

Nuclei — NEET Physics PYQ (2005-2021)

Class 12 Physics · 41 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

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

- (A) α , β^- , β^+
- (B) α , β^+ , β^-
- (C) β^+ , α , β^-
- (D) β^- , α , β^+

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2. The half-life of a radioactive nuclide is 100 hours. The fraction of original activity that will remain after 150 hours would be :

- (A) $1/2$
- (B) $1/(2\sqrt{2})$
- (C) $2/3$
- (D) $2/(3\sqrt{2})$

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3. 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 :

- (A) 0.9 MeV
- (B) 9.4 MeV
- (C) 804 MeV
- (D) 216 MeV

NEET 2020 · Q142

4. The energy equivalent of 0.5 g of a substance is :

- (A) 4.5×10^{16} J
- (B) 4.5×10^{13} J
- (C) 1.5×10^{13} J
- (D) 0.5×10^{13} J

NEET 2020 · Q158

5. When a uranium isotope ${}^{235}_{92}\text{U}$ is bombarded with a neutron, it generates ${}^{89}_{36}\text{Kr}$, three neutrons and :

- (A) ${}^{144}_{56}\text{Ba}$
- (B) ${}^{91}_{40}\text{Zr}$
- (C) ${}^{101}_{36}\text{Kr}$
- (D) ${}^{103}_{36}\text{Kr}$

NEET 2019 · Q31

6. α -particle consists of:

- (A) 2 protons and 2 neutrons only
- (B) 2 electrons, 2 protons and 2 neutrons
- (C) 2 electrons and 4 protons only
- (D) 2 protons only

NEET 2018 · Q13

7. 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

- (A) 30
- (B) 10
- (C) 20
- (D) 15

8. The energy liberated per nuclear fission is 200 MeV. If 10^{20} fissions occur per second the amount of power produced will be:

- (A) 32×10^8 W
- (B) 16×10^8 W
- (C) 5×10^{11} W
- (D) 2×10^{22} W

9. 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

- (A) 15
- (B) 30
- (C) 45
- (D) 60

10. If radius of the $^{27}_{13}\text{Al}$ nucleus is taken to be R_{Al} , then the radius of $^{125}_{53}\text{Te}$ nucleus is nearly:

- (A) $(13/53)^{(1/3)} R_{\text{Al}}$
- (B) $(53/13)^{(1/3)} R_{\text{Al}}$
- (C) $(5/3) R_{\text{Al}}$
- (D) $(3/5) R_{\text{Al}}$

11. The Binding energy per nucleon of ^7_3Li and ^4_2He nuclei are 5.60 MeV and 7.06 MeV, respectively. In the nuclear reaction $^7_3\text{Li} + ^1_1\text{H} \rightarrow ^4_2\text{He} + ^4_2\text{He} + Q$, the value of energy Q released is:

- (A) -2.4 MeV
- (B) 8.4 MeV
- (C) 17.3 MeV
- (D) 19.6 MeV

12. A radio isotope '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:

- (A) 3.92×10^9 years
- (B) 4.20×10^9 years
- (C) 8.40×10^9 years
- (D) 1.96×10^9 years

13. The half-life of a radioactive isotope 'X' is 20 years. It decays to another element 'Y' which is stable. The two elements 'X' and 'Y' 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 -

- (A) 40 years
- (B) 60 years
- (C) 80 years
- (D) 100 years

AIPMT 2012 Mains

14. The half life of a radioactive nucleus is 50 days. The time interval ($t_2 - t_1$) between the time t_2 when $2/3$ of it has decayed and the time t_1 when $1/3$ of it had decayed is

- (A) 30 days
- (B) 50 days
- (C) 60 days
- (D) 15 days

AIPMT 2012 Prelims

15. If the nuclear radius of ^{27}Al is 3.6 fermi, the approximate nuclear radius of ^{64}Cu in fermi is

- (A) 3.6
- (B) 2.4
- (C) 1.2
- (D) 4.8

AIPMT 2012 Prelims

16. 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 160 g of A_2 . The amount of the two in the mixture will become equal after

- (A) 40 s
- (B) 60 s
- (C) 80 s
- (D) 20 s

AIPMT 2011 Mains

17. 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

- (A) $5N_0/2$
- (B) $2N_0$
- (C) $3N_0$
- (D) $9N_0/2$

AIPMT 2011 Prelims

18. The power obtained in a reactor using U-235 disintegration is 1000 kW. The mass decay of U-235 per hour is

- (A) 1 microgram
- (B) 10 microgram
- (C) 20 microgram
- (D) 40 microgram

AIPMT 2011 Prelims

19. 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

- (A) 100 years
- (B) 150 years
- (C) 200 years
- (D) 250 years

20. Fusion reaction takes place at high temperature because

- (A) Molecules break up at high temperature
- (B) Nuclei break up at high temperature
- (C) Atoms get ionised at high temperature
- (D) Kinetic energy is high enough to overcome the coulomb repulsion between nuclei

21. A nucleus ${}^m_nX$ emits one α -particle and two β^- -particles. The resulting nucleus is

- (A) ${}^{m-4}_{n-2}Y$
- (B) ${}^{m-6}_{n-4}Z$
- (C) ${}^{m-6}_nZ$
- (D) ${}^{m-4}_nX$

22. 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 $(t_1 - t_2)$ is

- (A) $A_1 t_1 - A_2 t_2$
- (B) $A_1 - A_2$
- (C) $(A_1 - A_2)/\lambda$
- (D) $\lambda(A_1 - A_2)$

23. 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

- (A) 23.6 MeV
- (B) 2.2 MeV
- (C) 28.0 MeV
- (D) 30.2 MeV

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

- (A) $5 \log_e 2$
- (B) $\log_e(2/5)$
- (C) $5/\log_e 2$
- (D) $5 \log_{10} 5$

25. The mass of a ${}^7_3\text{Li}$ nucleus is 0.042 u less than the sum of the masses of all its nucleons. The binding energy per nucleon of ${}^7_3\text{Li}$ nucleus is nearly

- (A) 23 MeV
- (B) 46 MeV
- (C) 5.6 MeV
- (D) 3.9 MeV

26. In the nuclear decay given below:

the particles emitted in the sequence are: [notation: (mass number, atomic number)]

- (A) γ , β , α
- (B) β , γ , α
- (C) α , β , γ
- (D) β , α , γ

27. The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is an:

- (A) isomer of parent
- (B) isotone of parent
- (C) isotope of parent
- (D) isobar of parent

28. 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 of X_2 will be $1/e$ after a time

- (A) e/λ
- (B) λ
- (C) $(1/2)\lambda$
- (D) $1/(4\lambda)$

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

- (A) 1 : 1
- (B) 1 : 3
- (C) 3 : 1
- (D) $3^{1/3}$: 1

30. If $M(A, Z)$, M_p and M_n denote the masses of the nucleus ${}^A_ZX$, proton and neutron respectively in units of u ($1 u = 931.5 \text{ MeV}/c^2$) and BE represents its binding energy in MeV, then

- (A) $M(A, Z) = ZM_p + (A - Z)M_n + BE/c^2$
- (B) $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$
- (C) $M(A, Z) = ZM_p + (A - Z)M_n + BE$
- (D) $M(A, Z) = ZM_p + (A - Z)M_n - BE$

31. 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 $(1/e)^2$ after a time interval

- (A) 4λ
- (B) 2λ
- (C) $1/(2\lambda)$
- (D) $1/(4\lambda)$

32. In a radioactive decay process, the negatively charged emitted β -particles are

- (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

33. A nucleus ${}^A_ZX$ 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

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

34. If the nucleus $^{27}_{13}\text{Al}$ has nuclear radius of about 3.6 fm, then $^{125}_{32}\text{Te}$ would have its radius approximately as

- (A) 9.6 fm
- (B) 12.0 fm
- (C) 4.8 fm
- (D) 6.0 fm

35. The binding energy of deuteron is 2.2 MeV and that of ^4_2He is 28 MeV. If two deuterons are fused to form one ^4_2He then the energy released is :

- (A) 21.6 MeV
- (B) 23.6 MeV
- (C) 17.2 MeV
- (D) 28.2 MeV

36. 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 :

- (A) $R_1 = R_2 e^{(-\lambda(t_1 - t_2))}$
- (B) $R_1 = R_2 e^{(\lambda(t_1 - t_2))}$
- (C) $R_1 = R_2 e^{(t_2/t_1)}$
- (D) $R_1 = R_2$

37. The radius of germanium (Ge) nuclide is measured to be twice the radius of ^9_4Be . The number of nucleons in Ge are :

- (A) 73
- (B) 74
- (C) 76
- (D) 72

38. In the reaction $^2_1\text{H} + ^3_1\text{H} \rightarrow ^4_2\text{He} + ^1_0\text{n}$, if the binding energies of ^2_1H , ^3_1H and ^4_2He are respectively a, b and c (in MeV), then the energy (in MeV) released in this reaction is :

- (A) $c + a - b$
- (B) $c - a - b$
- (C) $a + b + c$
- (D) $a + b - c$

39. The nuclei of which one of the following pairs of nuclei are isotones ?

- (A) $^{74}_{34}\text{Se}$, $^{71}_{31}\text{Ga}$
- (B) $^{92}_{42}\text{Mo}$, $^{92}_{40}\text{Zr}$
- (C) $^{84}_{38}\text{Sr}$, $^{86}_{38}\text{Sr}$
- (D) $^{40}_{20}\text{Ca}$, $^{32}_{16}\text{S}$

40. Fission of nuclei is possible because the binding energy per nucleon in them :

- (A) increases with mass number at high mass numbers
- (B) decreases with mass number at high mass numbers
- (C) increases with mass number at low mass numbers
- (D) decreases with mass number at low mass numbers

41. In any fission process the ratio (mass of fission products/mass of parent nucleus) is :

- (A) less than 1
- (B) greater than 1
- (C) equal to 1
- (D) depends on the mass of parent nucleus

Answer key and explanations

1. Answer: (C) β^+ , α , β^-

$Z \rightarrow Z - 1$: atomic number falls by 1 with no other change, which is β^+ emission. $Z - 1 \rightarrow Z - 3$: falls by 2, which is α emission. $Z - 3 \rightarrow Z - 2$: rises by 1, which is β^- emission. So the sequence is β^+ , α , β^- .

2. Answer: (B) $1/(2\sqrt{2})$

150 h is 1.5 half-lives, so the fraction of activity remaining is $(1/2)^{1.5} = 1/(2\sqrt{2}) \approx 0.354$. Linear interpolation between $1/2$ and $1/4$ is wrong because decay is exponential.

3. Answer: (D) 216 MeV

Initial binding energy = $240 \times 7.6 = 1824$ MeV; final = $2 \times 120 \times 8.5 = 2040$ MeV. Gain = $2040 - 1824 = 216$ MeV. 0.9 MeV is only the change per nucleon, not the total.

4. Answer: (B) 4.5×10^{13} J

$E = mc^2 = 0.5 \times 10^{-3} \text{ kg} \times (3 \times 10^8 \text{ m/s})^2 = 0.5 \times 10^{-3} \times 9 \times 10^{16} = 4.5 \times 10^{13}$ J. Forgetting to convert grams to kilograms gives the 4.5×10^{16} J trap.

5. Answer: (A) $^{144}_{56}\text{Ba}$

Conserving mass number: $235 + 1 = 89 + 3 + A$, so $A = 144$; conserving charge: $92 = 36 + Z$, so $Z = 56$, which is barium-144. The krypton options keep $Z = 36$ and so violate charge conservation.

6. Answer: (A) 2 protons and 2 neutrons only

An α -particle is a helium-4 nucleus: 2 protons and 2 neutrons, with no electrons (hence its $+2e$ charge). Including 2 electrons would describe a neutral helium atom.

7. Answer: (C) 20

After 450 decay, 150 of 600 remain, i.e. $1/4 = (1/2)^2$. That is two half-lives = 20 minutes. 30 minutes would leave only 75 nuclei.

8. Answer: (A) 32×10^8 W

$200 \text{ MeV} = 200 \times 10^6 \times 1.6 \times 10^{-19} \text{ J} = 3.2 \times 10^{-11} \text{ J}$. Power = $10^{20} \text{ s}^{-1} \times 3.2 \times 10^{-11} \text{ J} = 3.2 \times 10^9 \text{ W} = 32 \times 10^8 \text{ W}$. Forgetting to convert MeV to joules gives a value like $2 \times 10^{22} \text{ W}$.

9. Answer: (D) 60

After 40% decay 60% remains; after 85% decay 15% remains. $60\% \rightarrow 15\%$ is a factor of $4 = 2^2$, i.e. two half-lives = $2 \times 30 = 60$ minutes. Subtracting the percentages (45%) and treating decay as linear is the trap.

10. Answer: (C) $(5/3) R_{\text{Al}}$

Nuclear radius $R \propto A^{(1/3)}$, so $R_{\text{Te}}/R_{\text{Al}} = (125/27)^{(1/3)} = 5/3$. Using atomic numbers instead of mass numbers gives the $(53/13)^{(1/3)}$ trap.

11. Answer: (C) 17.3 MeV

$Q = \text{BE of products} - \text{BE of reactants} = 2 \times 4 \times 7.06 - 7 \times 5.60 = 56.48 - 39.20 = 17.28 \approx 17.3$ MeV (the proton has no binding energy).

12. Answer: (B) 4.20×10^9 years

$X : Y = 1 : 7$ means $1/8$ of the original X remains, i.e. 3 half-lives. Age = $3 \times 1.4 \times 10^9 = 4.2 \times 10^9$ years.

13. Answer: (B) 60 years

$X : Y = 1 : 7$ means $1/8$ of the original X remains. $1/8 = (1/2)^3$, so three half-lives have passed: $3 \times 20 = 60$ years. 80 years would leave $1/16$.

14. Answer: (B) 50 days

When $1/3$ has decayed, $2/3$ remains; when $2/3$ has decayed, $1/3$ remains. The undecayed amount halves between these instants, which takes exactly one half-life, 50 days.

15. Answer: (D) 4.8

Nuclear radius $R \propto A^{(1/3)}$, so $R_{\text{Cu}} = 3.6 \times (64/27)^{(1/3)} = 3.6 \times 4/3 = 4.8$ fermi. A heavier nucleus must have a larger radius, which rules out the smaller values.

16. Answer: (A) 40 s

After t seconds, $A_1 = 40^{(1/2)^{(t/20)}}$ and $A_2 = 160^{(1/2)^{(t/10)}}$. Equating: $4 = 2^{(t/10 - t/20)} = 2^{(t/20)}$, so $t/20 = 2$ and $t = 40$ s. Check: both become 10 g at 40 s.

17. Answer: (D) $9N_0/2$

P: $4N_0(1/2)^t$ and Q: $N_0(1/2)^{(t/2)}$ with t in minutes. Setting them equal gives $2^{(2-t)} = 2^{(-t/2)}$, so $t = 4$ min, when $P = Q = N_0/4$. $R = 5N_0 - N_0/2 = 9N_0/2$. $5N_0/2$ would count only the decayed P nuclei incorrectly.

18. Answer: (D) 40 microgram

Energy produced in one hour = $10^6 \text{ W} \times 3600 \text{ s} = 3.6 \times 10^9 \text{ J}$. Mass converted = $E/c^2 = 3.6 \times 10^9 / (9 \times 10^{16}) = 4 \times 10^{-8} \text{ kg} = 40 \text{ } \mu\text{g}$. Forgetting the factor 3600 or using kW as W gives the smaller options.

19. Answer: (C) 200 years

If $X : Y = 1 : 15$, the fraction of X remaining is $1/16 = (1/2)^4$, so four half-lives have passed: $4 \times 50 = 200$ years. Taking $1/15$ as the remaining fraction or counting 3 half-lives gives the wrong ages.

20. Answer: (D) Kinetic energy is high enough to overcome the coulomb repulsion between nuclei

Fusing nuclei are positively charged and repel each other; only at very high temperatures ($\sim 10^7 \text{ K}$) do they have enough kinetic energy to overcome this Coulomb barrier. Ionisation of atoms or breaking of molecules is not the reason fusion needs high temperature.

21. Answer: (D) ${}^{m-4}_{n-2}\text{X}$

Alpha emission lowers mass number by 4 and atomic number by 2; each β^- raises atomic number by 1 with no mass change. Net: mass number $m - 4$, atomic number $n - 2 + 2 = n$, so the product is an isotope of X, ${}^{m-4}_{n-2}\text{X}$.

22. Answer: (C) $(A_1 - A_2)/\lambda$

Activity $A = \lambda N$, so $N_1 = A_1/\lambda$ and $N_2 = A_2/\lambda$. The number decayed between the two instants is $N_1 - N_2 = (A_1 - A_2)/\lambda$. The difference $A_1 - A_2$ alone is a difference of decay rates, not a number of nuclei.

23. Answer: (A) 23.6 MeV

Binding energy of two deuterons = $2 \times (2 \times 1.1) = 4.4 \text{ MeV}$; of helium-4 = $4 \times 7.0 = 28.0 \text{ MeV}$. Energy released = $28.0 - 4.4 = 23.6 \text{ MeV}$. 28.0 MeV is just the helium binding energy without subtracting that of the reactants.

24. Answer: (A) $5 \log_e 2$

Activity falls to $1/e$ in 5 min, so $\lambda = 1/5$ per minute (mean life 5 min). $T_{1/2} = \ln 2/\lambda = 5 \log_e 2 \text{ min} \approx 3.47 \text{ min}$. $5/\log_e 2$ inverts the relation.

25. Answer: (C) 5.6 MeV

Binding energy = $0.042 \times 931 \approx 39.1 \text{ MeV}$. Per nucleon: $39.1/7 \approx 5.6 \text{ MeV}$. 39 MeV would be the total, not per nucleon.

26. Answer: (D) β, α, γ

X to Y keeps the mass number and raises the atomic number by 1, which is β^- emission. Y to B^* lowers A by 4 and Z by 2, which is α emission. B^* to B changes neither A nor Z, so the excited nucleus de-excites by γ emission, giving the order β, α, γ .

27. Answer: (C) isotope of parent

One α emission lowers Z by 2 and A by 4; two β^- emissions raise Z by 2 and leave A unchanged. Net: same Z, A reduced by 4, so the daughter is an isotope of the parent, not an isobar (same mass number).

28. Answer: (D) $1/(4\lambda)$

$N_1/N_2 = e^{(-5\lambda t)}/e^{(-\lambda t)} = e^{(-4\lambda t)}$. Setting this to $1/e$ gives $4\lambda t = 1$, so $t = 1/(4\lambda)$. λ and $\lambda/2$ cannot be times, since λ has units of inverse time.

29. Answer: (A) 1 : 1

Nuclear radius $R = R_0 A^{(1/3)}$, so volume is proportional to A, just as mass is. Their ratio, the density, is the same for all nuclei, 1 : 1. The $3^{(1/3)}$ form is the ratio of radii, not of densities.

30. Answer: (B) $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$

A bound nucleus is lighter than its free nucleons by the mass defect, and the mass defect equals BE/c^2 . So $M(A, Z) = ZM_p + (A - Z)M_n - BE/c^2$. The plus sign would make the nucleus heavier than its parts, and subtracting BE without c^2 mixes energy with mass units.

31. Answer: (C) $1/(2\lambda)$

$N_A/N_B = e^{(-5\lambda t)}/e^{(-\lambda t)} = e^{(-4\lambda t)}$. Setting this equal to $e^{(-2)}$ gives $4\lambda t = 2$, so $t = 1/(2\lambda)$. Answers like 2λ have the wrong dimensions for a time.

32. Answer: (A) the electrons produced as a result of the decay of neutrons inside the nucleus

In β^- decay a neutron inside the nucleus changes into a proton, emitting an electron (and an antineutrino). Electrons do not exist inside the nucleus beforehand, and orbital electrons are not involved.

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

Binding energy is the mass defect times c^2 : $B.E. = [ZM_p + (A - Z)M_n - M(A, Z)]c^2$. The expression without c^2 is a mass, not an energy, and the reversed sign would give a negative binding energy.

34. Answer: (D) 6.0 fm

$R \propto A^{1/3}$, so $R_{Te} = 3.6 \times (125/27)^{1/3} = 3.6 \times 5/3 = 6.0$ fm. Scaling the radius in proportion to A instead of its cube root would give a much larger value.

35. Answer: (B) 23.6 MeV

Energy released = binding energy of products – binding energy of reactants = $28 - 2 \times 2.2 = 23.6$ MeV. Subtracting the binding energy of only one deuteron gives 25.8 MeV, and adding them gives 32.4 MeV, neither of which applies.

36. Answer: (A) $R_1 = R_2 e^{(-\lambda(t_1 - t_2))}$

Activity decays as $R = R_0 e^{(-\lambda t)}$, so $R_1 = R_0 e^{(-\lambda t_1)}$ and $R_2 = R_0 e^{(-\lambda t_2)}$. Dividing, $R_1 = R_2 e^{(-\lambda(t_1 - t_2))}$; since $t_1 < t_2$ the exponent is positive and $R_1 > R_2$, as expected for the earlier time. The form with $e^{(\lambda(t_1 - t_2))}$ would make the earlier activity smaller.

37. Answer: (D) 72

Nuclear radius $R = R_0 A^{1/3}$, so doubling R needs A to increase by $2^3 = 8$. The Ge nucleus therefore has $8 \times 9 = 72$ nucleons. The other numbers are other germanium isotopes, not the one fixed by this radius.

38. Answer: (B) $c - a - b$

Energy released = total binding energy of products – total binding energy of reactants = $c - (a + b)$. The free neutron has zero binding energy. $a + b - c$ has the sign reversed.

39. Answer: (A) $^{74}_{34}\text{Se}$, $^{71}_{31}\text{Ga}$

Isotones have the same neutron number $N = A - Z$. Se: $74 - 34 = 40$; Ga: $71 - 31 = 40$. The Sr pair are isotopes (same Z) and the Mo/Zr pair are isobars (same A).

40. Answer: (B) decreases with mass number at high mass numbers

At high mass numbers the binding energy per nucleon falls as A increases, so splitting a heavy nucleus into medium nuclei raises the binding energy per nucleon and releases energy. Increase with A at low mass numbers explains fusion, not fission.

41. Answer: (A) less than 1

Fission releases energy $Q = \Delta m c^2$, which comes from a loss of mass, so the products are lighter than the parent nucleus and the ratio is less than 1. 'Equal to 1' ignores the mass defect.

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