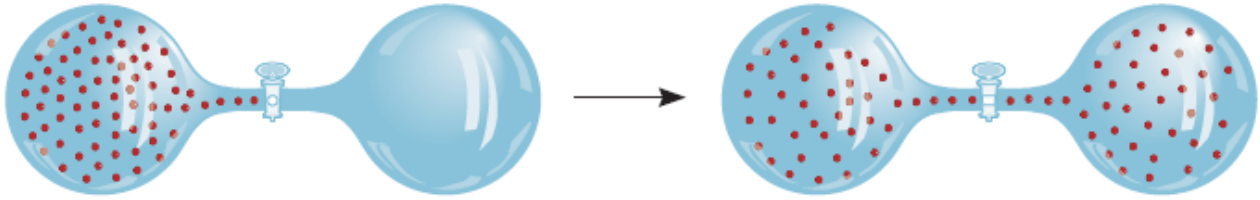
Spontaneous processes

Spontaneous reaction → a reaction that occur under the given set of conditions.

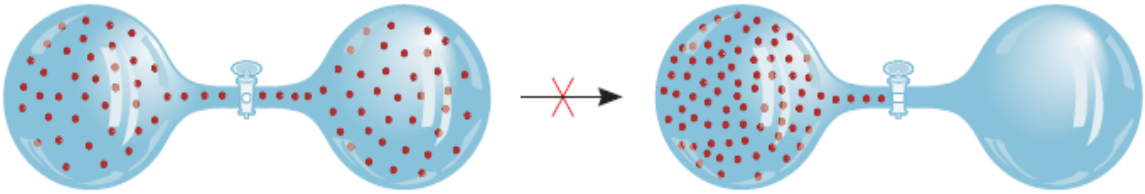
Non-spontaneous → a reaction that does not occur under specified conditions.

We observe spontaneous physical and chemical processes every day as examples.

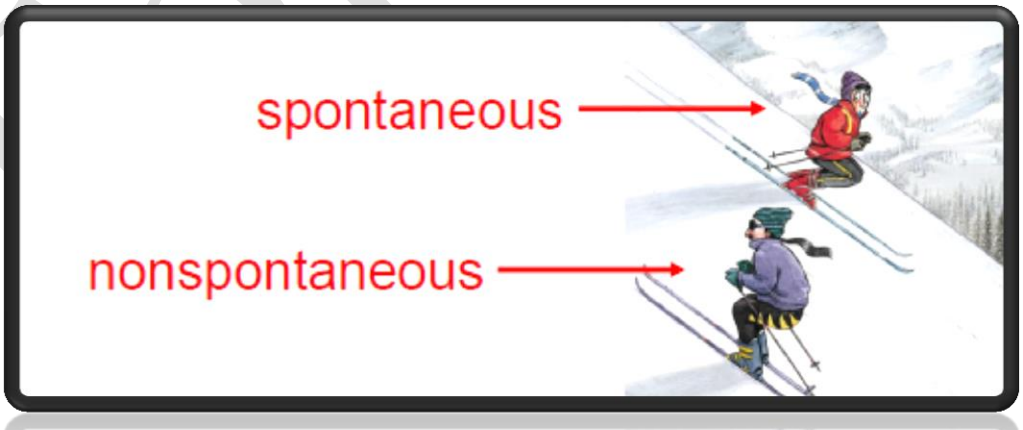
- A waterfall runs downhill, but never up, spontaneously.
- Water freezes spontaneously below 0ºC, and ice melts spontaneously above 0ºC.
- Heat flows from a hotter object to a colder one, but the reverse never happens spont.
- Iron exposed to water and oxygen forms rust, but rust does not spontaneously change back to iron.



Spontaneous process → after the valve is opened, the molecules distribute evenly between the two bulbs.



Non-spontaneous process → after the valve is opened, the molecules preferentially gather in one bulb.



❖ If we assume that spontaneous processes that occur to decrease the energy of a system, we can explain, why a ball rolls downhill and why springs in a clock unwind.

Similarly, a large number of exothermic reactions are spontaneous.

An Example

Combustion of methane

$CH_{4\,(g)}+2O_{2(g)} \rightarrow CO_{2(g)}+2H_2O_{(l)}$ $\Delta H^o=-890.4KJ/mole$

Acid-base neutralization reaction

$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$ $\Delta H^o=-56.2KJ/mol$

But consider a solid to liquid phase transition such as:

$H_2O_{(s)} \rightarrow H_2O_{(L)}$ $\Delta H^o=6.01KJ/mol$

- in this case , the assumption that spontaneous process always decrease a system's energy fails
- Experience tells us that spontaneous above 0ºC even though the process is endothermic.

Another example that contradicts our assumption is the dissolution of ammonium nitrate in water.

$NH_4NO_{3(s)} \xrightarrow{H2O} NH_4^+{}_{(aq)}+NO_3^-{}_{(aq)}$ $\Delta H^o= 25\ KJ/mol$

Conclusion

1- Exothermicity favors the spontaneity of a reaction but doesn't guarantee it.

2- It is possible for an endothermic reaction to be spontaneous; it is possible for an exothermic reaction to be nonspontaneous.

3- We can't decide whether or not a chemical reaction will occur spontaneously on the basis of energy changes in the system

Top Te

Choose

1) A reaction that occur a given set of conditions is……..

A) spontaneous
B) non spontaneous
C) reversible
D) none of them

2) A reaction that doesn't occur under specified conditions is……

A) spontaneous
B) non spontaneous
C) reversible
D) none of them

3) Water freezes below 0ºC and ice melts above 0ºC is an examples of……...

A) non spontaneous
B) spontaneous
C) endothermic spontaneous
D) exothermic spontaneous

4) which one of the following example is spontaneous?

A) water fall runs down hills
B) iron rust when exposed to water and oxygen
C) rust change back to iron
D) both A and B

5) which one of the following example is nonspontaneous?.

A) water falls runs down hills
B) Iron rust when exposed to water and oxygen
C) water freezes below 0ºC
D) none of them

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6) A large number of exothermic reactions favors…….

A) non spontanousty
B) Spontaneousty
C)both A and B
D)None of all

7) Although combustion of methane is an exothermic spont.reaction , solid to liquid phase transition such as $H_2O_{(s)} \rightarrow H_2O_{(L)}$

A) exothermic spontaneous
B) endothermic non spontaneous
C) endothermic spontaneous
D) exothermic non spontaneous

8) acid-base neutralization reaction H+ (aq) + OH-(aq) → H2O (L) is an…….

A) exothermic non spontaneous
B) endothermic spontaneous
C) endothermic non spontaneous
D) exothermic spontaneous

9) Ice melt spontaneous above 0ºC even If the process is……..

A) exothermic
B) endothermic
C) none of them
D) reversible

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10) Its …….. For endothermic reaction to be spontaneous.

A) impossible
B) possible
C) never
D) easy

11) Its……. for exothermic reaction to be spontaneous.

A) possible
B) impossible
C) easy
D) never

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