22-23/12454

M.Sc. 1st Semester Examination-2022-23

PHYSICS

Course ID : 12454 **Course Code : PHYS/104C**

Course Title : Atomic spectroscopy & Nuclear Physics–I

Time : 2 Hours *Full Marks :* 40

The figures in the right hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Unit–I

1. Answer any *three* of the following : 2×3=6

(a) Calculate the ground state energy of He^+.

(b) What is Auger electron ? Briefly describe its emission mechanism.

(c) Write two differences between spontaneous and stimulated emissions.

(d) What is characteristic x-ray ? Pictorially show the origin of K_α lines.

(e) Briefly describe the origin of spin-orbit and hyperfine splitting.

2. Answer any *two* of the following : 4×2=8

(a) Discuss how the Sodium D-lines are affected due to the presence of strong and weak magnetic field.

(b) Calculate the most probable value of radius of the electron in the ground state of the hydrogen atom. Show that this value is the same as that obtained from the uncertainty principle. 2+2

(c) Find the total number of degenerate states for the electron in hydrogen atom with principal quantum number n = 3. Assuming L-S coupling, find the J values for all possible l-values for n = 3. Does the total number of states remains same after applying L-S coupling ? 1+2+1

(d) What is fine structure ? Explain qualitatively, why the degree of find structure is splitting so much bigger in lead rather than in hydrogen atom.

3. Answer any *one* of the following : 6×1=6

(a) Discuss on different corrections to the energy level of Hydrogen atom.

(b) Sketch schematically the experimental set-up of Stem-Gerlach experiment and discuss the results. 2+4

Unit–II

4. Answer any *three* of the following : 2×3=6

(a) What are the possible values of isospin quantum number for ^{14}N ?

(b) Briefly mention the properties of the nuclear force.

(c) What are the applications of accelerators ?

(d) Which nuclei generally show rotational band structure and why ?

(e) Determine the ground-state spin and parity of ^{15}O nucleus.

5. Answer any *two* of the following : 4×2

(a) Explain why the deuteron system is very loosely bound. What fraction of time do the neutron and proton in the deuteron system spend beyond the range of their nuclear force ?

(b) Discuss the working principle of a Cyclotron with a suitable diagram.

(c) Calculate the depth of nuclear potential by using the experimentally measured properties of deuteron system.

(d) Draw the binding energy per nucleon curve obtained from the liquid drop model and qualitatively explain how energy is released in nuclear fission viz.

$$n + {}^{235}U \rightarrow {}^{93}Rb + {}^{141}Cs + 2n.$$

6. Answer any *one* of the following : 6×1=6

(a) Discuss the high-energy electron scattering experiment for measuring the nuclear size with suitable experimental diagram and hence calculate the size of ^{16}O nucleus.

(b) (i) Write down the differences between direct and compound nuclear reactions.

(ii) A compound nuclear state is formed in ^{119}Sb by bombarding a 30 MeV α particle on ^{115}In target nucleus having zero kinetic energy. A neutron of energy 2 MeV is emitted from the compound state resulting in an excited state in ^{118}Sb. Calculate the energy of the excited state in ^{118}Sb. The Q value for the reaction for the formation of the compound state is 2.4 MeV and the neutron separation energy of ^{119}Sb is 9.6 MeV. 2+4

———