D 140216 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER (CBCSS—U.G.) DEGREE EXAMINATION
APRIL 2026

Physics/Applied Physics

PHY6B12/APH6B12—NUCLEAR PHYSICS AND PARTICLE PHYSICS

(2020 Admission onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in this question paper have their usual meanings.

Section A (Short Answer Type)

Answer **all** *questions in two* **or** *three sentences, each correct answer carries a maximum of* 2 *marks.*

1. Define nuclear binding energy and its significance.
2. Explain the concept of the liquid drop model.
3. What are the key features of the shell model of the nucleus ?
4. Describe the conservation laws in radioactive decay.
5. What is the Mossbauer effect ? Give an example of its application.
6. Differentiate between nuclear fission and nuclear fusion.
7. Explain the role of neutron activation analysis in nuclear applications.
8. What are the working principles of a Geiger-Muller counter ?
9. Describe the function of a Wilson Cloud Chamber in particle detection.
10. What is the purpose of a betatron ?
11. Briefly explain the four fundamental forces in nature.
12. Define the term “quark” and list the six types of quarks.

(Ceiling-20)

Turn over

Section B (Paragraph / Problem Type)

Answer **all** *questions in a paragraph of about* **half a page** *to* **one page**, *each correct answer carries a maximum of* 5 *marks.*

13. Derive the expression for the energy released in an alpha decay process. Also obtain the expression for the Kinetic energy of alpha particle.

14. Explain how nuclear reactors work, and discuss the differences between a fission reactor and a fusion reactor.

15. Describe the working principle of a scintillation counter and its applications.

16. Explain the function of a cyclotron and how it accelerates charged particles.

17. Discuss the Standard Model of particle physics and its components.

18. Radius of the nucleus of a ^{12}C atom is 2.7fm. Determine its nuclear density. Also determine the nuclear radius of ^{238}U.

19. Describe the concept of resonance particles and their role in particle interactions.

(Ceiling - 30)

Section C (Essay Type)

Essays - Answer in about **two pages**, *any* **one** *question.*
The question carries 10 *marks.*

20. Discuss in detail the different types of radioactive decay (alpha, beta, and gamma) and the governing principles behind each.

21. Explain the quark model of particle physics and how it contributes to our understanding of elementary particles.

(1 × 10 = 10 marks)

D 120206 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER (CBCSS—UG) DEGREE EXAMINATION
MARCH 2025

Physics/Applied Physics

PHY6B12/APH6B12—NUCLEAR PHYSICS AND PARTICLE PHYSICS

(Admissions Year—2019 Onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in this question paper have their usual meanings.

Section A (Short Answer Type)

Answer **all** *questions in two* **or** *three sentences, each correct answer carries a maximum of* 2 *marks.*

1. Discuss any *two* properties of nuclear forces.
2. Give four evidences for the existence of magic numbers.
3. Explain the working of Scintillation Counters.
4. Mention any *four* conservation laws governing radioactive decay.
5. Why the nuclei are so small compared to the atom ?
6. Briefly give the working of Cosmotron.
7. Explain the Gamma decay process.
8. What are the basic requirements for a plasma state ?
9. What are the applications of radio isotopes ?
10. What is the strange behavior of kaons and hyperons ?
11. Explain nuclear fission.
12. Explain the terms particle and antiparticle.

(Ceiling = 20 marks)

Turn over

Section B (Paragraph / Problem Type)

Answer **all** *questions in a paragraph of about* **half a page** *to* **one page**, *each correct answer carries a maximum of* 5 *marks.*

13. What is binding energy ? Explain the stability of nucleus and binding energy.

14. Given the following isotopic masses ${}_3Li^7 = 7.016004$, ${}_3Li^6 = 6.015125$ and ${}_0n^1 = 1.008665$. Calculate the binding energy of neutron in ${}_3Li^7$ nucleus. Express the result in u, MeV and Joules.

15. Write the working of Photographic plate ?

16. A cyclotron in which the flux density is 1.4weber/m^2 is employed to accelerate protons. How rapidly should the electric field between the Dees be reversed ? Mass of the proton = 1.67×10^{-27} kg. and charge = 1.6×10^{-19}.

17. Discuss the working principle of Van de Graff electrostatics generator.

18. Explain the basic features of fission reactions that make it useful as a means to generate electrical energy.

19. A reactor is developing energy at the rate of 3000 kW. How many atoms of U^{235} undergo fission per second ? How many kilograms of U^{235} would be used in 1000 hours of operation assuming that on an average energy of 200 MeV is released per fission ?

(Ceiling = 30 marks)

Section C (Essay Type)

Essays - Answer in about **two pages**, *any* **one** *question.*

The question carries 10 *marks.*

20. Explain liquid drop model of a nucleus and arrive at the semi-empirical mass formula.

21. Explain the different elementary particle quantum numbers and their conservation laws with examples.

(1 × 10 = 10 marks)

D 100636 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER U.G. (CBCSS–UG) DEGREE EXAMINATION, MARCH 2024

Physics/Applied Physics

PHY6B12/APH 6B 12—NUCLEAR PHYSICS AND PARTICLE PHYSICS

(2019 Admission onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in this question paper have their usual meanings.

Section A – Short Answer type

Answer **all** *questions in two or three sentences, each correct answer carries a maximum of* 2 *marks.*

1. Explain the correction in the binding energy formula obtained using liquid drop model.
2. Why do heavy nuclei have more neutrons than protons ?
3. Write a short note on radio isotope production in nuclear reaction.
4. What is the strange behavior of kaons and hyperons ?
5. What is the working principle of an intersecting beam accelerator ?
6. Give the list of leptons. Mention the charge of each particle.
7. What do you mean by quantum chromodynamics ?
8. In general, would you expect fission fragment to decay by positive or negative beta decay ? Why ?
9. Comment on the property of nuclear force.
10. List some similarities and difference between the properties of photons and neutrinos.
11. Explain the working of semiconductor counters.
12. Explain why a fusion reactor requires a high particle density, a high temperature and a long confinement time ?

(Ceiling 20 marks)

Section B - Paragraph / Problem type

Answer **all** *questions in a paragraph of about half a page to one page, each correct answer carries a maximum of* 5 *marks.*

13. Consider a single helium nucleus formed by the fusion of two deuterium nuclei. Mass of ${}_1H^2 = 2.014102u$; mass of ${}_2He^4 = 4.002604u$. Find out the energy released in fusion.
14. Distinguish between fission and fusion reactions. Explain the fusion process in stars.

Turn over

15. Determine whether the following reactions are allowed or forbidden.

    (i) $p + p \rightarrow n^{+} + p + \pi^{+}$.

    (ii) $p + \pi^{-} \rightarrow \pi^{0} + n$.

    (iii) $e^{+}e^{+} \rightarrow \mu^{+} + \pi^{-}$.

16. Discuss briefly low energy reaction kinematics.

17. The disintegration constant λ of a radioactive element is 0.00231 per day. Calculate its half-life and average life.

18. Discuss the Quark model.

19. A reactor is developing energy at the rate of 3000kW. How many atoms of U^{235} undergo fission per second ?

(Ceiling 30 marks)

Section C - Essay type

Essays - Answer in about two pages, any **one** *question.*
Answer carries 10 *marks.*

20. Using a neat diagram explain the working principle of Van de Graaff electrostatic generator.

21. Explain the different elementary particle quantum numbers and their conservation laws with examples.

(1 × 10 = 10 marks)

C 40627 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER U.G. DEGREE EXAMINATION, MARCH 2023

(CBCSS—UG)

Physics/Applied Physics

PHY 6B 12/APH 6B 12—NUCLEAR PHYSICS AND PARTICLE PHYSICS

(2019 Admissions onwards)

Time : Two Hours Maximum : 60 Marks

The symbols used in question paper have their usual meanings.

Section A (Short Answer Type)

Answer **all** *questions in two* **or** *three sentences.*
Each correct answer carries a maximum of 2 *marks.*

1. What are Isotopes ? Give an example.
2. Explain the electron capture process.
3. What do you mean by radiocarbon dating ?
4. Explain Lawson's criterion for fusion reactors.
5. Draw the schematic of a pressurized water nuclear reactor.
6. Draw the count rate versus applied voltage of a GM tube and indicate the different regions.
7. What are the basic requirements of a neutron counting system ?
8. Explain the working principle of an intersecting beam accelerator.
9. Compare the basic properties of particles and antiparticles. Give an example.
10. What is the strange behavior of kaons and hyperons ?
11. List the different quarks and their charges.
12. Give the essence of electroweak theory.

(Ceiling 20)

Turn over

Section B (Paragraph/Problem Type)

(Answer **all** *questions in* **a paragraph** *of about* **half a page to one page**.
Each correct answer carries a maximum of 5 *marks.*

13. The half-life of radon is 3.8 days. After how many days will only one twentieth of a radon sample be left over ?

14. Draw the schematic of an ionization chamber and indicate the parts involved.

15. Using a suitable figure, explain the working principle of a linear accelerator.

16. Explain the advantage of a synchrocyclotron over a cyclotron.

17. Calculate the threshold kinetic energy for the reaction $p + {}^{3}_{1}H_{2} \rightarrow {}^{2}_{1}H_{1} + {}^{2}_{1}H_{1}$, if the protons are incident on ${}^{3}_{1}H$ at rest.

18. Find the Q value of the following decay $K^0 \rightarrow \pi^+ + \pi^-$.

19. Name the conservation law that would be violated in the following decay $p + p \rightarrow p + n + K^+$.

(Ceiling 30)

Section C (Essay Type)

Answer in about **two pages**, *any* **one** *question.*
Answer carries 10 *marks.*

20. Discuss the essential properties of an atomic nucleus: constituents, size, shape, mass and binding energy.

21. Explain the proton-proton and carbon cycles of nuclear fusion.

(1 × 10 = 10 marks)

C 20660 **(Pages : 2)** **Name.....**

Reg. No.....

SIXTH SEMESTER U.G. DEGREE EXAMINATION, MARCH 2022

(CBCSS—UG)

Physics/Applied Physics

PHY 6B 12/APH 6B 12—NUCLEAR PHYSICS AND PARTICLE PHYSICS

(2019 Admissions)

Time : Two Hours Maximum : 60 Marks

The symbols used in question paper have their usual meanings.

Section A (Short Answer Type)

Answer at least **eight** *questions.*
Each question carries 3 *marks.*
All questions can be attended.
Overall Ceiling 24.

1. Discuss any *two* properties of nuclear forces.
2. Draw a typical binding energy per nucleon versus mass number plot indicating its features.
3. Explain the Gamma decay process.
4. Distinguish between prompt and delayed neutrons.
5. What are the basic requirements for a plasma state ?
6. What is the working principle of a proportional counter ?
7. What is the working principle of a Van de Graaff accelerator ?
8. Draw the schematic of a proton synchrotron.
9. What is the working principle of an intersecting beam accelerator ?
10. Give the list of leptons. Mention the charge of each particle.
11. What is the strange behavior of kaons and hyperons ?
12. What do you mean by quantum chromodynamics ?

(8 × 3 = 24 marks)

Turn over

Section B (Paragraph/Problem Type)

Answer at least **five** *questions.*
Each question carries 5 *marks.*
All questions can be attended.
Overall Ceiling 25.

13. Estimate the binding energy of the nucleus $^{12}_{6}C$. Also determine its density.
14. With the help of a neat diagram, explain the working principle of a Wilson cloud chamber.
15. Briefly explain the working principle of a proportional counter using a suitable figure.
16. Using a suitable figure, discuss the principle of a betatron accelerator.
17. Determine the energy released when three alpha particles combine to form ^{12}C.
18. Find the Q value of the following decay.

    $\pi^- \rightarrow \mu^- + \nu_\mu$

19. Name the conservation law that would be violated in the following decay.

    $\nu_e + p \rightarrow e^+ + n.$

(5 × 5 = 25 marks)

Section C (Essay Type)

Answer any **one** *question.*
The question carries 11 *marks.*

20. Explain the conservation laws in radioactive decays using suitable examples.
21. Discuss the stages involved in nuclear fission illustrating examples. Explain the basic features of fission reactions that make it useful as a means to generate electrical energy.

(1 × 11 = 11 marks)