



1.1 Fire as a physical process

A photograph of a forest fire. A large, bright fireball is rising from the trees, illuminating the surrounding forest. The sky is filled with smoke and fire. The trees are dark green, and the fire is bright orange and yellow.

What is “fire” anyway?

For now we will use the simpler term
“combustion”, for reasons that will
become clear...

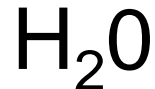
A simple example

Oxidation of methane (CH₄)

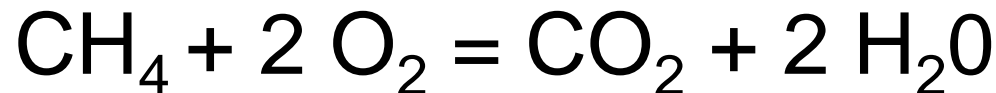
Reactants:



Products:



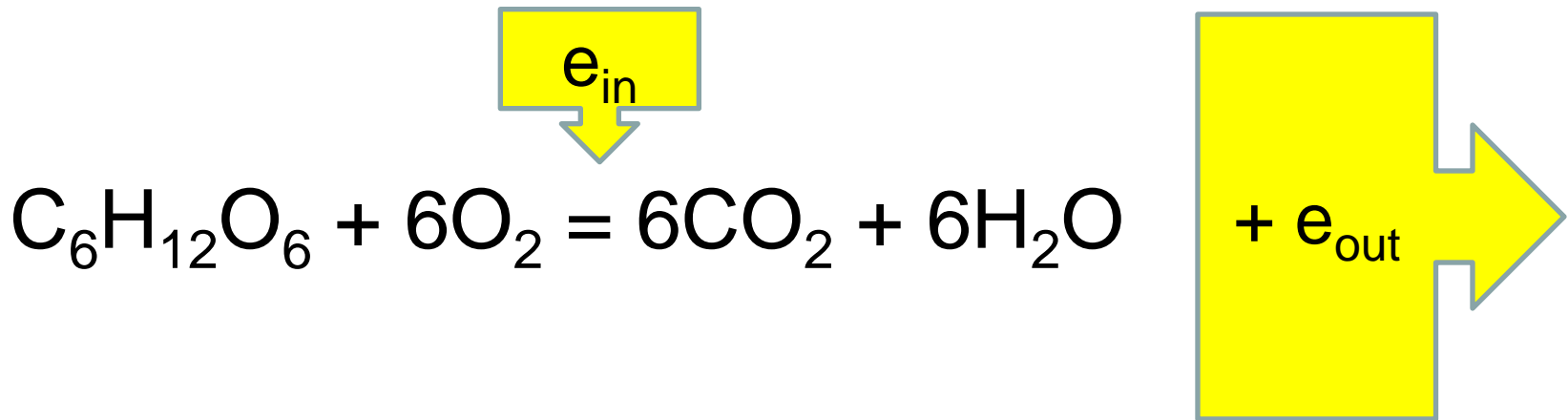
Balance the equation!



Now try glucose

- $C_6H_{12}O_6$
- Spreadsheet exercise

Final form (*stoichiometry*) of oxidation (combustion) of glucose



Energy!

Initiation energy: the first part of the oxidation reaction is *endothermic*

- Gk. *endon* (inside, inner), from *en* (in) + *don* (house, entity) + *therme* (heat)
- So the reaction takes in (*i.e.* requires) energy!
- What is this energy being used for?

Output energy

The eventual output of the combustion reaction generates or emits energy:

- Where does this energy come from?
 - Breaking of molecular bonds of the glucose molecule
 - Pretty much the same amount of energy that went into assembling the molecule in the first place

Energetics

If the output energy is larger than the initiation energy (that is, $e_{\text{out}} > e_{\text{in}}$), we call the reaction *exothermic*

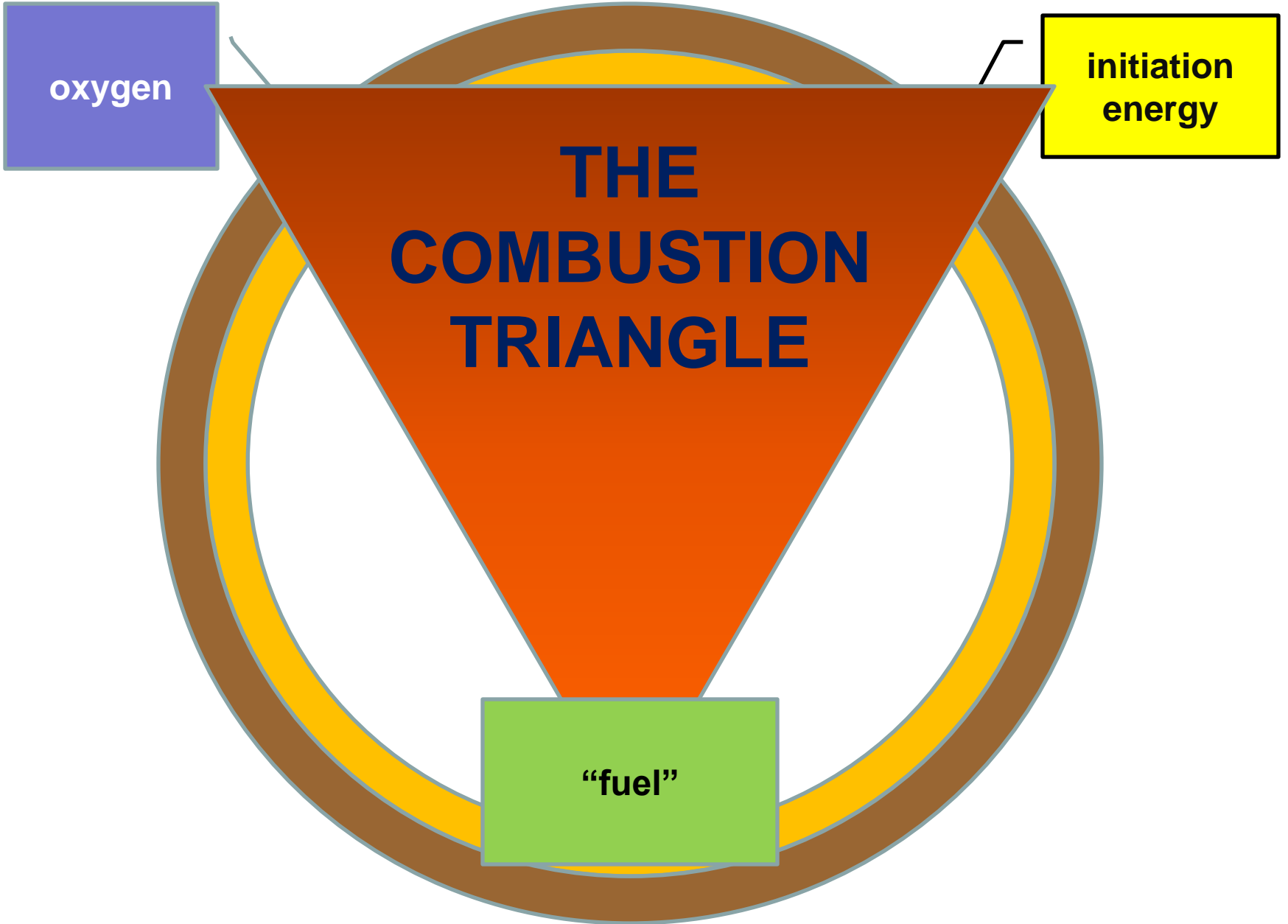
– *Gk. exo* (out of, outside)

Combustion of glucose releases $\sim 2,800$ kJ / mol
– exactly what was required in the photosynthesis process to create it!

So what do we need for combustion?

1. **Combustible molecules** (embedded molecular energy)
2. **Initiation energy** (to overcome the endothermic reaction phase)
3. **Oxygen** (because these are oxidation reactions!) (duh)

Congratulations, you have just
invented...



oxygen

initiation
energy

**THE
COMBUSTION
TRIANGLE**

“fuel”

By the way, about that energy that results from the oxidation reaction: what form does it take?

- **heat** (molecular excitation)
- **light** (*i.e.*, electromagnetic radiation)
- **mass movement** (*e.g.* rising air, convection)

Heat is a form of Energy

heat is the process of energy transfer from one body or system due to thermal contact

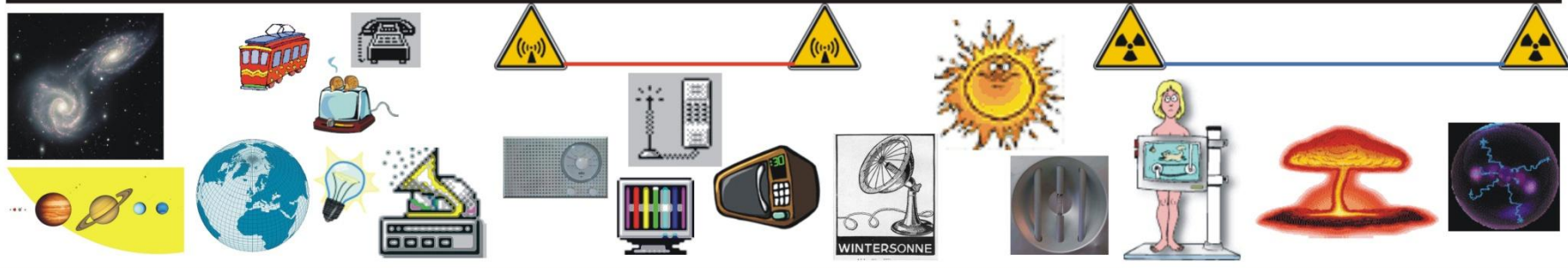
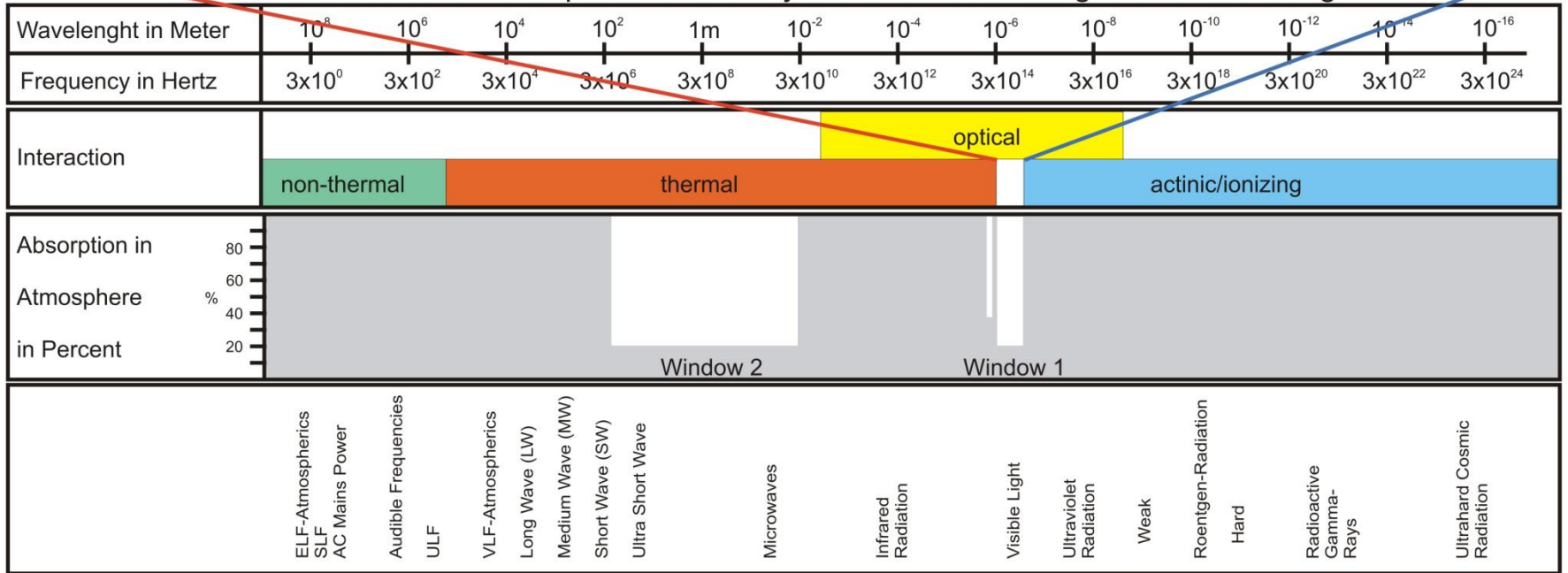
thermal energy is proportional to a body's temperature

Heat transfers between bodies according to the second law of thermodynamics (in this case, heat flows from high to low energy states)
– i.e., hot to cold bodies

The Electromagnetic Spectrum



wallchart released into public domain by www.international-light-association.org



Next time:

1.2 Fire, photosynthesis, and
the carbon cycle