

8.5 Energy

Contextual Outline

Anthropologists and palaeontologists tell us that one of the important cultural achievements of early humans was the discovery of fire and the invention of ways to use fire. Burning is then one of the most common and oldest chemical reactions. People meet this in their everyday life in such varied ways as lighting a match, cooking with gas and using fires.

The arrival of the industrial revolution and the increased need for fuels to power machinery mean that humans have become increasingly dependent on fuels. Heat is a major product of the burning process. Most burning of fuels in our society is done to produce heat for powering machinery, cooking or providing warmth. The efficiency with which this is done is becoming of increasing concern to society because fossil fuels, which have been the mainstay fuels, are finite and non-renewable.

People are becoming increasingly concerned about the damage done to the Earth's environment by careless and inefficient use of fossil fuels. Strategies for the efficient use of fuels can be assessed in the light of the factors that drive chemical reactions, including combustion. As fossil fuels are carbon compounds, an understanding of the structure and properties of simple carbon compounds assists understanding of the issues associated with the use of these fuels.

This module increases students' understanding of the applications and uses of chemistry and the implications of chemistry for society and the environment.

Assumed Knowledge

Domain: knowledge and understanding

Refer to the *Science Years 7–10 Syllabus* for the following:

- 5.7.3a) identify that a new compound is formed by rearranging atoms rather than by creating matter
- 5.7.3b) classify compounds into groups based on common chemical characteristics
- 5.7.3c) construct word equations from observations and written descriptions of a range of reactions
- 5.7.3d) identify a range of common compounds using their common names and chemical formulae
- 5.7.3e) qualitatively describe reactants and products in the following chemical reactions:
 - i) combustion
 - vi) decomposition
- 5.11.2a) relate pollution to contamination by unwanted substances.

	<i>Students learn to:</i>	<i>Students:</i>
1. Living organisms make compounds which are important sources of energy	<ul style="list-style-type: none"> outline the role of photosynthesis in transforming light energy to chemical energy and recall the raw materials for this process outline the role of the production of high energy carbohydrates from carbon dioxide as the important step in the stabilisation of the sun's energy in a form that can be used by animals as well as plants identify the photosynthetic origins of the chemical energy in coal, petroleum and natural gas 	<ul style="list-style-type: none"> process and present information from secondary sources on the range of compounds found in either coal, petroleum or natural gas and on the location of deposits of the selected fossil fuel in Australia
2. There is a wide variety of carbon compounds	<ul style="list-style-type: none"> identify the position of carbon in the Periodic Table and describe its electron configuration describe the structure of the diamond and graphite allotropes and account for their physical properties in terms of bonding identify that carbon can form single, double or triple covalent bonds with other carbon atoms explain the relationship between carbon's combining power and ability to form a variety of bonds and the existence of a large number of carbon compounds 	<ul style="list-style-type: none"> perform a first-hand investigation, analyse information and use available evidence to model the differences in atomic arrangement of diamond, graphite and fullerenes process and present information from secondary sources on the uses of diamond and graphite and relate their uses to their physical properties identify data, and choose resources from secondary sources such as molecular model kits, digital technologies or computer simulations to model the formation of single, double and triple bonds in simple carbon compounds

3. A variety of carbon compounds are extracted from organic sources

Students learn to:

- describe the use of fractional distillation to separate the components of petroleum and identify the uses of each fraction obtained
- identify and use the IUPAC nomenclature for describing straight-chained alkanes and alkenes from C1 to C8
- compare and contrast the properties of alkanes and alkenes C1 to C8 and use the term 'homologous series' to describe a series with the same functional group
- explain the relationship between the melting point, boiling point and volatility of the above hydrocarbons, and their non-polar nature and intermolecular forces (dispersion forces)
- assess the safety issues associated with the storage of alkanes C1 to C8 in view of their weak intermolecular forces (dispersion forces)

Students:

- perform a first-hand investigation and gather first-hand information using the process of fractional distillation to separate the components of a mixture such as ethanol and water
- plan, identify and gather data from secondary sources to model the structure of alkanes and alkenes C1 to C8
- process and present information from secondary sources and use available evidence to identify safety issues associated with the storage of alkanes

4. Combustion provides another opportunity to examine the conditions under which chemical reactions occur

Students learn to:

- describe the indicators of chemical reactions
- identify combustion as an exothermic chemical reaction
- outline the changes in molecules during chemical reactions in terms of bond-breaking and bond-making
- explain that energy is required to break bonds and energy is released when bonds are formed
- describe the energy needed to begin a chemical reaction as activation energy
- describe the energy profile diagram for both endothermic and exothermic reactions
- explain the relationship between ignition temperature and activation energy
- identify the sources of pollution which accompany the combustion of organic compounds and explain how these can be avoided
- describe chemical reactions by using full balanced chemical equations to summarise examples of complete and incomplete combustion

Students:

- solve problems and perform a first-hand investigation to measure the change in mass when a mixture such as wood is burned in an open container
- identify the changes of state involved in combustion of a burning candle
- perform first-hand investigations to observe and describe examples of endothermic and exothermic chemical reactions

	<i>Students learn to:</i>	<i>Students:</i>
5. The rate of energy release is affected by factors such as types of reactants	<ul style="list-style-type: none">• describe combustion in terms of slow, spontaneous and explosive reactions and explain the conditions under which these occur• explain the importance of collisions between reacting particles as a criterion for determining reaction rates• explain the relationship between temperature and the kinetic energy of particles• describe the role of catalysts in chemical reactions, using a named industrial catalyst as an example• explain the role of catalysts in changing the activation energy and hence the rate of chemical reaction	<ul style="list-style-type: none">• solve problems, identify data, perform first-hand investigations and gather first-hand data where appropriate, to observe the impact on reaction rates of:<ul style="list-style-type: none">- changing temperature- changing concentration- size of solid particles- adding catalysts• process information from secondary sources to investigate the conditions under which explosions occur and relate these to the importance of collisions between reacting particles• analyse information and use the available evidence to relate the conditions under which explosions occur to the need for safety in work environments where fine particles mix with air• analyse information from secondary sources to develop models to simulate the role of catalysts in changing the rate of chemical reactions