PREVIOUS YEARS' QUESTIONS — EXERCISE-II

NUCLEAR PHYSICS

1. In the nuclear fusion reaction,

$${}_1^2H + {}_1^3H \rightarrow {}_2^4He + n$$

given that the repulsive potential energy between the two nuclei is 7.7×10^{-14} J, the temperature at which the gases must be heated to initiate the reaction is nearly [Boltzmann's constant $k = 1.38 \times 10^{-23}$ J/K]- **[AIEEE - 2003]**

(1) 10^7 K (2) 10^5 K (3) 10^3 K (4) 10^9 K

2. A nucleus with Z = 92 emits the following in a sequence : $\alpha, \alpha, \beta^-, \beta^-, \alpha, \alpha, \alpha, \alpha, \beta^-, \beta^-, \alpha, \beta^+, \beta^+, \alpha$. The Z of the resulting nucleus is- **[AIEEE - 2003]**

(1) 76 (2) 78 (3) 82 (4) 74

3. When U^{238} nucleus originally at rest, decays by emitting an alpha particle having a speed u, the recoil speed of the residual nucleus is- **[AIEEE - 2003]**

(1) $\frac{4u}{238}$ (2) $-\frac{4u}{234}$ (3) $\frac{4u}{234}$ (4) $-\frac{4u}{238}$

4. A nucleus disintegrates into two nuclear parts which have their velocities in the ratio 2 : 1 The ratio of their nuclear sizes will be- **[AIEEE - 2004]**

(1) $2^{1/3} : 1$ (2) $1 : 3^{1/2}$

(3) $3^{1/2} : 1$ (4) $1 : 2^{1/3}$

5. The binding energy per nucleon of deuteron $({}_1^2H)$ and helium nucleus $({}_2^4He)$ is 1.1 MeV and 7 MeV respectively. If two deuteron nuclei react to form a single helium nucleus, then the energy released is- **[AIEEE - 2004]**

(1) 13.9 MeV (2) 26.9 MeV

(3) 23.6 MeV (4) 19.2 MeV

6. If radius of the ${}_{13}^{27}Al$ nucleus is estimated to be 3.6 fermi, then the radius of ${}_{52}^{125}Te$ nucleus be nearly- **[AIEEE - 2005]**

(1) 6 fermi (2) 8 fermi

(3) 4 fermi (4) 5fermi

7. A nuclear transformation is denoted by $X(n, \alpha) \rightarrow {}_3^7Li$. Which of the following is the nucleus of element X ? **[AIEEE - 2005]**

(1) ${}_6^{12}C$ (2) ${}_5^{10}B$ (3) ${}_5^9B$ (4) ${}_4^{11}Be$

8. If a star converts all of its Helium into oxygen nucleus, find the amount of energy released per nucleus of oxygen. O = 15.9994 amu and He = 4.0026 amu **[JEE' 2005 (Scr)]**

(1) 7.26 MeV (2) 7 MeV

(3) 10.24 MeV (4) 5.12 MeV

9. An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to- **[AIEEE - 2006]**

(1) v^2 (2) $1/m$

(3) $1/v^4$ (4) $1/Ze$

10. When ${}_3Li^7$ nuclei are bombarded by protons and the resultant nuclei are ${}_4Be^8$, the emitted particles will be- **[AIEEE - 2006]**

(1) alpha particles (2) beta particles

(3) gamma photons (4) neutrons

11. If the binding energy per nucleon in ${}_3^7Li$ and ${}_2^4He$ nuclei are 5.60 MeV and 7.06 MeV respectively, then in the reaction :

$$p + {}_3^7Li \rightarrow 2\,{}_2^4He$$

energy of proton must be- **[AIEEE - 2006]**

(1) 28.24 MeV (2) 17.28 MeV

(3) 1.46 MeV (4) 39.2 MeV

12. If M_0 is the mass of an oxygen isotope ${}_8O^{17}$, M_p and M_n are the masses of a proton and a neutron, respectively, the nuclear binding energy of the isotope is- **[AIEEE - 2007]**

(1) $(M_o - 8M_p)c^2$

(2) $(8M_p + 9M_n - M_o)c^2$

(3) M_oc^2

(4) $(M_o - 17M_n)c^2$

13. In the options given below, let E denote the rest mass energy of a nucleus and *n* a neutron. The correct option is :- **[JEE-2007]**

(1) $E\left({}_{92}^{236}U\right) > E\left({}_{53}^{137}I\right) + E\left({}_{39}^{97}Y\right) + 2E(n)$

(2) $E\left({}_{92}^{236}U\right) < E\left({}_{53}^{137}I\right) + E\left({}_{39}^{97}Y\right) + 2E(n)$

(3) $E\left({}_{92}^{236}U\right) < E\left({}_{56}^{140}Ba\right) + E\left({}_{36}^{94}Kr\right) + 2E(n)$

(4) $E\left({}_{92}^{236}U\right) = E\left({}_{56}^{140}Ba\right) + E\left({}_{36}^{94}Kr\right) + 2E(n)$

14. This question contains Statement-1 and Statement-2. Of the four choices gives after the statements, choose the one that best describes the two statements.

Statement-1

Energy is released when heavy nuclei undergo fission or light nuclei undergo fusion.

Statement-2

For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z. **[AIEEE - 2008]**

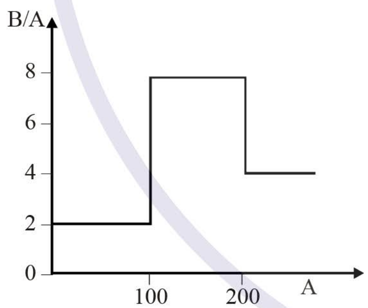
(1) Statement-1 is false, Statement-2 is true.

(2) Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

(3) Statement-1 is true, Statement-2 is true; Statement-2 is not a correct explanation for Statement-1.

(4) Statement-1 is true, Statement-2 is false.

15. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice(s) given below : **[JEE-2008]**



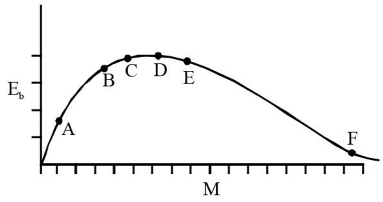
(1) Fusion of two nuclei with mass numbers lying in the range of $1 < A < 50$ will release energy

(2) Fusion of two nuclei with mass numbers lying in the range of $51 < A < 100$ will release energy

(3) Fission of a nucleus lying in the mass range of $100 < A < 200$ will release energy when broken into two equal fragments

(4) Fission of a nucleus lying in the mass range of $200 < A < 260$ will release energy when broken into two equal fragments

16.



The above is a plot of binding energy per nucleon E_b, against the nuclear mass M; A, B, C, D, E, F correspond to different nuclei. Consider four reactions :

(i) $A + B \rightarrow C + \varepsilon$ (ii) $C \rightarrow A + B + \varepsilon$

(iii) $D + E \rightarrow F + \varepsilon$ (iv) $F \rightarrow D + E + \varepsilon$

where ε is the energy released ? In which reactions is ε positive ? **[AIEEE - 2009]**

(1) (ii) and (iv) (2) (ii) and (iii)

(3) (i) and (iv) (4) (i) and (iii)

Directions : Questions number 17–18 are based on the following paragraph.

A nucleus of mass $M + \Delta m$ is at rest and decays into two daughter nuclei of equal mass $\frac{M}{2}$ each. Speed of light is c.

17. The speed of daughter nuclei is:- **[AIEEE-2010]**

(1) $c\sqrt{\frac{\Delta m}{M+\Delta m}}$ (2) $c\frac{\Delta m}{M+\Delta m}$

(3) $c\sqrt{\frac{2\Delta m}{M}}$ (4) $c\sqrt{\frac{\Delta m}{M}}$

18. The binding energy per nucleon for the parent nucleus is E_1 an that for the daughter nuclei is E_2. Then :- **[AIEEE-2010]**

(1) $E_1 = 2E_2$ (2) $E_2 = 2E_1$

(3) $E_1 > E_2$ (4) $E_2 > E_1$

19. A radioactive nucleus (initial mass number A and atomic number Z) emits 3 α-particles and 2 positrons. The ratio of number of neutrons to that of protons in the final nucleus will be **[AIEEE-2010]**

(1) $\frac{A-Z-4}{Z-2}$ (2) $\frac{A-Z-8}{Z-4}$

(3) $\frac{A-Z-4}{Z-8}$ (4) $\frac{A-Z-12}{Z-4}$

20. When Uranium is bombarded with neutrons, it undergoes fission. The fission reaction can be written as :

$_{92}U^{235} + _0n^1 \rightarrow _{56}Ba^{141} + _{36}Kr^{92} + 3x + Q$ (energy)

where three particles named x are produced and energy Q is released . What is the name of the particle x ? **[JEE(Main)-2013 (Online)]**

(1) neutrino (2) α-particle

(3) electron (4) neutron

21. Match List I of the nuclear processes with List II containing parent nucleus and one of the end products of each process and then select the correct answer using the codes given below the lists: **[JEE Advance-2013]**

	List I		**List II**
P.	Alpha decay	1.	$^{15}_{8}O \rightarrow ^{15}_{7}N + ...$
Q.	β^+ decay	2.	$^{238}_{92}U \rightarrow ^{234}_{90}Th + ...$
R.	Fission	3.	$^{185}_{83}Bi \rightarrow ^{184}_{82}Pb + ...$
S.	Proton emission	4.	$^{239}_{94}Pu \rightarrow ^{140}_{57}La + ...$

Codes :

	P	Q	R	S
(1)	4	2	1	3
(2)	1	3	2	4
(3)	2	1	4	3
(4)	4	3	2	1

22. Match the nuclear processes given in column-I with the appropriate option(s) in column-II. **[JEE Advance-2015]**

Column-I	**Column-II**
(A) Nuclear fusion	(P) Absorption of thermal neutrons by $^{235}_{92}U$
(B) Fission in a nuclear reactor	(Q) $^{60}_{27}Co$ nucleus
(C) β-decay	(R) Energy production in stars via hydrogen conversion to helium
(D) γ-ray emission	(S) Heavy water
	(T) Neutrino emission

(1) (A)–P & S; (B)–R or R,T; (C)–Q & T; (D)–R

(2) (A)–R; (B)–P & S; (C)–Q & T; (D)–R or R,T

(3) (A)–R or R,T; (B)–P & S; (C)–Q & T; (D)–R

(4) (A)–R or R,T; (B)–Q & T; (C)–P & S; (D)–R

RADIOACTIVITY

23. A 280 days old radioactive substance shows an activity of 6000 dps, 140 days later it's activity becomes 3000dps. What was its initial activity. **[JEE 2004 (Scr)]**

(1) 20000 dps

(2) 24000 dps

(3) 12000 dps

(4) 6000 dps

24. A radioactive sample S1 having an activity of 5μCi has twice the number of nuclei as another sample S2 which has an activity of 10μCi. The half lives of S1 and S2 can be : **[JEE-2008]**

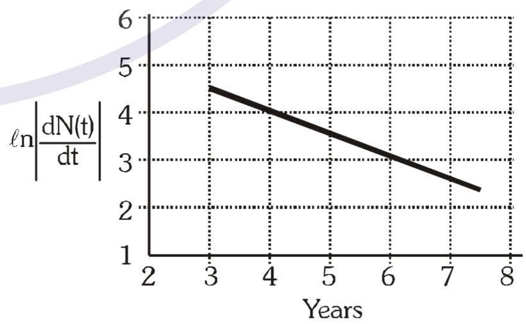
(1) 20 years and 5 years, respectively

(2) 20 years and 10 years, respectively

(3) 10 years each

(4) 5 years each

25. To determine the half life of a radioactive element, a student plots a graph of $\ell n\left|\frac{dN(t)}{dt}\right|$ versus t. Here $\frac{dN(t)}{dt}$ is the rate of radioactive decay at time t. If the number of radioactive nuclei of this element decreases by a factor of p after 4.16 years, the value of p is **[JEE 2010]**



(1) 2 (2) 4

(3) 6 (4) 8

Paragraph for Questions 26 and 27

The β-decay process, discovered around 1900, is basically the decay of a neutron (n). In the laboratory, a proton (p) and an electron (e^-) are observed as the decay products of the neutron. Therefore, considering the decay of a neutron as a two-body decay process, it was predicted theoretically that the kinetic energy of the electron should be a constant. But experimentally, it was observed that the electron kinetic energy has a continuous spectrum. Considering a three-body decay process, i.e. $n \rightarrow p + e^- + \vec{v}_e$, around 1930, Pauli explained the observed electron energy spectrum. Assuming the anti-neutrino $(\vec{v}_e)$ to be massless and possessing negligible energy, and the neutron to be at rest, momentum and energy conservation principles are applied. From this calculation, the maximum kinetic energy of the electron is 0.8×10^6 eV. The kinetic energy carried by the proton is only the recoil energy.

26. If the anti-neutrino had a mass of 3 eV/c^2 (where c is the speed of light) instead of zero mass, what should be the range of the kinetic energy, K, of the electron? **[JEE 2012]**

(1) $0 \le K \le 0.8 \times 10^6 eV$

(2) $3.0eV \le K \le 0.8 \times 10^6 eV$

(3) $3.0eV \le K < 0.8 \times 10^6 eV$

(4) $0 \le K < 0.8 \times 10^6 eV$

27. What is the maximum energy of the anti-neutrino? **[JEE 2012]**

(1) zero

(2) much less than 0.8×10^6 eV

(3) Nearly 0.8×10^6 eV

(4) Much larger than 0.8×10^6 eV

28. Half-lives of two radioactive elements A and B are 20 minutes and 40 minutes, respectively. Initially, the samples have equal number of nuclei. After 80 minutes , the ratio of decayed numbers of A and B nuclei will be :- **[JEE-Main-2016]**

(1) 5 : 4 (2) 1 : 16

(3) 4 : 1 (4) 1 : 4

29. A radioactive nucleus A with a half life T, decays into a nucleus B. At t = 0, there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by : **[JEE-Main-2017]**

(1) $t = T \log(1.3)$ (2) $t = \dfrac{T}{\log(1.3)}$

(3) $t = \dfrac{T}{2}\dfrac{\log 2}{\log 1.3}$ (4) $t = T\dfrac{\log 1.3}{\log 2}$

30. It is found that if a neutron suffers an elastic collinear collision with deuterium at rest, fractional loss of its energy is p_d ; while for its similar collision with carbon nucleus at rest, fractional loss of energy is p_c. The values of p_d and p_c are respectively : **[JEE-Main-2018]**

(1) (·28, ·89) (2) (0, 0)

(3) (0, 1) (4) (·89, ·28)

PREVIOUS YEARS QUESTIONS — ANSWER KEY — Exercise-II

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	4	2	3	4	3	1	2	3	2	3
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	2	2	1	4	2,4	3	3	4	3	4
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	3	3	2	1	4	4	3	1	4	4