QER for Schools

QER Science Lesson – Year 11

Chemistry of oil shale waste management

NOTES

The QER New Fuels Development Centre and oil shale mine at Yarwun near Gladstone is dedicated to the creation of low sulphur oil from shale to produce diesel and jet fuels. The management of waste materials is an important priority in the production process, encompassing air, water, physical waste and noise. In this lesson, you will investigate the chemistry of waste management.

In this lesson, students will:

- discover twenty-four processes used for waste management
- investigate physical changes and chemical reactions in waste management, with a particular focus on redox and acid-base reactions

LESSON-LEVEL CONTENT DESCRIPTIONS

Queensland Chemistry Syllabus: Year 11

Key concept R1 – Specific criteria can be used to classify chemical reactions.

Key ideas

R1.1 Redox reactions involve a transfer of electrons and a change in oxidation number.

R1.3 Acid-base reactions involve transfer of protons from donors to acceptors.

LESSON OUTCOMES

The assessment focus of this lesson is formative: The classroom activities provide an opportunity for students to generate evidence with which the teacher can establish the student's progress towards understanding the concepts that are being developed in this lesson.

Science Outcomes	Literacy Outcomes	Numeracy Outcomes
Students may/should be able to:		
• identify and distinguish between physical changes and chemical reactions • articulate the role of redox and acid-base reactions in the management of waste materials	• listen • read • view • write • speak • discuss scientific phenomena • document scientific phenomena • use technical terms in a scientific context	• represent data • interpret data • collect qualitative data • analyse data

BACKGROUND INFORMATION

Students should have a prior knowledge of:

- physical changes
- chemical reactions
- pH
- ions
- balancing chemical equations

PREPARATION LIST

- distribute resource Waste Management Technology & Practices to students
- 3D animation video
- powerPoint Presentation: Paraho Process Presentation

ACTIVITY SEQUENCE

1. Introduce the QER New Fuels Development Centre and oil shale mine so as to set the context for the chemistry of waste management. Use the PowerPoint Presentation: Paraho Process Presentation, which includes a particular focus on process water, gas and biological treatment. Focus on slides 5, 6, 12, 13 and 14.

2. For an animated version of process water and gas treatments, view the 3D animation video with particular attention to the waste treatment sections (from 7:29).

3. Instruct students to draw up a large, double-page table in their books, as follows:

Physical Change	Chemical Reaction	Neither

4. Divide students into groups of 3-4. Distribute the resource "Waste Management Technology & Practices". Students read the resource and summarise each of the 24 strategies into one sentence and categorise it in their table as a physical change, chemical reaction or neither. Overlap between columns is permitted.

5. Discuss the findings of the groups as a class.

6. Ask students to identify processes in which the following chemical reactions are used:
   - Redox reactions (oxidation)
   - Acid-base reactions (pH correction).

7. Introduce the chemistry of acid-base reactions, as follows:

Acid-Base Reactions

When dissolved in water, acids dissociate to form hydrogen ions. For instance, hydrogen chloride, hydrocholic acid, becomes:

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

When dissolved in water, bases dissociate to form hydroxide ions. For instance, sodium hydroxide becomes:

$$NaOH \rightarrow Na^+ + OH^-$$

An acid-base reaction is a type of double displacement reaction that occurs between an acid and a base. When the two solutions are mixed the H_3O^+ and OH^- ions combine to form water molecules and the other ions combine to form an ionic salt, here NaCl (table salt):

$$H_3O^+ + Cl^- + Na^+ + OH^- \rightarrow 2H_2O + NaCl$$

The general equation for an acid-base reaction is: Acid + Base → Salt + Water

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8. Introduce the chemistry of redox reactions, as follows:

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Oxidation-Reduction or Redox Reactions

In a redox reaction the oxidation number (oxidation state) of an atom is changed. The combustion of hydrocarbons is a type of redox reaction which produces water, carbon dioxide and energy.

For instance, the combustion of methane gas is given by:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + 891\text{kJ/mol}$$

In organic chemistry, the stepwise oxidation of a hydrocarbon produces water and, first, an alcohol, then an aldehyde or a ketone, carboxylic acid and then a peroxide.

Acid-base reactions and redox reactions are detailed topics which could be extended into further lessons and activities in writing and balancing chemical equations.

OPPORTUNITIES FOR CONDUCTING FORMATIVE ASSESSMENT

- Observation of students' responses in QER Waste Management & Technology Practices table

LINKS TO OTHER LEARNING AREAS

The following suggested activities may be used to provide a link between the content of this unit and that of other learning areas, in particular those related to Mathematics, English and ICT.

- use of software to write and balance chemical equations

ADDITIONAL RESOURCES

- www.qervisitorcentre.com.au – Extensive overview of QER New Fuels Development Centre, including video snippets, animations, graphs, maps and explanations relating to:
  - Australia's fuel challenge
  - QER and sustainability
  - benefits for Australians
  - turning oil shale into fuel
- Oil Shale fact sheet www.oresomeresources.com/resources_view/resource/fact_sheet_oil_shale