23. Nuclear physics

Starter Quiz · 课前小测

A-Level Physics Name: _____ Score: _____

1. The mass-energy relation is:

   ☐ $E = mc^2$

   ☐ $E = mc$

   ☐ $E = \frac{1}{2}mc^2$

   ☐ $E = m^2c$

2. Energy is released when nuclei move:

   ☐ toward the iron peak (higher binding energy per nucleon)

   ☐ away from the iron peak

   ☐ to lower nucleon number, always

   ☐ nowhere — energy is never released

3. Select **all** the true statements about radioactive decay.

   ☐ it is spontaneous (no trigger needed)

   ☐ it is random

   ☐ the rate is unaffected by temperature

   ☐ you can predict exactly when one nucleus will decay

   Tick every correct option.

4. A mass change of 1 u corresponds to about how many MeV?

   _____ MeV

5. Fusion needs very high temperatures to overcome the electrostatic repulsion between nuclei.

   ☐ True ☐ False

6. The activity of a radioactive source is:

   ☐ $A = \lambda N$ (decays per second, in Bq)

   ☐ $A = \dfrac{N}{\lambda}$

   ☐ $A = \dfrac{\lambda}{N}$

   ☐ $A = \lambda + N$

7. A nucleus has _____ mass than its separate protons and neutrons added together.

   _____

8. The extra neutrons released in fission can trigger a _____ reaction.

   _____

9. A source has $\lambda = 0.010$ per second and 1.0×10^6 undecayed nuclei. What is its activity?

   _____ Bq

10. The binding energy is the energy needed to pull a nucleus completely apart.

    ☐ True ☐ False

A-Level Physics

1. $E = mc^2$

   Mass and energy are equivalent: $E = mc^2$, so a mass change Δm releases $c^2\Delta m$.

2. **toward the iron peak (higher binding energy per nucleon)**

   Climbing the B/A curve toward iron means the products are more tightly bound, so energy is released.

3. **it is spontaneous (no trigger needed); it is random; the rate is unaffected by temperature**

   It is spontaneous and random, and the rate does not depend on conditions. You can only give the probability of a single decay.

4. **931 MeV**

   1 u $= 1.66 \times 10^{-27}$ kg gives $\Delta E = c^2\Delta m \approx 931$ MeV.

5. **True**

   The nuclei must get close enough for the strong force to act, despite repelling — hence the millions of kelvin in stars.

6. $A = \lambda N$ **(decays per second, in Bq)**

   Activity = decay constant × number of undecayed nuclei, measured in becquerel.

7. **less**

   That missing mass (the mass defect) was released as energy when the nucleus formed.

8. **chain**

   Each fission releases neutrons that cause more fissions — a chain reaction in a critical mass of fuel.

9. **10000 Bq**

   $A = \lambda N = 0.010 \times 1.0 \times 10^6 = 1.0 \times 10^4$ Bq.

10. **True**

    $B = \Delta m\, c^2$ — the energy released on forming the nucleus, which must be returned to separate it.