Investigating fuel and aerodynamics of 3D printed rockets on its height and maximum velocity.

Project Context
The project idea was inspired by SpaceX who in 2015 successfully launched and recovered the first reusable rocket. The investigation was based on the idea of creating a small rocket, that could be 3D printed.

The project has two main parts: a theoretical with the propulsion and combustion and the practical part of rocket design, optimisation and experiments.

Combustion
To create the force for the rocket, combustion causes an increase in pressure which exits out the nozzle to create the force required.

For the fuel we decided on ethanol due to its accessibility to us and its high purity and entropy allowing the greatest increase in pressure and temperature during combustion.

Ethanol requires $3O_2$ for combustion so we added hydrogen peroxide, which decomposes exothermically to $H_2O$ and $O_2$ creating more oxygen in combustion.

To make sure the mixture could combust, we made a test chamber. The mixture successfully combusted, much more aggressively than the molecule on its own, creating a fierce red flame and combusted much faster.

Optimisations
To calculate the best height and radius of rocket a computer program was written. It used the combustion equation and the results of the rate of reaction to calculate maximum altitude, velocity, acceleration for a set of dimensions. Results show a 5cm radius and 7 cm height of the rocket would be the best.

Design
To decide the shape of the rocket, each member of the group all made a design which we simulated.

With the combustion of both hydrogen peroxide and ethanol at 1 : 6 ratio. The rocket has a centre column for the ethanol, with four surrounding chamber for the hydrogen peroxide which on the exit will pass through a catalyst for decomposition. We choose this design as best as the size of rocket can be changed easily and that the rocket should stay stable in the air.

Experiments
We completed four experiments looking at the reaction speed of hydrogen peroxide, the enthalpy of ethanol, the flow rate of ethanol and hydrogen peroxide and to test the combustion chamber.

The enthalpy change of ethanol found to get $-373 \text{ kJ} / \text{mol}$ which is a quarter of the accepted value. This is understandable as we could not prevent heat loss or use more accurate equipment.

For the rate of hydrogen peroxide decomposition, it was found that in the control, silver catalyst and hot water bath experiments had very little difference. However a Manganese oxide catalyst increase decomposition to 600%.