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(CBCS)

(5th Semester)

PHYSICS

SEVENTH PAPER

(Classical Mechanics and Nuclear Physics—II)

Full Marks : 75

Time : 3 hours

(PART : A—OBJECTIVE)

(*Marks : 25*)

The figures in the margin indicate full marks for the questions

SECTION—A

(*Marks : 10*)

Put a Tick (✓) mark against the correct answer in the brackets provided : $1 \times 10 = 10$

1. If force is applied at the centre of mass then torque is

(a) infinity ()

(b) maximum ()

(c) zero ()

(d) 1 ()

2. The range of azimuthal angle in the spherical coordinates is

(a) $[0, 2\pi]$ ()

(b) $[0, \pi]$ ()

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

(d) $[\pi, 2\pi]$ ()

3. Binding energy increases linearly with the

(a) mass number ()

(b) atomic number ()

(c) magnetic moment ()

(d) charge ()

4. Identify isotopes among the following :

(a) ${}^{58}_{26}\text{Fe}$ and ${}^{58}_{27}\text{Ni}$ ()

(b) ${}^{35}_{17}\text{Cl}$ and ${}^{37}_{17}\text{Cl}$ ()

(c) ${}^{24}_{11}\text{Na}$ and ${}^{24}_{12}\text{Mg}$ ()

(d) ${}^{16}_8\text{O}$ and ${}^{17}_7\text{N}$ ()

5. In SI base units, 1 becquerel is equal to

(a) 5 disintegration per second ()

(b) 3 disintegration per second ()

(c) 2 disintegration per second ()

(d) 1 disintegration per second ()

6. What was the prediction of Rutherford from his α -particle scattering experiment?

(a) Existence of nucleus ()

(b) Existence of neutron ()

(c) Existence of proton ()

(d) Existence of electron ()

7. The type of ionization chamber which measures voltage pulses due to the entry of individual ionizing particle is

(a) integrating type ()

(b) pulse type ()

(c) spark chamber ()

(d) cloud chamber ()

8. For Cherenkov radiation to be emitted, the velocity of the charged particle v should be

(a) $v < \frac{c}{n}$ ()

(b) $v > \frac{c}{n}$ ()

(c) $v < nc$ ()

(d) None of the above ()

9. Cosmic rays are made up of

(a) protons ()

(b) electrons ()

(c) neutrons ()

(d) All of the above ()

10. The baryon number for proton is

(a) 0 ()

(b) 1 ()

(c) 1 ()

(d) $\frac{1}{2}$ ()

SECTION—B

(Marks : 15)

Answer briefly on the following :

3×5=15

1. State Kepler's laws of planetary motion.

OR

2. Explain K-capture in β^- -decay.

3. Write the semi-empirical mass formula and explain.

OR

4. Proton is having uud quarks whereas neutron has udd. Find the total charge of proton and neutron.

5. Write a note on d'Alembert's principle.

OR

6. Show that the length of the drift tubes in linear accelerator is proportional to $1 : \sqrt{2} : \sqrt{3} : \sqrt{4} \dots$, etc.

7. State the significance of critical size in nuclear reaction. What is supercriticality?

OR

8. Discuss how neutrons are detected in neutron detector.

9. How is the mass of neutron determined?

OR

10. What do you mean by Altitude and Latitude effects in cosmic rays?

(PART : B—DESCRIPTIVE)

(Marks : 50)

The figures in the margin indicate full marks for the questions

1. (a) What is reduced mass? Explain the reduction of two-body problem to one-body problem. 1+4=5
- (b) Deduce Newton's law of gravitation from Kepler's laws of planetary motion. 5

OR

2. (a) What do you mean by constrains? Obtain Lagrange's equations for simple pendulum problems. 1+4=5
- (b) Deduce Hamilton's canonical equation from Lagrange's equation. 5
3. (a) What is quadrupole moment? Explain the terms 'packing fraction' and 'mass defect'. What is the difference between packing fraction and mass defect? 5
- (b) What is binding energy? Using binding energy curve, explain how the stability of nucleus relates with binding energy. 2+3=5

OR

4. (a) State and explain Geiger-Nuttall law. 3
- (b) Discuss the origin of gamma rays. Using appropriate diagram, describe the measurement of gamma ray energies by crystal spectrometer. 2+5=7
- 5 (a) What are the properties of neutron? Classify neutrons according to their kinetic energy. 5
- (b) What do you mean by enriched uranium? Explain in detail uranium-graphite nuclear reactor. 1+4=5

OR

6. (a) Describe the mechanism of proton-proton (p-p) cycle in nuclear fusion. 3
(b) Explain in detail nuclear shell model. 7
7. Using a neat diagram, explain the principle and working of electron synchrotron. How is the phase stability maintained in electron synchrotron? 10

OR

8. (a) How does photomultiplier tube multiply signal? Explain the construction and operation of scintillation counter. 2+3=5
(b) What is a superheated liquid? Explain the construction and action of a bubble chamber with diagram. Mention two advantages of bubble chamber over cloud chamber. 1+3+1=5
9. (a) Write the origin of cosmic rays. What do you mean by East-West effect of cosmic rays? 2+2=4
(b) Explain the term 'primary and secondary' cosmic rays as well as 'soft and hard' components of cosmic rays. Discuss the mechanism of air shower production. 2+2+2=6

OR

10. (a) Discuss in brief 'antiparticle'. What do you mean by 'hypercharge' and 'strangeness'? 3
(b) Explain the six different types of quarks along with their properties. Are quarks fermions or bosons? 6+1=7
