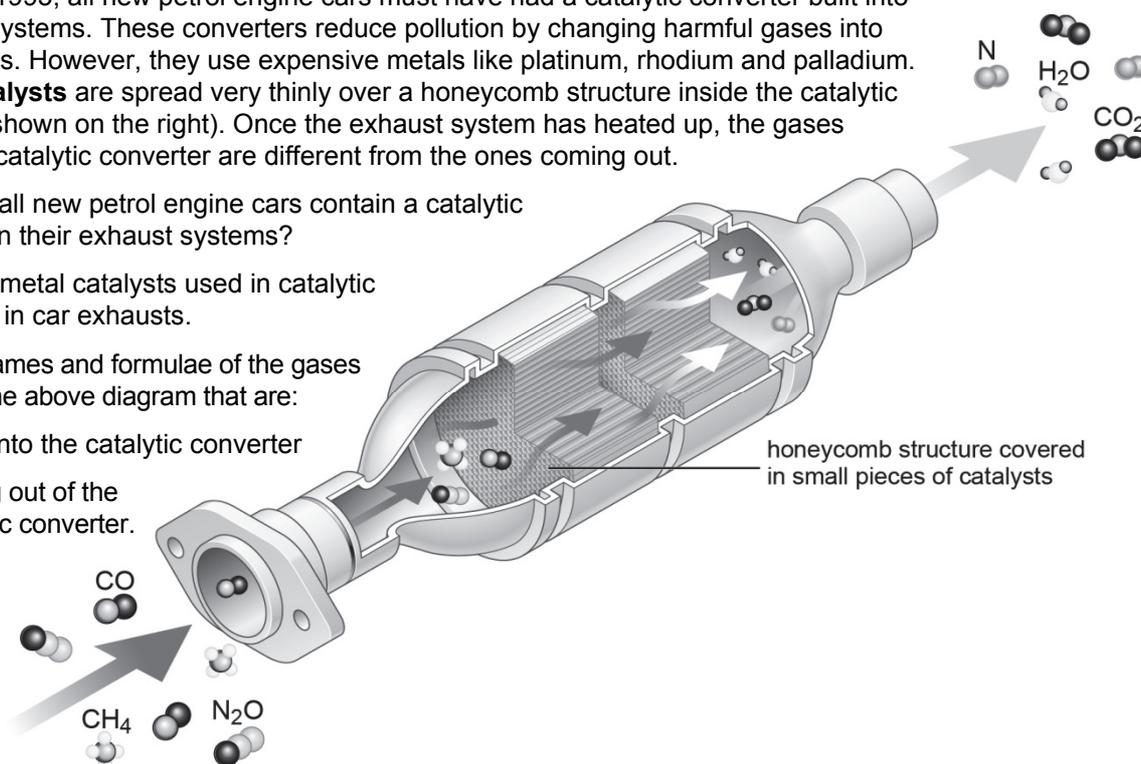


The combustion of petrol in car engines produces a number of exhaust gases that can cause air pollution. These harmful gases include carbon monoxide, unburnt hydrocarbons and nitrogen oxides. Since 1993, all new petrol engine cars must have had a catalytic converter built into their exhaust systems. These converters reduce pollution by changing harmful gases into harmless gases. However, they use expensive metals like platinum, rhodium and palladium. The metal **catalysts** are spread very thinly over a honeycomb structure inside the catalytic converter (as shown on the right). Once the exhaust system has heated up, the gases going into the catalytic converter are different from the ones coming out.



- Why must all new petrol engine cars contain a catalytic converter in their exhaust systems?
- Name two metal catalysts used in catalytic converters in car exhausts.
- Give the names and formulae of the gases shown in the above diagram that are:
 - going into the catalytic converter
 - coming out of the catalytic converter.
- Describe a danger caused by carbon monoxide gas.
- A number of reactions occur in the catalytic converter, for example carbon monoxide (CO) and dinitrogen oxide (N₂O) can be changed into carbon dioxide (CO₂) and nitrogen (N₂).
 - Write a word equation and balanced equation for the reaction described above.
 - Write a balanced equation for the reaction between methane (CH₄) and oxygen (O₂) to form carbon dioxide (CO₂) and water (H₂O).
- Explain why the catalyst is spread very thinly over a honeycomb.
 - Suggest another possible reason why the catalysts are spread very thinly.
 - Suggest a reason why the catalytic converter works better when the exhaust system is hot.
- The table shows data for cars with and without catalytic converters. Note that diesel cars produce a lot of carbon particles (soot), whereas petrol cars do not. The levels of pollutants are given in comparison to those from a petrol car without a catalytic converter, which has a baseline value of 100.

Car type	Carbon monoxide	Unburnt hydrocarbon	Oxides of nitrogen	Carbon dioxide
Petrol car without catalytic converter (baseline values)	100	100	100	100
Petrol car with catalytic converter	42	19	23	100
Diesel car without catalytic converter	2	3	31	85

- Draw a suitable graph or chart to show the relative amounts of gases given out by each car.
- Describe the effect of the catalytic converter on emissions of these four types of gas.
- How do emissions from a diesel car compare with emissions from a petrol car with a catalytic converter?