48

6 SEM TDC PHY M 3

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(May)

PHYSICS

(Major)

Course : 603

(Nuclear Physics)

Full Marks : 60

Pass Marks : 24/18

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct answer from the following : 1×5=5

   (a) Nuclear spin represents

   (i) nuclear orbital angular momentum

   (ii) nuclear spin angular momentum

   (iii) nuclear total angular momentum

   (iv) nuclear isospin

(Turn Over)

(b) Which of the following energy terms in the semi-empirical mass formula favours the stability of a nucleus?
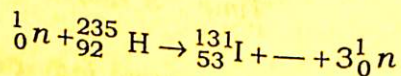
(i) Volume energy

(ii) Surface energy

(iii) Asymmetry energy

(iv) All of the above

(c) Which of the following correctly balances the following nuclear fission reaction?

$${}^{1}_{0}n + {}^{235}_{92}H \to {}^{131}_{53}I + - + 3{}^{1}_{0}n$$

(i) ${}^{104}_{39}Y$

(ii) ${}^{105}_{36}Kr$

(iii) ${}^{102}_{39}Y$

(iv) ${}^{102}_{36}Kr$

(d) The radioactive isotope Z has a half-life of 12 hours. After 2 days, the fraction of the original amount remaining is

(i) $\frac{1}{2}$ g

(ii) $\frac{1}{4}$ g

(iii) 4 g

(iv) $\frac{1}{16}$ g
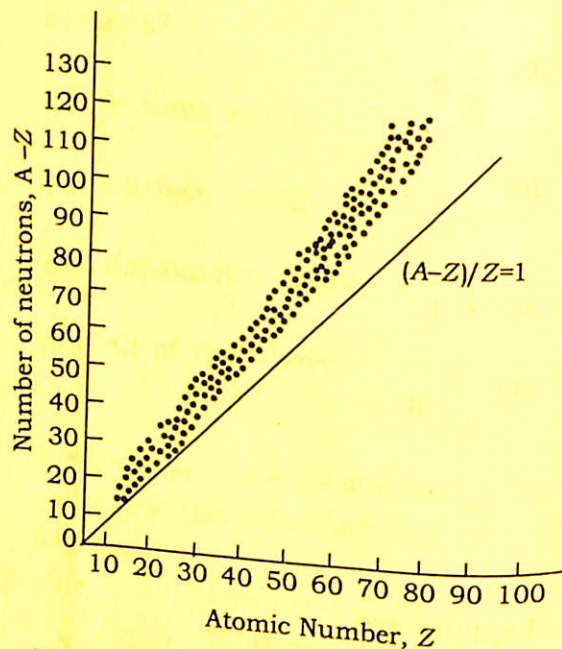
(e) Leptons are

(i) bosons

(ii) fermions

(iii) hadrons

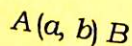(iv) mesons

2. Answer the following questions :   2×5=

(a) Following is the Segrè plot for stable nuclides :

Now, explain the deviation from the ideal straight line nature towards high Z in the above graph.

(b) What are doubly magic nuclei? Give examples.   1+1=

(c) Write the meaning of the following nuclear reaction :

$$A(a, b)B$$

(d) In an experiment, 1·0 g of ^{59}Co is placed in a neutron flux with an intensity of 10^{15} neutrons $s^{-1}cm^{-2}$. The cross-section for ^{59}Co is 17 b. What is the radius of the nucleus?   2

(e) What are quarks? How many quarks are there?   1+1=2

3. Calculate the total energy of an electron in MeV assuming it to be inside the nucleus.   3

4. Write the assumptions of nuclear shell model.   3

Or

Write the experimental evidences in support of nuclear shell structure.

5. Write the different members of the family of leptons.   3

6. Define nuclear magnetic dipole moment. What is its unit? Compare nuclear magnetic moment with atomic magnetic moment.   2+1+1=4

Or

Discuss the quantum numbers of an individual nucleus.

7. Discuss the applications and limitations of liquid-drop model of the nucleus.

8. Define radioactivity. Write the generic equations representing different types of radioactivity. 1+3

Or

Compare nuclear fusion and fission reactions.

9. Electrons of kinetic energy 500 MeV are scattered from a target of nuclei into a diffraction pattern that has minima with an average separation of $\theta = 30°$. Find the charge distribution radius of the target nuclei. [Hint : Use the theory of diffraction]

10. Define Q-value of a nuclear reaction. The Q-value of reaction $^{12}_{6}C_{(d, \alpha)}{}^{10}_{5}B$ is 1·34 MeV. Find the mass of $^{10}_{5}B$ if $m(d) = 2·0141\, u$, $m(\alpha) = 4·0026\, u$ and $m(^{12}_{6}C) = 12·0000\, u$. 2+4=

11. What are particle accelerators? Discuss briefly the principle, construction and working of any one of the particle accelerators. 2+4=6

12. What are cosmic rays? Write the differences between primary and secondary cosmic rays. 2+5=7

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