23 Mass defect and binding energy – Part 2

Name: _____ Class: _____ Date: _____

Vocabulary 词汇

Write each word three times. 把每个单词抄写三遍。

English	中文	Write it 3 times (English)		
nucleus	原子核			
mass defect	质量亏损			
binding energy	结合能			
Fusion	聚变			
fission	裂变			

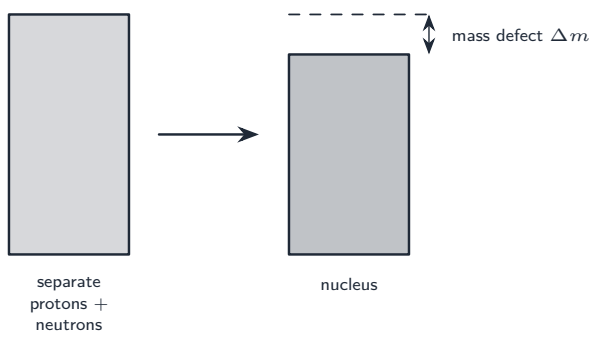
Recall

A **nucleus** 原子核 weighs *less* than its separate parts. That missing mass is the key to nuclear energy.

New ideas

Read these first. Each idea has a short worked example. Then do the Practice.

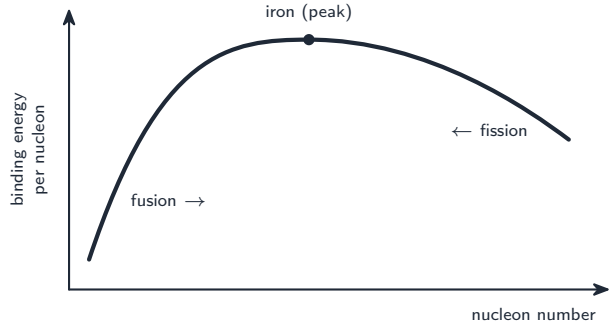
■ 1 Mass defect and binding energy



The **mass defect** 质量亏损 Δm is how much less the nucleus weighs than its separate parts. By $E = mc^2$ this matches the **binding energy** 结合能 — the energy needed to pull the nucleus apart.

Worked example. A nucleus has a mass defect $\Delta m = 5.0 \times 10^{-29}$ kg. Its binding energy is $E = c^2\,\Delta m = (3.0 \times 10^8)^2(5.0 \times 10^{-29}) = 4.5 \times 10^{-12}$ J.

■ 2 Fusion and fission



Binding energy per nucleon peaks near iron. **Fusion** 聚变 of light nuclei and **fission** 裂变 of heavy nuclei both move towards the peak, releasing energy.

Worked example. Light nuclei (like hydrogen) sit to the left of the iron peak, so *joining* them climbs the curve and releases energy — this powers the Sun. Heavy nuclei (like uranium) sit to the right, so *splitting* them also climbs the curve — this powers a reactor.

> **Watch out:** binding energy is the energy needed to *pull a nucleus apart* (and is released when it forms). A higher binding energy *per nucleon* means a more stable nucleus.

Practice

Try these in order.

23.1 What is the *mass defect*? [1]

23.2 What does the mass defect match (by $E = mc^2$)? [1]

23.3 What is the *binding energy*? [1]

23.4 Which element is at the peak of the binding-energy-per-nucleon curve? [1]

23.5 Name the two processes that release nuclear energy. [2]

23.6 A nucleus has a mass defect of 4.0×10^{-29} kg. Find its binding energy ($c = 3.0 \times 10^{8}$ m s^{-1}). [2]

23.7 Challenge. The Sun fuses hydrogen, while a power station splits uranium. Using the binding-energy-per-nucleon curve, explain why both *joining* and *splitting* nuclei can release energy. [2]