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

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(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

(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 α -particle and a β -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

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

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

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 : $2 \times 3 = 6$
- (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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