom is 13.6 eV . An electron in the ground state of hydrogen atom absorbs a photon of energy 12.75 eV. How many different spectral lines can one expect when the electron makes a downward transition ?

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Examination Archive With Solutions Assertion Reason Type

1. Statement I: The total positive charge and almost all the mass of an atom are confined in the nucleus.

Statement II: In Rutherford's α -particle scattering experiment, majority of the α -particles penetrate the target without any deflection.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

A : Statement I is true , statement II is true, statement II is a correct

explanation for statement I.

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

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

Answer: B

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2. Statement I: The circular orbit of the electron as stated in Rutherford's atomic model can never be a stable orbit.

Statement II: Any accelerated charged particle radiates energy.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

B: Statement I is true , statement II is true, statement II is not a

correct explanation for statement I.

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

Answer: A

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3. Statement I: The distance of the electron from the nucleus is minimum when a hydrogen atom is in ground state.

Statement II: According to Bohr's theory the radius of circular motion of an electron in n-th energy state, $r_n \propto n$.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

A : Statement I is true , statement II is true, statement II is a correct

explanation for statement I.

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

C: Statment I is true, statement II is false.

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

Answer: C

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4. Statement I: The kinetic energy of an electron in the first excited state of a hydrogen atom is 6.8 eV.

Statement II: Total energy of first excited state of hydrogen atom is -3.4 eV.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

B: Statement I is true , statement II is true, statement II is not a

correct explanation for statement I.

C: Statment I is true, statement II is false.

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

Answer: D

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5. Statement I: All lines in the Balmer series of hydrogen spectrum are in the visible region.

Statement II: Balmer series is formed due to transition of electrons from 2,3,4.... permitted energy levels to the ground levels.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

Answer: C

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6. Statement I: Ionisation potential of hydrogen atom is 13.6 eV.

Statement II: Ground state energy of hydrogen atom is 13.6 eV.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

A : Statement I is true , statement II is true, statement II is a correct

explanation for statement I.

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

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

Answer: C

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7. Statement I: Magnetic moment of an electron in the n-th orbit of hydrogen atom $\mu_n \propto n$.

Statement II: Magnetic moment of a particle of charge e rotating in an orbit of radius r with velocity v is given by $\mu = \frac{1}{2}evr$.

A. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

B. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

C. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

B: Statement I is true , statement II is true, statement II is not a

correct explanation for statement I.

C: Statment I is true, statement II is false.

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

D. Direction: These question have statement I and statement II. Of the four choices given below , choose the one that best describes the two statements.

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

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

C: Statment I is true, statement II is false.

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

Answer: A

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1. Let $\lambda_{21}, \lambda_{31}$ and λ_{32} be the wavelengths of the spectral lines for transition of electron in the energy levels $2 \rightarrow 1, 3 \rightarrow 1$ and $3 \rightarrow 2$ of an atom. Then

A. $\lambda_{21} > \lambda_{31}$

B. $\lambda_{21} > \lambda_{32}$

C. $\lambda_{31} < \lambda_{32}$

D. $\lambda_{31} > \lambda_{32}$

Answer: A::C

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2. Energy in the second energy state of hydrogen atom is E_2. Then

A. energy in the third energy state of He^{+} ion (Z=2) is $\frac{4}{9}E_2$

B. energy in the ground state He^{+} ion (Z=2) is $16E_2$

C. energy in the third energy state of Li^{2+} ion (Z=3) is $4E_2$

D. energy in the second energy state of Li^{2+} ion (Z=3) is $9E_2$

Answer: B::C::D

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3. The radius of the orbit of an electron in the ground state of hydrogen atom is a_0. Then

A. the radius of the orbit of an electron in the second energy state of He^{+} ion (Z=2) is $2a_0$

B. the radius of orbit of an electron in the third energy state of He^{+} ion (Z=2) is $3a_0$

C. the radius orbit of an electron in the ground state of Li^{2+} ion (Z=3) is $\frac{a_0}{3}$

D. the radius of orbit of an electron in the third energy state of Li^{2+} ion (Z=3) is $3a_0$

Answer: A::C

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4. In hydrogen atom spectrum

A. lines of Balmer series are in the visible region

B. lines of Lyman series are in the ultraviolet region

C. lines of Paschen series are in the ultraviolet region

D. lines of Brackett series are in the infrared region

Answer: B::C::D

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5. In case of X-ray spectrum

A. cut-off wavelength depends on the kinetic energy of the electrons incident on the target

B. cut -off wavelength depends on the material of the target

C. wavelength of K_{α} -line depends on the material of the target

D. wavelength of K_{β} -line is larger than wavelength of K_{α} -line

Answer: A::B::D

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Examination Archive With Solutions Comprehension Type

1. H,He^{+}, Li^{2+} are examples of atoms or ions with one electron each . The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is

$$E_n = \frac{-13.6Z^2}{n^2} eV\left(1eV = 1.6 \times 10^{-19} J\right).$$

For the ground state ,n=1 . in order to raise the atom from the ground state to n=f , the suitable incident light should have a wavelength given by $\lambda = \frac{hc}{E_f - E_1}$. But the atom cannot stay permanently in the f-energy state, ultimately , it comes to the ground state by radiating the extra energy ,$E_f - E_1$ as electromagnetic radiation .

The electron of the atom comes from n=f to n=1 in one or more steps using the permitted energy levels .

As a result there is a possibility of emission of radiation with more than one wavelength from the atom.

Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light $c = 3 \times 10^8 m \cdot s^{-1}$.

(i)What is the wavelength of the light incident on the atom to raise it to the fourth quantum level from ground state ?

A. 952 Å

B. 975 Å

C. 1027 Å

D. 1219 Å

Answer: B

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2. H,He^{+}, Li^{2+} are examples of atoms or ions with one electron each .

The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is $E_n = \frac{13.6Z^2}{n^2}eV\left(1eV = 1.6 \times 10^{-19}J\right)$.

For the ground state ,n=1 . in order to raise the atom from the ground state to n=f , the suitable incident light should have a wavelength given by $\lambda = \frac{hc}{E_f - E_1}$. But the atom cannot stay permanently in the f-energy state, ultimately , it comes to the ground state by radiating the extra energy ,$E_f - E_1$ as electromagnetic radiation .

The electron of the atom comes from n=f to n=1 in one or more steps using the permitted energy levels .

As a result there is a possibility of emission of radiation with more than one wavelength from the atom.

Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light

$c = 3 \times 10^8 m \cdot s^{-1}$.

(ii) Radiations of how many wavelengths are possible in case of the excited atom in the example I to come to ground state?

A. 2

B. 3

C. 6

D. 9

Answer: C

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3. H,He^+, Li^{2+} are examples of atoms or ions with one electron each . The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is $E_n = \frac{13.6Z^2}{n^2} eV(1eV = 1.6 \times 10^{-19} J)$.

For the ground state ,n=1 . in order to raise the atom from the ground state to n=f , the suitable incident light should have a wavelength given by $\lambda = \frac{hc}{E_f - E_1}$. But the atom cannot stay permanently in the f-energy state, ultimately , it comes to the ground state by radiating the extra energy ,$E_f - E_1$ as electromagnetic radiation .

The electron of the atom comes from n=f to n=1 in one or more steps using the permitted energy levels .

As a result there is a possibility of emission of radiation with more than one wavelength from the atom.

Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light $c = 3 \times 10^8 m \cdot s^{-1}$.

(iii) What is the value of the maximum wavelength in example (ii) ?

A. 952 Å

B. 975 Å

C. 6577 Å

D. 18830 Å

Answer: D

View Text Solution

4. H,He^+, Li^{2+} are examples of atoms or ions with one electron each .

The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is

$E_n = \frac{13.6Z^2}{n^2} eV \left(1eV = 1.6 \times 10^{-19} J\right).$

For the ground state ,n=1 . in order to raise the atom from the ground state to n=f , the suitable incident light should have a wavelength given by $\lambda = \frac{hc}{E_f - E_1}$. But the atom cannot stay permanently in the f-energy state, ultimately , it comes to the ground state by radiating the extra energy ,$E_f - E_1$ as electromagnetic radiation .

The electron of the atom comes from n=f to n=1 in one or more steps using the permitted energy levels .

As a result there is a possibility of emission of radiation with more than one wavelength from the atom.

Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light $c = 3 \times 10^8 m \cdot s^{-1}$.

(iv) What is the value of the minimum wavelength in example (ii) ?

A. 952 Å

B. 975 Å

C. 6577 Å

D. 18830 Å

Answer: B

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5. H,He^{+}, Li^{2+} are examples of atoms or ions with one electron each . The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is $E_n = \frac{-13.6Z^2}{n^2}eV\left(1eV = 1.6 \times 10^{-19}J\right)$.

For the ground state ,n=1 . in order to raise the atom from the ground state to n=f , the suitable incident light should have a wavelength given by $\lambda = \frac{hc}{E_f - E_1}$. But the atom cannot stay permanently in the f-energy state, ultimately , it comes to the ground state by radiating the extra energy ,$E_f - E_1$ as electromagnetic radiation .

The electron of the atom comes from n=f to n=1 in one or more steps using the permitted energy levels .

As a result there is a possibility of emission of radiation with more than one wavelength from the atom.

Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light $c = 3 \times 10^{8} m \cdot s^{-1}$.

Energy of which quantum state of He^{+} ion will be equal to the ground level energy of hydrogen ?

A. n=1

B. n=2

C. n=3

D. n=4

Answer: B

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The wavelength of radiation emitted for the transition of the electron of He^+ ion from n=4 to n=2 is

A. 952 Å

B. 975 Å

C. 1027 Å

D. 1219 Å

Answer: D

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7. H,He^{+}, Li^{2+} are examples of atoms or ions with one electron each . The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is $E_n = \frac{13.6Z^2}{n^2}eV\left(1eV = 1.6 \times 10^{-19}J\right)$.

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Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light $c = 3 \times 10^8 m \cdot s^{-1}$.

For what wavelength of incident radiation He^+ ion will be raised to fourth quantum state from ground state?

A. 243.7 Å

B. 487.5 Å

C. 731.2 Å

D. 975 Å

Answer: A

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8. H,He^+, Li^{2+} are examples of atoms or ions with one electron each . The energy of such atoms when in the n-th energy state (according to Bohr,s theory , n=1,2,3.... =principal quantum number) is $E_n = \frac{13.6Z^2}{n^2} eV \left(1eV = 1.6 \times 10^{-19} J\right)$.

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As a result there is a possibility of emission of radiation with more than one wavelength from the atom.

Planck's constant $= 6.63 \times 10^{-34} J \cdot s$ and velocity of light $c = 3 \times 10^8 m \cdot s^{-1}$.

Which among the following differences in the energy levels for a Li^{2+} ion is minimum ?

A. $E_2 - E_1$

B. $E_3 - E_2$

C. $E_3 - E_1$

D. $E_4 - E_3$

Answer: D

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Examination Archive With Solutions Integer Answer Type

1. What is the ratio of kinetic energy of electrons rotating in the ground state to that in the first excited state of an atom ?

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2. What is the ratio of the frequency of electrons rotating in the ground state to that in the first excited state of an atom?

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3. What is the ratio of energy of the ground state of hydrogen atom and energy of the first excited state of He^{+} ion (Z=2) ?

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4. The electron in a hydrogen atom is in the third energy state. How many different frequencies can the emitted photon have ?

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5. The ionisation potential hydrogen atom is 13.6 V. when the atom is in n-th energy state. The maximum energy of the emitted photon is 12.1eV . What is the value of n?

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6. What is the ratio of frequencies of the spectral lines of hydrogen atom for transition form $4 \rightarrow 1 \text{ and } 4 \rightarrow 2$?

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7. On absorption of radiation of wavelength 1219 Å, a hydrogen atom is excited from ground state to the n-th energy state. What is the value of n?

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8. What is the ratio of frequencies of K_α -lines in the X-ray spectra of sodium (Z=11) and carbon (Z=6) ?

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1. In which part of the electromagnetic spectrum do the spectral lines of hydrogen atom as given by Balmer series occur?

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2. The energy of a hydrogen atom in a given orbit is -3.4 eV . Find the radius of the orbit .

$\left[\text{given}, e = -1.610^{-19} C, m_e = 9.1110^{-31} kg, \frac{h}{2\pi} = 1.055 \times 10^{-34} J \cdot s, \right.$

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3. The total energy of an electron for any particular energy level in hydrogen atom is -1.51 eV. The value of principal quantum number of the energy level is

A. n=1

B. n=2

C. n=3

D. n=4

Answer: C

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4. State Bohr's quantum condition in connection with the hydrogen atom.

What is the value of Bohr's radius in SI system ?

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5. The ratio of minimum wavelength of Lyman and Balmer series in hydrogen spectrum will be

A. 10

B. 5

C. 0.25

D. 1.25

Answer: C

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6. The energy of an excited hydrogen atom is -1.51 eV. Determine the angular momentum of the electron according to Bohr's hypothesis.

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7. State the postulates of Bohr's model of hydrogen atom .

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8. The voltage applied across the cathode and anode of an X-ray generating machine is 50000V. Determine the shortest wavelength of the X-ray emitted. Given $h = 6.62 \times 10^{-34} J \cdot s.$

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9. What will be the wavelength of the light emitted due to a transition of electron from n=3 orbit to n=2 orbit in hydrogen atom ? Given : in the

Rydbeg constant for hydrogen atom is $R_H = 1.09 \times 10^7 m^{-1}$.

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10. Using Bohr's postulates of atomic model , derive the expression for the radius of the n-th orbit.

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11. What is ionisation energy of atom ? What is the value of it for hydrogen atom ?

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12. If V be the accelerating voltage, then the maximum frequency of X-ray emitted from an X-ray tube is

A. $\frac{eh}{V}$

B. $\frac{eV}{h}$

C. $\frac{h}{eV}$

D. none of these

Answer: B

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Examination Archive With Solutions Wbjee

1. The ionisation energy of hydrogen is 13.6 eV. The energy of the photon released when an electron jumps from the first excited state (n=2) to the ground state of a hydrogen atom is

A. 3.4 eV

B. 4.53 eV

C. 10.2 eV

D. 13.6 eV

Answer: B

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2. A photon of wavelength 300 nm interracts with a stationary hydrogen atom in ground state. During the interaction, whole energy of the photon I transferred to the electron os the atom. State which possibility is correct. (Consider,Planck's constant $= 4 \times 10^{-15} eV \cdot s$, velocity of light $= 3 \times 10^8 m / s$, ionisation energy of hydrogen =13.6 eV.

A. electron will be knocked out of the atom

B. electron will go to any excited state of the atom

C. electron will go only to first excited state of the atom

D. electron will keep orbiting in the ground state of atom

Answer: D

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3. The number of Broglie wavelengths contained in the second Bohr orbit of Hydrogen atom is

A. 1

B. 2

C. 3

D. 4

Answer: B

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4. The wavelength of second Balmer line in Hydrogen spectrum is 600 nm. The wavelength for its third line in Lymann series is

A. 800 nm

B. 600 nm

C. 400 nm

D. 120 nm

Answer: D

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5. Let v_n and E_n be the respective speed and energy of an electron in the n-th orbit radius r_n in a hydrogen atom, as predicted by Bohr's model . Then

A. plot of $E_n r_n / E_1 r_1$ as a function of n is a straigth line of slope 0

B. plot of $r_n v_n / r_1 v_1$ as a function of n is a straight line of slope 1

C. plot of 1n $\frac{r_n}{r_1}$ as a function of $\ln(n)$ is a straight line of slope 2

D. plot of 1n $\left(\frac{r_n E_1}{E_n r_1}\right)$ as a function of 1n (n) is a straight line of slope 4

Answer: A::B::C::D

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6. How the linear velocity v of an electron in the Bohr orbit is related to its quantum number n ?

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

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

C. $v \propto \frac{1}{\sqrt{n}}$

D. $v \propto n$

Answer: A

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Examination Archive With Solutions Jee Main

1. The radiation corresponding to $3 \rightarrow 2$ transition of hydrogen atom falls on a metal surface to produce photoelectron . These electrons are made to enter a magnetic field of 3×10^{-4} T. if the radius of the largest circular path followed by these electrons in 10/0 mm, the work function of the metal is close to

A. 1.6 eV

B. 1.8 eV

C. 1.1 eV

D. 0.8 eV

Answer: C

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2. Hydrogen $\left({}_1^1H\right)$ deuterium $\left({}_1^2H\right)$, singly ionised helium $\left({}_2^4H\right)^+$ and doubly ionised lithium $\left({}_3^6Li\right)^{++}$ all have one electron around the nucleus. Consider an electron transition from n=2 to n=1 . If the wavelengths emitted radiation are $\lambda_1, \lambda_2, \lambda_3$ and λ_4 respectively then approximately which one of the following is correct?

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

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

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

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

Answer: D

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3. 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 decrease

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

D. kinetic energy and total energy decrease but potential energy increase

Answer: A

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4. An electron beam is accelerted by a potential difference V to hit a metallic target ot produce X-ray . It produces continuous as well as characteristic X-rays. If $\lambda_{\min}$ is the smallest possible wavelength of X-ray in the spectrum, the variation of log $\lambda_{\min}$ with log V is correctly represented in

A.

B.

C.

D.

Answer: A

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5. Some energy levels of a molecule are shown in the figure.

The ratio of the wavelengths r $= \lambda_1 / \lambda_2$ is given by

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

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

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

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

Answer: D

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6. If the series limit frequency of the Lyman series is ν_L, then the series limit frequency of the Pfund series is

A. $\frac{\nu_L}{16}$

B. $\frac{\nu_L}{25}$

C. $25\nu_L$

D. $16\nu_L$

Answer: B

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7. An electron from various excited states of hydrogen atom emit radiation to come to the ground state. Let λ_n, λ_g be the de Broglie wavelength of the electron in the n-th state and the ground state respectively. Let Λ_n be the wavelength of the emitted photon in the transition from the n-th state to the ground state. For large n,(A,B are constants)

A. $\Lambda_n^2 \approx A + B\lambda_n^2$

B. $\Lambda_n^2 \approx \lambda$

C. $\Lambda_n \approx A + \frac{B}{\lambda_n^2}$

D. $\Lambda_n \approx A + B\lambda_n$

Answer: C

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Examination Archive With Solutions Aipmt

1. 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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2. Consider 3rd orbit of He^{+} (Helium), using non-relativistic 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 $\times 10^{-34} J \cdot s$]

A. $2.92 \times 10^{6} m/s$

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

C. $0.73 \times 10^{6} m/s$

D. $3.0 \times 10^{8} m/s$

Answer: B

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Examination Archive With Solutions Neet

1. Given the value of Rydberg constant is $10^7 m^{-1}$, the wave number of the last 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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2. If the longest wavelength in the ultraviolet region of hydrogen spectrum is λ_0 then the shortest wavelength in its infrared region is

A. $\frac{46}{7}\lambda_0$

B. $\frac{20}{3}\lambda_0$

C. $\frac{36}{5}\lambda_0$

D. $\frac{27}{4}\lambda_0$

Answer: D

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3. The ratio of kinetic energy of the total energy of an electron in a Bohr orbit of the hydrogen atom, is

A. $2 : -1$

B. $1 : -1$

C. $1 : 1$

D. $1 : -2$

Answer: B

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