

IB Chemistry HL - R1.3

Energy from fuels

Exercises + Practice questions

Official answers appended at the end

Exercise

Q1. Identify the element in the third period which reacts with the least amount of oxygen when 1.0 mol of the element undergoes complete combustion.

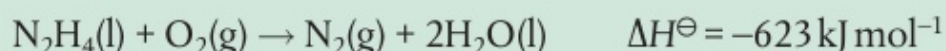
A aluminium **B** magnesium **C** sodium **D** sulfur

Q2. 1 mol of an organic compound X was found to require 2.5 mol of molecular oxygen for complete combustion. Which of the following could be X?

I. C_2H_2 II. CH_3CHO III. $\text{C}_2\text{H}_5\text{OH}$

A I and II only **B** I and III only **C** II and III only **D** I, II and III

Q3. Hydrazine, N_2H_4 , is used as a rocket fuel. It reacts according to the thermochemical equation:



Hydrazine does not, however, burn spontaneously in oxygen. What is the best explanation for this?

A Hydrazine is a liquid. **B** The $\text{N}\equiv\text{N}$ triple bond is too strong.
C The activation energy is too high. **D** The reaction is endothermic.

Exercise

- Q7.** Deduce the general equation for the incomplete combustion of a hydrocarbon C_xH_y which produces carbon monoxide.
- Q8.** Deduce the equation for the incomplete combustion of hexane which produces equal amounts of carbon dioxide and carbon monoxide.
- Q9.** (a) State the equation for the complete combustion of octane.
(b) Calculate the mass of oxygen which reacts with 1.00 g of octane during complete combustion.
(c) Assume that 20% by mass of the air is made up of oxygen. Calculate the mass of air which reacts with 1.00 g of octane.
(d) Explain why carbon monoxide is a dangerous pollutant.
(e) State one method of controlling carbon monoxide emissions from automobile engines.

retreating glacier in Iceland most probably caused by global warming.

Exercise

Q10. Consider the following specific energies of different fuels.

Fuel	Specific energy / kJ g^{-1}	Carbon content by mass / %
Coal	32	94
Oil	42	83
Natural gas	55	75
Wood	15	70
Hydrogen	142	0

- Suggest an explanation for the trend in specific energies between coal, oil, natural gas and hydrogen.
- The choice of fuel also depends on other factors besides specific energies. One of these is the amount of carbon dioxide produced. Explain why this is an important factor to consider.
- Calculate the carbon dioxide production for 1000 kJ of energy from each source and identify the best and worst fuel on this basis.

Q11. An analytical chemist determines the percentage composition by mass of a sample of coal.

C	H	O	N	S
84.96	5.08	7.55	0.73	1.68

- Determine the empirical formula of the coal.
- Explain how the combustion of the coal could produce acid rain. Give equations to illustrate how the elements in the coal can produce acidic gases.

- Q12.** The coal burnt in a 500 MW ($500 \times 10^3 \text{ kJ s}^{-1}$) power station has a specific energy of 33.0 kJ g^{-1} .
- (a) Determine the mass of coal burnt each second when the power station is operating at full capacity, assuming an efficiency of 38%.
 - (b) The empirical formula of the coal can be approximated as CH. Calculate the mass of carbon dioxide produced each second.
- Q13.** State three reasons for not relying on carbon-containing fuels in the future.
- Q14.** Crude oil currently provides a greater percentage of the world's energy than any other energy source.
- (a) State three reasons for its wide use as an energy source.
 - (b) Describe briefly how crude oil is formed in nature.
- Q15.** State three reasons why, worldwide, gas is preferred to oil as a fuel in power stations.

Exercise

- Q16.** (a) Scientists have described solar energy as the ultimate energy source. Identify energy sources which derive from photosynthesis.
- (b) Discuss the advantages and disadvantages of the use of biomass as a fuel.
- Q17.** (a) State the chemical equation for the photosynthesis of glucose.
- (b) Identify the molecule needed by plants to photosynthesize.
- (c) Glucose can be converted to ethanol, which can be used as a fuel. State the name and equation of the process and describe the conditions needed.
- Q18.** (a) When biomass decomposes in the absence of oxygen, biogas is formed. Name the main gas present in biogas.
- (b) When wood is burnt in an enclosed space, the combustion produces harmful pollutants. Identify the pollutants.
- (c) Suggest why biomass is likely to become more important in the future as a fuel.