



Nuclear Physics

Radio Activity:

The Phenomenon of nuclear decay of certain elements with the emission of radiations like alpha, beta, and gamma rays is called radioactivity and the elements which undergo this phenomenon are called radioactive elements.

Why?

The nucleus of some elements is unstable. Such nuclei undergo nuclear decay and get converted into more stable nuclei.

Natural Radioactivity:

The phenomenon of spontaneous emission of radiation from certain elements on their own is called natural radio activity.

Example: Uranium, Radium [Atomic Number > 82]

Technetium, Promethium [Atomic Number < 82]

43

61

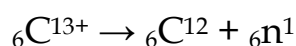
There have been 29 radioactive substance discovered so far.

Artificial (or) Induced Radioactivity:

The Phenomenon by which even light elements are made radioactive, by artificial or induced methods is called artificial radioactivity.

In 1934 Irene Curie and F. Joliot discovered this kind of radioactivity.

Example:



${}_{4}\text{Be}^9 \rightarrow$ Parent Nucleus

${}_{2}\text{He}^+ \rightarrow$ alpha (Projectile) Particle

${}_{6}\text{C}^{12} \rightarrow$ Daughter Nucleus

${}_{0}\text{n}^1 \rightarrow$ Ejected Particle

Units of Radioactivity:

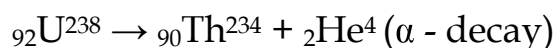
Curie : 1 Curie = 3.7×10^{10} disintegrations per second

Rutherford: 1 Rd = 10^6 disintegrations Per second.

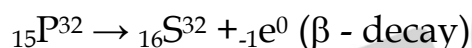
Becquerel: SI unit, quantity of one disintegration per second.

Roentgen (R): It is defined as the quantity of radio active substance which produces a charge of 2.58×10^{-4} C in 1 kg of air.

Alpha decay:



Beta decay:



Gamma decay:

In this decay only the energy level of the nucleus changes. Atomic number and mass number remains the same.

Nuclear Fission:

The process of breaking up of a heavier nucleus into two smaller nuclei with the release of a large amount of energy and a few neutrons is called 'nuclear fission'.



The average energy released in each fission process is about 3.2×10^{-11} J.

Fissionable Materials:

A Fissionable material is a radio active element, which undergoes fission in a sustained manner when it absorbs a neutron. It is also termed as 'fissile material'.

eg: U^{235} , Plutonium (Pu^{239} and Pu^{241})

Fertile Material: There are some radioactive elements, which can be converted into fissionable material. They are called as fertile material.

eg: U^{238} , Thorium - 232, Plutonium - 240

Chain Reaction:-

A chain reaction is a self-propagating Process in which the number of neutrons goes on multiplying rapidly almost in geometric progression.

- i) Controlled chain reaction (Neutron absorber)
- ii) Uncontrolled chain reaction (Atom Bomb)

Critical Mass:

The minimum mass of a fissile material necessary to sustain the chain reaction is called critical mass. It depends upon the nature, density and size of the fissile material.

Mass of the fissile material < Critical mass (sub critical)

Mass of the fissile material > Critical mass (super critical)

1eV = 1.602×10^{-19} joule.

1 million electron volt = 1 Mew = 10^6 eV

The energy released in a nuclear fission process is about 200 MeV.

Nuclear Fusion:

The process in which two lighter nuclei combine to form a heavier nucleus is termed as nuclear fusion.

eg: ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^4 + Q$ (energy)

${}_1H^2$ - an isotope of hydrogen known as 'deuterium'.

The average energy released in each fusion reaction is about 3.84×10^{-12} J.

Mass Defect - Mass of the daughter nucleus is less than the sum of the masses of the two parent nuclei. This mass is converted into energy. This concept of mass-energy equivalence was proposed by Einstein in 1905.

$E = mc^2$ where C is the velocity of light.

Hiroshima Nuclear bomb – Little Boy (Uranium)

Nagasaki Nuclear bomb – Fat man (Plutonium)

Conditions necessary for Nuclear Fusion:-

- i) 10^7 to 10^9 k High temperature
- ii) High pressure to push the hydrogen nuclei closer to fuse with each other. Hence it is named as 'Thermonuclear reaction'.
- iii) The repulsive force will be overcome by the kinetic energy of the nuclei at high temperature of the order of 10^7 to 10^9 K.

Stellar Energy:

The stars like our sun emit a large amount of energy in the form of light and heat. This energy is termed as the stellar energy. All stars contain a large amount of hydrogen.

Hydrogen Bomb : Atom Bomb + Nuclear Fusion.

Sun fuses about 620 million metric tons of hydrogen each second and radiates about 3.8×10^{26} joule of energy per second. When it reaches the earth its value is about 1.4 kilo joule per unit area in unit time.

Uses of Radio activity:

Agriculture: The radio isotope of phosphorus ($P-32$) helps to increase the productivity of crops

Medicine: Radio Sodium (Na^{24}) – used for effective functioning of heart.

Radio – Iodine (I^{131}) is used to cure goiter.

Radio – Iron (Fe^{59}) is used to diagnose anemia.

Radio Phosphorus (P^{32}) is used in the treatment of skin diseases.

Radio Cobalt (Co^{60})
Radio Gold (Au^{1987}) } Skin cancer

Industries: An isotope of californium (cf^{252}) is used in the airlines to detect the explosives in the luggage.

An isotope of Americium (Am^{241}) is used as smoke detector.

Archeological Research – Radio Carbon dating, age of earth, fossils, old paintings and monuments.



Previous Year Questions

1. Half-life of a radioactive substance with disintegration constant λ is
A. $0.6931/\lambda$ B. $0.6931 \times \lambda$ C. $\lambda / 0.6931$ D. $\lambda^2 / 0.6931$
சிதறல் மாறிலி கொண்ட ஒரு கதிர் வீச்சு பொருளின் அரை ஆயுட்காலம்
A. $0.6931 / \lambda$ B. $0.6931 \times \lambda$ C. $\lambda / 0.6931$ D. $\lambda^2 / 0.6931$

(Assistant Section Officer Translation (11.01.2020))

2. The Name of the launching vehicle used to launch Chandrayan-2 is
a. PSLV b. GSLV MKIII c. GSLV III d. PSLV-C45
சந்திராயன்-2 ஐ செலுத்த பயன்படுத்தப்பட்ட செலுத்து வாகனத்தின் பெயர்
a. PSLV b. GSLV MKIII c. GSLV III d. PSLV-C45

(Archaeological Officer in Archaeology Department in Tamil Nadu General Subordinate Exam 2020)

3. The control rods in a nuclear reactor
a. absorb neutrons b. accelerate neutrons
c. slowdown neutrons d. absorb excess heat produced in the reactor
அணுகரு உலையில் உள்ள கட்டுப்பாட்டு கோல்கள்
a. நியுட்ரான்களை உறிஞ்சும்
b. நியுட்ரான்களின் வேகத்தை அதிகரிக்கும்
c. நியுட்ரான்களின் வேகத்தை குறைக்கும்
d. உலையில் வெளியாகும் அதிக அளவு வெப்பத்தை உறிஞ்சும்

(Jailor in Tamilnadu Jail service Exam 2019)

4. The first ever satellite Sputnik 1 was launched in the year of
a. 1957 b. 1958 c. 1971 d. 1972
உலகின் முதல் செயற்கை கோள் ஸ்புட்னிக் 1 வின்னில் ஏவப்பட்ட ஆண்டு
a. 1957 b. 1958 c. 1971 d. 1972

(Assistant Training Officer in Tamilnadu and Training Subordinate service Exam 2019)

5. A projectile is fired at angle to the vertical with a small velocity its horizontal range will be maximum when the angle to the vertical is
a. 120° b. 90° c. 45° d. 30°

குறிப்பிட்ட, கோணத்தில் குறைந்த திசைவேகத்தில் எறிபொருள் செங்குத்தாக மேல் நோக்கி எறியப்படுகிறது. கிடைத்தள வீச்சு பெருமமாக இருக்க எறிய வேண்டிய கோணம் என்ன?

- a. 120° b. 90° c. 45° d. 30°

(Assistant Training Officer in Tamilnadu and Training Subordinate service Exam 2019)

6. Which one of the following is used as a fuel in nuclear power plants?
a. U^{235} b. PU^{238} c. Ba^{141} d. Ba^{140}
பின்வருவனவற்றில் எது அணு மின் உலைகளில் எரிபொருளாகப் பயன்படுகிறது?
a. U^{235} b. PU^{238} c. Ba^{141} d. Ba^{140}

(Assistant Training Officer in Tamilnadu and Training Subordinate service Exam 2019)

7. In which year India has signed in the Nuclear Test Bar Treaty (NTBT)?
a. 1st July 1968 b. 8th August 1963
c. 10th April 1970 d. 4th May 1975
அணு ஆயுதத் தடை ஒப்பந்தத்தில் இந்தியா கையெழுத்திட்ட ஆண்டு எது?
a. ஜூலை 1, 1968 b. ஆகஸ்ட் 8, 1963
c. ஏப்ரல் 10, 1970 d. மே 4, 1975

(Assistant Training Officer in Tamilnadu and Training Subordinate service Exam 2019)

8. When was the first Nuclear test conducted in India?
a. 1998 b. 1999 c. 1974 d. 1975
இந்தியாவில் எந்த ஆண்டு முதன் முறையாக அணு ஆயுத சோதனை நடத்தப்பட்டது?
a. 1998 b. 1999 c. 1974 d. 1975

(Jailor in Tamilnadu Jail service Exam 2019)

9. The atomic energy commission of India was formed in the year
a. 1947 b. 1948 c. 1949 d. 1950
இந்திய அணுசக்தி கழகம் உருவாக்கப்பட்ட ஆண்டு
a. 1947 b. 1948 c. 1949 d. 1950

(Assistant Tourist Officer Exam 2019)

10. Who was the first chairman of Atomic Energy Commission of India?
a. Vikram Sarabhai b. Homi J. Bhaba
c. Abdul Kalam d. Kasturi Rangan
இந்திய அணு சக்தி கழகத்தின் முதல் தலைவர் யார்?
a. விக்ரம் சாராபாய் b. ஹோமி J.பாபா
c. அப்துல் கலாம் d. கஸ்தூரி ரங்கன்

(Combine Engineering service Exam 2019)

11. The heaviest naturally occurring element is
a. Uranium b. Iron c. Aluminium d. Silicon
ஒரு கனமான, இயற்கையில் காணப்பெறும் உலோகம்
a. யுரேனியம் b. இரும்பு c. அலுமினியம் d. சிலிக்கான்

(Laboratory Assistant in Department of Fisheries Exam 2019)

12. In a reactor the moderator is
 a. Uranium 234 b. Uranium 238 c. Cadmium d. Heavy water
 அணுக்கரு உலையில் எது தணிப்பான்?
 a. யுரேனியம் 234 b. யுரேனியம் 238 c. காட்மியம் d. கடின நீர்
(Account Officer & Junior Chemistry, Exam 2019)
13. Fuel that is used in Jet air craft and stove
 a. Petrol b. Petroleum Gas c. Kerosene d. Diesel
 ஸ்டவ் மற்றும் ஜெட் ஏர் விமானத்தில் பயன்படுத்தும் எரிபொருள்
 a. பெட்ரோல் b. பெட்ரோலிய எரிவாயு c. மண்ணெண்ணெய் d. டீசல்
(Technical Assistant Handloom Exam 2019)
14. PSLVC 44 lifted off with microsat – R and Kalam sat on
 a. 24th January 2018 b. 24th January 2019
 c. 24th January 2017 d. 24th January 2016
 பி.எஸ்.எல்.வி.சி 44. மைக்ரோசாட் – R மற்றும் கலாம் சாட் விண்ணில் ஏவப்பட்ட நாள்
 a. 24 ஜனவரி 2018 b. 24 ஜனவரி 2019
 c. 24 ஜனவரி 2017 d. 24 ஜனவரி 2016
(Technical Assistant Handloom Exam 2019)
15. Nuclear Test Ban Treaty was signed in
 a. 1965 b. 1993 c. 1963 d. 1998
 அணு ஆயுத தடை ஒப்பந்தம் கையெழுத்தான ஆண்டு
 a. 1965 b. 1993 c. 1963 d. 1998
(Technical Assistant Handloom Exam 2019)