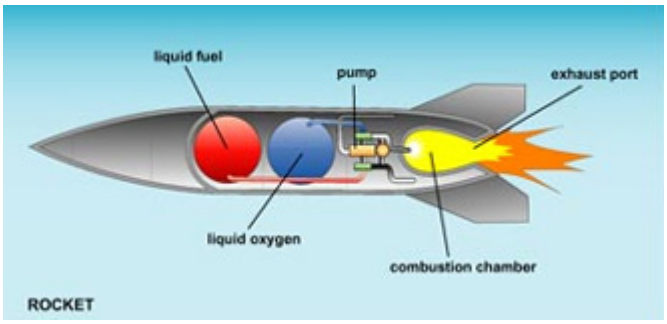
Hydrogen rocket fuel

Hydrogen can be used as a fuel for rockets. It is easy to make and can generate a lot of energy when recombined with oxygen to form water. This energy will be converted into kinetic energy, heat and sound. We use air as a source of oxygen in our experiment.



Source: http://www.nasa.gov/audience/forstudents/k-4/home/F_Why_Fly_Plane.html

In this picture, we see a schematic representation of a real rocket. What are the main differences between a real rocket and our bottle-rocket? Focus on differences in types of fuel and combustion chamber/tank.

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The following reaction shows the amount of energy produced per mole hydrogen.

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g),\ \Delta H^o = -\,484\ kJ\ mol^{-1} \qquad (1)$$

All gasses have the same volume under the same conditions. For standard conditions this is 22,4 dm^3 per mole gas.

What is the volumetric ratio between hydrogen and oxygen according to equation 1?

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The atmosphere of the earth consists for about 20% of oxygen. What will the optimal volumetric ratio between air:hydrogen be?

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Guess/measure the volume of the of the fuel reservoir of your rocket and calculate the volume which should be filled with hydrogen using the volumetric ratio from the previous question.

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The moles of hydrogen gas can be calculated by the following formula:

$$pV = nRT$$

Where:

p = Pressure [Pa]
V = Volume [m^3]
n = amounts of mole
R = Gasconstant = 8.31 [J $K^{-1}mol^{-1}$]
T = temperature [K]

Because the bottle does not have a pressure valve, we assume that the pressure is the same as the atmospheric pressure.

Calculate the moles of hydrogen in the rocket before takeoff.

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Calculate the total amount of energy, E_{chem}, released caused by reaction 1 with the amount of moles calculated in the previous question.

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What could be done to reduce the amount of volume of the fuel without decreasing the amount of moles?

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Why would you want to reduce the amount of volume of the fuels and which adjustments could you make to your rocket to achieve this?

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After the launch

Did you find any water droplets at the inside of the rocket? Where did they come from?
What was the maximum height of the rocket?

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The height energy could be calculated by:

$$E = mgh$$

Where:

E = energy [J]
m = mass of the rocket [m]
h = maximum height of the rocket [h]

We assume that the rocket only has height energy at its highest point. What is the amount of height energy of the rocket at the maximum height?

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Calculate the efficiency of the rocket with:

$$Efficiency = 100\% \cdot \frac{E_{height}}{E_{chem}}$$

Which types of energy losses have effect on the maximum height of the rocket?

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