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6 SEM TDC PHY M 3

2014

(May)

PHYSICS

(Major)

Course : 603

(Nuclear Physics)

Full Marks : 60
Pass Marks : 24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following (any *five*) : 1×5=5

(a) Isobars are nuclides which have same

(i) mass number

(ii) charge number

(iii) atomic number

(iv) None of the above

(b) 1 barn is equal to

(i) $10^{-27}\,m^2$

(ii) $10^{-28}\,m^2$

(iii) $10^{27}\,m^2$

(iv) $10^{30}\,m^2$

(c) The formation of cosmic ray showers are based upon the phenomenon of

(i) scattering

(ii) chain reaction

(iii) pair production

(iv) None of the above

(d) The spin of photon is

(i) 1

(ii) 0

(iii) 1/2

(iv) 3/2

(e) The following Z and / or N is called magic numbers of nuclides 2, 8, 20, 28, 50, 82 and

(i) 180

(ii) 175

(iii) 160

(iv) 126

(f) Nuclear forces are

(i) short-range forces

(ii) long-range forces

(iii) medium-range forces

(iv) None of the above

2. Answer any *five* of the following questions : 2×5=10

(a) What is binding energy? Explain the stability of nucleus on the basis of this concept.

(b) Explain the nature of range of nuclear force.

(c) Write a few drawbacks of liquid-drop model.

(d) Explain the latitude effect of cosmic rays.

(e) What are gauge bosons? Briefly discuss their properties.

(f) A nucleus with $A = 235$, splits into two nuclei whose mass numbers are in the ratio 2 : 1. Find the radii of the nuclei. [Given, $R_0 = 1 \cdot 4$ fm] [Ans. $R_1 = 5 \cdot 99$ fm, $R_2 = 7 \cdot 55$ fm]

3. What is proton-neutron hypothesis of nucleus? Give reasons for the acceptance of this hypothesis. 2+3=5

Or

Name the various contributions to the mass of a nucleus as taken in semiempirical mass formula. 5

4. Write the main assumptions of liquid-drop model of the nucleus. Justify the name liquid-drop model. 4+1=5

Or

Using semiempirical BE formula, calculate BE per nucleon of $_{20}Ca^{40}$.

[Given, $a_1 = 14 \cdot 1$ MeV, $a_2 = 13$ MeV, $a_3 = 0 \cdot 575$ MeV, $a_4 = 19$ MeV and $a_5 = 33 \cdot 5$ MeV] 5

5. What is nuclear reaction? Discuss the various conservation laws in nuclear reactions with illustrative examples. 1+4=5

Or

Define nuclear cross-section. Derive an expression for number of surviving particles, if a number of particles are incident on a slab of certain area, thickness and number density. 5

(Continued)

6. Discuss the principle, construction and working of cyclotron. What are the limitations of cyclotron? 1+1+3+2=7

Or

Explain the principle and working of a linear accelerator. Deduce an expression for the energy of the particle and length of cylinders in terms of the constants of the apparatus. 7

7. What are elementary particles? What are fermions and bosons? Mention important elementary particles in each category and discuss their characteristics. 1+2+4=7

Or

What are quarks? Write the properties of quarks. Give the quarks structure of proton and neutron. 1+4+2=7

8. What is Q-value of nuclear reactions? Derive an expression for the Q-value of the reaction $X(a, b)Y$ in terms of kinetic energy of the incident and product particles and masses of the various particles and nuclei. Assume the target nucleus to be at rest in the laboratory. Calculate the Q-value of the reaction $N^{14}(\alpha, p)O^{17}$. Whether the reaction is exoergic or endoergic? [Given, masses of N^{14}, O^{17}, α and p are 14·00753, 17·00450, 4·00260 and 1·00814 amu respectively] 1+3+3=7

Or

Discuss the various types of nuclear reaction which may occur when an energetic particle approaches a nucleus. Discuss the four basic interactions in terms of their range, relative strengths and the exchange particles responsible for them. 3+4=7

9. Write short notes on (any *three*) : 3×3=9

(a) Nuclear magnetic dipole moment

(b) Nuclear fusion

(c) Parity

(d) Packing fraction

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