

Atmospheric pollution

Answer all the questions below then check your answers

1. Most of our fuels are hydrocarbons. Name 3 fuels which are hydrocarbons.
2. What gas is needed for combustion?
3. What are the products of the combustion of hydrocarbons?
 - a. Complete the word equation below for the combustion of butane gas, the main constituent in calor gas.

Butane + oxygen \longrightarrow

4. Most of the fuel burned contain sulfur as an impurity. Complete the word and symbolic equation below for the combustion of sulfur.

a. sulfur + oxygen \longrightarrow

$S_{(s)} + O_{2(g)} \longrightarrow$

- b. Sulfur dioxide is an acidic gas. It dissolves in rain clouds to form sulfurous acid (H_2SO_3). Complete the equations below to show how this acid forms:

i. sulfur dioxide + water \longrightarrow

$SO_{2(g)} + H_2O_{(l)} \longrightarrow$

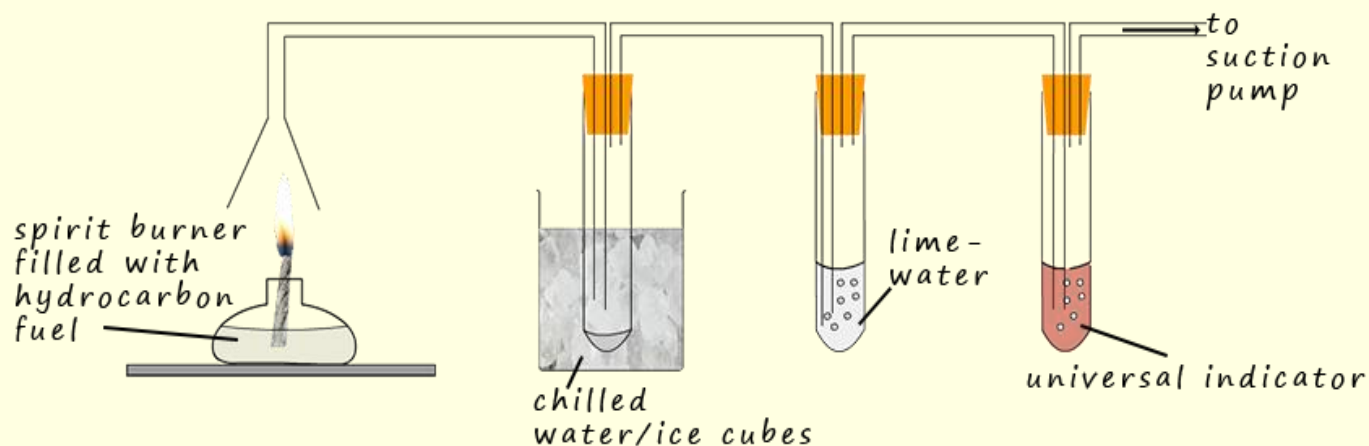
- ii. Sulfurous acid is easily oxidised by oxygen in the air to form sulfuric acid, $H_2SO_{4(aq)}$.

Write a word and balanced symbolic equation for this reaction.

5. This mixture of sulfuric and sulfurous acids is one of the main causes of acid rain. Describe some of the environmental problems caused by acid rain.



6. A student set-up the apparatus below to investigate the products of the combustion of a hydrocarbon fuel.



- a. What is limewater used to test-for? State the result of this test.
- b. What is the student testing for by having a boiling tube filled with universal indicator?

c. What will collect in the boiling tube in the iced water?

7. Car engines are a major source of air pollution, particularly in large cities.

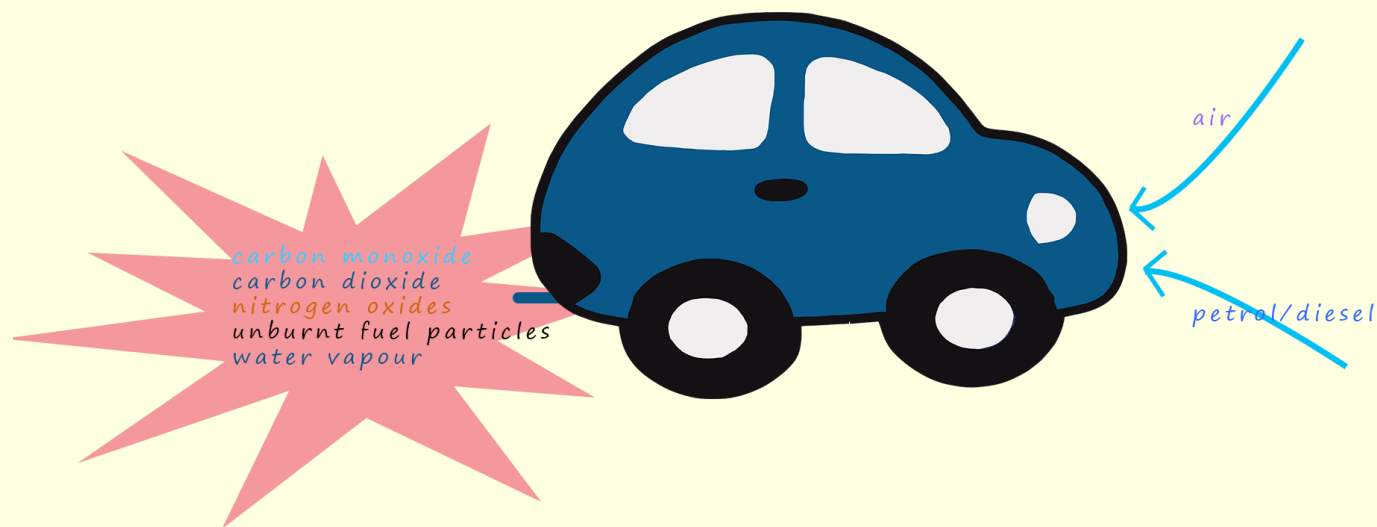
a. What two gases make up most of the air?

b. Inside car engines it is hot enough for the air itself to actually burn. Write a word and symbolic equation to show how nitrogen and oxygen in the air burn inside a car engine to form nitrogen dioxide gas.

i. What do motor manufacturers add to the exhaust pipes of cars to reduce the emissions of these oxides of nitrogen?



8. Cars use petrol as a fuel. Petrol contains the hydrocarbon octane (C_8H_{18}).



a. What happens to the petrol inside the car engine?

b. Complete the word and symbolic equation to show the complete combustion of petrol (octane).

octane + oxygen \longrightarrow

$C_8H_{18} + O_2 \longrightarrow$

- c. If the car above is badly maintained then instead of complete combustion occurring inside the car engine, incomplete combustion is likely to happen.
- What toxic gas will be produced by the incomplete combustion of carbon instead of carbon dioxide?
 - A badly maintained car can also produce many small particles of unburnt fuel and soot. What serious environmental problems do these small particulates cause?
 - Cars are fitted with catalytic converters in their exhaust systems. One job of the catalytic converter is to remove carbon monoxide gas from the exhaust emissions. It does this by oxidising the carbon monoxide to carbon dioxide. Write a word and symbolic equation to show this oxidation reaction.
 - Explain how oxides of nitrogen are produced inside car engines. Use appropriate equations to support your answer.

Atmospheric pollution

Answers

1. Most of our fuels are hydrocarbons. Name 3 fuels which are hydrocarbons.

Petrol, diesel, paraffin, butane, methane

2. What gas is needed for combustion? Oxygen

3. What are the products of the combustion of hydrocarbons?

Carbon dioxide gas and water vapour

a. Complete the word equation below for the combustion of butane gas, the main constituent in calor gas.

Butane + oxygen \longrightarrow carbon dioxide + water

4. Most of the fuel burned contain sulfur as an impurity. Complete the word and symbolic equation below for the combustion of sulfur.

a. sulfur + oxygen \longrightarrow sulfur dioxide

$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$

b. Sulfur dioxide is an acidic gas. It dissolves in rain clouds to form sulfurous acid (H_2SO_3). Complete the equations below to show how this acid forms:

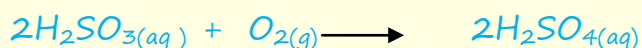
i. sulfur dioxide + water \longrightarrow sulfurous acid

$SO_{2(g)} + H_2O_{(l)} \longrightarrow H_2SO_{3(aq)}$

- ii. Sulfurous acid is easily oxidised by oxygen in the air to form sulfuric acid, $H_2SO_{4(aq)}$.

Write a word and balanced symbolic equation for this reaction.

sulfurous acid + oxygen \longrightarrow sulfuric acid



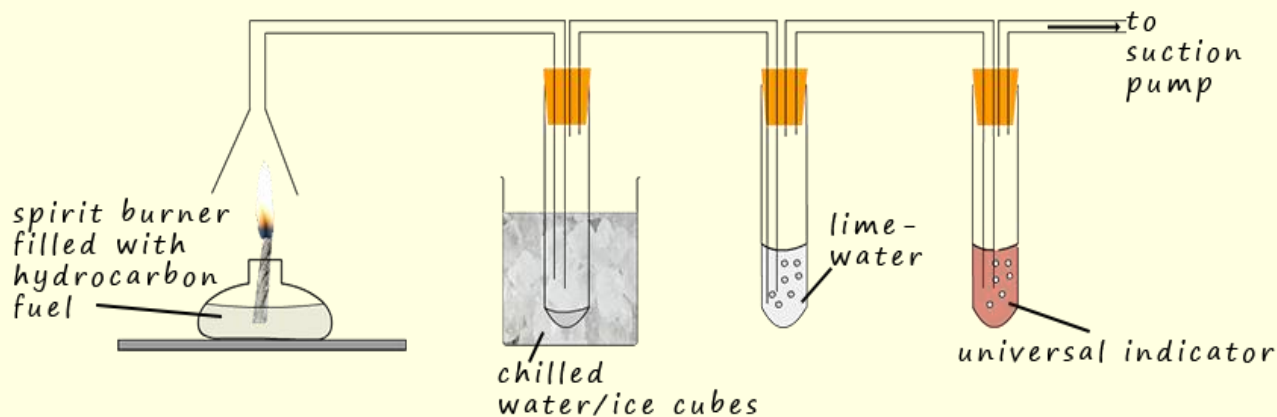
5. This mixture of sulfuric and sulfurous acids is one of the main causes of acid rain.

Describe some of the environmental problems caused by acid rain.

- Decrease the pH of soils making them very acidic and unusable.
- Reduce soil fertility and leach out valuable minerals from the soil.
- Reduce pH of lakes and rivers affecting many aquatic ecosystems.
- Erodes stonework in building and construction.
- Corrodes metals



6. A student set-up the apparatus below to investigate the products of combustion of a hydrocarbon fuel.



a. What is limewater used to test-for? State the result of this test.

Limewater turns milky or chalky in the presence of carbon dioxide gas.

b. What is the student testing for by having a boiling tube filled with universal indicator?

In this example testing for the presence of acidic gases, probably sulfur dioxide

c. What will collect in the boiling tube in the iced water?

Liquid water

7. Car engines are a major source of air pollution, particularly in large cities.

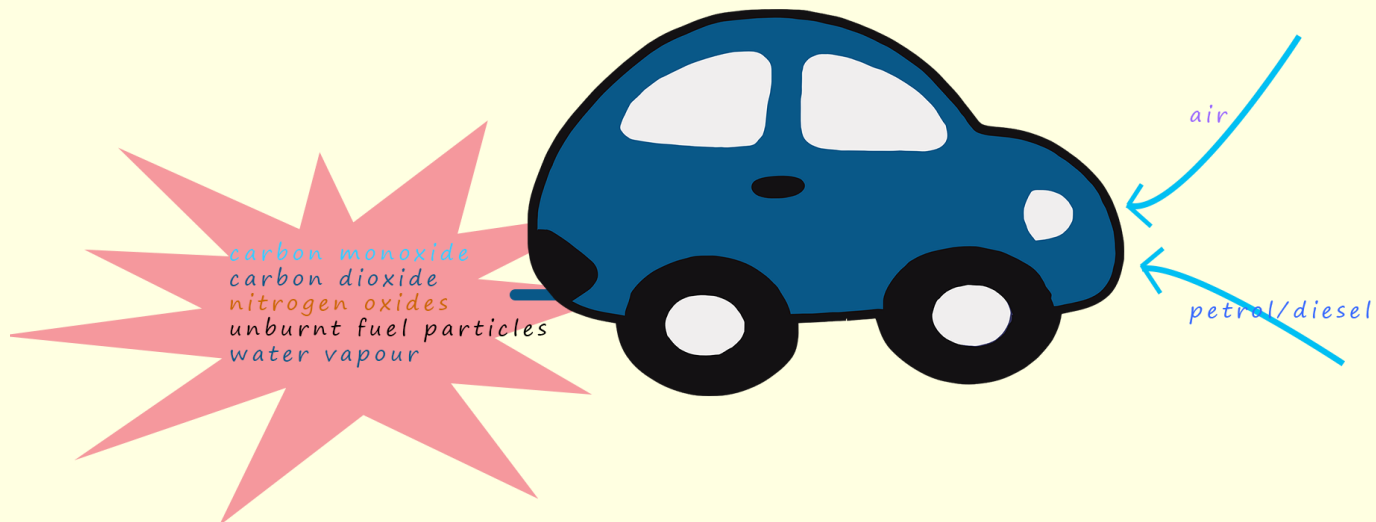
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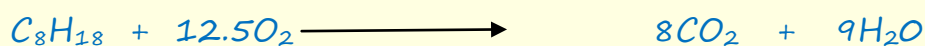


a. What happens to the petrol inside the car engine?

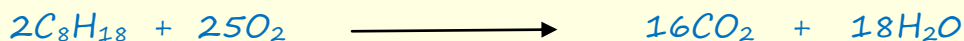
It undergoes a combustion reaction with the oxygen from the air.

b. Complete the word and symbolic equation to show the complete combustion of petrol (octane).

octane + oxygen \longrightarrow carbon dioxide + water vapour



OR

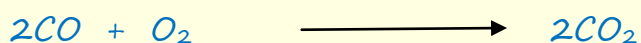


c. If the car above is badly maintained then instead of complete combustion occurring inside the car engine, incomplete combustion is likely to happen.

i. What toxic gas will be produced by the incomplete combustion of carbon instead of carbon dioxide? *Carbon monoxide*

- ii. A badly maintained car can also produce many small particles of unburnt fuel and soot. What serious environmental problems do these small particulates cause?
- Particulates can damage the respiratory system, especially of younger children.
 - Particulates also contribute to global dimming.
- iii. Cars are fitted with catalytic converters in their exhaust systems. One job of the catalytic converter is to remove carbon monoxide gas from the exhaust emissions. It does this by oxidising the carbon monoxide to carbon dioxide. Write a word and symbolic equation to show this oxidation reaction.

Carbon monoxide + oxygen \longrightarrow carbon dioxide



- iv. Explain how oxides of nitrogen are produced inside car engines. Use appropriate equations to support your answer.

The air which is drawn into the engine contains nitrogen and oxygen, these two gases can combine due to the high temperatures, pressures and high voltages inside car engines to form oxides of nitrogen e.g.

nitrogen + oxygen \longrightarrow nitrogen oxide or dioxide or oxides of nitrogen