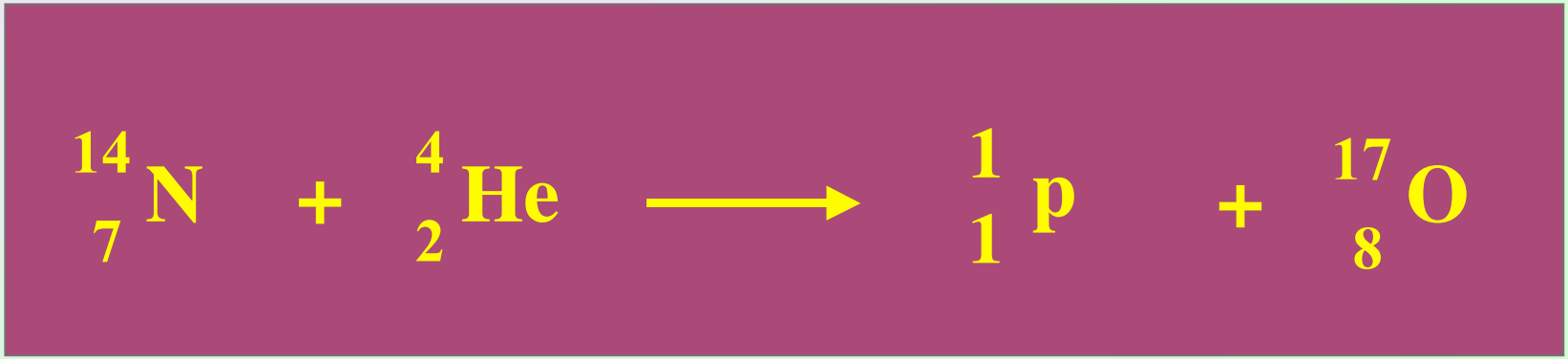
An experiment performed by Rutherford in 1919 produced artificial radioactivity

By bombarding a sample of nitrogen with α particles an oxygen-17 isotope was produced with the emission of a proton.

$$^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \longrightarrow {}^{1}_{1}\mathrm{p} + {}^{17}_{8}\mathrm{O}$$

Nuclear Transmutation

Converting one element into another element



balance the following nuclear equation

$^{56}_{26}Fe$ (d,a) $^{54}_{25}Mn$, where d represents the deuterium nucleus ($^{2}_{1}H$)

$$^{56}_{26}Fe + {}^{2}_{1}H \longrightarrow {}^{4}_{2}He + {}^{54}_{25}Mn$$

Transuranium Elements

Elements with atomic numbers greater than 92

made in particle accelerators

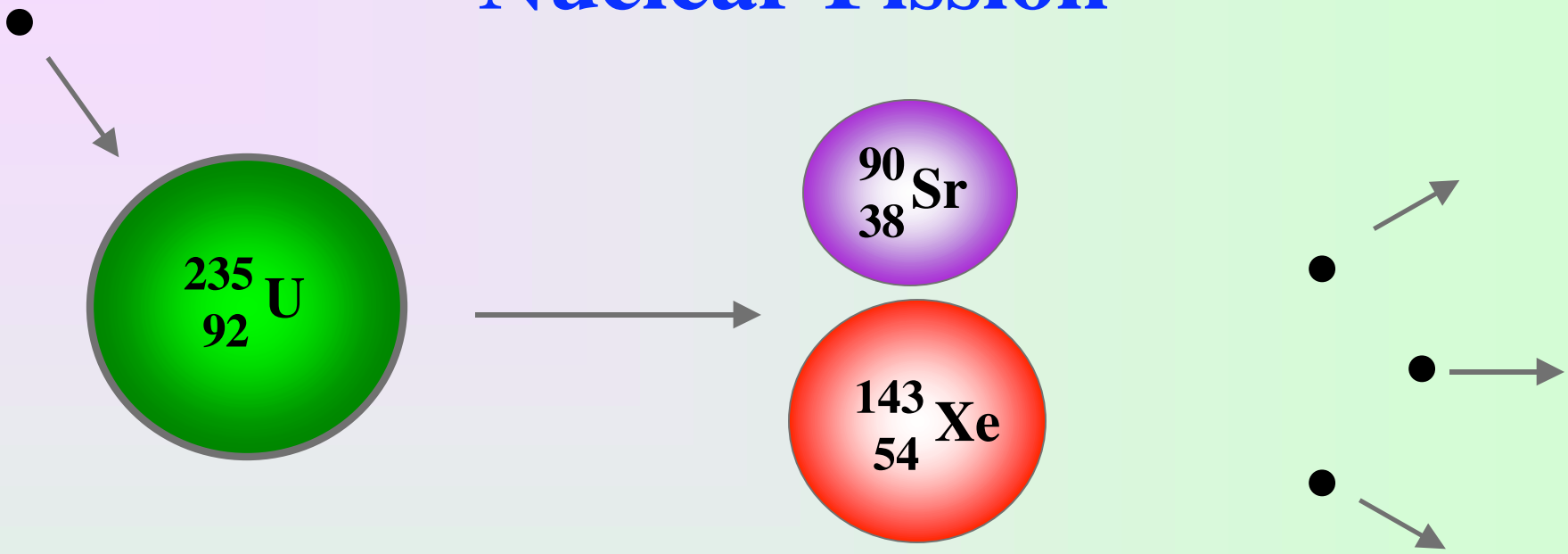
a device used to accelerate nuclear particles near the speed of light

Nuclear Fission

Nuclear Fission

process in which a heavy nucleus (mass number> 200) divides to form smaller nuclei of intermediate mass and one or more neutrons

Nuclear Fission



the U-235 nucleus captures a neutron

undergoes fission to yield two smaller nuclei

2.4 neutrons are emitted for every U-235 nucleus that divides

Although many heavy nuclei can be made to undergo fission only uranium-235 and plutonium-239 have any practical importance

Nuclear Fission

$$^{235}_{92}U + {}^{1}_{0}n \longrightarrow {}^{143}_{54}Xe + {}^{90}_{38}Sr + 3{}^{1}_{0}n$$

For one mole of uranium-235, the energy released is 2.0×10^{13} J

For one ton of coal, the energy released is only 8.0×10^{7} J

Chain Reaction

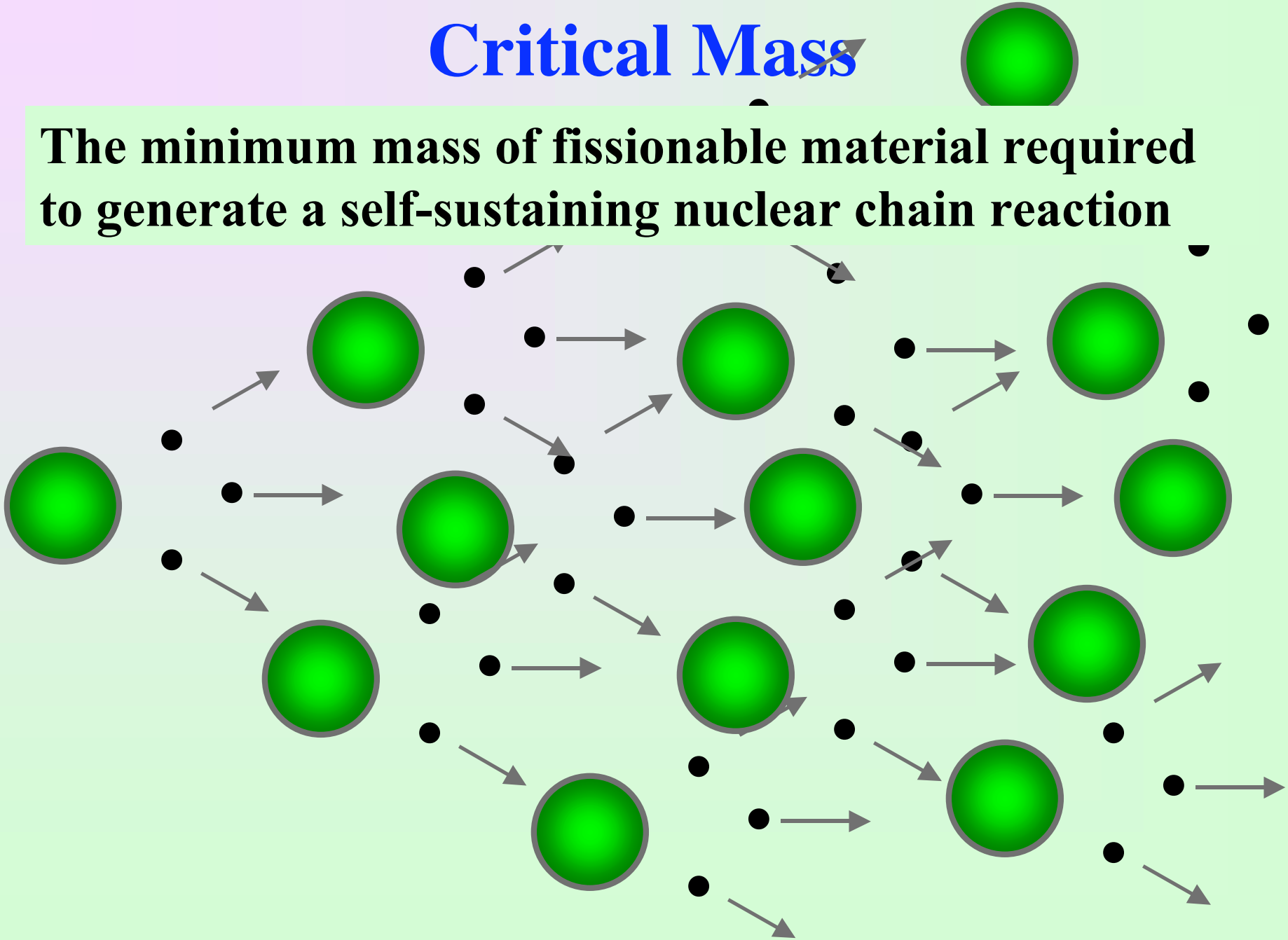
a self-sustaining sequence of nuclear fission reactions

$$^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \longrightarrow {}^{143}_{54}\mathrm{Xe} + {}^{90}_{38}\mathrm{Sr} + 3\,{}^{1}_{0}\mathrm{n}$$

the fact that more neutrons are produced then captured during uranium-235 fission makes a possible chain reaction possible

Critical Mass

The minimum mass of fissionable material required to generate a self-sustaining nuclear chain reaction

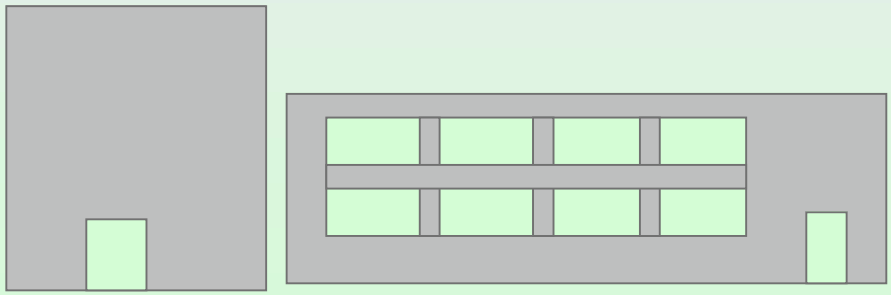


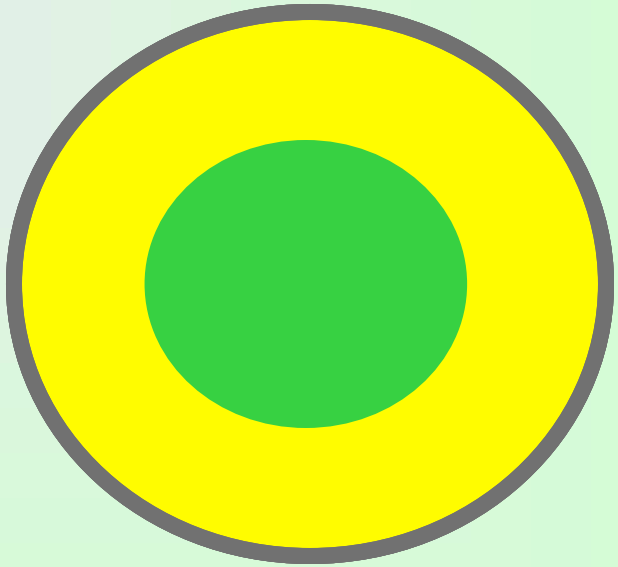
Atomic Bomb

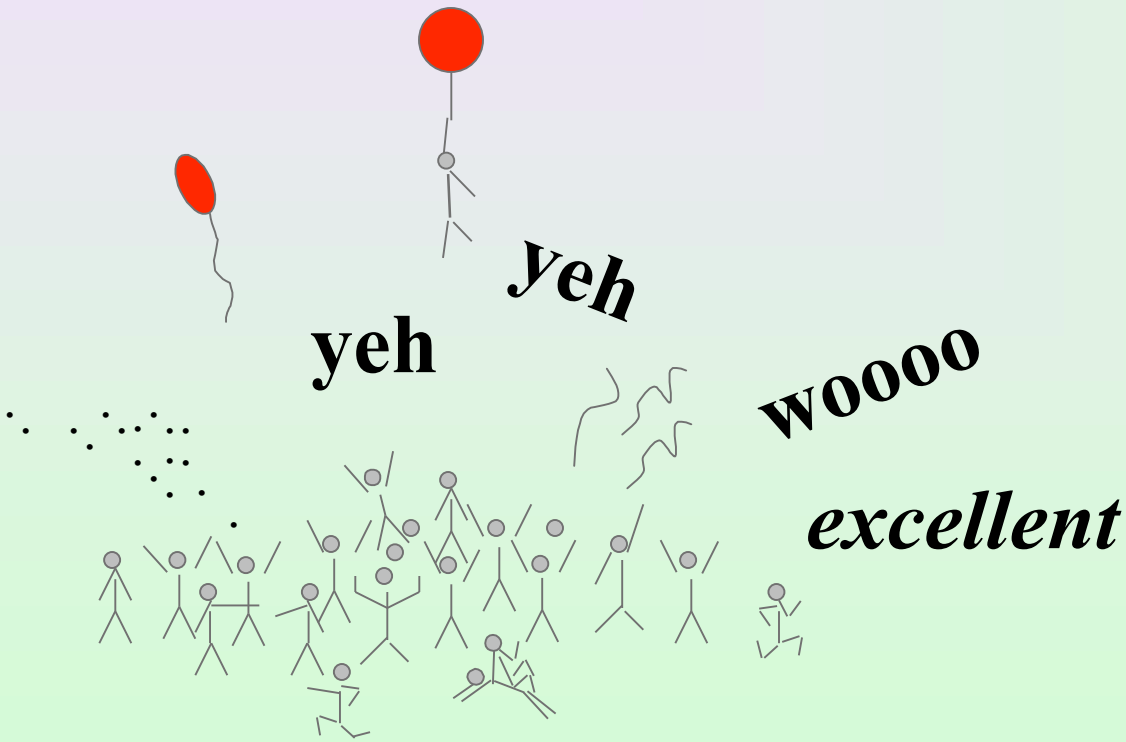
the first application of nuclear fission

critical mass is formed by using TNT to force the fissionable sections together

Lowell H.S.






yeh
yeh
woooo
excellent

Nuclear Fission Reactors

the generation of electricity using heat from a controlled chain reaction

Moderators : substances that can reduce the kinetic energy of neutrons

Nuclear Fusion

Nuclear Fusion

combining small nuclei into larger ones

Nuclear Fusion

$$^{1}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \longrightarrow {}^{3}_{2}\mathrm{He}$$

$$^{3}_{2}\mathrm{He} + {}^{3}_{2}\mathrm{He} \longrightarrow {}^{4}_{2}\mathrm{He} + 2\,{}^{1}_{1}\mathrm{H}$$

$$^{1}_{1}\mathrm{H} + {}^{1}_{1}\mathrm{H} \longrightarrow {}^{2}_{1}\mathrm{H} + {}^{0}_{+1}\square$$

Because fusion reactions take place at very high temperatures, they are often called *thermonuclear reactions.*

Mass and Energy

$$8\,{}^{1}_{1}\mathrm{H} + 8\,{}^{1}_{0}\mathrm{n} \longrightarrow {}^{16}_{8}\mathrm{O}$$

Mass of $8\,{}^{1}_{1}\mathrm{H} + 8\,{}^{1}_{0}\mathrm{n}$ = 2.67804×10^{-23} g

Mass of ${}^{16}_{8}\mathrm{O}$ = 2.65535×10^{-23} g

difference in mass = 2.269×10^{-25}

the difference in mass for the formation of one mole of ${}^{16}_{8}\mathrm{O}$ = -0.1366 g /mol

Mass Defect

when a system gains or loses energy, it also gains or loses a quantity of mass.

- equivalence of mass and energy
(derived from Einstein's theory of special relativity)

$$E = MC^2$$

energy — **mass** — **speed of light** 3.00×10^8 **m/s**