



B.Sc. PHYSICS
FOURTH SEMESTER
NUCLEAR & PARTICLE PHYSICS
BSP – 401 [OLD COURSE] [REPEAT]
(Use Separate Answer Scripts for Objective & Descriptive)

Duration: 3 hrs.

Full Marks: 70

Time: 30 min.

(Objective)

Marks: 20

Choose the correct answer from the following:

1X20=20

- The liquid drop model of nucleus was developed by
 - Bohr, Wheeler
 - Fermi
 - Rutherford
 - Chadwick
- Nuclear fission can be explained by
 - Shell model
 - Bohr atom model
 - Quark model
 - Liquid drop model
- A nucleus having mass number A decays by alpha emission. The Q value of the process is E . The energy of alpha particle is
 - $E \left(\frac{A-4}{A} \right)$
 - $E \left(\frac{A}{A-4} \right)$
 - $E \left(\frac{4}{A} \right)$
 - $E \left(\frac{4}{A-4} \right)$
- According to the shell model, the total angular momentum and the parity of the ground state of the ${}^7_3\text{Li}$ nucleus is
 - $3/2$ with positive parity
 - $1/2$ with positive parity
 - $3/2$ with negative parity
 - $1/2$ with negative parity
- The atomic number is not changed by which type of radioactive decay?
 - Beta
 - Gamma
 - Alpha
 - None of the mentioned
- Three types of radioactive elements are emitted when unstable nuclei undergo radioactive decay. Which of the following is not one of them
 - Alpha
 - Beta
 - Gamma
 - Delta
- Which statement is true for all three types of radioactive emission?
 - They are deflected by electric field
 - They ionizes gases
 - They are completely absorbed by a thin aluminium sheet
 - They emit light
- Which of the following substances cannot be emitted by radioactive substances during their decay?
 - Protons
 - Neutrinos
 - Helium nuclei
 - Electrons

9. Which of the following acts as ionizing gas in Geiger Muller counter?
- Alcohol
 - Argon
 - Krypton
 - Hydrogen
10. Which of the following is the main disadvantage of solid state semiconductor detector?
- Low accuracy
 - Low sensitivity
 - It should be maintained at low temperature
 - High pressure has to be produced
11. The magnetic moment for the orbital quantum number $l=2$ is
- $\sqrt{2} \frac{eh}{2m}$
 - $\sqrt{6} \frac{eh}{2m}$
 - $\frac{eh}{2m}$
 - $\sqrt{3} \frac{eh}{2m}$
12. Parity is positive, when
- $l=odd$
 - $l=even$
 - $l>0$
 - $l<0$
13. What is the approximate mass no (A) of a nucleus having radius 2.71Fm?
- 4
 - 8
 - 7
 - 6
14. The atomic number is equivalent to which of the following?
- The number of neutrons in the atom
 - The number of protons in the atom
 - The number of nucleons in the atom
 - The number of α -particles in the atom
15. What is the mass of the products of a nuclear fission reaction compared to the original products?
- Greater
 - Less
 - the same
 - varies according to the reaction
16. ${}_3\text{Li}^7 + {}_1\text{H}^1 \rightarrow ({}_4\text{Be}^8)^*$ This reaction is an example of
- (p, γ) reaction
 - (p, n) reaction
 - (p, p) reaction
 - (p, d) reaction
17. Which particle is bombarded on heavy nucleus of nuclear fuel?
- Electron
 - Proton
 - Neutron
 - Photon
18. An antiproton is an atomic particle that has
- the mass of a proton and the charge of an electron
 - the mass of an electron and the charge of a proton.
 - the mass of a neutron and the charge of a proton
 - the mass of a proton and the charge of a neutron

19. Particles that participate in the strong nuclear interaction are called
- neutrinos
 - hadrons
 - leptons
 - electrons
20. What are the fundamental particles of an atom?
- Quarks, gluons and electrons
 - Protons, neutrons and electrons
 - The nucleus and electron orbits
 - An atom cannot be broken down into anything smaller than itself

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(PART-B :Descriptive)

Time : 2 hrs. 40 min.

Marks : 50

[Answer question no.1 & any four (4) from the rest]

- Write five similarities between a liquid drop and a nucleus. 5+5=10
 - Calculate the Q-value of α -decay.
- Nuclei containing 2, 8, 20, 50, 82 & 126 nucleons form closed nuclear structure. Write five points in favor of this inference. 5+5=10
 - If a beam of particles is incident on a slab of thickness x of the material, how many particles will emerge out of the slab.
- Define half-life of a radioactive nuclei. Derive the radioactive law in terms of half-life. 3+2+5
=10
 - Find the half-life of a radioactive sample if number of radioactive nuclei in a sample decay to $1/16$ of the original number in 11.4 days.
 - Write five properties of Alpha particles.
- Explain the basics of Electron emission, positron emission and electron capture in a beta decay process. 6+2+2
=10
 - Explain Activity of a radioactive nuclei and express it in terms of half-life.



- c. Calculate the activity of 10 g of ^{232}Th . Given that $\lambda (^{232}\text{Th}) = 1.58 \times 10^{-18} \text{ s}^{-1}$.
5. a. With the help of a neat and labelled diagram explain the construction and working of a Linear accelerator (Lineac) and derive the expression of the oscillator frequency. 8+2=10
b. Write two advantages of Lineacas compared to cyclotron.
6. Discuss magnetic moment and electric quadruple moment of a nucleus. 5+5=10
7. a. The mass of Lithium atom is 7.01822 amu. Calculate the binding energy (in eV) of nucleus. Given mass of proton is 1.00814 amu., mass of neutron= 1.00893 amu., mass of electron= 0.00055 amu. 5+5=10
b. Calculate the Q-value for the formation of P^{30} in the ground state in the reaction $\text{Si}^{29}(\text{d},\text{n})\text{P}^{30}$ from the following cycles of nuclear reactions.
- $\text{P}^{31} + \gamma \rightarrow \text{P}^{30} + \text{n} - 12.37 \text{ MeV}$
 $\text{P}^{31} + \text{p} \rightarrow \text{Si}^{28} + \text{He}^4 + 1.909 \text{ MeV}$
 $\text{Si}^{28} + \text{d} \rightarrow \text{Si}^{29} + \text{p} + 6.246 \text{ MeV}$
 $2\text{d} \rightarrow \text{He}^4 + 23.834 \text{ MeV}$
8. a. The binding energy of a nucleus is 225 MeV. Determine the mass defect in atomic mass unit. 3+3+4
=10
b. Find the density of $^{12}\text{C}^6$ nucleus.
c. The binding energy of $^{10}\text{N}^{20}$ is 160.64 MeV. Find the atomic mass. Given mass of proton=1.007825 amu and of neutron= 1.008665 amu.

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