

Exercise walk-through

7.2

Fission and fusion

OxfordAQA · International GCSE · Physics

1. Nuclear physics

Nuclear physics

The nucleus is a millionth of the atom yet holds nearly all its mass — and unstable nuclei pour out energy as radiation, fission fragments, or the fusion that lights the stars

OxfordAQA's seventh topic covers the nuclear model, the three radiations, half-life, contamination versus irradiation, reactors and (P) fusion

2. Atomic structure

Atomic structure

An atom is about 10^{-10} m across: a tiny positive nucleus (protons and neutrons, nearly all the mass) with electrons around it — Rutherford's alpha-scattering evidence for the concentrated nucleus

Proton mass 1 charge +1; neutron mass 1 charge 0; electron charge -1 , negligible mass

4. Nuclear fission and (P) fusion

Nuclear fission and (P) fusion

Fission splits a large unstable nucleus: U-235 or Pu-239 absorbs a neutron, splits into two smaller nuclei with 2–3 neutrons and far more energy than any chemical reaction

Neutrons striking further nuclei give a chain reaction; in a reactor control rods absorb neutrons to hold one fission per neutron

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.