BYJU'S EXAM PREP

Important Questions on Nuclear Chemistry

https://byjusexamprep.com

Important Questions on Nuclear Chemistry

1. The correct order of penetrating power of the following rays is:

A. ϒ>β>α

B. β>α> ϒ

C. α> β> ϒ

D. β> ϒ> α

2. Identify the pair of isotones from the options given below.

A. $^{3}_{1}H$,$^{3}_{2}He$

B. $^{15}_{7}N$, $^{14}_{6}C$

C. $^{14}_{6}C$, $^{14}_{7}N$

D. $^{3}_{1}H$, $^{15}_{8}O$

3. Which of the following properties differs in nuclear isomers?

A. Neutron excess

B. Neutron

C. Protons

D. Nuclear energy states

4. What will be the charge and mass no. of antineutrino particles respectively?

A. 1,0

B. 0,0

C. 1,1

D. -1,0

5. What will be the binding energy per nucleon (in Mev) for $^{2}_{1}H$ (Atomic mass = 2.0141amu)?

Mass of neutron =1.0076 amu

Mass of proton = 1.0089 amu

Mass of electron =5.45×10^{-4} amu

A. 1.15 Mev

B. 1.20 Mev

C. 1.43 Mev

D. 1.12 Mev

6. $^{214}Bi_{83}$ undergoes alpha emission and forms A. A further undergoes two consecutive beta emission and forms D. Which of the following is the product of reaction?

A. $^{210}D_{81}$

B. $^{212}D_{83}$

C. $^{210}D_{80}$

D. $^{210}D_{83}$

7. What will be the product of the reaction: $^{225}A_{100}$ (α,2n) .

A. $^{227}M_{102}$

B. $^{229}M_{100}$

C. $^{229}M_{102}$

D. $^{227}M_{100}$

8. $^{237}Np_{93}$ is a stable isotope, so $^{235}Np_{93}$ is expected to undergo ....emission.

A. Beta

B. Alpha

C. Gamma

D. Positron

9. Ratio of $t_{1/2}/t_{av}$ for a nuclear reaction is:

A. 2

B. ½

C. 1/0.693

D. 0.693

10. The half-life of $^{237}Np_{93}$ is 4.5×10^{9} year. What will be the activity of 1 g sample of $^{237}Np_{93}$?

A. 3.91×10^{-12} Bq

B. 3.91×10^{9} Bq

C. 1.24×10^{4} Bq

D. 1.24×10^{9} Bq

Answer Key:

1. A

2. B

3. D

4. B

5. D

6. D

7. A

8. D

9. D

10. C

Solutions:

Solution 1: The correct order of penetrating power of the rays is:

$\gamma > \beta > \alpha$ and this order is experimentally determined.

Solution 2: Isotones are those species which have the same no. of neutrons.

No. of neutrons (n) = A (Mass No.) –Z (At. No.)

In ${}^{3}_{1}H$, (n) =3-1 =2

${}^{3}_{2}He$, (n) = 3-2 =1

${}^{15}_{7}N$, (n) = 15-7 =8

${}^{14}_{6}C$, (n) = 14 -6 =8

${}^{14}_{7}N$, (n) =14-7 =7

${}^{15}_{8}O$, (n) = 15-8 =7

So, both ${}^{15}_{7}N$, ${}^{14}_{6}C$ contain the same no. of neutrons, hence, they are a pair of isotones.

Solution 3: In nuclear isomers, we have the same no. of protons, same no. of electrons, neutrons and neutron excess is also the same, but energy levels contain different energies. An example is Co -58. This species has a half-life of 17 days.

Solution 4: There are two types of particles which are emitted during the radioactive process, neutrino, and Antineutrino. These are mainly used to balance the nuclear reactions statistics, energy, and spins. The mass and charge of antineutrino is 0 and 0 respectively.

Solution 5: Mass defect = $(A-Z)m_n + Zm_p + Zm_e - M_H$

Since, the mass of the electron (m_e) is very less, it can be neglected.

Mass defect = $(2-1) \times 1.0076 + 1 \times 1.0089 - 2.0141 = 2.4 \times 10^{-3}$ amu

Nuclear Binding Energy (NBE) = mass defect× 931.5 Mev

NBE = $2.4\times10^{-3}\times931.5$ = 2.235 Mev

$$\text{NBE per nucleon} = \frac{\text{NBE}}{\text{no. of nucleon}} = \frac{2.2356}{2} = 1.12 \text{ Mev}$$

Solution 6: $^{214}Bi_{83} \longrightarrow {}^{x}A_{y} + {}^{4}_{2}\alpha$

On comparing,

214 = x + 4

x = 210

83 = y + 2

y = 81

So, $^{210}A_{81}$ will be formed. This A further undergoes two beta emissions.

$$^{210}A_{81} \longrightarrow {}^{210}B_{82} + {}_{-1}\beta^{0}$$

$$^{210}B_{82} \longrightarrow {}^{210}D_{83} + {}_{-1}\beta^{0}$$

Solution 7: $^{225}A_{100} + {}^{4}_{2}\alpha \longrightarrow {}^{Y}M_{x} + 2\left({}^{1}_{0}n\right)$

On comparing both sides:

225 + 4 = y + 2

Y = 227

100 + 2 = x = 102

So, the product of the overall reaction is $^{227}M_{102}$.

Solution 8: In $^{237}Np_{93}$, no. of protons(p) = no. of electrons(e) = 93

No. of neutrons(n) = 237-93 = 144

n/p = 144/93 = 1.55

So, for a stable isomer, n/p should be 1.55.

In $^{235}Np_{93}$, n= 235-93 = 142, e = p = 93

n/p = 142/93 = 1.53

For this isomer, n/p ratio is less than that of stable isomers. To attain stability, it needs to increase its n/p ratio by converting p to n.

$${}^{1}_{1}p \longrightarrow {}^{1}_{0}n + {}^{0}_{1}\beta\,.$$

During this process, positrons are emitted.

Solution 9: Half-life of the reaction ($t_{1/2}$)= 0.693/λ

Average lifetime of a nuclear reaction (t_{av}) = 1/ λ

So,

$t_{1/2}/ t_{av} = 0.693$

Solution 10: $t_{1/2} = 0.693/\lambda = 4.5\times10^9$ year

Here, λ = disintegration constant

$$\text{So, } \lambda = \frac{(0.693\times10^{-9})}{(4.5\times365\times24\times60\times60)}$$

No. of moles(n) = N/N_A = given mass/ molar mass

Here, N_A = Avogadro no.

$$\frac{N}{6.022\times10^{23}} = \frac{1}{237}$$

$$N = \frac{6.022\times10^{23}}{237}$$

Activity (A) = λN

$$A = \frac{(0.693\times10^{-9}\times6.022\times10^{23})}{(4.5\times365\times24\times60\times60\times237)}$$

$A = 1.24\times10^4$ Bq

Here, Bq = becquerel = 1 disintegration per second.