CHEMISTRY

FOR IIT JEE ASPIRANTS OF CLASS 12 FOR CHEMISTRY

RADIO ACTIVITY

Illustration

1. Half life period of ${}_{53}I^{125}$ is 60 days. Percentage of radioactivity preent after 180 days is a).5 b).75 c).36 d).125

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2. What mass of C^{14} with $t_{1/2} = 5730$ years has activity equal to curie?

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3. $._{90}Th^{234}$ disintegrates to give $._{82}Pb^{206}Pb$ as the final product. How many alpha and beta particles are emitted during this process ?

A. 7 and 6

B. 6 and 7

C. 2 and 4

D. 4 and 2

Answer: A

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4. The atomic mass of ${}_{.8}O^{16} = 15.9949$ amu. Calculate the $BE/\text{nucleon}$ for this atom. Mass $1n$ and $1p$ is 2.016490 amu and $m_e = 0.00055$ amu.

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5. Calculate the mass defect and binding energy per nucleon for an alpha particle (containing two protons and two neutrons) whose actual mass is 4.0028 amu (mass of proton = 1.00759 amu, mass of nuetron = 1.00898 amu).

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6. An old piece of wood has 25.6% as much C^{14} as ordinary wood today has. Find the age of the wood. Half-life period of C^{14} is 5760 years?

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7. Write equations for the following transformation:

(a) ${}_{7}^{17}N(n, p)$ (b) ${}_{19}^{39}K(n, \alpha)$

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Solved Examples

1. The half-life of a radioisotope is 1.5 hours. If its initial mass is 32g, the mass left undecayed after 6 hours is

A. 32 g

B. 16 g

C. 4 g

D. 2g

Answer: D

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2. After 24 hour, only 0.125 g out of the initial quantity of 1 g of a radioactive isotope remains behind. The half-life period of the radioactive isotope in hours is

A. $7.2h$

B. $7.99h$

C. $6.99h$

D. $10.0h$

Answer: B

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3. Half life period of ${}_{53}I^{125}$ is 60 days. Percentage of radioactivity preent after 180 days is a).5 b).75 c).36 d).125

A. $50\ \%$

B. $20.5\ \%$

C. $12.5\ \%$

D. $25\ \%$

Answer: C

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4. A radioisotope undergoes decomposition which follows two parallel paths as shown below

The percentage distribution of 'B' and 'C' are

A. 80% of 'B'and 20% of 'C'

B. $76.83\ \%\ 'B'\ \text{and}\ 23.17\ \%\ 'C'$

C. 90%'B' and 10% 'C'

D. 60% 'B' and 40% 'C'

Answer: B

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5. The activity of $1g$ radium is found to be 0.5. Calculate the half-life period of radium and the time required for the decay of $2g$ of radium to give $0.25g$ of radium (atomic mass off radium = 226).

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6. A certain radio isotope $._Z X^A$ (half life $= 10$ days) decays to give $._{Z-2} Y^{A-4}$. If $1.0g$ atom of X is kept in a sealed vessel, find the volume of helium accumulated at STP in 20 days ?

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7. A sample of $.^{14} CO_2$ was to be mixed with ordinary CO_2 for a biological tracer experiment . In order that $10cm^3$ of diluted gas should have $10^4 \text{dis}/\text{min}$, what activity (in μCi) of radioactive carbon is needed to prepare 60L of diluted gas at STP. [$1Ci = 3.7 \times 10^{10} dps$]

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8. The analysis of a uranium reveals that ratio of mole of $.^{206} Pb$ and $.^{238} U$ in sample is 0.2 . If effective decay constant of process

$._{}^{238}U \rightarrow ._{}^{206}Pb$ is λ then age of rock is

A. $\frac{1}{\lambda} In \frac{5}{4}$

B. $\frac{1}{\lambda} In\left(\frac{5}{1}\right)$

C. $\frac{1}{\lambda} \frac{\ln(4)}{1}$

D. $\frac{1}{\lambda} In\left(\frac{6}{5}\right)$

Answer: D

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Exercise

1. Match the following :

1.	Isotopes	$A.$	${}_{8}O^{16}$ and ${}_{8}O^{17}$
2.	Isobars	$B.$	$Na^{+}. Mg^{2+}. F^{-}$
3.	Isosters	$C.$	${}_{1}H^{2}$ and ${}_{2}He^{3}$
4.	Isotones	$D.$	CO_2 and N_2O
5.	Isoelectronic	$E.$	${}_{A}X^{z}. {}_{A-2}X^{z-A}$
6.	Isodiaphers	$F.$	${}_{20}Ca^{40}$ and ${}_{19}K^{40}$

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2. Half-life period of a radioactive element is 100 seconds. Calculate the disintegration constant and average life. How much time will it take to lose its activity by $90\ \%$?

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3. The atomic mass of thorium is 232 and its atomic number is 90. During the course of its radioactive disintegration 6α and 4β particles are emitted. What is the atomic mass and atomic number of the atom?

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4. Calculate the binding energy for ${}_1H^2$ atom. The mass of ${}_1H^2$ atom is 2.014102 amu where $1n$ and $1p$ have their weights 2.016490 amu. Neglect mass of electron.

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5. The ${}_6C^{14}$ and ${}_6C^{12}$ ratio in a piece of woods is $1/16$ part of atmosphere. Calculate the age of wood. $t_{1/2}\text{of}C^{14}$ is 5577 years?

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6. Complete the following :

(1). $_{7}N^{14} + {}_{2}He^{4} \rightarrow {}_{8}O^{17} + ...$, (2)

$_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{55}A^{142} + {}_{37}B^{92} + ...$

(3). $_{29}Cu^{53} \rightarrow {}_{28}Ni^{53} + ... ,$

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Exercise 1

1. $_{13}Al^{27}$ is a stable isotope. $_{13}Al^{29}$ is expected to disintegrate by

A. α emission

B. $_{-}(-1)^{0}\beta$ emission

C. Positron emission

D. Proton emission

Answer: B

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2. Loss of β-particles is equivalent to

A. Increase of one proton only

B. Decrease of one neutron only

C. Both (A) and (B)

D. None of these

Answer: C

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3. Two radioactive material A_1 and A_2 have decay constants of 10 λ_0 and λ_0. If initially they have same number of nuclei, then after time $\frac{1}{9\lambda_0}$ the ratio of number of their undecayed nuclei will be

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

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

C. $\frac{1}{e^3}$

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

Answer: A

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4. The half-life of a radioactive isotope is three hours. If the initial mass of the isotope were 256 g, the undecayed remaining mass after 18 hours would be

A. $16.0g$

B. $4.0g$

C. $8.0g$

D. $12.\ 0g$

Answer: B

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5. Consider the follwing nuclear reactions:

$$._{92}^{238}M \rightarrow ._{y}^{x}N + 2._{2}He^{4}$$

$$._{y}^{x}N \rightarrow ._{B}^{A}L + 2\beta^{+}$$

A. 142

B. 144

C. 140

D. 146

Answer: B

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6. The half-life of a radioisotope is four hours. If the initial mass of the isotope was 200 g , the undecayed mass remaining after 24 hours is :

A. $1.042g$

B. $2.084g$

C. $3.\ 125g$

D. $4.\ 167g$

Answer: C

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7. Helium nuclei combines to form an oxygen nucleus. The energy released per nucleon of oxygen nucleus is if $m_0 = 15.834$ amu and $m_{He} = 4.0026$amu

A. $10.24MeV$

B. 0MeV

C. $5.24MeV$

D. 4 MeV

Answer: A

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8. A radioactive element gets spilled over the floor of a room. Its half life period is 30 days. If its initial activity is ten times the

permissible value, after how many days will it be safe to enter the room?

A. 50 days

B. 30 days

C. 10 days

D. 100 days

Answer: D

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9. Which of the following nuclear reactions will generate an isotope ?

A. neutron particle emission

B. Positron emission

C. α-Particle emission

D. β-Particle emission

Answer: A

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10. The radioactive sources A and B of half lives of t hr and 2t hr respectively, initially contain the same number of radioactive atoms. At the end of t hours, their rates of disintegration are in the ratio:

A. $2\sqrt{2}:1$

B. $1:8$

C. $\sqrt{2}:1$

D. $\ln 2:1$

Answer: C

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11. The ratio of C^{14} to C^{12} in a living matter is measured to be $\frac{C_{14}}{C_{12}} = 1.3 \times 10^{-12}$ at the present time Activity of $12.0gm$ carabon sample is 180 dpm. The half life of C^{14} is nearly _____ $\times 10^{12}$ sec.

[Given : $N_A = 6 \times 10^{23}$]

A. 0.18

B. 1.8

C. 0.384

D. 648

Answer: A

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12. The analysis of a uranium reveals that ratio of mole of $.^{206}Pb$ and $.^{238}U$ in sample is 0.2 . If effective decay constant of process $.^{238}U \rightarrow .^{206}Pb$ is λ then age of rock is

A. $\frac{1}{\lambda} In \frac{5}{4}$

B. $\frac{1}{\lambda} In \left(\frac{5}{1}\right)$

C. $\frac{1}{\lambda} In \frac{4}{1}$

D. $\frac{1}{\lambda} In \left(\frac{6}{5}\right)$

Answer: D

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13. The half life of Tc^{99} is $6.0hr$. The delivery of a sample of Tc^{99} from the reactor to the nuclear medicine lab of a certain hospital takes $3.0hr$. What is the minimum amount of Tc^{99} that must be shipped in order for the lab to receive $10.0mg$?

A. $20.0mg$

B. $15.0mg$

C. $14.1mg$

D. $12.5mg$

Answer: C

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14. Two radioactive nuclides A and B have half-lives 50 min and 10 min respectively . A fresh sample contains the nuclides of B to be

eight times that of A. How much time should elapse so that the number of nuclides of A becomes double of B ?

A. 30

B. 40

C. 50

D. None

Answer: C

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15. Wooden article and freshly cut tree show activity 7.6 and 15.2 $\min^{-1} g^{-1}$ of carbon ($t_{1/2} = 5760$year) respectively. The age of the article is a)5760 year b)$5760 \times \frac{15.2}{7.6} year$ c)$5760 \times \frac{7.6}{15.2} year$ d)$5760 \times 15.2 - 7.6 year$

A. 5760

B. $5760 \times \left(\frac{15.2}{7.6}\right)$

C. $5760 \times \left(\frac{7.6}{15.2}\right)$

D. $5760 \times (15.2 - 7.6)$

Answer: A

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16. A radioactive sample had an initial activily of 56 dpm (disintegration per min). After 69.3 min it was found to have an activity of 28 dpm. Find the number of atoms in a sample having an activity of 10 dpm.

A. 693

B. 1000

C. 100

D. 10000

Answer: B

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17. C_{14} is a beta active nucleus. A sample of $C^{14}H_4$ gas kept in a closed vessel shows increase in pressure with time . This is due to

A. the formation of $N^{14}H_3$ and H_2

B. the formation of $B^{14}H_3$ and H_2

C. the formation of $C^{14}._2 H_4$ and H_2

D. the formation of $C^{12}H_3, N^{14}H_2$ and H_2

Answer: A

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18. ${}_{11}^{23}Na$ is the most stable isotope of Na. Find the process by which ${}_{11}^{24}Na$ can undergo radioactive decay :

A. β^--emission

B. α-emission

C. β^+-emission

D. K-electron capture

Answer: A

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19. There is a stream of neutrons with KE=2eV. If the half life of neutrons is 100 sec, what fraction of neutrons will decay before

they travel a distance of 1000 km. [Mass of neutrons $= 1.6 \times 10^{-24} g$]

A. 0.75

B. 0.25

C. 0.707

D. 0.293

Answer: D

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20. A periodic table has 18 groups numbered from 1 to 18. What will be the group number of the final daughter nucleus formed , if ${}_{63}Eu^{150}$ shows sequential decay emitting 1α and 1β particles.

A. 3

B. 2

C. 4

D. 5

Answer: A

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21. What will be the energy change in the following nuclear reaction,

$X^{40} + {}_0 n^1 \rightarrow Y^{30} + Z^{11}$

if binding energy per nucleon of X,Y and Z is 9, 7 and 6 MeV respectively.

A. Energy released 84 MeV.

B. Energy absorbed 84 MeV

C. Energy released 4 MeV

D. Energy absorbed 4 MeV.

Answer: B

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22. A radioactive substance has 0.1 gm at a particular instant and has an average life of 1 day . The mass of the substance which decays during the 4th day is give by :

A. $6.25mg$

B. $12.\ 5mg$

C. $3.2mg$

D. $1.25mg$

Answer: C

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23. Two radioactive nuclides A and B have half-lives 50 min and 10 min respectively . A fresh sample contains the nuclides of B to be eight times that of A. How much time should elapse so that the mumber of nuclides of A becomes double of B ?

A. 30

B. 40

C. 50

D. 100

Answer: C

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24. Assuming that only particles emitted from atoms during natural radioactive decay are alpha and beta particles, which of the following atoms could not possibly result from the natural decay of ${}_{92}U^{235}$ atoms ?

A. ${}_{90}Th^{231}$

B. ${}_{}(89)Ac^{227}$

C. ${}_{89}Ac^{231}$

D. ${}_{87}Fr^{227}$

Answer: C

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25. In every 45 minutes, the number of nuclei of a radionuclides becomes 80 % of its number before 45 minutes, then the time (in

minute) in which the number of nuclei of that nuclide becomes 64% of its initial number is

A. 50

B. 100

C. 90

D. 40

Answer: C

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26. $._{11}^{23}Na$ is the most stable isotope of Na. Find the process by which $._{11}^{24}Na$ can undergo radioactive decay :

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

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

C. $._9F^{18}$

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

Answer: B

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Exercise 2

1. Mass defect in the nuclear reactions may be expressed in terms of the atomic masses of the parent and daughter neucliders in place of their nuclear masses.

The mass defect of nuclear reaction : $._4Be^{10} \rightarrow ._5B^{10} + e^-$ is

A. $\Delta m = \text{At. mass of } {}_{.4}Be^{10} - \text{At. mass of } {}_5B^{10}$

B. $\Delta m = \text{At. mass of } {}_4Be^{10} - \text{At. mass of } {}_5B^{10}$ -mass of one electron

C. $\Delta m = \text{At. mass of } {}_4Be^{10} - \text{At. mass of } {}_5B^{10}$ + mass of one electron

D. $\Delta m = \text{At. mass of } {}_4Be^{10} - \text{At. mass of } {}_5B^{10}$ - mass of two electrons

Answer: A

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2. Mass defect in the nuclear reactions may by expressed in terms of the atomic masses of the parent and daughter nuclides in place of their nuclear masses.

The mass defect of the nuclear reaction ${}_5B^8 \rightarrow {}_4Be^8 + e^+$ is

A. $\Delta m = \text{At. mass of } {}_{5}B^{8} - \text{At. mass of } {}_{4}B^{8}$

B. $\Delta m = \text{At. mass of } {}_{5}B^{8} - \text{At. mass of } {}_{4}B^{8}$-mass of one electron

C. $\Delta m = \text{At. mass of } {}_{5}B^{8} - \text{At. mass of } {}_{4}B^{8}$+mass of one electron

D. $\Delta m = \text{At. mass of } {}_{5}B^{8} - \text{At. mass of } {}_{4}B^{8}$ - mass of two electrons

Answer: D

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3. A gaseous substance AB has a radioactive element A with a half life of 2 days. The gaseous substance decomposes to $A_{(g)}$ and $B_{(g)}$ in a closed container and an equilibrium gets established rapidly within a fraction of second . The substance to which A

decays into is non gaseous and does not effect volume of the container.

If at equilibrium total pressure is 4 atm and molar ratio of $AB:B$ is $2:1$ then equilibrium constant will be

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

B. $\frac{1}{2} \times 101325$Pa

C. 4atm^2

D. 4 atm

Answer: B

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4. A gaseous substance AB has a radioactive element A with a half life of 2 days. The gaseous substance decomposes to $A_{(g)}$ and $B_{(g)}$ in a closed container and an equilibrium gets established

rapidly within a fraction of second . The substance to which A decays into is non gaseous and does not effect volume of the container.

Which of the statement are correct regarding shifting of equilibria due to radioactive decay if data in question 1 is true.

A. Due to radioactive decay, equilibria will shift rightwards.

B. Equilibria will shift left

C. No shift in equilibria due to radioactive decay will occur.

D. Equilibria may shift in any direction.

Answer: C

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5. A gaseous substance AB has a radioactive element A with a half life of 2 days. The gaseous substance decomposes to $A_{(g)}$ and

$B_{(g)}$ in a closed container and an equilibrium gets established rapidly within a fraction of second . The substance to which A decays into is non gaseous and does not effect volume of the container.

If equilibrium constant is 9 atm then calculate partial pressure of AB after 4 days if initial pressure of AB taken was 4 atm.

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

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

C. 1 atm

D. 2 atm

Answer: A

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6. Radioactive decay follows first order kinetics and the rate constant is often termed as decay constant. Certain radioactive substances may undero sequential decays in order to convert into a stable nucleus. The series comprising all such elements is termed as radioactive disintegration series.

If a radioactive disintegration series is observed involving only α and β decays then which of the following isotopes cannot be a part of it if the parent isotope of the series is $._{91}Pa^{234}$.

A. $._{86}Rn^{222}$

B. $._{85}At^{216}$

C. $._{82}Pb^{210}$

D. $._{90}Th^{230}$

Answer: B

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7. Radioactive decay follows first order kinetics and the rate constant is often termed as decay constant. Certain radioactive substances may undero sequential decays in order to convert into a stable nucleus. The series comprising all such elements is termed as radioactive disintegration series.

A substance A undergoes sequential decay as shown $A \xrightarrow{\lambda_1} B \xrightarrow{\lambda_2} C$. If the decay constant λ_1 and λ_2 are $4 \times 10^{-2} \mathrm{min}^{-1}$ and $16 \times 10^{5} \mathrm{min}^{-1}$ respectively then the molar ratio of B to A after a very long time will be :

A. 2.5×10^{-8}

B. 4×10^{-2}

C. $\frac{1}{16} \times 10^{-5}$

D. 4×10^{7}

Answer: A

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8. Radioactive decay follows first order kinetics and the rate constant is often termed as decay constant. Certain radioactive substances may undero sequential decays in order to convert into a stable nucleus. The series comprising all such elements is termed as radioactive disintegration series.

A radioactive series is formed such that after each α decay there are two consecutive β decay and the cycle repeats. How many different elements this series can have if there are 12 members in the series ?

A. 12

B. 4

C. 3

D. 6

Answer: C

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9. Statement -I : Time required for 75% radioactive disintegration $\left(t_{3/4}\right) = 2 \times t_{1/2}$.

because

Statement -II : Half life $\left(t_{1/2}\right)$ of the radioactive disintegration in independent of temperature.

A. If both Statement -I & Statement -II are True & the Statement -II is a correct explanation of the Statement-I.

B. If both Statement -I & Statement -II are True but Statement -II is not a correct explanation of the Statement-I.

C. If Statement-I True but the Statement-II is False

D. If Statement-I is False but the Statement-II is True.

Answer: B

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10. Statement -I : ${}_{6}^{14}C$ is a ${}_{-1}^{0}\beta$ emitter.

Statement -II Unstable nucleus having $n/p >$ are ${}_{-1}^{0}\beta$ emitter.

A. If both Statement -I & Statement -II are True & the Statement -II is a correct explanation of the Statement-I.

B. If both Statement -I & Statement -II are True but Statement -II is not a correct explanation of the Statement-I.

C. If Statement-I True but the Statement-II is False

D. If Statement-I is False but the Statement-II is True.

Answer: A

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11. Statement-I : Coversionof a γ photon into an electron and a positron is an example of pair production.

Statement -II : Pair production refers to the creation of an elementary particle and its antiparticle,usually when a photon interacts with a nucleus.

A. If both Statement -I & Statement -II are True & the Statement -II is a correct explanation of the Statement-I.

B. If both Statement -I & Statement -II are True but Statement -II is not a correct explanation of the Statement-I.

C. If Statement-I True but the Statement-II is False

D. If Statement-I is False but the Statement-II is True.

Answer: A

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12. Select correct statement (s):

A. The emission of gamma radiation involves transition between energy levels within the nucleus.

B. $._{2}^{4}He$ is formed due to emission of beta particle from tritium $._{1}^{3}H$.

C. When positron $\left(._{+1}^{\circ}e\right)$ is emitted , $\frac{n}{p}$ ratio increases.

D. None of these

Answer: A::C

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13. Read the following :

A. The half -life period of a radioactive element X is same as the mean-life time of another radioactive element Y. Initially both of them have the same number of atoms. Then Y will decay at a faster rate than X.

B. The electron emitted in beta radiation originates from decay of a neutron in a nucleus

C. The half-life of $.^{215}\mathrm{At}$ is 100 ms. The time taken for the radioactivity of a sample of $.^{215}\mathrm{At}$ to decay to $1/16^{th}$ of its initial value is 400 ms.

D. The volume (V) and mass (m) of a nucleus are related as V $Alpha$m.

Answer: A::B::C::D

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14. Which of the following processes represents a gamma- decay only ?

A. $._{Z}^{A}X \rightarrow ._{Z-1}^{A}X + a + b$

B. $._{\_(Z)}^{A} + ._{0}^{1}n \rightarrow ._{Z-2}^{A-3}X + c$

C. $._{Z}^{A}X \rightarrow ._{Z}^{A}X + f$

D. $._{Z}^{A}X + e_{-1} \rightarrow ._{Z-1}^{A}X$

Answer: C

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15. Which of the following representation is correct?

A. $._{6}C^{12}\left(._{1}H^{1}, ._{0}n^{1}\right)._{7}N^{13}$

B. $._{25}Mn^{55}(n, p)._{25}Mn^{56}$

C. $._{20}Ca^{40}(p, n)._{21}Sc^{40}$

D. $._4Be^5(p, n)._3Li^6$

Answer: C

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16. Which of the following isotope of hydrogen is radioactive ?

A. $._{83}Bi^{209}$

B. $._{82}Pb^{210}$

C. $._6C^{12}$

D. $._{82}Pb^{206}$

Answer: B

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17. Which of the following statement is /are correct regarding nucleus of an atom ?

A. As number of protons increases in the nucleus, the number of neutrons required for overcoming proton-proton repulsions also increase.

B. Projectile capture reactions involving proton as projectile can occur with slow moving proton also.

C. When $._{92}^{235}U$ undergoes fission reaction to from $._{36}Kr^{90}\&._{56}Ba^{142}$ four neutrons are produced per Uraninum atom.

D. Gamma radiations can be emitted only along with α or β - decay and not alone.

Answer: A::C::D

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18. If proton/neutron ratio of an isotope is less than one then which of the following emission will be shown by the isotope

A. β-particle

B. Positron emission

C. K electron capture

D. Either (B) or (C)

Answer: A

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19. From the graph of binding energy (B.E.)vs mass number plotted as shown , identify the correct option (s)

A. Order of stability of nucleus is $D < A < C < B$.

B. If 'D' undergoes breakage to give 'C' then energy must be supplied.

C. If 'A' and 'B' combine to form 'D' then energy must be supplied.

D. If 'C' undergo breakage into two fragments of equal mass number then energy will be released.

Answer: A::B::C

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20. Match the column-

	Column-I (Nuclear reactor component)		Column-II (Used substance)
(A)	Moderator	(P)	Uranium
(B)	Control rods	(Q)	Graphite
(C)	Fuel rods	(R)	Boron
(D)	Coolent	(S)	Lead
		(T)	Sodium

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21. Match the column-

	Column-I (Atomic /Molecular species)		Column-II (Corresponding pairs)
(A)	Isotope	(P)	$.^{228}\mathrm{Ra}_{88}$ & $^{228}\mathrm{Ac}_{89}$
(B)	Isobar	(Q)	$.^{39}\mathrm{Ar}_{18}$ & $^{40}\mathrm{K}_{19}$
(C)	Isotone	(R)	$.^{235}\mathrm{U}_{92}$ & $^{231}\mathrm{Th}_{90}$
(D)	Isosters	(S)	$.^{235}\mathrm{U}_{92}$ & $^{231}\mathrm{Th}_{90}$
(E)	Isodiaphers	(T)	CO_2 & N_2O

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Exercise 3

1. The number of α and β - particles emitted, when the following nuclear transformation takes place are _____ and _____ respectively.

$$^{238}_{92}X \rightarrow {}^{206}_{82}Y$$

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2. The nuclides with same difference of number of neutrons and number of protons are called _____.

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3. Fill in the blanks with appropriate items :

The half-life period of radioactive element _____ minute if 75% of

it disintegrates in 40 min.

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4. Fill in the blanks with appropriate items :

Consider the following reaction, $._{1}^{2}H + ._{1}^{2}H = ._{2}^{4}He + Q$.

Mass of the deuterium atom= $2.0141u$, Mass of the helium atom = $4.0024u$

This is a nuclear _____ reaction in which the energy Q is released is _____ MeV.

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5. Fill in the blanks with appropriate items :

Symbol is needed to complete the nuclear equation $._{29}^{63}Cu(P, \ldots.)._{29}^{62}Cu$

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6. During the transformation of ${}_{c}^{a}X$ of ${}_{d}^{b}Y$ the number of β-particle emitted are:

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7. Fill in the blanks with appropriate items :

The α -activity of $1gm.^{226}Ra.$ $\left(t_{1/2} = 1620 \text{ year}\right)$ is _____ dpm.

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8. The half life of the nuclide Rn^{220} is54.5 sec. What mass of radon is equivalent to 1 millicurie.

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9. Fill in the blanks with appropriate items :

A radioactive substance decays 20% in 10 min if at start there are 5×10^{20} atoms present , after _____ hour the number of atoms will be reduced to 10^{18}.

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10. Fill in the blanks with appropriate items :

This binding energies per nucleon for ${}_{1}H^{2}$ and ${}_{2}H^{4}$ are $1.1MeV$ and $7.0MeV$ respectively. The energy released when two deuterons fuse to form a helium nucleus is _____.

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11. True or False Statements :

In the nuclear reaction $X^{200} \rightarrow A^{110} + B^{90}$. If the binding energy

per nucleon for X, A and B is 7.4 MeV, 8.2.MeV and 8.2 MeV respectively, the energy released is 160 MeV.

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12. True or False Statements :

The decay constant of the end product of a radioactive series is Zero

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13. True or False Statements :

A fraction f_1 of a radioactive sample decays in one mean life, and a fraction f_2 decays in one half-life, then $f_1 > f_2$.

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14. True or False Statements :

In a radioactive element the fraction of initial amount remaining after its mean life time is l/e.

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15. True or False Statements :

Half-life period of a radioactive substance can be changed by using some suitable catalyst.

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16. True or False Statements :

The S.I. unit of activity is Curie (Ci).

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17. True or False Statements :

90% of a radioactive sample is left undecayed after time t has elapsed, percentage of the initial sample which will decay in a total time 2t is 19%.

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18. Half-life for certain radioactive element is $5\ \min$. Four nuclei of that element are observed at a certain instant of time. After 5 minutes

STATEMENT-I: It can be definitely said that two nuclei will be left undecayed.

STATEMENT-II: After half-life that is 5 minutes, half of totan nuclei will disintegrate. So, only two nuclei will be left undecayed.

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19. True or False Statements :

5α and $4\beta^{-}$ are emitted during the radioactive decay chain starting from ${}_{88}^{226}Ra$ and ending at ${}_{82}^{206}Pb$.

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20. True or False Statements :

The ratio $t_{1/2}/t_{7/8}$ for a first order reaction is equal to $1/3$.

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21. Classify each of the following nuclides as either "beta $\left({}_{-1}^{0}\beta\right)$ emitter " , or " positron $\left({}_{+1}^{0}\beta\right)$ emitter " :

${}_{20}^{49}Ca \quad {}_{5}^{8}B \quad {}_{13}^{30}Al$

${}_{80}^{195}Hg \quad {}_{67}^{150}Ho \quad {}_{36}^{94}Kr$

Note : ${}_{36}^{84}Kr, {}_{80}^{200}Hg$ and ${}_{67}^{165}Ho$ are stable

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22. Which of the following are radioacitve?

a. $._{48}Cd^{114}$ b. $._{49}In^{114}$ c. $._{50}Sn^{114}$

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23. Consider the following nuclear reactions :

I $._{7}^{14}N + ._{2}^{4}He \rightarrow ._{8}^{17}O + X$

II $._{4}^{9}Be + ._{2}^{4}H \rightarrow ._{6}^{12}He + Y$

Then

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24. The activity of the radioactive sample drops to $\left(\frac{1}{64}\right)^{th}$ of its original value in 2 hr find the decay constant (λ).

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25. The half life period of ${}_{53}I^{125}$ is 60 days. What % of radioactivity would be present after 240 days.

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26. At any given time a piece of radioactive material $\left(t_{1/2} = 30\right.$ days) contains 10^{12} atoms. Calculate the activity of the sample in dps.

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27. An isotope of Potassium ${}^{40}_{19}K$ has a half life of 1.4×10^9year and decays to Argon ${}^{40}_{18}Ar$which is stable.

(i) Write down the nuclear reaction representing this decay.

(ii) A sample of rock taken from the moon contains both potassium and argon in the ratio $1/3$. find age of rock

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28. At a given instant there are 25% undecayed radioactive nuclei in a sample . After 10 sec the number of undecayed nuclei remains $12.5\ \%$ Calculate :

(i) mean - life of the nuclei and

(ii) The time in which the number of undecayed nuclears will further reduce to $6.25\ \%$ of the reduced number.

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29. Calculate the energy released in joules and MeV in the following nuclear reaction :

$._1^2 H +_1^2 \rightarrow_2^3 He +_0^1 n$

Assume that the masses of ${}_{1}^{2}H, {}_{2}^{3}He$ and neutron (n) respectively are $2.020, 3.0160$ and 1.0087 in amu.

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30. A sample of $U^{238}\left(\text{half life} = 4.5 \times 10^{9} yr\right)$ ore is found to contain $23.8g$ of U^{238} and $20.6g$ of Pb^{206}. Calculate the age of the ore

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31. Calculate the age of a vegetarian beverage whose tritium content is only 15% of the level in living plants. Given $t_{1/2}$ for ${}_{1}H^{3} = 12.3$ years.

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32. Ac^{227} has a half life of 22 year . The decay follows two parallel paths, one leading the Th^{227} and the other leading to Fr^{223}. The precentage yields of these two daughters nucleoids are 2% and 98 % respectively. What is the rate constant in yr^{-1}, for each of the separate paths ?

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33. Nuclei of $.^{64}Cu$ can decay be electron capture (probability 61%) or by β^+ decay (39%). Half life of $.^{64}Cu$ is 12.7 hour. Find the partial half life for electron capture decay process,

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34. In one of neutron induced fission of $._{92}U^{235}$, $._{38}Sr^{90}$ & $._{54}Xe^{143}$ were produced. Calculate energy released per neutron

produced if masses of ${}_{92}U^{235}$, ${}_{38}Sr^{90}$, ${}_{54}Xe^{143}$ & neutron are $234.83, 89.98, 142.71\& \ 1.02$ respectively. [Take 1 amu = 930 MeV]

Express your answer in the form $X \times 10^4 eV$ and fill the value of X in OMR sheet.

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35. Most of the weight of the human body is because of the water present inside the body. Although various dissolved salts are also present, their concentration is very small and hence density of water inside the body can be taken as 1 gm /ml. A man weighing 100 kg is injected with a sample of radioactive water containing Tritium having activity $6.4 \times 10^{12} d$ pm. After 10 min sample of water from the body is analysed and specific activity of water taken from body is found to be $\frac{10^6}{27} dps/ml$ Assuming the half life of the radioactive substance in water to be 2 min , calculate % by weight of water present in the human body.

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36. Calculate the specific activity of a radioactive substance ${}_{98}^{250}Cf$, if its half life is $6.93\ \min$. Express your answer in terms of $10^{16} dps$. (Use : $N_A = 6 \times 10^{23}$)

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37. An isotope of postassium K^{40} undergoes two parallel type of decay, one by electron capture and other by β decay with half lives as 1.3×10^9 year and $\frac{1.3}{9} \times 10^9$ year respectively. If in a sample of a mineral mass ratio of $K : Ar : Ca$ is 5,1.5 & 16 then calculate age of the mineral if it known that all Ca^{40} in the mineral is not from the radioactive decay of potassium.

[Express your answer in terms of 10^7 year for eg. if you answer is 2×10^9 years fill 0200 in OMR sheet]

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38. Find the decay constant of $.^{55} Co$ radio nuclide if its activity is known to decrease 4% per hour. The decay product is non-radioactive.

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Exercise 4

1. A radioactive sample emit $n\beta$ - particles is 2 sec , In next 2 sec it emits$0.75n\beta$- particle , what is the mean life of the sample?

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2. Fill in the blanks:

(a) $._{92}^{235} U + ._{0}^{1} n \rightarrow ._{55}^{142} A + ._{37}^{92} B + ...$

(b) $._{34}^{82} Se \rightarrow ... + 2._{-1} e^{0}$

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3. Carbon 14 is used to determine the age of organic material. The procedure is based on the formation of $.^{14} C$ by neutron capture in the upper atmosphere.

$._{7}^{14} N + ._{0}^{1} n \rightarrow ._{6}^{14} C + ._{1} p^{1}$

$.^{14} C$ is absorbed by living organisms during photosynthesis. The $.^{14} C$ content is constant in living organisms once the plant or animal dies, the uptake of carbon dioxide by it ceases and the level of $.^{14} C$ in the dead being, falls due to the decay which $.^{14} C$ undergoes.

$._{6}^{14} C \rightarrow ._{7}^{14} N + \beta^{-}$

The half-life period of $.^{14}C$ is 5730 years. The decay constant (λ) can be calculated by using the following formula $\lambda = \dfrac{0.693}{t_{1/2}}$

The comparison of the β^- activity of the dead matter with that of the carbon still in circulation enables measurement of the period of the isolation the material form the living cycle. The method however, ceases to be accurate ever periods longer than $30,000$ years. The proportion of $.^{14}C$ to $.^{12}C$ living matter is $1:10^{12}$.

Which fo the following option is correct?

A. In living organisms, circulation of $.^{14}C$ from atmosphere is high so the carbon content is constant in organism

B. Carbon dating can be used to find out the age of earth crust and rocks

C. Radioactive absorption due to cosmic radiation is equal to the rate of radioactive decay, hence the carbon content

remains constant in living organism

D. Carbon dating cannot be used to determine concentration of $.^{14}C$ in dead beings.

Answer: C

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4. Carbon 14 is used to determine the age of organic material. The procerdure is based on the formation of $.^{14}C$ by neutron capture in the upper atmosphere.

$$.^{14}_{7}N + .^{1}_{0}n \rightarrow .^{14}_{6}C + .^{1}n^{1}$$

$.^{14}C$ is abosorbed by living organisms during phostosythesis. The $.^{14}C$ content is constant in living organisms once the plant or animal dies, the uptake of carbon dioxide by it ceases and the level of $.^{14}C$ in the dead being, falls due to the decay which $.^{14}C$ undergoes.

$._{6}^{14}C \rightarrow ._{7}^{14}C + \beta^{-}$

The half-life period of $.^{14}C$ is 5770 years. The decay constant (λ) can be calculated by using the following formula $\lambda = \dfrac{0.693}{t_{1/2}}$

The comparison fo the β^{-} activity fo the dead matter with that of the carbon still in circulation enables measurement of the period of the isolation the materail form the living cycle. The method however, ceases to be accurate ever periods longer than $30,000$ years. The proportaion of $.^{14}C$ to $.^{12}C$ living matter is $1:10^{12}$.

What should be the age of fossil for meainingful determination of its age?

A. 6 years

B. 6000 years

C. 60000 years

D. it can be used to calculate any age

Answer: B

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5. A positron is emitted from $._{11}Na^{23}$. The ratio of the atomic mass and atomic number of the resulting nuclide is

A. 22/10

B. 22/11

C. 23/10

D. 23/12

Answer: C

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6. Statement : The plot of atomic number (y -axis) versus number of neutrons (x -axis) for stable nuclei shows a curvature towards x-axis fron the line of 45° slope as the atomic number is increased .

Explanation : proton -proton electrostatic repulsions begin to overcome attracive forces involving protons and neutrons in heavier nuclides.

A. If both Statement-I & Statement -II are True & the Statement -II is a correct explanation of the Statement -I.

B. If both Statement -I & Statement -II are True but Statement-II is not a correct explanation of the Statement-I.

C. If Statement-I is True but the Statement -II is False.

D. If Statement-I is False but the Statement -II is True.

Answer: A

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7. The total number of α and β particles emitted in the nuclear reaction

$^{238}_{92}U \rightarrow {}^{214}_{82}Pb$ is

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8. The number of neutrons emitteed when $.^{235}_{92}U$ undergoes controlled nulclear fission to $.^{142}_{54}Xe$ and $.^{90}_{38}Sr$ is:

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9. Bombardment of aluminium by α - particle leads to its artificial disintegration in two way (i) and (ii) as shown. Products X, Y and Z

respectively are,

A. proton, neutron, positron

B. neutron, positron, proton

C. proton, positron, neutron

D. positron, proton, neutron

Answer: A

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10. The periodic table consists of 18 grooups. An isotope of copper, on bombardment with protons, undergoes a nuclear reaction yielding element X as shown below. To which group, element X belogns in the periodic table?

$$._{29}^{63}Cu + ._{1}^{1}H \rightarrow 6._{0}^{1}n + \alpha + 2._{1}^{1}H + X$$

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11. In the nuclear transmutation :

$._4^9 Be + X \rightarrow_4^8 Be + Y$

(X,Y) is (are)

A. (γ, n)

B. (p,D)

C. (n,D)

D. (γ, p)

Answer: A::B

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12. A closed vessel with rigid walls contains 1 mole of ${}_{92}^{238}U$ and 1 mole of air at $298K$. Considering complete decay of ${}_{92}^{238}U$ to ${}_{82}^{206}Pb$the ratio of the final pressure to the initial pressure of the system at $298K$ is

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