Nuclear Reaction Q-Value and Threshold Energy

Energy released or absorbed by a nuclear reaction from the atomic masses of reactants and products, the energy per kilogram and the threshold energy if endothermic.

Method: Q-value from mass-energy balance; non-relativistic threshold energy

Input parameters

Unit system: SI

Parameter	Value	Unit
Projectile (or first reactant) atomic mass (u)	2.0141	
Target (second reactant) atomic mass (u)	3.0160	
First product atomic mass (u)	4.0026	
Second product atomic mass (u)	1.0087	
Third product atomic mass (u; 0 if none)	0	

Calculated results

Parameter	Value	Unit
Q-value (positive: energy released)	17.589	MeV
Mass change (u)	0.018883	
Energy per kilogram of reactants	3.3739e+08	MJ/kg
Threshold kinetic energy of the projectile (endothermic only)	0	MeV

Notes for this case

• Q = (Σ reactant masses − Σ product masses) × 931.494 MeV/u. Use atomic masses throughout so electrons balance; the threshold uses the non-relativistic form −Q(1 + M_a/M_X).

Formula and method

$$Q = \left(\sum M_{in} - \sum M_{out}\right) 931.494\ \text{MeV}, \quad E_{th} = -Q\left(1 + \frac{M_a}{M_X}\right)$$

Variables

M_a	Projectile (or first reactant) atomic mass (u)	-
M_X	Target (second reactant) atomic mass (u)	-
M_b	First product atomic mass (u)	-
M_Y	Second product atomic mass (u)	-
M_c	Third product atomic mass (u; 0 if none)	-
Q	Q-value (positive: energy released)	J
ΔM	Mass change (u)	-
Q/m	Energy per kilogram of reactants	J/kg
E_{th}	Threshold kinetic energy of the projectile (endothermic only)	J

Method and standards

Mass balance of a nuclear reaction.

Assumptions and limits

- Masses must be consistent (all atomic); the threshold is non-relativistic.

References

Q-value from mass-energy balance; non-relativistic threshold energy

Report details

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Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/nuclear-power/nuclear-reaction-q-value

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Reopens the calculator with the inputs of this report.