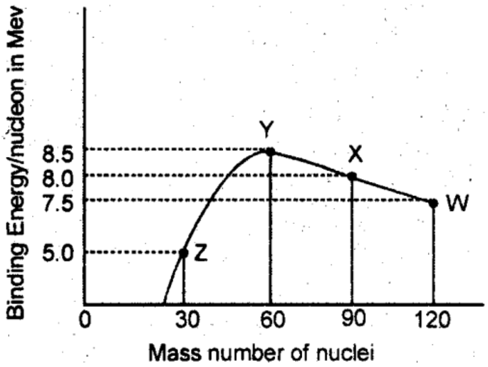
NUCLEUS
(MAINS)

SINGLE CORRECT OPTION TYPE

1. A nucleus ruptures into two nuclear parts which have their velocity ratio equal 2 : 1. What will be the ratio of their nuclear radius?
(A) $2^{1/3} : 1$ (B) $1 : 2^{1/3}$ (C) $3^{1/2} : 1$ (D) $1 : 3^{1/2}$

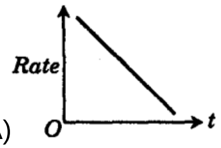
2. Binding energy per nucleon vs. mass number curve for nuclei is shown in the Figure W. X, Y and Z are four nuclei indicated on the curve. The process that would release energy is
(A) Y → 2Z (B) W → X + Z
(C) W → 2Y (D) X → Y + Z

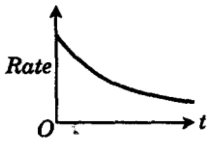


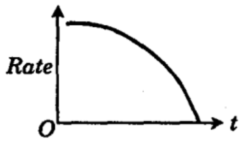
3. Atomic mass number of an element is 232 and its atomic number is 90. The end product of this radioactive element is an isotope of lead (atomic mass 208 and atomic number 82). The number of alpha and beta particles emitted is
(A) $\alpha = 3$ and $\beta = 3$ (B) $\alpha = 6$ and $\beta = 4$ (C) $\alpha = 6$ and $\beta = 0$ (D) $\alpha = 4$ and $\beta = 6$

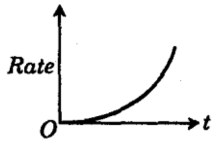
4. The probability of a radioactive atom to survive 5 times longer than its half value period is
(A) $\frac{2}{5}$ (B) 2 (5) (C) $\left(\frac{1}{2}\right)^5$ (D) 2^5

5. A radioactive substance X undergoes radioactive disintegration and produces a stable end product Z. The rate of production of Z in a sample of X will be correctly represented by the graph

(A) 

(B) 

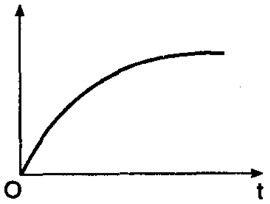
(C) 

(D) 

6. Two radioactive material A_1 and A_2 have decay constants of $10\lambda_0$ and λ_0. If initially they have same number of nuclei, the ratio of number of their undecayed nuclei will be (1/e) after a time
(A) $\frac{1}{\lambda_0}$ (B) $\frac{1}{9\lambda_0}$ (C) $\frac{1}{10\lambda_0}$ (D) 1

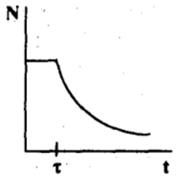
7. If 10% of a radioactive material decays in 5 days, then the amount of the original material left after 20 days is approximately:
(A) 60% (B) 65% (C) 70% (D) 75%

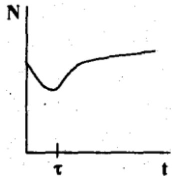
8. A radioactive isotope is being produced at a constant rate A. The isotope has a half-life T. After a time t >>T, the number of nuclei become constant. The value of this constant is

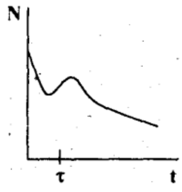


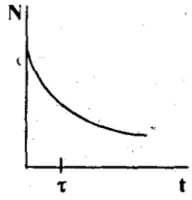
(A) $\frac{AT}{\log(2)}$ (B) AT . log 2 (C) $\frac{A}{T}\log(2)$ (D) AT

9. A radioactive sample consists of two distinct species having equal number of atoms initially. The mean life time of one species is τ and that of the other is 5τ. The decay products in both cases are stable. A plot is, made of the total number of radioactive nuclei as a function of time. Which of the following figures best represents the form of this plot?

(A) 

(B) 

(C) 

(D) 

10. Two radioactive materials X_1 and X_2 have decay constants 10λ 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) $\frac{1}{10\lambda}$ (B) $\frac{1}{11\lambda}$ (C) $\frac{11}{10\lambda}$ (D) $\frac{1}{9\lambda}$

11. The activity of a sample of a radioactive material is A, at time t_1 and A_2 at time t_2 $(t_2 > t_1)$. If its mean life T, then

(A) $A_1t_1 = A_2t_2$ (D) $A_1 - A_2 = t_2 - t_1$ (C) $A_2 = A_1e^{(t_1-t_2)/T}$ (D) $A_2 = A_1e^{(t_1/t_2)T}$

12. When a U^{218} nucleus originally at rest, decays by emitting an alpha-particle having a speed 'u', the recoil speed of the residual nucleus is

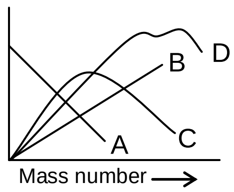
(A) $-\frac{4u}{238}$ (B) $\frac{4u}{238}$ (C) $-\frac{4u}{234}$ (D) $\frac{4u}{234}$

13. M_p and M_N are masses of proton and neutron, respectively at rest. If they combine to form deuterium nucleus, the mass of the nucleus will be

(A) less than M_p (B) less than $(M_p + M_N)$ (C) less than $(M_p + 2M_N)$ (D) greater than $(M_p + 2M_N)$

14. Binding energy per nucleon plot against the mass number for stable nuclei is shown in the figure. Which curve is current?

(A) A (B) B (C) C (D) D



15. The binding energy per nucleon for C^{12} is 7.68MeV and that for C^{13} us 7.47MeV. What is the energy required to remove a neutron from C^{13}?

(A) 0.21MeV (B) 2.52MeV (C) 4.95MeV (D) 2.75MeV

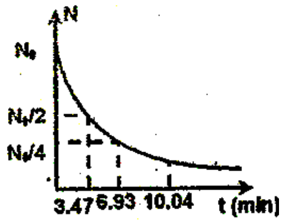
16. In a sample of radioactive material, what fraction of the initial number of active nuclei will remain undisintegrated after half of a half-life of the sample?

(A) 1/4 (B) $1/2\sqrt{2}$ (C) $1/\sqrt{2}$ (D) $2\sqrt{2}$

17. The activity of a sample of radioactive material is A_1 at time t_1 and A_2 at time t_2 $(t_2 > t_1)$. Its mean life is T, then which of the following is true?

(A) $A_1t_1 = A_2t_2$ (B) $\frac{A_1 - A_2}{t_2 - t_1}$ = constant (C) $A_2 = A_1e^{(t_1 - t_2)T}$ (D) $A_2 = A_1e^{t_1/Tt_2}$

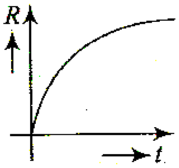
18. A radioactive sample undergoes decay as per the following graph. At time t = 0 the number of undecayed nuclei is $\mathbf{N_0}$. Calculate the number of nuclei left after one hour.



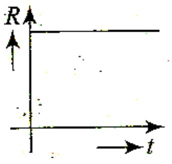
(A) N_0/e^8 (B) N_0/e^{10}

(C) N_0/e^{12} (D) N_0/e^{14}

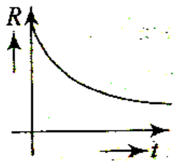
19. A radioactive nucleus 'X' decays to a stable nucleus 'Y'. Then, time graph of rate of formation of 'Y' against time 't' will be:



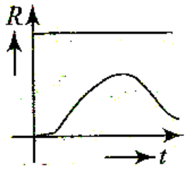
(A)



(B)



(C)



(D)

20. Two radioactive materials X_1 and X_2 have decay constants 10λ and λ, respectively. If initially they have the same number of nuclei, the ratio of the number of nuclei of X_1 to that of X_2 will be $1/e$ after a time

(A) $\frac{1}{10\lambda}$ (B) $\frac{1}{11\lambda}$ (C) $\frac{11}{10}\lambda$ (D) $\frac{1}{9\lambda}$

INTEGER TYPE

21. From a newly formed radioactive substance (half life 2 hours), the intensity of radiation is 64 times the permissible safe level. The minimum time after which work can be done safely from this source in hours is $6x$. Find x

22. After 280 days, the activity of a radioactive sample is 6000 dps. The activity reduces to 3000 dps after another 14 days. The initial activity of the sample in dps is $300x$, then x is

23. A star has 10^{40} deuterons. It produces energy via the process:

$${}_1H^2 + {}_1H^2 \rightarrow {}_1H^3 + P \qquad {}_1H^2 + {}_1H^3 \rightarrow {}_2He^4 + n$$

The masses of the nuclei are as follows: $M(H^2) = 2.014$ a.m.u.,

$M(p) = 1.007$ a.m.u., $M(n) = 1.008$ a.m.u. and $M(He^4) = 4.001$ a.m.u.]

If the average power radiated by the star is 10^{16} W, the deuteron supply of the star is exhausted in a time of the order of 10^{4x}. Find x.

24. A nucleus ruptures into two nuclear parts which have their velocity ratio equal to 2:1. The ratio of their nuclear size (nuclear radius) is $\sqrt{x}$. Find x.

25. $A \xrightarrow{\lambda} B \xrightarrow{2\lambda} C$

$T = 0$	N_0	0	0
T	N_1	N_2	N_3

The ratio of N_1 to N_2 when N_2 is maximum is _____________.

KEY

1.	B	**2.**	C	**3.**	B	**4.**	C	**5.**	D
6.	B	**7.**	B	**8.**	A	**9.**	D	**10.**	D
11.	C	**12.**	C	**13.**	B	**14.**	C	**15.**	C
16.	C	**17.**	C	**18.**	C	**19.**	C	**20.**	D
21.	2	**22.**	8	**23.**	3	**24.**	3	**25.**	2

❇ *Wish You all the Best* ❇