

7. Energy Diagrams: Endothermic and Exothermic Reactions

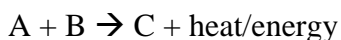
Chemical Reactions

Chemical reactions are always accompanied by a change in internal energy, ΔU , which is the difference between the internal energy of the reactants (U_{initial}) and the internal energy of the products (U_{final}):

$$\Delta U = U_{\text{final}} - U_{\text{initial}} \quad (1)$$

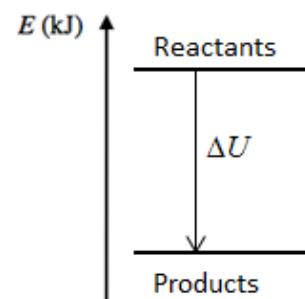
In some cases, the chemical reaction (the ‘system’) releases energy to the surroundings – this is called an *exothermic* reaction. In this case, the energy of the products is lower than that of the reactants, as can be seen in the diagram on the right.

Other than using the diagram, there are a few other ways of indicating that a reaction is exothermic. “Energy is released (from system to surroundings)”, $\Delta U < 0$, and “heat is a product” are all ways of indicating that a process is exothermic. Some people also write a chemical reaction including energy/heat:



Though writing a reaction like this is not rigorously correct, as heat/energy are not chemical species and therefore cannot be reactants or products, this can help you visualize whether heat is released by a reaction (exothermic) or absorbed by a reaction (endothermic).

In an *endothermic* reaction, the reverse occurs and energy is absorbed by the system. In this case, the overall energy of the system increases throughout the reaction and the resulting energy of the products is greater than that of the reactants.



1) Draw the diagram, like the one above, for an endothermic reaction.

2) Write a chemical reaction equation, like the one above, for an endothermic reaction.

3) In the discussion above, we listed four other ways of indicating the flow of energy in reactions in addition to drawing diagrams. Write this list for an endothermic reaction.

4) Did the overall energy of the reaction on the right increase or decrease? What kind of a reaction does this energy diagram represent?

