RAVI TEST PAPERS & NOTES, WHATSAPP 8056206308

12. Atoms previously asked

12th Standard

Physics

Multiple Choice Question 7 x 1 = 7

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

(a) 5.1 V (b) 12.1 V (c) 17.2 V (d) 7 V

2) What is the diameter of ${}_2Be^4$ in its ground state? Given Bohr radius of hydrogen atom is 53 pm.

(a) 53 pm (b) 26.5 pm (c) 1.6 pm (d) 100 pm

3) The energy of a hydrogen atom in the ground state is -13.6 eV. The energy of a He^+ ion in the first excited state will be

(a) -13.6 eV (b) -27.2 eV (c) -54.4 eV (d) -6.8 eV

4) The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is an

(a) isotope of parent (b) isobar of parent (c) isomer of parent (d) isotone of parent

5) In Balmer series of hydrogen atom, as the wavelength of spectral lines decreases, they appear

(a) equally spaced and equally intense. (b) further apart and stronger in intensity.

(c) closer together and stronger in intensity. (d) closer together and weaker in intensity.

6) The radius of the innermost electron orbit of a hydrogen atom is 5.3 x 10^{-11} m.The radius of the n = 3 orbit is

(a) 1.01 x 10^{-10} m (b) 1.59 x 10^{-10} m (c) 2.12 x 10^{-10} m (d) 4.77 x 10^{-10} m

7) In the α-particle scattering experiment, the shape of the trajectory of the scattered α-particles depend upon

(a) only on impact parameter (b) only on the source of α-particles

(c) Both impact parameter and source of α-particles (d) impact paramerer and the screen material of the detector

2 Marks 45 x 2 = 90

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

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

10) What is the ratio of radii of orbits corresponding to first excited state and ground state in a hydrogen atom?

11) Defina distance of closest approach and impact parameter.

12) The energy of electron in ground state of hydrogen atom is -13.6 eV. How much energy is required to take an electron in this atom from the ground state to first excited state.

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

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

15) If elements with principal quantum number n > 4 did not exist in nature, what would be the possible number of elements?

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

17) In H-atom, an electron undergoes transition from second excited state to the first excited state and then to the ground state. Find out the ratio of the wavelengths of the emitted radiations in the two cases.

18) Calculate the shortest wavelength in the Balmer series of hydrogen atom. In which region (infrared, visible, ultraviolet) of hydrogen spectrum does this wavelength lie?

19) Imagine removing one election from He^4 and He^3.Their energy levels, as worked out on the basis of Bohr's model will be very close. Explain why?

20) When is H_α -line of the Balmer series in the emission spectrum of H-atom obtained?

21) What is the maximum number of spectral line emitted by a hydrogen atom when is in the line third excited state?

22) Using Bohr's postulates of the atomic model, derive the expression for radius of nth electron orbit. Hence obtain the expression for Bohr's radius.

23) In the first excited state of hydrogen atom, its radius is found to be 21.2×10^{-11} m. Calculate its Bohr radius in the ground state. Also, calculate the total energy of the atom in the second excited state.

24) Calculate the wavelength of the first spectral line in the corresponding Lyman series of this atom.

25) Write any two characteristic properties of nuclear force

26) Using Rutherford's model of the atom, derive the expression for the total energy of the electron in H-atom. What is the significance of total negative energy possessed by the electron?

27) What is the relationship between the half-life and mean life of a radioactive nucleus?

28) A nucleus undergoes β-decay. How does its
(i) mass number and
(ii) atomic number change?

29) A nucleus $^{238}_{92}U$ undergoes α-decay and transforms to thorium. What is
(i) the mass number and
(ii) atomic number of the nucleus produced?

30) A radioactive nucleus A undergoes a series of decays according to the following scheme
$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$
The mass number and atomic number of A_4 are 172 and 69, respectively. What are these numbers for A?

31) Why is the classical (Rutherford) model for an atom of electron orbitting around the nucleus not able to explain the atomic structure?

32) State Bohr's quantisation condition for defining stationary orbits.

33) State Bohr's postulate of quantisation of angular momentum of the orbiting electron in hydrogen atom.

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

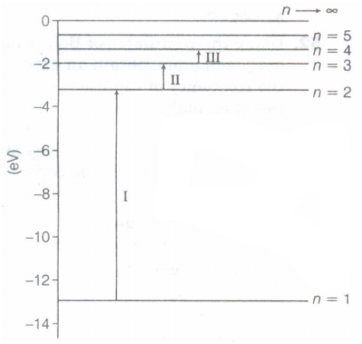
35) Calculate the de-Broglie wavelength of the electron orbiting in the n = 2 states of hydrogen atom

36) Use de-Broglie's hypothesis to write the relation for the nth radius of Bohr orbit in terms of Bohr's quantization condition of orbital angular momentum.

37) An α-particle moving with initial kinetic energy K towards a nucleus of atomic number Z approaches a distance d at which it reverses its direction. Obtain the expression for the distance of closest approach d in terms of the kinetic energy of α-particle K

38) (i) In the hydrogen atom, an electron undergoes the transition from second excited state to the first excited state and then to the ground state. Identify the spectral series to which these transitions belong.
(ii) Find out the ratio of the wavelengths of the emitted radiations in the two cases.

39) Photons with a continuous range of frequencies are made to pass through a sample of rarefied hydrogen. The transitions shown here indicate three of the spectral absorption lines in the continuous spectrum.

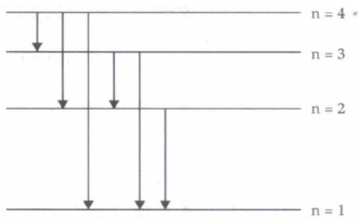


(i) Identify the spectral series of the hydrogen emission spectrum to which each of these three lines correspond.
(ii) Which of these lines corresponds to the absorption of radiation of maximum wavelength?

40) The electron, in a hydrogen atom, is in its second excited state. Calculated the wavelength of the lines in the Lyman series, that can be emitted through the permissible transitions of this electron. (Given the value of Rydberg constant, $R = 1.1 \times 10^7\ m^{-1}$)

41) An ∝-particle and a proton are accelerated through the same potential difference. Calculate the ratio of linear momenta acquired by the two.

42) The figure shows energy level diagram of hydrogen atom.
(i) Find out the transition which results in the emission of a photon of wavelength 496 nm.



(ii) Which transition corresponds to the emission of radiation of maximum wavelength? justify your answer.

43) Find the ratio of energies of photons produced due to transition of an electron of H-atom from its
(a) the highest permitted energy level to the first permitted level

44) In the ground state ofH-atom, its Bohr radius is given as 5.3×10^{-11}m. The atom is excited such that the radius becomes 21.2×10^{-1}m. Find
(i) the value of the principal quantum number and
(ii) the total energy of the atom in this excited state.

45) 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, then calculate the wavelength of the spectral line emitted and name the serres of hydrogen spectrum to which it belongs.

46) An electron jumps from fourth.to first orbit in an atom. How many maximum number of spectral lines can be emitted by the atom? To which series these lines correspond?

47) What is the minimum energy that must be given to a H-atom in ground state so that it can emit an H_γ - line in Balmer series? If the angular momentum of the system is conserved, what would be the angular momentum of such \mathrm{H}_\gamma H_γ photon?

48) Find the ratio between the wavelengths of the 'most energetic' spectral lines in the Balmer and Paschen series of the hydrogen spectrum.

49) In the Rutherford scattering experiment, the distance of closest approach for an a-particle is d_0. If an a-particle is replaced by a proton, how much kinetic energy in comparison to a-particle will it require to have the same distance of closest approach d_0?

50) A proton strikes another proton at rest. Assume impact-parameter to be zero, i.e. head-on collsion. How close will the incident proton go to other proton?

51) Write two important limitations of Rutherford nuclear model of the atom.

52) Define ionization energy. How would the ionization energy change when electron in a hydrogen atom is replaced by a particle of mass 200 times that of the electron but having the same charge?

3 Marks 38 x 3 = 114

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

54) At what speed must an electron revolve around the nucleus of hydrogen atom so that it may not be pulled into the nucleus by electrostatic attraction? Given, mass of electron $=9.1\times10^{-31}$, radius of orbit $=0.5\times10^{-10}m$ and $e=1.6\times10^{-19}C$.

55) Calculate longest wavelength of Paschen series.
Given $R=1.097\times107m-1R=1.097\times107m-1$.

56) The wavelength of H_β line of Balmer series is $4861\mathring{A}$. Calculate the wavelength of H_α line of series.

57) (i) The radius of the innermost electron orbit of a hydrogen atom is $r_1=5.3\times10^{-11}$ Calculate its radius in n=2 orbit.
(ii) The total energy of an electron in the second excited state of the hydrogen atom is -1.51eV. Find out its
(a) kinetic energy and
(b) potential energy in this state

58) At atomic power nuclear reactor can deliver 300 MW. The energy released due to fission of each nucleus of uranium atoms U^{238} is 170 MeV. What will be the number of atoms fissioned per hour?

59) In the study of Geiger-Marsdon experiment on the scattering of α-particles by a thin foil of gold, draw the trajectory of α -particles in the coulomb field of target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study. From the relation $R=R_0A^{1/3}$,Where R_0 is constant and A is the mass number of the nucleus, showing that nuclear matter density is independent of A.

60) Nuclei with magic number of protons Z = 2,8,20,28,50,52 and magic number of neutrons N = 2,8,20,28,5082 and 126 are found to be very stable.
(i) Verify this by calculating the proton separation energy S_p for $120_{Sn}(Z=50)$ and $121_{Sn}(Z=51)$ .The proton separation energy for a nuclide is the minimum energy required to separate the least tightly bound proton from a nucleus of that nuclide.It is given by
$S_P=(M_{Z-1,N}+M_H-M_{Z,N})c^2$
$given, 119_{In}=118.9058\ u,$
$120_{Sn}=119.902199\ u,$
$121_{Sb}=120.903824\ u,$
$1_H=1.0078252u$
(ii) What does the existence of magic number indicate?

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

62) (a) Define the term 'activity' of a sample of radioactive nucleus.Write its S.I unit
(b) The half life of $^{238}_{92}U$ undergoing $\alpha-$decay is 4.5×10^9. Determine the activity of 10g sample of $^{238}_{92}U$.Given that 1 g of $^{238}_{92}U$ contains 25.3×10^{20} atoms.

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64) (a) The radius of the innermost electron orbit of a hydrogen atom is 5.3 x 10^{-11} m. Calculate its radius in n = 3 orbit.
(b) The total energy of an electron in the first excited state of the hydrogen atom is -3.4 eV. Find out its
(i) kinetic energy and
(ii) potential energy in this state.

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(i) kinetic energy and
(ii) potential energy in this state.

66) The sequence of stepwise of a radioactive nucleus is $D\overset{\alpha}{\rightarrow}D_1\overset{\beta^-}{\rightarrow}D_2$. If the atomic number and mass number of D_2 are 71 and 176 respectively, what are their corresponding values for D?

67) The value of ground state energy of hydrogen atom is 13.-6 eV.
(i) Find value of required to move an electron from the ground state to the first excited state of the atom.
(ii) Determine (a) the kinetic energy and (b) orbital radius in the first excited state of the atom. (The value of Bohr radius $=0.53\mathring{A}$)

68) Show that the electron revolving around the nucleus in a radius 'r' with orbital speed 'v' has magnetic movement evr/2.
Hence, using Bohr's postulate of the quantization of angular momentum, obtain the expression for the magnetic of hydrogen atom in its ground state.

69) (a) Using de Broglie's hypothesis, explain with the help of a suitable diagram, Bohr's second postulate of quantization of energy levels in a hydrogen atom.
(b) The ground state energy of hydrogen atom is -13.6 eV. What are the kinetic and potential energies of the electron in this state?

70) A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. Upto which energy level the hydrogen atoms would be excited? Calculate the wavelength of the first member of Lyman and first member of Balmer series.

71) (i) 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.
(ii) Write the basic nuclear processes underlying β^+ and β^- decays.

72) The electron in a given Bohr orbit has a total energy of - 1.5 eV. Calculate its
(i) kinetic energy
(ii) potential energy
(iii) the wavelength of radiation emitted, when this electron makes a transition to the ground state.
[Given, energy in the ground state = - 13.6 eV and Rydberg's constant = $1.09 \times 10^7 m^{-1}$]

73) Using postulates of Bohr's theory of hydrogen atom, show that
(i) radii of orbits increases as n^2 and
(ii) the total energy of electron increases as $1/n^2$ where n is the principal quantum number of the atom.

74) Draw a schematic arrangement of the Geiger-Marsden experiment for studying a-particle scattering by a thin foil of gold. Describe briefly by drawing trajectories of the scattered a-particles. How can this study be used to estimate the size of the nucleus?

75) State the basic assumption of the Rutherford model of the atom. Explain in brief why this model cannot account for the stability of an atom?

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

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

78) (i) In H-atom, an electron undergoes transition from second excited state to the first excited state and then to the ground state. Identify the spectral series to which these transitions belong.
(ii) Find out the ratio of the wavelengths of the emitted radiations in the two cases.

79) A12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. Upto which energy level the H-atoms would be excited? Calculate the wavelengths of the first member of Lyman and first member of Balmer series.

80) In an experiment on a-particle scattering by a thin foil of gold, draw a plot showing the number of particles scattered versus the scattering angle θ.
Why is it that a very small fraction of the particles are scattered at $\theta > 90°$?
Write two important conclusions that can be drawn regarding the structure of the atom from the study of this experiment.

81) Consider energy level diagram of a hydrogen atom. How will the kinetic energy and potential energy of electron vary if the electron moves from a lower level to a higher level?

82) Using the postulates of Bohr's model of hydrogen atom, obtain an expression for the frequency of radiation emitted when the atom makes a transition from the higher energy state with quantum number ni to the lower energy state with quantum number n_f ($n_f < n_i$).

83) A single electron orbits around a stationary nucleus of charge +Ze, where Z is a constant and e is the magnitude of electronic charge. It requires 47.2 eV to excite the electron from the second to the third Bohr orbit. Find the value of Z.

84) Using Bohr's postulates, obtain the expressions for (i) kinetic energy and (ii) potential energy of the electron in stationary state of hydrogen atom.
Draw the energy level diagram showing how the transitions between energy levels result in the appearance of Lyman series.

85) If the energy of an electron in H-atom is $\frac{-13.6}{n^2}$eV. Then using above expression show that (a) an electron cannot have energy of- 2V (b) spacing between energy levels decreases as n increases.

86) Using Rydberg's formula, calculate the longest wavelengths belonging to Lyman and Balmer series. In which region of hydrogen spectrum do these transitions lie? [Given R = 1.1×10^7 m^{-1}]

87) Draw the graph showing variation of scattered particles detected (N) with the scattering angle (θ) in Geiger-Marsden experiment. Write two conclusions that you can draw from this graph. Obtain the expression for the distance of closest approach in this experiment.

88) Explain briefly how Rutherford scattering of α-particle by a target of nucleus can provide information on the size of the nucleus?

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

90) A hydrogen atom in the ground state is excited by an electron beam of 12.5 eV energy. Find out the maximum number of lines emitted by the atom from its excited state.

5 Marks 7 x 5 = 35

91) The half-life of ${}_{92}U^{238}$against $\alpha - decay$is $4.5 \times 10^9 years$. What is the activity of 1g sample of ${}_{92}U^{238}$?

92) Suppose India had a target of producing by 2020 AD, 200000 MW of electric power, 10% of which was to be obtained from nuclear power plants. 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 would our country need per year by 2020? Take the heat energy per fission of ${}^{235}U$ to be about 200 MeV.

93) Rakesh thought what would happen when performing the alpha-particle scattering experiment by using a thin sheet of should hydrogen in place of the foil. Hydrogen is a solid at temperatures below 14 k. He contacted his friend Rajesh for its answer. Rajesh explained him that in such case, no large angle of scattering of alpha particle is possible. Because hydrogen atom is a proton having mass of only 1.67×10^{-27}kg, while mass of alpha-particle is 6.64×10^{-27} kg, i.e., four times of mass of proton so the scattering particle is more massive than the target nucleus, thus the alpha-particle would not bounce back for a head on collision.
(a) What values are displayed by Rajesh?
(b) The ground state energy of hydrogen atom is -13.6 V. What are kinetic and potential energies of electron in this state?

94) In the ground state of H-atom, its Bohr radius is given as 5.3×10^{-11}m. The atom is excited such that the radius becomes 21.2×10^{-11}m. Find (i) the value of the principal quantum number and (ii) the total energy of the atom in this excited state.

95) Write shortcomings of Rutherford atomic model. Explain how these were overcome by the postulates of Bohr's atomic model?

96) Prove that the magnetic moment of the electron revolving around a nucleus in an orbit of radius r with orbital speed v is equal to evr/2. Hence using Bohr's postulate of quantisation of angular momentum, deduce the expression for the magnetic moment of hydrogen atom in the ground state.

97) (i) In Geiger-Marsden experiment, caleulate the distance of closest approach for an alpha particle with energy 2.56 x 10^{-12} J. Consider that the particle approaches gold nucleus (Z=79) in head-on-position.

(ii) In the above experiment is repeated with a proton of the same energy, then what will be the value of the distance of closest approach?

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