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. An iron-56 nucleus can release energy by either fusion or fission.

   ☐ True ☐ False

6. What is the evidence that radioactive decay is random?

   ☐ the count rate fluctuates from one interval to the next

   ☐ the activity falls over time

   ☐ the half-life is always the same

   ☐ heating the source does not change the rate

7. In alpha decay the nucleon number falls by 4 and the proton number falls by _____.

   _____

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

   ☐ True ☐ False

9. The activity of a radioactive source is:

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

   ☐ $A = \dfrac{N}{\lambda}$

   ☐ $A = \dfrac{\lambda}{N}$

   ☐ $A = \lambda + N$

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

    _____

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Answers · 答案

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

5. **False**

   It sits at the peak, so every move takes it DOWN the curve and would need energy put in. This is why fusion inside a star stops at iron.

6. **the count rate fluctuates from one interval to the next**

   A falling activity shows decay happens; a constant half-life shows the probability is fixed; heating shows it is SPONTANEOUS. Only the fluctuation shows randomness.

7. **2**

   An alpha particle is a helium-4 nucleus, 2 protons and 2 neutrons. Beta-minus leaves A unchanged and raises Z by 1, and the antineutrino must be written too.

8. **True**

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

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

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

10. **less**

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