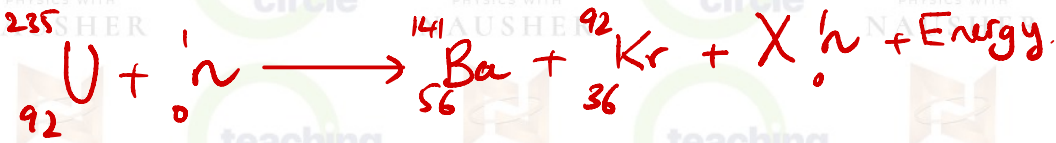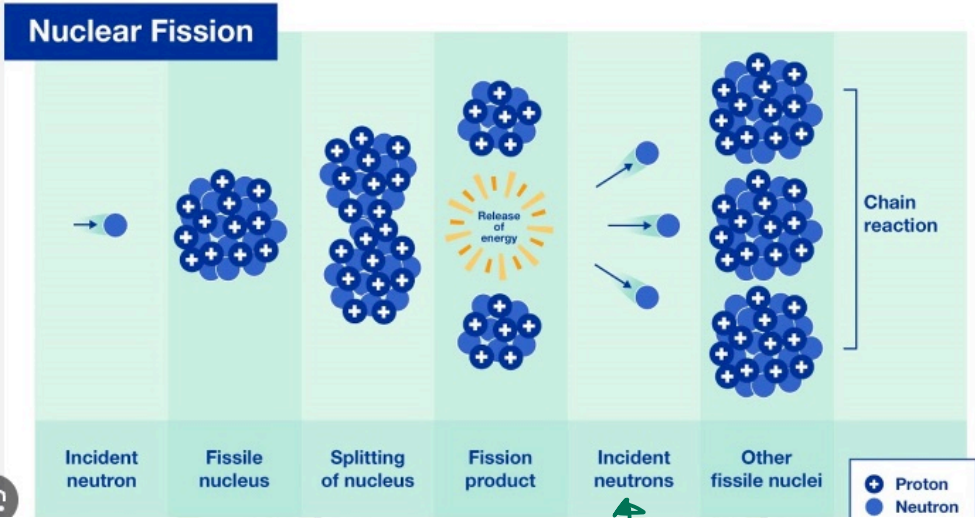# Nuclear Processes

Nuclear Fission

The process in which a nucleus such as Uranium absorbs a neutron and produces daughter nuclei and more neutrons, with the release of energy e.g nuclear reactors.

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{141}_{56}Ba + ^{92}_{36}Kr + X ^{1}_{0}n + Energy.$$

Find X

Reason for a chain reaction:

Nuclear Fission

Incident neutron — Fissile nucleus — Splitting of nucleus — Release of energy / Fission product — Incident neutrons — Other fissile nuclei — Chain reaction
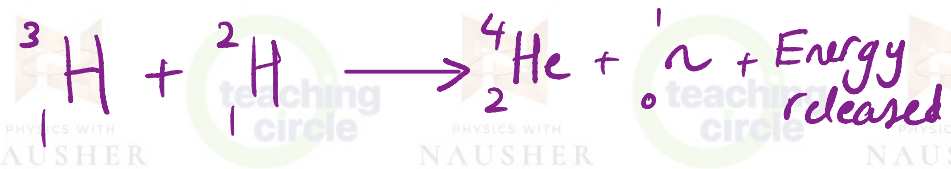
Proton
Neutron

A. Ejected by U-nucleus
B. Ejected by Fission products

The neutrons produced are absorbed by other U-235 nuclei which causes more fission products and neutrons and energy to be released. Hence it leads to a chain reaction, which if not controlled, can produce the effects of a nuclear bomb.

Nuclear Fusion

The process in which a larger nucleus is formed by combining two smaller nuclei, with the release of energy

e.g Nuclear fusion powers the stars e.g The sun's heat and light are generated from nuclear fusion.

$$^{3}_{1}H + ^{2}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + Energy\ released$$

- For nuclei to fuse together, they must have high Kinetic Energy. This is because the protons inside the nuclei are positively charged, which means they repel.

- It takes alot of energy to overcome the repulsive forces, hence it can only be achieved in an extremely high energy environment e.g sun

Significance of BEpN

. At low values of A, attractive nuclear forces between nucleons dominate over repulsive forces between protons.

In the right conditions, nuclei undergo fusion.
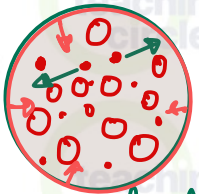
nucleus

. : proton

: strong force holding the nucleus.

Note: the size of the nucleus is small, hence distance between nucleons is less, there are fewer protons, hence strong force > repulsive force.

Note:
In fusion, the mass of the nucleons created is slightly less than total mass of original nuclei.
This $\triangle m$ causes binding energy to be released, since the nucleus that is formed is more stable.

· At high values of A, repulsive forces begin to dominate and these forces tend to break the nucleus.

Note: At high A, # of protons are higher, size of the nucleus is larger, strong force has a short range (it gets weak). Electrostatic rep. force has a greater range, it significantly increases with more protons.

Firing a neutron, makes the nucleus bigger, makes the strong force weaker, causes it to become unstable.
In the right conditions, nuclei undergo fission.

Note:
In fission, an unstable nucleus is converted into more stable nuclei with a smaller total mass.
· This difference in mass, Δm causes binding energy to be released.

① $^3_1H + ^2_1H \longrightarrow ^4_2He + ^1_0n$

Write down the equation in words for mole ratio:

Commonly the equation above is read as:
. one H-3 atom and one H-2 atom fuse together

to make one He-4 atom

A mole is just a way of counting huge numbers of atoms (like saying "dozen" for 12)

. In this reaction, one mole of H-3 atoms fuse with one mol of H-2 atoms to make one mol of He-4 atoms and one mol of neutrons.

Note:
. One mole is simply a larger no. of atoms.
The reaction happens the same way whether we are talking about one atom or a mole of atoms.
. 1 mole of a substance = 6.02×10^{23} particles

· No. of moles = $\dfrac{\text{mass in g}}{\text{mass number}}$

Q. Find no. of moles in 15kg of U_{92}^{235}

Q. How many particles in 15kg of U_{92}^{235}

Q. $^{2}_{1}H + ^{2}_{1}H \longrightarrow ^{3}_{2}He + ^{1}_{0}n$

· State in words the mole ratio for this equation.

· How many particles of He-3 are formed from 1mol of H-2