CHEMISTRY

BOOKS - BRILLIANT PUBLICATION

NUCLEAR CHEMISTRY

Question Answer

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

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2. A radioactive sample had an initial activity of 28 disintegrations per minute. 30 minutes later, its activity became 14 disintegrations per minute. How many atoms of the radioactive nuclide were present intially ?

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3. What is the mass of ^{14}C isotope that will have an activity of one curie if half-life period of ^{14}C is 5730 years ?

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4. The half-life of ^{232}Th is 14.05 billion years. Calculate its average life.

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5. Calculate the number of α and β- particles emitted in the disintegration of ${}_{94}Pu^{241}$ to ${}_{83}Bi^{209}$.

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6. Calculate the mass defect and binding energy per nucleon for an alpha particle whose mass is 4.0035 amu. (mass of proton = 1.0073 amu, mass of neutron = 1.0087 amu).

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7. A fresh piece of wood gives 16100 counts of β- emissions per minute per kg and a fossil give 13200 counts per minute per kg. Calculate the age of fossil. half life of C-14 is 5568 years.

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Level I

1. What fraction of the radioactive species $\left(t_{1/2} = 12\text{years}\right)$ remains after six years ?

A. 0.36

B. 0.60

C. 0.20

D. 0.45

Answer: A

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2. Emission of β-particles from a radioactive species produces its :

A. Isotope

B. Isotone

C. Isobar

D. Isodiapher

Answer: D

3. The activity of a radioactive samples reduces by 10% in 12.5 yr. The half-life of this

radioactivity species when it is reduded to 90%

.

A. 28.20 yr

B. 82.20 yr

C. 2.5 yr

D. 12.5 yr

Answer: B

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4. An heavier elements continuosly emits α- and β-particles. The finally stable element may belong to :

A. 14th gp.

B. 16th gp.

C. 10th gp.

D. 12th gp.

Answer: A

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5. A radionuclide having decay constant λ is produced at a constant rate of α per sec. If N_0 be the number of nucei at t = 0, then maximum number of nuclide possible are :

A. $N_0 + \frac{\alpha}{\beta}$

B. $N_0 + \frac{\lambda}{\alpha}$

C. $\frac{\alpha}{\lambda}$

D. N_0

Answer: C

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6. The nucleus ${}_{48}^{115}Cd$ after two sucessive β-decay will give :

A. ${}_{40}^{115}Pa$

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

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

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

Answer: D

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7. A 10 g sample of radioactive sample is present at t= 0. The approximate mass of this element in the sample after two mean life is :

A. 1.35 g

B. 2.50 g

C. 3.70 g

D. 6.30 g

Answer: A

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8. In a nuclear fission, 0.1% mass is converted into energy. The energy released by fission of 1 kg mass is :

A. 9×10^{19} J

B. 9×10^{17} J

C. 9×10^{16} J

D. 9×10^{13} J.

Answer: D

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9. The number of neutrons accompanying the formation of $^{139}_{54}Xe$ and $^{94}_{38}\mathrm{Sr}$ from the absorption of a slow neutron by $^{235}_{92}$ U, followed by nuclear fission is :

A. 0

B. 2

C. 1

D. 3

Answer: D

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10. A positron is emitted by $^{23}_{11}$ Na. 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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11. The total no. of α and β- particles emitted in the nuclear reaction : ${}_{92}^{238}U \rightarrow {}_{82}^{214}Pb$

A. 8

B. 6

C. 4

D. 2

Answer: A

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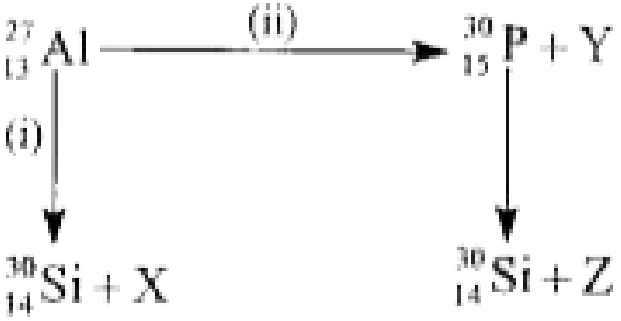
12. Bombardment of aluminium by α-particles leads to the artifical disintegration in two ways (i) and (ii) as shown produces X, Y and Z respectively are



A. Proton, neutron, positron

B. Neutron, positron, proton

C. Proton, Positron, neutron

D. Positron, proton, neutron

Answer: A

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13. The number of neutrons in the parent nucleus which gives ${}_{7}^{14}N$ on β-emission is

A. 6

B. 7

C. 8

D. 14

Answer: C

14. The triad of nuclei that is isotonic is

A. ${}_{6}^{14}C, {}_{7}^{15}N, {}_{9}^{17}F$

B. ${}_{6}^{12}C, {}_{7}^{14}N, {}_{9}^{19}F$

C. ${}_{6}^{14}C, {}_{7}^{14}N, {}_{9}^{17}F$

D. ${}_{6}^{14}C, {}_{7}^{14}N, {}_{9}^{19}F$

Answer: A

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15. Which of the following nucleus is unstable ?

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

B. ${}_{4}^{10}Be$

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

D. ${}_{8}^{16}O$

Answer: B

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16. The radioactive isotope tritum $\left(\frac{1}{3}H\right)$ has a half life 0f 12.3 years. IF the initial amount of tritium is 32 mg, how many milligrams of it would remain after 49. 2 years ?

A. 2 mg

B. 4 mg

C. 8 mg

D. 1 mg

Answer: A

17. If 8.0 g of radioactive isotope has a half-life of 10 h, the half-life of 2.0 g of the same substance is

A. 2.5 h

B. 5 h

C. 10 h

D. 40 h

Answer: C

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18. Which one of the following particles is used to bombard $^{27}_{13}Al$ to give $^{30}_{15}P$ and a neutron ?

A. Proton

B. Neutron

C. α-particle

D. Deuteron

Answer: C

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19. Which of the following nuclides are most likely to be neutron poor ?

A. ^{3}H

B. ^{11}C

C. ^{14}N

D. ^{40}K

Answer: B

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20. The half-life period of a radioactive element is 140 days. After 560 days, 1 g of the element will reduce to

A. 0.5 g

B. 0.25 g

C. 0.125 g

D. 0.0625 g

Answer: D

21. A nuclear reaction must be balanced in terms of

A. mass and energy

B. only masses

C. only energy

D. number of electrons

Answer: A

22. If half-life of a substance is 5 years, then the total amount of substance left after 15 years when initial amount is 64 g is

A. 16 g

B. 2 g

C. 32 g

D. 8 g

Answer: D

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23. The element 'X' in the following reaction is :

$$^{234}_{90}Th \rightarrow 7^{4}_{2}He + 6^{0}_{-1}e + X$$

A. Pb

B. Sn

C. Tl

D. Hg

Answer: A

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24. A radioactive element gets spilled over the floor of a room, Its half-life period is 30 days. If the initial activity is 10 times the permissible

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

A. 100 days

B. 1000 days

C. 300 days

D. 10 days

Answer: A

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25. You have 0.1 gram-atom of a radioactive isotope ${}_{Z}^{A}X$ (half-life = 5 days). How many atoms will decay during the eleventh day ?

A. 1.93×10^{21}

B. 3.05×10^{22}

C. 1.31×10^{22}

D. 4.32×10^{22}

Answer: C

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26. The observed massof $^{56}_{26}Fe$ is 55.9375 amu. Using the masses of proton and neutron as 1.00732 amu and 1.00866 amu respectively, calculate the binding energy per nucleon in joules

A. 3.56×10^{-12} J

B. 2.06×10^{-12} J

C. 1.36×10^{-12} J

D. 4.14×10^{-12} J

Answer: C

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27. Emission of a β -particle by an atom of an element results in the formation of

A. Isotone

B. Isobar

C. Isomer

D. Isomorph

Answer: B

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28. The 4n + 2 disintegration series is also known as

A. Uranium series

B. Actinium series

C. Neptunium series

D. Thorium series

Answer: A

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29. The radioactive series to which $^{228}_{88}Ra$ belongs is

A. Actinium series

B. Thorium series

C. Uranium series

D. Neptumium series

Answer: B

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30. Which of the following statements are correct ?

(i) All isotopes are radioactive

(ii) Emission of β-rays is accompanied by the emission of anti neutrinos

(iii) Alpha particles have a mass number of 4 and carry a charge of $+2$

(iv) γ -rays have a higher penetrating power than α -rays

A. I, ii and iii

B. ii, iii and iv

C. iii and iv

D. ii and iv

Answer: B

31. Transmutation of C-11 into the isotope B-11 is an example of

A. α -decay

B. β-decay

C. γ-decay

D. positron decay

Answer: D

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32. The most efficient material used in the nuclear reactor to slow down neutrons

A. Heavy water

B. Brine

C. Fused caustic soda

D. Molten, Na, K alloy

Answer: A

33. The radioactive decay follows ..... Order kinetics.

A. Zero

B. First

C. Second

D. Third

Answer: B

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34. Half life of a radioactive element is 16 hrs. What time will it take for 75% disintegration ?

A. 32 days

B. 32 hrs

C. 48 hrs

D. 16 hrs

Answer: B

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35. If the complex numbers z_1, z_2 and z_3 denote the vertices of an isosceles triangle, right angled at z_1, then $(z_1 - z_2)^2 + (z_1 - z_3)^2$ is equal to A)0 B) $(z_2 + z_3)^2$ C)2 D)3

A. α, β, γ

B. β, α, γ

C. γ, α, β

D. β, γ, α

Answer: B

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36. Which of the following nuclear changes is incorrect

A. ${}_{20}^{40}Ca + {}_{0}^{1}n \rightarrow {}_{19}^{40}K + {}_{1}^{1}H$

B. ${}_{12}^{24}Mg + \alpha \rightarrow {}_{14}^{27}Si + {}_{0}^{1}n$

C. ${}_{20}^{113}Cd + {}_{0}^{1}n \rightarrow {}_{20}^{112}Cd + {}_{-1}^{0}e$

D. ${}_{20}^{43}Ca + \alpha \rightarrow {}_{21}^{46}Sc + {}_{1}^{1}H$

Answer: C

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37. In a certain radioactive decay, an electron is emitted,it comes out from

A. Outermost orbit of the atom

B. Inner shells of the atom

C. Nucleus of the atom

D. None of these

Answer: C

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38. When passing through a magnetic field the largest deflection is experienced by

A. α- rays

B. β- rays

C. γ-rays

D. all equal

Answer: B

39. Which of the following is (n, p) type reaction.

A. ${}_{5}^{13}C + {}_{1}^{1}H \rightarrow {}_{6}^{14}C$

B. ${}_{7}^{14}N + {}_{1}^{1}H \rightarrow {}_{8}^{15}O$

C. ${}_{13}^{27}Al + {}_{0}^{1}n \rightarrow {}_{12}^{27}Mg + {}_{1}^{1}H$

D. ${}_{92}^{235}U + {}_{0}^{1}n \rightarrow {}_{54}^{140}Xe + {}_{88}^{94}Sr$

Answer: C

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40. Half-life of radioactive substance is 60 min. During 3 hrs, the fraction of total no. of atom have decayed would be

A. 0.125

B. 0.875

C. 8.5%

D. 0.25

Answer: B

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41. For a radioactive element, a graph of log N against time has a slope equal to :

A. $+2.303\lambda$

B. $+\frac{\lambda}{2.303}$

C. $-\frac{\lambda}{2.303}$

D. -2.303λ

Answer: C

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42. The neutron decay leads to emission of β-particles and :

A. neutrino

B. antineutrino

C. mesons

D. γ-rays

Answer: B

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43. The missing term in ${}_{+1}^{1}p + {}_{01}^{-1}e \rightarrow {}_{0}^{1}n + ?$

is :

A. γ - rays

B. infra red

C. X-rays

D. visible rays

Answer: C

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44. The emission of penetrating rays from a radioactive species can be shielded by :

A. Bi blocks

B. Pb blocks

C. C blocks

D. Mg blocks

Answer: B

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45. The value of 'n' for the parent and finally stable element obtained from the decay of $(4n+1)$ series respectively is

A. 60, 52

B. 58, 54

C. 58, 51

D. 60, 54

Answer: A

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Level Ii

1. $^{60m}Co \rightarrow ^{60}$ Co emits γ- radiations of wavelength 3×10^{-10}m. Assuming each nuclei emits one wavelength, with what mass per mole of two nuclei differ ?

A. 4.43×10^{-9} g

B. 4.43×10^{-6}g

C. 4.43×10^{-3} g

D. 4.43 g

Answer: B

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2. 1 g sample of ^{152}Sm has 27% purity and emits α - particles with half-life 10^{12} year. Calculate the number of α-particles approximately emitted in 1 sec :

A. 24

B. 48

C. 16

D. 32

Answer: A

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3. A sample of radioactive element has rate R_1 at time t_1 and R_2 at time t_2 $(t_2 > t_1)$. Which one is correct if λ is rate constant and τ is average life ?

A. $R_1 > R_2$

B. No. of atoms decayed in time $(t_2 - t_1) = \frac{(R_2 - R_1)}{\lambda}$

C. No. of atoms decayed in time

$$(t_2 - t_1) = (R_1 - R_2) \times \tau$$

D. No. of atoms decayed in time

$$(t_2 - t_1) = (R_2 - R_1)(\lambda)$$

Answer: D

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4. 5 g of radioactive- species having molar mass 200 undergoes decay with decay

constant of λ. The initial specific activity can be given by :

A. $3 \times 10^{23} \lambda$ dps

B. $3 \times 10^{24} \lambda$ dps

C. $3 \times 10^{21} \lambda$ dps

D. $3 \times 10^{30} \lambda$ dps

Answer: C

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5. In the reaction ${}_{1}^{2}H + {}_{1}^{3}H \rightarrow {}_{2}^{4}He + {}_{0}^{1}n$, if binding energies of ${}_{1}^{2}H, {}_{1}^{3}H, {}_{2}^{4}He$ are respectively a, b and c (in MeV), then the energy released in this reaction is :

A. a + b' + c

B. a + b - c

C. $c - (a + b)$

D. $c + a - b$

Answer: C

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6. Two radioactive materials A_1 and A_2 have decay constant 5λ and λ respectively. If initially they have the same numberof nuclei, then ratio of nuclei of $A_1 \rightarrow A_2$ will be $\frac{1}{e}$ after a time :

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

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

C. λ

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

Answer: A

7. The half-life period of a radioactive element is 140 days. After 560 days, one gram of the element will reduce

A. 1/2 g

B. 1/4 g

C. 1/8 g

D. 1/16 g

Answer: D

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8. Calculate number of $\alpha -$ and β- particles emitted when $^{238}_{92}U$ changes into radioactive $^{206}_{82}Pb$

A. 5, 8

B. 8, 6

C. 8, 9

D. 4, 6

Answer: B

9. A radioactive element $t_{0.5} = 30$ days is spread over a room, Its activity is 25 times the permissible value of safe working. Calculate the number of days after which the room will be available for safe working.

A. 139.37 days

B. 193.37 days

C. 183.37 days

D. 125.37 days

Answer: A

10. One of the harzards of nuclear explosion is the generation of $^{90}Sr$and its subsequent incorporation in bones. This nuclide has a half-life of 28.1 years. Suppose one microgram was

absorbed by new born child, how much ^{90}Sr will remain in his bones after 20 years.

A. 2.4×10^{-7} g

B. 4.2×10^{-6} g

C. 6.1×10^{-7} g

D. 1.6×10^{-7} g

Answer: C

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11. ^{18}F is found to undergo 90% radioactive decay in 366 minutes, calculate half-life of ^{18}F.

A. 90 minutes

B. 100 minutes

C. 105 minute

D. 110 minute

Answer: D

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12. upon irradiation californium with neutron, a radio chemist discovered a new nuclide having mass number of 250 and a half life of 30 minutes. Three hours after the irradiation, the observed radioactivity due to the nuclide was 10 dis/minute. How many atoms of the nuclide were prepared initially ?

A. 2.8×10^2

B. 2.8×10^4

C. 2.8×10^3

D. 2.8

Answer: B

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13. The half life of ^{212}Pb is 10.6 hour, that of daughter ^{212}Bi is 60.5 min. How long will it take for a maximum daughter acitivity to grow in freshly separated ^{212}Pb ?

A. 4.48 hr

B. 2.26 hr

C. 3.78 hr

D. 37 hr

Answer: C

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14. The disintegration rate of a certain in radioactive sample at an instant is 4750 dpm. 10 minutes later the rate becomes 2760 dpm. What is the half-life of sample.

A. 12.8 min

B. 11.2 min

C. 14.2 min

D. 6.8 min

Answer: A

15. Calculate the time required to lose radioactive intensity of a radioactive sample of ^{24}Na to 70% of its original value. Given $t_{0.5}$ of $^{24}Na = 14.8$ hours.

A. 20.5 hrs.

B. 25.7 hrs .

C. 28.8 hrs

D. 27.6 hrs.

Answer: B

16. Half-life of iodine (atomic mass 125) is 60 days. Calculate the present of radioactivity remain after 120 days.

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17. The radio isotope ${}_{15}^{32}P$ is used to bio-chemical studies. A sample containing this isotope has an activity 1000 times the detectable limit. How long could an experiment be run with the sample before the radioactivity could no longer be detected ? Half-life of ${}_{15}^{32}P$ is 14.2 days.

A. 141.5 days

B. 145.5 days

C. 143.5 days

D. 148.5 days

Answer: A

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18. The mass defect for $^{35}_{17}Cl$ is found to be 0.32 amn. Calculate the binding energy per nucleon.

A. 7.31 MeV

B. 9.31 MeV

C. 8.516 MeV

D. 4.34 MeV

Answer: C

19. Two radioactive isotopes A and B of atomic mass X and Y are mixed in equal amount by mass. After 20 days, their mass ratio is found to be 1: 4. Half life of 'A' is 1 day. What will be the half life of B ?

A. 1.11 day

B. 0.6237 day

C. $0.11\frac{X}{Y}$ day

D. $1.11\frac{Y}{X}$ day

Answer: A

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20. The radioactive disintegration of $^{239}_{94}Pu$ and α-emission process is accompanied by loss of 5.24 M ev/dis. If $t_{0.5}$ of

$^{239}_{94}Pu$ is 2.44×10^4 year, calculate the energy released per year from 1.0 g sample of $^{239}_{94}Pu$ in kJ.

A. 52.62 kJ

B. 60.06 kJ

C. 56.73 kJ

D. 68.74 kJ

Answer: B

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21. Calculate the energy released in joules in the following nuclear reaction : ${}_{1}^{2}H + {}_{1}^{2}H \rightarrow {}_{2}^{3}He + {}_{0}^{1}N$ Assume that the masses of ${}_{1}^{2}H, {}_{2}^{3}He$ and neutron are 2.0141, 3.0160 and 1.0087 amu respectively.

A. 5.22×10^{-13} J

B. 5.22×10^{-12} J

C. 5.22×10^{-14} J

D. 5.22×10^{-11} J

Answer: A

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22. One of the most stable nuclei is ^{55}. Mn. Its nuclide mass is 54.938 amu. Determine binding energy per nucleon (mass of proton: 1.00783u and neutron :1.00867 u).

A. 6.18 Mev/nucleon

B. 7.18 Mev/nucleon

C. 8.76 Mev/nucleon

D. 5.26 Mev/nucleon

Answer: C

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23. Energy for the combustion of 1 mole ethylene in oxygen is -1.4×10^3 KJ. What would be the loss in mass (expressed in amu) accompanying the oxidation of one molecule of ethylene ?

A. 1.2×10^{-8} amu/molecule

B. 1.6×10^{-6} amu/molecule

C. 1.4×10^{-8} amu/molecule

D. 1.6×10^{-8} amu/molecule

Answer: D

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24. Calculate the energy released in the reaction, ${}_{17}^{35}Cl + {}_{0}^{1}n \rightarrow {}_{16}^{35}S + {}_{1}^{1}H$

$[(Cl - 35) = 34.9688$ amu (S-35) = 34.9690 amu, (H-1) = 1.0078 amu, ${}_{0}^{1}n = 1.0087$ amu]

A. 0.6520 MeV

B. 0.5620 MeV

C. 0.2560 MeV

D. 0.6250 Mev

Answer: A

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25. Calculate the energy released in the formation of argon atom $^{40}_{18})$Ar. Isotopic mass

of Ar = 39.962384 amu (mass of proton : 1.00 783u and neutron: 1.00867 u).

26. One mole of fuel on combustion liberates 1800 KJ of energy. Calculate the loss in mass during the combustion.

A. 5×10^{-11} kg

B. 2×10^{-11} kg

C. 2×10^{-9} kg

D. 2×10^{-12}kg

Answer: B

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27. If the total binding energies of ${}_{1}^{2}H$, ${}_{2}^{4}He$, ${}_{26}^{56}Fe$ and ${}_{92}^{235}U$ nuclei are 2.22, 28.3, 492 and 1786 MeV respectively, identify the most stable nucleus out of the following

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

B. ${}_{1}^{2}H$

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

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

Answer: A

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28. Boron has two isotopes ${}_{5}^{10}B$ and ${}_{5}^{11}B$. If the atomic weight of boron is 10.81, the ratio of ${}_{5}^{10}B$ and $(5)^{11}B$ in nature is

A. $\frac{19}{81}$

B. $\frac{20}{53}$

C. $\frac{15}{16}$

D. $\frac{10}{11}$

Answer: A

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29. nα-particles per second are being emitted by N atoms of a radioactive element. The half-life of element will be :

A. $\left(\frac{n}{N}\right)s$

B. $\left(\frac{CN}{n}\right)s$

C. $\frac{0.693N}{n}s$

D. $\frac{0.693n}{N}$

Answer: C

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30. The energy released in the fission reaction $U^{236} \rightarrow X^{117} + Y^{117} + 2_0n^1$, given that the

binding energy per nucleon of X and Y is 8.5 MeV and that of $_{92}U^{236}$ is 7.6 MeV, is nearly.

A. 220 MeV

B. 180 MeV

C. 195 meV

D. 190 MeV

Answer: C

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31. In an old rock, the mass ratio of $^{238}_{92}U \rightarrow {}^{206}_{82}Pb$ is found to be $595:103$. The age of the rock is (Mean life of $^{238}_{92}U$ is T_0) :

A. T_0 In 1.2

B. T_0 In $\frac{698}{595}$

C. $T_0 \frac{\text{In}1.2}{\text{In}2}$

D. $T_0 \frac{\text{In}\frac{698}{595}}{In2}$

Answer: A

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32. The radio active isotope may emit

A. α, β and $\gamma -$ rays simultaneously

B. both α and β rays simultaneously

C. α, γ or β, γ

D. protons, α-rays and γ- rays

Answer: C

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33. Choose the wrong statement out of the following.

A. γ- rays are the electromagnetic radiations of shorter wavelength

B. β - rays consist of electron s

C. α-particle consists of two protons and two neutrons.

D. β-particles emitted are the electrons that revolve round the nucleus

Answer: D

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34. In a radioactive series a nucleus X distintegrates into nucleus Y by emitting two alpha and two beta particles. IF m and n are the mass number and atomic number of the nucleus X, then the mass number and atomic number of the nucleus Y respectively are

A. $(m-4)$, n

B. $(m-8),(n-2)$

C. $(m-8)$, n

D. $(m-4),(n-2)$

Answer: B

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35. The decay constant of a radioactive sample is λ. The value of half life of average life of a radioactive sample are respectively given by

A. $\lambda \log, 2\frac{1}{\lambda}$

B. $\frac{\log_e 2}{\lambda}, \lambda$

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

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

Answer: C

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36. Two elements P and Q have half lives of 10 and 15 minutes respectively. Freshly prepared samples of each isotope initial contain the

same number of atoms as each other. After 30 minutes, the ratio of number of P atoms to number of Q atoms will be :

A. 0.5

B. 2

C. 1

D. 3

Answer: A

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37. There are 0.618 μ g of ^{206}Pb and 0.238 μ g of ^{238}U in a rock. If T_{50} of ^{238} U is 1.5×10^9 yr. Age of the rock is

A. 1.5×10^9 yr

B. 3.0×10^9 yr

C. 4.5×10^9 yr

D. 0.75×10^9 yr

Answer: B

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38. In the nuclear reaction ${}_{3}^{7}Li + {}_{1}^{1}H \rightarrow 2{}_{2}^{4}He$, the mass loss is nearly 0.02 amu. Hence, the energy released (in units of million kcal/mol) in the process is approximately.

A. 430

B. 220

C. 120

D. 50

Answer: A

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Level Iii Single Correct Answer Type

1. The abundance of three isotopes of oxygen (atomic mass 16.12) contains 8, 9, 10 neutrons respectively. One of the heaviest isotopes has 2% abundance. The other two are :

A. 90, 8

B. 80, 18

C. 60, 38

D. 18, 80

Answer: A

2. The time required for a radioactive species to decay $\frac{2}{3}$ of its initial amount is 't'. The fraction of radioactive species left after t is :

A. $\frac{1}{\sqrt{3}}$

B. $\frac{1}{\sqrt{5}}$

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

D. $\frac{1}{3}$

Answer: A

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3. The decay constant of a radioactive species is λ for the process in which a parent element showing formation of a daughter element.After time t, P atoms of parent element ar left and D atoms of daughter

elements are formed. If $t_{1/2}$ is half life then which expression correctly represents decay of parent element,

A. $t = \frac{t_{1/2}}{0.693} \ln\left(1 + \frac{D}{P}\right)$

B. $t = \frac{t_{1/2}}{0.693} \ln\left(1 - \frac{D}{P}\right)$

C. $t = \frac{t_{1/2}}{0.693} \ln\left(\frac{D}{P}\right)$

D. $t = \frac{t_{1/2}}{0.693} \ln\left(\frac{P}{D}\right)$

Answer: A

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4. In an ore containing uranium, the ratio of U^{238} to Pb^{206} nuclei is 3. Calculate the age of the ore, assuming that all the lead present in the ores are the final stable product of U^{238}. The half-life of U^{238} is 4.5×10^9 years.

A. 1.25×10^6 yrs

B. 1.87×10^9 yrs

C. 1.48×10^9 yrs

D. 1.85×10^7 yrs

Answer: B

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5. ^{227} Ac has a half-life of 22.0 years with respect to radioactive decay. The decay follows two parallel paths, one leading to ^{222}Th and the other to ^{223}Fr. The percentage yields to these two daughter nuclides are 2.0 and 98.0 respectively. What are the decay constants (λ) for each of the separate paths ?

A. $k_1 = 0.00063y^{-1}, k_2 = 0.03087y^{-1}$

B. $k_1 = 0.0063y^{-1}, k_2 = 0.003087y^{-1}$

C. $k_1 = 0.063y^{-1}, k_2 = 0.04087y^{-1}$

D. $k_1 = 0.00063y^{-1}, k_2 = 0.003087y^{-1}$

Answer: A

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6. On analysis a sample of Uranium was found to contain 0.2777 g of $_{82}Pb^{206}$ and 1.667 g of $(92)U^{238}$. The half-life periodof $^{238}_{92}$ is 4.51×10^9 years. If all the lead were assumed

to have come from decay of $^{238}_{92}$, What is the age of the earth ?

A. 1.143×10^7 yrs

B. 1.43×10^9 yrs

C. 1.14×10^5 yrs

D. 1.143×10^9 yrs

Answer: D

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7. A mixture of ^{239}Pu and ^{240}Pu has an activity of 6.0×10^9 dis/s. The half-life lives of isotopes are 2.44×10^4 and 6.58×10^3 years, respectively. Calculate the isotopic composition of this sample.

A. $^{239}Pu = 38.96\,\%$, $^{240}Pu = 61.04\,\%$

B. $^{239}Pu = 3.89\,\%$, $^{240}Pu = 6.14\,\%$

C. $^{239}Pu = 30.9\,\%$, $^{240}Pu = 68.4\,\%$

D. $^{239}Pu = 0.389\,\%$, $^{240}Pu = 0.614\,\%$

Answer: A

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8. A radioactive element A says to B I am half of what you were when you ar one-fourth of what I was Moreover I was 1.414 times that what you were. If the half-life of A is 8 days. What is the half-life of B ?

A. 2 days

B. 4 days

C. 6 days

D. 8 days

Answer: D

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Level Iii Multiple Correct Answer Type

1. Decrease in atomic number is observed in :

A. α-emission

B. β- emission

C. positron emission

D. electron capture

Answer: A::C::D

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2. Select the correct statements :

A. Relative stabilities of radioactive isotopes are expressed in terms of their average life

B. The complete decay of radioactive species take place in infinite time

C. The half-life of ^{14}C in charcoal and in cellulose is same

D. Average life is defined as the time to reduce rate of decay by 63%

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

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3. The nuclear reactions accompanied with emission of neutrons (s) are :

A. ${}_{13}^{27}Al + {}_{2}^{4}He \rightarrow {}_{15}^{30}P$

B. ${}_{6}^{12}C + {}_{1}^{2}H \rightarrow {}_{7}^{14}N$

C. ${}_{15}^{30}P + {}_{14}^{30}Si \rightarrow {}_{1}^{0}e$

D. ${}_{95}^{241}Am + {}_{2}^{4}He \rightarrow {}_{97}^{244}Bk$

Answer: A::D

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4. In which of the following radioactive process, electrical neutrality is maintained in daughter element.

A. α - decay

B. K-electron capture

C. γ-decay

D. β - decay

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

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5. In the nuclear transmutation, ${}_4^9Be + X \rightarrow {}_4^8Be + Y$. X and Y are :

A. γ, n

B. p, D

C. n, D

D. γ, p

Answer: A::C::D

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6. A radioactive element X has an atomic number of 100. It decays directly into an element Y which decays directly into an element Z. In both processes, a charged particle in emitted. Which of the following statement (s)would be true ?

A. Y has an atomic number of 101

B. Y has an atomic number of 102

C. Z has an atomic number of 99

D. Z has an atomic number of 100

Answer: A::B::C

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7. What of the following are isotopes ?

A. A. 20 p + 15 n

B. B. 20 p + 17 n

C. C. 20 p + 20 n

D. D. 18 p + 22 n

Answer: A::B::C

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8. Which of the following does (do) not consist of particles of matter ?

A. α - rays

B. β-rays

C. γ - rays

D. X-rays

Answer: C::D

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9. A nitrogen nucleus ${}^{14}_{7}N$ absorbs a neutron and can transform into lithium nucleus ${}^{7}_{3}Li$ under suitable conditions, after emitting.

A. 4 protons and 3 neutrons

B. 3 protons and 1 beta particle

C. 2 alpha particles and 2 gamma photons

D. 1 alpha particle, 4 protons and 2 beta particle

Answer: C::D

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10. From the following equations pick out the possible nuclear fusion reactions :

A. ${}_{6}^{13}C + {}_{1}^{1}H \rightarrow {}_{6}^{14}C + 4.3$ MeV

B. ${}_{6}^{12}C + {}_{1}^{1}H \rightarrow {}_{7}^{13}N + 2$ MeV

C. ${}_{7}^{14}N + {}_{1}^{1}H \rightarrow {}_{8}^{15}O + 7.3$ MeV

D.

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + ^{1}_{0}n + \gamma + 200$$

MeV

Answer: B::C

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Level Iii Numerical Type

1. In the following distintegration $^{238}_{92}U \rightarrow ^{206}_{82}Pb +$ ..... , number of β- particles

emitted is

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2. 10 g of a radioactive element loses 8.75 g in 9 days. Thus half-life is ..... Days.

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3. The total no. of α and β- particles emitted in the nuclear reaction : ${}_{92}^{238}U \rightarrow {}_{82}^{214}Pb$

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4. The periodic table consists of 18 groups. An isotope of copper, on bombardment with protons, undergoes nuclear reaction yielding element X as shown below. To which group, element X belongs $Cu + H \longrightarrow 6n + \alpha + 2H + X$

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5. One mole of A present in a closed vessel undergoes decay as, ${}^{m}_{z}A \rightarrow {}^{m-8}_{z-4}B + 2\left({}^{4}_{2}He\right)$.

what will be the volume of helium collected after 20 days at STP?,(half life of A=10 days)

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6. In the sequence of following nuclear reaction,

$_{98}^{238}X \xrightarrow{-\alpha} Y \xrightarrow{-\beta} Z \xrightarrow{-\beta} L \xrightarrow{-n\alpha} {}_{90}^{218}M$ What is the value of 'n' ?

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Level Iii Matching Column Type

1. Match the series (in Column I) with the end product (in Column II).

Column I		Column II	
A)	4n	p)	$^{207}_{82}Pb$
B)	(4n + 1)	q)	$^{208}_{82}Pb$
C)	(4n + 2)	r)	$^{209}_{83}Bi$
D)	(4n + 3	s)	$^{206}_{82}Pb$

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2. Match the the Column I with the properties (one or more) in Column II.

Column I		Column II	
A)	Determination of age of rock	p)	$N = N_0\left(\frac{1}{2}\right)^x$
B)	Carbon-dating	q)	$\frac{0.693}{\lambda}$
C)	Half-life	r)	${}^{238}_{92}U \rightarrow {}^{206}_{82}Pb$
D)	β – particle	s)	${}^{14}_{6}C \rightarrow {}^{14}_{7}N$

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3. Match the Column I giving particles with the reaction involving these particles (one or

more) in column II.

Column I		Column II	
A)	${}_{2}^{4}He$	p)	${}_{7}^{14}N \rightarrow {}_{8}^{17}O$
B)	${}_{1}^{1}H$	q)	${}_{13}^{27}Al \rightarrow {}_{15}^{30}P$
C)	${}_{0}^{1}n$	r)	${}_{15}^{30}P \rightarrow {}_{14}^{30}Si$
D)	${}_{-1}^{0}e$	s)	${}_{11}^{23}Na \rightarrow {}_{11}^{24}Na$
E)	${}_{1}^{0}e$	t)	${}_{11}^{24}Na \rightarrow {}_{12}^{24}Mg$

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4. Match the nuclei/reaction with the process involved.

Column I	Column II
A) $^{235}_{92}U \rightarrow ^{234}_{90}Th$	p) α-decay
B) $^{23}_{11}Na + ^{1}_{0}n \rightarrow ^{24}_{12}Mg + ^{0}_{-1}e^{-}$	q) β-decay
C) $^{9}_{5}B \rightarrow ^{9}_{4}Be$	r) Positron emission
D) $^{226}_{88}Ra \rightarrow ^{221}_{84}Po$	s) Artificial radioactivity
	t) Electron capture

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5. Match the nuclei with their correct designation.

Column I	Column II
A) Isotopes	p) $^{40}_{20}Ca$ and $^{40}_{19}Kr$
B) Isotones	q) $^{16}_{8}O$ and $^{17}_{8}O$
C) Isobars	r) $^{2}_{1}H$ and $^{3}_{2}He$
D) Isosters	s) $^{39}_{19}K$ and $^{19}_{9}F$
E) Isodiaphers	t) CO_2 and N_2O

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Level Iii Statement Type

1. Statement 1 :In a nuclear fission process, the total massof fragments is always greater than the original nuclei.

Statement 2 : Difference in the mass due to fission of a heavy nucleus is converted into energy according t mass - energy conversion.

A. Statement 1 is True, statement 2 is True, Statement 2 is Correct explanation for Statement I.

B. Statement 1 is True, Statement 2 is True, Statement 2 is NOT a correct explanation for Statement 1.

C. Statement 1 is True, Statement 2 is False.

D. Statement 1 is False, Statement 2 is True.

Answer: D

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2. Statement 1 : the nuclear isomers are the atoms with the same atomic number and same mass number, but with different radioactive properties.

Statement : 2 The nucleus in the excited state will evidently have a different half-life as compared to that in group state.

A. Statement 1 is True, statement 2 is True, Statement 2 is Correct explanation for Statement I.

B. Statement 1 is True, Statement 2 is True, Statement 2 is NOT a correct explanation for Statement 1.

C. Statement 1 is True, Statement 2 is False.

D. Statement 1 is False, Statement 2 is True.

Answer: A

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3. Statement 1 : Radioactivity is a nuclear phenomenon.

Statement 2 : Radioactivity is the phenomenon of spontaneous emission of certain invisible radiations from the nuclei of the atoms of some elements.

A. Statement 1 is True, statement 2 is True, Statement 2 is Correct explanation for Statement I.

B. Statement 1 is True, Statement 2 is True, Statement 2 is NOT a correct explanation for Statement 1.

C. Statement 1 is True, Statement 2 is False.

D. Statement 1 is False, Statement 2 is True.

Answer: A

4. Statement 1 : Rate of disintegration of uranium increases with the increase in amount of uranium.

Statement 2 : Rate of disintegration of nuclide does not depends upon temperature, pressure, state of combination etc.

A. Statement 1 is True, statement 2 is True, Statement 2 is Correct explanation for Statement I.

B. Statement 1 is True, Statement 2 is True, Statement 2 is NOT a correct explanation for Statement 1.

C. Statement 1 is True, Statement 2 is False.

D. Statement 1 is False, Statement 2 is True.

Answer: B

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5. Statement 1 : ${}^{14}_{6}C^{0}_{-1}\beta$ emitter.

Statement 2 : Unstable nucleus having n/p 1 are ${}^{0}_{-1}\beta$ emitter.

A. Statement 1 is True, statement 2 is True, Statement 2 is Correct explanation for Statement I.

B. Statement 1 is True, Statement 2 is True, Statement 2 is NOT a correct explanation for Statement 1.

C. Statement 1 is True, Statement 2 is False.

D. Statement 1 is False, Statement 2 is True.

Answer: A

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Level Iii Linked Comprehension Type

1. A sample contains 10^{-2} kg of two substances A and B with half lives of 4 and 8 sec repsectively (Given that atomic mass of B is

twice of A).

The mass of A and B left after 16 second is :

A. 0.625 g 2.50 g

B. 0.625 g , 0.252 g

C. 0.8 g, 0.2 g

D. 0.8 g, 0.2 g

Answer: A

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2. A sample contains 10^{-2} kg of two substances A and B with half lives of 4 and 8 sec repsectively (Given that atomic mass of B is twice of A).

The ratio of average life of A and B is :

A. $3:2$

B. $2:1$

C. $4:1$

D. $3:4$

Answer: C

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3. A sample contains 10^{-2} kg of two substances A and B with half lives of 4 and 8 sec repsectively (Given that atomic mass of B is twice of A).

The ratio of average life of A and B is :

A. $1:2$

B. $2:1$

C. $1:4$

D. $4:1$

Answer: A

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4. A small amount of solution containing a radioactive nuclide A was administered into blood of a patient. The activity of the nuclide is 2×10^3 dps. Its half life is 15 hours. After 5 hours a sample of the a sample of the blood drawn out from the patient. It's activity was 16

dpm per mL.

What is the volume of the 'blood' in the patient ? $(\log(1.26) = 0.1)$

A. 2.92 lit

B. 3.95 lit

C. 4.92 lit

D. 5.95 lit

Answer: D

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5. A small amount of solution containing a radioactive nucleide A was administered into blood of a patient. The activity of the nucleide is 2×10^3 dps. Its hafl life is 15 hours. After 5 hours a sample of the a sample of the blood drawn out from the patient. It's activity was 16 dpm per mL.

What is activity of the sample after another 5 hours time ? $(\log 1.59 = 0.2)$

A. 11.18 dpm per mL

B. 1.118 dpm per mL

C. 12.71 dpm per mL

D. 1.271 dpm per mL

Answer: C

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6. A small amount of solution containing a radioactive nucleide A was administered into blood of a patient. The activity of the nucleide is 2×10^3 dps. Its half life is 15 hours. After 5 hours a sample of the blood drawn out from

the patient. It's activity was 16 dpm per mL.

Radioactive nuclide A^x decays by β^- emission (42%) β^+ emission (58%) in the patient body Then half value of β^- decay path is

A. 27.2 hours

B. 10.2 hours

C. 3.57 hours

D. 35.72 hours.

Answer: D

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7. Initially the earth was a fire-ball, slowly it has cooled to form earth crust and its different layers. At the beginning $^{238}_{92}U$ was present and no $^{206}_{82}$ Pb was there. With the passage of time, uranium decayed to $^{206}_{82}Pb$ The decay process is : $^{238}_{92}U \xrightarrow[x\alpha \quad y\beta]{} {}^{206}_{82}Pb$, $t_{1/2}$ of $^{238}U = 4.5 \times 10^9$ yrs

x and y in above decay series are :

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8. Initially the earth was a fire-ball, slowly it has cooled to form earth crust and its different layers. At the beginning $^{238}_{92}U$ was present and no $^{206}_{82}$ Pb was there. With the passage of time, uranium decayed to $^{206}_{82}Pb$ The decay process is : $^{238}_{92}U \xrightarrow[x\alpha \quad y\beta]{} {}^{206}_{82}Pb$, $t_{1/2}$ of $^{238}U = 4.5 \times 10^9$ yrs

A sample of rock from south America contains equal number of atoms of ^{238}U and ^{206}Pb. The age of the rock will be :

A. 4.5×10^9 years

B. 9×10^9 years

C. 13.5×10^9 years

D. 2.25×10^9 years

Answer: A

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9. Initially the earth was a fire-ball, slowly it has cooled to form earth crust and its different layers. At the beginning $^{238}_{92}U$ was present and no $^{206}_{82}$ Pb was there. With the passage of time,

uranium decayed to $^{206}_{82}Pb$ The decay process is : $^{238}_{92}U \xrightarrow[x\alpha \quad y\beta]{} {}^{206}_{82}Pb$, $t_{1/2}$ of $^{238}U = 4.5 \times 10^9$ yrs

Atomic mass of ^{238}U is 238.125 amu. Its packing fraction will be :

A. 5.25

B. 0.125

C. 12.5

D. 1.25

Answer: A

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10. A radioactive substance 'A' converts to stable nuclei D by following series of reaction.

$A \rightarrow B \rightarrow C \rightarrow D$, Given, $t_{1/2}$ for 'A' = 0.0693 days

$t_{1/2}$ for 'B' = 6930 days $t_{1/2}$ for 'C' = 6.93 days

Number of nuclei of 'C' formed (approximately) in the first 10 days are, If initially 10^{20} nuclei of A is taken

A. 10^{18}

B. 10^{16}

C. 10^{17}

D. 10^{19}

Answer: C

11. A radioactive substance 'A' converts to stable nuclei D by following series of reaction.

$A \rightarrow B \rightarrow C \rightarrow D$, Given, $t_{1/2}$ for 'A' = 0.0693 days

$t_{1/2}$ for 'B' = 6930 days $t_{1/2}$ for 'C' = 6.93 days

Number of nuclei of 'D' present after 6930 days are, if initially 10^{20} nuclei of A is taken

A. 10^{10}

B. $\frac{1}{2} \times 10^{20}$

C. $\frac{1}{2} \times 10^{17}$

D. 10^{9}

Answer: B

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