

PHY6B12:NUCLEAR PHYSICS AND PARTICLE PHYSICS

A Part

1. Distinguish between mass number and atomic number ?
2. How many protons and neutrons are present in an isotope of uranium with mass number 235 ?
3. What are isotopes ?
4. Distinguish between isotopes and isobars
5. What is meant by binding energy of a nucleus ?
6. What is meant by Proton and Neutron Separation Energies ?
7. Give Semiempirical binding-energy formula and value of constants in it ?
8. What are magic numbers in the nucleus ?
9. Write any two properties of liquid drop model
10. Distinguish between decay constant and activity in nuclear decay ?
11. What is carbon dating method?
12. Give expression of exponential law of radioactive decay ?
13. Write a short note on three different nuclear decay processes ?
14. Write any properties of nuclear force
15. What is meant by half-life of a nuclear decay ?
16. What is beta decay process ?
17. What is an alpha decay ?
18. Write down equations for 'Q value' calculation in different beta decay processes ?
19. What is meant by radioactivity?
20. What is electron capture process?
21. What is gamma decay process ?
22. What is a nuclear reaction ? Give an example ?
23. Give the relationship between reaction cross section and the rate of emission of outgoing particle in a nuclear reaction ?
24. What is meant by Q-value of a reaction?
25. What is reaction cross section in a nuclear reaction ?
26. Write down expression for Q-value of a nuclear reaction and explain the symbols ?
27. Write down expression for activity of a radio isotope produced in nuclear reaction and explain the symbols ?
28. How do we produce radio isotopes through nuclear reactions ?

29. What is meant by threshold kinetic energy of a projectile involved in a nuclear reaction ?
30. What is the use of cadmium rods in a nuclear reactor ?
31. What is induced nuclear fission ?
32. What is the function of moderators in nuclear reactors ?
33. What is nuclear fission reaction ?
34. What is nuclear fusion reaction ?
35. Differentiate between nuclear fission and fusion reactions ?
36. What are the applications of medical radiation physics ?
37. Give any three uses of neutron activation analysis ?
38. What is neutron activation analysis ?
39. Mention three applications of cloud chamber ?
40. What is an ionization chamber ?
41. What is a nuclear radiation detector?
42. What is a Wilson cloud chamber ?
43. What is a bubble chamber ?
44. What is a Geiger-Muller counter ?
45. What is a proportional counter ?
46. What are the advantages of scintillation counters ?
47. What is a semiconductor detector ?
48. What is Cerenkov radiation ?
49. What is the principle of linear accelerator?
50. What are accelerators?What is their uses?
51. What is a linear accelerator?
52. Write down the reaction of the first artificially transformed element using Cockcroft-walton accelerators?
53. What are the uses of linear accelerators?
54. What are the limitations of linear accelerators?
55. What is the difference between linear accelerator and a cyclotron?
56. What is the principle of Cockcroft-walton accelerators?
57. Can electron be accelerated by cyclotron.Why?
58. What is the basic difference between a cyclotron and a betatron?
59. What is a betatron?

60. What is the principle of cyclotron?
61. What is cyclotron frequency?
62. What is an electron synchrotron?
63. What is the difference between electrostatic accelerator and cyclic accelerators?
64. Write down the beatatron condition and explain the symbols used?
65. Write down an expression for cyclotron frequency and explain the symbols used ?
66. What is a synchrotron?
67. What is the disadvantage of proton synchrotron?
68. What is the difference between electron and proton synchrotron?
69. Draw a diagram of intersecting beam accelerator and label it?
70. What is the basic idea of intersecting beam accelerator?
71. What is proton synchrotron?
72. Give the names of three accelerators still in use?
73. What is an ISR?
74. What is the use of proton synchrotron?
75. What is an intersecting beam accelerator?
76. Which forces are to be considered while determining the stability and structure of nuclei?
77. Name the four basic forces in nature?
78. What is antihydrogen atom?
79. Distinguish between particles and antiparticles?
80. Name the three types of neutrinos?
81. Do all strongly interacting particles also feel weak interaction?
82. What are elementary particles?
83. How will you distinguish between weak force and strong force?
84. What are Fermions and Bosons?
85. Give an example for strangeness conservation?
86. What are leptons? Give their names?
87. What are mesons? Name three of them?
88. Give an example for lepton number conservation?
89. What are the types of interactions that baryons take part?
90. Classify the elementary particles on the basis of mass.

91. What are the types of interactions that leptons take part?
92. Give an example for baryon number conservation?
93. What are baryons? Name three of them?
94. In particle interaction and decays the beam particle and target particle are protons. Why?
95. In high energy particle physics, the neutral particles produced in reactions leave no tracks in the bubble chamber. Then how will we estimate their lifetime?
96. Give an example for the formation of resonance particle?
97. Write down an expression for threshold kinetic energy in particular reactions and explain the symbols used
98. What is meant by threshold energy in high energy particle reactions?.
99. What are resonance particles?
100. In high energy particle physics, lab frame or CM frame which is more efficient to conduct experiments?
101. What is meant by efficiency of a nuclear particle reaction?
102. How do we improve the efficiency of particles reaction?
103. Which are the mediating particles of electroweak force?
104. What is standard model?
105. What are quarks?
106. What is quarkonium?
107. Write down the names of all field particles?
108. What are messenger or field particles?
109. Give the names of flavours of quarks?
110. What is neutrino oscillation?
111. What is meant by quark confinement?
112. What is meant by flavour of quarks?
113. Write down the decay of a negatively charged pion?
114. What are Higgs bosons?
115. Write down the decay of a positively charged pion?
116. What is meant by colour of quarks?
117. What is quantum chromodynamics?
118. What is electroweak theory?
119. What is graviton?
120. Protons and neutrons are made up of quarks. Explain?

B Part

121. Explain about nuclear sizes, density and shape ?
122. Find the resultant mass if we could produce a nucleus with a radius of 1 cm ?
123. Compute the approximate nuclear radius of carbon ($A = 12$), germanium ($A = 70$), and bismuth ($A = 209$) ?
124. Compute the density of a typical nucleus ?
125. Show that all nuclei have roughly the same central density ?
126. Find the total binding energy B and also the average binding energy per nucleon B/A for ^{56}Fe ?
127. Explain nuclear binding energies ?
128. Find the proton separation energy and the neutron separation energy of ^{125}Te ?
129. Find the total binding energy B and also the average binding energy per nucleon B/A for ^{238}U ?
130. Discuss about shell model of nucleus ?
131. Using semiempirical binding energy formula calculate binding energy of ^{64}Zn ?
132. Discuss about liquid drop model of nucleus ?
133. What are Conservation Laws in Radioactive Decays ?
134. Explain the properties of nuclear forces ?
135. Discuss about the exchange particle in nuclear forces and its rest mass energy ?
136. The half-life of ^{198}Au is 2.70 days. What is the decay constant of ^{198}Au ? Suppose we had a 1.00 μg sample of ^{198}Au , What is its activity?
137. Explain different beta decay processes in detail ?
138. Find the kinetic energy of the alpha particle emitted in the alpha decay process $^{226}\text{Ra} \rightarrow ^{222}\text{Rn} + ^4\text{He}$?
139. ^{40}K is an unusual isotope, in that it decays by negative beta emission, positive beta emission, and electron capture. Find the Q values for these decays.
140. Explain Quantum Theory of Alpha Decay ?
141. Three different rock samples have ratios of numbers of ^{238}U atoms to ^{206}Pb atoms of 0.5, 1.0, and 2.0. Compute the ages of the three rocks.
142. Compute the Q value for the $^{238}\text{U} \rightarrow ^{206}\text{Pb}$ decay chain, and find the rate of energy production per gram of uranium.
143. Explain how radio activity can be used for calculating age of rocks ?
144. Explain radio carbon dating process for calculating age of fossils ?
145. ^{12}N beta decays to an excited state of ^{12}C , which subsequently decays to the ground state with the emission of a 4.43 MeV gamma ray. What is the maximum kinetic energy of the emitted beta particle?

146. For a certain incident proton energy the reaction $p + {}^{56}\text{Fe} \rightarrow n + {}^{56}\text{Co}$ has a cross section of 0.40 b. If we bombard a target in the form of a 1.0 cm^2 , $1.0 \text{ }\mu\text{m}$ -thick iron foil with a beam of protons equivalent to a current of $3.0 \text{ }\mu\text{A}$, and if the beam is spread uniformly over the entire surface of the target, at what rate are the neutrons produced ?
147. In nuclear reaction experiments, we usually measure two basic properties of the emitted particle y ; its energy and its probability to emerge at a certain angle with a certain energy. What useful information can we obtain from it ? Explain ?
148. Calculate the threshold kinetic energy for the reaction $p + {}^3\text{H} \rightarrow {}^2\text{H} + {}^2\text{H}$ (a) if protons are incident on ${}^3\text{H}$ at rest; (b) if ${}^3\text{H}$ (tritons) are incident on protons at rest ?
149. Thirty milligrams of gold are exposed to a neutron flux of $3.0 \times 10^{12} \text{ neutrons/cm}^2/\text{s}$ for 1.0 min. The neutron capture cross section of gold is 99 b. Find the resultant activity of ${}^{198}\text{Au}$?
150. Calculate the activity of radio isotope Y that is produced from a given exposure to a stable isotope X by a certain quantity of the particle x for a certain time t ?
151. Compute the Q value for the reaction ${}^2\text{H} + {}^{63}\text{Cu} \rightarrow n + {}^{64}\text{Zn}$ in SI unit (Joule).
152. Explain the process of electric power generation using nuclear fission process ?
153. Explain nuclear fusion process. How it can be used for electric power generation ?
154. Explain the technique of neutron activation analysis ?
155. What are the applications of medical radiation physics ?
156. How nuclear physics is used for diagnostic and therapeutic purposes in medical field ?
157. Explain the principle and working of an bubble chamber ?
158. Explain the principle and working of a Cloud chamber ?
159. Explain the principle and working of a ionization chamber ?
160. Describe the principles of nuclear radiation detection ?
161. Explain the principle and working of Scintillation counters ?
162. Explain the principle and working of Geiger-Muller Counter ?
163. Explain the principle and working of proportional counter ?
164. Explain the principle and working of semiconductor counter ?
165. Explain the principle and working of Spark chamber?
166. Explain the principle and working of Cerenkov counter ?
167. Explain the principle and working of cockcroft-walton accelerator
168. Explain the principle and working of linear accelerator
169. Explain the working of van de graaff generator with neat diagram
170. Explain the principle of betatron

171. The electric field in cyclotron is reversed every 9.372×10^{-8} sec. it is used to accelerate deuterons, each of mass 3.34×10^{-27} kg and charge 1.6×10^{-19} C. Calculate the flux density of the magnetic field.
172. Solve an expression for maximum energy of a particle and cyclotron frequency in cyclotron
173. A cyclotron is connected to the oscillator of frequency 15 MHz. what should be the operating magnetic field for accelerating protons. the radius of dees is 60 cm. calculate the maximum kinetic energy of proton in eV, the mass of the proton = 1.67×10^{-27} kg.
174. A cyclotron with dees of radius 0.9 m has a magnetic field of 0.8 T. calculate the generator frequency required to accelerate the proton to 25 MeV
175. What radius is needed in proton synchrotron to attain particle energies of 10 GeV. assume that magnetic field available is 1.5 T
176. Explain the principle of synchrocyclotron
177. Explain the principle of alternating gradient synchrotron
178. An electron after being accelerated through a potential difference of 100 V enters a uniform magnetic field of 0.004 T perpendicular to its direction. calculate the radius of the path described by the electron
179. Explain the differences between four basic forces
180. Write a brief note on any three families of particles. what is lepton number conservation? Give examples.
181. Explain the conservation of strangeness number with examples
182. What is lepton number conservation? Give examples
183. What is baryon number conservation . give examples
184. A negative muon collides with a proton, a neutron plus another particle is formed. what is the other particle
185. What is nucleon number conservation. write any two examples
186. A positive pion collides with a proton, two protons plus another particle are created. what is the other particle.
187. Explain what is meant by resonance and resonance particles
188. What is meant by efficiency of a nuclear particle reaction? How do we improve the efficiency of particles reaction?
189. Quarks have fractional charges. justify with two examples
190. Conclude the Gellmann attributes of quarks
191. Explain briefly the standard model of quarks
192. Explain the emergence of colour of quarks

C Part

193. Explain nuclear properties such as constituents, mass, size, shape, density, binding energy, nuclear forces, etc.
194. Explain the postulates of liquid drop model. Derive the Weizsacker Semi-empirical mass formula.

195. Explain liquid drop model of nucleus and obtain binding energy of a nucleus of atomic number Z and mass number A based on the model ?
196. Obtain an expression for calculating binding energy of a nucleus of atomic number Z and mass number A based on liquid drop model ?
197. Explain alpha, beta and gamma decay processes in detail ?
198. Explain the process of generating electric power using nuclear fission method
199. Explain the construction and working of a nuclear fission reactor ?
200. How fission and fusion reactions can be used to generate electrical power ?
201. Explain the process of Nuclear fusion with necessary theory
202. Discuss about applications of nuclear physics ?
203. Explain the principle, construction and working of a ionization chamber and scintillation counter.
204. Explain the principle, construction and working of Cloud chamber and bubble chamber
205. Explain the principle, construction and working of proportional counter and Geiger-Muller counter
206. Explain the principle, construction and working of the two types of semiconductor detectors with neat diagrams
207. Explain the principle, construction and working of Spark chamber and Cerenkov counter
208. Explain the principle, construction and working of Linear accelerator and Vande graff generator with suitable diagrams
209. Explain the principle, construction and working of cyclotron. Differentiate it with synchocyclotron.
210. Describe the principle, construction and working of electron synchrotron and proton synchotron with neat diagrams
211. Describe the principle, construction and working of betatron with neat diagram
212. Give a detailed explanation of families of elementary particles
213. Give an account of various conservation laws in particle reactions of elementary particles

D Part

E Part