M.8.2.9 CONVERTING MASS TO ENERGY OR ENERGY TO MASS

Video: Mass and Energy

Nuclear fusion reactions deep inside the Sun release the huge amounts of energy that stream from the Sun, resulting in a conversion of about 4 million tonnes of mass into energy every second.
Nuclear fusion occurs when two light nuclei are combined to form a larger nucleus.

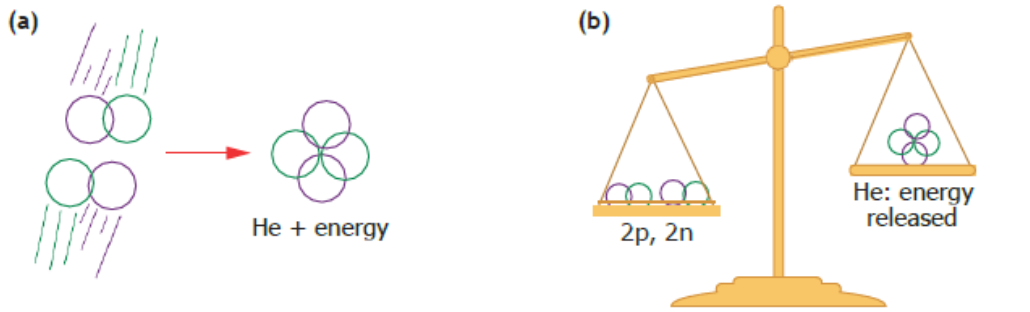

FIGURE 7.5.7 (a) When two isotopes of hydrogen fuse to form a helium nucleus, energy is released. (b) The binding energy of the nucleus appears as a loss in mass, Δm, which can be calculated using $\Delta E = \Delta mc^2$.

The amount of energy released is enormous and can be found by using the equation $\Delta E = \Delta mc^2$.
A tiny proportion of this energy reaches Earth and sustains life as we know it.

Example

Consider the fusion reaction shown below. A proton fuses with a deuterium nucleus (a hydrogen nucleus with one neutron) in the Sun. A helium nuclide is formed and a γ-ray released. 20 MeV of energy is released during this process.

$$ {}_1^1p + {}_1^2H \rightarrow {}_2^xHe + \gamma $$

a What is the value of the unknown mass number x?

mass numbers must balance on each side. 3 on left → $x = 3$

b How much energy is released in joules?

$20 \times 10^6 \times 1.6 \times 10^{-19} = 3.2 \times 10^{-12}\ J$

c Calculate the mass defect (converted) for this reaction.

$\Delta E = \Delta mc^2 \qquad 3.2 \times 10^{-12} = \Delta m \times (3.00 \times 10^8)^2 \qquad \Delta m = 3.55 \times 10^{-29}\ kg$

Note: this is a small mass change for a large amount of energy

Text Questions: Page 260 All Questions