Deliver Change

Key Stage 4 AQA Environmental Science 4440 GCSE

Lesson 1: "Fossil fuels, combustion and air pollution"

Divided into two parts
Length of Part 1: 30 minutes
Length of Part 2: 20 minutes

For Exams June 2014 onwards
Lesson Topic:
Section A2: Energy Resources
http://filestore.aqa.org.uk/subjects/AQA-4440-W-SP-14.PDF *page* 15

CURRICULUM

A2.3 Why is the continued use of fossil fuels unsustainable?
Candidates should know and understand that the current rate of fossil fuel use is unsustainable because:

- They are non renewable resources which are being used faster than they are being created
- Their combustion releases the greenhouse gas, carbon dioxide, which is associated with Global Climate Change
- Their combustion may also release nitrogen oxides, sulfur oxides, carbon monoxide and particles which are associated with poor human health and air pollution (details not required)

Candidates should be able to:

- Interpret data on declining fossil fuel resources

Opportunity to investigate using scientific knowledge and skills:

- Gases released when burning fossil fuels

LESSON PLAN

Part 1: The information given can be used in class by the teacher, as well as for students as exam or project revision.
Students will learn about various outdoor air pollutants formed when burning fossil fuels. Next, students will learn about the process around combustion systems, as well as catalytic converters.

Part 2: Students will be asked to work out their own carbon footprint, by accessing www.carbonfootprint.com. Part 2 can also be used as homework.

LEARNING OBJECTIVES

Students will:

- Understand the difference between complete and incomplete combustion and the creation of air pollutants
- Understand the impact of carbon monoxide
- Be able to describe the benefits of using catalytic converters
- Learn about their own consumption and use of resources, to gain a better understating of their own and household's impact on the environment.

LESSON REQUIREMENTS:

- White board
- Web access
- Handout to class (if applicable)

name .....

Part 1
Read & understand the following passage.

Complete combustion burning
When fossil fuels burn efficiently, the only products are carbon dioxide and water e.g. burning natural gas and petrol

- methane + oxygen ==> water + carbon dioxide
- $CH_{4(g)} + 2O_{2(g)} ==> CO_{2(g)} + 2H_2O_{(l)}$
- pentane + oxygen ==> water + carbon dioxide
- $C_5H_{12(g)} + 8O_{2(g)} ==> 5CO_{2(g)} + 6H_2O_{(l)}$

Power stations burn huge quantities of fossil fuels, including coal, some gas and oil. The heat from the combustion is used to turn water into steam and steam driven turbines power the electrical generators.

If there is not enough oxygen present to completely burn the fuel to carbon dioxide and water, other products may form causing pollution. This is called incomplete combustion. These can be carbon C (soot) and deadly carbon monoxide CO.

- Carbon-soot, a fine black powder-dust can be found in inefficient motor vehicle engines, and are harmful to human health.
- The soot, like any fine solid 'dust' is harmful when inhaled.
- Soot deposits cause coughing and sore throat and are ejected from your body through sneezing, coughing, and nose blowing.
- Coarse particles are approximately 10 microns long (too small for the human eye to see!) and are inhaled into your windpipe, causing irritation and more coughing.

Even very low concentrations of carbon monoxide can be fatal. Why?

- Oxygen is carried around the body by a complicated protein molecule in red blood cells called haemoglobin.
- The bonding between oxygen and haemoglobin is quite weak to allow easy oxygen transfer for cell respiration.
- The bonding between carbon monoxide and haemoglobin is stronger than with oxygen, so oxygen is replaced by carbon monoxide and blocks normal cell respiration.
- The consequences are reduced blood oxygen concentration in the body and this can lead to blood poisoning. Running the car engine in a closed garage is therefore a bad idea, and this is also why it is important to ventilate long road tunnels.

Carbon monoxide is emitted by all car exhausts, though catalytic converters help reduce this by converting nitrogen monoxide (another pollutant) and carbon monoxide into less harmful nitrogen and carbon dioxide.

$$2NO_{(g)} + 2CO_{(g)} ==> N_{2(g)} + 2CO_{2(g)}$$

(Transition metals like platinum and rhodium are used in the catalytic converter)

Nitrogen monoxide, NO, is formed by the combination of nitrogen and oxygen at high temperature in automobile engines (cars, lorries, buses etc. - its all the same!)

$$N_{2(g)} + O_{2(g)} ==> 2NO_{(g)}$$

Nitrogen monoxide readily forms nitrogen dioxide by combining with oxygen in air on exit from the engine exhaust.

$$2NO_{(g)} + O_{2(g)} ==> 2NO_{2(g)}$$

Nitrogen dioxide is a lung and eye irritant, and, along with nitrogen monoxide, it is involved in the complex chemistry of photochemical smogs which can also produce ozone and other harmful chemicals in the air.

The reduction of fossil fuel burning is the only way to reduce photochemical smog e.g. using renewable energy such as solar power to produce electricity and use electric cars that get their energy from renewable sources.

Resources:
1. http://www.carbonfootprint.com/
2. http://uk-air.defra.gov.uk/

Part 2

Please work out your carbon footprint:

http://www.carbonfootprint.com/