

1. Why is there a need for nuclear energy?

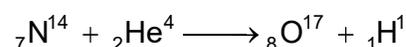
Traditionally used sources of energy like wood, coal and petroleum are not sufficient to meet the ever increasing demand for energy. We need to shift our dependence from non-renewable to renewable sources of energy. Hence there is a need for nuclear energy.

2. What are the changes that take place during radioactivity?

- a) Charged particles energy from neutral atoms.
- b) An atom gets transmuted into another atom with emission of charged particles.

3. Which was the first nuclear reaction achieved?

The first nuclear reaction was achieved by Ernest Rutherford.



4. What is the main advantage of nuclear reactions?

The main advantage of nuclear reaction is the production of radioactive and non-radioactive isotopes.

5. What is meant by artificial radioactivity?

The process of generating radioactive isotopes during nuclear reaction is called artificial radioactivity.

Ex: If aluminium atoms are hit by an alpha particle, we get phosphorous atom which is radioactive.

6. What is meant by transmutation?

The process of changing of one element into another element is called transmutation.

7. Mention the types of nuclear reactions.

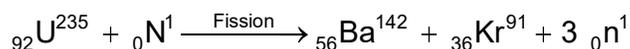
- a) Nuclear fission
- b) Nuclear fusion

8. What is meant by nuclear fission?

The process of splitting a heavy nucleus into two medium sized nuclei along with release of neutrons is called nuclear fission.

9. Explain nuclear fission with an example.

When uranium 235 atom is bombarded with a slow moving neutron, fission produced a barium atom, a krypton atom, 3 neutrons and a large amount of energy.



10. What is a chain reaction?

A chain reaction is the process in which number of neutrons keep on multiplying after each fission rapidly in geometric progression, till the whole of the fissionable material is disintegrated.

11. What is a controlled chain reaction?

A chain reaction in which the number of neutrons produced is kept constant is called controlled chain reaction.

12. How is controlled fission reaction achieved?

Nuclear fission reaction produces more than two neutrons. Excess of neutrons are absorbed so that the number of neutrons per fission is regulated to around one neutron per fission.

13. What is meant by enrichment of uranium?

The process of separating ${}_{92}\text{U}^{235}$ and ${}_{92}\text{U}^{238}$ isotopes is called enrichment of uranium.

14. What is the need for enrichment of uranium?

Naturally occurring uranium contains about 0.7% of ${}_{92}\text{U}^{235}$ isotope which is fissionable. Self sustained chain reaction are not possible in natural uranium which is not possible in natural uranium which is mostly made up of isotope ${}_{92}\text{U}^{238}$.

15. How is the Graham's law of diffusion useful in the enrichment of Uranium? Explain.

Graham's law states that the rate of diffusion of a gas is inversely proportional to the square root of its molecular mass. This principle is used to separate by passing gaseous uranium through several stages of semi-permeable membrane.

16. Explain Einstein's mass energy relation.

Albert Einstein derived an equation which is related to the mass transformed into energy and the amount of energy released.

The equation is $E = mc^2$ where

E is the energy released in joules,

M is the mass transformed in kg

C is the velocity of light ($3 \times 10^8 \text{ ms}^{-1}$)

17. Calculate the energy released when one a.m.u of mass is converted into energy.**18. State the unit of energy released.**

Joules or electron volt (ev) or million electron volt (Mev)

1 Mev = 1.6×10^{-13} joules

19. Define electron volt.

One electron volt is the energy gained by the electron when it is accelerated by applying a potential difference of one volt.

20. What is a nuclear reactor?

A nuclear reactor is a device used to carry out fission under controlled condition.

21. Mention the types of nuclear reactor.

- a) Breeder reactor [to produce radio isotopes]
- b) Power reactor [to generate electricity]
- c) Research reactor [to carry out research programmes related to atomic energy]

22. Explain the principle of a power reactor.

Nuclear reactor is a large reactor in which heat generated by nuclear fission is removed by water and the resulting steam is used to rotate turbine which is connected to a generator.

23. Name the parts of a nuclear power reactor.

- a) Nuclear fuel b) Control rods c) Moderator d) Reflector
- e) Coolant f) Radiation shield

24. Explain the following parts of a nuclear power reactor.

- a) Nuclear fuel: It is the fissionable material used in a reactor. It is in the form of rods placed in a regular array in a large container.
Ex: Enriched uranium 235, Plutonium
- b) Control rods: They are used to absorb the neutrons. Ex: Cadmium, Boron carbide.
- c) Moderator: They are used to slow down the neutrons emitted in the fission process.
Ex: Heavy water & graphite.
- d) Reflector: It is used to keep the neutrons confined to the core. Graphite or heavy water can be used as reflector.
- e) Coolant: It is used to continuously remove the heat released during the fission process. The heat is transferred to a heat exchanger.
Ex: Liquid sodium, hydrocarbons with high boiling point, heavy water.
- f) Radiation shield: It is used to protect the people in the vicinity of the reactor against the harmful effects of nuclear radiations. Ex: Lead
- g) Heat exchanger: It is used to transfer the heat energy of the coolant to convert water into steam.

25. What is heavy water? Write its chemical name.

Chemically heavy water is deuterium oxide (D_2O). It is used as a moderator to slowdown the fast neutrons released during fission or as a coolant to remove the heat generated.

26. When is a nuclear reactor said to be a) shut off b) critical?

A nuclear reactor is said to be shutoff when the control rods are inserted sufficiently deep into the core of the reactor.

A nuclear reactor is said to be critical when the number of fissions per unit time remains constant.

27. Draw a neat schematic diagram of a nuclear power reactor and label the parts.

28. Give reason:

a) Cadmium rods are used in nuclear reactor.

Cadmium is a neutron absorber. Hence they are used as control rods to absorb excess neutrons produced during fission reaction.

b) A nuclear reactor is enclosed in a concrete building with lead sheets covered inside.

To prevent radioactive radiations being released into the environment.

c) People working in a nuclear reactor wear lead jackets.

Lead can absorb radiations.

d) Moderators are not necessary in the IV generation nuclear wave reactors.

Slowing down of neutrons is not needed.

29. Write a note on atomic reactors in India.

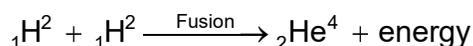
- Bhabha Atomic Research Centre [BARC] has been setup for research and development work in atomic energy.
- Tarapur [Maharashtra] atomic power station was the first to be setup in India [1969].
- Kota [Rajasthan]
- Kalpakam [Tamil Nadu]
- Kaiga [Karnataka]

30. What is meant by nuclear fusion?

The process by which two or more lighter nuclei combine to form a heavy nucleus with the liberation of large amounts of energy is called nuclear fusion.

31. Explain nuclear fusion with an example.

When deuterium [an isotope of hydrogen] combines with another deuterium nucleus it combines to form helium nucleus with release of energy.



32. What is meant by thermonuclear fusion reaction?

The reaction in which fusion of lighter nuclei into heavier nuclei takes place at very high temperatures is called thermonuclear fusion reaction.

Energy produced by stars and sun are due to thermonuclear fusion reactions.

33. Mention the differences between nuclear fission and nuclear fusion.

Nuclear Fission	Nuclear Fusion
1. A heavy nucleus splits into two lighter nuclei with liberation of energy	1. Two or more lighter nuclei fuse to form a heavy nucleus with liberation of energy.
2. It can be controlled.	2. At present there is no mechanism to control fusion reactions
3. It does not require high temperature.	3. It requires very high temperature (10^6K)
4. It causes radiation pollution due to radioactive products	4. It does not cause radiation pollution since the products are not radio active.
5. The energy produced is less than that of fusion.	5. The energy produced is much more than that of fission.

6. Uncontrolled fission results in an atom bomb.	6. Uncontrolled fusion results in hydrogen bomb.
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34. What are the hazards of nuclear materials?

- Ionising radiations like gamma rays can cause mutation in the living cells.
- It can cause DNA alterations.
- Certain types of cancer and hereditary disorder are caused by ionizing radiations.

35. Give reason: Radioactive material of longer half life is dangerous.

Since the radioactivity lasts longer.

36. Environmentalists oppose setting up nuclear power plants. List four arguments to support this.

- Fear of radioactive gases.
- Fear of destruction of large number of evergreen trees of Western Ghats.
- Health hazards of radioactive radiations.
- Nuclear wastes can cause soil pollution, water pollution.

37. How can nuclear wastes/ radioactive wastes disposed?

Radioactive matter is impregnated in glass slab and disposed in the deep sea in strong steel containers so that radiation cannot reach the level of biosphere.

38. Nuclear disarmament is a need in today's situation. Support this statement.

Production of dangerous weapons like atom bomb cause large scale destruction. Increased production of nuclear weapons has brought the world to the brink of a major war. Such weapons can also fall into hands of terrorists. Hence the need of today's world is nuclear disarmament.

39. Mention the differences between chemical reactions and nuclear reactions.

Chemical reactions	Nuclear reactions
1. Valence electrons of the atoms take part in the reaction	1. Electrons of an atom do not take part in nuclear reaction
2. Nucleus of an atom does not undergo any change	2. Nucleus of the atoms undergo a change
3. Products are predictable.	3. Products depend upon conditions
4. Mass conserved	4. A small amount of mass is converted into energy
5. Inter conversion of compounds to elements or elements to compounds take place	5. Production of new elements and isotopes take place.

Fill in the blanks:

1. Radioactivity is a **nuclear** phenomenon.
2. Nuclear reaction is a **chance** reaction.
3. The process of generating radioactive isotopes during nuclear reaction is called **artificial radioactivity**.
4. The process of splitting a heavy nucleus into two medium sized nuclei along with release of neutrons is called **nuclear fission**.
5. A chain reaction in which the number of neutrons produced is kept constant is called **controlled chain reaction**.
6. The principle of a nuclear reactor is **controlled chain reaction**.
7. Controlled chain reaction is the working principle of **nuclear reactor**.
8. The process of separating ${}_{92}\text{U}^{235}$ and ${}_{92}\text{U}^{238}$ is called **enrichment of uranium**.
9. The principle of enrichment of uranium is **Graham's law of diffusion**.
10. 1 a.m.u = **931** Mev.
11. Einstein's mass energy equation is **$E = mc^2$** .
12. The device used to carry out fission under controlled condition is called **nuclear reactor**.
13. Breeder reactor is used to produce radio isotopes.
14. Power reactor is used to generate electricity.
15. An example of nuclear fuel is **enriched uranium 235 / plutonium**.
16. An example of control rod is **cadmium / boron carbide**.
17. An example of moderator is **Heavy water / graphite**.
18. The chemical formula of heavy water is **D_2O** .
19. The ratio of number of ordinary water molecules to that of heavy water molecules is **1:6000**.
20. An example of coolant is liquid **sodium / hydrocarbon/ heavy water**.
21. The part of the nuclear reactor that controls the speed of neutrons released during nuclear fission is **moderator**.
22. The speed of neutrons in a nuclear reactor is reduced with the help of **graphite / heavy water**.
23. The metal cover used in the walls of nuclear reactor to prevent radioactive radiations being released to the environment is **lead**.
24. A nuclear reactor has to be shutdown, the rods used for this purpose is made of **cadmium / boron carbide**.
25. In modern reactors there is no need for **moderator**.
26. The first atomic power station in India was started at **Tarapur [Maharashtra]**.
27. India's uranium supply comes mainly from **Juduguda mines in Bihar**.
28. Fusion reactions which take place at very high temperature are called **thermonuclear fusion reactions**.