



HYDROGEN

fuel of the future

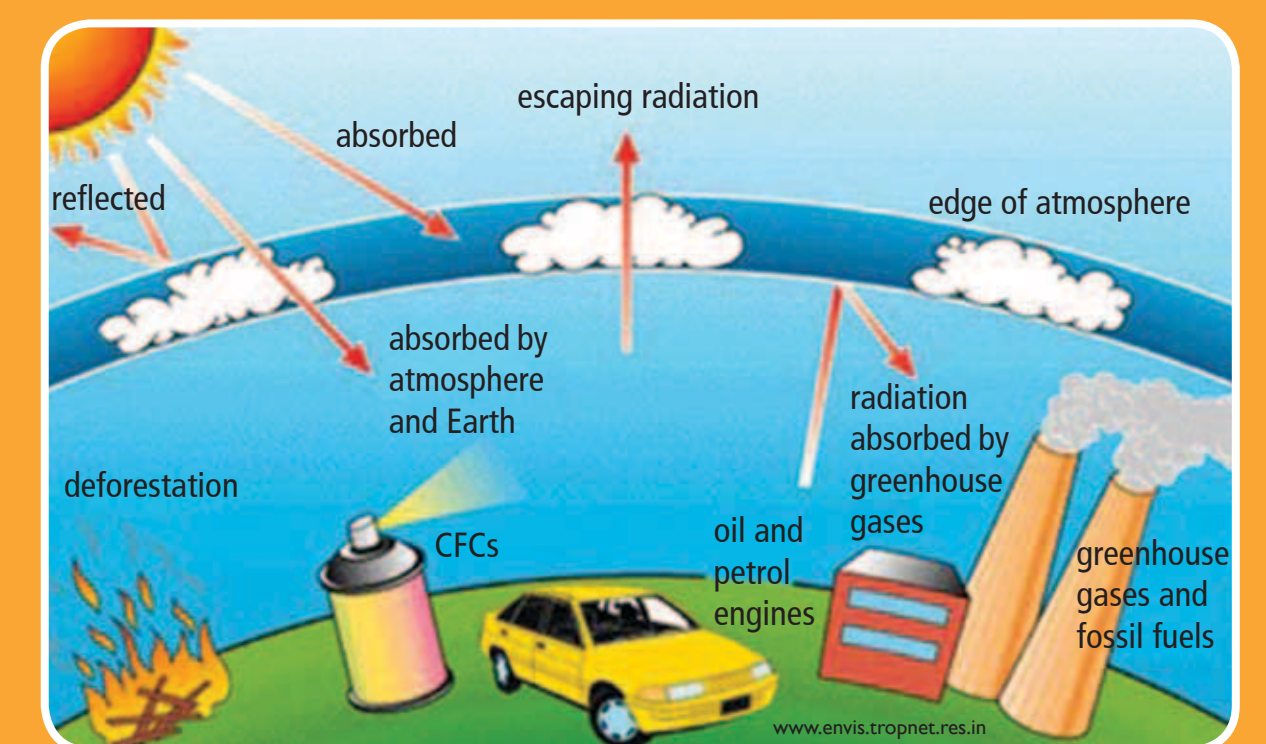
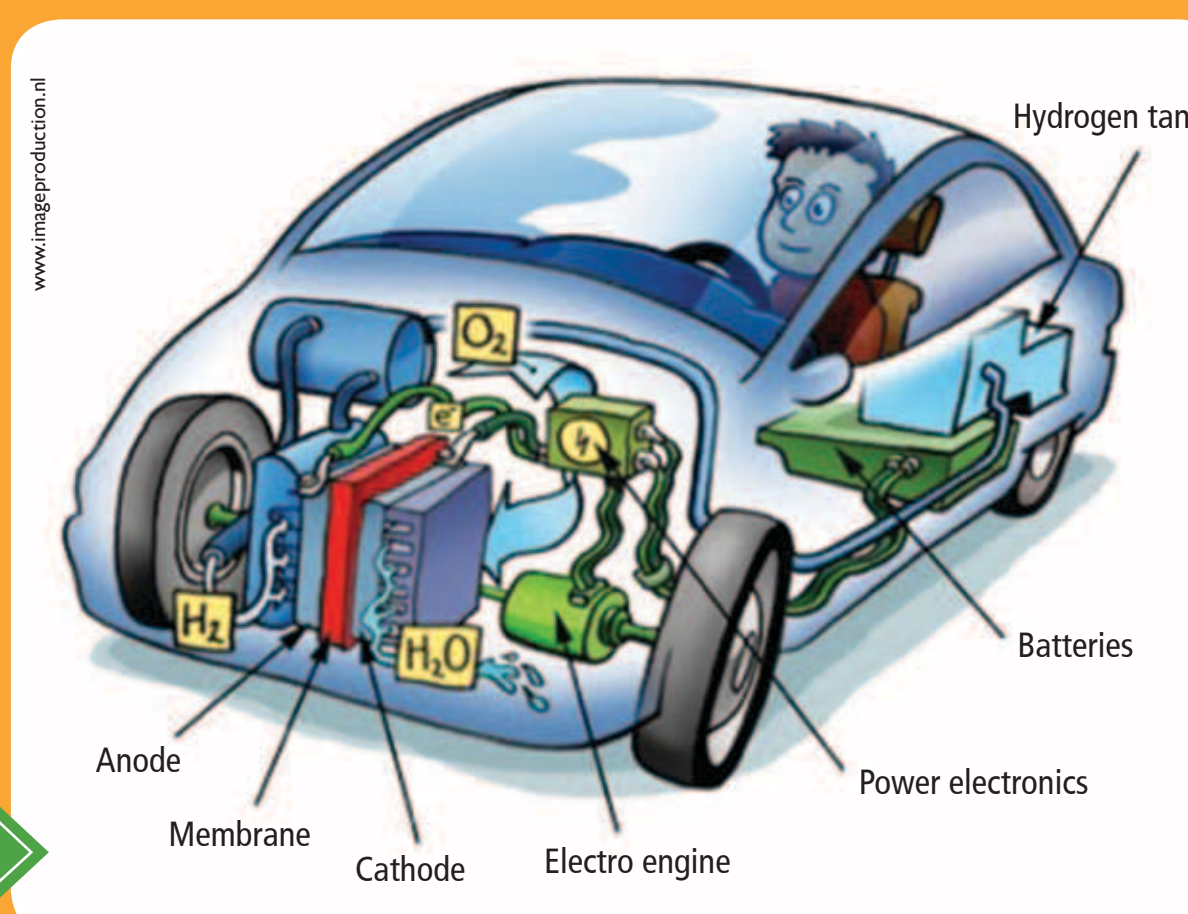
Most of the world's energy is derived from **fossil fuels** (oil, petroleum), a non-renewable source of energy which is being used much faster than it is replenished. It is predicted that it will be depleted very soon (estimated to be 50 to 100 years). Scientists have been searching for **an alternative source of fuel** and **hydrogen** has been identified as an alternative for cars and other vehicles.

Hydrogen as a fuel source

A chemical reaction between **hydrogen** and oxygen produces water. During this process the migration of electrons creates an electrical current which can be used to power a vehicle. Since only water is produced when **hydrogen** is used, it is considered a clean source of energy. **Hydrogen** fuel cells are also more efficient than the internal combustion engine.

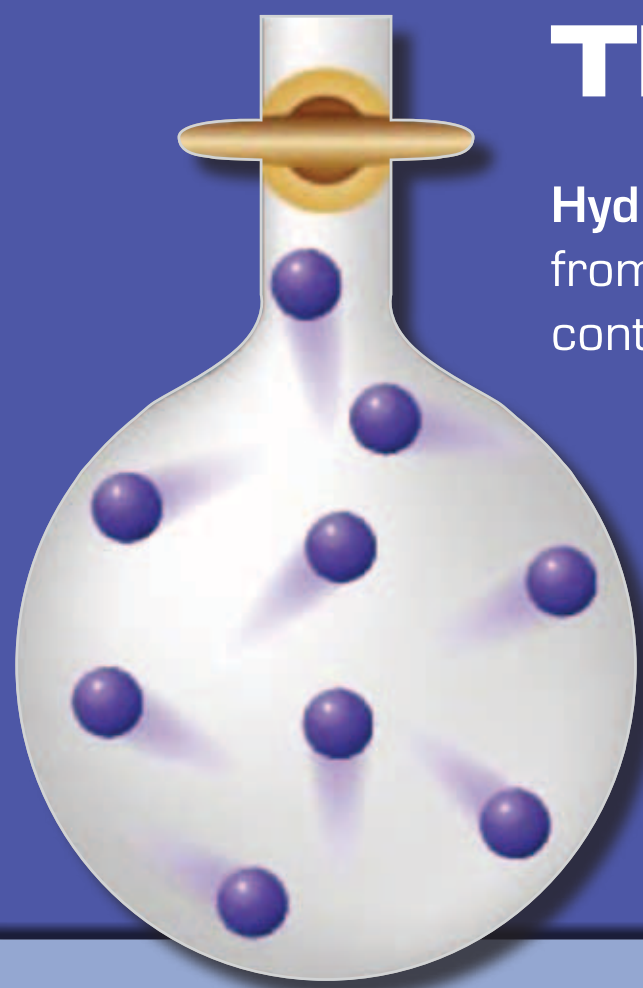
The chemical energy of **hydrogen** is at least three times that of fossil fuels and it is also the most abundant element on Earth. However, **hydrogen** needs to be stored in a safe manner on board a vehicle.

FUEL CELL CAR



Vehicles are major contributors to the greenhouse effect by emitting gases such as carbon monoxide and carbon dioxide

The major challenge of using hydrogen for vehicles



Hydrogen is a gas. Gases consist of particles (molecules or atoms) which are far apart from each other and high in energy. Collisions of these particles with the walls of a container creates "pressure".

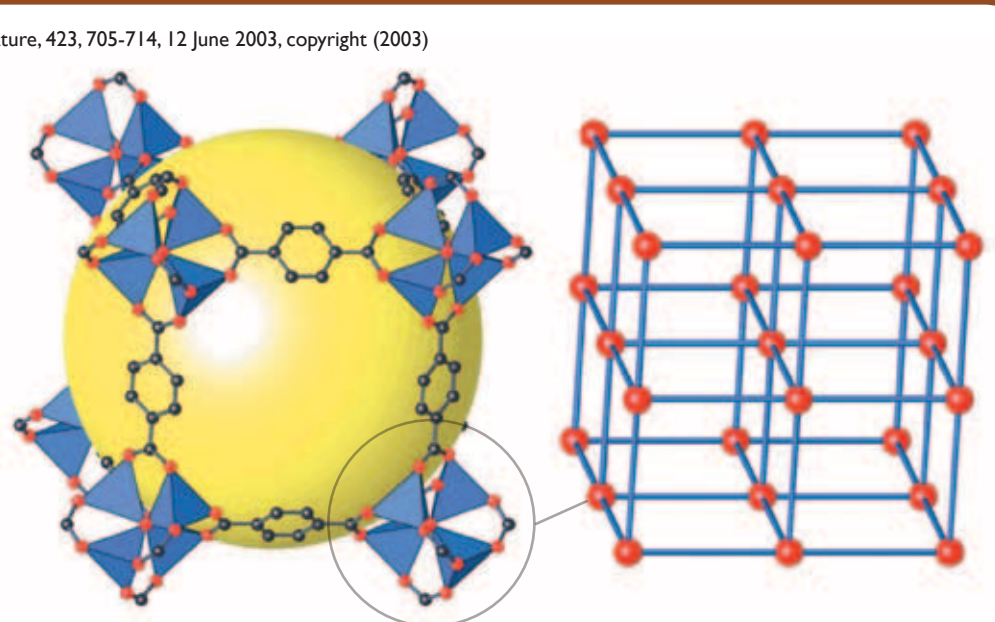
more particles → more collisions → higher pressure

The more particles there are, the more collisions and the higher the pressure. To have enough **hydrogen** to fuel a vehicle, a large amount of **hydrogen** is needed, causing high pressures. Large, heavy steel containers strong enough to contain the **hydrogen** will be necessary, making the vehicle very heavy and using even more fuel for the same distance.



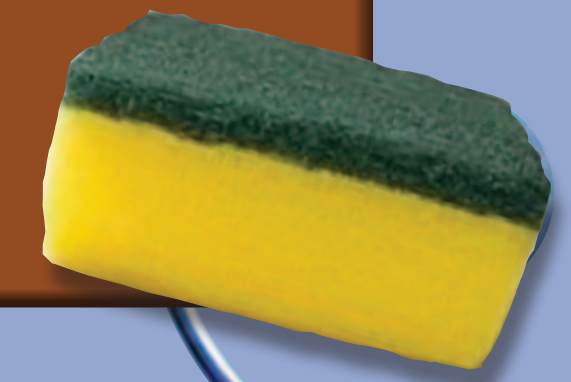
Sizes of tanks that would be needed for hydrogen in different forms

How do we make hydrogen cars lighter?



A sponge absorbs certain materials (like water) into its own 'body', removing the material from its environment. It is able to do this because it is porous (filled with holes). **Metal-organic frameworks (MOFs)** are materials which are 'sponge-like' with large 'holes' within the structure of the material. The **MOFs** act as sponges, absorbing gas molecules into their own structure. This reduces the number of gas molecules floating around in the 'atmosphere' of the container, thus reducing the pressure. Therefore, moving **MOFs** inside the **hydrogen** storage tanks will make it lighter, reducing the weight of the vehicles.

The yellow sphere represents the space that is available for hydrogen molecules to be stored.



Is hydrogen safe to use?

Concerns about the safety of hydrogen stems from the Hindenburg disaster in 1937 where a hydrogen-filled airship exploded and burnt. It was in fact not hydrogen which was dangerous, but the fact that the canvas of the airship was coated with flammable components used in rocket fuel!

Present day car with hydrogen as the fuel of the future

The **Mercedes-Benz F125** is the first vehicle which uses **MOFs** as a storage material for **hydrogen**. It has zero carbon emissions and compared to a diesel vehicle, it can cover the same distance on a full tank of **hydrogen**!

