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Total No. of Questions : 9]  
(2032)

[Total No. of Printed Pages : 4

**UG (CBCS) IIIrd Year (Annual) Examination**

**3229**

**B.Sc. PHYSICS**

(Nuclear and Particle Physics)

(DSE-1B)

Paper : PHYS 304 TH

**Time : 3 Hours]**

**[Maximum Marks : 70**

*Note* :- Attempt *five* questions in all, selecting *one* question from each Section. Question No. 1 is compulsory.

**Section-A**

**(Compulsory Question)**

1. (i) Magnetic moment of neutron is :

- (a) Positive                       (b) Negative  
 (c) Zero                              (d) Infinite

(ii) Which has the highest penetrating power ?

- (a)  $\alpha$  particles  
(b)  $\beta$  particles  
 (c)  $\gamma$  rays

(d) All have the same penetrating power

**CH-29**

( 1 )

Turn Over

(iii) The decay constant of the end product of natural radioactive series is :

- (a) Zero (b) One  
(c) Infinite (d)  $\pi$

(iv) A meson is a bound state of :

- (a) 3 quarks  
(b) 2 quarks  
(c) 1 quark and 1 anti-quark  
(d) 3 anti-quarks

(v) The values of Baryon number, Lepton number, Iso-spin, Strangeness number of neutron are :

(a) 1, 0,  $\frac{1}{2}$ , 0

(b) 1, 1,  $\frac{1}{2}$ , 0

(c) 0, 1,  $\frac{1}{2}$ , 1

(d) 1, 0, 0, 1

(vi) Nuclear forces are saturated forces. Explain. -1

(vii) What are Thermal Neutrons ? -1

(viii) What are the processes by which a  $\gamma$ -ray may lose its energy ?

(ix) What are Cerenkov radiations ?

(x) What is a Cyclotron ? How does it differ from a betatron ? -1

(xi) Give an example of each : Fermion, Boson, Baryon, Lepton.

$11 \times 2 = 22$

### Section-B

2. (a) Why electron cannot be a constituent part of the nucleus ? Explain in detail. (4)

(b) What is Binding Energy (BE) per nucleon ? What inferences can be drawn from BE per nucleon curve ? (2)

(c) Assuming that average mass of a nucleon is  $1.67 \times 10^{-27}$  kg and radius of a nucleus to be given  $R = R_0 A^{1/3}$ , calculate the density of the nucleus ( $R_0 = 1.5 \times 10^{-15}$  m). (1/2)

3. Describe the nuclear shell model. Show how 'magic numbers' are obtained in nuclear shell model. Describe limitations of nuclear shell model. (6,3,3)

### Section-C

4. Discuss Gamow's theory of  $\alpha$ -decay and derive the expression for transmission coefficient for  $\alpha$ -decay. (12)

5. (a) Derive the expression for half life and mean life time of radioactive substance. What is the relation between these two ? (2)

(b) Explain neutrino hypothesis of  $\beta$ -decay.

(c) Explain inverse  $\beta$ -decay. (6,3,3)

### Section-D

6. (a) What is Compton Effect ? Derive an expression for the change in wavelength of a scattered photon. (1)
- (b) Why a photon cannot transfer its entire energy to the electron in Compton process ? (2) 6,3,3
- (c) Explain why visible light cannot demonstrate Compton effect ? (2)
7. Describe the construction and working of Geiger-Muller (GM) counter. What do you mean by dead time and recovery time of GM counter ? Explain the differences between GM counter and proportional counter. 12

### Section-E

8. What are Quarks ? Discuss qualitative aspects of quark model. On the basis of quark model discuss quark content of mesons and baryons. 12
9. (a) For each of the following decays state the conservation law that forbids it :
- (i)  $n \rightarrow p + e^-$
- (ii)  $n \rightarrow p + \gamma$
- (iii)  $n \rightarrow \pi^+ + e^-$
- (b) Write a short note on composition of cosmic rays. (1,2)
- (c) Write a short note on variation of cosmic rays intensity with latitude and altitude. (2) 6,3,3

Student Strength-250  
HOUSE EXAMINATION  
Nuclear and Particle Physics  
PHYS304TH

Duration: 1 hour and 30 minutes

Maximum Marks: 10

Instructions:

- Attempt Three question in total.
- Section A is compulsory and select one question from Section B and C.

SECTION A

1. Attempt any six of the following:

- Give two reasons for non-existence of electrons in the nucleus.
- Define parity. What is the parity of p and d-electron?
- Derive relation between a.m.u and MeV.
- What are Magic Numbers? Give two experimental evidences for their existence.
- What is Beta Decay? Explain briefly neutrino hypothesis.
- What is Internal Conversion?
- What are Pick up, Stripping and Fission reaction? Give one example of each reaction.  $(\frac{1}{2} \times 6 = 3)$

SECTION B

- a. Define binding energy per nucleon. Outline main features of Binding energy curve. (b) Calculate the B.E./nucleon of  ${}_{17}\text{Cl}^{35}$  nucleus (its mass being 34.9800 a.m.u).  
Given mass of  ${}_{0}\text{n}_1 = 1.008665$ . Mass of  ${}_{1}\text{H}^1 = 1.007825$  a.m.u.

$(2 + 1\frac{1}{2} = 3\frac{1}{2})$

Or

- a. Derive the semi-empirical mass formula of a liquid drop model.  
b. Give three achievements of nuclear shell model.  $(2\frac{1}{2} + 1 = 3\frac{1}{2})$

SECTION C

- Discuss Gamow's theory of alpha decay and derive expression for transmission coefficient.  $3\frac{1}{2}$

Or

- a. Define Q - value of a nuclear reaction. Obtain an expression for it and also explain its physical significance.  
b. Explain nuclear reaction cross section. State its units.  $(2\frac{1}{2} + 1 = 3\frac{1}{2})$