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**6 SEM TDC DSE PHY (CBCS) 1 (H)**

**2024**

( May )

**PHYSICS**

( Discipline Specific Elective )

( For Honours )

Paper : DSE-1

( Nuclear and Particle Physics )

Full Marks : 80

Pass Marks : 32

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

1. Choose the correct option from the following :

1×5=5

(a) The radii of two nuclei with mass numbers 1 and 8 are in the ratio

(i) 1 : 8

(ii) 8 : 1

(iii) 1 : 2

(iv) 2 : 1

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- (b) The average binding energy of a nucleus is of the order of
- (i) 8 eV
  - (ii) 8 keV
  - (iii) 8 MeV
  - (iv) None of the above
- (c) On emitting an  $\alpha$ -particle and a  $\beta$ -particle, the mass number and atomic number of a nucleus  ${}_n X^m$  change to
- (i)  $m-4, n$
  - (ii)  $m-4, n-1$
  - (iii)  $m-3, n+1$
  - (iv)  $m-3, n-1$
- (d) A kaon is a \_\_\_\_\_ and a proton is a \_\_\_\_\_.
- (i) fermion, boson
  - (ii) fermion, fermion
  - (iii) boson, fermion
  - (iv) boson, boson
- (e) Isospins for a proton and a neutron are
- (i)  $\frac{1}{2}$  and  $-\frac{1}{2}$  respectively
  - (ii)  $-\frac{1}{2}$  and  $\frac{1}{2}$  respectively
  - (iii) both  $\frac{1}{2}$
  - (iv) None of the above

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2. (a) What is separation energy of a nucleon? 2  
(b) Derive an expression for nuclear magnetic dipole moment. 3
3. (a) What are 'independent particle model' and 'strong interaction model' in connection with a nucleus? 2  
(b) Discuss the evidences of a shell structure in a nucleus. Give a brief description of the shell model. 3+3=6  
(c) Write down the Bethe-Weizsacker semi-empirical mass formula. Describe briefly the significance of each term of the formula. 1+4=5
4. (a) Compare the energy spectra of alpha and beta rays. 4
- Or
- Give a qualitative description of the Gamow's theory of alpha decay. What is Gamow factor? 3+1=4
- (b) Why is gamma ray assumed to be emitted from inside the nucleus? 2
- (c) Explain the term 'internal conversion' in connection with gamma radiation. 3

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5. (a) What are the conservation laws to be followed by a nuclear reaction? 3
- (b) What is nuclear cross-section? Derive an expression for nuclear cross-section. What is its unit? 1+3+1=5
- (c) What are resonance reactions? 1

6. Write short notes on any two of the following: 4×2=8

- (a) Bethe-Bloch formula
- (b) Gamma ray interaction through matter
- (c) Compton effect

7. Describe the construction and working of a GM counter. What are dead time and recovery time? What is quenching? How is it achieved? 4+2+1+2=9

Or

What is a semiconductor detector? Name a few types of semiconductor detector. What are its advantages over a gas-filled detector? Describe any one type of semiconductor detector. 1+2+2+4=9

8. Give a brief description of the working of a linear accelerator. Derive a relation between frequency of the applied a.c. voltage and the length of a conducting cylinder. 3+2=5

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( Continued )

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9. (a) Classify elementary particles on the basis of standard model. 4
- (b) Describe briefly the term 'strange particles'. What is strangeness quantum number  $S$ ? What are the values of  $S$  for omega and lambda particles? 2+1+2=5
- (c) What is CPT invariance? 2
- (d) Check whether Baryon number and strangeness are conserved in the following reactions: 2×3=6
- (i)  $\pi^+ + n \rightarrow \Lambda^0 + K^+$
- (ii)  $\pi^+ + n \rightarrow K^0 + K^+$
- (iii)  $\pi^+ + n \rightarrow \pi^- + p$

Or

Describe the conservation laws to be followed specifically in a strong interaction. In which interaction is parity violated? 5+1=6

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