EXERCISE 1

CBSE FLASH BACK

[RadioActivity]

Q.1 Complete the following reactions:

$^{55}_{25}Mn\ (n, \gamma)......;$ **[1980]**

Q.2 Give the main differences between nuclear fission and fusion. **[1991]**

Q.3 What is the main use of $^{14}_{6}C \longrightarrow\ ^{14}_{7}N +\ ^{0}_{-1}e$ nuclear disintegration? **[1991]**

Q.4 How many α-particles and β-particles are emitted when $^{238}_{92}U$ changed to $^{230}_{90}Th$? **[1992]**

Q.5 Write the principle of neutron activation analysis. **[1992]**

Q.6 Name the major centres for research and development work in atomic energy in India. **[1992, 1993]**

Q.7 Starting with 1.0 gm of a radioactive sample, 0.25 g of it is left after 5 days. Calculate the amount which was left after one day. **[1993]**

Q.8 Calculate the energy released in the fusion reaction per atom of helium formed:

$$^{2}_{1}H +\ ^{3}_{1}H \longrightarrow\ ^{4}_{2}He +\ ^{1}_{0}n$$

Given the following masses:

$^{2}_{1}H = 2.014;\ ^{3}_{1}H = 3.016;\ ^{4}_{2}He = 4.0303;\ ^{1}_{0}n = 1.009$ **[1994]**

Q.9 A radioactive substance is half distintegrated in 40 minutes. What is the time required for the decay of 75% of the element? **[1994]**

Q.10 Complete the reaction $^{7}_{3}Li\,(\alpha, ...) \longrightarrow\ ^{8}_{3}Li$ **[1995]**

Q.11 Complete the following reaction : $^{14}_{7}N\,(n, ...)\ ^{14}_{6}C$ **[1995]**

Q.12 Fill in the blank: Alpha rays are fast moving.............. nuclei. **[1996]**

Q.13 Fill in the blank: The radioactive series consisting of man made elements if filled............. **[1996]**

Q.14 Balance the following nuclear equations: **[1997]**

(a) $^{82}_{35}Br \longrightarrow\ ^{82}_{36}Kr + ...$ (b) $^{14}_{7}N +\ ^{4}_{2}He \longrightarrow ...... +\ ^{0}_{-1}e$

(c) $^{27}_{12}Mg \longrightarrow .... +\ ^{0}_{-1}e$ (d) $............... \longrightarrow\ ^{14}_{7}N +\ ^{0}_{-1}e$

Q.15 Complete the following nuclear reaction

$^{235}_{92}U +\ ^{1}_{0}n \longrightarrow\ ^{140}_{56}Ba + ... + 2\left(^{1}_{0}n\right)$ **[1997]**

Q.16 Complete the following reactions:

(a) $^{14}_{7}N\ (\alpha, ...)\ ^{17}_{8}O;$ **[1997]**

(b) $^{27}_{13}Al\ (\alpha, n)......$ **[1997]**

Q.17 Complete the following : ${}^{23}_{11}Na + ... \longrightarrow {}^{23}_{12}Mg + {}^{1}_{0}n$. **[1993, 1998]**

Q.18 Why are fusion reactions in nuclear chemistry refferred to as thermonculear reactions? **[1999]**

Q.19 Calculate the energy change in J/mol for the nuclear reaction

$${}^{1}_{0}n \longrightarrow {}^{1}_{1}p + {}^{0}_{-1}e$$

[Given m = 1.00728 amu, mn = 1.00867 amu and velocity of light in air, c = $3 \times 10^8 ms^{-1}$]

Q.20 Write nuclear reactions for the following transformation : **[1999]**

(a) ${}^{238}_{92}U$ undergoes α-decay. (b) ${}^{234}_{91}Pa$ undergoes β-decay.

Q.21 (i) State the factors on which rate of radioactive decay depends.

(ii) Thorium isotope, ${}^{232}_{90}Th$, is an alpha particle emitter with a half-life of 1.41×10^{10} year. Given a 0.25 g of sample of this thorium, how many α-particles will it emit per second. ($N_A = 6.02 \times 1023\ mol^{-1}$) **[1999]**

Q.22 Explain the principle of radiocarbon dating. **[1996, 1999]**

Q.23 (i) What is the nuclear fission reaction?
(ii) Describe the basic principle of a nuclear reactor. **[2000]**

Q.24 (a) In what context is the term critical mass used?
(b) Starting with 1.0 g of a radioactive smaple, 0.25 g of it is still left after 5 days. Calculate the amount which was left after one day. **[2001]**

Q.25 Complete the following nuclear reactionns and name the type of nuclear tranformation involved in each case **[2002]**

(i) ${}^{6}_{3}Li + {}^{1}_{0}n \longrightarrow {}^{4}_{2}He + ...$ **(ii)** ${}^{12}_{36}S + {}^{1}_{0}n \longrightarrow {}^{32}_{15}P + ...$

(iii) ${}^{27}_{13}Al + ... \longrightarrow {}^{30}_{15}P + {}^{1}_{0}n$

Q.26 Complete the nuclear equation **[2003]**

$${}^{238}_{92}U + {}^{12}_{6}C \longrightarrow {}^{246}_{98}Cf + ...$$

Q.27 Complete the nuclear equation

$$4{}^{1}_{1}H \longrightarrow {}^{4}_{2}He + ...$$ **[2003]**

Q.28 Define the group displacement laws with example. **[2004]**

Q.29 Discuss the use of radioactive isotopes **[2004]**
(i) in studying reaction mechanism **(ii)** in the treatment of diseases
(iii) in agriculture.

Q.30 Give one example of each of (i) β^+ emission (ii) K-capture. **[2004]**

Q.31 Write the nuclear reactions for the following radiactive decay.

${}^{238}_{92}U$ undergoes α-decay **[2004]**

Q.32 Complete the equations for the following nuclear process:

(a) ${}^{35}_{17}Cl + {}^{1}_{0}n \longrightarrow .... + {}^{4}_{2}He$ **[2005]**

(b) ${}^{235}_{92}U + {}^{1}_{0}n \longrightarrow .... + {}^{137}_{54}Xe + 2{}^{1}_{0}n$ **[2005]**

Q.33 Discuss the principle of neutron activation analysis. **[2005]**

Q.34 Complete the following reactions:

(a) $^{96}_{42}\text{Mo}$ (......., n) $^{97}_{43}\text{Tc}$ **[2011]**

(b) .....(α, 2n) $^{211}_{85}\text{At}$ [$^{209}_{83}\text{Bi}$]

(c) $^{246}_{96}\text{Cm} + ^{12}_{6}\text{C} \longrightarrow ...... + 4\,(^{1}_{0}\text{n})$ **[2011]**

(d) $^{239}_{94}\text{Pu}(\alpha, \beta^{-})$....... **[2011]**

EXERCISE 2

CONCEPTUAL OBJECTIVE

[SINGLE CORRECT]

Q.18 When a β-particle is emitted by the atom of a radioactive element, the new species formed possesses:
(A) same atomic mass and atomic number less by one unit
(B) same atomic mass and atomic number less by two units
(C) same atomic mass and atomic number higher by one unit
(D) same atomic mass and atomic number higher by two units

Q.19 The number of α- and β-particle emitted in the nuclear reaction $^{228}_{90}\text{Th} \longrightarrow ^{212}_{83}\text{Bi}$ are :
(A) 8α, 1β (B) 4α, 7β (C) 3α, 7β (D) 4α, 1β

Q.20 A radioactive element A on disintegration gives two elements B and C., If B is helium and C is the element of atomic number 90 and atomic mass 234, the element A is :
(A) $^{238}_{92}\text{U}$ (B) $^{234}_{88}\text{Ra}$ (C) $^{234}_{90}\text{Sc}$ (D) $^{234}_{91}\text{Pa}$

Q.21 One curie of activity is equivalent to :
(A) 3.7×10^{17} disintegrations per sec (B) 3.7×10^{10} disintegrations per sec
(C) 3.7×10^{14} disintegrations per sec (D) 3.7×10^{3} disintegrations per sec

Q.22 Radioactivity of a radioactive element remains 1/10 of the original radioactivity after 2.303 seconds. The half life period is :
(A) 2.303 (B) 0.2303 (C) 0.693 (D) 0.0693

Q.23 The half life periods of four isotopes are given below :
(i) 7.6 years (ii) 4000 years, (iii) 6000 years (iv) 3.2×10^{5} years
Which of the above isotopes is most stable ?
(A) iv (B) iii (C) ii (D) i

Q.24 Which of the following transformations is not correct ?
(A) $^{75}_{33}\text{As} + ^{4}_{2}\text{He} \longrightarrow ^{78}_{35}\text{Br} + ^{1}_{0}\text{n}$ (B) $^{7}_{3}\text{Li} + ^{1}_{1}\text{H} \longrightarrow ^{7}_{4}\text{Be} + ^{1}_{0}\text{n}$
(C) $^{45}_{21}\text{Sc} + ^{1}_{0}\text{n} \longrightarrow ^{45}_{20}\text{Ca} + ^{1}_{0}\text{n}$ (D) $^{209}_{83}\text{Bi} + ^{2}_{1}\text{H} \longrightarrow ^{210}_{84}\text{Po} + ^{1}_{0}\text{n}$

Q.25 A sample of rock from moon contains equal number of atoms of uranium and lead ($t_{1/2}$ for U = 4.5×10^{9} years). The age of the rock would be :
(A) 9.0×10^{9} years (B) 4.5×10^{9} years (C) 13.5×10^{9} years (D) 2.25×10^{9} years

EXERCISE 3

CONCEPTUAL SUBJECTIVES

Q.11 In the fission of $_{92}U^{235}$, 6% of the fission product is $_{42}Mo^{99}$. This material is radioactive and decays as follows :
$_{42}Mo^{99} \longrightarrow X + {}_{43}Tc^{99}$
$_{43}Tc^{99} \longrightarrow X + Y$
What are X & Y.

Q.12 A radioactive element (A) of atomic weight 238 and atomic no. 92 loses 7α and 14β-particles. What will be approximate atomic weight of last element B ? How would it be related with original element?

Q.13 An atomic battery wrist watch uses $_{61}Pm^{147}$ as a source of β-particles ($t_{1/2}$ = 2.62 year) for energy required for its operation. How long would it take for the rates of β-emission in the battery to reduced by 5% of its original value ?

Q.14 A sample contains 10^{-2} kg each of two substance A and B with half lives of 4 and 8 second respectively. The atomic weight of A and B are in the ratio of 1 : 2. Find the amount of A and B after an interval of 16 second. Also report the ratio of initial rates of decay of these two.

Q.15 The lowest level C^{14} activity for experimental detection is 0.03 dis/min/g of C^{14}. What is the maximum age of an object that can be determined by C^{14} method ? The activity of C^{14} in atmosphere is 15 dis/min/g of C^{14}.
($t_{1/2}$ of C^{14} = 5730 year)

Q.16 Complete the following nuclear reactions :
(a) $_4Be^9 + {}_2He^4 \longrightarrow {}_6C^{12}$ + ...
(b) $_1T^3 + {}_1D^2 \longrightarrow {}_2He^4$ + ...
(c) $_7N^{14} + {}_2He^4 \longrightarrow {}_8O^{17}$ + ...
(d) $_{92}U^{235} + {}_0n^1 \longrightarrow {}_{56}Ba^{137} + {}_{36}Kr^{93}$ + ...
(e) $_{29}Cu^{53} \longrightarrow {}_{28}Ni^{53}$ + ...
(f) $2\ {}_1H^3 \longrightarrow {}_2He^4$ + ...

Q.17 Write equation for the following transformations :
(a) $_7N^{14}$ (n, p)
(b) $_{19}K^{39}$ (p, α)

Q.18 Calculate the no. of neutrons in the product obtained in the following transformation :
$$_{92}X^{238} \longrightarrow A + {}_2He^4$$

Q.19 To which radioactive series the following appears during disintegrations :
$_{89}Ac^{228}$; $_{89}Ac^{227}$

Q.20 Atoms $_7A$, $_8B$ and $_9C^{17}$ are such that $_8B$ is an isobar of $_7A$ and atom $_9C^{17}$ is isotone to $_8B$. Calculate the mass no. for A and B.

EXERCISE 4

BRAINSTORMING OBJECTIVES

[SINGLE CORRECT]

Q.23 The decay constant of ^{226}Ra is 1.37×10^{-11} sec^{-1}. A sample of $_{226}Ra$ having an activity of 1.5 milli curie will contain .... atoms.
(A) 4.05×10^{18} (B) 3.7×10^{17} (C) 2.05×10^{15} (D) 4.7×10^{10}

Q.24 Which among the following is wrong about isodiaphers ?
(A) they have the same difference of neutrons and protons or same isotopic number
(B) nuclide and its decay product after α-emission are isodiaphers
(C) $_{Z}A^{m} \longrightarrow {}_{Z-2}B^{m-4} + {}_{2}He^{4}$ 'A' and 'B' are isodiaphers
(D) all correct

Q.25 A radioactive element decays as

$$X \xrightarrow[t_{1/2}=30\text{ min.}]{\alpha\text{ decay}} Y \xrightarrow[t_{1/2}=2\text{ days}]{(-2\beta)\beta\text{ decay}} Z$$

which of the following statements about this decay process is incorrect ?
(A) after two hours, less than 10% of the initial X is left
(B) maximum amount of Y present at any time before 30 min is less than 50% of the initial amount of X.
(C) atomic number of X and Z are same
(D) the mass number of Y is greater than X

Q.26 Among the following nuclides, the highest tendency to decay by (β^{+}) emission is –
(A) Cu^{59} (B) ^{63}Cu (C) ^{67}Cu (D) ^{68}Cu

Q.27 The number of α-particles emitted per second by 1 g of ^{226}Ra is 3.7×10^{10}. The decay constant is
(A) 1.39×10^{-11} sec^{-1} (B) 13.9×10^{-11} sec^{-1} (C) 139×10^{-10} sec^{-1} (D) 13.9×10^{-10} sec^{-1}

28. The average life of a W gm sample ^{200}RaE is T second and average energy of the b-particles emitted is E MeV. At what rate in watts does the sample emit energy?

(A) $\dfrac{8WN_0E}{T}\times 10^{-16}$ (B) $\dfrac{8(\ln 2)WN_0E}{T}\times 10^{-13}$

(C) $\dfrac{8WN_0E}{T}\times 10^{-13}$ (D) None is correct

29. The activity of a radioactive substance is R_1 at time t_1 and R_2 at time t_2 ($> t_1$). Its decay constant is l. Then :

(A) $R_1t_1 = R_2t_2$ (B) $R_2 = R_1e^{\lambda(t_2-t_1)}$

(C) $R_2 = R_1e^{\lambda(t_1-t_2)}$ (D) $\dfrac{R_1-R_2}{t_2-t_1}$ = constant

EXERCISE 5

BRAINSTORMING SUBJECTIVE

Q.9 The isotopes ^{238}U and ^{235}U occurs in nature in the ratio of 140 : 1. Assuming that at the time of earth formation, they were present in equal ratio, make an estimation of the age of earth. The half life period of ^{238}U and ^{235}U are 4.5×10^{9} and 7.13×10^{8} years respectively.

Q.10 A solution contains 1 millicurie of L-phenyl alanine C^{14} (uniformly labbled) in 2.0 mL solution. The activity of labelled sample is given as 150 milli curie/milli mole. Calculate :
(a) the concentration of sample in the solution in mole/litre
(b) the activity of the solution in terms of counting per minute/mL at a counting efficiency of 80%

Q.11 A mixture of Pu^{239} and Pu^{240} has a specific activity of 6×10^9 dps per g sample. The half lives of the isotopes are 2.44×10^4 year and 6.58×10^3 years respectively. Calculate the composition of mixture.

Q.12 The half life of ^{212}Pb is 10.6 hours. It undergoes decay to its daughter (unstable) element ^{212}Bi of half life 60.5 minute. Calculate the time at which the daughter element will have maximum activity ?

Q.13 All naturally occurring rubidium ores contain ^{87}Sr resulted from the beta decay of

^{87}Rb, i.e., $^{87}_{37}Rb \longrightarrow ^{87}_{38}Sr + {}_{-1}e^0$.

In naturally occurring rubidium, 278 of every 1000 rubidium atoms are ^{87}Rb. A mineral containing 0.85% Rb was analysed and found to contain 0.0089% Sr. Assuming that all of the strontium originated by radioactive decay of ^{87}Rb, estimate the age of mineral. Half life of ^{87}Rb is 4.7×10^{10} year

Q.14 ${}_{92}U^{235}$ has a half life of 7.1×10^8 year and its daughter element ${}_{90}Th^{231}$ has half life of 24.6 hr. What is the mass of ${}_{90}Th^{231}$ in equilibrium with 1g ${}_{92}U^{235}$?

Q.15 The mean lives of a radioactive substance are 1620 year and 405 year for α-emission and β-emission respectively. Find out the time during which three fourth of a sample will decay if it is decaying both by α-emission and β-emission simultaneously.

EXERCISE 8

IIT - JEE FLASH BACK

[Radioactivity]

1988

Q.1 A freshly prepared radioactive source of half life period 2 hours emits radiations of intensity which is 64 times the permissible safe level. The minimum time after which it would be possible to work with this source is

(A) 6 hours (B) 12 hours (C) 24 hours (D) 48 hours

Q.2 Nuclear reaction accompanied with emission of neutron(s) is :

(A) $^{27}_{13}Al + ^{4}_{2}He \longrightarrow ^{30}_{15}P$ (B) $^{12}_{6}C + ^{1}_{1}H \longrightarrow ^{13}_{7}N$

(D) $^{30}_{15}P \longrightarrow ^{30}_{14}Si + ^{0}_{1}e$ (D) $^{240}_{96}Am + ^{4}_{2}He \longrightarrow ^{244}_{97}Bk + ^{0}_{1}e$

1993

Q.3 Successive emission of an α-particle and two β-particle by an atom of a radioactive element results in the formation of its :

(A) isobar (B) isomer (C) isotone (D) isotope

1996

Q.4 $^{27}_{13}Al$ is stable isotope. $^{29}_{13}Al$ is expected to disintegrate by :

(A) α-emission (B) β-emission (C) positron emission (D) proton emission

1999

Q.5 The number of neutron accompanying the formation of $^{139}_{54}Xe$ and $^{94}_{38}Sr$ from the absorption of a slow neutron by $^{235}_{92}U$, followed by nuclear fission is –

(A) 0 (B) 2 (C) 1 (D) 3

2003

Q.6 ^{23}Na is the more stable isotope of Na. Find out the process by which ${}^{24}_{11}Na$ can undergo radioactive decay–

(A) α emission (B) β^- emission (C) β^+ emission (D) K electron capture

2004

Q.7 Complete and balance the following reactions

$${}_{92}Th^{234} \longrightarrow .... + 7\ {}_2H^4 + 5\ {}_{-1}\beta^0$$

2005

Q.8 Complete and balance the following reactions

(i) ${}_{92}Th^{234} + {}_0n^1 \longrightarrow .... + {}_{52}Te^{137} + {}_{40}Zr^{92}$

(ii) ${}_{34}Se^{86} \longrightarrow 2\ {}_{-1}e^0 + ...$

2006

Read the passage given below and answer the questions that follows.

Several short-lived radioactive species have been used to determine the age of wood or animal fossils. One of the most interesting substances is ${}_6C^{14}$ (half-life 5760 year) which is used in determining the age of carbon-bearing materials (e.g. wood, animal fossils, etc.) Carbon-14 is produced by the bombardment of nitrogen atoms present in the upper atmosphere with neutrons (from cosmic rays).

$${}_7N^{14} + {}_0n^1 \longrightarrow {}_6C^{14} + {}_1H^1$$

thus carbon-14 is oxidised to CO_2 and eventually ingested by plants and animals. The death of plants or animals put an end to the intake of C^{14} from the atmosphere. After the amount of C^{14} in the dead tissues starts decreasing due to its disintegration as per the following reaction:

$${}_6C^{14} \longrightarrow {}_7N^{14} + {}_{-1}b^0$$

The C^{14} isotope enters the biosphere when carbon dioxide is taken up in plant photosynthesis. Plants are eaten by animals, which exhale C^{14} as CO_2. Eventually, C^{14} participates in many aspects of the carbon cycle. The C^{14} lost by radioactive decay is constantly replenished by the production of new isotopes in the atmosphere. In this decay-replenishment process, a dynamic equilibrium is established whereby the ratio of C^{14} to C^{12} remains constant in living matter. But when an individual plant or an animal dies, the C^{14} isotope in its is no longer replenished, so the ratio decreases as C^{14} decays. So, the number of C^{14} nuclei after time t (after the death of living matter) would be less than in a living matter. The decay constant can be calculated using the following formula,

$$t_{1/2} = \frac{0.693}{\lambda}$$

The intensity of the cosmic rays have remain the same for 30,000 years. But since some years the changes in this are observed due to excessive burning of fossil fuel and nuclear tests.

Q.9 Why do we use the carbon dating to calculate the age of the fossil?

(A) Rate of exchange of carbon between atmosphere and living is slower than decay of C^{14}

(B) It is not appropriate to use C^{14} dating to determine age

(C) Rate of exchange of C^{14} between atmosphere and living organism is so fast that an equilibrium is set up between the intake of C^{14} by organism and its exponential decay.

(D) none of the above

Q.10 What should be the age of the fossil for meaningful determination of its age?

(A) 6 years (B) 6000 years

(C) 60,000 years (D) can be used to calculate any case

Q.11 A nuclear explosion has taken place leading to increase in concentration of C^{14} in nearby areas. C^{14} concentration is C_1 in nearby areas and C_2 in areas far away. If the age of the fossil is determined to be T_1 and T_2 at the respective places then

(A) The age of the fossil will increase at the place where explosion has taken place and T1–T2 $= \frac{1}{\lambda} \ln \frac{C_1}{C_2}$

(B) The age of the fossil will decrease at the place where explosion has taken place and T1–T2 $= \frac{1}{\lambda} \ln \frac{C_1}{C_2}$

(C) The age of fossil will be determined to be same

(D) $\frac{T_1}{T_2} = \frac{C_1}{C_2}$

2007

Q.12 A positron is emitted from ${}^{23}_{11}Na$. 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

2009

Q.13 Given that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5% , 90% and 5%, respectively, the atomic mass of Fe is

(A) 55.85 (B) 55.95 (C) 55.75 (D) 56.05

EXERCISE 9

IIT - JEE FLASH BACK SUBJECTIVE

[Radioactivity]

1986

Q.1 What mass of C^{14} with $t_{1/2} = 5730$ year has activity equal to one curie ?

Q.2 The disintegration rate of a certain radioactive sample at any instant is 4750 dpm. Five minutes later, the rate becomes 2700 dpm. Calculate half life of sample.

Q.3 ${}_{90}Th^{234}$ disintegrates to give ${}_{82}Pb^{206}$ as the final product. How many α and β-particles are emitted out during this process ?

1987

Q.4 A certain radio isotope ${}_ZX^A$ ($t_{1/2} = 10$ days) decays to give ${}_{Z-2}Y^{A-4}$. If one g atom of ${}_ZX^A$ is kept in a sealed vessel, how much He will accumulate in 20 days at STP ?

1988

Q.5 0.1 g atom of radioactive isotope ${}_ZX^A$ (half life 5 days) is taken. How many number of atoms will decay during eleventh day ?

1989

Q.6 10 g atoms of α-active radioactive isotope are disintegrating in a sealed container. In one hour, the He gas collected at STP is 11.2 cm^3. Calculate half life of radioactive isotope.

Q.7 An experiment requires minimum β-activity produced at the rate of 346 β-particles per minute. The half life period of ${}_{42}Mo^{99}$ which is a β-emitter is 66.6 hr. Find the minimum amount of ${}_{42}Mo^{99}$ required to carry out the experiment in 6.909 hours.

1990

Q.8 $_{92}U^{238}$ by successive radioactive decays changes to $_{82}Pb^{206}$. A sample of uranium ore was analysed and found to contain 1.0 g U^{238} and 0.1 g Pb^{206}. Assuming that Pb^{206} has accumulated due to decay of uranium, find out the age of ore. $t_{1/2}$ for $U^{238} = 4.5 \times 10^9$ year.

1991

Q.9 $_{84}Po^{210}$ decays with α-particle to $_{82}Pb^{206}$ with a half life of 138.4 days. If 1.0 g of $_{84}Po^{210}$ is placed in a sealed tube, how much helium will accumulate in 69.2 days ? Express the answer in cm^3 at STP. Also report the volume of He formed if 1 g of $Po^{210}O_2$ is used.

1992

Q.10 In nature a decay chain series starts with $_{90}Th^{232}$ and finally terminates at $_{82}Pb^{208}$. A thorium ore sample was found to contain 8×10^{-5} mL of He at STP and 5×10^{-7} g of Th^{232}. Find the age of ore sample assuming that source of He to be only due to decay of Th^{232}. Also assume complete retention of He within the ore.

$t_{1/2}$ $Th^{232} = 1.39 \times 10^{10}$ year.

Q.11 The nucleidic ratio of $_1H^3$ to $_1H^1$ in a sample of water is $8.0 \times 10^{-18} : 1$. Tritium undergoes decay with a half life period of 12.3 year. How many tritium atoms would 10.0 g of such a sample contains 40 year after the original sample is collected ?

1994

Q.12 A small amount of solution containing Na^{24} radio nucleide with activity $A = 2 \times 10^3$ dps was administered into blood of a patient in a hospital. After 5 hour, a sample of the blood drawn out from the patient showed an activity of 16 dpm per c.c. $t_{1/2}$ for $Na^{24} = 15$ hr. Find –

(a) volume of the blood in patient

(b) Activity of blood sample drawn after a further time of 5 hr.

1995

Q.13 One of the hazards of nuclear explosion is the generation of Sr^{90} and its subsequent incorporation in bones. This nucleide has a half life of 28.1 year. Suppose one microgram was absorbed by a new-born child, how much Sr^{90} will remain in his bones after 20 years ?

1996

Q.14 A sample of U^{238} (half life $= 4.5 \times 10^9$ yr) ore is found to contain 23.8 g of U^{238} and 20.6 g of Pb^{206}. Calculate the age of the ore.

Q.15 Ac^{227} has a half life of 22 year with respect to radioactive decay. The decay follows two parallel paths, one leading the Th^{227} and the other leading to Fr^{223}. The percentage yields of these two daughters nucleides are 2% and 98.0% respectively. What is the rate constant in $year^{-1}$ for each of the separate paths ?

1997

Q.16 With what velocity should an α-particle travel towards the nucleus of a copper atom so as to arrive at a distance 10^{-13} meter from the nucleus of the copper atom ?

Q.17 Write a balanced equation for the reaction $_{14}N$ with α-particle.

2000

Q.18 Calculate no. of α and β-particles emitted when $_{92}U^{238}$ changes into radioactive $_{82}Pb^{206}$.

Q.19 On analysis a sample of uranium ore was found to contain 0.277 g of $_{82}Pb^{206}$ and 1.667 g of $_{92}U^{238}$. The half life period of U^{238} is 4.51×10^9 year. If all the lead were assumed to have come from decay of $_{92}U^{238}$, what is the age of earth.

2010

Q.20 ^{64}Cu (half life = 12.8 h) decays by β^- emission (38%), β^+ emission (19%) and electron capture (43%). Write the decay products and calculate partial half lives for each of the decay processes.

ANSWERSHEET

Exercise - 01

2. 9.30×10^{-5} mol L^{-1} sec^{-1} **4.** First order **5.** Second order

8. 8.548 min **11.** 0.384 min **12.** Second order

13. Zero order **14.** 111.838 kJ mol^{-1} **16.** First order

17. $103.27 \times \log 5 = 72.19$ min. **18.** 20.35×10^{12} sec.

19. 8.52×10^{-4} s^{-1} **20.** $k_2 = 30.98 \times 10^{-3}$ sec^{-1} **21.** 53.599 kJ

28. t = 62.13 minutes **29.** 51.86 kJ mol^{-1} **33.** First order

34. 3.8% **35.** 146.68 min

36. (i) 1.49×10^{-2} min^{-1} (ii) 154.56 (iii) 29.94 min **37.** 22.01 kJ mol^{-1}

39 No relation **40.** a/k

41 $-\dfrac{dx}{dt} = k$ where k is rate constrant of the reaction **43** 0.038 s

44. **(b)** 1.25×10^{-4} mol^{-1} L s^{-1}, 3.75×10^{-4} mol^{-1} L s^{-1}

OR

(a) [(i) Nature of reactant, (ii) concentration of reactant (iii) Catalyst, (iv) Temperature,]

(b) [1847.37]

[Radio activity]

1. ${}^{56}_{25}Mn$ **4.** $(2\alpha, 2\beta)$

6. Tarapur, Kalapakkam, Narora, Rawatbhata, Kakrapara

7. 0.758 gm **8.** 16.758 MeV

9. t = 80.0 **10.** ${}^{3}_{2}He$ **11.** ${}^{1}_{0}n$

12. ${}^{4}_{2}He$ **13.** 4n + 1

14. (a) ${}^{0}_{-1}e$ (b) ${}^{17}_{8}N$ (c) ${}^{27}_{13}Al$ (d) ${}^{14}_{6}C$ **15.** ${}^{94}_{36}Kr$

16. (a) ${}^{1}_{1}H$ **(b)** ${}^{30}_{15}P$ **17.** ${}^{1}_{1}H$ **19.** 12.487×10^{10} J mol^{-1}

21. (ii) 1011 α particles **24. (b)** 0.7586 gm

25. (i) ${}^{3}_{1}H$ (n, α type) **(ii)** ${}^{1}_{1}H$ (n, p type) **(iii)** ${}^{1}_{0}n$ (α, n type) **26.** $4\,{}^{1}_{0}n$

27. $2\,{}^{0}_{+1}e + \nu$ **32. (a)** ${}^{32}_{15}P$ **(b)** ${}^{97}_{38}Sr$ **32. (a)** ${}^{32}_{15}P$ **(b)** ${}^{97}_{38}Sr$

34. (a) ${}^{2}_{1}H$ **(b)** ${}^{209}_{83}Bi$ **(c)** ${}^{254}_{102}No$ **(d)** ${}^{243}_{97}Bk$

Exercise - 02

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

Exercise - 03

1. T = 310.96 K **2.** $\frac{K_{cat}}{k_{uncat}} = 8.88 \times 10^{32}$ **3.** $A = 5.04 \times 10^5\ s^{-1}$

4. $r_2/r_1 = 2.34 \times 10^{13}$ **5. (i)** t = 53.4 sec **(ii)** total pressure = 0.201 atm

6. II order **7.** 1.09×10^{-5} mol $lit^{-1}sec^{-1}$ **8.** time = 6×10^{-9} sec

9. (a) $\Delta H = -10$kJ/mol **(b)** $E_f = 30$ kJ/mol; $E_b = 40$kJ/mol

(c) $E_f = 10$ kJ/mol; $E_b = 20$ kJ/mol **(d)** NO

10. $K = \frac{2.303}{t}\log_{10}\frac{2P_0}{3P_0 - P}$ **11.** ${}_{-1}e^0$, ${}_{44}Y^{99}$ **12.** 210, ${}_{92}B^{210}$, A and B are isotopes

13. 0.194 year **14.** 6.25×10^{-4} kg; 2.5×10^{-3} kg ; 4: 1 **15.** 51379.28 year

16. (a) ${}_0n^1$ (b) ${}_0n^1$(c) ${}_1H^1$ (d) $6{}_0n^1$ (e) ${}_{+1}e^0$ (f) $2{}_0n^1$

17. (a) ${}_7N^{14} + {}_0n^1 \longrightarrow {}_6C^{14} + {}_1p^1$ **(b)** ${}_{19}K^{39} + {}_1H^1 \longrightarrow {}_{18}Ar^{36} + {}_2He^4$

18. ${}_{90}Th^{234}$, 144 neutrons **19.** (4n + 3) series **20.** 16

Exercise - 04

1. B	**2.** B	**3.** B	**4.** A	**5.** B	**6.** B
7. B	**8.** B	**9.** C	**10.** B	**11.** B	**12.** C
13. B	**14.** D	**15.** C	**16.** A	**17.** C	**18.** D
19. D	**20.** C	**21.** B	**22.** B	**23.** A	**24.** D
25. D	**26.** C	**27.** A	**28.** A	**29.** C	

Exercise - 05

1. $A = 115.98\ sec^{-1}$ **2.** total pressure = 379.73 mm Hg **3.** $K = 7.512 \times 10^{-3}\ min^{-1}$

4. 1.188×10^{17} **5.** $A = 2p^0 - \frac{(2p^0 - p)^2}{p^0}$

6. 36.2% **7.** 1 : 2.449 **8. (a)** 90 mm **(b)** 47 mm **(c)** 10.677 min

9. $t = 6.04 \times 10^9$ years	**10. (a)** 3.33×10^{-2} M **(b)** 88.8×10^7 cpm/mL	
11. $Pu^{239} = 38.95\%$, $Pu^{240} = 61.05\%$	**12.** 227.1 min	
13. 2.51×10^9 year	**14.** 3.89×10^{-12} g	**15.** 449.24 year

Exercise - 06

ONE or MORE than one correct

1. ABC	**2.** ABCD	**3.** ABCD	**4.** ABCD	**5.** AB	**6.** AC
7. ABC	**8.** AC	**9.** ABC	**10.** BC	**11.** ABCD	**12.** BCD
13. D	**14.** C	**15.** CD	**16.** C	**17.** CD	**18.** B
19. B	**20.** BC				

Match the followng columns

21. A-r; B-p, C-t, d-q

22. A-r, B-s, C-q, D-p,r

23. C	**24.** D	**25.** B	**26.** A	**27.** A	**28.** D

Paragraph.

29.	B	**30.**	A	**31.**	C	**32.**	D	**33.**	B	34.	A
35.	B	**36.**	C	**37.**	D	**38.**	A	**39.**	A	**40.**	A
41.	D	**42.**	B	**43.**	D	**44.**	B	**45.**	C	**46.**	C
47.	A	**48.**	C	**49.**	C	**50.**	A				

Assertion& Reason

51.	D	**52.**	B	**53**.	C	**54.**	A	**55.**	D	**56.**	B
57.	B	**58.**	C								
59.	D	**60.**	B	**61.**	D						

Fill in the blanks

62.	pseudo, first	**63.**	faster	**64.**	photochemical
65.	slowest	**66.**	order	**67.**	0.693/k
68.	0.5	**69.**	may or may not	**70.**	visible radiations
71.	atm sec^{-1}	**72.**	k_{308}/k_{298}	**73.**	k
74.	cannot	**75.**	three	**76.**	$-\Delta[B]/\Delta t$
77.	At $T \longrightarrow \infty$	**78.**	dark	**79.**	1/2
80.	geometrical isomerisation	**81.**	$\ln \frac{k_2}{k_1}$		

True/False.

82.	T	**83.**	F	**84.**	F	**85.**	T	**86.**	F	**87.**	F
88.	T	**89.**	F	**90.**	F	**91.**	T	**92.**	T	**93.**	F
94.	T	**95.**	F	**96.**	T						

Exercise - 07

1.	B	2.	C	**3.**	D	**4.**	C	**5.**	A	**6.**	A
7.	A	**8.**	D	**9.**	A	**10.**	C	**11.**	A	**12.**	B
13.	C	**14.**	C	**15.**	D	**16.**	B	**17.**	C	**18.**	D

19. D

Exercise - 08

1. B	**2.** T	**3.** F	
4. concentration of reactants	**5.** acidic, I	**6.** D	**7.** D
8. Mn^{+2} ions	**9.** B	**10.** F	**11.** D
12. C	**13.** B	**14.** A	**15.** A
16. B	**17.** C	**18.** C	**19.** A
20. A, D	**21.** A	**22.** D	**23.** B
24. A	**25.** C	**26.** C	**27.** D
28. D	**29.** A	**30.** D	

[Radioactivity IIT-JEE]

1. B	**2.** A	**3.** D	**4.** D	**5.** D	**6.** B	**7.** $_{83}Pb^{206}$
8. (i) 6 $_{0}n^{1}$ (ii) $_{36}Kr^{86}$		**9.** C	**10.** C	**11.** B	**12.** C	**13.** B

Exercise - 09

1. **(a)** Rate = $k[A]^1[B]^2$ **(b)** k = 0.1 $lit^2 mol^{-2} min^{-1}$

2. 5.25% , 128.33 hr **3.** 398.78 min

4. **(a)** $K_1 = 2.31\times10^{-2}$ min^{-1}, k_2 = 6.93 10^{-2} min^{-1} **(b)** E_a = 43.85 kJ mol^{-1}
(c) 93.85 kJ mol^{-1}

5. **(a)** K = 6.23×10^{-3} sec^{-1} **(b)** P = 0.033 atm

6. T = 311.35 K **7.** **(a)** = I order **(b)** k = 1.308×10^{-2} min^{-1} (c) 73%

8. k = 5.206×10^{-3} min^{-1} **9.** $\left[\frac{dx}{dt} = k[B_2]^1\right]$ **10.** K_{II} at 300 K = 0.0327 min^{-1}

11. Rate = 2×10^{-4} mol dm^{-3} min^{-1}; x = 18.12%
12. % decomposition = 67.21%

13. **(a)** order wrt NO = 2, Cl_2 =1 **(b)** r = $k[Cl_2]^1[NO_2]^2$
(c) k = 8 $lit^2 mol^{-2} sec^{-1}$ **(d)** r = 0.256 mol $lit^{-1} sec^{-1}$

14. **(a)** Rate = 1×10^{-2} mol lit^{-1} sec^{-1} **(b)** rate after 1 min = 5.49×10^{-3} mol $lit^{-1} sec^{-1}$

15. total pressure = 0.75 atm **16.** **(i)** $t_{99\%}$ = 13.95 hour **(ii)** 2.217 litre

17. **(i)** n = 2 **(ii)** K = 1.2 mol lit^{-1} **(iii)** initial rate of conversion of A = 0.1 mol lit^{-1} $hour^{-1}$

18. **(i)** order w.r.t A = 2; B = 1 **(ii)** K = 2.66×10^8 $lit^2 mol^{-2} sec^{-1}$
(iii) E_a = 55.44 kJ/mol **(iv)** A = 1.140×10^{18}

19. t = 20.39 min
20. **(a)** order with r.t. A = 2, B = 0 **(b)** k = 4×10^{-2} lit $mol^{-1} sec^{-1}$
(c) rate = 16×10^{-4} mol $lit^{-1} sec^{-1}$

21. $\Delta E = 18.33$ Kcal mol^{-1}; $k = 9.22 \times 10^{-4}$ sec^{-1}

22. (a) $E_a = 24.83$ kcal mol^{-1} **(b)** $K = 2.35 \times 10^{-5}$ sec^{-1} **(c)** $T = 513$ K

23. $E_a = 2.2 \times 10^4$ J mol^{-1} ; $A = 5.42 \times 10^{10}$

24. $K = 3.4354 \times 10^{-3}$

25. $E_a = 100$ kJ mol^{-1}

26. (a) (i) O.R. = I order **(ii)** $K = 0.069$ hr^{-1} **(b)** $t_{1/2} = 24.06$ min

27. order = 1 $k = 2.30 \times 10^{-2}$ sec^{-1}

28. 1.005×10^{-4} min^{-1}

29. (a) $r = k[A][B]^\circ$ **(b)** $k = 5 \times 10^{-1}$sec^{-1}

30. (i) 1, **(ii)** 6.93×10^{-3} min^{-1}, **(iii)** 200 min, **(iv)** 950 mm Hg

[Radioactivity IIT-JEE]

1. 0.2243 g

2. $t_{1/2} = 6.13$ min

3. 7α, 6β

4. 16800 mL He

5. 1.93×10^{21} atoms

6. $t_{1/2} = 1.58$ YEARS

7. 3.56×10^{-16} g

8. 7.1×10^8 year

9. 31.25 cm^3, 27.104 cm^3

10. 4.89×10^9 year

11. 5.624×10^5 atoms

12. (a) $V = 5.95 \times 10^3$ mL **(b)** 0.2118 dps per mL

13. 6.1×10^{-7} g

14. $t = 4.5 \times 10^9$ year

15. 6.30×10^{-4} yr^{-1} , 3.087×10^{-2} yr^{-1}

16. 6.3×10^6 m sec^{-1}

17. $[\,^{14}_{7}N + \,^{4}_{2}He$ (α-particle) $\rightarrow \,^{17}_{8}O + \,^{1}_{1}H\,]$

18. $\alpha = 8$, $\beta = 6$

19. $t = 1.143 \times 10^9$ year

20. $t_{1/2}$ for β^- emission = 33.70 hr**;** $t_{1/2}$ for β^+ emission = 67.41 hr **;** $t_{1/2}$ for electron capture = 29.78 hr