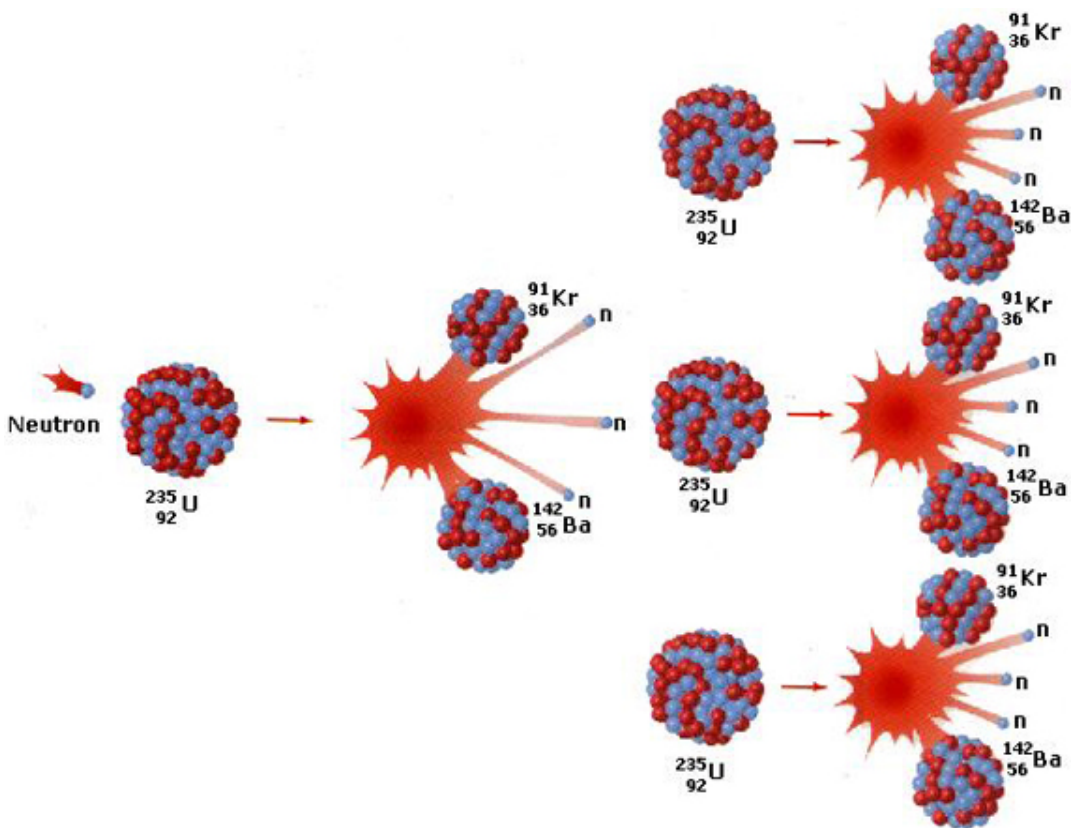


Fission, Fusion, Atomic and Hydrogen Bombs

Nuclear Fission:

nuclear fission is either a [nuclear reaction](#) or a [radioactive decay](#) process in which the [nucleus](#) of an atom splits into smaller parts (lighter [nuclei](#)).

The fission process often produces free [neutrons](#) and [gamma rays](#), and releases a very large amount of [energy](#)



The fission of U-235 into Kr-92 and Ba-141 releases three neutrons that in turn cause additional fissions, each releasing three new neutrons, and so the process continues. This is called a Fission Chain Reaction.

On August 2, 1939, just before the beginning of World War II [Albert Einstein](#) wrote to then President Franklin D. Roosevelt.

Einstein and several other scientists told Roosevelt of efforts in Nazi Germany to purify uranium-235, which could be used to build an atomic bomb.

It was shortly thereafter that the United States Government began the serious undertaking known then only as "The Manhattan Project."

Simply put, the Manhattan Project was committed to expediting research that would produce a viable atomic bomb.

Over the course of six years, from 1939 to 1945, more than \$2 billion was spent during the history of the Manhattan Project. The formulas for refining uranium and putting together a working atomic bomb were created and seen to their logical ends by some of the greatest minds of our time. Chief among the people who unleashed the power of the atom was [Robert Oppenheimer](#), who oversaw the project from conception to completion.

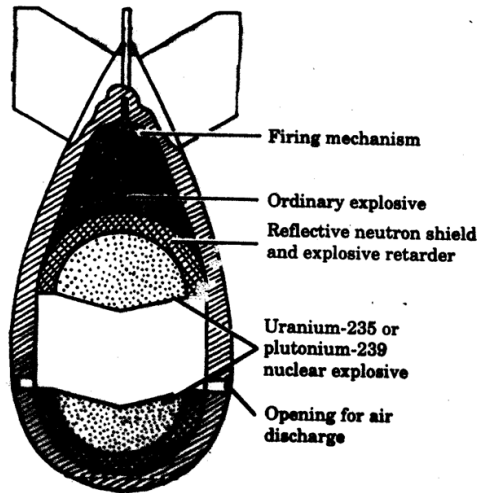
At 5:29 on July 16, 1945, in Los Alamos, "The Gadget" ushered in the Atomic Age. The [light of the explosion](#) then turned orange as the atomic fireball began shooting upwards at 360 feet per second, reddening and pulsing as it cooled. The characteristic mushroom cloud of radioactive vapor materialized at 30,000 feet. Beneath the cloud, all that remained of the soil at the blast site were fragments of jade green radioactive glass created by the heat of the reaction.

The brilliant light from the detonation pierced the early morning skies with such intensity that residents from a faraway neighboring community would swear that the sun came up twice that day. Even more astonishing is that a blind girl saw the flash 120 miles away.

Upon witnessing the explosion, its creators had mixed reactions. Isidor Rabi felt that the equilibrium in nature had been upset as if humankind had become a threat to the world it inhabited. Robert Oppenheimer, though ecstatic about the success of the project, quoted a remembered fragment from the Bhagavad Gita. "I am become Death," he said, "the destroyer of worlds."

Scientists Who Invented the Atomic Bomb under the Manhattan Project:
[Robert Oppenheimer](#), [David Bohm](#), [Leo Szilard](#), Eugene Wigner, Otto Frisch, Rudolf Peierls, Felix Bloch, [Niels Bohr](#), Emilio Segre, James Franck, [Enrico Fermi](#), [Klaus Fuchs](#) and [Edward Teller](#).

Atomic Bomb



The detonation of regular explosives propels two pieces of nuclear explosive material against each other. Their combined mass exceeds critical mass. Thus, simply forcing nuclear explosives together causes a nuclear explosion.

4 effects of atomic bomb explosion:

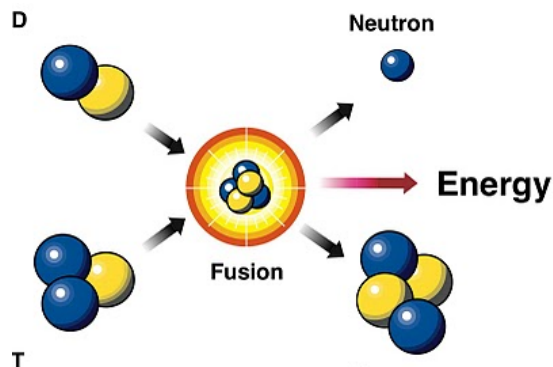
- direct radiation
- extremely high temperatures
- huge blast of air
- radioactive dust particles carried by air (radioactive fallout)

Facts to know about A-Bomb:

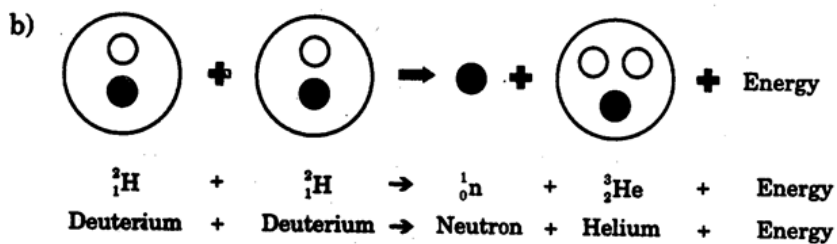
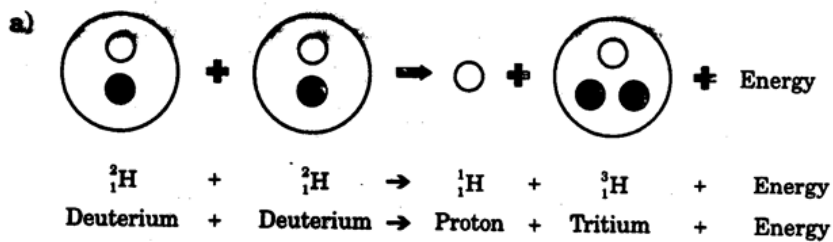
- It uses a chain reaction (at least one neutron released during a fission reaction is captured by another nucleus, which in turn undergoes fission and releases another neutron, etc.).
- It needs an easily fissionable isotope like U-235 or Pu-239
- Energy is released each time a neutron is released.
- Just the right amount of matter must be used for the reaction to be controlled (called critical mass). If too little mass is used then the reaction stops. If too much mass is used then the reaction goes out of control (i.e. explosion).
- In the A-bomb, two blocks of fissionable material are used (each with a mass less than critical mass).
- When the two blocks propel together their combined mass exceeds critical mass.
- Something like a dynamite explosion is used to propel the two blocks together.
- When the two blocks strike each other a chain reaction is triggered. The U or Pu nuclei begin to fission rapidly. The whole reaction takes less than a thousandth of a second.
- A-bombs were dropped on Hiroshima and Nagasaki (Japan) in 1945.

Nuclear Fusion:

nuclear fusion is a [nuclear reaction](#) in which two or more [atomic nuclei](#) collide at a very high speed and join to form a new type of atomic nucleus. Fusion generally occurs with very light elements only.



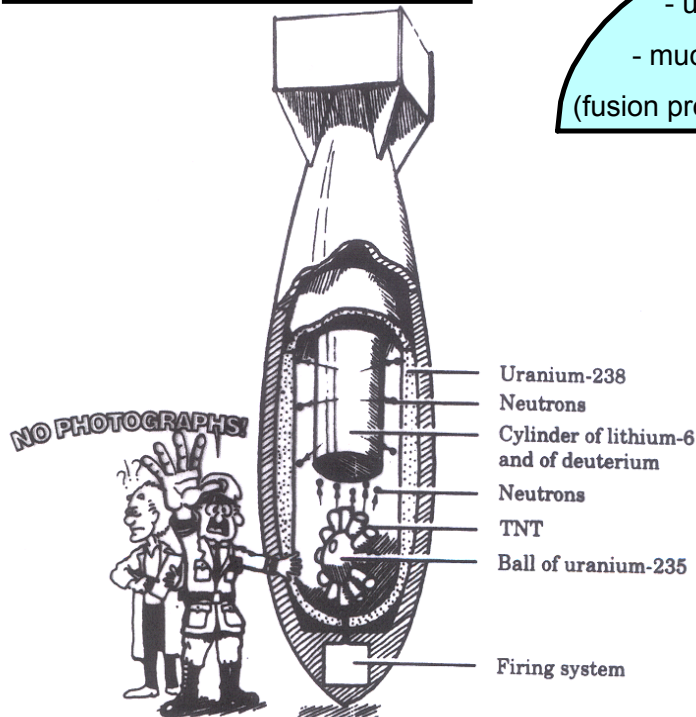
Nuclear Fusion



Legend: ○ protons ● neutrons

- a) Two deuterium nuclei combine to form a tritium nucleus, which is heavier and more rare than deuterium. This reaction releases a proton, namely an ordinary hydrogen nucleus.
- b) Two deuterium atoms combine to form a helium-3 nucleus. This reaction also releases a neutron.

Hydrogen Bomb



- developed in 1952
- uses FUSION rather than fission
- much more powerful than the A-bomb
(fusion produces 3.5x more energy than fission)

The H-bomb is called a thermonuclear bomb since it requires such high temperature for the fusion to occur.

Steps:

1. Detonation of TNT
2. U-235 and U-238 are propelled together and a fission chain reaction is started. Neutrons are released. This fission reaction generates enough heat that a temperature of around 100 million degrees C is achieved. This is the temperature needed for fusion to occur.
3. The neutrons released in step 2 collide with lithium isotopes to produce tritium.
4. The tritium formed in step 3 fuses with deuterium to form helium. Energy and neutrons are released.

Step 4 is the fusion reaction!

In theory, there is no limit to the explosive power of the H-bomb. The more fuel used, the bigger the explosion. (Unlike the A-bomb, since the explosive power of the A-bomb is limited due to critical mass. No more than double the critical mass can be used.)