Use separate answer script for each Group

B.Sc.(Honours) Examination, 2019

Semester - VI

Physics (Honours)

Paper: BPC-64

(Atomic, Molecular, Nuclear & Particle Physics)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Unless otherwise specified symbols carry their usual meanings.

Answer ***any four*** questions taking ***at least one question*** from ***each group***.

Group-A

1. a) What are the postulates of Bohr Theory of atomic models?
   b) Find the expression for total energy for Hydrogen-like atoms. How do you confirm that this is the condition for a bound state?
   c) Find the energy required to raise Hydrogen atom from the ground state to the first excited state (n = 2). $\epsilon_0 = 8.85\times10^{-12} C^2 N^{-1} m^{-2}$. 3+3+1+3

2. a) Show that in the limit of large principal quantum number, Bohr's theory yields classical result.
   b) An electron circles a nucleus of charge $+Ze$ of any two orbit 1 and 2, its total energy is greater while in orbit 1. Do a comparative studies between the radii of the orbits velocities and the accelerations of the electrons in those orbits clearly.
   c) Show that in a Bohr atom, if the electron is considered as a wave travelling along the circular path, the *n*-th orbit with contain *n* complete de Broglie waves. 3+4+3

3. a) What are the difference between spontaneous emission and stimulated emission of radiation?
   b) Mention the important features of Raman spectra.
   c) Find the expression for the rotation energy states for molecular spectra. 3+3+4

Group-B

4. a) Obtain the binding energies for $_{26}Fe^{56}$ and $_{82}Pb^{208}$ and compare the binding energy per nucleon for these two nuclei.
   b) Express the *Q*-value of a two body process in terms of the binding energies of the constituents.
   c) Obtain the value of *Q* if the two body process considered is elastic in nature.
   d) Consider the emission of α decay from an α-active nucleus. Obtain the amount of energy released in the process.
   e) Show that for super massive parent nuclei, almost the whole amount of released energy will be carried by the emitted α-particle. 3+3+1+2+1

5. a) Obtain the numerical value of the potential barrier in MeV between an α-particle and an O^{16} nucleus. (use $e^2 = 1.44$ MeV fm)
   b) Obtain the amount of energy released in a *K*-capture process.
   c) What is an Auger electron?
   d) How do you distinguish an Auger electron with that of β-decay electron?
   e) Using uncertainty principle, show that a β-decay electron cannot come out from the decaying nucleus. 3+2+1+1+3

Group-C

6. a) Write down the names of the members of the baryon decuplate along with their quark constituents. **P.T.O.**

b) What is J/Ψ particle? Is it a fermion or a boson?
c) What is the quark constituent of ϕ-meson.
d) Draw the Feynman diagram for the decay processes

$$\mu^- \rightarrow e^- + \nu_\mu + \overline{\nu_e}$$

$$n \rightarrow p + e^- + \overline{\nu_e}$$

e) Use also the quark level diagram for the neutron decay process. 3+(1+1)+1+(1+1)+2

7. a) It is well known that only the left handed neutrinos and the right handed anti-neutrinos exist in nature. Show with a proper example that *C* and *P* are not conserved individually in weak processes, but the product *CP* or *PC* is conserved.

b) Consider an electron-neutrino scattering process ($e^+ + \nu \rightarrow e^- + \nu$). Draw the Feynman diagram with the exchange of *W* and *Z* bosons. (4+4)+2

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