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D6BPH1803 (S3) (PAGES 2) **Reg. No.....**

Name: .....

SIXTH SEMESTER B.Sc. DEGREE EXAMINATION, APRIL 2024

(Supplementary - 2018 Admission)

PHYSICS

APHY6B12T: NUCLEAR PHYSICS, PARTICLE PHYSICS & ASTROPHYSICS

Time: 3 Hours **Maximum Marks: 80**

SECTION A: Answer *all* questions each in two or three sentences. Each carries *one* mark.

1. What are isotopes? Give an example.
2. List the magic numbers. Which model was used to explain magic numbers?
3. What are the different types of radioactive decays?
4. Name any two gas filled counters for particle detection.
5. What is meant by cosmic ray showers?
6. What are hadrons? Name a hadron.
7. What is meant by apparent luminosity?
8. What is Schwarzschild radius?

(8 x 1 = 8 Marks)

SECTION B: Answer any *six* questions each in about a page. Each carries *four* marks

9. What is Nuclear Magnetic Resonance (NMR)? Explain an application based on NMR.
10. Prove that electrons do not exist inside the nucleus using uncertainty principle.
11. Explain the proton – proton cycle of nuclear fusion in stars.
12. With a neat diagram, explain the working of a scintillation counter.
13. Discuss the working principle of a LINAC.
14. Explain the fundamental interactions in nature.
15. Describe the construction and working of a cloud chamber
16. Explain the quark model of hadrons.
17. Explain H R Diagram and mention its uses.

(6 x 4 = 24 Marks)

SECTION C: Answer any *eight* questions. Each carries *four* marks.

18. Estimate the binding energy of the nucleus $^{12}C_6$. Also determine its density.
19. Find the energy difference the spin up and spin down states of a proton in a magnetic field of B= 1 T (b) What is the Larmor frequency of a proton in this field? Given $\mu_{pz} = 2{,}793\ \mu_N$ and $\mu_N = 3.153 \times 10^{-8}\ eV/T$. and $h = 4.136 \times x\ 10^{-15} eV.s$
20. A piece of wood from the ruins of an ancient dwelling was found to have a *C-14* activity of 13 disintegrations per minute per gram of its carbon content. The *C-14* activity of living wood is 16 disintegrations per minute per gram. How long ago did the tree died from which the wood sample came?

(PTO)

21. Derive the relation for half-life and mean life of a sample. Also find the relation between the two.
22. Find the energy needed to remove a neutron from ^{81}Kr, ^{82}Kr, and from ^{83}Kr Why is the figure for ^{82}Kr different from others?
23. A particle of energy 5 MeV pass through an ionization chamber at the rate of 10 per second. Assuming all the energy is used in producing ion pairs, calculate the current produced. (35 eV is required for producing an iron pair and $e = 1.6 \times 10^{-19} C.$)
24. It is required to operate a proportional counter with a maximum radial field of $10^7 Vm^{-1}$. What is the applied voltage required if the radii of the wire and the tube are 0.002cm and 1 cm respectively?
25. 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.
26. In a cyclotron the strength of the magnetic field is 0.954Wbm-2 and the dees are dimensioned so that the accelerated protons emerge tangentially at a distance of 0.15m from the centre. What should be the frequency of the oscillator and the energy in MeV of the emerging protons? ($m_p = 1.67 \times 10^{-27} kg.$)
27. State whether the reactions are possible or not and classify the type of interaction
    $(a) p + K^- \rightarrow \pi^0 + \Lambda^0 \quad (b) p + \pi^+ \rightarrow \Sigma^+ + K^+ \quad (c) K^- + p \rightarrow \Omega^- + K^+ + K^0$
28. Give the quark content of π^+, Σ, Ω^- and p.
29. Derive the relation between Astronomical Unit, light year and Par second.

(8 x 4 = 32 Marks)

SECTION D: Answer any *two* in about two pages. Each carries *eight* marks.

30. Obtain the expression for the binding energy per nucleon of a nucleus using liquid drop model. Discuss the corrections to the expression from asymmetry energy and pairing energy and obtain the semi empirical binding energy formula.
31. Explain the instrumentation and working of a nuclear fission reactor.
32. Describe the construction and working of a Betatron.
33. What are the important quantum numbers and conservation laws in elementary particle physics?

(2 x 8 = 16 Marks)