TEST

JEE Mains PYQs Nuclei (Physics Master Academy)

QUESTIONS

SECTIONS

1. Section A - 25 Questions

## Section 1 : Section A - 25 Questions

SECTION INSTRUCTIONS

This section contaisn 25 MCQs, +4 for every correct answer, -1 for every incorrect answer.

**1** The radius R of a nucleus of mass number A can be estimated by the formula $R = (1.3\times10^{-15})A^{1/3}$ m. It follows that the mass density of a nucleus is of the order of ($M_{prot} = M_{neut} = 1.67\times 10^{-27}$kg)

- $10^{3}$kgm$^{-3}$
- $10^{10}$kgm$^{-3}$
- $10^{24}$kgm$^{-3}$
- $10^{17}$kgm$^{-3}$

Correct: +4 · Incorrect: -1

**2** The ratio of mass densities of nuclei $^{40}$Ca and $^{16}$O is close to

- 1
- 0.1
- 5
- 2

Correct: +4 · Incorrect: -1

**3** From the given data the amount of energy required to break the nucleus of aluminium $^{27}_{13}$Al ti s___x × $10^{-3}$J. Mass of neutron = 1.00866u.

- 25.60
- 27.16
- 27.0
- 28.34

Correct: +4 · Incorrect: -1

**4** Given the masses of various atomic particles $m_p$ = 1.0072u, $m_n$ = 1.0087u$_s$$m_e$ = 0.000548u, $m_{\bar{\nu}}$ = 0, $m_d$ = 2.0141u where p = proton, n – neutron, e = electron, $\bar{\nu}$ = antineutrino and d = deuteron. Which of the following processes is allowed by momentum and energy conservation?

- n + n → deuterium atom (electron bound to the nucleus)
- $p \rightarrow n + e^+ + \bar{\nu}$
- $n + p \rightarrow d + \gamma$
- $e^+ + e^{-1} \rightarrow \gamma$

Correct: +4 · Incorrect: -1

**5** Find the binding energy per nucleon for $^{120}_{50}Sn$. Mass of proton $m_p$ = 1.00783U, mass of neutron, $m_n$ = 1.00867 U and mass of tin nucleus, $m_{Sn}$ = 119.902199U. (take 1U = 931MeV)

- 7.5MeV
- 9.0MeV
- 8.0MeV
- 8.5MeV

Correct: +4 · Incorrect: -1

**6** In a reactor, 2kg of $_{92}U^{235}$ fuel is fully used up in 30 days. The energy released per kssion ins 200MeV. Given that the Avogadro number, N = $6.023\times10^{26}$ per kilo mole and 1eV = $1.6\times10^{-19}$J. The power output of the reactor is close to

- 35MW
- 60MW

- 125MW
- 54MW

Correct: +4 · Incorrect: -1

**7** Consider the nuclear kssion: $Ne^{20}$ $\rightarrow$ $2He^4 + C^{12}$

Given that the binding energy/nucleon of $Ne^{20}$, $He^4$ and $C^{12}$ are respectively 8.03MeV, 7.07 MEv and 7.86 MEV. Identify the correct statement

- energy of 12.4MeV will be supplied
- 8.3MeV energy will be released
- energy of 3.6MeV will be released
- energy of 11.9MeV has to be supplied

Correct: +4 · Incorrect: -1

**8** Statement 1: Energy is released when heavy nuclei undergo kssion of light nuclei undergo kssion and
Statement 2: For heavy nuclei, binding energy per nucleon increases with increasing Z while for light nuclei it decreases with increasing Z.

- Statement 1 is false, Statement 2 is true
- Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1
- Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1
- Statement 1 is true, Statement 2 is false

Correct: +4 · Incorrect: -1

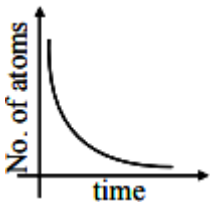
**9** The half life period of element x is same as the mean life time of another radioactive radioactive element y. Initially they have the same number of atoms. Then

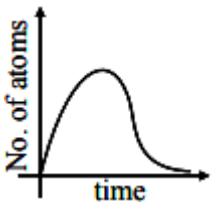
- x will decay faster than y
- y will decay faster than x
- x an y will decay rate initially and later n different decay rate
- x and y decay at same rte always

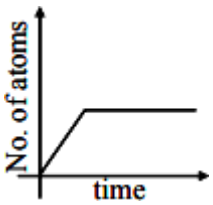
Correct: +4 · Incorrect: -1

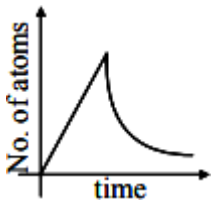
**10** A sample of a radioactive nucleus A disintegrates to another radioactive nucleus B, which in turn disintegrates to some other stable nucleus C. Plot of a graph showing the variation of number of atoms of nucleus B verses time is (Assume that at t = 0 there are not B atoms in

the sample)




Correct: +4 · Incorrect: -1

**11** There are $10^{10}$ radioactive nuclei in a given radioactive element, its half life is 1 minute. How many nuclei will remain after 30 seconds? ( $\sqrt{2} = 1.414$)

- $2\times10^{10}$
- $7\times10^{9}$
- $10^{5}$
- $4\times10^{10}$

Correct: +4 · Incorrect: -1

**12** A radioactive sample ha an average life of 30 ms and is decaying. A capacitor200mF is krst charged and later connected with resistor 'R'. If the ratio of charge on capacitor to the activity of radioactive sample is kxed with respect to time then the value of 'R' should be___Ω.

- ○ 100
- ○ 125
- ○ 150
- ○ 135

Correct: +4 · Incorrect: -1

**13** A radioactive sample is undergoing $\alpha$ decay. At any time $t_1$, its activity is A and another time $t_2$, the activity is A/5. What is the average life time of the sample?

- ○ $\frac{t_2-t_1}{ln5}$
- ○ $ln¿¿¿$
- ○ $\frac{ln5}{t_2-t_1}$
- ○ $\frac{t_1-t_2}{ln5}$

Correct: +4 · Incorrect: -1

**14** Two radioactive substances X and Y originally have $N_1$ and $N_2$nuclei respectively. Half life of X is half of the half life of Y. After three half lives of Y, the number of nuclei of both are equal. The ratio $N_1/N_2$ will equal to

- ○ 1/3
- ○ 8/1
- ○ 1/8
- ○ 3/1

Correct: +4 · Incorrect: -1

**15** Two radioactive materials A and B have decay constants $10\lambda$ and $\lambda$, respectively. If initially they have the same number of nuclei, then the ratio of the number of nuclei of A to that of B will be 1/e after a time:

- ○ $\frac{1}{9\lambda}$
- ○ $\frac{1}{11\lambda}$

- $\frac{11}{10\lambda}$
- $\frac{1}{10\lambda}$

Correct: +4 · Incorrect: -1

**16** In a radioactive decay chain, the initial nucleus is $^{232}_{90}$Th. At the end there are 6 $\alpha$-particles and 4$\beta$-particles, which are emitted. If the end nucleus is $^{A}_{Z}$X, A and Z are given by

- A = 208; Z = 80
- A = 202; Z = 80
- A = 208; Z = 82
- A = 200; Z = 81

Correct: +4 · Incorrect: -1

**17** Using a nuclear counter the count rate of emitted particles from a radioactive source is measured. At particles from a radioactive source is measured. At t = 0 it was 1600 counts per second and t = 8 seconds it was 100 counts per second. The count rate observed, as counts per second at t = 6 seconds is close to

- 200
- 150
- 400
- 360

Correct: +4 · Incorrect: -1

**18** A sample of radioactive material A, that has an activity of 10mnCi(1Ci = $3.7\times10^{10}$ decays/s), has twice the number of nuclei as another sample of a different radioactive material B which has an activity of 20mCi. The correct choices for half lives of A and B would be then

- 5 days and 10 days
- 10 days and 40 days
- 20 days and 5 days
- 20 days and 10 days

Correct: +4 · Incorrect: -1

**19** At a given instant say t = 0, two radioactive substances A and B have equal activities. The ratio $R_B/R_A$ of their activities after time t itself decays with time t as $e^{-3t}$. If the half life of A is ln 2, the half life of B is

- 4ln 2
- ln2/ 2
- ln2/ 4
- 2ln 2

Correct: +4 · Incorrect: -1

**20** A solution containing active cobalt $^{60}_{27}Co$ having activity of 0.8μC and decay constant λ is injected in an animal's body. If 1$cm^3$ of blood is drawn from the animal's body after 10 hrs of injection, the activity is found was 300 decays per minute. What is the volume of blood that is flowing in the body? (1Ci = $3.7\times10^{10}$decay per second and at t= 10 hrs $e^{-\lambda t}$ = 0.84)

- 6 litres
- 7 litres
- 4 litres
- 5 litres

Correct: +4 · Incorrect: -1

**21** A radioactive nucleus A with half life T, decays into a nucleus B. At t = 0, there is not nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then t is given by

- $t = T \log(1.3)$
- $t = \frac{T}{\log(1.3)}$
- $t = T\frac{\log 2}{\log 1.3}$
- $t = \frac{\log 1.3}{\log 2}$

Correct: +4 · Incorrect: -1

**22** Let $N_\beta$ be the number of β particles emitted by 1 gram of $Na^{24}$ radioactive nuclei (half life = 15 hrs) in 7.5 hours. $N_\beta$ is close to (Avogadro number = $6.023\times10^{23}$/g.mole)

- $6.2\times10^{21}$

- $7.5\times10^{21}$
- $1.25\times10^{22}$
- $1.75\times10^{22}$

Correct: +4 · Incorrect: -1

**23** The half life of a radioactive element A is the same as the mean life of another radioactive element B. Initially both substances have the same number of atoms, then

- A and B decay at the same rate always
- A and B decay at the same rate initially
- A will decay at a faster rate than B
- B will decay at a faster rate than A

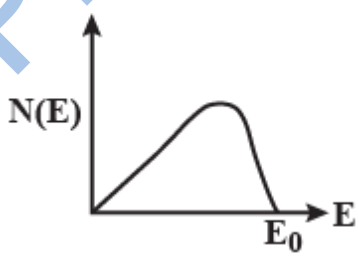
Correct: +4 · Incorrect: -1

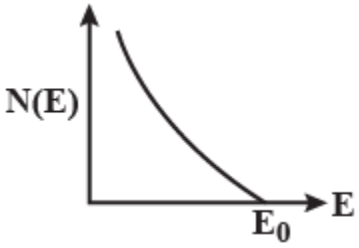
**24** A radioactive nucleus (initial mass number A and atomic number Z emits 3 $\alpha$-particles and 2 positrons. The ratio of number of neutrons to that of protons in the knal nucleus will be

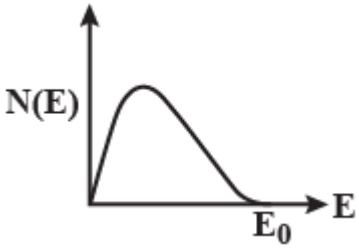
- $\frac{A-Z-8}{Z-4}$
- $\frac{A-Z-4}{Z-8}$
- $\frac{A-Z-12}{Z-4}$
- $\frac{A-Z-4}{Z-2}$

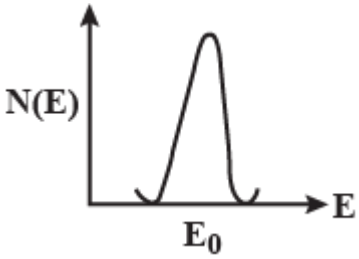
Correct: +4 · Incorrect: -1

**25** The energy of spectrum of $\beta$-particles (number N(E) as a function of $\beta$-energy E] emitted from a radioactive source



○ 


○ 


○ 


Correct: +4 · Incorrect: -1

TEST

JEE Mains PYQs Nuclei (Physics Master Academy)

ANSWERS

SECTIONS

1. Section A - 25 Questions

## Section 1 : Section A - 25 Questions

**1** $10^{17}kgm^{-3}$

**2** 1

**3** 27.16

**4** $n + p \rightarrow d + \gamma$

**5** 8.5MeV

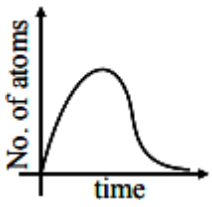
**6** 60MW

**7** energy of 11.9MeV has to be supplied

**8** Statement 1 is true, Statement 2 is false

**9** y will decay faster than x

**10**



**11** $7\times10^{9}$

**12** 150

**13** $\frac{t_2-t_1}{ln5}$

**14** 8/1

**15** $\frac{1}{9\lambda}$

**16** A = 208; Z = 82

**17** 200

**18** 20 days and 5 days

**19** ln2/ 4

**20** 5 litres

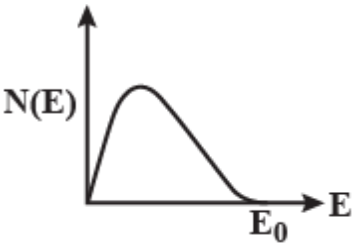
**21** $t=\frac{\log 1.3}{\log 2}$

**22** $7.5\times10^{21}$

**23** B will decay at a faster rate than A

**24** $\frac{A-Z-4}{Z-8}$

**25**




**25** The range of energy of β-particles is from zero to some maximum value.