Hydrogen and Transport

To phase out fossil fuels, some large trucks and trailers used in transport are switching to using hydrogen. **Hydrogen** gas, H_2, is stored in gas tanks on the back of the trucks and is used with **oxygen**, O_2, from the air drawn inside the engine. Other vehicles use a different technology called hydrogen fuel cells. However the energy releasing equation is the same: The hydrogen gas reacts, releasing energy.

Equations

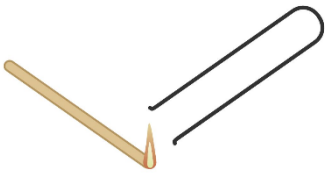
hydrogen + oxygen → water

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

Tests and Observations

Experiment

Some students made and collected some hydrogen gas by placing a 2 cm length of magnesium ribbon in 3 cm depth of dilute acid.
They collected the hydrogen gas in the upturned test tube.



They reacted the hydrogen gas they collected with oxygen gas in the air, by igniting it with a lit splint.

They rubbed a piece of blue cobalt chloride paper inside the test tube. The paper turned from blue to pink.

hydrogen + oxygen → water

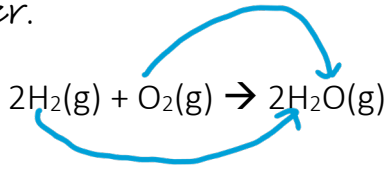
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

The reaction is a combination reaction. It is combination because two non-metal elements hydrogen and oxygen (the reactants) have combined to make a compound, water (the product). It matches the equation on the resource sheet where:

non-metal + non-metal → covalent molecule.

Hydrogen gas (made in the experiment) and oxygen gas (in the air) are both colourless gases (so they cannot be seen). When ignited, the hydrogen gas burns with a squeaky pop (which is the test to identify hydrogen). The product is colourless water vapour. Some of this condenses on the colder parts of the test tube, and it can be identified as water because it turns blue cobalt chloride paper pink (the test for the presence of water). Energy is released when the hydrogen and oxygen combine, as heat and sound.

In a chemical reaction mass is conserved; the total mass of the reactants will equal the mass of the product. The hydrogen and oxygen atoms in the reactants all end up in the product water.



By looking at the balanced equation it can be seen that 4 hydrogen atoms and 2 oxygen atoms are found on each side of the arrow; all that has happened is they have rearranged themselves into a new substance. The type and total number of atoms do not change.

Hydrogen is being used to attempt to phase out fossil fuels.
These fossil fuels produce products such as:

- carbon, C
- carbon monoxide, CO
- carbon dioxide, CO_2
- sulfur dioxide, SO_2.

By comparing to the products formed by the combustion of fossil fuels, explain the potential benefits for human health and the environment of switching to using hydrogen in cars.

Combustion of fossil fuels that contain carbon can lead to a variety of pollutants. Carbon monoxide (CO) and carbon dioxide (CO_2) pose significant threats to health and the environment. CO, a colourless and odourless gas, binds with haemoglobin in the blood, reducing oxygen transport and causing symptoms like headaches,

dizziness, and, at high levels, death. Carbon dioxide, CO_2, while naturally occurring, has risen to dangerous levels. Elevated CO_2 contributes to climate change, leading to extreme weather, rising sea levels, and disrupted ecosystems. Carbon emissions in the form of carbon/soot can make asthma worse in individuals by causing inflammation and irritation of the airways. This can lead to symptoms such as wheezing, coughing, shortness of breath, and chest tightness. If the fossil fuel contains sulfur dioxide this can contribute to another environmental issue, that of acid rain.

However, the only product formed by the combination of hydrogen and oxygen is water which is harmless; there are no harmful emissions. While water is also considered to be a greenhouse gas it is not as harmful as the gases produced by the combustion of fossil fuels. Therefore, it is suitable as a fuel for use in transport.