PREVIOUS HSE QUESTIONS FROM THE CHAPTER "STRUCTURE OF ATOM"

1. Write any two important results observed during photoelectric effect.
2. Represent the orbitals with the following quantum numbers :
   (i) n = 2, l = 1 (1)
   (ii) n = 5, l = 0 (1)
3. (i) Write the important observations made by Rutherford in his ?-particle scattering experiment. (2)
   (ii) What are the important postulates of Rutherford's nuclear model of atom. (2)
4. (i) State Heisenberg's Uncertainty Principle. Give its mathematical expression. (2)
   (ii) What will be the wavelength of a ball of mass 0.1 kg moving with a velocity of 10 m/s ?
   ($h = 6.626 \times 10^{-34}$ Js) (2) [December 2021]
5. Write the orbital representation for the following quantum numbers :
   (a) n = 3, l = 1
   (b) n = 5, l = 0
6. Identify the correct electronic configuration of Cu (z = 29) from the following and give reason for your answer.
   (a) Cu – $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$
   (b) Cu – $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ 4s^2$
7. (i) State Heisenberg uncertainty principle. (2)
   (ii) Name any four spectral lines of hydrogen atom. (2)
8. (i) Write the conclusions of Rutherford Alpha ray scattering experiment. (2)
   (ii) Write two demerits of Rutherford atom model. (2) [September 2021]
9. The quantum number which gives the energy of an electron in an atom is …….
   (a) Principal quantum number (b) Azimuthal quantum number (c) Magnetic quantum number (d) Spin quantum number (1)
   (b) What is photoelectric effect? (2)
   (c) (a) Sketch the shape of 2s orbital. (1)
   (a) State Pauli's exclusion principle. (1)
   (b) Write the values of all quantum numbers for the last electron in sodium atom. (2) [December 2020]
   (d) The number of radial nodes of 4p orbital is ……………
   (a) 1 (b) 2 (c) 3 (d) 4 (1)
   (e) Write any two characteristic properties of canal rays. (2)
   (f) (a) Write the n and l values of a 4d electron. (1)
   (b) Give the names of series of spectral lines of atomic hydrogen and their region in the electromagnetic spectrum. (2)
   (c) State Hund's rule of maximum multiplicity. (1) [March 2020]
   (g) Represent the orbital with quantum numbers n = 5 and l = 3. (1)
   (h) The threshold frequency for a metal is $7.0 \times 10^{14}\ s^{-1}$. Calculate the kinetic energy of an emitted electron when radiation of frequency (v) $1.0 \times 10^{15}\ s^{-1}$ hits the metal. (2)
   (i) What are the important observations and conclusions made by Rutherford from his alpha ray scattering experiment? Give any two limitations of Rutherford's nuclear model of atom. (4) [July 2019]

(j) The minimum value for the product of uncertainties in position and momentum of a moving microscopic particle is equal to .... (1)

(k) Mention two observations which could not be explained by wave nature of electromagnetic radiations. (2)

(l) Explain quantum numbers. Give the importance of quantum numbers in Pauli's Exclusion Principle. (4) [March 2019]

(m) Name the quantum number which gives the spatial orientation of an orbital with respect to standard set of co-ordinate axes. (1)

(n) Write two important results observed during photoelectric effect. (2)

(o) Explain how, the different series of lines are formed in the hydrogen spectrum. Derive an equation to find the wave number of a line in the hydrogen spectrum. (4) [August 2018]

(p) How many angular nodes are present in a 5f-orbital? (1)

(q) Represent graphically, the variation of probability density ($\psi^2_{(r)}$) as a function of distance (r) of the electron from the nucleus for 1s and 2s orbitals.(2)

(r) Give the postulates of Bohr model of hydrogen atom. Also write two merits and two limitations of this model. (4) [March 2018]

(s) a) Cathode rays are rays moving from cathode to anode. Give any two properties of cathode rays. (2)

b) Write the electronic configuration of Cr. (1)

c) Draw the shapes of s and p orbitals. (2) [July 2017]

(t) a) i) Write the electronic configuration of chromium (z = 24) (1)

ii) Find the number of electrons in the subshell with azimuthal quantum number l =2. (1)

iii) Represent the orbital with quantum numbers n = 1 and l = 0 (1)

b) Give the mathematical representation of Heisenberg's uncertainty principle and its one important significance. (2) [March 2017]

(u) Bohr was the first to explain the structure of hydrogen atom and spectrum.

a) Give the main postulates of Bohr model of atom. (2)

b) Calculate the wavelength of the first line in Lyman series of the hydrogen spectrum (R = 109677 cm^{-1}). (3)

(v) a) There are some rules governing the filling of electron in orbitals. State and explain Hund's rule of maximum multiplicity. (2)

b) Quantum number gives the address of electrons. Explain the quantum number which determines:

i) Distance of electron from nucleus.

ii) The orbital angular momentum of electron. (3) [September 2016]

(w) Atomic orbitals are precisely distinguished by what are known as Quantum numbers.

a) Name the four quantum numbers. (2)

b) Represent the orbitals given below:

i) n = 1, l = 0 ii) n = 2, l = 1 (2)

c) The number of unpaired electrons present in Ni is .... (Atomic number of Ni = 28)

i) 2 ii) 0 iii) 1 iv) 3 (1) [March 2016]

(x) The quantum numbers provide / valuable information regarding electrons in an atom.

a) Which one of the following statements is CORRECT about quantum numbers?
   i) The principal quantum number can have fractional values.
   ii) The azimuthal quantum number defines the three dimensional shape of the orbital.
   iii) The magnetic quantum number determines the size of the orbital.
   iv) Spin quantum number gives information about the spatial orientation of the orbital with respect to standard set coordinate axes. (2)

b) A photon has a wavelength of 3.5 A^0. Calculate its mass (Given h = 6.626 x 10^{-34} Js. Velocity of light = 3 x 10^8 m/s) (2)

(y) The uncertainty principle contributed significantly in the formulation of the quantum mechanical model of atom.

a) Which one of the following statements is CORRECT about the uncertainty principle?
   i) The exact position and the exact momentum of an electron in an atom can be determined simultaneously.
   ii) It is a consequence of the dual behavior of matter and radiation.
   iii) It is significant only for motion of microscopic objects and is negligible for that of macroscopic objects.
   iv) It supports the existence of definite paths or trajectories of electrons and other similar particles. (1)

b) An electron is moving with a velocity of 2.5 x 10^6 m/s. If the uncertainty in its velocity is 0.1%. Calculate the uncertainty in its position. (Planck's constant, h = 6.626 x 10^{-34} Js. Mass of the electron = 9.1 x 10^{-31} kg). [October 2015]

(z) a) The number of protons, electrons and neutrons in a species are equal to 17, 18 and 18 respectively. Which of the following will be the proper symbol of this species?
   i) ${}_{17}{}^{35}Cl$ ii) ${}_{17}{}^{35}Cl^-$ iii) ${}_{17}{}^{36}Cl$ iv) ${}_{17}{}^{36}Cl^-$ (1)

b) i) Give any 2 postulates of Rutherford's nuclear model of an atom. (2)
   ii) Write the two main drawbacks of Rutherford's atomic model. (2)

(aa) a) Representation of the orbital with quantum numbers n = 3, l = 1 is ....
   i) 3s ii) 3d iii) 3p iv) 1s (1)

b) i) Which of the following sets of quantum numbers are NOT possible?
   1) n = 2, l = 2, m_l = 0, m_s = + ½
   2) n=1, l = 0, m_l = 0, m_s = - ½
   3) n = 3, l = 2, m_l = -3, m_s = + ½
   4)n = 2, l = 1, m_l = 1, m_s = + ½ (2)
   ii) Justify your answer. (2) [March 2015]

(bb) a) Write the subshell-wise electronic configurations of the following elements:
i) Cu (Z = 29), ii) Cr (Z = 24) give reason for the extra stability of these atoms. (2)

b) Canal rays were discovered by discharge tube experiments conducted in a modified cathode ray tube. Give any two characteristics of canal rays. (1)

c) A microscope with suitable photons is employed to locate an electron in an atom within a distance of 0.4 A^0. What is the uncertainty involved in the measurement of its velocity? (2) [August 2014]

(cc) a) The number of electrons, protons and neutrons in a species are equal to 18, 16 and 16 respectively. Assign the proper symbol to the species. (1)

b) Write any two drawbacks of the Rutherford model of atom. (2)

c) Among the following electronic configurations, which one is correct? Substantiate your answer.

i) [↑↓] [↑↓] [↑|↓|↑]

ii) [↑↓] [↑↓] [↑↓|↑|]

iii) [↑↓] [↑↓] [↑|↑|↑] (2) [March 2014]

(dd) a) A large number of orbitals are possible in an atom. Using s, p, d or f notations describe the orbital with the following quantum numbers. i) n = 4, l = 0 ii) n = 3, l = 2 (1)

b) The Balmer series of lines in the hydrogen spectrum appear in the visible region of the electromagnetic spectrum. Calculate the wave number of the second line in the Balmer series. (Rydberg constant for Hydrogen is 109677 cm^{-1}) (2)

c) Bohr model of hydrogen atom contradicts dual behaviour of matter and Heisenberg's uncertainty principle. Justify. (2) [September 2013]

(ee) Photoelectric effect was first observed by Hertz.

a) The number of electrons ejected in the photoelectric effect is proportional to …………. of light used. (frequency, intensity) (1)

b) Select the correct statement related to the photoelectric effect:

i) Threshold frequency is the maximum frequency required to photoelectric emission from a particular metal.

ii) The kinetic energy of the photoelectrons is directly proportional to the frequency of incident light.

iii) Work function is same for all metals. (1) [March 2013]

(ff) The general features of the structure of a hydrogen atom and hydrogen like species were quantitatively explained by Niels Bohr.

a) Write any postulate of the Bohr's model of hydrogen atom. (1)

b) Calculate the radius of the second orbit of Li^{2+}. (Express answer in nm). (2) [March 2013]

(gg) The dual behaviour of matter was proposed by French physicist de Broglie.

a) State the dual behaviour of matter. (1)

b) A moving electron has a de Broglie wave length of 7×10^{-7} m. calculate its kinetic energy. (Planck's constant = 6.626×10^{-34} Js, mass of an electron = 9.1×10^{-31} kg) (2) [March 2013]

(hh) a) In order to specify the size, energy, shape and orientation of orbitals and spin of the electrons, we need 4 quantum numbers.

i) Write the 4 quantum numbers. (1)

ii) Represent the orbital with the following quantum numbers, n = 4 and l = 0. (1)

b) State the rules behind the electronic configuration in an atom. (3) [September 2012]

(ii) The photon has a momentum as well as a wavelength.

a) Which property of matter is revealed in the above statement? (1)

b) A photon has a mass of 8.6×10^{-30} kg. Calculate its wavelength. (Planck's constant = 6.626×10^{-34} Js (2) [March 2012]

(jj) Heisenberg's uncertainty principle rules out the existance of definite paths for electrons and other similar particles.

a) State Heisenberg's uncertainty principle.(1)

b) Calculate the uncertainty in the velocity of a cricket ball of mass 130 g, if the uncertainty in its position is of the order of 1.2 A^0. (2) [March 2012]

(kk) The electrons in an atom are designated by a set of quantum numbers labeled as n, l, m and s.

a) Give the values of n, l, m and s for the valence electron of sodium atom (Atomic number = 11) (2)

b) Which of the following set of quantum numbers are not allowed?

i) n = 3, l = 3, m = -3, s = +½

ii) n = 2, l = 1, m = 0, s = -½

iii) n = 1, l = 0, m = 0, s = +½

iv) n = 0, l = 0, m = 0, s = +½ (2)

c) State Pauli's exclusion principle. (1) [October 2011]

(ll) Based on his α-ray scattering experiment, Rutherford proposed the nuclear model of an atom.

a) Give the main postulates of Rutherford's atom model. (2)

b) Write the important demerits of Rutherford model. (1)

c) The threshold frequency, ν_0 for a metal is $6.2 \times 10^4\ s^{-1}$. Calculate the K.E of an ejected electron when the radiation of frequency, $\nu = 8.7 \times 10^4 s^{-1}$ strikes the metal. (2) [March 2011]

(mm) During Rutherford's α-ray scattering experiment, it was observed that most of the α-particles passed through the Gold-foil without any deflection, a small fraction deflected by small angles and very few bounced back.

a) What are the main conclusions made by Rutherford? (1½)

b) Give the atom model proposed by him. (1½)

c) What are the main drawbacks of this model and how Niels Bohr overcame these defects in his model? (2) [September 2010]

(nn) Niels Bohr was the first to explain quantitatively the general features of hydrogen atom structure and its spectrum.

a) Give the main postulates of Bohr's model of atom. (2)

b) Find the maximum number of emission lines, when the excited electron of hydrogen atom in n =6, drops to the ground state (n = 1). (1½)

c) Calculate the wave number of radiation due to transition of an electron from 4th orbit to 2nd orbit (R_H = 109677 cm^{-1}) (1½) [March 2010]

(oo) Dual nature of matter was proposed by Louis-de-Broglie.

a) Calculate the de Broglie wave length associated with an electron with velocity 1.6×10^6 m/s (3)

b) State Pauli's exclusion principle and Hund's rule of maximum multiplicity. (2) [March 2009]

(pp) Quantum numbers give the address of an electron. Explain all the four quantum numbers. (4) [March 2008]

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