c) Write down Gellmann Nishijima formula and explain each term. 2

d) What do you mean by primary and secondary Cosmic rays? What are their main constituents? Explain how the secondary cosmic ray particles are formed mentioning the relevant decay schemes. 3+4

7. a) Describe the difference between the working of an ionisation chamber and a GM counter and show their respective regions of operation in the curve – "Number of ion-pairs collected vs Applied voltage". 7

b) Explain the phenomenon of quenching in a GM counter. 3

c) Calculate the number of ion pairs formed in a proportional counter, if a 60 MeV ^{28}Si ion is completely stopped in it. Given gas multiplication factor is 1200 and energy required to create one ion pair is 32 eV. 2

d) Give the basic principle of conversion of light into an electrical pulse and its amplification in a scintillation counter. 3

B. Sc. Physics (Hons.) Examination, 2023

(3rd Year, 1st Semester)

Nuclear & Particle Physics

Paper – UG/Sc/DSE/PHY/TH / 02 /A1

Time : Three hours   Full Marks : 75

Answer *any five* questions.   5×15

1. a) Show the variation of nuclear mass density with distance from the centre. Nuclear mass density is almost constant for all the nuclei – Justify. 2+3

b) What do you mean by nuclear spin? Nuclear spin is always small though it can contain large number of neutrons and protons. Explain. 2+3

c) Show that theoretically Alpha energy spectrum should be mono-energetic. How can the existence of fine structure of alpha spectrum be explained? 3+2

2. a) An Alpha and a beta particle are moving through some medium. Draw a simple picture to show their paths in the medium. Why are they different? 2+2

b) What do you mean by stopping power? Find the ratio of stopping powers of a proton and an alpha particle moving with same velocity in a medium.

A proton and a deuteron are moving through some absorber material with equal energy. Which one will stop first? Justify your answer. 2+2+1+2

[Turn over

c) What are the processes by which a gamma beam can interact with matter? Which one will be predominant at very low energies? Describe how its cross-section varies with energy. 1.5+0.5+2

3. a) Why Cyclotron not suitable for accelerating electron to high energies? Discuss the basic principle of acceleration of electrons in a Betatron. Show that non-uniform magnetic field over the total orbit region is required and find the relation between average magnetic field and the magnetic field at the orbit position. Why do we not get continuous beam from a betatron? 2+2+4+2

b) Calculate the maximum energy of a proton (mass = 1.67×10^{-27} kg) moving inside a cyclotron operated at 1 Wb/m^2 describing a radius of 0.6m. Maximum value of the alternating potential difference applied to the dees is 50kV. Find the number of revolutions made by the proton to gain the energy. 5

4. a) What is a compound nuclear reaction? 1

b) What does the X in the following reaction represent? Explain how you arrive at your answer.

$$^{14}_{7}N(X,p)^{17}_{8}O$$
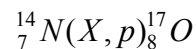
Write the compound nucleus formed in the above reaction. 3

b) What is the Q value of a nuclear reaction? Classify nuclear reactions in terms of Q value. 3

c) Define the threshold energy for a nuclear reaction and derive an expression for it for the reaction *X(a,b)Y* in terms of Q value and other relevant parameters. 4

d) Calculate the threshold energy for reaction. Given

$$m(n) = 1.008983 \text{ amu}$$
$$m(\alpha) = 4.003879 \text{ amu}$$
$$m(^{14}N) = 14.007550 \text{ amu}$$
$$m(^{11}B) = 11.012811 \text{ amu}$$ 4

5. a) What is weight diagram? 2

b) Draw nine pseudoscalar mesons (spin parity $= 0^-$) in weight diagram. 5

c) Write down the quark contents of any six members of the above mentioned meson octet with proper justification. 6

d) Indicate the difference in quark composition of a baryon and a meson as per the quarks model. 2

6. a) What are 2nd generation leptons? Discuss about their lifetime and decay. Why neutrinos are difficult to detect? 1+2+1

b) What is isospin? Discuss with example. 2