2017

(6th Semester)

PHYSICS

TENTH PAPER

(Nuclear Physics—II)

(Revised)

Full Marks : 75

Time : 3 hours

(PART : B—DESCRIPTIVE)

(*Marks* : 50)

The figures in the margin indicate full marks for the questions

1. *(a)* What do you understand by mass defect and binding energy per nucleon? 2

(b) Describe graphically, how the binding energy per nucleon for light, medium and heavy nuclei vary with mass number. Explain how the energy is released when both light nuclei fuse together and a heavy nucleus undergoes fission. 6

(c) Calculate the binding energy per nucleon for -particle or He-nucleus ($_2He^4$), given masses m_p 1 007276 amu, m_n 1 008665 amu and M 4 001506 amu [1 amu = 931 MeV]. 2

Or

(a) Discuss about the nuclear stability. Hence explain the significance of magic numbers. 2+2

(b) Write down the semi-empirical mass formula of von Weizsaecker and explain the significance of various terms in it. Mention some applications of the formula. 5+1

2. *(a)* State the laws of radioactive decay and hence define the decay constant. 2+1

(b) Prove that the decay constant of a substance is the reciprocal of the time after which the number of nuclei falls to $\frac{1}{e}$ of its original value. 5

(c) Calculate the half-life and mean life of a substance whose decay constant is 4 28 10 ^{4} per year. 2

Or

(a) State and explain Geiger-Nuttall law. 4

(b) What is beta decay? Discuss the energy spectrum curve from beta decay. Explain how Pauli's neutrino hypothesis accounts for the continuous beta-ray spectra. 6

3. *(a)* What do you mean by '*Q*-value' and 'threshold energy' of a nuclear reaction? 2+2

(b) For a nuclear reaction $a\ X\ Y\ b$, where X and Y are target and product nuclei respectively, and a and b are the bombarding and outgoing particles, obtain an expression for *Q*-value and threshold energy. 6

Or

(a) Discuss the terms related to nuclear fission : 3

(i) Chain reaction

(ii) Critical mass

(iii) Multiplication factor

(b) Discuss how nuclear fusion reaction enables energy generation inside stars. (State the detailed steps of either *p-p* cycle or *C-N* cycle.) 4

(c) Explain the differences between nuclear fission and nuclear fusion by using suitable examples of these reactions. 3

4. Describe the construction and working principle of a cyclotron with neat diagram. What are its limitations and how these are resolved? 7+3

Or

Describe the construction and principle of a GM counter and explain its operations. What do you mean by the 'counter efficiency' and 'dead time' of a GM counter? 8+2

5. *(a)* Discuss primary and secondary cosmic rays. 4

(b) Explain the terms in detail : 3+3

(i) Latitude effect

(ii) Altitude effect in cosmic rays

Or

(a) Mention four fundamental interactions found in nature. What are the corresponding force carriers or exchange particles for these interactions? 2+2

(b) What do you mean by 'hadrons'? How are they further classified? Give examples of each type of hadrons and mention their quark structures. 1+1+2

(c) Based on the conservation of quantum numbers, mention whether the following reaction can occur or not : 2

$$p \quad p \quad n \quad p$$

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Subject Code : PHY/VI/10 (R)

Booklet No. A

Date Stamp .....

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To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

Subject .....

Paper .....

INSTRUCTIONS TO CANDIDATES

1. **The Booklet No. of this script should be quoted in the answer script meant for descriptive type questions and vice versa.**
2. **This paper should be ANSWERED FIRST and submitted within 1 (one) Hour of the commencement of the Examination.**
3. **While answering the questions of this booklet, any cutting, erasing, over-writing or furnishing more than one answer is prohibited. Any rough work, if required, should be done only on the main Answer Book. Instructions given in each question should be followed for answering that question only.**

To be filled in by the Candidate

DEGREE 6th Semester
(Arts / Science / Commerce / .....) Exam., **2017**

Roll No. .....

Regn. No. .....

Subject .....

Paper .....

Descriptive Type

Booklet No. B .....

Signature of Scrutiniser(s)

Signature of Examiner(s)

Signature of Invigilator(s)

/413

2017

(6th Semester)

PHYSICS

TENTH PAPER

(Nuclear Physics—II)

(Revised)

(PART : A—OBJECTIVE)

(*Marks* : 25)

The figures in the margin indicate full marks for the questions

SECTION—I

(*Marks* : 10)

Tick (✓) the correct answer in the brackets provided : 1×10=10

1. Which of the following nuclei are isobars?

(a) $_{14}Si^{28}$, $_{14}Si^{29}$ ( )

(b) $_{8}O^{16}$, $_{7}N^{16}$ ( )

(c) $_{6}C^{14}$, $_{8}O^{16}$ ( )

(d) None of the above ( )

2. The radius of $_2He^4$ is 2·24 fm. Hence the radius of $_{99}Es^{256}$ is

(a) 4·48 fm ( )

(b) 6·72 fm ( )

(c) 8·96 fm ( )

(d) 11·20 fm ( )

3. When $_{29}Cu^{64}$ emits a positron, the resultant nucleus is

(a) $_{28}Ni^{64}$ ( )

(b) $_{29}Cu^{63}$ ( )

(c) $_{30}Zn^{64}$ ( )

(d) $_{28}Ni^{63}$ ( )

4. When $_5B^{11}$ is bombarded with proton, it is artificially transmuted to $_4Be^8$. The outgoing particle is

(a) proton ( )

(b) deuteron ( )

(c) neutron ( )

(d) α-particle ( )

5. Nuclear isomers are the nuclei having

(a) different charge numbers ( )

(b) different mass numbers ( )

(c) different nuclear energy states ( )

(d) All of the above ( )

6. Controlled thermonuclear reaction may be possible in

(a) International Thermonuclear Energy Reactor (ITER) ( )

(b) nuclear reactor ( )

(c) atom bomb ( )

(d) hydrogen bomb ( )

7. In a linear accelerator, the tubes must have lengths proportional to

(a) 1 : 2 : 3 : 4 ... ( )

(b) $1 : \sqrt{2} : \sqrt{3} : \sqrt{4}$ ... ( )

(c) 1 : 4 : 9 : 16 ... ( )

(d) 1 : 1 : 1 : 1 ... ( )

8. According to standard model of particle physics, the fundamental matter particles are

(a) quarks and leptons ( )

(b) leptons and mesons ( )

(c) quarks and gluons ( )

(d) leptons and baryons ( )

9. Which of the following instruments is not a radiation detector?

(a) Ionisation chamber ( )

(b) Proportional counter ( )

(c) Cloud chamber ( )

(d) Electron synchrotron ( )

10. The isotopic spin I is related to multiplet number M as

(a) $M = 2I + 1$ ( )

(b) $M = I + 1$ ( )

(c) $M = 2I - 1$ ( )

(d) $M = I - 1$ ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. What do you mean by nuclear density? Show that it is constant for all nuclei.

2. What do you mean by radioactive dating? Discuss the carbon dating technique.

3. Mention some of the basic properties of neutrons and their classifications.

4. Write a short note on proportional counter.

5. Based on quark structure, show that proton has charge +1, π^- has charge –1 and neutron has no charge.

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