

# Advanced Nuclear Energy Science and Engineering

Nuclear Energy · Practice Test · 17 Questions

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**1. What is the primary mechanism by which neutrons are slowed down in a thermal nuclear reactor to achieve criticality?**

- A) Neutron scattering by heavy nuclei
- B) Neutron absorption and subsequent re-emission
- C) Elastic scattering with light nuclei (moderator)
- D) Neutron capture followed by alpha decay

**2. The concept of a "breeding ratio" in a nuclear reactor refers to the ratio of:**

- A) Fissile material produced to fissile material consumed
- B) Heat generated to electrical power output
- C) Neutrons absorbed by fuel to neutrons absorbed by control rods
- D) Radioactive waste generated to useful energy produced

**3. In the context of nuclear fuel, what is the significance of the "neutron multiplication factor" ( $k$ )?**

- A) It quantifies the rate of heat transfer from the fuel rods.
- B) It represents the ratio of neutrons produced in one generation to the neutrons lost in the previous generation.
- C) It measures the efficiency of control rod insertion for power regulation.
- D) It indicates the level of radioactivity in the spent fuel.

**4. Which of the following is a key characteristic of a Fast Breeder Reactor (FBR) compared to a Light Water Reactor (LWR)?**

- A) It uses heavy water as a moderator.
- B) It primarily uses thermal neutrons to sustain the chain reaction.
- C) It can produce more fissile material than it consumes.
- D) It operates at significantly lower temperatures.

**5. What is the primary reason for the use of zirconium alloys (like Zircaloy) as cladding material for nuclear fuel rods in most power reactors?**

- A) High neutron absorption cross-section
- B) Excellent thermal conductivity and resistance to high temperatures and neutron bombardment
- C) Low melting point for easy reprocessing
- D) High density to prevent radiation leakage

**6. The Curie (Ci) is a unit of radioactivity. What does it specifically measure?**

- A) The absorbed dose of radiation
- B) The number of disintegrations per second
- C) The energy imparted by ionizing radiation
- D) The biological effect of radiation exposure

**7. What phenomenon is responsible for the delayed neutrons emitted by certain fission products, which is crucial for reactor control?**

- A) Neutrino oscillations
- B) Beta decay of some fission fragments
- C) Spontaneous fission of heavy isotopes
- D) Gamma ray emission

**8. In nuclear reactor safety, what is the primary function of the containment building?**

- A) To house the turbines and generators
- B) To prevent the release of radioactive materials into the environment in case of an accident
- C) To absorb excess neutrons and control the reaction rate
- D) To cool the reactor core during normal operation

**9. Which of the following describes the process of "neutron activation analysis"?**

- A) Measuring the decay rate of fissile isotopes
- B) Inducing radioactivity in a sample by neutron bombardment to identify its elemental composition
- C) Calculating the critical mass of a nuclear material
- D) Tracking the movement of radioactive isotopes in the environment

**10. The "Samarium Effect" in nuclear reactors refers to:**

- A) The increase in reactivity due to the presence of samarium isotopes.
- B) The buildup of samarium-149, a strong neutron absorber, which reduces reactivity over time.
- C) The spontaneous emission of samarium isotopes during fission.
- D) The decay of samarium isotopes into more fissile materials.

**11. What is the primary advantage of using Thorium-232 as a potential nuclear fuel precursor over Uranium-238?**

- A) Thorium-232 is more readily fissionable by thermal neutrons.
- B) Thorium-232 has a higher natural abundance and produces less long-lived transuranic waste upon neutron capture and decay.
- C) Thorium-232 requires less moderator to achieve criticality.
- D) Thorium-232 has a significantly higher heat output per unit mass.

**12. In a Pressurized Water Reactor (PWR), what is the primary purpose of the pressurizer?**

- A) To control the flow rate of coolant through the core.
- B) To maintain a high pressure in the primary coolant loop to prevent boiling.
- C) To remove decay heat from the spent fuel.
- D) To generate steam for the turbines.

**13. Which nuclear reaction is the basis for nuclear fission in most power reactors?**

- A) Proton-proton chain reaction
- B) Deuterium-tritium fusion
- C) Neutron-induced fission of heavy isotopes like Uranium-235 or Plutonium-239
- D) Beta decay of radioactive elements

**14. The "burnup" of nuclear fuel is a measure of:**

- A) The rate at which fuel rods corrode.
- B) The amount of fission products that have accumulated within the fuel.
- C) The energy extracted from the fuel, typically expressed in megawatt-days per metric ton of heavy metal (MWd/tU).
- D) The temperature reached by the fuel during operation.

**15. What is the specific activity of a radioactive isotope?**

- A) The total number of atoms in a sample.
- B) The rate at which alpha particles are emitted.
- C) The number of radioactive decays per unit mass or volume per unit time.
- D) The half-life of the isotope.

**16. In the context of nuclear waste management, "vitrification" is a process used for:**

- A) Compacting low-level radioactive waste.
- B) Encasing high-level radioactive waste in a stable glass matrix.
- C) Incinerating radioactive organic materials.
- D) Diluting liquid radioactive waste.

**17. What is the main difference between a "chain reaction" and a "controlled chain reaction" in nuclear reactors?**

- A) A chain reaction involves only gamma rays, while a controlled chain reaction involves neutrons.
- B) A chain reaction is spontaneous and uncontrolled, while a controlled chain reaction maintains a stable neutron population for power generation.
- C) A chain reaction requires a moderator, while a controlled chain reaction does not.
- D) A chain reaction produces heat, while a controlled chain reaction produces electricity directly.