

Week 8: Fuels and Hydrocarbons

Lesson 3: Skills Lesson

Complete Starter (in back of class jotter)

Starter

- 1) What is produced during the complete combustion of a hydrocarbon?
- 2) How could you test for both products?
- 3) If the cobalt chloride paper didn't change colour but the lime water went milky, give a possible fuel that had been combusted.



Learning Outcomes

By the end of this lesson you should know:

- How to extract data from a paragraph of information

Success Criteria

You will have been successful in this lesson if you:

1. Completed Homework 1 of the new topic
2. Complete questions provided
3. Self-assessed your work from this week with the solutions (posted on Wednesdays on the S2 Team)

If you have any questions about the content of this lesson, you should ask your **class teacher either through your class MS team or via email**. You will be receiving printed notes booklets in the coming months so there **is no need to copy down notes**.

What to do

Complete tasks 1 - 4 - This involves answering questions in your class jotter on Combustion and completing **Unit 2 Homework 1 in your class jotter**. Please **submit this to your class teacher via the usual channel of communication**. Once completed, your Extension activity can be found at the end of the document.



Task 1: Homework Task due Friday 12th March 1pm

Unit 2 Homework 1: Fuels and combustion

- 1) Carbon burns in an exothermic reaction to form carbon dioxide.
 - a) Explain what is meant by an *exothermic* reaction.
 - b) Write an equation, using symbols and formulae, for the combustion of carbon.
 - c) What is the test for oxygen?
 - d) What is the test for carbon dioxide?
- 2) Wood is a solid fuel.
 - a) What is meant by the word *fuel*?
 - b) What gas is used up when coal burns?
 - c) Name the **three** things that are required for burning to take place.
- 3) Carbon is an important fuel. Depending on the conditions of combustion it may burn to produce carbon monoxide or carbon dioxide.
 - a) Give the formulae for:
 - i) Oxygen
 - ii) carbon monoxide
 - iii) carbon dioxide
 - b) Under what conditions will carbon burn to make carbon monoxide?
 - c) Write an equation for the reaction in which carbon burns to form carbon monoxide.
- 4) Hydrogen is a useful fuel. It is often used to power rockets.
 - a) What is the test for hydrogen?
 - b) What is the formula of hydrogen?
 - c) Write an equation for hydrogen burning.
- 5) Different **types of coal** have different **moisture content (%)**. The **heat output (kW/kg)** depends on the type of coal. Anthracite coal has a moisture content of 15%. The heat output of anthracite is 9 kW/kg. Bituminous coal has a higher moisture content of 20% and gives out 7.5 kW/kg. The heat output of lignite coal is 6 kW/kg and it has a moisture content of 30%. Brown coal has the lowest heat output, 5 kW/kg, and at 45%, it has the highest moisture content. Show this information in a table with three suitable headings.



Task 2: Take the heading Self Check 5 in your class jotter

Self Check 5

- 1) Natural gas is a hydrocarbon. A Bunsen burner uses natural gas as a fuel. When the air hole in the Bunsen is open, the gas burns efficiently.
 - a) What are the products of combustion of natural gas in excess air?
 - b) Why can combustion of natural gas have fatal consequences?
- 2) Some fuels contain sulfur. Combustion of these fuels produces a poisonous gas which can damage the environment.
 - a) What gas is produced when sulfur is burned?
 - b) Give an equation for the combustion of sulfur.
 - c) How can the fumes from burning sulphur damage the environment?
- 3) The exhaust fumes from a car is a complex mixture of chemicals including unburnt petrol, nitrogen dioxide, nitrogen monoxide, water, carbon dioxide, carbon monoxide and soot.
 - a) Explain why the following gases are present in car exhausts:
 - i) Carbon monoxide
 - ii) Oxides of nitrogen.
 - b) Explain why the following substances are dangerous.
 - i) Carbon monoxide
 - ii) Nitrogen Dioxide
- 4) Many cars now come equipped with catalytic converters. Explain what catalytic converters do.



Task 3: Take the heading Extra Fuels Work in your class jotter

Extra Work Self Check 1

- 1) Nature turns plants into fossil fuels using heat and pressure in the absence of air. By turning cellulose from household and agricultural waste into oil, scientists can do in minutes what took nature millions of years. The result is a high quality oil.

The process is not economical as a source of fuel, but it could be used to get rid of the increasingly large amounts of household waste which contain cellulose. Also, as the oil produced does not contain sulphur, it does not produce acid rain when burned.

As well as household waste, the process can use the residue from sugar beet and grape harvesting. Recent experiments have shown that the oil can be processed to provide a substitute for petrol.

- a) What must not be present when plants are changed into fossil fuel?
- b) Give one disadvantage of the process for changing cellulose from waste into oil.
- 2) The table below shows the relationship between the percentage of ethanol and the density of alcoholic drinks.

| | | | | | |
|--|-------|-------|-------|-------|-------|
| Percentage of ethanol (%) | 40 | 50 | 60 | 70 | 80 |
| Density of alcoholic drink (g/ cm ³) | 0.928 | 0.907 | 0.886 | 0.865 | 0.844 |

- a) Write a general statement describing how the percentage of ethanol affects the density of the alcoholic drink.
- b) The density of a particular brand of alcoholic drink is 0.970 g/cm³. Predict the percentage of ethanol in this alcoholic drink.



3) The table shows the mass of various pollutants produced by recycling aluminium.

| Pollutant | Mass of pollutant produced per tonne of aluminium (kg) |
|-----------------|--|
| Sulfur dioxide | 1.0 |
| Dust | 1.5 |
| Carbon monoxide | 2.5 |
| Nitrogen oxides | 7.0 |
| Hydrocarbons | 5.0 |

Present this information on a bar chart.



Extra Work Self Check 4

- 1) The table gives information on the hardness of some steel alloys.

| Carbon present in steel alloy (%) | Hardness (units) |
|-----------------------------------|------------------|
| 0.1 | 123 |
| 0.2 | 157 |
| 0.3 | 190 |
| 0.4 | 220 |
| 0.5 | 260 |

Predict the hardness of a steel alloy containing 0.6% carbon.

- 2) Airbags in cars are designed to prevent injuries in car crashes. They contain sodium azide (NaN_3) which produces nitrogen gas on impact. The nitrogen inflates the airbag very quickly. The table gives information on the volume of nitrogen gas produced.

| Time (microseconds) | Volume of nitrogen gas produced (litres) |
|---------------------|--|
| 0 | 0 |
| 5 | 46 |
| 10 | 64 |
| 15 | 74 |
| 20 | 82 |
| 25 | 88 |
| 30 | 88 |

Draw a line graph of the results.



- 3) Loft insulation is an effective way of keeping houses warmer and reducing heating costs. Up to 20% of heating costs can be saved by installing effective loft insulation. The three main types of loft insulation are blown insulation, blanket insulation and loose-fill insulation. Blanket and loose-fill insulation can be easily installed, but blown insulation must be installed by a specialist contractor.

Most houses have blanket insulation. Blanket insulation can be made from mineral fibre or rock fibre and is supplied in rolls. Mineral fibre and rock fibre are non-flammable but must be treated to protect them from rot, vermin and dampness. When installing blanket insulation, protective clothing including gloves and a face mask must be worn to prevent fibres damaging skin and lungs. Loose-fill insulation can be made from cork granules, vermiculite or cellulose fibre. This type of insulation is not advised for use in a draughty loft because the material can blow about.

- a) How much can heating costs be reduced by installing effective loft insulation?
- b) Which type of insulation must be installed by a specialist contractor?
- c) Why must protective clothing be worn when installing blanket insulation?
- d) Why should loose-fill insulation not be used in a draughty loft?



Task 4: Correct today's starter

- 1) During the complete combustion of a hydrocarbon, carbon dioxide and water are produced.
- 2) Water can be tested by adding cobalt chloride paper, if it is water a colour change of blue to pink will occur. Carbon dioxide can be tested by bubbling through lime water, if it is carbon dioxide a colour change of colourless to cloudy will occur.
- 3) This would suggest that the fuel used did not contain Hydrogen but instead solely contained Carbon. I would assume pure carbon was the fuel used here.

Extension activity

Once completed all your Chemistry work, here is a link to look further into the Fuels and Hydrocarbons topic:

- Watch this video: <https://video.link/w/RonYb>
- Take down the word equation for complete combustion given at 1:20 in the video
- Take down the word equation for incomplete combustion given at 1:50 in the video
- Write two sentences in your jotter about why carbon monoxide is dangerous.