Atoms and Nuclei

Question1

The spectral series which corresponds to the electronic transition from the levels n_2 = 5, 6,... to the level n_1 = 4 is

[NEET 2024 Re]

Options:

A.

Pfund series

B.

Brackett series

C.

Lyman series

D.

Balmer series

Answer: B

Solution:

The spectral series which corresponds to the electronic transition from the levels n_2 = 5, 6,... to n_1 = 4 is Brackett series.

Question2

Water is used as a coolant in a nuclear reactor because of its

[NEET 2024 Re]

Options:

A.

high thermal expansion coefficient

B.

high specific heat capacity

C.

low density

D.

low boiling point

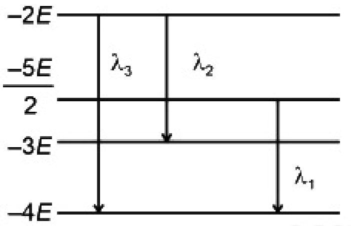
Answer: B

Solution:

Water is used as a coolant in nuclear reactor because of its high specific heat capacity.

Question3

Some energy levels of a molecule are shown in the figure with their wavelengths of transitions. Then:



[NEET 2024 Re]

Options:

A.

$\lambda_3 > \lambda_2, \lambda_1 = 2\lambda_2$

B.

$\lambda_3 > \lambda_2, \lambda_1 = 4\lambda_2$

C.

$\lambda_1 > \lambda_2, \lambda_2 = 2\lambda_3$

D.

$\lambda_2 > \lambda_1, \lambda_2 = 2\lambda_3$

Answer: D

Solution:

$$h\frac{c}{\lambda_1} = \frac{-5E}{2} + 4E = \frac{3}{2}E \quad ....(1)$$

$$h\frac{c}{\lambda_2} = -2E + 3E = E \quad ....(2)$$

$$h\frac{c}{\lambda_3} = -2E + 4E = 2E \quad ....(3)$$

Comparing (2) and (3)

$$\frac{1}{\lambda_3} = \frac{2}{\lambda_2} \quad \lambda_2 = 2\lambda_3$$

Comparing (1) and (2)

$$3\lambda_1 = 2\lambda_2 \quad \lambda_1 < \lambda_2$$

Question4

Select the correct statements among the following :

A. Slow neutrons can cause fission in ${}^{235}_{92}\mathrm{U}$ than fast neutrons.

B. α-rays are Helium nuclei.

C. β-rays are fast moving electrons or positrons.

D. γ-rays are electromagnetic radiations of wavelengths larger than X-rays.

Choose the most appropriate answer from the options given below :

[NEET 2024 Re]

Options:

A.

A, B and C only

B.

A, B and D only

C.

A and B only

D.

C and D only

Answer: A

Solution:

(A) Slow neutron can cause fission in ${}^{235}_{92}\mathrm{U}$ than fast neutrons because fast neutrons are too quick so they scatter of atoms instead of being captured by them

(B) α-rays are Helium nuclei, is a true statement

(C) β-rays aregenerated when neutron is converted into proton by releasing electron or proton is converted into neutron by releasing positron.

(D) γ-rays have higher energies as compared to X-rays. So they have smaller wavelength as compared to X-rays.

Question5

Given below are two statements:
Statement I: Atoms are electrically neutral as they contain equal number of positive and negative charges.
Statement II: Atoms of each element are stable and emit their characteristic spectrum.

In the light of the above statements, choose the most appropriate answer from the options given below.

[NEET 2024]

Options:

A.

Both Statement I and Statement II are correct

B.

Both Statement I and Statement II are incorrect

C.

Statement I is correct but Statement II is incorrect

D.

Statement I is incorrect but Statement II is correct

Answer: C

Solution:

Statement I is true as atoms are electrically neutral because they contain equal number of positive and negative charges.

Statement II is wrong as atom of most of the elements are stable and emit characteristic spectrum. But this statement is not true for every atom.

Question6

Match List I with List II.

	List I (Spectral Lines of Hydrogen for transitions from)		List II (Wavelengths (nm))
A.	$n_2 = 3$ to $n_1 = 2$	I.	410.2
B.	$n_2 = 4$ to $n_1 = 2$	II.	434.1
C.	$n_2 = 5$ to $n_1 = 2$	III.	656.3
D.	$n_2 = 6$ to $n_1 = 2$	IV.	486.1

Choose the correct answer from the options given below:

[NEET 2024]

Options:

A.

A-II, B-I, C-IV, D-III

B.

A-III, B-IV, C-II, D-I

C.

A-IV, B-III, C-I, D-II

D.

A-I, B-II, C-III, D-IV

Answer: B

Solution:

Energy difference $\Delta E = \frac{hc}{\lambda}$

$\therefore \lambda \propto \frac{1}{\Delta E}$

$(\Delta E)_{6-2} > (\Delta E)_{5-2} > (\Delta E)_{4-2} > (\Delta E)_{3-2}$

$\lambda_{6-2} < \lambda_{5-2} < \lambda_{4-2} < \lambda_{3-2}$

A-III, B-IV, C-II, D-I

Question7

$$_{82}^{290}X \xrightarrow{\alpha} Y \xrightarrow{e^+} Z \xrightarrow{\beta^-} P \xrightarrow{e^-} Q$$

In the nuclear emission stated above, the mass number and atomic number of the product Q respectively, are

[NEET 2024]

Options:

A.

280,81

B.

286,80

C.

288,82

D.

286,81

Answer: D

Solution:

$${}_{82}^{290}X \xrightarrow{\alpha} {}_{80}^{286}Y \xrightarrow{e^-} {}_{79}^{286}Z \xrightarrow{\beta^-} {}_{80}^{286}P \xrightarrow{e^-} {}_{81}^{286}Q$$

$A \longrightarrow 286$

$Z = 81$

Question8

In hydrogen spectrum, the shortest wavelength in the Balmer series is λ. The shortest wavelength in the Bracket series is

[NEET 2023]

Options:

A.

4λ

B.

9λ

C.

16λ

D.

2λ

Answer: A

Solution:

$$\frac{1}{\lambda} = R\left[\frac{1}{n_2^2} - \frac{1}{n_1^2}\right]$$

For Balmer $[n_2 = 2, n_1 = \infty]$

$$\frac{1}{\lambda} = R\left[\frac{1}{4} - \frac{1}{\infty}\right]$$

$$\lambda = \frac{4}{R} \quad \cdots\cdots(1)$$

For Bracket, $(n_2 = 4, n_1 = \infty)$

$$\frac{1}{\lambda'} = R\left[\frac{1}{16} - \frac{1}{\infty}\right]$$

$$\lambda' = \frac{16}{R} \quad \cdots\cdots(2)$$

$$\frac{Eq^n(1)}{Eq^n(2)}$$

$$\lambda' = 4\lambda$$

Question9

The radius of inner most orbit of hydrogen atom is 5.3×10^{-11}m. What is the radius of third allowed orbit of hydrogen atom?

[NEET 2023]

Options:

A.

1.06Å

B.

1.59Å

C.

4.77Å

D.

0.53Å

Answer: C

Solution:

$$r_n = \frac{n^2}{Z}$$

$$\frac{r_1}{r_2} = \left(\frac{1}{3}\right)^2$$

$$r_2 = 9r_1 = 5.3 \times 10^{-11} \times 9$$

$$= 47.7 \times 10^{-11}$$

$$= 4.77\mathring{A}$$

Question10

The half life of a radioactive substance is 20 minutes. In how much time, the activity of substance drops to (1/16)th of its initial value?

[NEET 2023]

Options:

A.

40 minutes

B.

60 minutes

C.

80 minutes

D.

20 minutes

Answer: C

Solution:

$$A = \frac{A_0}{2^n}$$

$$\frac{A}{A_0} = \frac{1}{2^n}$$

$$\frac{1}{16} = \frac{1}{2^n}$$

$$\frac{1}{2^4} = \frac{1}{2^n}$$

$$n = 4$$

$$n = \frac{t}{T_1}, t = 4 \times T_{\frac{1}{2}}{}^{2} = 4 \times 20$$

$$= 80 \text{ minutes}$$

Question11

The ground state energy of hydrogen atom is −13.6eV. The energy needed to ionize hydrogen atom from its second excited state will be :

[NEET 2023 mpr]

Options:

A.

13.6eV

B.

6.8eV

C.

1.51eV

D.

3.4eV

Answer: D

Solution:

$$E_n = -13.6 \frac{Z^2}{n^2} \text{ ev} \quad \text{for } H\text{-atom } Z = 1$$

$$\frac{E_2}{E_1} = \left(\frac{n_1}{n_2}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$E_2 = \frac{E_1}{4} = \frac{13.6 \text{ eV}}{4} = 3.4 \text{ eV}$$

Question12

The wavelength of Lyman series of hydrogen atom appears in:

[NEET 2023 mpr]

Options:

A.

visible region

B.

far infrared region

C.

ultraviolet region

D.

infrared region

Answer: C

Solution:

$$\frac{1}{\lambda} = R\left(\frac{1}{(1)^2} - \frac{1}{n^2}\right) n = 2, 3, 4, \ldots\ldots$$

$$\left(\frac{1}{\lambda_L}\right)_{max} = R\left(\frac{1}{(1)^2} - \frac{1}{(2)^2}\right) \quad \left(\because \frac{1}{R} \simeq 912Å\right)$$

$$(\lambda_L)_{max} = \frac{4}{3}\frac{L}{R}$$

$$(\lambda_L)_{max} = \frac{4}{3} \times 912Å = 4 \times 304Å = 1216Å$$

$$\left(\frac{1}{\lambda_L}\right)_{min} = R\left(\frac{1}{(1)^2} - \frac{1}{(\infty)^2}\right)$$

$$(\lambda_L)_{min} = \frac{1}{R} \simeq 912Å$$

Range of λ is 912Å to 1216Å which lies in U.V. region.

Question13

The angular momentum of an electron moving in an orbit of hydrogen atom is 1.5(h/π). The energy in the same orbit is nearly.

[NEET 2023 mpr]

Options:

A.

$-1.5 \mathrm{eV}$

B.

$-1.6 \mathrm{eV}$

C.

$-1.3 \mathrm{eV}$

D.

$-1.4 \mathrm{eV}$

Answer: A

Solution:

Given $mvr = 1.5 \frac{h}{\pi}$

Compare with mvr $= n \frac{h}{2\pi}$

So $\frac{n}{2} = 1.5$ or $n = 3$

Now $E_3 = -\frac{13.6}{(3)^2} eV \simeq -1.5 \text{ eV}$

Question14

Let R_1 be the radius of the second stationary and R_2 be the radius of the fourth stationary orbit of an electron in Bohr's model. The ratio $\frac{R_1}{R_2}$ is : [NEET Re-2022]

Options:

A. 4

B. 0.25

C. 0.5

D. 2

Answer: B

Solution:

$R = 0.529 \times \frac{n^2}{z} \overset{o}{A}$

$\frac{R_1}{R_2} = \frac{2^2}{4^2} = \frac{1}{4}$

Question15

Given below are two statements:
Statement I: The law of radioactive decay states that the number of nuclei undergoing the decay per unit time is inversely proportional to the total number of nuclei in the sample.
Statement II : The half life of a radionuclide is the sum of the life time of all nuclei, divided by the initial concentration of the nuclei at time t = 0.
In the light of the above statements, choose the most appropriate answer from the options
given below:
[NEET Re-2022]

Options:

A. Statement I is incorrect but Statement II is correct

B. Both Statement I and Statement II are correct

C. Both Statement I and Statement II are incorrect

D. Statement I is correct but Statement II is incorrect

Answer: C

Solution:

According to Radioactive decay law,

$-\frac{dN}{dt} \propto N$ ($\Rightarrow$ Rate is directly proportional)

Half life is the duration in which half of the active nuclei decayed.

Question16

At any instant, two elements X_1 and X_2 have same number of radioactive atoms. If the decay constant of X_1 and X_2 are 10λ and λ respectively, then thetime when the ratio of their atoms becomes $\frac{1}{e}$ respectively will be:
[NEET Re-2022]

Options:

A. $\frac{1}{5\lambda}$

B. $\frac{1}{11\lambda}$

C. $\frac{1}{9\lambda}$

D. $\frac{1}{6\lambda}$

Answer: C

Solution:

$N_x = N_0 e^{-\lambda_x t}$

$N_y = N_0 e^{-\lambda_y t}$

$\frac{N_x}{N_y} = e^{-(\lambda_x - \lambda_y)t}$

$\frac{1}{e} = e^{-(\lambda_x - \lambda_y)t}$

$\Rightarrow e^{-1} = e^{-(\lambda_x - \lambda_y)t}$

$(\lambda_x - \lambda_y)t = 1$

$t = \frac{1}{\lambda_x - \lambda_y} = \frac{1}{10\lambda - 1\lambda} = \frac{1}{9\lambda}$

Question17

In the given nuclear reaction, the element X is
${}_{11}^{22}Na \rightarrow X + e^{+} + v$
[NEET-2022]

Options:

A. ${}_{11}^{23}Na$

B. ${}_{10}^{23}Ne$

C. ${}_{10}^{22}Ne$

D. ${}_{12}^{22}Mg$

Answer: C

Solution:

The nuclear reaction is given as

$_{11}^{22}Na \rightarrow {}_{Z}^{A}X + {}_{+1}e^{0} + v$

From conservation of atomic number

$11 = Z + 1 \Rightarrow Z = 10 \Rightarrow Ne$

From conservation of mass number

$22 = A + 0 \Rightarrow A = 22$

$\therefore \ {}_{Z}^{A}X = {}_{10}^{22}Ne$

Question18

Let T_1 and T_2 be the energy of an electron in the first and second excited states of hydrogen atoms, respectively. According to the Bohr's model of an atom, the ratio $T_1 : T_2$ is [NEET-2022]

Options:

A. 1 : 4

B. 4 : 1

C. 4 : 9

D. 9 : 4

Answer: D

Solution:

$E_n = \frac{E_0}{n^2}$,

For first excited state $\Rightarrow n = 2$

For second excited state $\Rightarrow n = 3$

$$\Rightarrow \ \frac{T_1}{T_2} = \frac{\frac{E_0}{4}}{\frac{E_0}{9}} = \frac{9}{4}$$

Question19

A nucleus of mass number 189 splits into two nuclei having mass number 125 and 64 . The ratio of radius of two daughter nuclei respectively is
[NEET-2022]

Options:

A. 1 : 1

B. 4 : 5

C. 5 : 4

D. 25 : 16

Answer: C

Solution:

Radius of nuclei with mass number A varies as

$R = R_0 A^{1/3}$

$$\frac{R_1}{R_2} = \left(\frac{125}{64} \right)^{1/3} = \frac{5}{4} = 5 : 4$$

Question20

A radioactive nucleus $_{Z}^{A}X$ undergoes spontaneous decay in the sequence $_{Z}^{A}X \rightarrow _{Z-1}B \rightarrow _{Z-3}C \rightarrow _{Z-2}D$, where Z is the atomic number of element X. The possible decay particles in the sequence are
[NEET 2021]

Options:

A. α, β^-, β^+

B. α, β^+, β^-

C. β^+, α, β^-

D. β^-, α, β^+

Answer: C

Solution:

On β^+decay atomic number decreases by 1
On β^{-1} decay atomic number increases by 1
On α decay atomic number decreases by 2

$$_{z}^{A}X \xrightarrow{\beta^+ \text{ decay}} {}_{z-1}B \xrightarrow{\alpha \text{ decay}} {}_{z-3}C \xrightarrow{\beta^- \text{ decay}} {}_{z-2}D$$

Hence correct order of decay are β^+, α, β^-

Question21

The half-life of a radioactive nuclide is 100 hours. The fraction of original activity that will remain after 150 hours would be [NEET 2021]

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Options:

A. $\frac{1}{2}$

B. $\frac{1}{2\sqrt{2}}$

C. $\frac{2}{3}$

D. $\frac{2}{3\sqrt{2}}$

Answer: B

Solution:

The activity of a radioactive substance is given as

$$A = A_0 \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$$

Now, $\frac{A}{A_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

$\Rightarrow \frac{A}{A_0} = \left(\frac{1}{2}\right)^{\frac{150}{100}}$

$\Rightarrow \frac{A}{A_0} = \left(\frac{1}{2}\right)^{\frac{3}{2}}$

$\Rightarrow \frac{A}{A_0} = \frac{1}{2\sqrt{2}}$

Question22

A nucleus with mass number 240 breaks into two fragments each of mass number 120, the binding energy per nucleon of unfragmented nuclei is 7.6 MeV while that of fragments is 8.5 MeV. The total gain in the Binding Energy in the process is [NEET 2021]

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Options:

A. 0.9 MeV

B. 9.4 MeV

C. 804 MeV

D. 216 MeV

Answer: D

Solution:

Mass number of reactant = 240
BE per nucleon = 7.6 MeV
Mass number of products = 120
BE per nucleon of product = 8.5 MeV
Total gain in BE = (BE) of products – (BE) of reactants.
= [120 + 120] × 8.5 – [240] × 7.6
= (240) × 8.5 – 240 × 7.6
= (2040 – 1824) MeV
Gain in BE = 216 MeV

Question23

For which one of the following, Bohr model is not valid ? [2020]

Options:

A. Singly ionised helium atom (He^+)

B. Deuteron atom

C. Singly ionised neon atom (Ne^+)

D. Hydrogen atom

Answer: C

Solution:

Solution:
(c) Bohr model is only valid for single electron species i.e., Hydrogen or hydrogen like atom He^+, deuteron, etc. Singly ionised neon atom has more than one electron in orbit. Hence, Bohr model is not valid.

Question24

When a uranium isotope $^{235}_{92}U$ is bombarded with a neutron, it generates

$^{89}_{36}$**kr, three neutrons and:**
[2020]

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Options:

A. $^{91}_{40}Zr$

B. ^{101}Kr

C. $^{103}_{36}Kr$

D. $^{144}_{56}Ba$

Answer: D

Solution:

(d) It is a nuclear fission reaction.

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{89}_{36}Kr + ^{144}_{56}Ba + ^{1}_{3}n + Q$$

Question25

The energy equivalent of 0.5g of a substance is: (2020)

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Options:

A. $4.5 \times 10^{13} J$

B. $1.5 \times 10^{13} J$

C. $0.5 \times 10^{13} J$

D. $4.5 \times 10^{16} J$

Answer: A

Solution:

Solution:
(a) From the Einstein's mass-energy equivalence, the relation between the mass of a substance m and its energy E is
$E = mc^2$
Here, c = speed of light
$\therefore E = 0.5 \times 10^{-3} \times (3 \times 10^8)^2 = 0.5 \times 10^{-3} \times 9 \times 10^{16}$
$= 4.5 \times 10^{13} J$

Question26

The total energy of an electron in an atom in an orbit is -3.4eV. Its kinetic and potential energies are, respectively
(NEET 2019)

Options:

A. 3.4eV, 3.4eV

B. -3.4eV, -3.4eV

C. -3.4eV, -6.8eV

D. 3.4eV, -6.8eV

Answer: D

Solution:

Total energy of electron in n^{th} orbit,
$E_n = \frac{-13.6Z^2}{n^2}\text{eV}$
Kinetic energy of electron in n^{th} orbit,
$K.E. = \frac{13.6Z^2}{n^2}\text{eV}$
Potential energy of electron in n^{th} orbit,
P.E. $= \frac{-27.2Z^2}{n^2}\text{eV}$
Thus, total energy of electron, $E_n = -K.E. = \frac{P.E.}{2}$
$\therefore$ K.E. $= 3.4\text{eV}$ [Given $E_n = -3.4\text{eV}$]
P.E. $= 2 \times -3.4 = -6.8\text{eV}$.

Question27

α -particle consists of
(NEET 2019)

Options:

A. 2 protons only

B. 2 protons and 2 neutrons only

C. 2 electrons, 2 protons and 2 neutrons

D. 2 electrons and 4 protons only

Answer: B

Solution:

Alpha particle is a positively charged particle. It is identical to the nucleus of the helium (${}_2He^4$) atom, so it contains 2 protons and 2 neutrons.

Question28

The radius of the first permitted Bohr orbit for the electron, in a hydrogen atom equals 0.51Å and its ground state energy equals −13.6eV . If the electron in the hydrogen atom is replaced by muon (μ^-)[charge same as electron and mass $207m_e$], the first Bohr radius and ground state energy will be (OD NEET 2019)

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Options:

A. 0.53×10^{-13}m, −3.6eV

B. 25.6×10^{-13}m, −2.8eV

C. 2.56×10^{-13}m, −2.8keV

D. 2.56×10^{-13}m, −13.6eV

Answer: C

Solution:

Solution:
Given, radius of first Bohr orbit for electron in a hydrogen atom, r = 0.51Å
and its ground state energy, $E_n = -13.6eV$
Charge of muon = charge of electron
Mass of muon = 207 × (mass of electron)
Therefore, when electron is replaced by muon then, first Bohr radius, $r_1' = \frac{0.51Å}{207}$
$= 2.56 \times 10^{-13}m$
and ground state energy, $E_1' = -13.6 \times 207$
$= -2815.2eV = -2.815keV$

Question29

The rate of radioactive disintegration at an instant for a radioactive sample of half life 2.2×10^9s is $10^{10}s^{-1}$. The number of radioactive atoms in the sample at that instant is, (OD NEET 2019)

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Options:

A. 3.17×10^{20}

B. 3.17×10^{17}

C. 3.17×10^{18}

D. 3.17×10^{19}

Answer: D

Solution:

Given, $t_{\frac{1}{2}} = 2.2 \times 10^{9}s$

and rate of radioactive disintegration,

$\frac{dN}{dt} = 10^{10}s^{-1}$

$\therefore \lambda = \frac{0.693}{t_{\frac{1}{2}}} = \frac{0.693}{2.2 \times 10^{9}} = 3.15 \times 10^{-10}s^{-1}$

Now, we know that, $N = N_0 e^{-\lambda t}$

$\Rightarrow \frac{dN}{dt} = -\lambda N_0 e^{-\lambda t} = -\lambda N$

$\Rightarrow 10^{10} = 3.15 \times 10^{-10} \times N \Rightarrow N = 3.17 \times 10^{19}$

Question30

For a radioactive material, half-life is 10 minutes. If initially there are 600 number of nuclei, the time taken (in minutes) for the disintegration of 450 nuclei is (NEET 2018)

Options:

A. 20

B. 10

C. 30

D. 15

Answer: A

Solution:

Number of nuclei remaining,
$N = 600 - 450 = 150$
According to the law of radioactive decay,

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$; where N_0 is the number of nuclei initially.

$\therefore \frac{150}{600} = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$; where $T_{1/2} =$ half life.

or $\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{\frac{t}{T_{1/2}}}$

$\Rightarrow t = 2T_{1/2} = 2 \times 10$ minutes $= 20$ minutes

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Question31

The ratio of kinetic energy to the total energy of an electron in a Bohr orbit of the hydrogen atom, is
(NEET 2018)

Options:

A. 1: 1

B. 1:-1

C. 2:-1

D. 1:-2

Answer: B

Solution:

Solution:
In a Bohr orbit of the hydrogen atom, Kinetic energy $= -($ Total energy $)$
So, Kinetic energy : Total energy $= 1 : -1$

Question32

Radioactive material ‘A’ has decay constant $'8\lambda'$ and material 'B' has decay constant $'\lambda'$.Initially they have same number of nuclei.After what time,the ratio of number of nuclei of material 'B' to that 'A' will be $\frac{1}{e}$?
(2017 NEET)

Options:

A. $\frac{1}{7\lambda}$

B. none

C. $\frac{1}{9\lambda}$

D. $\frac{1}{\lambda}$

Answer: B

Solution:

The number of radioactive nuclei 'N' at any time t is given as $N(t) = N_0 e^{-\lambda t}$
where N_0 is number of radioactive nuclei in the sample at some arbitrary time $t = 0$ and λ is the radioactive decay constant
Given: $\lambda_A = 8\lambda$, $\lambda_B = \lambda$, $N_{0A} = N_{0B} = N_0$
$\therefore \frac{N_B}{N_A} = \frac{e^{-\lambda t}}{e^{-8\lambda t}}$
$\Rightarrow \frac{1}{e} = e^{-\lambda t} e^{8\lambda t} = e^{7\lambda t}$
$\Rightarrow -1 = 7\lambda t$ or $t = \frac{-1}{7\lambda}$
Negative value of time is not possible.
So given ratio in question should be $\frac{N_B}{N_A} = e$.
*Question is not properly framed.

Question33

The ratio of wavelengths of the last line of Balmer series and the last line of Lyman series is
(2017 NEET)

Options:

A. 1

B. 4

C. 0.5

D. 2

Answer: B

Solution:

The wavelength of last line of Balmer series
$\frac{1}{\lambda_B} = Rc\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = \frac{Rc}{4}$
The wavelength of last line of Lyman series
$\frac{1}{\lambda_L} = Rc\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = Rc$
$\therefore \frac{\lambda_B}{\lambda_L} = \frac{4}{1} = 4$

Question34

Given the value of Rydberg constant is $10^7 m^{-1}$,the wave number of the

last line of the Balmer series it. hydrogen spectrum will be
(2016 NEET Phase - I)

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Options:

A. $0.25 \times 10^{7} m^{-1}$

B. $2.5 \times 10^{7} m^{-1}$

C. $0.025 \times 10^{4} m^{-1}$

D. $0.5 \times 10^{7} m^{-1}$

Answer: A

Solution:

Solution:
Here $R = 10^{7} m^{-1}$
The wave number of the last line of the Balmer series in hydrogen spectrum is given by
$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = \frac{R}{4} = \frac{10^7}{4} = 0.25 \times 10^{7} m^{-1}$

Question35

when an α - particle of mass m moving with velocity v bombards on a heavy nucleus of charge Ze, its distance of closest approach from the nucleus depends on m as
(2016 NEET phase-I)

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Options:

A. $\frac{1}{m^2}$

B. m

C. $\frac{1}{m}$

D. $\frac{1}{\sqrt{m}}$

Answer: C

Solution:

Solution:
Distance of closest approach when an a-particle of mass m moving with velocity v is bombarded on a heavy nucleus of charge Ze, is given by
$r_0 = \frac{Z e^2}{\pi \varepsilon_0 m v^2} \therefore r_0 \propto \frac{1}{m}$

Question36

If an electron in a hydrogen atom jumps from the 3rd orbit to the 2nd orbit, it emits a photon of wavelength λ. When it jumps from the 4th orbit to the 3rd orbit, the corresponding wavelength of the photon will be
(2016 NEET Phase -II)

Options:

A. $\frac{16}{25}\lambda$

B. $\frac{9}{16}\lambda$

C. $\frac{20}{7}\lambda$

D. $\frac{20}{13}\lambda$

Answer: C

Solution:

Solution:
When electron jumps from higher orbit to lower orbit then, wavelength of emitted photon is given by,
$\frac{1}{\lambda} = R\left(\frac{1}{{n_f}^2} - \frac{1}{{n_f}^2}\right)$
so, $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{36}$ and $\frac{1}{\lambda'} = R\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = \frac{7R}{144}$
$\therefore \lambda' = \frac{144}{7} \times \frac{5\lambda}{36} = \frac{20\lambda}{7}$

Question37

The half-life of a radioactive substance is 30 minutes. The time (in minutes) taken between 40% decay and 85% decay of the same radioactive substance is
(2016 NEET Phase-II)

Options:

A. 15

B. 30

C. 45

D. 60

Answer: D

Solution:

N_0 = Nuclei at time t = 0
N_1 = remaining nuclei after 40% decay
$= (1 - 0.4)N_0 = 0.6N_0$
N_2 = Remaining nuclei after 85% decay
$= (1 - 0.85)N_0 = 0.15N_0$
$\therefore \frac{N_2}{N_1} = \frac{0.15N_0}{0.6N_0} = \frac{1}{4} = \left(\frac{1}{2}\right)^2$
Hence, two half life is required between 40% decay and 85% decay of a radioactive substance.
$\therefore$ Time taken $= 2\tau_{\frac{1}{2}} = 2 \times 30$ min = 60 min

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Question38

If radius of the $_{13}{}^{27}Al$ nucleus is taken to be R_{Al}, then the radius of $_{53}{}^{125}Te$ nucleus is nearly
(2015 Cancelled)

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Options:

A. $\frac{3}{5}R_{Al}$

B. $\left(\frac{13}{53}\right)^{\frac{1}{3}}R_{Al}$

C. $\left(\frac{53}{13}\right)^{\frac{1}{3}}R_{Al}$

D. $\frac{5}{3}R_{Al}$

Answer: D

Solution:

Radius of the nucleus $R = R_A{}^{\frac{1}{3}}$
$\therefore \frac{R_{Al}}{R_{Te}} = \left(\frac{A_{Al}}{A_{Te}}\right)^{\frac{1}{3}}$
Here, $A_{Al} = 27$, $A_{Te} = 125$, $R_{Te} = ?$
$\frac{R_{Al}}{R_{Te}} = \left(\frac{27}{125}\right)^{\frac{1}{3}} = \frac{3}{5} \Rightarrow R_{Te} = \frac{5}{3}R_{Al}$

Question39

Consider 3rd orbit of He^{+} (Helium), using non-relativistic approach, the speed of electron in this orbit will be [give $K = 9 \times 10^{9}$ constant, $Z = 2$ and h(Planck's Constant) = 6.6×10^{-34}Js]
(2015 Cancelled)

Options:

A. 0.73×10^{6} m/s

B. 3.0×10^{8} m/s

C. 2.92×10^{6} m/s

D. 1.46×10^{6} m/s

Answer: D

Solution:

Energy of electron in He^{+} 3rd orbit

$$E_3 = -13.6 \times \frac{Z^2}{n^2} eV = -13.6 \times \frac{4}{9} eV$$

$$= -13.6 \times \frac{4}{9} \times 1.6 \times 10^{-19} J \simeq 9.7 \times 10^{-19} J$$

As per Bohr's model
Kinetic energy of electron in the 3rd orbit $= -E_3$

$$\therefore 9.7 \times 10^{-19} = \frac{1}{2} m_e v^2$$

$$v = \sqrt{\frac{2 \times 9.7 \times 10^{-19}}{9.1 \times 10^{-31}}} = 1.46 \times 10^{6} ms^{-1}$$

Question40

A nucleus of uranium decays at rest into nuclei of thorium and helium. Then
(2015)

Options:

A. The helium nucleus has more momentum than the thorium nucleus.

B. The helium nucleus has less kinetic energy than the thorium nucleus.

C. The helium nucleus has more kinetic energy than the thorium nucleus.

D. The helium nucleus has less momentum than the thorium nucleus.

Answer: C

Solution:

If $\vec{P}_{Th}$ and $\vec{P}_{He}$ are the momenta of thorium and helium nuclei respectively, then according to law of conservation of linear momentum

$0 = \vec{P}_{Th} + \vec{p}_{He}$ or $\vec{p}_{Th} = -\vec{p}_{He}$

-ve sign shows that both are moving in opposite directions. But in magnitude

$p_{Th} = p_{He}$

If m_{Th} and p_{He} are the masses of thorium and helium nuclei respectively, then

Kinetic energy of thorium nucleus is $K_{Th} = \frac{p_{Th}{}^2}{2m_{Th}}$

and that of helium nucleus is

$K_{He} = \frac{p_{He}{}^2}{2m_{He}}$

$\therefore \frac{K_{Th}}{K_{He}} = \left(\frac{p_{Th}}{p_{He}}\right)^2 \left(\frac{m_{He}}{m_{Th}}\right)$

But $p_{Th} = p_{He}$ and $m_{He} < m_{Th}$

$\therefore K_{Th} < K_{He}$ or $K_{He} > K_{Th}$

Thus the helium nucleus has more kinetic energy than the thorium nucleus.

Question41

In the spectrum of hydrogen, the ratio of the longest wavelength in the Lyman series to the longest wavelength in the Balmer series is (2015)

Options:

A. $\frac{27}{5}$

B. $\frac{5}{27}$

C. $\frac{4}{9}$

D. $\frac{9}{4}$

Answer: B

Solution:

Solution:

The wavelength of a spectral line in the Lyman series is

$\frac{1}{\lambda_L} = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$, n = 2, 3, 4........

and that in the Balmer series is

$\frac{1}{\lambda_B} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$, n = 3, 4, 5........

For the longest wavelength in the Lyman series, $n = 2$

$\therefore \frac{1}{\lambda_L} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = R\left(\frac{1}{1} - \frac{1}{4}\right) = R\left(\frac{4-1}{4}\right) = \frac{3R}{4}$

or $\lambda_L = \frac{4}{3R}$

For the longest wavelength in the Balmer series, $n = 3$

$\therefore \frac{1}{\lambda_B} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{1}{4} - \frac{1}{9}\right) = R\left(\frac{9-4}{36}\right) = \frac{5R}{36}$

or $\lambda_B = \frac{36}{5R}$

Thus, $\frac{\lambda_L}{\lambda_B} = \frac{\frac{4}{3R}}{\frac{36}{5R}} = \frac{4}{3R} \times \frac{5R}{36} = \frac{5}{27}$

Question42

Hydrogen atom in ground state is excited by a monochromatic radiation of λ = 975Å. Number of spectral lines in the resulting spectrum emitted will be (2014)

Options:

A. 3

B. 2

C. 6

D. 10

Answer: C

Solution:

Energy of the photon, $E = \frac{hc}{\lambda}$

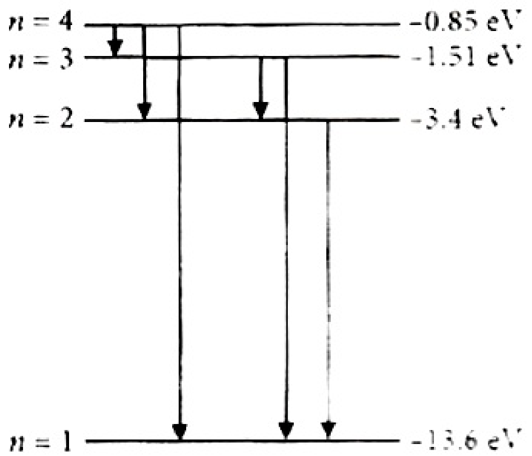
$E = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{975 \times 10^{-10}} J$

$= \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{975 \times 10^{-10} \times 1.6 \times 10^{-19}} eV = 12.75 eV$

After absorbing a photon of energy $12.75 eV$, the electron will reach to third excited state of energy $-0.85 eV$, since energy difference corresponding to $n = 1$ and $n = 4$ is $12.75 eV$

$\therefore$ Number of spectral lines emitted

$\frac{(n)(n-1)}{2} = \frac{(4)(4-1)}{2} = 6$



Question43

The binding energy per nucleon of $_3^7Li$ and $_2^4He$ nuclei are 5.60 MeV and 7.06 MeV respectively. In the nuclear reaction
$_3^7Li + _1^1H \rightarrow _2^4He + _2^4He + Q$
the value of energy Q released is
(2014)

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Options:

A. 19.6 MeV

B. -2.4 MeV

C. 8.4 MeV

D. 17.3 MeV

Answer: D

Solution:

Bindding energy of $_3^7Li$ nucleus
$= 7 \times 5.60 MeV = 39.2 MeV$
Binding energy of $_2^4He$ nucleus $= 4 \times 7.06 MeV = 28.24 MeV$
The reaction is
$_3^7Li + _1^1H \rightarrow 2(_2^4He) + Q$
$\therefore Q = 2(BE \text{ of } _2^4He) - (B.E \text{ of } _3^7Li)$
$= 2 \times 28.24 MeV - 39.2 MeV = 56.48 MeV - 39.2 MeV$

$= 17.28 MeV \approx 17.3 MeV$

Question44

A radioisotope X with a half life 1.4×10^9 years decays to Y which is

stable. A sample of the rock from a cave was found to contain X and Y in the ratio 1 : 7. The age of the rock is
(2014)

Options:

A. 1.96×10^9 years

B. 3.92×10^9 years

C. 4.20×10^9 years

D. 8.40×10^9 years

Answer: C

Solution:

	X→	Y
Number of nuclei at t = 0	N_0	0
Number of nuclei at time t	$N_0 - x$	x

As per question

$$\frac{N_0 - x}{x} = \frac{1}{7}$$

$7N_0 = 7x = x$ or $x = \frac{7}{8}N_0$

∴ Remaining nuclei of isotope X

$$= N_0 - x = N_0 - \frac{7}{8}N_0 = \frac{1}{8}N_0 = \left(\frac{1}{2}\right)^3 N_0$$

So three half lives would have been passed

$\therefore t = nT_{\frac{1}{2}} = 3 \times 1.4 \times 10^9$ years $= 4.2 \times 10^9$ years

Hence, the age of rock is 4.2×10^9 years.

Question45

Ratio of longest wavelengths corresponding to Lyman and Balmer series in hydrogen spectrum is
(2013 NEET)

Options:

A. $\frac{7}{29}$

B. $\frac{9}{31}$

C. $\frac{5}{27}$

D. $\frac{3}{23}$

Answer: C

Solution:

The wavelength of different spectral lines of Lyman series is given by
$\frac{1}{\lambda_L} = R\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$ where $m = 2, 3, 4 \ldots\ldots$
where subscript L refers to Lyman.
For longest wavelength, $n = 2$
$\therefore \frac{1}{\lambda_{L_{longest}}} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = \frac{3}{4}R$..........(i)

The wavelength of different spectral series of Balmer series is given by
$\frac{1}{\lambda_B} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$ where $n = 3, 4, 5 \ldots\ldots$
where subscript B refers to Balmer.
For longest wavelength, $n = 3$
$\therefore \frac{1}{\lambda_{B_{longest}}} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5R}{36}$..........(ii)

Divide (ii) by (i), we get
$\frac{\lambda_{L_{longest}}}{\lambda_{B_{longest}}} = \frac{5R}{36} \times \frac{4}{3R} = \frac{5}{27}$

Question46

A certain mass of Hydrogen is changed to Helium by the process of fusion. The mass defect in fusion reaction is 0.02866 u. The energy liberated per u is
(given 1 u = 931 MeV)
(2013 NEET)

Options:

A. 6.675 MeV

B. 13.35 MeV

C. 2.67 MeV

D. 26.7 MeV

Answer: A

Solution:

As ${}_1^2H + {}_1^2H \rightarrow {}_2^4He$
Here, $\Delta M = 0.02866u$
$\therefore$ The energy liberated per u is

$= \frac{\Delta M \times 931}{4} MeV$

$= \frac{0.02866 \times 931}{4} MeV = \frac{26.7}{4} MeV = 6.675 MeV$

Question47

The half life of a radioactive isotope X is 20 years. It decays to another element F which is stable. The two elements X and 'F were found to be in the ratio 1 : 7 in a sample of a given rock. The age of the rock is estimated to be (2013 NEET)

Options:

A. 80 years

B. 100 years

C. 40 years

D. 60 years

Answer: D

Solution:

Solution:

	X→	Y
Initial number of atoms	N_0	0
Number of atoms after time t	N	$N_0 - N$

As per question

$\frac{N}{N_0 - N} = \frac{1}{7}$

$7N = N_0 - N$

$8N - N_0$

$\frac{N}{N_0} = \frac{1}{8}$

As $\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ where n is the no. of half lives

$\therefore \frac{1}{8} = \left(\frac{1}{2}\right)^n$

$\left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n$

$\therefore n = 3$

$n = \frac{t}{T_{\frac{1}{2}}}$ or $t = nT_{\frac{1}{2}} = 3 \times 20$ years $= 60$ years

Hence, the age of rock is 60 years.

Question48

How does the Binding Energy per nucleon vary with the increase in the number of nucleons?
(KN NEET 2013)

Options:

A. Decrease continuously with mass number.

B. First decreases and then increases with increase in mass number.

C. First increases and then decreases with increase in mass number.

D. Increases continuously with mass number.

Answer: C

Question49

An electron in hydrogen atom makes a transition $n_1 \rightarrow n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assuming Bohr's model to be valid, the time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are
(KN NEET 2013)

Options:

A. $n_1 = 6$ and $n_2 = 2$

B. $n_1 = 8$ and $n_2 = 1$

C. $n_1 = 8$ and $n_2 = 2$

D. $n_1 = 4$ and $n_2 = 2$

Answer: D

Solution:

$\because T \propto n^3$

$$\frac{T_1}{T_2} = \frac{8T_2}{T_2} = \left(\frac{n_1}{n_2}\right)^3$$

Hence, $n_1 = 2n_2$

Question50

α -particles, β -particles and γ -rays are all having same energy. Their penetrating power in a given medium in increasing order will be
(KN NEET 2013)

Options:

A. γ, α, β

B. α, β, γ

C. β, α, γ

D. β, γ, α

Answer: B

Solution:

Solution:
For a given energy, γ -rays has highest penetrating power and α -particles has leastpenetrating power.

Question51

Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ratio of the wavelengths $\lambda_1 : \lambda_2$ emitted in the two cases is
(2012)

Options:

A. $\frac{7}{5}$

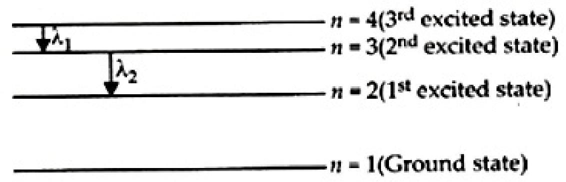
B. $\frac{27}{20}$

C. $\frac{27}{5}$

D. $\frac{20}{7}$

Answer: D

Solution:



According to Rydberg formula

$\frac{1}{\lambda} = R\left[\frac{1}{n_f^{\,2}} - \frac{1}{n_i^{\,2}}\right]$

In first case, $n_f = 3$, $n_i = 4$

$\therefore \frac{1}{\lambda_1} = R\left[\frac{1}{3^2} - \frac{1}{4^2}\right] = R\left[\frac{1}{9} - \frac{1}{16}\right] = \frac{7}{144}R$.........(i)

In Second case,$n_f = 2$, $n_i = 3$

$\therefore \frac{1}{\lambda_2} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5}{36}R$...........(ii)

Divide (ii) by (ii)we get

$\frac{\lambda_1}{\lambda_2} = \frac{5}{36} \times \frac{144}{7} = \frac{20}{7}$

Question52

If the nuclear radius of ^{27}Al is 3.6 frmi,the approximate nuclear radius of ^{64}Cu in fermi is (2012)

Options:

A. 2.4

B. 1.2

C. 4.8

D. 3.6

Answer: C

Solution:

Nuclear radius,$R = R_0 A^{\frac{1}{3}}$

where R_0 is a constant and A is the mass number

$\therefore \frac{R_{Al}}{R_{Cu}} = \frac{(27)^{\frac{1}{3}}}{(64)^{\frac{1}{3}}} = \frac{3}{4}$

or $R_{Cu} = \frac{4}{3} \times R_{Al} = \frac{4}{3} \times 3.6$ fermi $= 4.78$ fermi

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Question53

A mixture consists of two radioactive materials A_1 and A_2 with half lives of 20 s and 10 s respectively. Initially, the mixture has 40 g of A_1 and 160g of A_2. The amount of the two in the mixture will become equal after
(2012)

Options:

A. 60 s

B. 80 s

C. 20 s

D. 40 s

Answer: D

Solution:

Let after t s amount of the A_1 and A_2 will become equal in the mixture

As $N = N_0\left(\frac{1}{2}\right)^n$

where n is the number of half-lives

For A_1, $N_1 = N_{01}\left(\frac{1}{2}\right)^{\frac{t}{20}}$

For A_2, $N_2 = N_{02}\left(\frac{1}{2}\right)^{\frac{t}{10}}$

According to question, $N_1 = N_2$

$N_1 = N_2$

$\frac{40}{2^{\frac{t}{20}}} = \frac{160}{2^{\frac{t}{10}}}$

$2^{\frac{t}{10}} = 4\left(2^{\frac{t}{20}}\right)$ or $2^{\frac{t}{10}} = 2^2 2^{\frac{t}{20}}$

$2^{\frac{t}{10}} = 2^{\left(\frac{t}{20}+2\right)}$

$\frac{t}{10} = \frac{t}{20} + 2$ or $\frac{t}{10} - \frac{t}{20} = 2$

or $\frac{t}{20} = 2$ or t = 40s

Question54

An electron of a stationary hydrogen atom passes from the fifth energy level to the ground level. The velocity that the atom acquired as a result of photon emission will be
(m is the mass of the electron, R, Rydberg constant and h Planck's constant)
(2012)

Options:

A. $\frac{24hR}{25m}$

B. $\frac{25hR}{24m}$

C. $\frac{25m}{24hR}$

D. $\frac{24m}{25hR}$

Answer: A

Solution:

According to Rydberg formula

$\frac{1}{\lambda} = R\left[\frac{1}{n_f^2} - \frac{1}{n_i^2}\right]$

Here $n_f = 1, n_i = 5$

$\therefore \frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{5^2}\right] = R\left[\frac{1}{1} - \frac{1}{25}\right] = \frac{24}{25}R$

According to conservation of linear momentum, we get Momentum of photon = Momentum of atom

$\frac{h}{\lambda} = mv$ or $v = \frac{h}{m\lambda} = \frac{h}{m}\left(\frac{24R}{25}\right) = \frac{24hR}{25m}$

Question55

The transition from the state n = 3 to n = 1 in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from (2012 Mains)

Options:

A. 2→ 1

B. 3 → 2

C. 4 → 2

D. 4 → 3

Answer: D

Question56

The half life of a radioactive nucleus is 50 days. The time interval $(t_2 - t_1)$ between thre time t_2 when $\frac{2}{3}$ of it has decayed and time t_1 when $\frac{1}{3}$ of it had decayed is
(2012 Mains)

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Options:

A. 30 days

B. 50 days

C. 60 days

D. 15 days

Answer: B

Solution:

According to radioactive decay law
$N = N_0 e^{-\lambda t}$
where $N_0 =$ Number of radioactive nuclei at time t = 0
N = Number of radioactive nuclei left un decayed at any time t
$\lambda =$ decay constant
At time t_2, $\frac{2}{3}$ of the sample had decayed
$\therefore N = \frac{1}{3} N_0$
$\therefore \frac{1}{3} N_0 = N_0 e^{-\lambda t_2}$.......(i)
At time t_1, $\frac{1}{3}$ of the sample had decayed
$\therefore N = \frac{2}{3} N_0$
$\therefore \frac{2}{3} N_0 = N_0 e^{-\lambda t_1}$.......(ii)
Divide (i) by (ii), we get
$\frac{1}{2} = \frac{e^{-\lambda t_2}}{e^{-\lambda t_1}}$
$\frac{1}{2} e^{\lambda (t_2 - t_1)}$
$\lambda (t_2 - t_1) = \ln 2$
$t_2 - t_1 = \frac{\ln 2}{\lambda} = \frac{\ln 2}{\left(\frac{\ln 2}{T_{\frac{1}{2}}}\right)} \left(\because \lambda = \frac{\ln 2}{T_{\frac{1}{2}}}\right)$

$= T_{\frac{1}{2}} = 50$ days

Question57

The wavelength of the first line of Lyman series for hydrogen atom is

equal to that of the second line of Balmer series for a hydrogen like ion. The atomic number Z of hydrogen like ion is (2011)

Options:

A. 3

B. 4

C. 1

D. 2

Answer: D

Solution:

The wavelength of the first line of lyman series for hydrogen atom is

$\frac{1}{\lambda} = R\left[\frac{1}{1^2} - \frac{1}{2^2}\right]$

The wavelength of the second line of Balmer series for hydrogen like ion is

$\frac{1}{\lambda'} = Z^2R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$

According to question, $\lambda = \lambda'$

$\Rightarrow R\left[\frac{1}{1^2} - \frac{1}{2^2}\right] = Z^2R\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$

or $\frac{3}{4} = \frac{3Z^2}{16}$ or $z^2 = 4$ or $Z = 2$

Question58

The half life of a radioactive isotope X is 50 years. It decays to another element Y which is stable. The two elements X and Y were found to be in the ratio of 1 : 15 in a sample of a given rock. The age of the rock was estimated to be (2011)

Options:

A. 150 years

B. 200 years

C. 250 years

D. 100 years

Answer: B

Solution:

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

where n is number of half lives

$\therefore \frac{1}{16} = \left(\frac{1}{2}\right)^n$ or $\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$ or $n = 4$

Let the age of rock be t years

$\because n = \frac{1}{T_{\frac{1}{2}}}$

or $t = nT_{\frac{1}{2}} = 4 \times 50$years $= 200$

Question59

The power obtained in a reactor using U^{235} disintegration is 1000 kW. The mass decay of U^{235} per hour is (2011)

Options:

A. 10 microgram

B. 20 microgram

C. 40 microgram

D. 1 microgram

Answer: C

Solution:

According to Einstein's mass energy relation

$E = mc^2$ or $m = \frac{E}{c^2}$

Mass decay per second

$$\frac{\Delta m}{\Delta t} = \frac{1}{c^2}\frac{\Delta E}{\Delta t} = \frac{P}{c^2} = \frac{1000 \times 10^3 W}{\left(3 \times 10^8 \frac{m}{s}\right)^2} = \frac{10^6}{9 \times 10^{16}} kg/s$$

Mass decay per hour

$$= \frac{\Delta m}{\Delta t} \times 60 \times 60 = \left(\frac{10^6}{9 \times 10^6 kg/s}\right)(3600s)$$

$$= 4 \times 10^{-8} kg = 10 \times 10^{-6} g = 40 \mu g$$

Question60

A radioactive nucleus of mass M emits a photon of frequency υ and the nucleus recoils. The recoil energy will be (2011)

Options:

A. $Mc^2 - h\upsilon$

B. $\frac{h^2\upsilon^2}{2Mc^2}$

C. zero

D. $h\upsilon$

Answer: B

Solution:

Momentum of emitted photon $= p_{photon} = \frac{h\upsilon}{c}$

From the law of conservation of linear momentum.

Momentum of recoil nucleus $= p_{nucleus} = p_{photon}$

$\therefore Mv = \frac{h\upsilon}{c}$

where v is the recoil speed of the nucleus

or $v = \frac{h\upsilon}{Mc}$..........(i)

The recoil energy of the nucleus

$= \frac{1}{2}Mv^2 = \frac{1}{2}M\left(\frac{h\upsilon}{Mc}\right)^2 = \frac{h^2\upsilon^2}{2Mc^2}$ (Using (i))

Question61

A nucleus ${}_{n}^{m}X$ emits one α- particle and two β^- particles. The resulting nucleus is
(2011)

Options:

A. ${}_{n-4}^{m-6}Z$

B. ${}_{n}^{m-6}Z$

C. ${}_{n}^{m-4}X$

D. ${}_{n-2}^{m-4}Y$

Answer: C

Solution:

When an alpha particle (${}_{2}^{4}He$) is emitted, the mass number and the atomic number of the daughter nucleus decreases by four and two respectively. When a beta particle (β^-) is emitted, the atomic number of the daughter nucleus increases by one but the mass number remains the same.

$_{n}^{m}X \xrightarrow{\alpha} {}_{n-2}^{m-4}Y \xrightarrow{2\beta^-} {}_{n}^{m-4}X$

Question62

Fusion reaction takes place at high temperature because
(2011)

Options:

A. nuclei break up at high temperature

B. atoms get ionised at high temperature

C. kinetic energy is high enough to overcome thecoulomb repulsion between nuclei

D. molecules break up at high temperature

Answer: C

Solution:

Solution:
Extremely high temperature needed for fusion make kinetic energy large enough to overcome coulomb repulsion between nuclei.

Question63

Two radioactive nuclei P and Q, in a given sample decay into a stable nucleus R. At time t = 0, number of P species are $4N_0$ and that of Q are N_0.Half-life of P(for conversion to R) is 1 minute whereas that of Q is 2 minutes. Initially, there are no nuclei of R present in the sample. When number of nuclei of P and Q are equal, the number of nuclei of R present in the sample would be
(2011 Mains)

Options:

A. $2N_0$

B. $3N_0$

C. $\frac{9N_0}{2}$

D. $\frac{5N_0}{2}$

Answer: C

Solution:

	P	Q
No. of nuclei,at t=0	$4N_0$	N_0
Half - life	1 min	2 min
No. of nuclei after time t	N_p	N_Q

Let after t min, the number of nuclei of P and Q are equal

$\therefore N_P = 4N_0\left(\frac{1}{2}\right)^{\frac{t}{1}}$ and $N_Q = N_0\left(\frac{1}{2}\right)^{\frac{t}{2}}$

As $N_P = N_Q$

$\therefore 4N_0\left(\frac{1}{2}\right)^{\frac{t}{1}} = N_0\left(\frac{1}{2}\right)^{\frac{t}{2}}$

$\frac{4}{2^{\frac{t}{1}}} = \frac{1}{2^{\frac{t}{2}}}$ or $4 = \frac{2^t}{2^{\frac{t}{2}}}$

or $4 = 2^{\frac{t}{2}}$ or $2^2 = 2^{\frac{t}{2}}$ or $\frac{t}{2} = 2$ or $t = 4$ min

After 4 minutes, both P and Q have equal number of nuclei.

∴ Number of nuclei of R

$= \left(4N_0 - \frac{N_0}{4}\right) + \left(N_0 - \frac{N_0}{4}\right) = \frac{15N_0}{4} + \frac{3N_0}{4} = \frac{9N_0}{2}$

Question64

Out of the following which one is not a possible energy for a photon to be emitted by hydrogen atom according to Bohr's atomic model? (2011 Mains)

Options:

A. 0.65 eV

B. 1.9 eV

C. 11.1 eV

D. 13.6 eV

Answer: C

Solution:

The energy of nth orbit of hydrogen atom is given as

$E_n = -\frac{13.6}{n^2}$eV

$\therefore E_1 = -13.6eV$

$E_2 = -\frac{13.6}{2^2} = -3.4eV$

$E_3 = -\frac{13.6}{3^2} = -1.5eV$

$E_4 = -\frac{13.6}{4^2} = -0.85eV$

$\therefore E_3 - E_2 = -1.5 - (-3.4) = 1.9eV$

$E_4 - E_3 = -0.85 - (-1.5) = 0.65eV$

Question65

The mass of a $_7{}^3Li$ nucleus is 0.042 u less than the sum of the masses of all its nucleons. The binding energy per nucleon of $_7{}^3Li$ nucleus is nearly
(2010)

Options:

A. 46 MeV

B. 5.6 MeV

C. 3.9 MeV

D. 23 MeV

Answer: B

Solution:

$\Delta m = 0.042$

$= 0.042 + 2 \times 1.66 \times 10^{-27} kg$

Binding energy $= \Delta mc^2$

Binding energy per nucleon

$= \frac{\Delta mc^2}{7}$ [mass number of li =7]

$= \frac{0.042 \times 1.66 \times 10^{-27} \times (3 \times 10^8)^2}{7} J$

To convert the energy in ev from joule, we will divide it by 1.6×10^{-19}

$= \frac{0.042 \times 1.66 \times 10^{-27} \times (3 \times 10^8)^2}{7 \times 1.6 \times 10^{-19}} ev$

$= 5.4 \times 10^6 ev$

$\therefore$ Energy lost $= 5.4M\ ev$

Question66

The activity of a radioactive sample is measured as N_0 counts per minute at t = 0 and $\frac{N_0}{e}$ counts per minute at t = 5 minutes. The time (in minutes) at which the activity reduces to half its value is

(2010)

Options:

A. $\log_e \frac{2}{5}$

B. $\frac{5}{\log_e 2}$

C. $5\log_{10} 2$

D. $5\log_e 2$

Answer: D

Solution:

According to activity law
$R = R_0 e - \lambda t$...........(i)
where
$R_0 =$ initial activity at $t = 0$
$R =$ activity at time t
$\lambda =$ decay constant
According to given problem
$R_0 = N_0$ couts per minute
$R = \frac{N_0}{e}$ counts per minute
$t = 5$ minutes
Substituting these values in equation (i), we get
$\frac{N_0}{e} = N_0 e^{-5\lambda}$
$e^{-1} = e^{-5\lambda}$
$5\lambda = 1$ or $\lambda = \frac{1}{5}$ per minute
At $t = T_{\frac{1}{2}}$ the activity R reduces to $\frac{R_0}{2}$
where $T_{\frac{1}{2}} =$ half life of a radioactive sample
From equation (i), we get
$\frac{R_0}{2} = R_0 e^{-\lambda T_{\frac{1}{2}}}$
$e^{\lambda T_{\frac{1}{2}}} = 2$
Taking natural logarithms on both sides of above equation,we get
$\lambda T_{\frac{1}{2}} = \log_e 2$
or $T_{\frac{1}{2}} = \frac{\log_e 2}{\lambda} = \frac{\log_e 2}{\left(\frac{1}{5}\right)} = 5\log_e 2$ minute

---

Question67

The energy of a hydrogen atom in the ground state is -13.6eV. The energy of a He^+ ion in the first excited state will be
(2010)

Options:

A. -13.6 eV

B. -27.2 eV

C. -54.4 eV

D. -6.8 eV

Answer: A

Solution:

Solution:
Energy of an hydrogen like atom like He^{+} in an nth orbit is given by
$E_n = -\frac{13.6Z^2}{n^2}eV$
For hydrogen atom, $Z = 1$
$\therefore E_n = -\frac{13.6}{n^2}eV$
For ground state, $n = 1$
$\therefore E_1 = -\frac{13.6}{1^2}eV = -13.6eV$
For He^{+} ion, $Z = 2$
$E_n = -\frac{4(23.6)}{n^2}eV$
For first excited state, $n = 2$
$\therefore E_2 = -\frac{4(13.6)}{(2)^2}eV = -13.6eV$
Hence, the energy in He^{+}
ion in first excited state is same that of energy of the hydrogen atom in ground state i.e. $-13.6eV$

Question68

An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to (2010)

Options:

A. $\frac{1}{Z}e$

B. v^2

C. $\frac{1}{m}$

D. $\frac{1}{v^4}$

Answer: C

Solution:

At the distance of closest approach d. Kinetic energy = Potential energy
$\frac{1}{2}mv^2 = \frac{1}{4\pi\varepsilon_0}\frac{(2e)(Z e)}{d}$
where, Ze = charge of target nucleus
2e = charge of alpha nucleus
$\frac{1}{2}mv^2$ = kinetic energy of alpha nucleus of mass m moving with velocity v
or $d = \frac{2Z e^2}{4\pi\varepsilon_0\left(\frac{1}{2}mv^2\right)}$ $\therefore d \propto \frac{1}{m}$

Question69

The decay constant of a radio isotope is λ.If A_1 and A_2 are its activities at times t_1 and t_2 respectively, the number of nuclei which have decayed during the time $(t_1 - t_2)$
(2010 Mains)

Options:

A. $A_1t_1 - A_2t_2$

B. $A_1 - A_2$

C. $\frac{(A_1 - A_2)}{\lambda}$

D. $\lambda(A_1 - A_2)$

Answer: C

Solution:

Solution:
$A_1 = \lambda N_1$ at times t_1, $A_2 = \lambda N_2$ at time t_2
Therefore, number of nuclei decayed during time interval $(t_1 - t_2)$ is
$N_1 - N_2 = \frac{(A_1 - A_2)}{\lambda}$

Question70

The binding energy per nucleon in deuterium and helium nuclei are 1.1 MeV and 7.0 MeV, respectively. When two deuterium nuclei fuse to form a helium nucleus, the energy released in the fusion is
(2010 Mains)

Options:

A. 23.6 MeV

B. 2.2 MeV

C. 28.0 MeV

D. 30.2 MeV

Answer: A

Solution:

Solution:
${}_1H^2 + {}_1H^2 \rightarrow {}_2He^2 + \Delta E$
The binding energy per nucleon of a deuteron =1.1 MeV
$\therefore$ Total binding energy $= 2 \times 1.1 = 2.2$ MeV
The binding energy per nucleon of a helium nuclei $= 7\text{M eV}$
$\therefore$ Total binding energy $= 4 \times 7 = 28\text{M eV}$
Hence, energy released
$\Delta E = (28 - 2 \times 2.2) = 23.6\text{MeV}$

Question71

In the nuclear decay given below ${}_Z{}^AX \rightarrow {}_{Z+1}{}^AY \rightarrow {}_{Z-1}{}^{A-4}B^* \rightarrow {}_{Z-1}{}^{A-4}B$

the particles emitted in the sequence are (2009)

Options:

A. γ, β, α

B. β, γ, α

C. α . β, γ

D. β, α, γ

Answer: D

Solution:

${}_Z{}^AX \overset{\beta^-}{------>} {}_{Z+1}{}^AY \overset{\alpha}{------>} A-4_{Z-1}B* \overset{\gamma}{------>} {}_{Z-1}{}^{A-4}B$

First X decays by β^- emission emitting $\overline{\upsilon}$,antineutrinosimultaneously. Y emits α resulting in the excited level of B which in turn emits a a γ ray.
$\therefore \beta^-$, α, γ is the answer

Question72

The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is a (2009)

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Options:

A. isomer of parent

B. isotone of parent

C. isotope of parent

D. isobar of parent

Answer: C

Solution:

Solution:

$_{Z}^{A}X \xrightarrow{2\beta^-} {}_{Z+2}^{A}Y_1 \xrightarrow{\alpha} {}_{Z}^{A-4}Y_2$

The resultant daughter is an isotope of the original parent nucleus.

Question73

In a Rutherford scattering experiment, when a projectile of charge z_1 and Mass M_1 approaches a target nucleus of charge z_2 and mass M_2, the distance of closer approach is r_0.The energy of the projectile is (2009)

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Options:

A. directly proportional to $z_1 z_2$

B. inversely proportional to z_1

C. directly proportional to mass M_1

D. directly proportional to $M_1 \times M_2$

Answer: A

Solution:

Energy of the projectile is the potential energy at closest approach, $\frac{1}{4\pi\varepsilon_0}\frac{z_1 z_2}{r_0}$

Therefore, energy $\propto z_1 z_2$

Question74

The ionization energy of the electron in the hydrogen atom in its ground state is 13.6 eV. The atoms are excited to higher energy levels to emit radiations of 6 wavelengths.Maximum wavelength of emitted radiation corresponds to the transition between
(2009)

Options:

A. n = 3 to n = 1 states

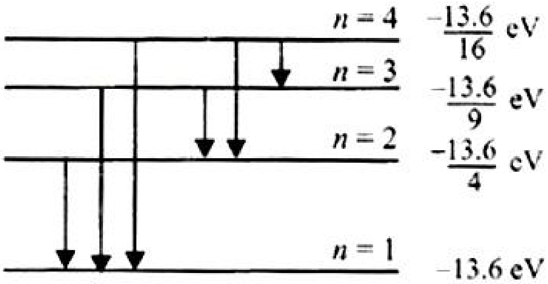
B. n = 2 to n = 1 states

C. n = 4 to n = 3 states

D. n = 3 to n = 2 states

Answer: C

Solution:



The maximum wavelength emitted here corresponds to the transition n = 4 —> n = 3 (Paschen series 1st line).

Question75

If $M(A,Z)$, M_p and M_n denote the masses of the nucleus ${}_Z^AX$,proton and neutron respectively in units of u(1u = 93.15M eV /c^2) and BE represents its binding energy in MeV, then
(2008)

Options:

A.

$M(A, Z) = ZM_p + (A - Z)M_n - BE$

B.

$M(A, Z) = ZM_p + (A - Z)M_n + \frac{BE}{c^2}$

C.

$M(A, Z) = ZM_p + (A - Z)M_n - \frac{BE}{c^2}$

D.

$M(A, Z) = ZM_p + (A - Z)M_n + BE$

Answer: C

Solution:

$ZM_p + (A - Z)M_n - M(A, Z) = \text{ mass defect} = \frac{BE}{c^2}$

$\Rightarrow M(A, Z) = ZM_p + (A - Z)M_n - \frac{BE}{c^2}$

Question76

Two nuclei have their mass numbers in the ratio of 1 : 3. The ratio of their nuclear densities would be (2008)

Options:

A. $(3)^{\frac{1}{3}} : 1$

B. 1 : 1

C. 1 : 3

D. 3 : 1

Answer: B

Solution:

$A_1 : A_2 = 1 : 3$

Their radii will be in the ratio

$R_0 A_1^{\frac{1}{3}} : R_0 A_2^{\frac{1}{3}} = 1 : 3^{\frac{1}{3}}$

Density $= \frac{A}{\frac{4}{3}\pi R^3}$

$\therefore \rho_{A_1} : \rho_{A_2} = \frac{1}{\frac{4}{3}\pi R_0{}^3 . 1^3} : \frac{3}{\frac{4}{3}R_0{}^3\left(3^{\frac{1}{3}}\right)^3} \Rightarrow 1 : 1$

Their nuclear densities will be the same

Question77

The ground state energy of hydrogen atom is -13.6eV .When its electron is in the first excited state, its excitation energy is (2008)

Options:

A. 10.2 eV

B. 0

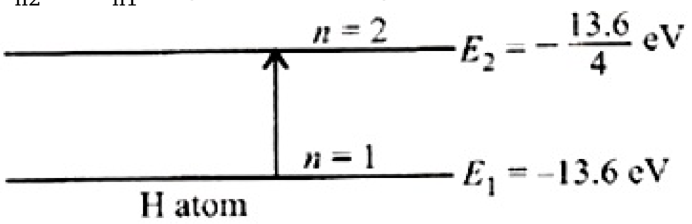
C. 3.2 eV

D. 6.8 eV

Answer: A

Solution:

1st excitation energy,
$E_{n2} - E_{n1} = (-3.4 + 13.6) = 10.2\text{eV}$



Question78

Two radioactive materials X_1 and X_2 have decay constants 5λ and λ respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of X_1 to that X_2 will be $\frac{1}{e}$ after a time (2008)

Options:

A. $\frac{1}{4\lambda}$

B. $\frac{e}{\lambda}$

C. λ

D. $\frac{1}{2}\lambda$

Answer: A

Solution:

$X_1 = N_0 e^{-\lambda_1 t}; X_2 = N_0 e^{-\lambda_2 t}$
$\frac{X_1}{X_2} = e^{-1} = e^{(-\lambda_1 + \lambda_2)t}; e^{-1} = e^{-(\lambda_1 - \lambda_2)t}$
$\therefore t = \frac{1}{\lambda_1 - \lambda_2} = \frac{1}{(5\lambda - \lambda)} = \frac{1}{4\lambda}$

Question79

Two radioactive substances A and B have decay constants 5λ and λ respectively. At t = 0 they have the same number of nuclei. The ratio of number of nuclei of A to those of B will be $\left(\frac{1}{e}\right)^2$ after a time interval (2007)

Options:

A. 4λ

B. 2λ

C. $\frac{1}{2}\lambda$

D. $\frac{1}{4}\lambda$

Answer: C

Solution:

Given : $\lambda_A = 5\lambda, \lambda_B = \lambda$
At t = 0, $(N_0)_A = (N_0)_B$
$\frac{N_A}{N_B} = \left(\frac{1}{e}\right)^2$
According to radioactive decay, $\frac{N}{N_0} = e^{-\lambda t}$
$\therefore \frac{N_A}{(N_0)_A} = e^{-\lambda_A t}$ ....(i)
$\frac{N_B}{(N_0)_B} = e^{-\lambda_B t}$ ....(ii)
Divide (i) by (ii), we get
$\frac{N_A}{N_B} = e^{-(\lambda_A - \lambda_B)t}$ or, $\frac{N_A}{N_B} = e^{-(5\lambda - \lambda)t}$
or, $\left(\frac{1}{e}\right)^2 = e^{-4\lambda t}$ or, $\left(\frac{1}{e}\right)^2 = \left(\frac{1}{e}\right)^{4\lambda t}$

or, $4\lambda t = 2 \Rightarrow t = \frac{2}{4\lambda} = \frac{1}{2\lambda}$

Question80

In a radioactive decay process, the negatively charged emitted β - particles are
(2007)

Options:

A. the electrons produced as a result of the decay of neutrons inside the nucleus

B. the electrons produced as a result of collisions between atoms

C. the electrons orbiting around the nucleus

D. the electrons present inside the nucleus.

Answer: A

Solution:

Solution:
In beta minus (β^-) decay, a neutron is transformed into a proton and an electron is emitted with the nucleus along with an antineutrino.
$n \longrightarrow p + e^- + \bar{v}$, where $\bar{v}$ is the antineutrino.

Question81

In a mass spectrometer used for measuring the masses of ions, the ions are initially accelerated by an electric potential V and then made to describe semicircular paths of radius R using a magnetic fieldB. If V and B are kept constant, the ratio left $\left(\frac{\text{charge on the ion}}{\text{mass of the ion}}\right)$ will be proportional to
(2007)

Options:

A. $\frac{1}{R^2}$

B. R^2

C. R

D. $\frac{1}{R}$

Answer: A

Solution:

In mass spectrometer when ions are accelerated through potential V

$\frac{1}{2}mv^2 = qV$ ...(i)

where m is the mass of ion, q is the charge of the ion.

As the magnetic field curves the path of the ions in a semicircular orbit

$\therefore Bqv = \frac{mv^2}{R} \Rightarrow v = \frac{BqR}{m}$ ......(ii)

Substituting (ii) in (i), we get

$\frac{1}{2}m\left[\frac{BqR}{m}\right]^2 = qV$ or, $\frac{q}{m} = \frac{2V}{B^2R^2}$

since V, B are constants,

$\frac{q}{m} \propto \frac{1}{R^2}$ or, $\frac{\text{charge on the ion}}{\text{mass of the ion}} \propto \frac{1}{R^2}$

Question82

A nucleus $_Z^AX$ has mass represented by $M(A, Z)$. If M_p and M_n denote the mass of proton and neutron respectively and B.E. the binding energy in MeV, then
(2007)

Options:

A. B.E. $= [ZM_p + (A - Z)M_n - M(A, Z)]c^2$

B. B.E. $= [ZM_p + AM_n - M(A, Z)]c^2$

C. B.E. $= M(A, Z) - ZM_p - (A - Z)M_n$

D. B.E. $= [M(A, Z) - ZM_p - (A - Z)M_n]c^2$.

Answer: A

Question83

If the nucleus $_{13}^{27}Al$ has a nuclear radius of about $3.6fm$, then $_{32}^{125}Te$ would have its radius approximately as
(2007)

Options:

A. 9.6fm

B. 12.0fm

C. 4.8fm

D. 6.0fm

Answer: D

Solution:

Nuclear radii $R = (R_0) A^{1/3}$
where A is the mass number.
$\therefore \frac{R_{Te}}{R_{Al}} = \left(\frac{A_{Te}}{A_{Al}}\right)^{1/3} = \left(\frac{125}{27}\right)^{1/3} = \left(\frac{5}{3}\right)$
or, $R_{Te} = \frac{5}{3} \times R_{Al} = \frac{5}{3} \times 3.6 = 6fm$ (Given $R_{Al} = 3.6fm$)

Question84

The total energy of electron in the ground state of hydrogen atom is −13.6eV. The kinetic energy of an electron in the first excited state is (2007)

Options:

A. 6.8eV

B. 13.6eV

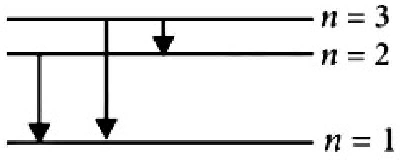
C. 1.7eV

D. 3.4eV

Answer: D

Solution:

Energy of n^{th} orbit of hydrogen atom is given by



$E_n = \frac{-13.6}{n^2} eV$
For ground state, n = 1
$\therefore E_1 = \frac{-13.6}{1^2} = -13.6eV$
For first excited state, n = 2
$\therefore E_2 = \frac{-13.6}{2^2} = -3.4eV$
Kinetic energy of an electron in the first excited state is

$K = -E_2 = 3.4eV$

Question85

Ionization potential of hydrogen atom is 13.6eV . Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1 eV. According to Bohr's theory, the spectral lines emitted by hydrogen will be
(2006)

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Options:

A. one

B. two

C. three

D. four.

Answer: C

Solution:

Ionisation potential of hydrogen atom is $13.6eV$.
Energy required for exciting the hydrogen atom in the ground state to orbit n is given by
$E = E_n - E_1$
i.e., $12.1 = -\frac{13.6}{n^2} - \left(\frac{-13.6}{1^2}\right) = -\frac{13.6}{n^2} + 13.6$
or, $-1.5 = \frac{-13.6}{n^2}$ or, $n^2 = \frac{13.6}{1.5} = 9$ or, $n = 3$
Number of spectral lines emitted
$= \frac{n(n-1)}{2} = \frac{3 \times 2}{2} = 3$

Question86

In a radioactive material the activity at time t_1 is R_1 and at a later time t_2, it is R_2. If the decay constant of the material is λ, then
(2006)

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Options:

A. $R_1 = R_2$

B. $R_1 = R_2 e^{-\lambda(t_1 - t_2)}$

C. $R_1 = R_2 e^{\lambda(t_1 - t_2)}$

D. $R_1 = R_2 \left(\frac{t_2}{t_1}\right)$

Answer: B

Solution:

According to activity law, $R = R_0 e^{-\lambda t}$

$\therefore R_1 = R_0 e^{-\lambda t_1}$ and $R_2 = R_0 e^{-\lambda t_2}$

$\therefore \frac{R_1}{R_2} = \frac{R_0 e^{-\lambda t_1}}{R_0 e^{-\lambda t_2}} = e^{-\lambda t_1} e^{\lambda t_2} = e^{-\lambda(t_1 - t_2)}$

or, $R_1 = R_2 e^{-\lambda(t_1 - t_2)}$

Question87

The binding energy of deuteron is 2.2MeV and that of $_2^4He$ is 28MeV. If two deuterons are fused to form one $_2^4He$ then the energy released is (2006)

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Options:

A. 30.2MeV

B. 25.8MeV

C. 23.6MeV

D. 19.2MeV.

Answer: C

Solution:

$_1^2H + _1^2H \rightarrow _2^4He +$ energy

$\therefore$ Energy released = B.E. of $_2^4He - 2($ B.E. of $_1^2H)$

$= 28 - 2(2.2) = 28 - 4.4 = 23.6MeV$.

Question88

The radius of germanium (Ge) nuclide is measured to be twice the radius of $_4^9Be$. The number of nucleons in Ge are (2006)

Options:

A. 72

B. 73

C. 74

D. 75

Answer: A

Solution:

Nuclear radii $R = R_0(A)^{1/3}$,
where $R_0 \approx 1.2 fm$
or $R \propto (A)^{1/3}$
$\therefore \frac{R_{Be}}{R_{Ge}} = \frac{(9)^{1/3}}{(A)^{1/3}}$ or, $\frac{R_{Be}}{2R_{Be}} = \frac{(9)^{1/3}}{(A)^{1/3}}$
$(\because$ given $R_{Ge} = 2R_{Be})$
or, $(A)^{1/3} = 2 \times (9)^{1/3}$
or, $A = 2^3 \times 9 = 8 \times 9 = 72$.
$\therefore$ The number of nucleons in Ge is 72 .

Question89

In the reaction ${}_1^2H + {}_1^3H \rightarrow {}_2^4He + {}_0^1n$, ifthe binding energies of ${}_1^2H$, ${}_1^3H$ and ${}_2^4He$ are respectively a, b and c (in MeV), then the energy (in MeV) released in this reaction is
(2005)

Options:

A. $a + b + c$

B. $a + b - c$

C. $c - a - b$

D. $c + a - b$.

Answer: C

Solution:

Energy released, $E = (\Delta m) \times 931 MeV$
$\Delta m =$ mass of product $-$ mass of reactant
$\Delta m = c - a - b$
$E = (\Delta m) \times 931$ or, $E = (c - a - b)$.

Question90

The total energy of an electron in the first excited state of hydrogen atom is about -3.4eV. Its kinetic energy in this state is (2005)

Options:

A. 3.4eV

B. 6.8eV

C. -3.4eV

D. -6.8 eV.

Answer: A

Solution:

Solution:

$K.E. = \left|\frac{1}{2}P.E.\right|$

But P.E. is negative.

$\therefore$ Total energy $= \left|\frac{1}{2}P.E.\right| -$ P.E. $= \frac{-P.E.}{2} = -3.4$ eV.

$\therefore K.E. = +3.4\text{eV}$

Question91

Which one of the following pairs of nuclei are isotones? (2005)

Options:

A. ${}_{34}Se^{74}$, ${}_{31}Ga^{71}$

B. ${}_{38}Sr^{84}$, ${}_{38}Sr^{86}$

C. ${}_{42}Mo^{92}$, ${}_{40}Zr^{92}$

D. ${}_{20}Ca^{40}$, ${}_{16}S^{32}$.

Answer: A

Solution:

Isotones means number of neutron remains same.

Question92

In any fission process the ratio $\frac{\text{mass of fission products}}{\text{mass of parent nucleus}}$ is
(2005)

Options:

A. equal to 1

B. greater than 1

C. less than 1

D. depends on the mass of the parent nucleus.

Answer: C

Question93

Energy levels A, B and C of a certain atom corresponding to increasing values of energy i.e., $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are wavelengths of radiations corresponding to transitions C to B, B to A and C to A respectively, which of the following relations is correct?
(2005, 1990)

Options:

A. $\lambda_3 = \lambda_1 + \lambda_2$

B. $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

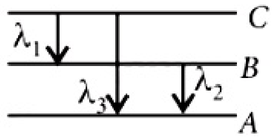
C. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

D. $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Answer: B

Solution:

Solution:



$(E_C - E_A) = (E_C - E_B) + (E_B - E_A)$

$\frac{hc}{\lambda_3} = \frac{hc}{\lambda_1} + \frac{hc}{\lambda_2}$ or $\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$

$\therefore \frac{1}{\lambda_3} = \frac{\lambda_1 + \lambda_2}{\lambda_1 \lambda_2}$ or $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

Question94

Fission of nuclei is possible because the binding energy per nucleon in them
(2005)

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Options:

A. increases with mass number at low mass numbers

B. decreases with mass number at low mass numbers

C. increases with mass number at high mass numbers

D. decreases with mass number at high mass numbers.

Answer: D

Solution:

Solution:
For nuclei having $A > 56$ binding energy per nucleon gradually decreases.

Question95

A nucleus represented by the symbol ${}_Z^AX$ has
(2004)

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Options:

A. Z neutrons and $A - Z$ protons

B. Z protons and $A - Z$ neutrons

C. Z protons and A neutrons

D. A protons and $Z - A$ neutrons

Answer: B

Solution:

Z is number of protons and A is the total number of protons and neutrons.

Question96

If in a nuclear fusion process the masses of the fusing nuclei be m_1 and m_2 and the mass of the resultant nucleus be m_3, then
(2004)

Options:

A. $m_3 = m_1 + m_2$

B. $m_3 = |m_1 - m_2|$

C. $m_3 < (m_1 + m_2)$

D. $m_3 > (m_1 + m_2)$

Answer: C

Solution:

Solution:
In nuclear fusion the mass of end product or resultant is always less than the sum of initial product, the rest is liberated in the form of energy, like in Sun energy is liberated due to fusion of two hydrogen atoms.

Question97

The Bohr model of atoms
(2004)

Options:

A. Assumes that the angular momentum of electrons is quantized.

B. Uses Einstein's photoelectric equation.

C. Predicts continuous emission spectra for atoms.

D. Predicts the same emission spectra for all types of atoms.

Answer: A

Question98

The half life of radium is about 1600 years. If 100g of radium existing now, 25g will remain unchanged after (2004)

Options:

A. 4800 years

B. 6400 years

C. 2400 years

D. 3200 years

Answer: D

Solution:

Using $N = N_0 \left(\frac{1}{2}\right)^n \Rightarrow \frac{N}{N_0} = \left(\frac{1}{2}\right)^n$

$\Rightarrow \frac{25}{100} = \left(\frac{1}{2}\right)^n \Rightarrow n = 2$

The total time in which radium change to 25g is

$= 2 \times 1600 = 3200\,\text{yr}$

Question99

An electron is moving round the nucleus of a hydrogen atom in a circular orbit of radius r. The Coulomb force $\vec{F}$ between the two is (2003)

Options:

A. $\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}\hat{r}$

B. $-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^3}\hat{r}$

C. $\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^3}\vec{r}$

D. $-\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^3}\vec{r}$

Answer: D

Solution:

The charge on hydrogen nucleus$q_1 = +e$
charge on electron, $q_2 = -e$
Coulomb force, $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{(+e)(-e)}{r^2}$
$= -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^3}\vec{r} = -\frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^3}\hat{r}.$

Question100

Solar energy is mainly caused due to
(2003)

Options:

A. burning of hydrogen in the oxygen

B. fission of uranium present in the Sun

C. fusion of protons during synthesis of heavier elements

D. gravitational contraction

Answer: C

Question101

The volume occupied by an atom is greater than the volume of the nucleus by a factor of about
(2003)

Options:

A. 10^1

B. 10^5

C. 10^{10}

D. 10^{15}

Answer: D

Solution:

$$\frac{\text{Volume of atom}}{\text{Volume of nucleus}} = \frac{\frac{4}{3}\pi(10^{-10})^3}{\frac{4}{3}\pi(10^{-15})^3} = 10^{15}$$

Question102

A sample of radioactive element has a mass of 10g at an instant t = 0. The approximate mass of this element in the sample after two mean lives is (2003)

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Options:

A. 1.35g

B. 2.50g

C. 3.70g

D. 6.30g

Answer: A

Solution:

Let ,$t = 0$, $M_0 = 10g$

$t = 2\tau = 2\left(\frac{1}{\lambda}\right)$ (given)

Then from, $M = M_0 e^{-\lambda t} = 10e^{-\lambda\left(\frac{2}{\lambda}\right)}$

$= 10\left(\frac{1}{e}\right)^2 = 1.35g$

Question103

In which of the following systems will the radius of the first orbit (n = 1) be minimum? (2003)

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Options:

A. doubly ionized lithium

B. singly ionized helium

C. deuterium atom

D. hydrogen atom

Answer: A

Solution:

Radius of first orbit, $r \propto \frac{1}{Z}$,
for doubly ionized lithium Z (= 3) will be maximum, hence for doubly ionized lithium, r will be minimum.

Question104

The mass of proton is 1.0073u and that of neutron is 1.0087u (u = atomic mass unit).
The binding energy of ${}_2^4He$ is (Given helium nucleus mass ≈4.0015 u.) (2003)

Options:

A. 0.0305 J

B. 0.0305 erg

C. 28.4M eV

D. 0.061u

Answer: C

Solution:

$$\text{Mass defect } = 2M_P + 2M_N - M_{He}$$
$$= 2 \times 1.0073 + 2 \times 1.0087 - 4.0015 = 0.0305$$
$$\Rightarrow \text{Binding energy } = (931 \times \text{mass defect })\text{MeV}$$
$$= 931 \times 0.0305\text{MeV} = 28.4\text{MeV} \ (1\text{ amu} = 931\text{Mev})$$

Question105

The mass number of a nucleus is (2003)

Options:

A. always less than its atomic number

B. always more than its atomic number

C. sometimes equal to its atomic number

D. sometimes less than and sometimes more than its atomic number

Answer: C

Solution:

Solution:
Mass number = atomic number + no. of neutrons
For hydrogen, number of neutrons = 0
So, mass number = Atomic number.
Hence mass number is sometimes equal to atomic number.

Question106

A nuclear reaction given by $z^{X} \rightarrow z + 1Y^{A} + _{-1}e^{0} + \bar{v}$ represents (2003)

Options:

A. β -decay

B. γ -decay

C. fusion

D. fission

Answer: A

Solution:

Solution:
β -decay.

Question107

Which of the following are suitable for the fusion process? (2002)

Options:

A. light nuclei

B. heavy nuclei

C. element lying in the middle of the periodic table

D. middle elements, which are lying on binding energy curve.

Answer: A

Solution:

Solution:
The nuclei of light elements have a lower binding energy than that for the elements of intermediate mass. They are therefore less stable; consequently the fusion of the light elements results in more stable nucleus.

Question108

A sample of radioactive element containing 4×10^{16} active nuclei. Half life of element is 10 days, then number of decayed nuclei after 30 days (2002)

Options:

A. 0.5×10^{16}

B. 2×10^{16}

C. 3.5×10^{16}

D. 1×10^{16}.

Answer: C

Solution:

Number of initial active nuclei $= 4 \times 10^{16}$
Number of decayed nuclei after 10 days (half life)
$+ = \frac{4 \times 10^{16}}{2} = 2 \times 10^{16}$
Remaining number of nuclei after 10 days
$= 4 \times 10^{16} - 2 \times 10^{16} = 2 \times 10^{16}$.
∴ Number of decayed nuclei in next 10 days
$= 2 \times 10^{16} 2 = 1 \times 10^{16}$
Similarly, number of decayed nuclei in next 10 days $= 0.5 \times 10^{16}$
∴ Total number of nuclei decayed after 30 days
$= 2 \times 10^{16} + 1 \times 10^{16} + 0.5 \times 10^{16} = 3.5 \times 10^{16}$.

Question109

A deutron is bombarded on ${}_8O^{16}$ nucleus then alpha -particle is emitted. The product nucleus is

(2002)

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Options:

A. $_7N^{13}$

B. $_5B^{10}$

C. $_4Be^9$

D. $_7N^{14}$.

Answer: D

Solution:

Solution:
The nuclear reaction is
$_8O^{16} + {}_1H^2 \rightarrow {}_7N^{14} + {}_2He^4$
So when a deuteron is bombarded on $_8O^{16}$ nucleus then an α -particle ($_2He^4$) is emitted and the product nucleus is $_7N^{14}$..

Question110

Which rays contain (positive) charged particles? (2001)

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Options:

A. α -rays

B. β -rays

C. γ -rays

D. X-rays.

Answer: A

Solution:

Solution:
α -rays are positively charged particles.

Question111

$X\,(n, \alpha)\,{}_3^7Li$, then X will be (2001)

Options:

A. ${}_{5}^{10}B$

B. ${}_{5}^{9}B$

C. ${}_{4}^{11}Be$

D. ${}_{2}^{4}He$

Answer: A

Solution:

${}_{5}^{10}B + {}_{0}^{1}n \rightarrow {}_{2}^{4}He + {}_{3}^{7}Li$

Question112

Half life of a radioactive element is12.5 hour and its quantity is 256 g. After how much time its quantity will remain 1g?
(2001)

Options:

A. 50 hrs

B. 100 hrs

C. 150 hrs

D. 200 hrs.

Answer: B

Solution:

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^n$ n→ no.of decays

$\frac{1}{256} = \left(\frac{1}{2}\right)^8 = \left(\frac{1}{2}\right)^n \therefore n = 8$

Time for 8 half life = 100 hours.

Question113

The interplanar distance in a crystal is 2.8×10^{-8} m. The value of

maximum wavelength which can be diffracted
(2001)

Options:

A. 2.8×10^{-8} m

B. 5.6×10^{-8} m

C. 1.4×10^{-8} m

D. 7.6×10^{-8} m.

Answer: B

Solution:

$2d\ \sin\phi = n\lambda$; $(\sin\phi)_{max} = 1$
i.e., $\lambda_{max} = 2d$
$\Rightarrow \lambda_{max} = 2 \times 2.8 \times 10^{-8} = 5.6 \times 10^{-8}$ m.

Question114

The energy of hydrogen atom in n^{th} orbit is E_n then the energy in n^{th} orbit of singly ionised helium atom will be
(2001)

Options:

A. $4E_n$

B. $\frac{E_n}{4}$

C. $2E_n$

D. $\frac{E_n}{2}$.

Answer: A

Solution:

$$E \propto \frac{Z^2}{n^2}$$

Question115

M_n and M_p represent the mass of neutron and proton respectively. An element having mass M has N neutrons and Z protons, then the correct relation will be
(2001)

Options:

A. $M < \{N \cdot M_n + Z \cdot M_p\}$

B. $M > \{N \cdot M_n + Z \cdot M_p\}$

C. $M = \{N \cdot M_n + Z \cdot M_p\}$

D. $M = N\{M_n + M_p\}$

Answer: A

Question116

Energy released in nuclear fission is due to
(2001)

Options:

A. some mass is converted into energy

B. total binding energy of fragments is more than the binding energy of parental element

C. total binding energy of fragments is less than the binding energy of parental element

D. total binding energy of fragments is equal to the binding energy of parental element.

Answer: A

Question117

For the given reaction, the particle X is
$_6C^{11} \rightarrow {}_5B^{11} + \beta^+ + X$
(2000)

Options:

A. neutron

B. anti neutrino

C. neutrino

D. proton.

Answer: C

Question118

Maximum frequency of emission is obtained for the transition (2000)

Options:

A. n = 2 to n = 1

B. n = 6 to n = 2

C. n = 1 to n = 2

D. n = 2 to n = 6

Answer: A

Solution:

$$\upsilon \propto \left[\frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

Question119

The relation between λ and $T_{1/2}$ as ($T_{1/2} \rightarrow$ half life) (2000)

Options:

A. $T_{1/2} = \frac{\ln 2}{\lambda}$

B. $T_{1/2} \ln 2 = \lambda$

C. $T_{1/2} = \frac{1}{\lambda}$

D. $(\lambda + T_{1/2}) = \ln 2$.

Answer: A

Question120

Nuclear fission is best explained by (2000)

Options:

A. liquid droplet theory

B. Yukawa π -meson theory

C. independent particle model of the nucleus

D. proton-proton cycle.

Answer: A

Question121

The life span of atomic hydrogen is (2000)

Options:

A. fraction of one second

B. one year

C. one hour

D. one day.

Answer: A

Question122

When an electron does transition from n = 4 to n = 2, then emitted line spectrum will be
(2000)

Options:

A. first line of Lyman series

B. second line of Balmer series

C. first line of Paschen series

D. second line of Paschen series.

Answer: B

Solution:

Solution:
Jump to second orbit leads to Balmer series. The jump from 4th orbit shall give rise to second line of Balmer series.

Question123

Alpha particles are
(1999)

Options:

A. neutrally charged

B. positron

C. protons

D. ionized helium atoms

Answer: D

Question124

After 1α and 2β -emissions
(1999)

Options:

A. mass number reduces by 6

B. mass number reduces by 4

C. mass number reduces by 2

D. atomic number remains unchanged

Answer: D

Solution:

1α reduce the mass number by 4 units and atomic number by 2 units, while 1β only increase the atomic number by 1 unit.

Question125

Complete the equation for the following fission process
$_{92}U^{235} + _{0}n^{1} \rightarrow _{38}Sr^{90} + ...$
(1998)

Options:

A. $_{57}X^{142} + 3_{0}n^{1}$

B. $_{54}X^{145} + 3_{0}n^{1}$

C. $_{54}X^{143} + 3_{0}n^{1}$

D. $_{54}X^{142} + _{0}n^{1}$

Answer: C

Question126

A nucleus $_{n}X^{m}$ emits one alpha and two β particles. The resulting nucleus is
(1998)

Options:

A. $n - 4^{Z^{m-4}}$

B. $n - 2Y^{m-4}$

C. $_{n}X^{m-4}$

D. $_{n}Z^{m-4}$

Answer: C

Question127

Atomic weight of Boron is 10.81 and it has two isotopes $_{5}B^{10}$ and $_{5}B^{11}$. Then the ratio of $_{5}B^{10}$: $_{5}B^{11}$ in nature would be
(1998)

Options:

A. 15: 16

B. 10: 11

C. 19: 81

D. 81: 19

Answer: C

Solution:

Let ${}_5B^{10}$ be present as x%

and percentage of ${}_5B^{11}$ = (100 − x)

∴ Average atomic coefficient $= \frac{10x + 11(100 - x)}{100} = 10.81 \Rightarrow x = 19$

∴% of ${}_5B^{11}$ is $100 - 19 = 81$. Ratio is 19: 81

Question128

In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass and e is the charge on the electron and ε_0 is the vacuum permittivity, the speed of the electron is
(1998)

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Options:

A. $\frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$

B. $\frac{e}{\sqrt{\varepsilon_0 a_0 m}}$

C. 0

D. $\frac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

Answer: A

Solution:

Centripetal force = force of attraction of nucleus on electron

$\frac{mv^2}{a_0} = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{a_0{}^2}; v = \frac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$.

Question129

The 21cm radiowave emitted by hydrogen in interstellar space is due to the interaction called the hyperfine interaction in atomic hydrogen. The energy of the emitted wave is nearly
(1998)

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Options:

A. 7×10^{-8} joule

B. 1 joule

C. 10^{-17} joule

D. 10^{-24} joule

Answer: D

Solution:

Energy = $h\upsilon$

$$= \frac{hc}{\lambda} = \frac{6.625 \times 10^{-34} \times 3 \times 10^{8}}{21 \times 10^{-2}}$$

$$= 0.9464 \times 10^{-24} J \cong 1 \times 10^{-24} J$$

Question130

Half-lives of two radioactive substances A and B are respectively 20 minutes and 40 minutes. Initially the samples of A and B have equal number of nuclei. After 80 minutes the ratio of remaining numbers of A and B nuclei is
(1998)

Options:

A. 1: 4

B. 4: 1

C. 1: 16

D. 1: 1

Answer: A

Solution:

For A, 80 min. = 4 half lives

No. of atoms left $= \frac{N_0}{16}$

For B, 80 min. $\cong$ 2 half lives

No. of atoms left $= \frac{N_0}{4}$.

Ratio $= 1 : 4$

Question131

Due to earth's magnetic field, the charged cosmic rays particles
(1997)

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Options:

A. can never reach the pole

B. can never reach the equator

C. require greater kinetic energy to reach the equator than pole

D. require less kinetic energy to reach the equator than pole.

Answer: C

Question132

Which of the following is used as a moderator in nuclear reaction? (1997)

Options:

A. cadmium

B. plutonium

C. uranium

D. heavy water.

Answer: D

Solution:

Solution:
In nuclear fission, the chain reaction is controlled in such way that only one neutron, produced in each fission, causes further fission. Therefore some moderator is used to slowdown the neutrons. Heavy water is used for this purpose.

Question133

The energy of the ground electronic state of hydrogen atom is - $13.6\mathrm{eV}$. The energy of the first excited state will be (1997)

Options:

A. -27.2 eV

B. -52.4 eV

C. -3.4 eV

D. -6.8 eV

Answer: C

Solution:

Solution:
Energy of the ground electronic state of hydrogen atom $E = -13.6 eV$.
We know that energy of the first excited state for second orbit (where $n = 2$)
$E_n = -\frac{13.6}{(n)^2} = -\frac{13.6}{(2)^2} = -3.4 eV$

Question134

When hydrogen atom is in its first excited level, its radius is ...... of the Bohr radius.
(1997)

Options:

A. twice

B. 4 times

C. same

D. half.

Answer: B

Solution:

Solution:
When a hydrogen atom is in its excited level, then $n = 2$.
Therefore radius of hydrogen atom in its first excited level $(r) \propto n^2 r_0 \propto (2)^2 = 4r_0$.

Question135

The most penetrating radiation out of the following are
(1997)

Options:

A. β -rays

B. γ -rays

C. X-rays

D. α -rays.

Answer: B

Solution:

Solution:
γ -ray are most penetrating radiations.

Question136

The minimum wavelength of the X-rays produced by electrons accelerated through a potential difference of V volts is directly proportional to (1996)

Options:

A. $\frac{1}{\sqrt{V}}$

B. $\frac{1}{V}$

C. $\sqrt{V}$

D. V^2.

Answer: B

Solution:

By the law of photo-electric effect
$\frac{hc}{\lambda} = eV$ or $\lambda = \frac{hc}{eV} \propto \frac{1}{V}$

Question137

The energy of a hydrogen atom in its ground state is -13.6 eV. The energy of the level corresponding to the quantum number n = 2 in the hydrogen atom is (1996)

Options:

A. -0.54 eV

B. -3.4 eV

C. -2.72 eV

D. -0.85 eV

Answer: B

Solution:

Energy of hydrogen atom in ground state $= -13.6\text{eV}$ and quantum number $(n) = 2$.
We know that energy of hydrogen atom
$(E_n) = -\frac{13.6}{n^2} = -\frac{13.6}{(2)^2} = -3.4\text{eV}$

Question138

According to Bohr's principle, the relation between principal quantum number (n) and radius of orbit (r) is (1996)

Options:

A. $r \propto \frac{1}{n}$

B. $r \propto \frac{1}{n^2}$

C. $r \propto n$

D. $r \propto n^2$

Answer: D

Solution:

According to Bohr's principle, radius of orbit $(r) = 4\pi\varepsilon_0 \times \frac{n^2h^2}{4\pi^2me^2} \propto n^2$.
where $n =$ principal quantum number.

Question139

A nucleus ruptures into two nuclear parts, which have their velocity ratio equal to 2 : 1. What will be the ratio of their nuclearsize (nuclear radius)?

(1996)

Options:

A. $3^{1/2} : 1$

B. $1 : 3^{1/2}$

C. $2^{1/3} : 1$

D. $1 : 2^{1/3}$

Answer: D

Solution:

Velocity ratio $(v_1 : v_2) = 2 : 1$.
Mass $(m) \propto$ Volume $\propto r^3$.
According to law of conservation of momentum,
$m_1 v_1 = m_2 v_2$

Therefore $\frac{v_1}{v_2} = \frac{m_2}{m_1} = \frac{{r_2}^3}{{r_1}^3}$

or $\frac{r_1}{r_2} = \left(\frac{v_2}{v_1}\right)^{1/3} = \left(\frac{1}{2}\right)^{1/3} = \frac{1}{2^{1/3}}$

or $r_1 : r_2 = 1 : 2^{1/3}$

Question140

What is the respective number of α and β particles emitted in the following radioactive decay?

$^{200}X_{90} \rightarrow {}^{168}Y_{80}$

(1995)

Options:

A. 8 and 8

B. 8 and 6

C. 6 and 8

D. 6 and 6.

Answer: B

Solution:

On emission of one α -particle, atomic number decreases by 2 units and atomic mass number decrease by 4 units.
Here, decrease in mass number $= 200 - 168 = 32$

$\therefore$ Number of α -particles $= \frac{32}{4} = 8$

While the emission of β -particle does not effect the mass number and atomic number increases by 1 unit.
$\therefore$ Number of β -particles $= 16 - 10 = 6$

Question141

The binding energies per nucleon for a deuteron and an α -particle are x_1 and x_2 respectively. The energy Q released in thereaction $^2H_1 + {}^2H_1 \rightarrow {}^4He_2 + Q$, is (1995)

Options:

A. $4(x_1 + x_2)$

B. $4(x_2 - x_1)$

C. $2(x_2 - x_1)$

D. $2(x_1 + x_2)$.

Answer: B

Solution:

No. of nucleon on reactant side $= 4$
Binding energy for one nucleon $= x_1$
Binding energy for 4 nucleons $= 4x_1$
Similarly on product side binding energy $= 4x_2$
Now, Q = change in binding energy $= 4(x_2 - x_1)$

Question142

The count rate of a Geiger Muller counter for the radiation of a radioactive materialof half-life of 30 minutes decreases to 5 second $^{-1}$ after 2 hours. The initial countrate was (1995)

Options:

A. 80 second $^{-1}$

B. 625 second $^{-1}$

C. 20 second $^{-1}$

D. 25 second $^{-1}$.

Answer: A

Solution:

Half-life time = 30 minutes; Rate of decrease (N) = 5 per second and total time = 2 hours = 120 minutes. Relation forinitial and final count rate

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{\text{time / half-life}} = \left(\frac{1}{2}\right)^{120/30} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$$

Therefore $N_0 = 16 \times N = 16 \times 5 = 80 s^{-1}$

Question143

An electron makes a transition from orbitn = 4 to the orbit n = 2 of a hydrogen atom. What is the wavelength of the emitted radiations? (R = Rydberg's constant)
(1995)

Options:

A. $\frac{16}{4R}$

B. $\frac{16}{5R}$

C. $\frac{16}{2R}$

D. $\frac{16}{3R}$

Answer: D

Solution:

Transition of hydrogen atom from orbit $n_1 = 4$ to $n_2 = 2$.

Wave number $= \frac{1}{\lambda} = R\left[\frac{1}{{n_1}^2} - \frac{1}{{n_2}^2}\right] = R\left[\frac{1}{(2)^2} - \frac{1}{(4)^2}\right]$

$= R\left[\frac{1}{4} - \frac{1}{16}\right] = R\left[\frac{4-1}{16}\right] = \frac{3R}{16} \Rightarrow \lambda = \frac{16}{3}R$

Question144

When a hydrogen atom is raised from the ground state to an excited state,
(1995)

Options:

A. both K.E. and P.E. increase

B. both K.E. and P.E. decrease

C. the P.E. decreases and K.E. increases

D. the P.E. increases and K.E. decreases.

Answer: D

Solution:

Solution:

Potential energy of hydrogen atom is given by $PE = \frac{-kZe^2}{r}$

As atom is excited, its radius increases. But due to negative sign or reverse sign. Its actual potential energy increases.

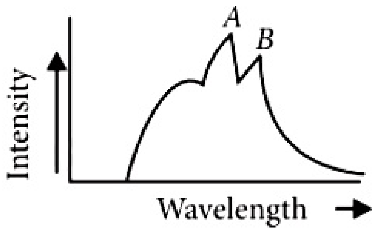
And Kinetic energy is given by $KE = \frac{kZe^2}{2r}$

As atom is excited, its radius increases thus resulting in decrease of Kinetic energy.

Ans: The PE increases and KE decreases.

Question145

The figure represents the observed intensity of X-rays emitted by an X-ray tube, as a function of wavelength. The sharp peaks A and B denote (1995)



Options:

A. white radiations

B. characteristic radiations

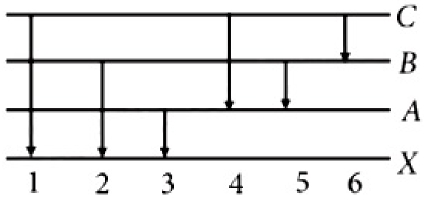
C. band spectrum

D. continuous spectrum

Answer: B

Question146

The figure indicates the energy level diagram of an atom and the origin of six spectral lines in emission (e . g., line no. 5 arises from the transition from level B to A).



Which of the following spectral lines will occur in the absorption spectrum?
(1995)

Options:

A. 4,5,6

B. 1,2,3,4,5,6

C. 1,2,3

D. 1,4,6

Answer: C

Solution:

Solution:
Absorption spectrum involves only excitation of ground level to higher level.
Therefore spectral lines 1,2,3 will occur in the absorption spectrum.

Question147

The mass number of He is 4 and that of sulphur is 32 . The radius of sulphur nucleus is larger than that of helium by the factor of
(1995)

Options:

A. 4

B. 2

C. 8

D. $\sqrt{8}$

Answer: B

Solution:

Mass number of helium (A_{He}) = 4 and mass number of sulphur (A_S) = 32 .
Radius of nucleus, $r = r_0(A)^{1/3}(A)^{1/3}$. Therefore
$\frac{r_s}{r_{He}} = \left(\frac{A_s}{A_{He}}\right)^{1/3} = \left(\frac{32}{4}\right)^{1/3} = (8)^{1/3} = 2.$

Question148

The binding energy per nucleon is maximum in case of (1993)

Options:

A. ${}_2{}^4He$

B. ${}_{56}{}^{26}Fe$

C. ${}_{56}{}^{141}Ba$

D. ${}_{92}{}^{235}U$

Answer: B

Solution:

Solution:
From binding energy curve, the curve reaches peak for ${}_{26}Fe^{56}$.

Question149

Which source is associated with a line emission spectrum? (1993)

Options:

A. Electric fire

B. Neon street sign

C. Red traffic light

D. Sun

Answer: B

Solution:

Neon street sign is a source of line emission spectrum.

Question150

Energy released in the fission of a single ${}_{92}^{235}U$ nucleus is 200MeV. The fission rate of ${}_{92}^{235}U$ filled reactor operating at a power level of 5W is (1993)

Options:

A. $1.56 \times 10^{-10}\ s^{-1}$

B. $1.56 \times 10^{11}\ s^{-1}$

C. $1.56 \times 10^{-16}\ s^{-1}$

D. $1.56 \times 10^{-17}\ s^{-1}$

Answer: B

Solution:

Fission rate = $\frac{\text{total power}}{\frac{\text{energy}}{\text{fission}}} = \frac{5}{200 \times 1.6 \times 10^{-13}} = 1.56 \times 10^{11} s^{-1}$

Question151

Hydrogen atoms are excited from ground state of the principle quantum number 4 . Then the number of spectral lines observed will be (1993)

Options:

A. 3

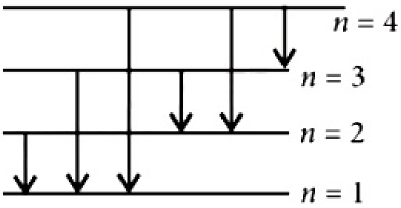
B. 6

C. 5

D. 2

Answer: B

Solution:



No. of spectral lines $= \frac{n(n-1)}{2} = \frac{4(4-1)}{2} = 6$

Question152

In terms of Bohr radius a_0, the radius of the second Bohr orbit of a hydrogen atom is given by (1992)

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Options:

A. $4a_0$

B. $8a_0$

C. $\sqrt{2}a_0$

D. $2a_0$

Answer: A

Solution:

As $r \propto n^2$, therefore, radius of 2^{nd}
Bohr's orbit $= 4a_0$

Question153

Solar energy is due to (1992)

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Options:

A. fusion reaction

B. fission reaction

C. combustion reaction

D. chemical reaction

Answer: A

Solution:

Fusion reaction.

Question154

The ionization energy of hydrogen atom is 13.6 eV . Following Bohr's theory, the energy corresponding to a transition between 3^{rd} and 4^{th} orbit is (1992)

Options:

A. 3.40 eV

B. 1.51 eV

C. 0.85 eV

D. 0.66 eV

Answer: D

Solution:

$$E = E_4 - E_3$$
$$= -\frac{13.6}{4^2} - \left(-\frac{13.6}{3^2}\right) = -0.85 + 1.51 = 0.66\text{eV}$$

Question155

The energy equivalent of one atomic mass unit is (1992)

Options:

A. 1.6×10^{-19} J

B. 6.02×10^{23} J

C. 931 M eV

D. 9.31 M eV

Answer: C

Solution:

1 a.m.u $= 931\text{ MeV}$

Question156

The mass of α -particle is
(1992)

Options:

A. less than the sum of masses of two protons and two neutrons

B. equal to mass of four protons

C. equal to mass of four neutrons

D. equal to sum of masses of two protons and two neutrons

Answer: A

Solution:

α -particle $= {}_2He^4$. It contains 2p and2n.
As some mass is converted into binding energy, therefore, mass of α particle is slightly less than sum of the masses of 2p and 2n.

Question157

Of the following pairs of species which one will have the same electronic configuration for both members?
(1992)

Options:

A. Li^+ and Na^+

B. He and Ne^+

C. H and Li

D. C and N^+

Answer: D

Solution:

Clearly C and N^+ have same electronic configuration as they are isoelectronic.

Question158

The mass density of a nucleus varies with mass number A as (1992)

Options:

A. A^2

B. A

C. constant

D. $\frac{1}{A}$

Answer: C

Solution:

The nuclear radius r varies with mass number A according to the relation
$r = r_0 A^{1/3} \Rightarrow r \propto A^{1/3}$ or $A \propto r^3$

Now density $= \frac{\text{mass}}{\text{volume}}$

Further mass $\propto A$ and volume $\propto r^3$

$\therefore \frac{\text{mass}}{\text{volume}} =$ constant

Question159

The constituents of atomic nuclei are believed to be (1991)

Options:

A. neutrons and protons

B. protons only

C. electron and protons

D. electrons, protons and neutrons

Answer: A

Solution:

Nucleus contains only neutrons andprotons.

Question160

The half life of radium is 1600 years. The fraction of a sample of radium that would remain after 6400 years (1991)

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Options:

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. $\frac{1}{8}$

D. $\frac{1}{16}$

Answer: D

Solution:

$$\frac{N}{N_0} = \left(\frac{1}{2}\right)^{6400/1600} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$$

Question161

In the nucleus of $_{11}Na^{23}$, the number of protons, neutrons and electrons are (1991)

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Options:

A. 11,12,0

B. 23,12,11

C. 12,11,0

D. 23,11,12

Answer: A

Solution:

$Z = 11$ i.e., number of protons $= 11$, $A = 23$
$\therefore$ Number of neutrons $= A - Z = 12$
Number of electron $= 0$ (No electron in nucleus)
Therefore 11,12,0.

Question162

The ground state energy of H-atom is 13.6 eV . The energy needed to ionize H-atom from its second excited state
(1991)

Options:

A. 1.51 eV

B. 3.4 eV

C. 13.6 eV

D. none of these

Answer: A

Solution:

Second excited state corresponds to $n = 3$
$\therefore E = \frac{13.6}{3^2} eV = 1.51 eV$
but one has to ionise only from ground state. Even if one has to excite an atom from $n = 3$, one has to excite from $n = 1$

Question163

If the nuclear force between two protons, two neutrons and between proton and neutron is denoted by F_{pp}, F_{nn} and F_{pn} respectively, then
(1991)

Options:

A. $F_{pp} \approx F_{nn} \approx F_{pn}$

B. $F_{pp} \neq F_{nn}$ and $F_{pp} = F_{nn}$

C. $F_{pp} = F_{nn} = F_{pn}$

D. $F_{pp} \neq F_{nn} \neq F_{pn}$

Answer: C

Solution:

Nuclear force is the same between any two nucleons.

Question164

The valence electron in alkali metal is a (1990)

Options:

A. f -electron

B. p -electron

C. s -electron

D. d -electron

Answer: C

Solution:

Solution:
For all first group elements, Na, K, Rb Cs, Fr. They have one electron in the s subshell.

Question165

Consider an electron in the n^{th} orbit of a hydrogen atom in the Bohr model. The circumference of the orbit can be expressed in terms of de Broglie wavelength λ of that electron as (1990)

Options:

A. $(0.529)n\lambda$

B. $\sqrt{n\lambda}$

C. $(13.6)\lambda$

D. $n\lambda$

Answer: D

Solution:

The circumference of an orbit in an atom in terms of wavelength of wave associated with electron is given by the relation,
Circumference $= n\lambda$, where $n = 1, 2, 3, \ldots\ldots$

Question166

The nuclei $_6C^{13}$ and $_7N^{14}$ can be described as (1990)

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Options:

A. isotones

B. isobars

C. isotopes of carbon

D. isotopes of nitrogen

Answer: A

Solution:

As $_6C^{13}$ and $_7N^{14}$ have same no. ofneutrons
$(13 - 6 = 7 \text{ for C and } 14 - 7 = 7 \text{ for N})$, they are isotones.

Question167

Which of the following statements is true for nuclear forces? (1990)

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Options:

A. They obey the inverse square law of distance.

B. They obey the inverse third power law of distance.

C. They are short range forces.

D. They are equal in strength to electromagnetic forces.

Answer: C

Solution:

Nuclear forces are short range forces

Question168

The ratio of the radii of the nuclei $_{13}Al^{27}$ and $_{52}Te^{125}$ approximately (1990)

Options:

A. 6: 10

B. 13: 52

C. 40: 177

D. 14: 73

Answer: A

Solution:

$R \propto (A)^{1/3}$ from $R = R_0 A^{1/3}$.

$\therefore R_{Al} \propto (27)^{1/3}$ and $R_{Te} \propto (125)^{1/5}$

$\therefore \frac{R_{Al}}{R_{Te}} = \frac{3}{5} = \frac{6}{10}$

Question169

The nucleus $_6C^{12}$ absorbs an energetic neutron and emits a beta particle (β). The resulting nucleus is
(1990)

Options:

A. $_7N^{14}$

B. $_7N^{13}$

C. $_5B^{13}$

D. $_6C^{13}$

Answer: B

Solution:

$_6C^{12} + {_0n^1} \rightarrow {_6C^{13}} \rightarrow {_7N^{13}} + {_{-1}\beta^0}$ + Energy

Question170

A radioactive element has half life period 800 years. After 6400 years what amount will remain?
(1989)

Options:

A. $\frac{1}{2}$

B. $\frac{1}{16}$

C. $\frac{1}{8}$

D. $\frac{1}{256}$

Answer: D

Solution:

Number of half lives, $n = \frac{t}{T} = \frac{6400}{800} = 8$

$\frac{N}{N_0} = \left(\frac{1}{2}\right)^8 = \frac{1}{256}$

Question171

An element A decays into element C by a two step process
$A \rightarrow B + {}_2He^4$; $B \rightarrow C + 2e^-$, Then
(1989)

Options:

A. A and C are isotopes

B. A and C are isobars

C. A and B are isotopes

D. A and B are isobars

Answer: A

Solution:

From equation (ii), B has 2 units of charge more than C.
From equation (i), A loses 2 units of charge by emission of alpha particle. Hence, A and C are isotopes as their charge number is same.

Question172

Curie is a unit of
(1989)

Options:

A. energy of gamma rays

B. half-life

C. radioactivity

D. intensity of gamma rays

Answer: C

Solution:

Curie is a unit of radioactivity

Question173

The average binding energy of a nucleon inside an atomic nucleus is about
(1989)

Options:

A. 8 M eV

B. 8 eV

C. 8 J

D. 8 erg

Answer: A

Solution:

Average binding energy/nucleon in nuclei is of the order of $8 \mathrm{MeV}$.

Question174

To explain his theory, Bohr used
(1989)

Options:

A. conservation of linear momentum

B. quantisation of angular momentum

C. conservation of quantum frequency

D. none of these

Answer: B

Solution:

Bohr used quantisation of angular momentum. For stationary orbits, Angular momentum $I\omega = \frac{nh}{2\pi}$ where $n = 1, 2, 3, \ldots$ etc.

Question175

The atomic number of silicon is 14. Its ground state electron configuration is
(1989)

Options:

A. $1s^2 2s^2 2p^2 2s^4$

B. $1s^2 2s^2 2p^6 3s^1 3p^3$

C. $1s^2 2s^2 2p^8 3s^2$

D. $1s^2 2s^2 2p^6 3s^2 3p^2$

Answer: D

Question176

A radioactive sample with a half life of 1 month has the label : 'Activity $= 2$ micro curies on $1 - 8 - 1991'$. What would be itsactivity two months earlier?
(1988)

Options:

A. 1.0 micro curie

B. 0.5 micro curie

C. 4 micro curie

D. 8 micro curie

Answer: D

Solution:

In two half lives, the activity becomes one fourth.
Activity on $1 - 8 - 91$ was 2 micro curie
∴ Activity before two months,
4×2 micro-Curie $= 8$ micro curie

Question177

The nucleus ${}_{48}{}^{115}Cd$, after two successive β -decay will give
(1988)

Options:

A. ${}_{46}{}^{115}Pa$

B. ${}_{49}{}^{114}In$

C. ${}_{113}{}^{50}Sn$

D. ${}_{50}{}^{115}Sn$

Answer: D

Solution:

Two successive β decays increase the charge no. by 2 .

Question178

The ionisation energy of hydrogen atom is 13.6 eV , the ionisation energy of a singly ionised helium atom would be (1988)

Options:

A. 13.6 eV

B. 27.2 eV

C. 6.8 eV

D. 54.4 eV

Answer: D

Solution:

$E \propto Z^2$ and Z for singly ionised helium is 2 (i.e., 2 protons in the nucleus)
$\therefore (E)_{He} = 4 \times 13.6 = 54.4 eV$
