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P-003-1016031 Seat No. _____

B. Sc. (Sem. VI) (CBCS) Examination

March / April - 2020

Physics : Paper - 601

(Nuclear & Particle Physics)

(New Course)

Faculty Code : 003

Subject Code : 1016031

Time : $2\frac{1}{2}$ Hours] [Total Marks : **70**

Instructions : (1) All questions are compulsory.
(2) Symbols have their usual meaning.
(3) Figures on right hand sides indicate full marks.

1 (A) Fill up the blank. **4**

(1) Two nuclides are _____ if they have same number of neutrons but different number of protons.

(2) The nuclear shell model is also known as _____ model.

(3) The nuclei having even number of protons and even number of neutrons are called _____ nuclei.

(4) The volume term of semi-empirical mass formula is E_v = _____.

(B) Solve Any **One** : **2**

(1) Find binding energy of ${}_{26}Fe^{56}$. Atomic mass of Fe^{56} is 55.939395 amu, mass of proton is 1.007825 amu and mass of neutron is 1.008665 amu.

(2) Calculate the binding energy of ${}_{29}Cu^{64}$, using semi-empirical mass formula :

$$B.E. = 14A - 13A^{\frac{2}{3}} - 0.583\, Z^2 A^{-\frac{1}{3}} - 19.5(A-2Z)^2 A^{-1} \pm 33.5A^{-\frac{1}{2}}.$$

(C) Answer Any **One** : **3**

(1) Find binding energy of ${}_{24}Cr^{50}$ using Weizsacker's formula. The constants of the formula are : $a = 14.0,\ b = -13.0,\ c = 0.583.\ d = 19.3$ *and* $\delta = 33.5$.

(2) Discuss binding energy.

(D) Answer Any **One** : **5**

(1) Explain intrinsic properties of nucleus.

(2) Explain classification of nuclei.

2 (A) Fill up the blanks : **4**

(1) The α – particles carries _____ unit of positive charge.

(2) ${}_{Z}X^{A} \rightarrow$ _____ $+ \alpha$.

(3) 1 Curie = _____ disintegration / second.

(4) ${}_{Z}X^{A} +$ _____ $\rightarrow {}_{z-1}Y^{A}$.

(B) Solve Any **One** : **2**

(1) A radioactive substance has a half-life period 300 days. Calculate radioactive disintegration constant and the mean life time.

(2) If a radioactive element disintegrates for a period of time equal to its mean life, what fraction of the original amount remains and what fraction will have disintegrated ?

(C) Answer Any **One** : **3**

(1) Identify the nuclei that result from the positive β – decay of ${}_{48}Cd^{107}$, ${}_{19}K^{38}$ and ${}_{51}Sb^{120}$.

(2) Write properties of γ – rays.

(D) Answer any one : **5**

(1) Explain the law of radioactive decay.

(2) Explain three natural radioactive series.

3 (A) Fill up the blank : **4**

(1) In pair production _____ disappear and electron hole pair appears.

(2) The flat region of characteristic curve of G. M. counter is _____ of the counter.

(3) In nuclear reaction, if Q is negative, the reaction is _____

(4) A reaction, ${}_{14}Si^{28} + {}_{2}He^{4} \rightarrow {}_{15}P^{31} + {}_{1}H^{1}$ known as _____ reaction.

(B) Solve Any **One** : **2**

(1) Is the following reaction exoergic or endoergic ? Calculate. ${}_{7}N^{14} + {}_{2}He^{4} \rightarrow {}_{8}O^{17} + {}_{1}H^{1} + Q$.

The atomic masses of N^{14}, He^{4}, O^{17} and ${}_{H}{}^{1}$ are 14.003074 amu, 4.002604 amu, 16.99913 amu and 1.007825 amu respectively Take amu = 931.3 MeV

(2) Write in abbreviated form :

(i) ${}_{7}N^{14} + {}_{0}n^{1} \rightarrow {}_{5}B^{11} + {}_{2}He^{4}$.

(ii) ${}_{12}Mg^{24} + {}_{0}n^{1} \rightarrow {}_{11}Na^{24} + {}_{1}H^{1}$.

(C) Answer Any **One** : **3**

(1) Write in expanded form :

(i) ${}_{79}Au^{197}(\alpha,\alpha)_{79}Au^{197}$.

(ii) ${}_{7}N^{14}(\alpha,p)_{8}O^{17}$.

(iii) ${}_{11}Na^{23}(p,\alpha)_{10}Fe^{20}$.

(2) Explain construction of ionization chamber.

(D) Answer Any **One** : **3**

(1) Describe characteristic of G. M. counter.

(2) Obtain Q-value equation for a nuclear reaction.

4 (A) Fill up the blank : **4**

(1) The time taken by an ion to travel a semi-circle in cyclotron depends only on the _____.

(2) The _____ consist magnets of four segments connected by four equal straight sectors.

(3) ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow$ _____ $+ {}_{36}Kr^{92} + 3\ {}_{0}n^{1} + Q$.

(4) The chain reaction is steady when multiplication factor K = _____

(B) Solve Any **One** : **2**

(1) A reactor is developing energy at the rate of 32×10^{6} Watt. How many atoms of U^{235} undergo fission per second ? Assume that on the average, 200 MeV energy is released per fission.

(2) Calculate the frequency of oscillating potential that must be applied to a cyclotron in which deuterons are accelerated in a constant field of intensity 25000 gauss. Mass of deuteron = 3.34×10^{-27} kg and $q = 1.6 \times 10^{-19} C$.

(C) Answer Any **One** : **3**

(1) Energy released by fission of one nucleus of ${}_{92}U^{235}$ is 200 MeV. How much energy released by 1 kg of uranium ?

(2) Describe self-sustaining chain reaction.

(D) Answer Any **One** : **5**

(1) Explain construction and working of linear accelerator.

(2) Explain principle of phase stability.

5 (A) Fill up the blank : **4**

(1) The Sun radiates _____ joule energy per second.

(2) In nuclear fusion reaction

$_1H^2 +_1 H^2 \rightarrow$ _____ $+ Q.$

(3) Nucleons and hyperons are jointly called _____.

(4) The multiplet number for pions is M = _____

(B) Solve Any **One** : **2**

(1) Complete the reactions :

(i) $_1H^1 +_1 H^1 \rightarrow$ _____ + _____ + _____ + _____.

(ii) $_1H^2 +_1 H^1 \rightarrow$ _____ + _____ + _____

(iii) $_2He^3 +_2 He^3 \rightarrow$ _____ + _____ + _____.

(2) Give the quark model of antineutron and antiproton.

(C) Answer Any **One** : **3**

(1) Write the net result of the following reactions :

$_6C^{12} +_1 H^1 \rightarrow_7 N^{13} + \gamma + 1.95\ MeV.$

$_7N^{13} \rightarrow_6 C^{13} +_1 e^0 + v + 2.22\ MeV.$

$_6C^{13} \rightarrow_1 H^1 \rightarrow_7 N^{14} + \gamma + 7.54\ MeV.$

$_7N^{14} \rightarrow_1 H^1 \rightarrow_8 O^{15} + \gamma + 7.35\ MeV.$

$_8O^{15} \rightarrow_7 N^{15} +_1 e^0 + \gamma + 2.7\ MeV.$

$_7N^{15} +_1 H^1 \rightarrow_6 C^{12} +_2 He^4 + 4.96\ MeV.$

(2) Explain three generations of quarks and leptons.

(D) Answer Any **One** : **5**

(1) Explain the classification of elementary particles.

(2) Explain elementary particle quantum numbers.
