

Solutions

2.1 Uranium-235 and plutonium-239.

2.2 Two smaller nuclei roughly equal in size; two or three neutrons; gamma rays.

2.3 Fusion is the joining of two light nuclei to form a heavier nucleus; some of the mass is converted into the energy of the radiation.

3.1 (a) Two smaller nuclei of roughly equal size; two or three neutrons; gamma rays, with energy released and all products carrying kinetic energy. (b) The released neutrons can be absorbed by other U-235 nuclei; each causes another fission, so the number of fissions multiplies – a chain reaction. (c) Control rods (neutron-absorbing material) are lowered into the reactor; they absorb neutrons, setting how many continue the chain and so controlling the energy released.

3.2

$$\text{days} = \frac{92}{100} \times 365 = \mathbf{336} \text{ days (accept 335 or 336)}$$

(fraction C1, answer A1)

3.3 Indicative content – fission uses uranium-235/plutonium-239, a finite fuel that must be mined; fusion uses hydrogen isotopes, effectively unlimited from water. Fission waste stays radioactive for thousands of years and needs secure storage; fusion makes no long-lived high-level waste (activated structural material only). Fission is a mature technology running commercial stations today; fusion has produced net energy only in laboratories – sustained reactor operation (ITER and successors) is still in development because holding light nuclei together needs extreme temperature and pressure. Level 2 (4–6): both processes compared on all three axes with accurate physics. Level 1 (1–3): some correct points on one or two axes.