Roll No. ……..

PHY–551

Nuclear Physics and Analytical Techniques

M. Sc. Physics (MSCPHY–12/13/16)

Second Year, Examination, 2017

Time : 3 Hours **Max. Marks : 60**

Note : This paper is of **sixty (60)** marks containing **three (03)** sections A, B and C. Attempt the questions contained in these sections according to the detailed instructions given therein.

Section–A

(Long Answer Type Questions)

Note : Section 'A' contains four (04) long answer type questions of fifteen (15) marks each. Learners are required to answer *two* (02) questions only.

1. Discuss the multipolarity of a gamma transition and explain the selection rules.
2. Describe the predictions related to the theory of shell-model. Give the experimental evidence for the shell-model.
3. With a neat sketch, explain the functioning of different parts of SEM.

4. Explain how the nuclear magnetic resonance is achieved in practice. To what characteristic energy is the NMR technique sensitive ?

Section–B

(Short Answer Type Questions)

Note : Section 'B' contains eight (08) short answer type questions of five (05) marks each. Learners are required to answer *four* (04) questions only.

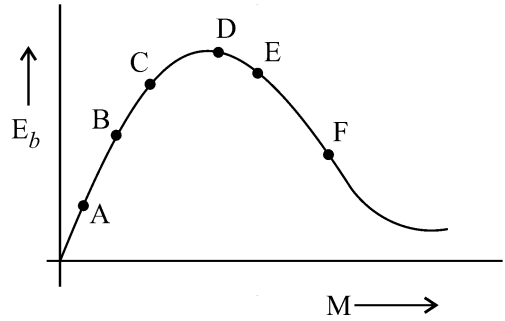
1. Discuss the Gamow theory of α-decay and how it explains the main features of α-particle emission process.
2. Derive Fermi age equation.
3. Discuss Bohr and Wheeler theory of nuclear fission.
4. What is neutron ? How do you classify the neutrons as fast and slow neutrons based on their energy range ? Discuss the basic properties possessed by the neutrons.
5. Explain the principle and working of a scintillator detector with a diagram.
6. Explain the fundamental interactions in nature.
7. Explain isospin and strangeness. In what respect are they important in the classification of the elementary particles ?
8. A gamma-ray source emits gamma-ray photons of energies 0.1, 1.0 and 8 MeV. Find the frequencies of the emitted gamma-rays.

Section–C

(Objective Type Questions)

Note : Section 'C' contains ten (10) objective type questions of one (01) mark each. All the questions of this section are compulsory.

1.



The above plot is of binding energy per nucleon E_b against the nuclear mass M; A, B, C, D, E, F correspond to different nuclei. Consider four reactions :

(i) $A + B \rightarrow C + \Sigma$

(ii) $C \rightarrow D + A + \Sigma$

(iii) $D + E \rightarrow F + \Sigma$

(iv) $F \rightarrow D + E + \Sigma$

Where Σ is the energy released. In which reactions is Σ positive ?

(a) (i) and (iv)

(b) (i) and (iii)

(c) (ii) and (iv)

(d) (i) and (iii)

2. What is the missing particle in the reaction :

$$^{12}_{6}C + ^{3}_{1}H \rightarrow ^{4}_{7}N + ...$$

(a) $^{1}_{0}n$

(b) $^{0}_{-1}e$

(c) γ

(d) $^{1}_{1}H$

3. The binding energy per nucleon for the parent nucleus is E_1 and that for the daughter nuclei is E_2. Then :

(a) $E_1 = 2E_2$

(b) $E_1 > E_2$

(c) $E_2 = 2E_1$

(d) $E_2 > E_1$

4. Which of the following statement is incorrect for the nuclear force between two nucleons ?

(a) It is charge independent

(b) It is spin independent

(c) It is velocity independent

(d) It has non-central component

5. A radioactive nuclei with decay constant 0.5/s is being produced at a constant rate of 100 nuclei/s. If at $t = 0$, there were no nuclei, the time when there are 50 nuclei is :

(a) 1 *s*

(b) 2 ln (4/3) *s*

(c) ln 2 *s*

(d) ln (4/3) *s*

6. The half-life of a radioactive substance depends upon :
   (a) its temperature
   (b) the external pressure on it
   (c) the mass of the substance
   (d) None of these

7. During negative beta decay :
   (a) An atomic electron is ejected
   (b) An electron which is already present within the nucleus is ejected
   (c) A neutron in the nucleus decays emitting an electron
   (d) None of these

8. When an electron and positron annhilate :
   (a) Nothing is created
   (b) One photon is created
   (c) Two photons are created
   (d) Two neutrons are created

9. The scintillator counter :
   (a) is not used for counting α-particles
   (b) counts only β-particles
   (c) counts only γ-radiations
   (d) None of these

10. Radius of ${}^{165}_{67}H_0$ nucleus in f_m is :
   (a) 15.4
   (b) 5.5
   (c) 12.8
   (d) 6.8