

Nuclear Energy

A photograph of a nuclear power plant with three large, white, conical cooling towers. Steam is rising from the towers. In the background, there is a large industrial building and a tall smokestack. The foreground is a grassy field. The sky is clear and blue.

The Source of Nuclear Energy

- Some elements undergo a nuclear reaction in which a heavy nucleus splits into two lighter nuclei **releasing neutrons** and a tremendous amount of energy.
- This nuclear reaction is called **fission**.
- Fission is started by the capture of a neutron fired at the nucleus of an unstable atom.
- The lighter elements that form from fission are more stable than the parent element.



Fissile Isotopes

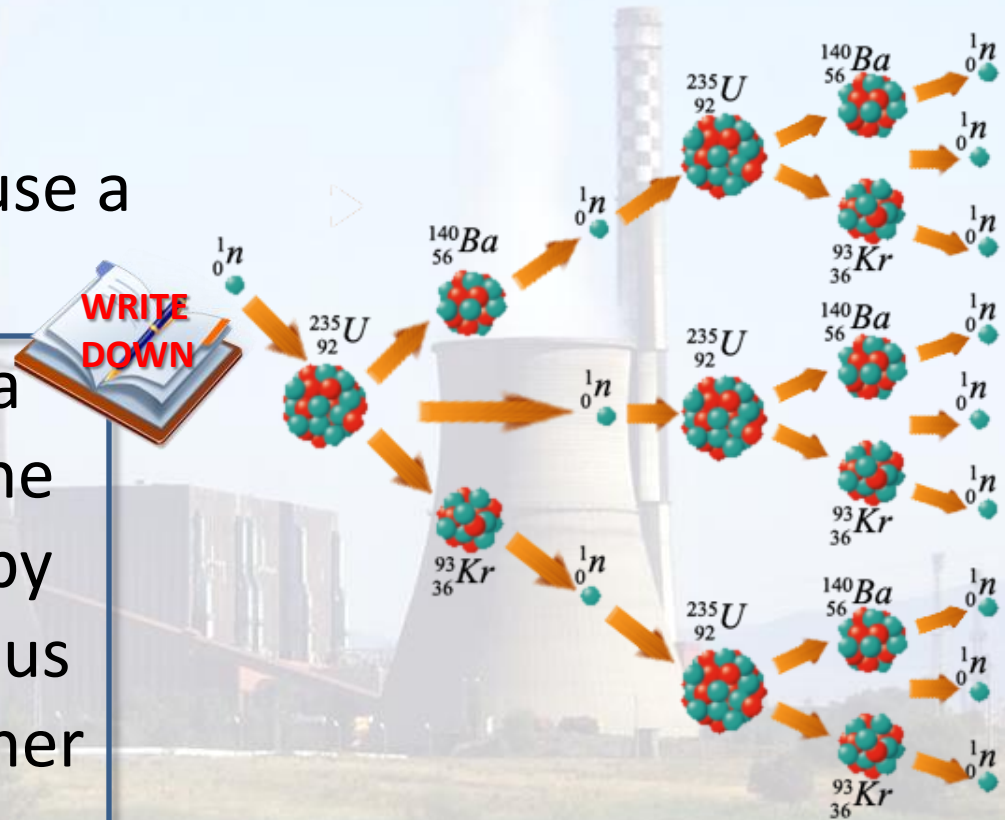
- Very few elements will actually undergo fission.
- Elements that do undergo fission include:
 - ^{235}U
 - ^{239}Pu
 - ^{232}Th
- Uranium-235 is the most common fissile fuel for nuclear reactors and atomic bombs.



Chain Reactions

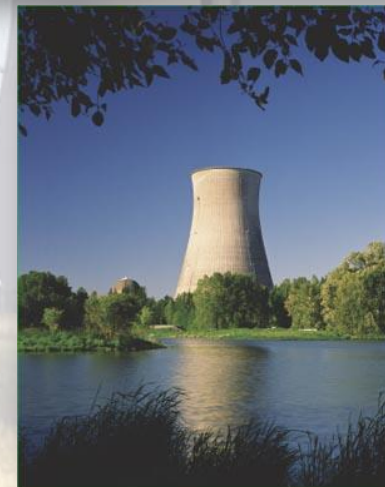
- Because fission of uranium releases neutrons, it can cause a chain reaction.

- A chain reaction is a reaction in which the neutrons released by fission of one nucleus trigger fission in other nuclei nearby.



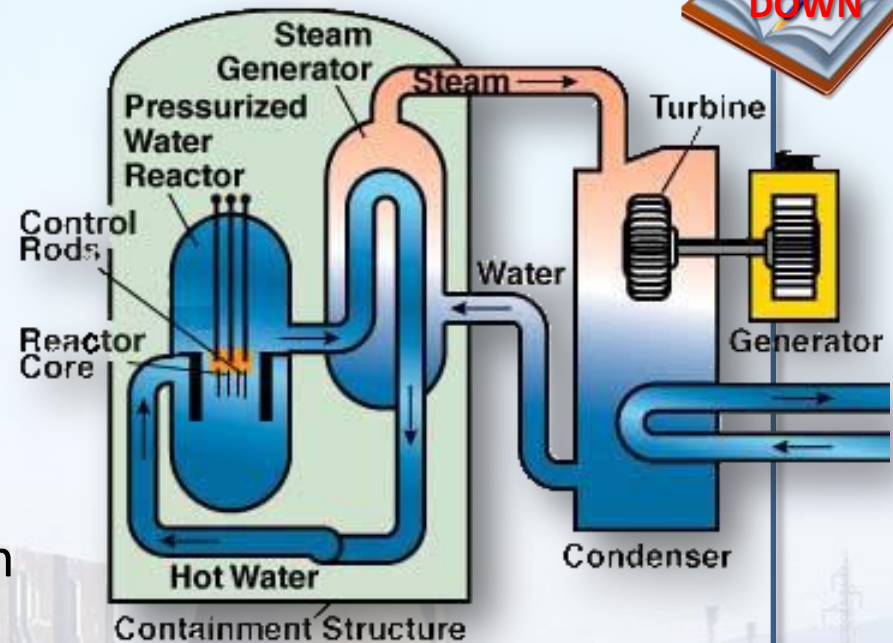
Importance of Uranium Fission

- An uncontrolled chain reaction results in a nuclear explosion (atomic bomb).
- A controlled chain reaction can be used as a source of energy (nuclear reactor).



A Nuclear Reactor

- A **nuclear reactor** is a device that converts nuclear energy into heat energy.
- Main Components
 - Fuel - usually U-235
 - Moderator - substance that slows neutrons down without absorbing them in order to increase the chance of collision between the neutrons and the U-235 nuclei
 - Coolant - keeps the system from overheating
 - Control Rods - boron or cadmium steel rods that absorb neutrons controlling the rate of fission (if the number of neutrons absorbed is greater than the number of neutrons released, fission stops)
 - Shielding - protection from radiation damage
 - Internal: core - Steel vessel 20 cm thick containing fuel
 - External - high density concrete



Nuclear Power Plants



Nuclear power plants generate electricity by energy transformations.

- Heat released by nuclear fission is used to heat water and produce steam.
- The steam pushes on the fan blades of a turbine causing it to spin.
- The spinning turbine spins a generator that transforms the kinetic energy into electrical energy.

Pros and Cons

- Nuclear energy produces no air pollution.
- Unfortunately, nuclear energy produces wastes that are radioactive.
- Radioactive wastes need to be stored underground in special containers. No solution to this problem has been found yet.



You Decide!!