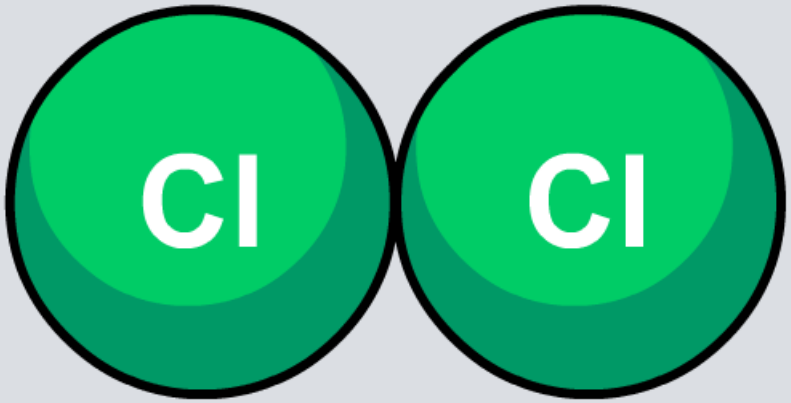
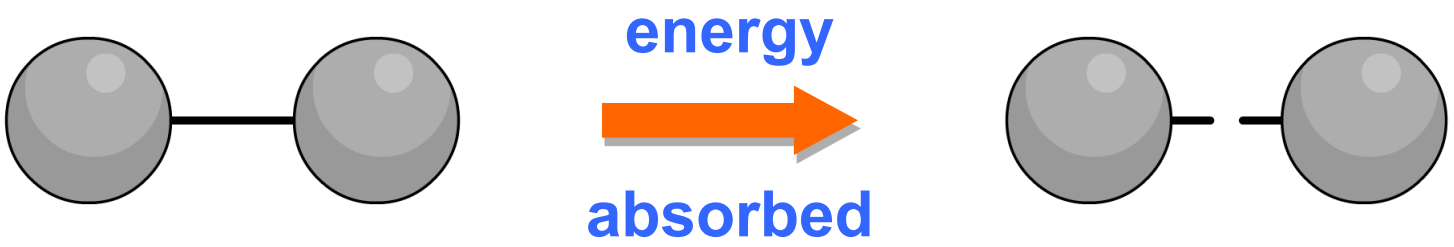
Bonds and Activation Energy

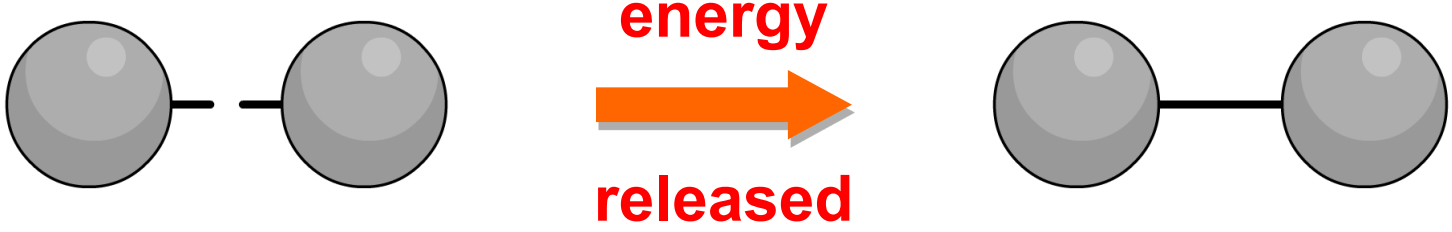


Making and breaking chemical bonds

Most chemicals will break up (decompose) if they are heated strongly enough. This means that energy is needed to break chemical bonds – an **endothermic** process.



Because bond-breaking is endothermic, bond-making must therefore be **exothermic**. This means that energy is released when chemical bonds are made.

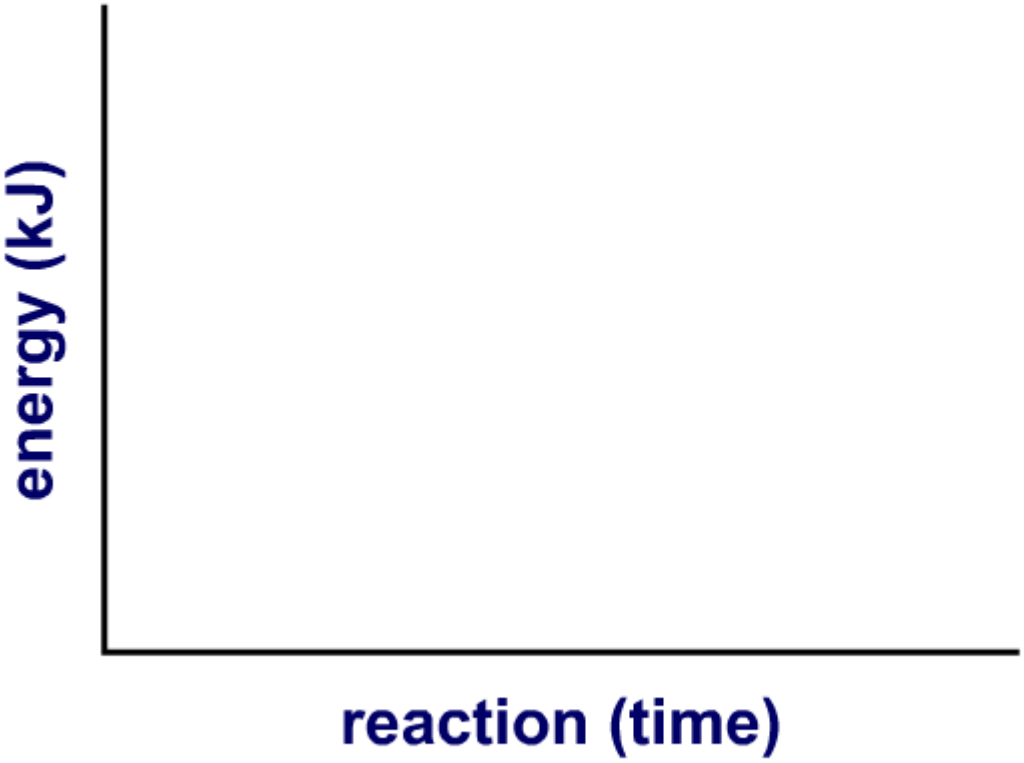


Bonds and exothermic reactions

Bond-breaking and bond-making energy level diagram for an exothermic reaction

What is the difference in energy between bond-breaking and bond-making in an exothermic reaction?

Click "**play**" to find out more.



Bonds and endothermic reactions

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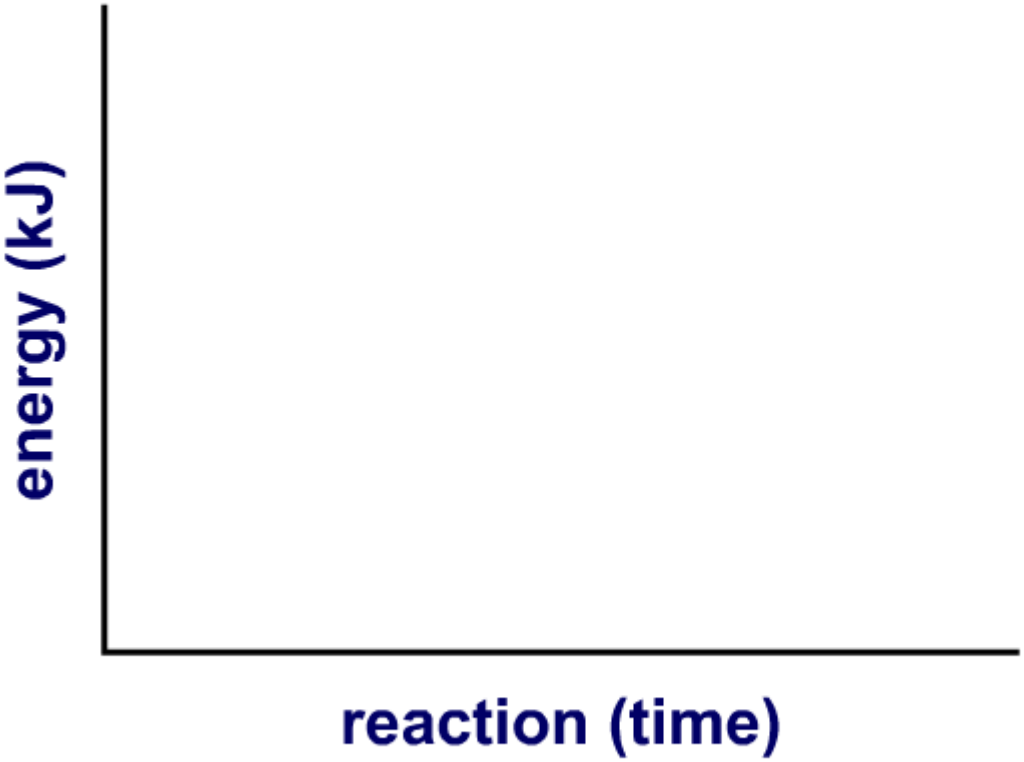
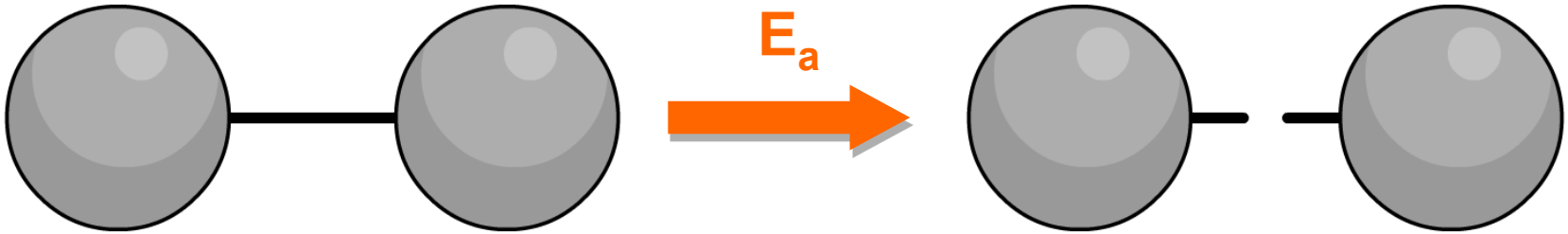


What is activation energy?

All reactions need a certain amount of energy to get started. This is called the **activation energy** (E_a).

Activation energy is needed to start breaking the bonds of the reactants. In most chemical reactions, some existing bonds need to be broken (an endothermic process) before new bonds can be made (an exothermic process).



Do different reactions need different E_a?

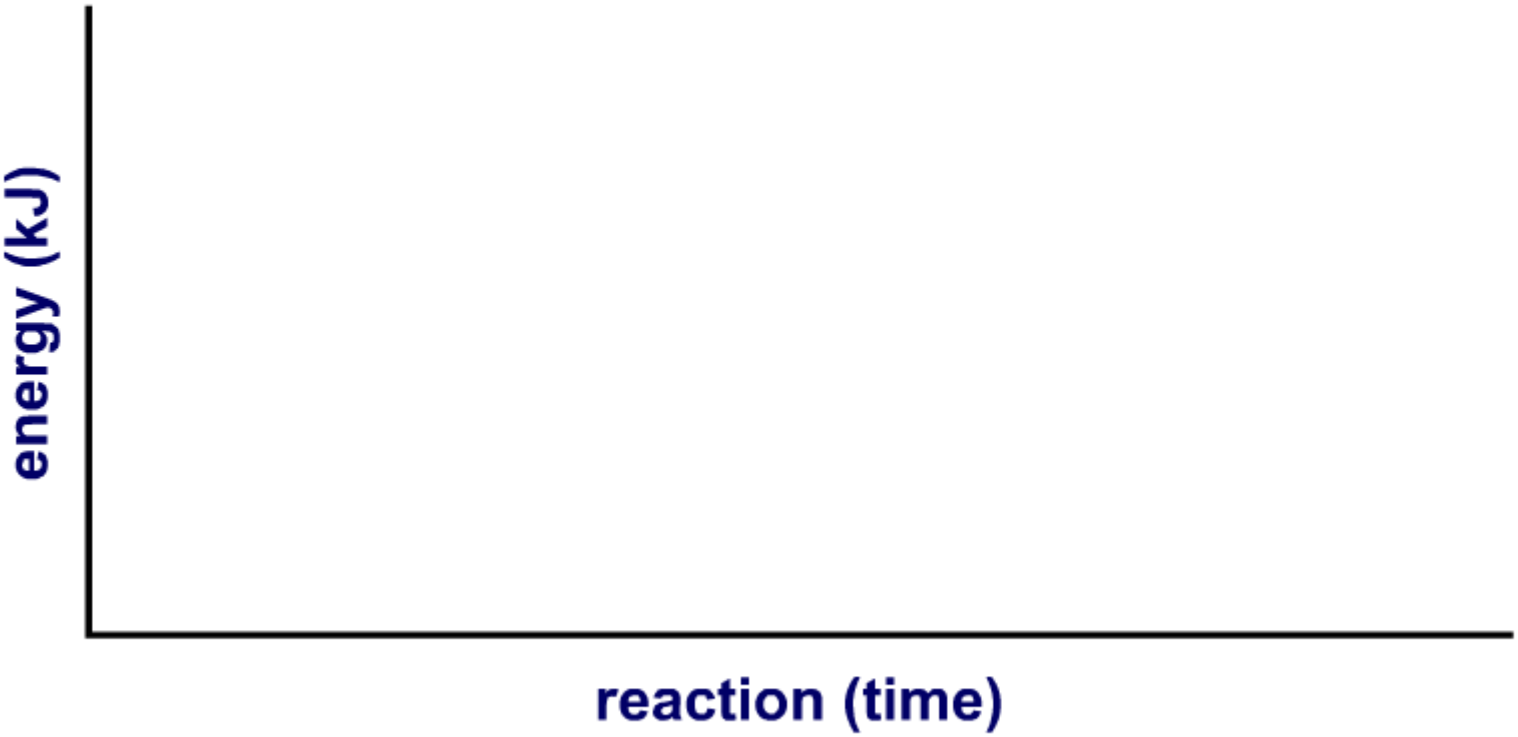
In some reactions, the bonds are easily broken and a low activation energy is needed; for example, the reaction between sodium hydroxide and water starts at room temperature.

In other reactions, the bonds are strong and not easily broken. The reaction needs lots of activation energy.

An example is the combustion of charcoal (carbon) – it needs lots of heating before it will start to burn.

E_a: exothermic reactions

What is the E_a and overall energy change for this exothermic reaction?



E_a: endothermic reactions

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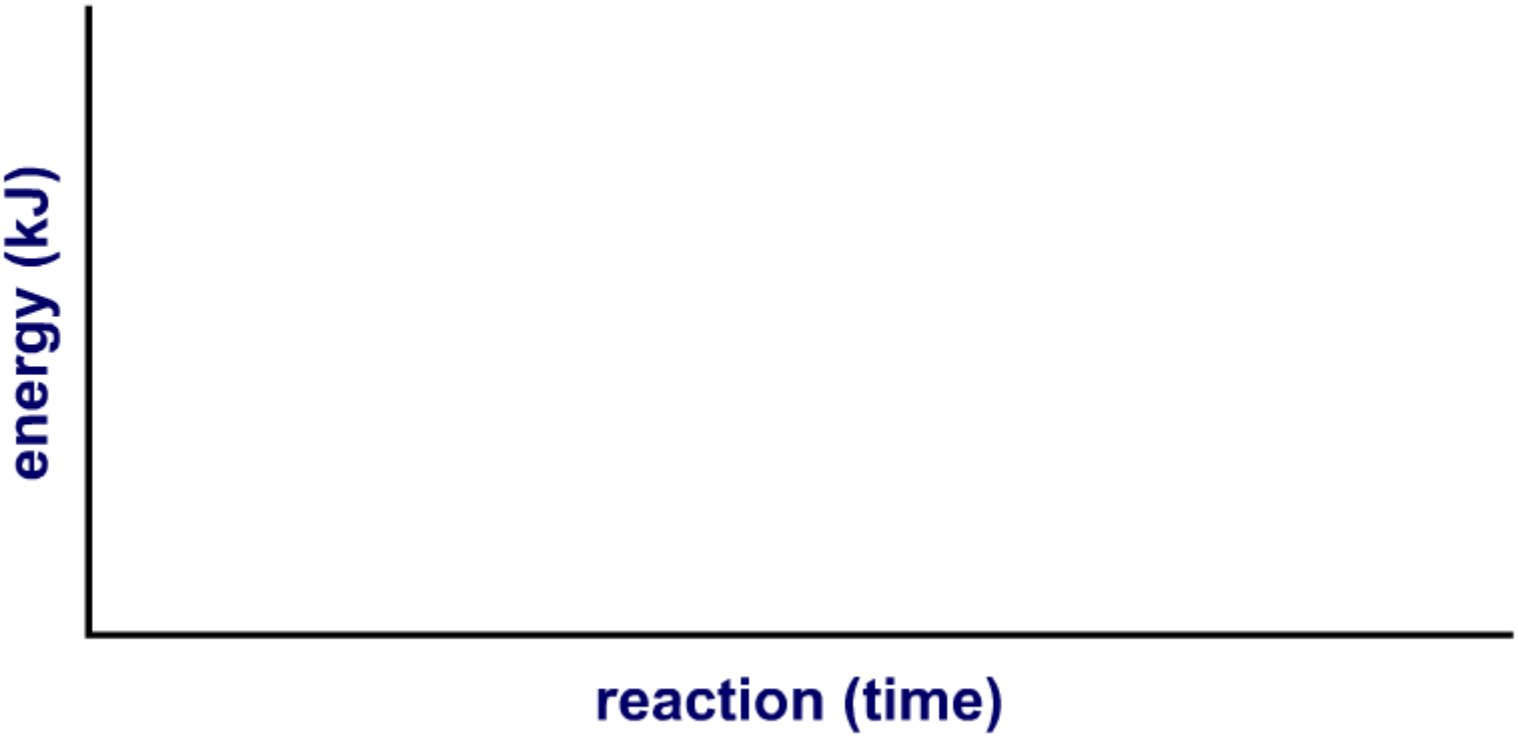


Bond energies

The amount of energy needed to break or make a bond is called the **bond energy**.

Different chemical bonds have different bond energies. For example:

Bond	Bond energy (kJ)
H–H	432
Cl–Cl	240
H–Cl	428

The energy changes in a reaction can be calculated from the bond energies of the reactants and the products.

Calculating bond energies

What are the energy changes in the reaction between hydrogen and chlorine?

hydrogen	+	chlorine	→	hydrogen chloride
H_2	+	Cl_2	→	2HCl

energy for bond-breaking

= H–H + Cl–Cl

= 432 kJ + 240 kJ

= **672 kJ**

energy from bond-making

= H–Cl + H–Cl

= 428 kJ + 428 kJ

= **856 kJ**

total energy change = energy out – energy in

= 672 kJ – 856 kJ

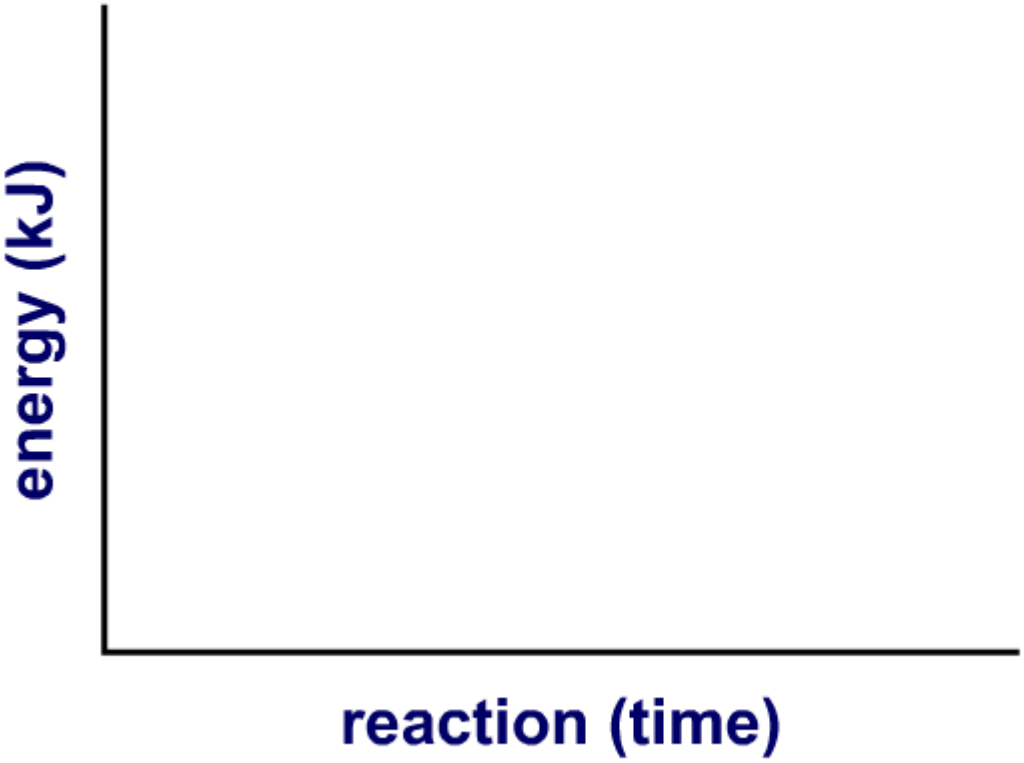
= **–184 kJ**

Energy level diagram for $H_2 + Cl_2$

Energy level diagram for the reaction between hydrogen and chlorine

Is the energy change in the reaction between hydrogen and chlorine endothermic or exothermic?

Click "**play**" to find out.



True or false?