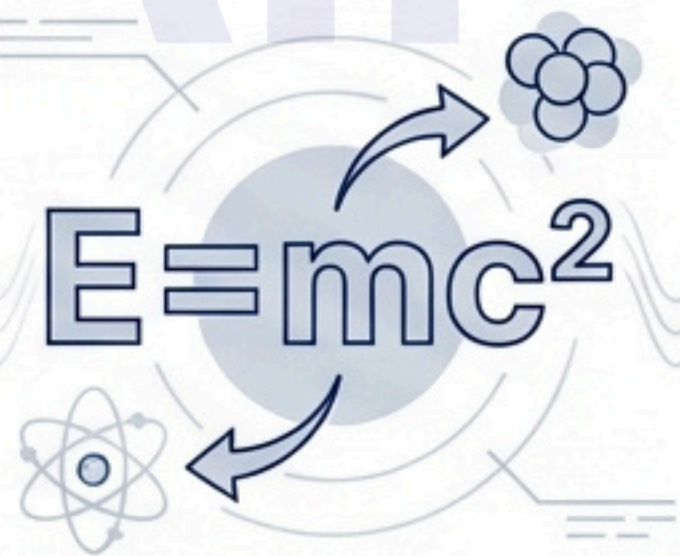


CLASS 12 PHYSICS • CHAPTER 13

Einstein's Equation in Nuclear Physics

**Demystifying 13.4.1
Mass–Energy Equivalence**



The Paradigm Shift in Physics



The Classical Presumption

Before special relativity, it was presumed that mass and energy were entirely separate entities.

They were believed to be conserved independently in any reaction.

Einstein's Reality

Einstein's theory of special relativity proved that mass is simply another form of energy.

Mass-energy can be converted into other forms of energy (like energy) and vice-versa vice-versa.

The Mass-Energy Equivalence Relation EQ. 13.6

Energy Equivalent

Measured in
Joules (J).

Mass

Mass of the
substance,
measured in
kilograms (kg).

$$E = mc^2$$

CONSTANT

Velocity of light
in a vacuum

Approximately
 $3 \times 10^8 \text{ m s}^{-1}$.



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$$E=mc^2$$



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Example 13.2: The Power of One Gram



Calculating Energy for 1g of Matter

Step 1: $m = 10^{-3} \text{ kg}$

Step 2: $c = 3 \times 10^8 \text{ m s}^{-1}$

Step 3: $E = 10^{-3} \times (3 \times 10^8)^2 \text{ J}$

$$E = 9 \times 10^{13} \text{ J}$$

Tiny Mass $\rightarrow$ Huge Energy



1 gram
of matter

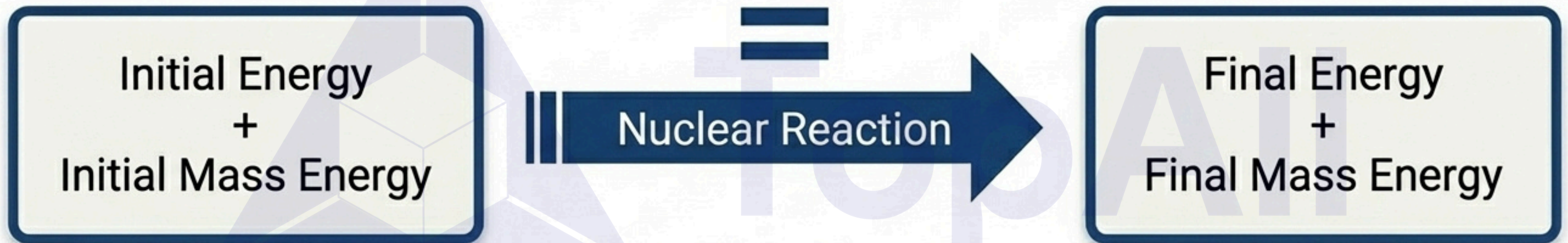


**90,000,
000,000,
000,000
Joules**

The Unified Conservation Law

How $E = mc^2$ applies to nuclear reactions.

In reactions involving interacting nucleons, nuclei, and electrons, mass and energy can no longer be evaluated separately.



The conservation law of energy states that initial energy equals final energy only when the energy associated with mass is included. This is fundamental for understanding nuclear masses and interactions.

Key Takeaways

EXAM RECALL



- ✓ Special relativity fundamentally changed physics: mass is another form of energy.
- ✓ The equivalence relation is $E = mc^2$ (Eq. 13.6).
- ✓ The speed of light (c) is approximately $3 \times 10^8 \text{ m s}^{-1}$.
- ✓ Converting just 1 gram of matter releases an enormous $9 \times 10^{13} \text{ J}$ of energy.
- ✓ In nuclear reactions, the combined total of mass and energy is what is strictly conserved.



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