Question Bank of Physics

PHY-404: Atomic & Nuclear Physics (Elective)

Fourth Paper- PHY: SE 44

Full Mark: 75 Pass mark:25

Q1. Objective type question: 1mark

(a) The purpose of the presence of dynodes in a scintillation counter is for (i) multiplication of number of optical photons (ii) multiplication of electrons (iii) reflection of optical photons (iv) reemission of photoelectrons.
Unit-IV (2017)

(b) Uranium eventually decays in the stable (i) radium (ii) plutonium (iii) lead (iv)thorium Unit-lll (2017)

(c) A hydrogen atom is in its ground state when its orbital electron(i) is stationary (ii) has escaped from the atom (iii) is in its lowest energy level (iv) is within the nucleus
Unit-II(2017)

(d) Which spectral region of hydrogen spectrum lies in the visible region? (i) Lyman series(ii) Balmer series (iii) Paschen series (iv) Brackett series Unit-II (2017)

(e) Which of the following is not a magic number?
(i) 126 (ii)82 (iii) 60(iv) 20Unit-VI (2017)

(f) According to Moseley's law, the square of the frequency of a spectral line is proportional to (i) the square of an atomic number (ii) the square of atomic weight (iii) atomic number (iv) atomic weight Unit-I (2018)

(g) According to Pauli's exclusion principle, the total number of electrons that can be accommodated in the n=4 shell of hydrogen atom is (i) 20 (ii) 36 (iii) 32 (iv) 18
Unit-II (2018)

(h) In a β-decay, the nucleus is transformed by (i) isotopic transition (ii) isobaric transition (iii) isotonic transition(iv) isomeric transition Unit-III (2018)

(i) Which of the following nuclei is not doubly magic?
(i) $_2He^4$ (ii) $_8O^{17}$ (iii) $_{20}Ca^{40}$ (iv) $_{82}Pb^{208}$ Unit-VI (2018)

(j) The wavelength of X-rays is of the order of
(i) meter (ii) micron (iii) nanometer (iv) angstrom Unit-I (2019)

(k) B-rays are experimentally found to be high energy beam of : (i) protons (ii) electrons (iii) neutron (iv) positron Unit-III (2019)

(l) The unit of nuclear cross-section is barn where one barn is equal to
(i) 10^{-28} cm^2 (ii) 10^{-24} cm^2 (iii) $10^{-28}m^2$ (iv) 10^{-24} m^2Unit-VII (2019)

(m) A nuclear model leads to the understanding of (i) nuclear shape and size (ii) nuclear properties exhibited by a nucleus (iii) origin of nuclear force (iv) nuclear fission Unit-I

(n) In a nuclear reaction, the physical quantity which is not conserved,is (i) total energy (ii) angular momentum (iii) parity (iv) electric quadrupole moment Unit-VII (2019)

Q2. Very short answer: 1 mark (2017)

(a) State Moseley's Law. Unit-I
(b) State Pauli's exclusion principle. Unit-II
(c) Define 'rutherford' as unit of radioactivity. Unit-III
(d) What are mirror nuclei?
(e) What is thermal neutron? Unit-VII

Q3. Short answer: 3 marks

(a) Derive an expression for the magnetic moment of an atom. Unit-V (2017)
(b) Describe liquid-drop model of nucleus. Unit-VI (2017)
(c) Find the Q-value of the reaction $N^{14}(\alpha,p)O^{17}$ with the following dataMass of N^{14}=14.007518 u, Mass of O^{17}=17.004529 u,Mass of He^4= 4.003873u, Mass of H^1=1.008144 uUnit-VII(2017)
(d) Distinguish between normal and anomalous Zeeman Effect. Unit-II (2018)
(e) A spectral line of wavelength 4000 $A^0$is subjected to a magnetic field of 8000 gauss. Find the wavelength separation between the two component lines which would be seen in normal Zeeman effect.[Take, mass of electron=9.1×10^{-31}Kg.]
Unit-II (2018)
(f) The wavelength of the first member of the Balmer series in hydrogen spectrum is 6563 A^0. Find the wavelength of the second number of the Lyman series in the same spectrum.
Unit-II (2018)
(g) Can the principal quantum number be zero? Justify your answer Unit- (2019)
(h) Name the factors which led to the discovery of spin. Unit- (2019)
(i) Calculate the energy released by fission of 1kg of U^{235}in KWh. Unit- (2019)

Q4. Answer the following questions: 5 marks

(a) Describe vector model of atom. Name different quantum numbers associated with it. Unit-II (2017)
(b) Describe the experimental procedure used by Geiger and Marsden to verify Rutherford's α-scattering theory. Unit-v (2017
orExplain in short the nuclear stability and the forces between nucleons.
(c) The atomic mass of zinc isotope $_{30}Zn^{64}$ is 63.929 u. Calculate the binding energy predicted by C.F. Von Weizsacker's semi-empirical binding energy formula with the following set of empirical coefficients: α_v= 14.1 MeV, α_s=13.0 MeV, α_c= 0.6 MeV, α_a= 19.0 MeV, α_p=33.5 MeV Unit-VI (2017)
(d) Derive the four-factor formula for neutron cycle in a fission reaction.
Or Describe the proton-proton and carbon-nitrogen cycles of reaction for production of stellar energy. Which one of the two is dominant in the present stage of the sun?
Unit-VII (2017)

(e) Derive an expression for the impact parameter in terms of the scattering angle in Rutherford's α-scattering experiment. Unit-V (2018)

(f) Explain the phenomenon of nuclear fission reaction with examples.

Or

Explain why $_{92}U^{235}$ can undergo fission reaction with thermal neutron but $_{92}U^{238}$ cannot do so. Unit-VII (2018)

(g) A deutron reaction that occurs in an experimental fusion reactor is given by 3 $_1H^2 \rightarrow$ $_2He^4 + _1H^1 + _0 n^1 +$ energyCalculate the energy released per gram of the deuteron used in the fission reaction. [Given masses of $_1 H^1$=1.007825 a.m.u, $_2He^4$ =4.002604 a.m.u, $_1H^2$= 2.014102 a.m.u and $_0 n^1$ =1.008665 a.m.u] Unit-VIII (2018)

(h) What is spin-orbit coupling? What happens when a magnetic field is applied.

Or

What is vector atom model? Name and explain the essential concepts characterize the vector atom model? Unit-II (2019)

(i) What is electric quadrupole moment of a nucleus? What is its role in nuclear physics? Unit-V (2019)

(j) Explain the sources of stellar energy. Discuss the proton-proton cycle as a source of stellar energy. Unit-VII (2019)

Q5. Answer the following questions: 9 marks

(a) Describe Aston's mass spectrograph with necessary theory of focusing action.
orUnit-I (2017)Deduce Bragg's law and explain the working principle of an X-ray spectrometer. How is it used to determine the wavelength of X-rays?

(b) What do you mean by spin-orbit interaction? How does it explain the fine structure of different spectra of atomic hydrogen? Unit-II (2017)

Or

State modifications introduced by Sommerfield in Bohr's theory of hydrogen atom. Discuss the relativistic correction to elliptic orbits. How does it explain fine structure of $H_\alpha$line?

(c) Work out an elementary theory of successive disintegration of radioactive elements. Hence, obtain the conditions for their secular and transient equilibrium. Unit-III(2017)

(d) Describe the construction and working of betadron. Derive the condition under which it works.
Or Describe the construction and working of bubble chamber. State its advantages over cloud chamber. Unit-IV (2017)

(e) Describe the construction and working of Bainbridge mass spectrograph to measure the atomic mass of isotopes.
Or What are the continuous and characteristic X-rays? Discuss their origin. Unit-I (2018)

(f) State and explain Pauli's exclusion principle. How can it be used for understanding the periodic table of elements?
OrWhat is spin-orbit coupling? Explain in brief about **L-S** and **J-J** coupling schemes of multielectron atom. Unit-II (2018)

(g) Deduce the law of decay of radioactive nuclei. Define half-life and mean life. Write down the relation between the two. Unit-III (2018)

(h) Derive Weizsaecker's semi-empirical mass formula from the liquid-drop model of the nucleus. Unit-VI (2018)

(i) Describe the essential parts of a cyclotron and explain the principle underlying its operation. What are its limitations?

Or

Describe the construction and working of GM counter. Explain the action of self-quenching. Unit-IV (2018)

(j) Describe Aston's mass spectrograph and explain its focusing action. Or Derive Mosley's law on the basis of Bohr's theory and point out its importance.Unit-I (2019)

(k) Obtain Bohr's theory of hydrogen atom and discuss the origin of different spectral lines. Or Discuss the theory of anomalous Zeeman effect for the splitting sodium D-lines. Explain why normal Zeeman Effect occurs only in atoms with even number of electrons. Unit-II (2019)

(l) Discuss the theory of successive disintegration of radioactive substance and obtain the conditions of secular andtransient equilibrium. Unit-III (2019)

(m) What are the main evidences in favor of shell model of the nucleus? Discuss the successes and limitations of this model. Unit-VII (2019)

(n) Explain the construction of betatron with a neat sketch and explain its principle of working. Describe the condition for its operation. How is it achieved?

Or

What is a bubble chamber? Explain briefly its construction & working principle. What is its advantage over a cloud chamber? Unit-IV (2019)

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