

**B.Sc. PHYSICS**  
**FOURTH SEMESTER**  
**NUCLEAR & PARTICLE PHYSICS**  
**BSP – 401**

( Use Separate Answer Scripts for Objective & Descriptive )

Duration: 3 hrs.

Full Marks: 70

( PART-A: Objective )

Time: 20 min.

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
  - Hyton
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
- $\sqrt{2} \frac{e\hbar}{2m}$
  - $\sqrt{6} \frac{e\hbar}{2m}$
  - $\frac{e\hbar}{2m}$
  - $\sqrt{3} \frac{e\hbar}{2m}$
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  $\alpha$ -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
- $(p, \gamma)$  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
- a. neutrinos
  - b. hadrons
  - c. leptons
  - d. electrons
20. What are the fundamental particles of an atom?
- a. Quarks, gluons and electrons
  - b. Protons, neutrons and electrons
  - c. The nucleus and electron orbits
  - d. An atom cannot be broken down into anything smaller than itself

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**( PART-B : Descriptive )**

Time : 2 hrs. 40 min.

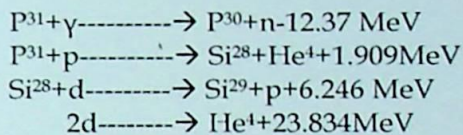
Marks : 50

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

1. a. Write five similarities between a liquid drop and a nucleus. 5+5=10  
b. Calculate the Q-value of  $\alpha$ -decay.
2. a. Nuclei containing 2, 8, 20, 50, 82 & 126 nucleons form closed nuclear structure. Write five points in favor of this inference. 5+5=10  
b. 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.
3. a. Define half-life of a radioactive nuclei. Derive the radioactive law in terms of half-life. 3+2+5=10  
b. 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.  
c. Write five properties of Alpha particles.
4. a. Explain the basics of Electron emission, positron emission and electron capture in a beta decay process. 6+2+2=10  
b. Explain Activity of a radioactive nuclei and express it in terms of half-life.  
c. Calculate the activity of 10 g of  $^{232}\text{Th}$ . 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  $Si^{29}(d,n)P^{30}$  from the following cycles of nuclear reactions.



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  ${}_{12}C^6$  nucleus.
- c. The binding energy of  ${}_{10}N^{20}$  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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