

(4)

6. (a) What is isospin quantum number? How was it assigned to particles? Explain with example. 4
- (b) Draw baryon octet (spin parity = $\frac{1}{2}^+$) in weight diagram. 5
- (c) Write down the quark contents of any six members of the above mentioned baryon octet with proper justification. 6
7. (a) Draw the number of ion-pairs collected vs applied voltage graph for gas filled detectors and name each region. Describe working of the first region. 3+3=6
- (b) What are Townsend avalanche and gas multiplication factor? 3
- (c) What do you mean by resolving time in a G. M. counter? The resolving time of a G. M. counter is 100 μ s. Find the true counting rate, if the measured rate is 10000 counts per min. 2+2=4
- (d) What are the uses of dynodes in a scintillation counter? 2

★ ★ ★

Ex/SC/PHY/UG/DSE/TH/02/A1/2024

BACHELOR OF SCIENCE EXAMINATION, 2024

(3rd Year, 1st Semester)

PHYSICS

PAPER : DSE/TH/02/A1

(Nuclear & Particle Physics)

Time : Three Hours

Full Marks : 75

Answer *any five* questions.

The figures in the margin indicate full marks.

1. (a) What do you mean by binding energy per nucleon of an atomic nucleus? How can it be estimated from the knowledge of atomic and neutron masses? Binding energy per nucleon is almost constant for most of the nuclei — why? Approximately how much energy is required to separate all the nucleons from Silver-108 nucleus? What kind of forces act between the nucleons within the nucleus and is there any difference between them? 1+2+2+2+2=9
- (b) Find the ratio of volumes of C-12 and O-16 nuclei. What is the magnetic moment of a neutron and what does it indicate? Calculate the magnetic moment of O-16 nucleus? 2+2+2=6

(2)

2. (a) Radium nucleus emits alpha particles but not He-3 or H-3 — explain. Calculate the energy of the emitted alpha particle from a nucleus (mass no. 204), if the recoiling nucleus has energy 0.1 MeV. $2+3=5$
- (b) Draw beta energy spectrum. Why is it continuous in nature? The end point energy is almost equal to the Q value of the process – what does it indicate? $1+1+2=4$
- (c) What are the processes by which a gamma beam is attenuated in a material? Which process is predominant at low energies and how its probability varies with energy? Among the other processes which one has energy threshold for its occurrence and why such threshold exists? $1+2\frac{1}{2}+2\frac{1}{2}=6$
3. (a) Discuss the principle of acceleration of a charged particle in a Cyclotron with a suitable diagram. Show that maximum energy obtainable in a Cyclotron is proportional to the square of the radius of the dees. What kind of problem will arise when the velocity of the particle becomes relativistic? How the problem is tackled in a Synchrotron and Synchrocyclotron? Why is it not suitable accelerating electron? $4+2+1+2+2=11$
- (b) A betatron has a magnetic current supply frequency of 60 Hz and the peak magnetic flux density at the orbit is 0.5 Wb/m^2 . If the radius of the electron orbit is 0.75 m, then calculate (i) the final energy of the electrons and (ii) the total time of flight of electrons. 4

(3)

4. (a) What do you mean by elementary particles? How are they classified? Which among them are the constituents of matter? What is the role of the other type of elementary particles? 4
- (b) What are antiparticles? Give example. Mention a particle which is its own antiparticle. 3
- (c) What are leptons? Mention name, symbol and electric charge of all the leptons including anti-leptons. Mention the type of interaction/interactions in which electron and electron neutrino can take part. $1+3+2=6$
- (d) Are all leptons stable? Justify your answer. 2
5. (a) “All mesons are unstable and not abundant in nature.” – Explain with example. 2
- (b) What are strange particles? 2
- (c) Which basic interaction allows flavor changing of quarks? Explain with one example. 2
- (d) What are gluons? What are the basic difference between a gluon and a photon? 2
- (e) What is the natural source of high energy particles? How can you infer that they are mainly positively charged particles? Draw a graph to show its altitude effect and explain the effect. What is the problem in using it as a projectile for high energy experiments? $1+2+3+1=7$