Reakcje jądrowe. Energia reakcji

1. Rozpad alfa uranu-238

Reakcja:

$$^{238}_{92}\mathrm{U} \rightarrow {}^{234}_{90}\mathrm{Th} + {}^{4}_{2}\alpha$$

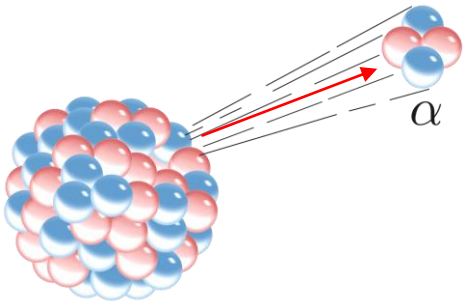
Składniki	Produkty
Uran-238: A = 238, Z = 92, masa = 238.05079 u	Tor-234: A = 234, Z = 90, masa = 234.04359 u
	Cząstka alfa: A = 4, Z = 2, masa = 4.00260 u

Deficyt masy:

$$\Delta m = (238.05079\,\mathrm{u}) - (234.04359\,\mathrm{u} + 4.00260\,\mathrm{u}) = 0.00460\,\mathrm{u}$$

Energia jądrowa:

$$E = \Delta m \times 931.5\,\mathrm{MeV/u} = 0.00460\,\mathrm{u} \times 931.5\,\mathrm{MeV/u} = 4.29\,\mathrm{MeV}$$



2. Fuzja deuteru i trytu

Reakcja:

$$ {}^{2}_{1}\mathrm{H} + {}^{3}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n} $$

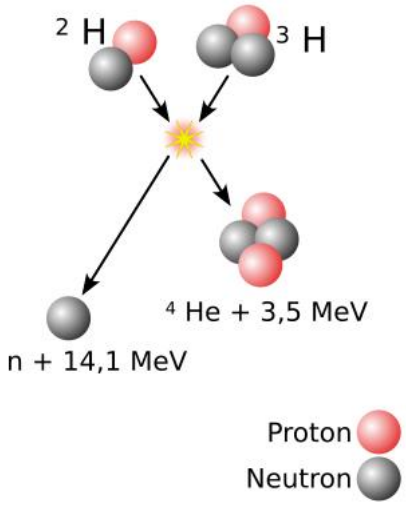
Składniki	Produkty
Deuter: A = 2, Z = 1, masa = 2.01410 u	Hel-4: A = 4, Z = 2, masa = 4.00260 u
Tryt: A = 3, Z = 1, masa = 3.01605 u	Neutron: A = 1, Z = 0, masa = 1.00866 u

Deficyt masy:

$$ \Delta m = (2.01410\,\mathrm{u} + 3.01605\,\mathrm{u}) - (4.00260\,\mathrm{u} + 1.00866\,\mathrm{u}) = 0.01899\,\mathrm{u} $$

Energia jądrowa:

$$ E = \Delta m \times 931.5\,\mathrm{MeV/u} = 0.01899\,\mathrm{u} \times 931.5\,\mathrm{MeV/u} = 17.73\,\mathrm{MeV} $$



3. Rozszczepienie uranu-235

Reakcja:

$$^{235}_{92}\mathrm{U} + ^{1}_{0}\mathrm{n} \rightarrow \ ^{141}_{56}\mathrm{Ba} + ^{92}_{36}\mathrm{Kr} + 3\ ^{1}_{0}\mathrm{n}$$

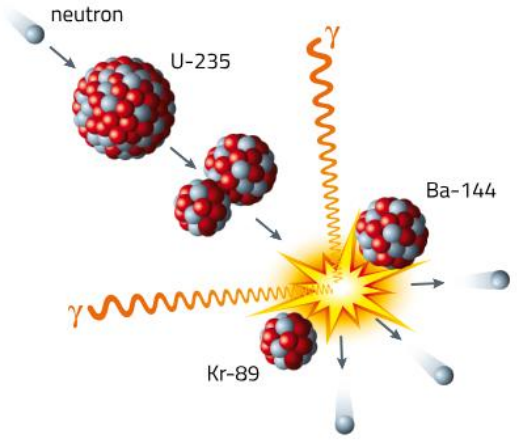
Składniki	Produkty
Uran-235: A = 235, Z = 92, masa = 235.04393 u	Bar-141: A = 141, Z = 56, masa = 140.91441 u
Neutron: A = 1, Z = 0, masa = 1.00866 u	Krypton-92: A = 92, Z = 36, masa = 91.92615 u
	3 neutrony: A = 1, Z = 0, masa = 1.00866 u

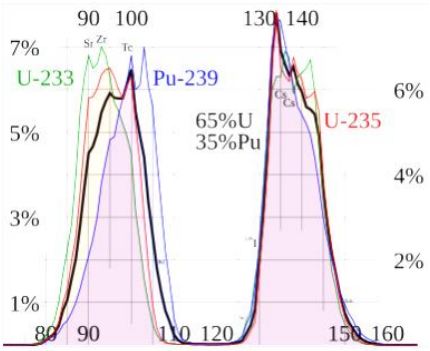
Deficyt masy:

$$\Delta m = (235.04393\,\mathrm{u} + 1.00866\,\mathrm{u}) - (140.91441\,\mathrm{u} + 91.92615\,\mathrm{u} + 3 \times 1.00866\,\mathrm{u}) = 0.18605\,\mathrm{u}$$

Energia jądrowa:

$$E = \Delta m \times 931.5\,\mathrm{MeV/u} = 0.18605\,\mathrm{u} \times 931.5\,\mathrm{MeV/u} = 173.6\,\mathrm{MeV}$$





Rozkład masowy fragmentów rozszczepienia neutronami o energii 1,5 MeV dla różnych materiałów rozszczepialnych.

4. Rozpad beta-minus trytu

Reakcja:

$$^{3}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + e^{-} + \bar{\nu}_{e}$$

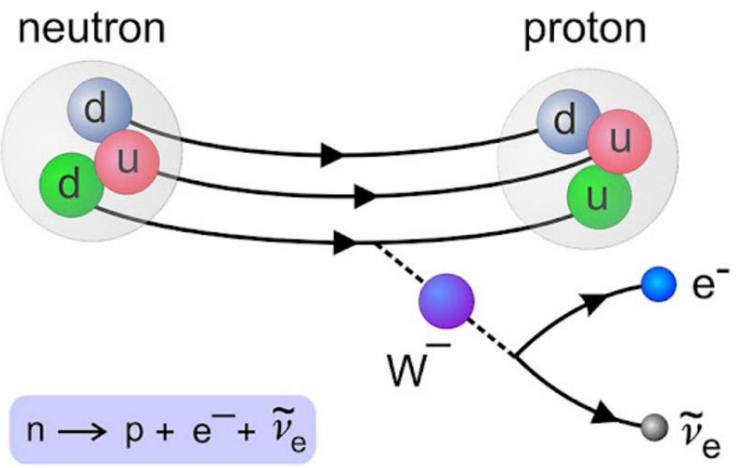
Składniki	Produkty
Tryt: A = 3, Z = 1, masa = 3.01605 u	Hel-3: A = 3, Z = 2, masa = 3.01603 u
	Elektron: A = 0, Z = -1, masa = 0.000548 u

Deficyt masy:

$$\Delta m = 3.01605\,\mathrm{u} - (3.01603\,\mathrm{u} + 0.000548\,\mathrm{u}) = 0.000474\,\mathrm{u}$$

Energia jądrowa:

$$E = \Delta m \times 931.5\,\mathrm{MeV/u} = 0.000474\,\mathrm{u} \times 931.5\,\mathrm{MeV/u} = 0.441\,\mathrm{MeV}$$



5. Fuzja deuteru i deuteru

Reakcja:

$$^{2}_{1}\mathrm{H} + ^{2}_{1}\mathrm{H} \rightarrow ^{3}_{1}\mathrm{He} + ^{1}_{0}\mathrm{n}$$

Składniki	Produkty
Deuter: A = 2, Z = 1, masa = 2.01410 u	Hel-3: A = 3, Z = 2, masa = 3.01603 u
	Neutron: A = 1, Z = 0, masa = 1.00866 u

Deficyt masy:

$$\Delta m = (2 \times 2.01410\,\mathrm{u}) - (3.01603\,\mathrm{u} + 1.00866\,\mathrm{u}) = 0.00451\,\mathrm{u}$$

Energia jądrowa:

$$E = \Delta m \times 931.5\,\mathrm{MeV/u} = 0.00451\,\mathrm{u} \times 931.5\,\mathrm{MeV/u} = 4.20\,\mathrm{MeV}$$