18U608 (Pages: 2) Name: ……..…….

Reg. No……..……

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, APRIL 2021

(CUCBCSS - UG)

(Regular/Supplementary/Improvement)

CC15U PH6 B12 - NUCLEAR PHYSICS, PARTICLE PHYSICS AND ASTROPHYSICS

(Physics - Core Course)

(2015 Admission onwards)

Time: Three Hours Maximum: 80 Marks

The symbols used in this question paper have their usual meanings

Section A (Answer in a word or a phrase)

Answer ***all*** questions. Each question carries 1 mark.

1. When an electron is captured by a nuclear proton, the resulting particle is ……..
2. Graphite is used as a …….. in nuclear reactors.
3. The dimension of nuclear cross-section is ……..
4. A Tokamak is employed for …….. confinement of plasma.
5. The …….. is the nearest supernova remnant.

Write True or False:

6. A proportional counter is used for neutron counting.
7. Secondary cosmic rays mainly contain alpha particles.
8. Hyper charge is equal to sum of lepton number and strangeness.
9. When a charged particle moves through a magnetic field it suffers a change in its energy.
10. Gauge invariance is related to conservation of charge

(10 × 1 = 10 Marks)

Section B (Answer in two or three sentences)

Answer ***all*** questions. Each question carries 2 marks.

11. What are magic numbers?
12. What is inverse β decay?
13. What is east – west effect of cosmic rays?
14. Draw the count rate versus voltage characteristics of a G.M counter.
15. Give the quark structure of proton and neutron.
16. Explain why cyclotron cannot be used to accelerate electrons.
17. What is Schwarzschild radius?

(7 × 2 = 14 Marks)

Section C

Answer in a paragraph of about half a page to one page.

Answer any ***five*** questions. Each question carries 4 marks.

18. Prove that nuclear electrons do not exist inside the nucleus using uncertainty principle

19. Explain the proton – proton cycle of nuclear fusion in stars?
20. Write a note on cosmic ray showers.
21. What are semiconductor detectors? Explain.
22. List the four fundamental interactions and compare the characteristics.
23. What is the principle of working of an electron synchrotron?
24. Explain H-R Diagram and mention its uses.

(5 × 4 = 20 Marks)

Section D

(Problems - write all relevant formulas, all important steps carry separate marks)

Answer any ***four*** questions. Each question carries 4 marks.

25. Find the Binding energy per nucleon of $^{56}_{26}Fe$. Given mass of $^{1}_{1}H$ = 1.007825u Mass of neutron=1.008665u and Mass of $^{56}_{26}Fe$ = 55.934939u.
26. The relative radio carbon activity in a piece of charcoal from the remains of an ancient campfire was 0.1 of a contemporary specimen. How long ago did the fire occur? $T_{1/2}$ for radioactive carbon = 5760 years.
27. Derive the relation $\boldsymbol{K_\alpha = \left(\frac{A-4}{A}\right) Q}$, for the kinetic energy of the alpha particle released in the decay of a nucleus of mass number *A*.
28. Analyse the following decays or reactions for possible violations of the basic conservation laws. In each case state which conservation law, if any are violated and through which interaction the process will most likely proceed

    $(\boldsymbol{a})$ $\boldsymbol{K^- \rightarrow \pi^+ + e^+ + e^-}$ $(\boldsymbol{b})$ $\boldsymbol{\lambda^0 + p \rightarrow \Sigma^+ + n}$
29. In a linear accelerator, proton accelerated thrice by a potential of 40kV leaves a tube and enters an accelerating space of length 30cm before entering the next tube. Calculate the frequency of the r.f voltage?
30. Derive the relation between Astronomical Unit, light year and Parsecond.
31. Determine the luminosity of a star of radius four times the radius of sun and effective temperature twice as that of sun if the luminosity of sun is 3.84×10^{33}erg/s.

(4 × 4 = 16 Marks)

Section E (Essays – Answer in about two pages)

Answer any ***two*** questions. Each question carries 10 marks.

32. Explain liquid drop model of nucleus? How does it lead to the semi empirical mass formula?
33. Explain the tunnel theory of α-decay and derive the expression for decay constant.
34. Discuss the important quantum numbers and the conservation laws in elementary particle physics.
35. Explain the principle, construction, working and limitations of a linear accelerator.

(2 × 10 = 20 Marks)

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