

Exercise walk-through

7.2

Fission and fusion

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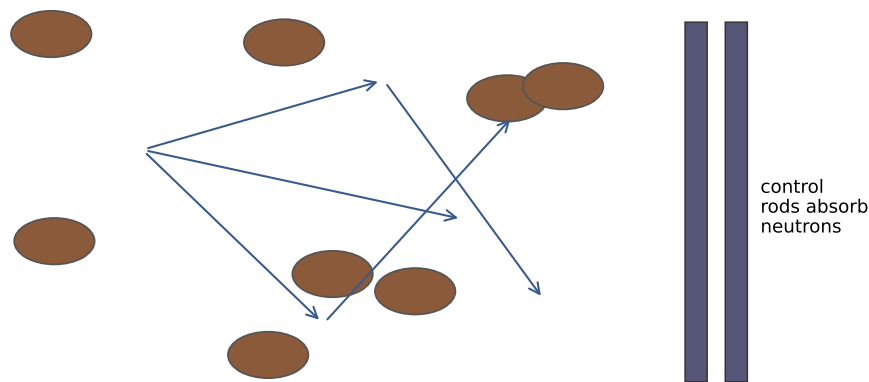
The method

Method — Split, chain, contain

$\text{U-235} + \text{n} \rightarrow \text{two smaller nuclei} + 2\text{--}3 \text{ neutrons} + \text{energy}$; control rods hold the chain steady; waste stays radioactive for its half-life.

Method — Split, chain, contain

$\text{U-235} + n \rightarrow \text{two smaller nuclei} + 2\text{--}3 \text{ neutrons} + \text{energy}$; control rods hold the chain steady;
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one fission: $\text{U-235} + n \rightarrow 2 \text{ nuclei} + 2\text{--}3 n + \text{energy}$

Chain reaction with control rods absorbing neutrons.

Exercises 2.1·2.3

2.1 Which nuclide must absorb a neutron before fission can occur? [1]

2.2 Name the three products of fission besides energy. [3]

2.3 What do control rods do? [1]

Exercises 2.1·2.3

2.1 Which nuclide must absorb a neutron before fission can occur? [1]

2.1 Uranium-235 (or plutonium-239).

2.2 Name the three products of fission besides energy. [3]

2.2 Two smaller (daughter) nuclei and 2–3 neutrons.

2.3 What do control rods do? [1]

2.3 Absorb neutrons so on average only one neutron per fission causes another fission.

Exercises 2.4·3.1

2.4 Why is fission waste dangerous for a long time? [1]

2.5 (P) What powers the stars? [1]

3.1 Describe how a chain reaction builds and how a reactor keeps it steady. [3]

Exercises 2.4·3.1

2.4 Why is fission waste dangerous for a long time? [1]

2.4 Its radioactive isotopes have long half-lives, emitting ionising radiation for thousands of years.

2.5 (P) What powers the stars? [1]

2.5 (P) Nuclear fusion of light nuclei (hydrogen to helium).

3.1 Describe how a chain reaction builds and how a reactor keeps it steady. [3]

3.1 Each fission releases 2–3 neutrons; these strike further U-235 nuclei causing more fissions – the chain grows; control rods lowered into the core absorb excess neutrons, holding the rate steady.

Exercises 3.2-3.3

3.2 Compare the energy released per kilogram in fission with a chemical reaction, and give one reason nuclear waste is a disposal problem. [3]

3.3 (P) Explain why fusion reactors are harder to build than fission reactors. [3]

Exercises 3.2-3.3

3.2 Compare the energy released per kilogram in fission with a chemical reaction, and give one reason nuclear waste is a disposal problem. [3]

3.2 Fission releases far more energy per kilogram than any chemical reaction; the waste stays radioactive for very long half-lives, so it must be shielded and stored securely for millennia.

3.3 (P) Explain why fusion reactors are harder to build than fission reactors. [3]

3.3 (P) Both fusing nuclei are positively charged and repel; they must collide at enormous speed to approach closely enough to fuse; that requires extreme temperatures and pressures, which are hard to contain.