Nuclear Chemistry

NET/JRF Previous Year's Question

Q1. For a given nuclear fission reaction of ^{235}U **[NET June 2011]**

$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{142}_{56}Ba + ^{91}_{36}Kr + 3^{1}_{0}n$

The amount of energy (in kJ/mol) released during this process is (given $^{235}U = 235.0439$ amu, $^{142}Ba = 141.9164$ amu, $^{91}Kr = 90.9234$ amu, neutron $= 1.00866$ (amu)

(a) 3.12×10^{12} (b) 2.8×10^{11} (c) 1.0×10^{9} (d) 1.68×10^{10}

Q2. For the nuclear reactions. **[NET Dec. 2011]**

(A) $^{8}_{4}Be \rightarrow 2^{4}_{2}He$ (B) $^{80}_{36}Kr \rightarrow 2^{40}_{18}Ar$

(Given masses: $^{8}Be = 8.005300, ^{4}He = 4.002603$ and $^{80}_{36}Kr = 79.81638, ^{40}_{18}Ar = 39.96238$

The correct statements is
(a) (A) and (B) are both spontaneous fission processes.
(b) (A) is spontaneous fission but (B) is not
(c) (B) is spontaneous fission but (A) Is not
(d) Both (A) and (B) are not spontaneous fission proceses.

Q3. The carbon -14 activity of an old wood sample is found to be 14,2 disintegrations min $^{-1}g^{-1}$. Calculate age of old sample, if for fresh wood sample carbon – 14 activity 15.3 disintegrationsmin $^{-1}g^{-1}$ ($t_{1/2}$ carbon -14 is 5730 years), is: **[NET June 2012]**

(a) 5,000 years (b) 4,000 years (c) 877 years (d) 617 years

Q4. In 'carbon-dating' application of radioisotopes, ^{14}C emits **[NET June2012]**

(a) $\beta-$particle (b) $\alpha-$particle (c) $\gamma-$ radiation (d) Positron.

Q5. A radioisotope ^{41}Ar initially decays at the rate of 34,500 disintegrations/minute, but decay rate falls to 21, 500 disintegrations/minute 75 minutes. The $t_{1/2}$ for ^{41}Ar is: **[NET June 2013]**

(a) 90 minutes (b) 110 minutes (c) 180 minutes (d) 220 minutes

Q6. For neutron activation analysis of an element, the favourable characteristics of both the target and the product are from the following **[NET June 2013]**

(A) high neutron cross-section area of target

(B) long half-life of the product

(C) low neutron cross-section area of target

(D) low half-life time of the product

The correct characteristics from the above are

(a) A and B (b) C and D (c) B and C (d) A and D

Q7. The particles postulated to always accompany the positron emission among

(A) neutrino, (B) anti-neutrino , (C) electron **[NET June 2014]**

(a) A,B and C (b) A and B (c) A and C (d) B and C

Q8. The nuclides among the following, capable of undergoing fission by thermal neutrons, are

(A) $^{233}\mathrm{U}$ (B) $^{235}\mathrm{U}$ (C) $^{239}\mathrm{Pu}$ (D) $^{232}\mathrm{Th}$ **[NET June 2014]**

(a) A, B and D (b) A, C and D (c) B, C and D (d) A, B and C

Q9. For a low energy nuclear reaction, $^{24}\mathrm{Mg}\ \ \mathrm{d},\alpha\ \ ^{22}$Na, the correct statements from the following are

(A) Kinetic energy of d particle Is not fully available for exciting $^{24}\mathrm{Mg}$ **[NET June 2014]**

(B) Total number of protons and neutrons is conserved.

(C) Q value of nuclear reaction is much higher in magnitude relative to heat of chemical reaction

(D) Threshold energy is ≤ 0 value.

(a) A, B and C (b) A, B and D (c) B, C and D (d) A, C and D

Q10. Q value for the reaction $^{13}\mathrm{N}\ \ \mathrm{n,p}\ \ ^{13}\mathrm{C}$ is 3.236 MeV. The threshold energy (in MeV) for the reaction $^{13}\mathrm{C}$ (n, p) $^{13}\mathrm{N}$ is **[NET June 2015]**

(a) – 3.236 (b) – 3.485 (c) 3.485 (d) 3.845

Q11. Identify radioactive capture from the following nuclear reactions **[NET Dec. 2015]**

(a) $^{9}\mathrm{Be}\ \ \gamma.\mathrm{n}\ \ ^{8}\mathrm{Be}$ (b) $^{23}\mathrm{Na}\ \ \mathrm{n}.\gamma\ \ ^{24}\mathrm{Na}$

(c) $^{63}\mathrm{Cu}\ \ \mathrm{p.p}\ 3\mathrm{n}\ 9\alpha\ \ ^{24}\mathrm{Na}$ (d) $^{107}\mathrm{Ag}\ \ \mathrm{n.\ n}\ \ ^{107}\mathrm{Ag}$

Q12. On two sequential electrons capture, $_{56}\mathrm{Ba}^{131}$ will give **[NET June 2016]**

(a) $_{54}\mathrm{Xe}^{131}$ (b) $_{54}\mathrm{Xe}^{130}$ (c) $_{56}\mathrm{Ce}^{131}$ (d) $_{56}\mathrm{Ce}^{130}$

Q13. On continuous exposure of $^{10}\mathrm{B}$ sample to a slow neutron flux of $10^{16}\,\mathrm{m}^2\mathrm{s}^{-1}$ its 3% weight fraction disappears in 3×10^{7} s. Cross section for neutron capture (in barns) by $^{10}\mathrm{B}$ is **[NET June 2016]**

(a) 1000 (b) 3000 (c) 10,000 (d) 30,000

Q14. Saturation factor in neutron activation analysis is

(A = induced radioactivity ; φ = neutron flux; σ = effective nuclear cross section; N = no. of target atoms; λ = decay constant) **[NET Dec. 2016]**

(a) $\dfrac{\mathrm{A}}{\varphi\sigma\mathrm{N}}$ (b) $\dfrac{\varphi\sigma\mathrm{Na}}{\lambda}$ (c) $\dfrac{\lambda}{A\varphi\sigma\mathrm{N}}$ (d) $\dfrac{\varphi\sigma\mathrm{N}}{\mathrm{A}}$

Q15. Consider following statements for fission of ^{235}U with thermal neutrons. **[NET June 2017]**

A. The % of nuclei undergoing unsymmetrical fission is maximum

B. In each fission, one thermal neutron is produced

C. Magnitude of energy released per fission is of the order 200 MeV

Correct statements(s) is/are

(a) A and B (b) A and C (c) B and C (d) C only

Q16. Choose the correct statement for magnitude of threshold energy of an endoergic nuclear reaction between stationary nucleus and a moving projectile. **[NET June 2017]**

(a) It is greater than $'|Q|'$ of nuclear reaction.

(b) It has to be more than kinetic energy of a projectile.

(c) It is less than $'|Q|'$ of nuclear reaction

(d) It has to be equal to kinetic energy of a projectile.

Q17. Among the following nuclear reactions of thermal neutrons, the cross section is highest for

(a) ${}_{92}U^{235} +_0 n^1 \rightarrow_{92} U^{235} +_0 n^1$ **[NET Dec. 2017]**

(b) ${}_{92}U^{235} +_0 n^1 \rightarrow_{92} U^{236}$

(c) ${}_{92}U^{235} +_0 n^1 \rightarrow_{92} Th^{232} +_2 He^4$

(d) ${}_{92}U^{235} +_0 n^1 \rightarrow_{36} Kr^{94} +_{56} Ba^{140} + 2_0 n^1$

Q18. Match the items given in **Column I** with those given in **Column II** **[NET Dec. 2018]**

	Column I	**Column II**
a.	Magic number	i. Nuclear fission
b.	Liquid drop model of nucleus	Ii. Q-value
c.	Actinides	iii. Radioactivity
d.	Threshold energy	iv. Shell model of nucleus

The correct match

(a) a – iv: b – i; c – iii; d – ii (b) a –ii; b – I; c – iii; d -iv

(c) a – iii; b – iv; c – i; d – ii (d) a – iv; b – iii; c – i; d – ii

Q19. In fission of ^{235}U atom the energy relased 200MeV. In one day fission of 1 kg ^{235}U will give power (in MW) approximately **[NET June 2018]**

(a) 550 (b) 650 (c) 950 (d) 1250

Answer Key

1. (d)	2.(b)	3.(d)	4.(a)	5.(b)	6. (a)	7.(d)
8.(d)	9.(a)	10.(c)	11.(b)	12.(a)	13.(a)	14.(a)
15. ( )	16. ( )	17. (d)	18. (a)	19.(c)		

GATE Previous Year's Question

Q1. Among the following, the most stable isotope or radioactive decay is **[GATE 2016]**

(a) $^{206}_{82}Pb$ (b) $^{210}_{82}Pb$ (c) $^{212}_{82}Pb$ (d) $^{214}_{82}Pb$

Q2. ^{210}Bi undergoes β^- decay to 1/8 of its initial amount in 15 days. The time required for its decay to ¼ of its initial amount is _________ days (up two decimal places) **[GATE 2017]**

Q3. 21. For the radioactive isotope ^{131}I, , the time required for 50% disintegration is 8 days. The time required for the 99.9% disintegration of 5.5g of ^{131}I is _________ days. (Upto one decimal place) **[GATE 2018]**

Answer Key

1. (a) 2. (9.90 to 1.10) 3. (80.33)

Other Examinations Year's Question

Q1. The $t_{1/2}$ of a radioactive element is 231 min. The time taken for 9/10th fraction of this element to decay is approximately.

(a) 770 min (b) 77 min (c) 375 min (d) 35 min

Q2. Alpha decay of $_{10}^{22}Mg$ results in

(a) $_{10}^{22}Mg$ (b) $_{12}^{24}Ne$ (c) $_{11}^{23}Na$ (d) $_{13}^{27}Al$

Q3. The ratio of the amount of two element X and Y at radioactive equilibrium is $1:2\times10^{-6}$ Half-life Period of element Y is 4.9×10^{-4} days. Then the half-life period of element X will be

(a) 4.8×10^{-3} days (b) 245 days (c) 122.5 days (d) None of these

Q4. An element 'X' emits successively two β particles, on e α particle, one position and one neutron. The mass and atomic numbers of the element are decreased by, respectively,

(a) 4 and 1 (b) 5 and 1 (c) 3 and 2 (d) 3 and 1

Q5. One gram of ^{90}Sr gets converted to 0.953 g after 2 years. The half-life of ^{90}Sr, and the amount of ^{90}Sr remaining after 5 years are

(a) 1.44 years and 0.916 g (b) 57.6 years and 0.75 g

(c) 28.8 years and 0.887 g (d) 100 years and 0.982 g

Q6. The radioactivity decay of $^{239}_{92}U \rightarrow ^{239}_{94}Pu$ is an example of

(a)Zero order reaction (b)Photochemical reaction

(c)Chain reaction (d)Consecutive reaction

Q7. Radioactivity effect by

(a) Temperature (b) Pressure (c) electric and magnetic field (d) none of these

Q8. The radiation from naturally occurring radioactive substances as seen deflection by a magnetic field in one direction are :

(a) α-rays (b) β-rays (c) both α and β rays (d) either α and β rays

Q9. In the radioactive decay, ${}_{z}X^{A} \rightarrow {}_{z+1}Y^{A} \underset{\text{High energy}}{\rightarrow} {}_{z-1}X^{A-4} \underset{\text{Low energy}}{\rightarrow} {}_{z-1}Z^{A-4}$ the sequence of the radiation emitted is:

(a) α, β, γ (b) γ, α, β (c) β, γ, α (d) β, α, γ

Q10. A radioactive nuclide emitts γ - rays due to the

(a) emission of an electron from its orbital.

(b) nuclear energy transition from a higher state to a lower state.

(c) presence of less neutrons than protons

(d) presence of more neutrons than protons.

Q11. Consider the following decay ${}_{z}X^{A} \rightarrow {}_{z+1}Y^{A} + {}_{-1}e^{0}, X$ is unstable because

(a) its nucleus has excess energy (b) n/p ratio is high

(c) n/p ratio is low (d) none of these

Q12. Consider the following decay ${}_{z}X^{A} \rightarrow {}_{z+1}Y^{A} + {}_{+1}e^{0}\ \ \beta^{+}\ \ X$ is unstable because

(a) its nucleus has excess energy (b) $\frac{n}{P}$ ratio is high

(c) $\frac{n}{p}$ ratio is low (d) none of these

Q13. During $\alpha -$ decay

(a) $\frac{n}{p}$ ratio decreases (d) $\frac{n}{p}$ ratio increase

(c) $\frac{n}{p}$ remains constant (d) may increase or decrease

Q14. Which of the following processes causes the emission of X-ray?

(a) $\alpha-$ emission (b) $\beta-$emission

(c) β^{+} (Positron emission) (d) electron capture

Q15. Which of the following processes results in an increase in atomic number of nuclide ?

(a) $\alpha-$ emission (b) electron capture (c) $\gamma-$emission (d) β - (Beta)emission

Q16. ……. Is produced when a positron and an electron collide:

(a) X-ray (b) Neutron (c) $\gamma-$radiation (d)Neutrino

Q17. ${}_{67}Ho^{165}$ is stable isotope ${}_{67}Ho^{150}$ is expected distintegrated by:

(a) $\alpha-$ emission (b) $\beta-$emission (c) positron emission (d) $\gamma-$ emission

Q18. ${}_{1}H^{1}$ is a stable isotope, ${}_{1}H^{3}$ is expected to disintegrated by

(a) $\alpha-$ emission (b) $\beta-$emission (c) positron emission (d) Proton emission

Q19. Loss in $\beta-$ particle is equivalent to:

(a) increase of one proton only (b) decrease of one neutron only

(c) Both (a) and (b) (d) none of these

Q20. Atoms ${}_{7}X^{A}, {}_{8}Y^{B}$ and ${}_{9}Z^{17}$ are such that ${}_{8}Y$ is an isobar of ${}_{7}X$ and atom ${}_{9}Z^{17}$ is isotone of ${}_{8}Y$. Mass no. of X and no. of neutrons in Y are respectively

(a) 8,8 (b) 17,7 (c) 9,8 (d) 16,8

Q21. ${}_{90}Th^{234}$ n disintegrate to give the ${}_{82}Pb^{206}$ as the final product. Total number of α and β particles emitted out during this process are:

(a) 6 (b) 7 (c) 8 (d) 13

Q22. An isotone of ${}_{32}Ge^{76}$ is:

(a) ${}_{32}Ge^{77}$ is: (b) ${}_{33}As^{77}$ (c) ${}_{34}Se^{77}$ (d) ${}_{36}Se^{77}$

Q23. Isobaric pair is:

(a) ${}_{6}C^{13}, {}_{7}N^{13}$ (b) ${}_{6}C^{13}, {}_{7}N^{14}$ (c) ${}_{6}C^{14}, {}_{8}N^{15}$ (d) none of these

Q24. Isodiaphers are atoms having

(a) n/p constant (b) p/n constant (c) (n-p) constant (d) (n-p) different

Q25. The 'Group disphlacement law' was given by

(a) Bacqueral (b) Rutherford (c) Madam Curie (d) Soddy and Fajan

Q26. $_{3}Li^{7} + _{1}p^{1} \rightarrow X$; identify X if reaction is p, α type

(a) $_{4}Be^{8}$ (b) $_{2}He^{4}$ (c) $_{0}\gamma^{0}$ (d) none of these

Q27. Identify reaction type

$_{13}Al^{27} + _{1}H^{2} \rightarrow _{13}Al^{28} + _{1}H^{1}$

(a) d, p (b) p, p (c) p, d (d)none of these

Q28. $_{13}Al^{27} + _{1}P^{1} \rightarrow X + _{0}\gamma^{0}$; identify X if reaction is p, γ type artificial radioactive reaction.

(a) $_{13}Al^{28}$ (b) $_{14}Si^{27}$ (c) $_{14}Si^{28}$ (d) none of these

Q29. The number of neutrons accompanying the formation of $_{54}X^{139}$ and $_{38}Sr^{194}$ from the absorption of slow neutron by $_{92}U^{235}$ followed by nuclear fission is:

(a) 0 (b) 1 (c) 2 (d) 3

Q30. What will be the product of reaction $_{101}Md^{225}$ $\alpha, 2n$?

(a) $_{103}Lr^{256}$ (b) $_{102}No^{257}$ (c) $_{103}Lr^{257}$ (d) $_{82}Pb^{205}$

Q31. Complete the following nuclear equation by supplying the symbol for the other product of the fission

$_{92}U^{235} + _{0}n^{1} \rightarrow _{38}Sr^{94} + ... + 2\,_{0}n^{1}$

(a) $_{54}Xe^{139}$ (b) $_{54}Xe^{140}$ (c) $_{64}Gd^{104}$ (d) none of these

Q32. Proton bombardment of Th^{230} followed by emission of two alphas Particles produce:

(a) Rn^{232} (b) Ra^{233} (c) Fr^{223} (d) Fr^{222}

Q33. $_{84}Po^{210} \rightarrow _{82}Pb^{206} + _{2}He^{4}$. In this reaction predict the position of group of Po when Pb is the IV B group

(a) II B (b) IV B (c) VI A (d) VI B

Q34. $_{90}Th$ is a member of III group on losing a-particle forms a new element belonging to:

(a) I group (b) II group (c) III group (d)IV group

Q35. Alpha decay of $_{92}U^{238}$ forms $_{90}Th^{234.}$. What kind of decay from $_{90}Th^{234}$ produce $_{89}Ac^{234}$?

(a) α (b) β (c) β (positron) (d) γ - emission

Q36. $_{83}Bi^{214}$ decays to A by α - emission; A then decays to B by beta emission, which decays to C by another beta emission. Element C decays to D by still another beta emission, and D decays by α - emission to a stable isotope E. What is an element E?

(a) $_{81}Tl^{207}$ (b) $_{80}Hg^{206}$ (c) $_{79}Au^{206}$ (d) $_{82}Pb^{206}$

Q37. A radioactive sample has initial activity of 28 dmp 30 minutes later its activity 14 dmp. How many atoms of nuclide were present initially?

(a) 2800 (b) 1217 (c) 528 (d) 2802

Q38. The activity of the hair of Egyptian mummy is 1.75 dpm. $t_{1/2}$ of $_6C^{14}$ is 5770 year and disintegration rate of fresh sample of C^{14} is 14 dpm. Find out the age of mummy.

(a) 23080 year (b) 138480 year (c) 11998.3 year (d) 17313.6 year.

Q39. Indium – 112 is radioactive and has very short half-life $t_{1/2} = 14\,\text{min}$. Its decay constant and average life are respectively

(a) $0.0495\,\text{min}^{-1}, 9.7$ min (b) $0.495\,\text{min}^{-1}, 20.2\,\text{min}$

(c) $9.7\,\text{min}^{-1}, 20.2\,\text{min}$ (d) $0.0495, 20.20.2\,\text{min}$

Q40. The half-life of Tc^{99} is 6.0 hr. The total residual activity in a patient 30hr receiving an injected containing T_c^{99} must be more than 0.01 μC_1. What is the maximum activity (in μC_1) that the sample injected an have ?

(a) 0.16 (b)0.32 (c) 0.64 (d) 0.08

Q41. A pure radio-chemical preparation was observed to disintegrate at the rate of 2140 counts/minutes at 12.35 P.M. At 3.55 P.M. of the same day, the disintegration rate of the sample was only 535 count/minutes. What is the half-life of the material ?

(a) 50 min (b) 100 min (c) 200 min (d) none of these

Q42. A certain radioactive isotope $_zX^A$ $t_{1/2} = 100\text{ days}$ decays to $_{z-2}Y^{A-8}$. If 1 mole of $_zX^A$ is kept in sealed container, how much He gas will accumulate at STP in 200 days ?

(a) 11.2 litre (b) 33.6 litre (c) 22.4 litre (d) 44.8 litre

Q43. Two radio isotopes A and B of atomic weight X and Y are mixed in equal amount by weight. After 20 days, their weight ratio is found to be 4:1 Isotope A has a half-life of 1 day. The half-life of isotope B is

(a) $1.11\frac{Y}{X}$ day (b) $0.11\frac{X}{Y}$ day (c) 0.6237 day (d) 1.11 day

Q44. A radioactive nuclide is produced at a constant rate of α per second. Its decay constant is λ, if N_0 be the number of nuclei at time t = 0, then max no, of nuclei possible are

(a) N_0 (b) α/λ (c) $N_0 + \frac{\alpha}{\lambda}$ (d) $\frac{\lambda}{\sigma} + N_0S$

Q45. A radioactive substance (parent) decays to its daughter element, the age of radioactive substance(t) is related to the daughter (d)/parent(p) ratio by the equation

(a) $t=\frac{1}{\lambda}\ln\left(1+\frac{p}{d}\right)$ (b) $t=\frac{1}{\lambda}\ln\left(1+\frac{d}{p}\right)$ (c) $t=\frac{1}{\lambda}\ln\left(\frac{d}{p}\right)$ (d) $t=\frac{1}{\lambda}\ln\left(\frac{p}{d}\right)$

Q46. The species ^{19}Ne and ^{14}C emit a positron and β - particle respectively. The resulting species formed are respectively

(a) ^{19}Na and ^{14}B (b) ^{19}F and ^{14}N (c) ^{19}Na and ^{14}N (d) ^{19}F and ^{14}B

Answer Key

1. (a)	2. (b)	3. (b)	4. (b)	5. (c)	6. (d)	7. (d)
8. (d)	9. (d)	10. (d)	11. (b)	12. (c)	13. (b)	14. (d)
15. (d)	16. (c)	17. (c)	18. (b)	19. (c)	20. (d)	21. (d)
22. (b)	23. (a)	24. (c)	25. (d)	26. (b)	27. (a)	28. (c)
29. (d)	30. (d)	31. (c)	32. (b)	33. (c)	34. (c)	35. (c)
36. (d)	37. (b)	38. (d)	39. (d)	40. (b)	41. (b)	42. (b)
43. (d)	44. (d)	45. (b)	46. (b)			