Fusion and fission: comparing nuclei

Student activity • observation and reasoning

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The question

How can combining light nuclei and splitting heavy nuclei both release energy?

Balance one fusion example and compare the nuclear changes with fission.

Equipment

- Booklet, paper nuclear labels and calculator

Paper calculations and models only. No hydrogen, tritium, radioactive material, plasma apparatus or high-voltage equipment is used.

Course coverage: Shared Physics / Double Award: 7.17, 7.23–7.24. Fusion, fission, mass decrease and energy release.

Plan, model or apparatus sketch

Draw a labelled nuclear or astronomical model and state its limits.

Method and reasoning

Read the whole sequence before starting

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1. Draw deuterium with one proton and one neutron, and tritium with one proton and two neutrons. Keep these as paper models.

2. Combine the model reactants into a helium-4 nucleus and a neutron. Check total nucleon number 5 and charge number 2 on both sides.

3. Compare this fusion process with a heavy nucleus splitting in fission. Explain that chemical burning instead rearranges electrons and bonds without the same nuclear transformation.

4. Explain that the total rest mass of the stated products is slightly less than the reactants, and the difference corresponds to released energy. Nucleon number remains conserved even though total rest mass changes.

5. Using a separately labelled invented mass decrease of 2.0×10^{-29} kg, calculate $E = \Delta mc^2$ with $c = 3.0 \times 10^{8}$ m s^{-1} as an extension. Do not identify this value as the actual deuterium–tritium reaction mass change.

6. Explain why repulsion between positively charged nuclei makes fusion difficult at ordinary conditions. Keep conditions for fusion separate from the subsequent energy release.

Cleanup

- Collect labels and retain calculations.

Record your evidence

Blank spaces are for your own work

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Reference and task data

The D–T example produces helium-4 and one neutron. The optional invented mass-change calculation gives 1.8 × 10^{-12} J. This numerical example is not a measured reaction yield.

Process / check	Before	After / conclusion
Fusion nucleons		
Fusion charge		
Fission comparison		
Mass / energy extension		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What combines in fusion?

2. What splits in fission?

3. Check nucleon number in the stated fusion.

4. Check charge number.

5. Is nucleon-number conservation the same as unchanged total rest mass?

6. Find the optional practice energy.