8 **(a)** State what is meant by the binding energy of a nucleus.

.....

.....

..... [2]

(b) A nucleus of uranium-235 absorbs a neutron and becomes unstable. It then undergoes a fission reaction. One possible reaction is

$$^{235}_{92}\text{U} + ^{1}_{0}\text{n} \rightarrow ^{142}_{54}\text{Xe} + ^{90}_{38}\text{Sr} + \text{neutrons}.$$

(i) Determine the number of neutrons produced in this fission reaction.

number = ... [1]

(ii) Data for the binding energies per nucleon for this fission reaction are given in Table 8.1.

Table 8.1

isotope	binding energy per nucleon / MeV
uranium-235	7.59
xenon-142	8.37
strontium-90	8.72

Calculate the energy released, in MeV, from the fission of one nucleus of uranium-235.

energy = ... MeV [2]

(iii) The isotope xenon-142 is unstable. The isotope xenon-132 is stable.

Suggest a reason why xenon-142 is unstable.

.....

..... [1]

(iv) Xenon-142 decays into the isotope caesium-142.

A sample initially contains only nuclei of xenon-142. After a time equal to 6.0 s, the ratio

$$\frac{\text{number of decayed nuclei of xenon-142}}{\text{number of undecayed nuclei of xenon-142}}$$

is equal to 31.

Calculate the half-life of xenon-142. Show your working.

half-life = ... s [3]

[Total: 9]