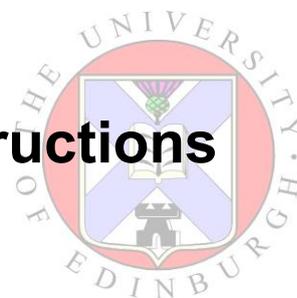


# The Bottle Rocket – Teacher's Instructions

For Demonstration Only



## ***Make Sure You Have...***

Plastic bottle (500 ml Irn Bru/Coca Cola bottles are perfect) reinforced with sellotape and filled with a 1:1 mixture of hydrogen:oxygen clamped on a clamp stand

Palladium on charcoal (5 % Pd)

Cut out plastic pipette

Spatula

Tongs

## ***What to Do...***

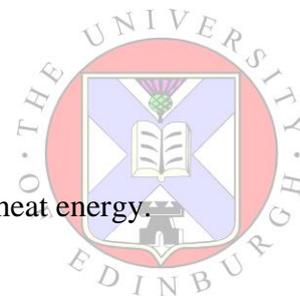
1. Scoop the tip of a microspatula of palladium on charcoal into the cut out plastic pipette
2. Encourage the audience to put their fingers in their ears.
3. Remove bottle lid and drop in (use the tongs!) the cut out pipette with the palladium on charcoal.
4. Stand well back and wait!

**After a few seconds there should be a short, sharp explosion and a flame should be visible out of the top of the bottle**

**NB. If no reaction occurs, the bottle should be left for as long as possible before the demonstrator returns to it. The bottle should then be slowly and carefully filled with water from a plastic wash bottle so that all the gas is removed.**

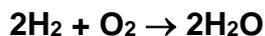
## ***Clear Up...***

1. Allow the bottle to cool and then rinse thoroughly with water.
2. Dispose of the bottle in domestic waste. **DO NOT RE-USE IT!**

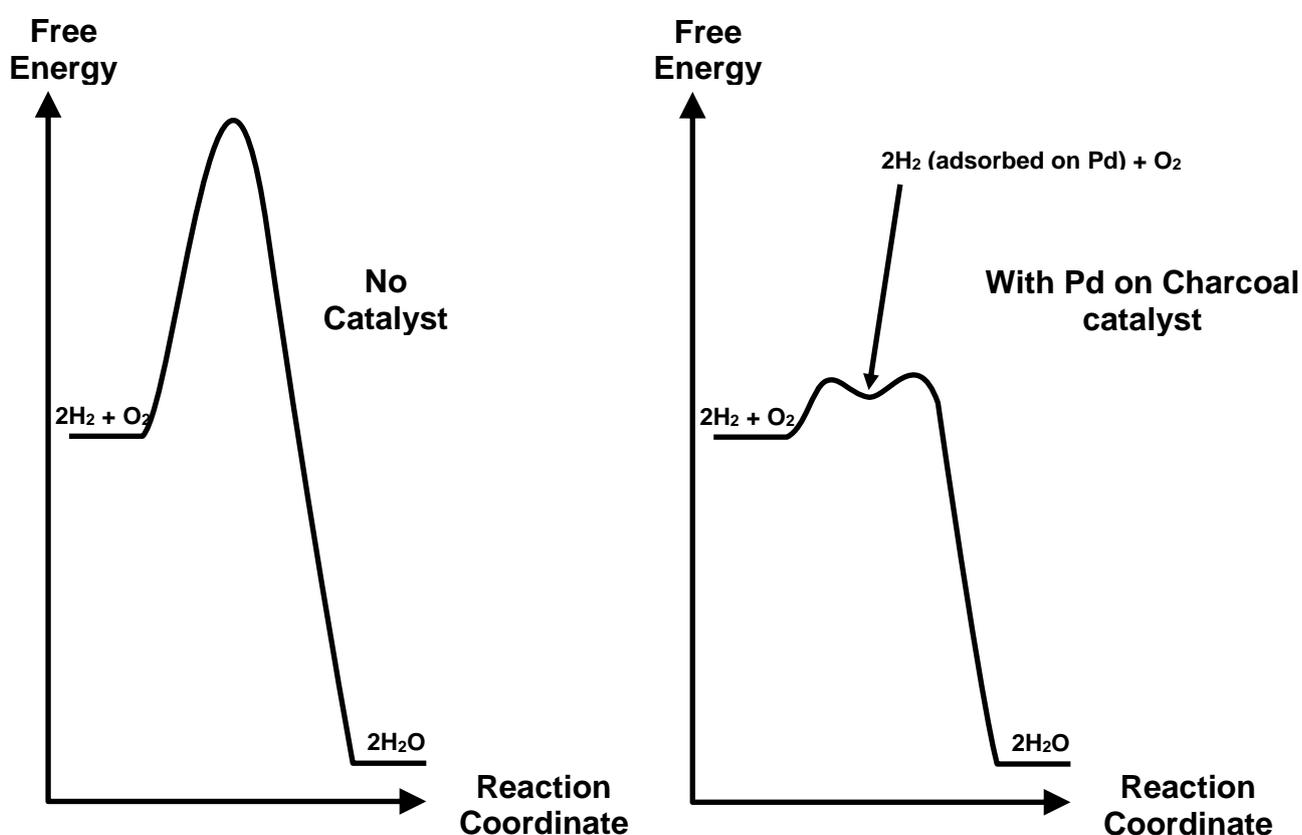


## What's Happening?

Hydrogen and oxygen can react to form water. This reaction produces a lot of heat energy.

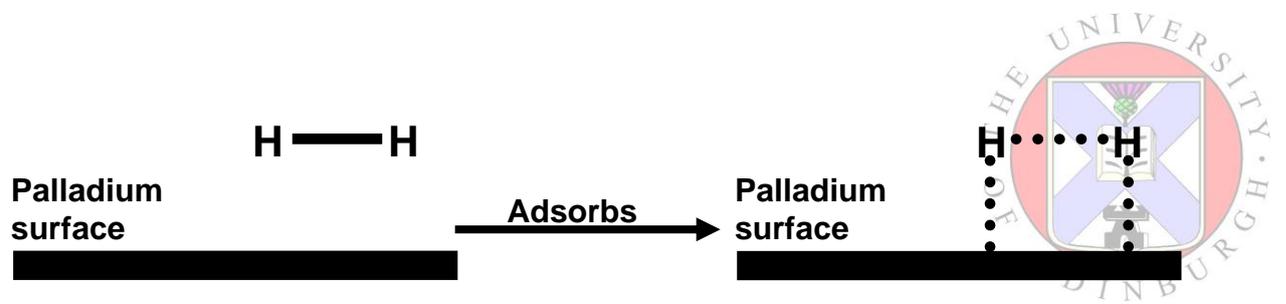


While this reaction is thermodynamically feasible (*i.e.* water has a much lower free energy than the hydrogen/oxygen mixture), there is a large kinetic (activation energy) barrier to the reaction happening. You can make it happen by adding a spark or, you can add a catalyst.



*Reaction profile for reaction of hydrogen with oxygen to make water*

The reason that the reaction takes a few seconds to happen is that the hydrogen has to adsorb onto the palladium surface. When this happens, the hydrogen bond is weakened and can be attacked by the oxygen. The chain reaction proceeds from there and the effect is obvious!



*Hydrogen has to adsorb onto the palladium surface before it can react*