

King of Dumbs

Level: ♣ Newbie

Why doesn't diamond turn into graphite?

Breaking bonds costs energy and making them pays it back, but almost no reaction starts without climbing a hill. Why diamond lasts and water works as a battery.

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Scan to open the interactive lesson

<https://kingofdumbs.com/en/lessons/chemical-reactions-energy>

What you'll learn

- Why some reactions give off heat and others take it in: the energy in bonds
- Activation energy: the hill to climb before reacting
- Stable isn't the same as fast: why diamond lasts
- Oxidation and reduction: splitting water and burning it is charging and draining a battery

Before this lesson

If something sounds like gibberish, these lessons explain it from scratch:

1. [What is a wall made of? Atoms and elements without fear](#)
2. [Joules, watts or calories? Energy and power without fear](#)

Symbols you'll meet

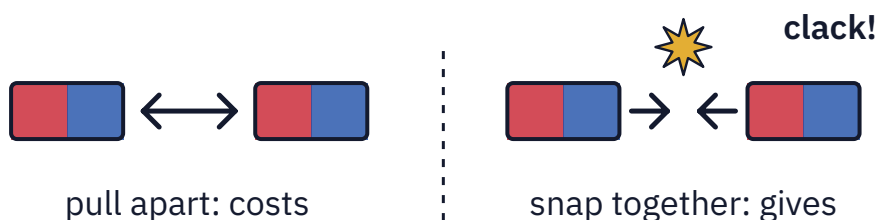
Δ change: how much it moved (♠) · E_a subscript: the label underneath (♦♠) · H° ° for standard, not degrees (♠) · Σ sum: add them all up (♠) · $\approx$ approximately equal (♠) · $|x|$ absolute value: drop the sign (♠) · · dot: multiply (or dot product) (♠) · $\rightarrow$ arrow: turns into / tends to (♦♠) · J/(mol·K) compound units (♦♠) · e the number e (≈ 2.718) (♠) · log logarithm: how many times do I multiply? (♠) · ν nu: coefficient or neutrino (♠)

A diamond ring can pass from grandmother to granddaughter for centuries and stay the same. But a chemist would tell you that diamond “should” turn into graphite, the stuff in a pencil, because graphite is more stable. And it doesn’t.

This lesson’s dumb question is: **why doesn’t diamond turn into graphite?** The answer is the same one that explains why the gas on your stove doesn’t catch fire by itself, why food keeps longer in the fridge and why hydrogen stores energy like a battery. Every reaction has a bill, the energy it gives off or asks for, and a hill to climb before it starts.

Pick your card: ♣ if you’re starting from zero, ♦ if a simple formula doesn’t scare you, ♠ if you want the notation. You can switch at any time.

Breaking costs, joining pays



A reaction breaks links and makes new ones.

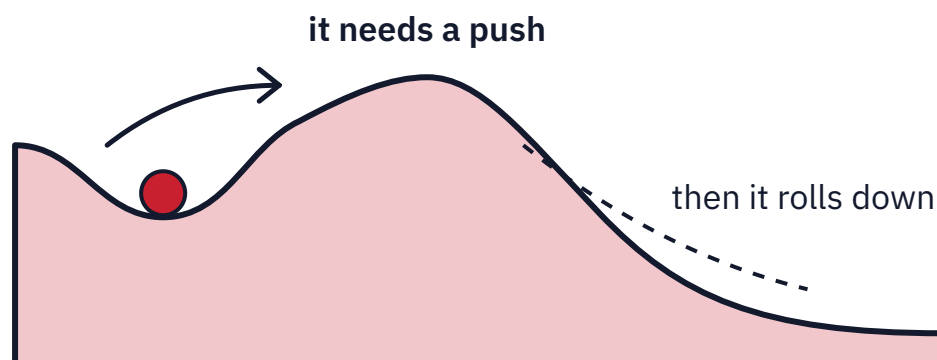
If the new ones grip harder, out comes heat.

Take two magnets that are stuck together and pull them apart: it takes effort. Bring them close and they snap together with a clack: joining up gives off energy.

The atoms in a molecule are held together by **bonds**, and something similar happens with them: breaking a bond costs energy and making one gives it back. A chemical reaction breaks some bonds and makes others. If the new ones grip harder than the old ones, they give back more than the breaking cost, and what's left over comes out as heat. That's how the gas on your stove heats things.

If it's the other way round, the reaction asks for energy and you have to supply it, for example with electricity. You'll see that at the end, with water.

The hill: why almost nothing starts by itself



Picture a ball in a hollow. Next to it there's a very long downhill slope, but between the hollow and the slope there's a small hill. Even though it would be better off at the bottom, the ball goes nowhere until someone pushes it over the hill. After that it rolls down on its own.

Reactions are like that. The gas on your stove and the oxygen in the air can sit together all day without burning, until a spark gives the push. Once it starts, the heat of the flame pushes the molecules next to it, and the reaction keeps going by itself.

What pushes hardest is temperature. When it's hot, molecules move faster and collide harder, so more collisions make it over the hill. That's why food keeps longer in the fridge: in the cold, the reactions that spoil it go more slowly.

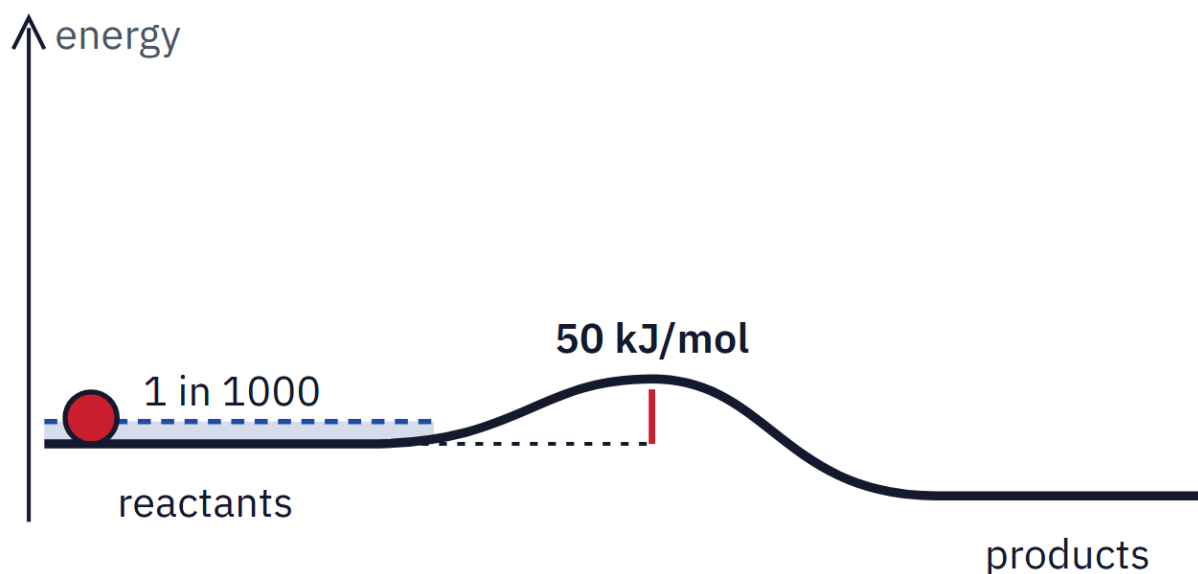
The King of Dumbs says:

It's not enough for a reaction to be worth it: first you have to climb the hill. That's why paper doesn't burst into flames on the shelf.



Try it: climb the hill

Move the height of the hill and the temperature. The blue band marks how high 1 in 1000 collisions gets: when it's over the top, the reaction runs fast. Try 190 kJ/mol, close to the hill measured in diamond powder, and turn up the temperature: even at 1,500 °C the band doesn't get there, but look how much faster it goes.



Height of the hill 50 kJ/mol

Temperature 25 °C (room)

Collisions that reach the top **1 in 5.7×10^8**

Compared with 25 °C the same

If it took a minute at 25 °C, it would take **1 min**

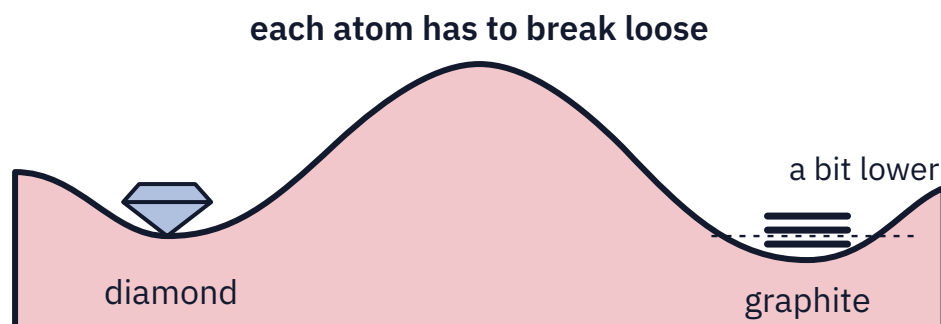
A 50 kJ/mol hill at 25 °C (room): 1 in 5.7×10^8 collisions reach the top.



Interactive widget. Try it on the web: <https://kingofdumbs.com/en/lessons/chemical-reactions-energy>



Diamond: stable isn't the same as fast



It lasts because of the mountain, not the valley.

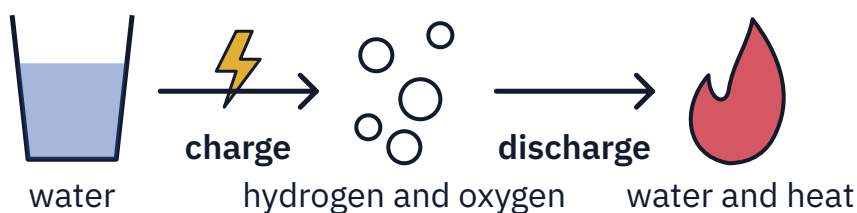
Now picture two valleys. In one, a little higher up, is diamond. In the other, just a little lower, is graphite. Both are pure carbon, arranged in two different ways: you saw it in the atoms lesson.

Going down into the graphite valley would give off a tiny bit of energy, which is why chemists say graphite is more **stable**. But there's a huge mountain between the two valleys: to move over to graphite, each carbon atom has to break loose from the diamond, and pulling it loose takes a huge amount of energy. At room temperature, practically no atom manages it.

Diamond isn't safe because it's the most stable, but because the mountain is so high. If you heat it above about 1,500 °C in a container with no air, it starts turning into graphite.



Oxidising and reducing: water as a battery



Splitting 1 L costs at least 4.4 kWh.

Burning it gives the same back: like a battery.

A nail that rusts and a log that burns are doing the same thing: something is joining up with oxygen. The difference is speed: rust takes months and the flame, seconds. That's why these are called **oxidation** reactions.

You can make a battery out of water. With electricity, water splits into hydrogen and oxygen: that's climbing the slope, and it costs energy. Splitting a litre of water costs at least 4.4 kWh, what a kettle uses running for over two hours.

If you then burn that hydrogen, it goes back down the slope and gives back the same energy, as heat. Not one joule more: hydrogen isn't a source of energy but a way of storing it, like a battery.

The King of Dumbs says:

Hydrogen isn't an energy mine: it's a battery. What you get out by burning it, you put in before by splitting the water.



Final challenge

1. The gas on your stove and the oxygen in the air sit together and don't burn until you light the burner. Why?

- a. Because burning gas doesn't give off energy
- b. Because first there's a hill to climb: it needs a push, like a spark
- c. Because the gas has no energy until it's heated

2. Graphite is more stable than diamond. Why doesn't a diamond ring turn into graphite?

- a. Because diamond is actually the most stable
- b. Because the hill between them is huge and at room temperature almost no atom gets across
- c. Because diamond and graphite are different elements

3. You split water with electricity and then burn the hydrogen that comes out. How much energy do you get?

- a. More than you spent: hydrogen is a source of energy
- b. At most what you spent: the water works as a battery
- c. None, because water doesn't burn



In three sentences

1. A reaction breaks bonds, which costs energy, and makes others, which give it back: if there's some left over it comes out as heat (exothermic), and if there's some missing you have to put it in (endothermic).
2. Almost no reaction starts by itself, because first there's a hill to climb, the activation energy: heat and catalysts help get over it.
3. That's why diamond lasts even though graphite is more stable, and why splitting water and burning the hydrogen is charging and draining a battery, never gaining energy.



Sources

- Bond energy and estimating ΔH : OpenStax, *Chemistry 2e*, [7.5](#). Enthalpy, exothermic and endothermic, Hess's law and enthalpies of formation: [5.3](#) and [appendix G](#). NIST-JANAF tables at 298.15 K: [H](#), [O](#), [water vapour](#) and [liquid water](#).
- Temperature and speed (the fridge): [OpenStax, 12.2](#). Activation energy and Arrhenius: [12.5](#). Catalysts: [12.7](#). Gas constant and Faraday constant (CODATA 2022): NIST, [R](#) and [F](#).
- Spontaneity and Gibbs energy: OpenStax, [16.1](#) and [16.4](#). Metastable diamond: [UW–Madison, Chem 109, D26.1](#).
- Diamond kinetics: G. Davies and T. Evans, *Proc. R. Soc. Lond. A* 328, 413 (1972), [doi:10.1098/rspa.1972.0086](#); Yu. V. Butenko and others, *J. Appl. Phys.* 88, 4380 (2000), [doi:10.1063/1.1289791](#); O. V. Sedelnikova and others, *Beilstein J. Nanotechnol.* 16, 887 (2025), [doi:10.3762/bjnano.16.67](#).
- Oxidation and reduction: [OpenStax, 4.2](#). Electrolysis of water: [17.7](#). Fuel cells: [17.5](#).

How this lesson was made: researched and written with help from Claude from the sources above, checked and cross-checked against a second source on 16 October 2026 and reviewed again on 17 October 2026. Figures without their own link are calculations from them and from the atoms and energy lessons. The drawings are our own.

Answers

1. **b)** Because first there's a hill to climb: it needs a push, like a spark. That's it. First the push; after that the flame pushes itself.
2. **b)** Because the hill between them is huge and at room temperature almost no atom gets across. Right. Stable isn't the same as fast.
3. **b)** At most what you spent: the water works as a battery. Exactly. Climbing the slope costs what going down gives back.

A King of Dumbs lesson, kingofdumbs.com. Offline version; the original, with widgets you can play with, is at: <https://kingofdumbs.com/en/lessons/chemical-reactions-energy>

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