Click on the icons to go to the other modules.

module 3  |  BP energy education programme 2008

oil and gas
exploration and production
Learning Area, Outcomes and Phase

<table>
<thead>
<tr>
<th>Learning Area</th>
<th>Society and Environment Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcomes</td>
<td>Investigation, Communication and Participation (S&amp;E)</td>
</tr>
<tr>
<td></td>
<td>Place and Space (S&amp;E)</td>
</tr>
<tr>
<td></td>
<td>Resources (S&amp;E)</td>
</tr>
<tr>
<td></td>
<td>Energy and Change (SCI)</td>
</tr>
<tr>
<td></td>
<td>Earth and Beyond (SCI)</td>
</tr>
<tr>
<td>Phase</td>
<td>Early Adolescence</td>
</tr>
<tr>
<td>Program</td>
<td>BPEEP Module 3: Oil and Gas Exploration and Production</td>
</tr>
</tbody>
</table>

Copyright
This training module is copyright. Apart from fair dealing for private study or research as permitted under the Copyright Act 1968, no part may be reproduced, copied, transmitted in any form or by any means without the prior written permission of BP Australia Pty Ltd. All requests and enquiries should be directed to the BPEEP Coordinator on (08) 9419 9623.

Disclaimer
The content of this training module is provided for educational purposes only. In no event will BP Australia Pty Ltd or any related corporation be liable for the accuracy of the information contained in the module or the reliance placed upon it. The module is provided on the basis that all persons using it take responsibility for assessing the relevance and accuracy of its content.

The content was compiled by teachers Chris Hickman and Kate Bowman of Perth, Western Australia who have sourced and written the content.
Overview of Learning Module

Module 3, titled ‘Oil and Gas Exploration and Production’ is part of the teaching and learning sequence to the BP Energy Education Program. The main objective of the module is for students to understand the stages and environmental management of oil and gas exploration and production.

Key understandings addressed in this module are delivered through 3 major conceptual areas:

1. **Locating Oil and Natural Gas accumulations**:
   - Recall the origin of oil and gas.
   - Examine the background to oil discovery and use.
   - Explain the impact of oil density and other factors on the formation of oil reservoirs.
   - Identify the essential conditions that are required when exploring for oil and gas.
   - Examine how seismic surveys are used to explore for oil and gas.

2. **Oil and Gas Fields**:
   - Describe the stages of oil and gas exploration and production
   - Examine factors that need to be considered once oil and gas are discovered.

3. **Environmental Management (BP Focus)**:
   - Locate areas where oil and gas are being explored and produced by BP.
   - Investigate environmental projects BP is involved with around the world.
   - Examine career opportunities involved with oil and gas exploration and production.
   - Investigate the causes, effects and resultant actions by oil companies to assess the environmental impact oil and gas exploration and production has on the environment, compared to other human activities.

Each conceptual area is presented as a series of learning experiences that can be used sequentially or as stand-alone learning experiences. However when delivered in sequence these learning experiences provide the comprehensive understanding necessary for the Science and Society and Environment Curricula, and a background to the other modules in the BPEEP learning program.

Module 3 ‘Oil and Gas Exploration and Production’ is linked to the Western Australian Department of Education and Training’s Curriculum, Assessment and Reporting Policy (CAR Policy) and associated documentation. The program, presented as a series of teaching and learning experiences, links teacher planning and learning area (Science and Society and Environment) coverage back to the initial planning documents, namely the ‘Curriculum Framework’ and ‘Outcomes and Standards Framework’. Planning documentation provides teachers with the explicit links to the Curriculum Framework; Knowledge, Skills and Values focus; and learning area Outcomes and Standards coverage. Relevant learning area documentation, and teaching and learning links, are colour coded for both Science (ORANGE) and Society and Environment (PURPLE).
Overview of Learning Module

Teachers should refer to both Learning Area Curriculum Guides (What students should be taught) and Learning Area Outcomes and Standards Framework (What levels of achievement students can demonstrate/achieve across the relevant Learning Area outcomes) when considering the application of the BPEEP modules to their individual teaching and learning program requirements.

A suggested timeframe is provided as a guide only to how long teachers may expect to spend on the learning experiences contained in each of the 3 conceptual areas of the module. A teacher guide is provided for each of these conceptual areas. Lesson support material is also provided.
## Contents

This symbol denotes worksheets

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of Learning Module</td>
<td>1</td>
</tr>
<tr>
<td>Relevance to BP</td>
<td>5</td>
</tr>
<tr>
<td>BPEEP Learning Area Outcome/Aspect Coverage</td>
<td>6</td>
</tr>
<tr>
<td>Educator’s Summary of Module 3</td>
<td>7</td>
</tr>
<tr>
<td>Suggested Teaching Timeframe</td>
<td>9</td>
</tr>
<tr>
<td>Conceptual Area 1: Locating Oil and Gas Accumulations</td>
<td>10</td>
</tr>
<tr>
<td>Learning Experience 1.1: ‘Crude Documentary’</td>
<td>11</td>
</tr>
<tr>
<td>Learning Experience 1.2: ‘Oil and Water’</td>
<td>11</td>
</tr>
<tr>
<td>Learning Experience 1.3: ‘Going Up’</td>
<td>12</td>
</tr>
<tr>
<td>Learning Experience 1.4: ‘Exploring for Oil’</td>
<td>12</td>
</tr>
<tr>
<td>Learning Experience 1.5: ‘Seismic Surveys’</td>
<td>12</td>
</tr>
<tr>
<td>Learning Experience 1.6: ‘Drilling’</td>
<td>13</td>
</tr>
<tr>
<td>Learning Experience 1.1</td>
<td>17</td>
</tr>
<tr>
<td>Learning Experience 1.2</td>
<td>21</td>
</tr>
<tr>
<td>Learning Experience 1.3</td>
<td>25</td>
</tr>
<tr>
<td>Learning Experience 1.4</td>
<td>27</td>
</tr>
<tr>
<td>Learning Experience 1.5</td>
<td>33</td>
</tr>
<tr>
<td>Learning Experience 1.6</td>
<td>39</td>
</tr>
<tr>
<td>Conceptual Area 2: Oil and Gas Fields</td>
<td>44</td>
</tr>
<tr>
<td>Learning Experience 2.1: ‘The Exploration and Production Lifecycle’</td>
<td>45</td>
</tr>
<tr>
<td>Learning Experience 2.2: ‘Developing an Oil or Gas Field’</td>
<td>45</td>
</tr>
<tr>
<td>Learning Experience 2.1</td>
<td>47</td>
</tr>
<tr>
<td>Learning Experience 2.2</td>
<td>51</td>
</tr>
</tbody>
</table>
Contents

Conceptual Area 3: Environmental Management........................................................................59

Learning Experience 3.1: ‘Where is BP exploring and producing oil and gas?’ ....................60
Learning Experience 3.2: ‘BP around the world’.................................................................60
Learning Experience 3.3: Guest Speaker.............................................................................61
Learning Experience 3.4: Energy Careers.........................................................................61
Learning Experience 3.5: Research Assessment Task.......................................................62
  ☛ Learning Experience 3.1..............................................................................................65
  ☛ Learning Experience 3.2..............................................................................................67
  ☛ Learning Experience 3.3..............................................................................................71
  ☛ Learning Experience 3.4..............................................................................................75
  ☛ Learning Experience 3.5..............................................................................................77

References for Module 3......................................................................................................81
Relevance to BP

As well as knowing how, where and when oil and gas are formed (Module 2), scientists and engineers within BP must also know how to precisely locate oil and gas accumulations.

This process of ‘exploration’ is a complex and costly business, since oil and gas resources may be buried far underground, often in extreme water depths far out at sea, and often in remote and inhospitable parts of the Earth. BP continues to develop its understanding of how oil and gas form accumulations under the ground, their shape, size and other physical properties. BP also uses a huge variety of seismic, drilling and other technologies to detect, map, drill and exploit oil and gas accumulations.

BP is striving to improve these technologies all the time to make exploration more successful and less costly. When oil or gas is found, the emphasis is then on how to produce it economically and efficiently, with minimal impact on the environment.
## BPEEP Learning Area Outcome/Aspect Coverage

Click on the module number to go to that module.

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>BPEEP MODULE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10 11</td>
</tr>
<tr>
<td>SCIENCE</td>
<td></td>
</tr>
<tr>
<td>Earth and Beyond</td>
<td></td>
</tr>
<tr>
<td>Sustainability of life and wise resource use</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>Earth forces and materials</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>Relationships between the Earth, our Solar System and the Universe.</td>
<td>X</td>
</tr>
<tr>
<td>Energy and Change</td>
<td></td>
</tr>
<tr>
<td>Energy, sources, patterns and uses.</td>
<td>X X X X X X X X</td>
</tr>
<tr>
<td>Transfer and transformation.</td>
<td>X X</td>
</tr>
<tr>
<td>Natural and Processed Materials</td>
<td></td>
</tr>
<tr>
<td>Structures, Properties and Uses</td>
<td>X</td>
</tr>
<tr>
<td>Interactions and Changes</td>
<td>X</td>
</tr>
<tr>
<td>SOCIETY AND ENVIRONMENT</td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td></td>
</tr>
<tr>
<td>Use of Resources</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>Management and Enterprise</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>People and Work</td>
<td>X X X X X X X X X X</td>
</tr>
<tr>
<td>Place and Space</td>
<td></td>
</tr>
<tr>
<td>Features of Places</td>
<td>X X</td>
</tr>
<tr>
<td>People and Places</td>
<td>X X X</td>
</tr>
<tr>
<td>Care of Places</td>
<td>X X X</td>
</tr>
<tr>
<td>Investigation, Communication, Participation</td>
<td></td>
</tr>
<tr>
<td>Planning</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>Conducting</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>Processing and Translating</td>
<td>X X X X X X X X X X X</td>
</tr>
<tr>
<td>Applying and Communicating</td>
<td>X X X X X X X X X X X</td>
</tr>
</tbody>
</table>
Educator’s Summary of Module 3

DESCRIPTION OF CROSS CURRICULAR PROGRAM

Module 3: “Oil and Gas Exploration and Production” is predominantly focused upon the Science outcomes ‘Earth and Beyond’ and ‘Energy and Change’; and the Society and Environment outcomes ‘Resources’, ‘Place and Space’ and ‘Investigation, Communication & Participation’. The module requires students to investigate how oil and gas reservoirs are found and extracted. This provides essential knowledge for the students to engage in Module 4 (Refining).

Teachers are encouraged to adopt a cross curricular approach, primarily between Science and Society and Environment.

CONCEPTUAL FOCUS

- Origin of oil and gas.
- Stages of oil and gas exploration and production.
- Factors impacting on oil exploration and production.
- BP activities around the world.
- Environmental management involved with oil exploration and production.

SKILLS FOCUS

- Ongoing literacy focus: paragraphing.
- Viewing and information retrieval.
- Science Practicals/Investigations
- Information retrieval/note-taking.
- Internet/Website information retrieval
- Mapping and atlas skills
- Group work and independent work.
- Research skills (as per S&E I.C.P. ladder process).

DESCRIPTION OF ASSESSMENT

Supporting the on-going literacy focus a paragraph task is included. Though some conceptual understanding can be levelled in certain Learning Area Outcomes, teachers are encouraged to use the paragraph rubric (provided) through the delivery of the BPEEP modules to monitor the student’s ability to construct well structured paragraphs over an extended period of time. Consideration should be given to both modelling and scaffolding the paragraph framework prior to assessing this vital literacy skill.

The major assessment piece for this module requires students to develop a presentation that investigates the environmental impact of oil and gas exploration. This task is ideally suited to a cross curricular approach where students follow the research process outlined by the ICP ladder and connected support frameworks. These resources are available in the appendix section of the BPEEP resource file. An assessment rubric is provided.

LITERACY FOCUS

A major on-going focus on paragraphing utilising the paragraph framework. Also emphasis on keywords, note-taking and other literacy oriented strategies.

NUMERACY FOCUS

Distance and time calculations – echo activity.

PEDAGOGICAL FOCUS

Inquiry learning
Group work.
Scaffolding

CURRICULUM FRAMEWORK VALUES

| A pursuit of knowledge & a commitment to achievement of full potential. | 1.1 – 1.7 (CF) |
| Self Acceptance and Respect of Self. | 2.1 – 2.5 (CF) |
| Respect and Concern for Others and Their Rights. | 3.1 – 3.7 (CF) |
| Social and Civic responsibility. | 4.4, 4.8, 4.9 (CF) |
| Environmental responsibility. | 5.2, 5.3 |
### OVERARCHING LEARNING OUTCOMES

<table>
<thead>
<tr>
<th></th>
<th>OVERARCHING LEARNING OUTCOMES</th>
<th>CONTEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Students use language to understand, develop and communicate ideas and information with others.</td>
<td>Literacy Focus and wide range of learning experiences.</td>
</tr>
<tr>
<td>2</td>
<td>Students select, integrate and apply numerical and spatial concepts and techniques.</td>
<td>Units of measurement and simple calculations. Map interpretation.</td>
</tr>
<tr>
<td>3</td>
<td>Students recognise when and what information is needed, locate and obtain it from a range of sources and evaluate, use and share it with others.</td>
<td>Focus of S&amp;E ICP outcome and associated skills eg. keywords, note-taking, sources.</td>
</tr>
<tr>
<td>4</td>
<td>Students use, select and apply technologies.</td>
<td>Internet (website) research.</td>
</tr>
<tr>
<td>5</td>
<td>Students describe and reason about patterns, structures and relationships in order to understand, interpret, justify and make predictions.</td>
<td>Analysing current trends to predict future outcomes.</td>
</tr>
<tr>
<td>6</td>
<td>Students visualise consequences, think laterally, recognise opportunity and potential and are prepared to test opinions.</td>
<td>Cause, effect, resultant actions and future decisions.</td>
</tr>
<tr>
<td>7</td>
<td>Students understand and appreciate the physical, biological and technological world and have the knowledge and skills to make decisions in relation to it.</td>
<td>Conceptual Areas 1, 2 and 3.</td>
</tr>
<tr>
<td>8</td>
<td>Students understand their cultural, geographical and historical contexts and have the knowledge, values and skills to make decisions in relation to it.</td>
<td>Conceptual 1, 2 and 3.</td>
</tr>
<tr>
<td>9</td>
<td>Students interact with people and cultures other than their own and are equipped to contribute to the global community.</td>
<td>Conceptual area 3 – BP activities around the world and global environmental management.</td>
</tr>
<tr>
<td>10</td>
<td>Students participate in creative activity of their own and understand and engage with the artistic, cultural and intellectual work of others.</td>
<td>Learning Experiences comprising of variety of tasks throughout Conceptual Areas 1, 2 and 3.</td>
</tr>
<tr>
<td>11</td>
<td>Students value and implement practices that promote personal growth and well-being.</td>
<td>Group Work and values oriented learning.</td>
</tr>
<tr>
<td>12</td>
<td>Students are self motivated and confident in their approach to learning and area able to work individually and collaboratively.</td>
<td>Range of teaching strategies – individual and group work.</td>
</tr>
<tr>
<td>13</td>
<td>Students recognise that everyone has the right to feel valued and to be safe and in this regard understand their rights and obligations and behave responsibly.</td>
<td>Explicit teaching and implementation of group learning strategies.</td>
</tr>
</tbody>
</table>
## Suggested Teaching Timeframe

<table>
<thead>
<tr>
<th>DAY</th>
<th>TIME</th>
<th>LEARNING EXPERIENCE</th>
<th>LEARNING AREA</th>
<th>LEARNING TASK</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CONCEPTUAL AREA 1: LOCATING OIL AND GAS ACCUMULATIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>60 minutes – DVD 0.00 – 40.30m</td>
<td>Experience 1.1 ‘Crude: Part 1’</td>
<td>Science</td>
<td>Documentary – Worksheet</td>
</tr>
<tr>
<td>2</td>
<td>30–60 minutes</td>
<td>Experience 1.2 ‘Oil and Water’</td>
<td>Science</td>
<td>Practical lab to investigate densities of different liquids. Paragraph Framework</td>
</tr>
<tr>
<td>3</td>
<td>30–60 minutes</td>
<td>Experience 1.3 ‘Going Up’</td>
<td>Science</td>
<td>Practical lab/demonstration showing how oil reservoirs are formed.</td>
</tr>
<tr>
<td>4</td>
<td>60–120 minutes</td>
<td>Experience 1.4 ‘Exploring for Oil’</td>
<td>Science</td>
<td>Worksheet – information retrieval, internet research, paragraph framework.</td>
</tr>
<tr>
<td>5</td>
<td>60–180 minutes</td>
<td>Experience 1.5 ‘Seismic Surveys’</td>
<td>Science</td>
<td>Practical activity investigating echoes. Research activity on echoes.</td>
</tr>
<tr>
<td>6</td>
<td>60–180 minutes</td>
<td>Experience 1.6 ‘Drilling Techniques’</td>
<td>Science</td>
<td>Practical activity investigating the properties of fluids, the effects of pressure and the concept of porosity</td>
</tr>
<tr>
<td><strong>CONCEPTUAL AREA 2: OIL AND GAS FIELDS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>60–120 minutes</td>
<td>Experience 2.1 ‘Exploration and Production Lifecycle’</td>
<td>Science/Society and Environment</td>
<td>Note-taking from article. Individual or group poster activity.</td>
</tr>
<tr>
<td>8</td>
<td>60–120 minutes</td>
<td>Experience 2.2 ‘What happens after oil and gas is discovered?’</td>
<td>Science/Society and Environment</td>
<td>Group work task investigating what happens after oil and gas are discovered.</td>
</tr>
<tr>
<td><strong>CONCEPTUAL AREA 3: ENVIRONMENTAL MANAGEMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>30 minutes</td>
<td>Experience 3.1 ‘Where is BP exploring for and producing oil and gas?’</td>
<td>Society and Environment</td>
<td>Atlas and mapping activity.</td>
</tr>
<tr>
<td>10</td>
<td>60–120 minutes</td>
<td>Experience 3.2 ‘BP around the world’</td>
<td>Society and Environment</td>
<td>Research activity.</td>
</tr>
<tr>
<td>11</td>
<td>60 minutes</td>
<td>Experience 3.3 Guest Speaker</td>
<td>Science/Society and Environment</td>
<td>Guest Speaker</td>
</tr>
<tr>
<td>12</td>
<td>Teacher determined</td>
<td>Experience 3.4 ‘Energy Careers’</td>
<td>Science/Society and Environment</td>
<td>Career inquiry</td>
</tr>
<tr>
<td>13</td>
<td>Teacher determined</td>
<td>Experience 3.5 Research Assessment</td>
<td>Society and Environment/Science</td>
<td>Environmental Management Research task</td>
</tr>
</tbody>
</table>
Conceptual Area 1: Locating Oil and Gas Accumulations

LEARNING AREA: Science
OUTCOME/S: Energy and Change (Sci) Earth and Beyond (Sci)
PHASE OF DEVELOPMENT: Early Adolescence
CONCEPTUAL AREA: Locating Oil and Gas Accumulations
KEY UNDERSTANDINGS: Students will be able to identify how oil companies locate oil and gas reservoirs.

<table>
<thead>
<tr>
<th>CONCEPTUAL UNDERSTANDINGS</th>
<th>SKILLS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Different densities of liquids</td>
<td>• Science Practical Lab skills.</td>
<td>1.1 – 1.7</td>
</tr>
<tr>
<td>• Source Rocks, Reservoirs and Seals</td>
<td></td>
<td>2.1 – 2.5</td>
</tr>
<tr>
<td>• Seismic Surveys</td>
<td></td>
<td>3.1 – 3.7</td>
</tr>
<tr>
<td>• Echoes</td>
<td></td>
<td>4.1, 4.2, 4.4, 4.7, 4.8, 4.9</td>
</tr>
<tr>
<td>• Drilling Techniques</td>
<td></td>
<td>5.2, 5.3, 5.4</td>
</tr>
</tbody>
</table>

TEACHER INFORMATION:
This series of learning experiences aims to examine the characteristics that determine the formation of oil and gas reservoirs and the techniques oil companies use to locate them.

Practical lab-based learning experiences will be utilised to encourage students to adopt an inquiry-based approach to understand key concepts associated with oil exploration, including the use of seismic surveys to locate oil and gas reservoirs.

Consideration has been given to the selected activities given the complexity of this aspect of the oil industry. The practical activities chosen are aimed to simulate aspects of oil exploration and support students in developing their understanding of these.

RESOURCES
“Crude” documentary.
Class sets of worksheets connected to all Learning Experiences.

EQUIPMENT
Oil and Water: 500ml beaker, water, cooking oil, milk, vinegar, saltwater and liquid soap.
Going Up: plates, water, sponge, absorbent paper and piece of plastic.
Seismic Surveys: two flat pieces of wood (approximately 120mmx19mmx300mm), timer and measuring equipment (ie. measuring tape) Access to computers and internet.
TV/DVD
A Model Oil Well: a clear container preferably 12-15 cm (minimum) across the bottom (large beaker, juice bottle or small aquarium), 2 glass tubes or transparent drinking straws, a funnel, a piece of plastic (rubber) tubing which will fit both the tubing (straws) and the funnel, aquarium or garden gravel (approx. 5 mm sized grains), sand, Plasticine or “Play Dough” to simulate clay, water (food colouring should be added), cooking oil

Student Prior Knowledge: Prior to delivering this module it is recommended that students complete all or some aspects of Module 2: Oil Formation. This provides students with an understanding of how oil and gas are formed prior to investigating the exploration and production of them in this module.
Learning Experiences:

Learning Experience 1.1: ‘Crude Documentary’

‘Crude’, a documentary produced by the ABC, examines the journey of oil. It is available from most large retail outlets or the ABC Shop. It is also available to download from the ABC website [http://www.abc.net.au/science/crude/](http://www.abc.net.au/science/crude/). Whilst relevant to most modules in the BPEEP program it has been used in this module as a means of linking oil and gas formation (Module 2) to oil and gas exploration (Module 3). This Learning Experience uses the first 40 minutes of the documentary, called “Part 1: The Age of Oil”. A worksheet is provided for students to complete during or after viewing the documentary. Teachers may opt for students to complete the worksheet as they view, or initially collect notes using a note-taking framework such as H.A.K.D. (Headings, Abbreviations, Keywords, Dot Points) in their files prior to completing the worksheet.

If time constraints are an issue the documentary could also be used as a stand alone without worksheet support. Teachers are encouraged to question student knowledge before, during and after the viewing.

→ go to Learning Experience 1.1 worksheet

Learning Experience 1.2: ‘Oil and Water’

This learning experience explores the concept of liquid densities. Before introducing the practical lab process the teacher should pose the students some initial questions to gauge student prior understanding of liquid densities. For example: What are different liquids you use at home? How would you describe each liquid to another person? What would happen if you combined some of these liquids? Do all liquids mix?

The fact that water is denser than oil, and oil denser than gas, is a vitally important concept in exploration & production. In an oil & gas field, gas is always found at the top, with oil below, and water at the base. This can be demonstrated with a plastic bottle containing oil (cooking oil), water and air.

The ‘Oil and Water’ learning experience encourages students to develop their understanding of liquid densities through a practical investigation process. Teachers should adopt their usual practical activity routines. The worksheet provides an outline of key practical aspects: aim, equipment, method, results, discussion and conclusion. Teachers may opt to use this in different ways (i.e. as an overhead, a handout or board notes). Where possible teachers should allow students to complete as much of the practical process without teacher intervention to allow for inquiry based learning. This will depend on the students’ prior exposure to practical activities and existent routines.

A paragraph framework task is provided as an optional addition to monitor student understanding.

→ go to Learning Experience 1.2 worksheet
Learning Experience 1.3: ‘Going Up’
This practical learning experience explores the characteristics of reservoir and seal rocks. Before students work through the activity the teacher should question the students about their knowledge of rocks, their formation and composition. A rock box, containing a variety of samples (generally found in a school’s science resource room) would provide good stimulus for teacher questioning and discussion. A Venn Diagram or Compare and Contrast Chart could be used for students to consider the similarities and differences between rock samples such as granite and limestone. It would be great to have one or more samples of sandstone, as these are the most common reservoirs worldwide. Using a hand lens or magnifying glass, it is often possible to see that such rocks are porous. The porosity of different rocks may then be compared. The fact that rocks can absorb fluids can also be shown by adding water or oil.

The “Going Up” learning experience encourages students to develop their understanding of rock porosity and the formation of oil and gas reservoirs. The two demonstrations should be viewed by the students as the teacher prompts student understanding through questioning and outlining the steps of each demonstration. Alternatively, if enough equipment is readily available students can complete the steps of the demonstrations themselves. A series of worksheet questions is provided to clarify student learning and prompt teacher questioning and class discussion.

Learning Experience 1.4: ‘Exploring for Oil’
Primarily an information retrieval task, this Learning Experience requires students to consider keywords and key ideas from a section of text taken from BP’s Energy Business Booklet “Oil & Gas Formation and Production”. Teachers may opt to set this as a homework activity and use it to begin the lessons on Seismic Surveys in the form of discussion and teacher questioning. Alternatively, the learning experience provides students with a structured learning process among a series of optional practical based lessons (i.e. Learning Experiences 1.2, 1.3 and 1.5).

The teacher should adopt a reading strategy that is appropriate to the class group (strategies such as a dictoglos would be effective), followed by the structured activities provided including: keywords/definitions, identifying main ideas, using keywords to explain understanding of text, library/internet research and a paragraph framework (paragraph rubric located in appendix section of BPEEP file). The teacher should determine the extent to which these optional activities are completed.

Learning Experience 1.5: ‘Seismic Surveys’
This learning experience explores the use of seismic surveys to locate oil and gas accumulations. Initially the teacher should refer students to the introductory text on the worksheet. Using the question: ‘How does BP find oil and gas?’ as a starting point students should make dot point notes under this question to cover the text. The main points that students raise should lead to a class discussion.

The practical exercise uses echoes to explore the concept of seismic testing. Before introducing the practical lab process the teacher should pose to the students some initial questions to gauge student prior knowledge and initial understanding of echoes and seismic testing. For example: How does a fish finder work? How is it similar to seismic testing to locate oil and gas? How does a dolphin navigate? How does echo sounding on a boat or submarine work? As an option the teacher may choose to use the ‘Echoes’ research sheet prior to or after the practical exercise. This requires students to research what an echo is and examples of where echoes are used.
The ‘Echo Location’ practical learning experience encourages students to develop their understanding of echoes and the speed of sound, through a practical investigation process. Teachers should adopt their usual practical activity routines. The worksheet provides an outline of key practical aspects: aim, equipment, method, results, discussion and conclusion. Teachers may opt to use this in different ways (i.e. as an overhead, a handout or board notes). Where possible teachers should allow students to complete as much of the practical process without teacher intervention to allow for inquiry based learning. This will depend on the student’s prior exposure to practical activities and existent routines.

A KWH (What do you Know? What do you Want to know? How will you find out?”) note taking framework is provided as an optional addition to assist students in identifying their previous knowledge, what they want to know and how they will find that information out. The teacher should determine the extent of the conclusion part of the practical activity. This may be developed into a more formal assessment task. Module 3 does use a more thorough research task for its major assessment that draws upon ‘seismic survey’ understandings developed in this practical activity. A thorough debrief and discussion about what has been learnt is essential to reinforce and consolidate student learning.

Learning Experience 1.6: ‘Drilling’

In this learning experience students will find out about the most important aspects of drilling wells. Drilling wells is the only sure way to find oil and gas, determine the size of a field, assess whether it can be produced profitably, and finally, produce the oil or gas.

The key components of an onshore drilling rig are described with reference to a simplified diagram. The most important terminology is introduced. Teachers may wish to test students’ understanding of the diagram and terminology by asking them to describe it in their own words, and/or to research the terms more fully using other sources of information, such as the internet.

One of the most important reasons for drilling a well is to collect information about the rocks and fluids at the bottom, hence there is a brief introduction here to what kinds of data and information might be collected, and how.

Offshore drilling is an important activity in many parts of the world, including Australia, where all of BP’s drilling activity is offshore. Therefore, this section goes on to describe how drilling rigs may be mounted on various types of drilling vessels, which are used in different water depths. An additional activity would be for students to search the internet for photos of such drilling vessels, using the terminology described. In many cases it will be possible for students to annotate photos of vessels, using the terms mentioned in this learning experience. The section concludes with a discussion of the differences between exploration, appraisal and development wells (including both production and injection wells).

This leads into the experimental activity, which aims to demonstrate some of the physical processes involved in extracting oil and gas from a reservoir via a well. The experiment has been adapted from http://earthnet-geonet.ca/activities/activity9_e.php
A Model Oil Well (experiment)

Some sedimentary rocks are filled with fluid. At the time of deposition, water associated with the sediment grains is trapped within the pores. Burial and subsequent hardening will seal much of the water within the sediment. Generation and the migration of hydrocarbons will often displace the water where porosity and permeability permits.

Movement of fluids within a sediment layer which possesses permeability is primarily controlled by pressure. Fluids will flow upward (toward lower pressure) until they reach an impermeable layer (seal).

The construction of the model will help explain the concepts of porosity and permeability, seals, and reservoirs. The experiment will reveal the need for the fluid to have a pathway provided by the spaces between the sand grains which will permit its movement.

The porosity that is in evidence in the sand is sharply contrasted with the students’ perception of permeability in the Plasticine or “Play Dough” layer.

The role of hydrostatic head and pressure differential may be explored. The obvious link is that with increased pressure there will be increased flow. The concept of pumping of the oil and natural gas could be explored.

The experiment is explained on the Learning Experience 1.6 worksheet.

Expected Responses to experiment questions:

1. The air in the pores of the gravel was displaced by the water and escaped through the exit tube. The water filled the pores at the bottom of the gravel layer.
2. The Plasticine (or Play Dough) acts as a seal. If it was not there water would rise freely through the gravel and sand.
3. When oil was added, it initially pooled around the base of the inlet tube and displaced the water downwards and outwards. Eventually, the water settled at the bottom and the oil at the top of the gravel layer. Oil will not mix with water; also oil is less dense than water so it settles above the water layer.
4. By blowing into the funnel pressure is added. The pressure is transferred to the fluid in the gravel layer (reservoir) and speeds up the flow (movement) of the fluid toward the exit tube. Since the base of the exit tube lies within the oil layer, oil was produced from the tube.
5. Blowing harder increased the pressure and the fluid flow rate. Water began to cone up towards the exit tube and some water was produced with the oil. (Blowing air into the system leads to air also being produced since air is less dense than oil or water and flows along the top of the gravel layer).
6. The liquid could be removed by applying suction, i.e., pumping.
Monitoring and Evaluation:

Student understanding of oil and gas reservoir characteristics, and the use of seismic surveys as one means of identifying their location, is assessed through the completion of learning experience tasks (including science practical activities) and a paragraph task. A rubric is provided in the appendix section of the BPEEP resource file to assess the student’s ability to construct a well structured paragraph. Paragraphs should be used by the teacher as evidence toward the attainment of conceptual outcome levels.

Teachers are encouraged to utilise informal assessment practices throughout the module to continually monitor and consolidate student understandings.

Teachers are encouraged to determine the extent in which they use Learning Experiences 1.2, 1.3 and 1.5 (Practical Learning Experiences) for assessment, based on their already existent routines and assessment practices for practical based activities. A science practical (lab-based) framework is provided in the appendix section of the file, thanks to Professor Mark Hackling of Edith Cowan University.

The student’s ability to demonstrate their knowledge of key understandings explored in this conceptual area will be essential in the student’s ability to complete the major assessment task (research task) included in Conceptual Area 3.
CRUDE Documentary
(0min-40.30min)

Part 1: The age of oil

This is often noted as being the Silicon age, what could be a more correct title for the times we live in?

The central character in the formation of crude oil is C _ _ _ _, it is the substance of L _ _ _.

Everything in the world is recycled or _ _ _ _ _ _ _ _ _ _, including you.

Follow the oily adventure of a carbon atom that starts its life wrapped up in a molecule of carbon dioxide (use this space to record its journey … you might have to come back to it several times throughout the documentary)
What happens when there is too little carbon dioxide in the atmosphere?

What happens when there is too much carbon dioxide in the atmosphere?

The Earth did not look the same in the Jurassic Period, describe it in terms of:

- continents
- carbon dioxide
- animals
- temperature

How can you test to find out if there actually is oil in rock?

Oil is in fact fossilised Jurassic S _____

Part 2: The last hours of ancient sunlight

When did we first encounter oil?
Name some of the historic uses of oil.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

What shortage led to the modern day oil industry?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

What happened in 1859 that had a big impact on the oil industry?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

How much energy is contained in one teacup full of petroleum?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Refineries have developed ways to sort out hydrocarbons. What has this allowed them to develop?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

They have even been able to develop ways to crack long hydrocarbons into smaller hydrocarbons and glue smaller ones together.

Now _____% of oil is converted into the massive variety of products we use today such as:

• ______________________________________________________________________

• ______________________________________________________________________

• ______________________________________________________________________

• ______________________________________________________________________

• ______________________________________________________________________
Reflection Task

Complete a PMI chart for the section of the documentary you viewed. What are the pluses, minuses and interesting facts about oil?

<table>
<thead>
<tr>
<th>PLUS</th>
<th>MINUS</th>
<th>INTERESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Background Information

Extracting oil and gas involves understanding a lot of science, like chemistry and physics. For example, knowing about the properties of oil helps us to figure out the best way of extracting it from the ground. One important property of oil is its density, which makes it easier to extract from under the ocean.

Aim: To investigate the densities of different liquids

Equipment:
- 500ml beaker
- water
- cooking oil
- milk
- vinegar
- saltwater
- liquid soap

Method:
1) Half fill the beaker with water.
2) Slowly add approximately 20ml of oil
3) Observe whether the oil sinks or floats
4) Stir the mixture and then let it stand
5) Observe
6) Add 20ml of milk, vinegar, saltwater and liquid soap one at a time.
7) Observe whether these liquids float or sink

Results: (Draw a labelled diagram of the beaker with the different layers)
**Discussion:**
Density is a comparison between a liquid’s mass and volume. If the density of a liquid is lower it will float on a liquid of a higher density. Therefore in your glass the liquid on the top is the least dense, and the one on the bottom is the most dense.

*Complete the following using your results*

**LEAST DENSE**

________________________________________

________________________________________

________________________________________

**MOST DENSE**

________________________________________

*Complete the following sentence by deleting the incorrect terms*

Oil and gas is extracted from rocks deep beneath the earth’s surface. Oil is less/more dense than the sea water so it travels upwards/downwards until it is capped by impenetrable/penetrable rock.

*Think of some more situations where it is important to know about the different densities of liquids.*

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

**Conclusion:** Follow the paragraph framework to explain why an understanding of liquid densities is important in the oil exploration and production process.
Why is an understanding of liquid densities important in the oil exploration and extraction process?

**THINK**

**PLAN**

**Statement (Topic Sentence T.S.)**

**Explanation (Developing Sentence D.S.)**

**Examples (Supporting Sentence S.S.)**

**Conclusion (Concluding Sentence C.S.)**
(Identify each type of sentence using T.S.[ST], D.S.[EXP], S.S.[EG], C.S.[CON]).

WRITE

EDIT

PRESENT
Going Up!

Some types of rocks have tiny holes called pores that allow liquids and gases to move through. These are called “reservoir rocks”. Oil and gas are lighter than water, so it can rise through these rocks and sometimes make it all the way to the surface.

So why isn’t oil and gas easy to find? Shouldn’t we be able to see it all over the Earth’s surface?

Well, if on the way up the oil and gas comes across some rock called “the seal” it cannot reach the surface. That’s because the seal doesn’t have pores and so does not have the space that allows oil and gas to migrate through to the surface, therefore it gets trapped beneath the surface. In this case the only way we can get to the oil and gas is to drill down to it.

The following activity demonstrates how oil and gas can move through “reservoir rocks” and get trapped by the seal.

First you need to get some sponges – the ones you use to wash your dishes.

Sponges are full of tiny holes or pores that allow water to move through them. This is why sponges can be used to wipe up liquids.

Next you need a piece of plastic, the lid of a margarine container is ideal. This piece of plastic represents the seal because it does not have pores.

You will also need a plate, water and some absorbent paper towel.

**DEMONSTRATION 1**

1) Place approximately 25ml of water onto the plate and then place the sponge or “reservoir rock” on top.
2) Observe what happens to the water on the plate.
3) Place a piece of absorbent paper towel on top of the sponge.
4) Observe.

**DEMONSTRATION 2**

1) Place approximately 25ml of water onto another plate and place a dry sponge or “reservoir rock” on top.
2) Observe what happens to the water on the plate.
3) Place the piece of plastic on top of the sponge.
4) Place a piece of absorbent paper towel on top on the plastic.
5) Observe.
### Learning Experience 1.3 (contd.)

<table>
<thead>
<tr>
<th>DEMONSTRATION</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

What do you think the absorbent paper towel represented?

Find out about the physical characteristics of the following types of rock:

**Sandstone:**

Shale:

Based on what you now know about their physical characteristics, decide which of these rocks would be a seal or a reservoir rock. Give reasons for your decisions.
Read the following text and complete the tasks that follow:

(adapted from BP’s Energy Business Booklet “Oil & Gas Formation and Production”, page 5)

The only sure way of finding hydrocarbons is to drill through maybe thousands of metres of rock and see whether oil or gas can be detected. But because drilling an oil well can often cost many tens of millions of dollars, energy companies must use other techniques to pinpoint where oil or gas is likely to be found before committing to drill.

Almost without exception, hydrocarbons are found in sedimentary basins. These are huge areas throughout the world, which can either be on land, or below the sea. Both onshore and offshore Australia, there are lots of sedimentary basins, like the Perth basin in the southwest corner of Western Australia. Although we now know where these basins are located, not all of them contain oil or gas. We need to know much more accurately whether oil or gas might be trapped within a basin before deciding to drill.

We have seen how oil and gas can collect in reservoirs deep below the land or seabed. Geologists and geophysicists working for energy companies look for evidence of the conditions that will be favourable to trapping large volumes of hydrocarbons. They must be able to show that a source rock, migration path, seal, trap and reservoir rock all exist, which together form what is called a petroleum system.

In the early days of exploring for oil, around the start of the last century, geologists spent a lot of time ‘in the field’ studying rocks, fossils and landforms on the ground, which might give clues to the presence of all of the essential conditions for the formation of an oil or gas field.

Today, the most important techniques that are used to locate oil and gas fields are called geophysical surveys such as seismic surveys. Geophysical surveys are based on the physics which can be applied to the study of rock formations deep below the surface of both the land and the seabed.

As well as geophysics, oil companies still use conventional geology, aerial photography or satellite imagery from outer space to locate rock formations worth investigating. Of course, these techniques cannot be used when exploring for oil deep below the seabed.
Learning Experience 1.4 (contd.)

Complete the following tasks:

1. Define the following terms. You may need to use your notes, textbooks and other resources to complete this task.
   a. hydrocarbon
   b. sedimentary
   c. geologist
   d. geophysicist
   e. petroleum
   f. fossil
   g. offshore

Check your understanding!

Write one paragraph that uses at least 4 of the terms above, which summarises the text you have just read. Underline each term when you use it. How many can you use?
Learning Experience 1.4 (contd.)

2. What do you believe to be the 8 most important points made in the text about oil exploration? Record them and then explain why they are important in your own words.

<table>
<thead>
<tr>
<th>IMPORTANT POINT</th>
<th>MY EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>
3. Use library or internet resources to construct a labelled diagram that shows the essential conditions geologists are looking for when exploring for oil and gas. Your diagram should include a brief description of these essential conditions and labels including: source rock, migration path, seal, trap and reservoir rock.

![The Petroleum System Diagram](image)

Give examples of source rocks, seals and reservoir rocks.

- Source rock: 
- Seal: 
- Reservoir rock: 

4. Using the paragraph framework write a well structured paragraph that demonstrates your understanding of the following statement:

“Oil exploration is an incredibly costly exercise so oil companies have to be very thorough in trying to pin point the exact location of oil and/or gas accumulations.”
Paragraph Framework

The main idea of the paragraph is ...

“Oil exploration is an incredibly costly exercise so oil companies have to be very thorough in trying to pinpoint the exact location of oil and/or gas accumulations.”

THINK

PLAN

Statement (Topic Sentence T.S.)

Explanation (Developing Sentence D.S.)

Examples (Supporting Sentence S.S.)

Conclusion (Concluding Sentence C.S.)
WRITE

(Identify each type of sentence using T.S.[ST], D.S.[EXP], S.S.[EG], C.S.[CON]).

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

EDIT

☐ Spelling ☐ Punctuation ☐ Grammar ☐ Sentences ☐ Keywords

PRESENT
There are a number of ways of locating oil and gas reservoirs such as surveys based on the earth’s gravitational pull, magnetic field or electrical resistance; but the most important way of locating oil and gas reservoirs is by seismic surveys.

How does BP find oil and gas?

For over one hundred years BP and other companies have been looking for oil and gas in every corner of the world. In the past, wells were drilled into the Earth where people had a ‘feeling’ that there could be oil- perhaps where oil seeps had been found nearby. Often, large folds of rocks, called ‘anticlines’, seen at the earth’s surface, were drilled in the hope that oil or gas may be trapped in the folds down below. Now there are more scientific approaches, such as using a combination of the geology of an area, gravity and magnetic surveys, seismic surveys and remote sensing techniques like aerial photography and satellite imagery from outer space. These methods all help to point to areas where oil and gas may be found.

However, seismic surveys are the most important modern technique for locating new oil and gas deposits. A seismic survey uses sound waves which are created just beneath the land surface or near the surface of the sea. The waves travel down through layers of rocks and bounce back like echoes. By using computers, geologists and geophysicists can build up an accurate picture of what is under the ground or seabed, and then figure out where oil and gas might be found. Seismic pictures can be in 2D (a vertical slice through the layered earth), or in 3D (a whole cube of information about the layers inside of the earth).

When the petroleum geologists are exploring a possible location, seismic surveys help them to pinpoint whether the underground rock types and structures are right for there to be oil or natural gas present. Then an exploration well is drilled to judge whether the area contains any oil or gas and is worth exploring further. If so, other team members are brought in to shoot more detailed seismic surveys, drill more wells, and eventually to design the oil platforms and pipelines required to extract and transport the oil and gas to be processed.

A seismic survey relies on sound waves which are created at the land surface or near the surface of the sea. The sound waves are usually made by specially built trucks that thump and vibrate the ground, or ships towing ‘guns’ powered by compressed air. The sound waves travel down through layers of rocks and bounce back like echoes. The sound waves are recorded by arrays of special microphones, called ‘geophones’ on land, and ‘hydrophones’ at sea. By using computers, geologists and geophysicists can analyse the sounds that are recorded, and use them to create an accurate picture of where oil and gas might be found.
Echo location

Aim:
To investigate echoes and the speed of sound

Equipment:
• two flat pieces of wood (approximately 120mmx19mmx300mm)
• timer
• measuring equipment (i.e. measuring tape)

Method:
1) Measure a distance of 100m
2) Sound makers (students with the pieces of wood) move to one end of the set distance, the timers at the other end.
3) Sound makers must signal when they make sound so the timers can begin timing.
4) Sound makers clap the wood together at the same time they signal the timers to start timing.
5) When the timers hear the sound they are to stop timing
6) Record the time it taken for the sound to travel as well as other observations
7) Repeat

*Repeat this activity over different distances and in different areas of the school*

Results:

<table>
<thead>
<tr>
<th>Location (buildings, trees, inside or outside etc.)</th>
<th>Distance (m)</th>
<th>Time (sec)</th>
<th>Observations (i.e. were there any echoes?)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Discussion:
Did the distance the sound makers and the timers stood apart affect the time taken for the sound to reach the timers? How was it affected?

Was the number of echoes you heard affected by the location? How?

Did anything particular about locations affect the type or number of echoes created?

Did you experience any difficulties while conducting this investigation? What were they and how could you improve the investigation to minimise these difficulties?

How could you extend this investigation? Think of a question that you would like answered with a future investigation.
Conclusion:

<table>
<thead>
<tr>
<th>What do you know?</th>
<th>What do you want to know?</th>
<th>How will you find out?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Learning Experience 1.5 (contd.)

Echoes

Use textbooks, library searches and/or the internet to complete the following:

What is an echo?

Research one of the following uses of echoes

- echo location (as used by bats to locate prey or obstacles),
- echo sounding (for submarines and boats to calculate depth of water below)
- echo sounding to find fish

...
This page is intentionally blank for aesthetic printing.
Drilling

The only sure way to find oil or gas under the ground is by actually drilling a hole down through the earth, using special drilling equipment. We commonly call a hole like this a “well”. Geoscientists and engineers are interested to find out as much information as possible, to answer questions such as:

- Is there any oil or gas present?
- In what kind of rock is the oil or gas trapped?
- How deep is the oil or gas?
- How thick is the oil or gas reservoir, and so, how much is there?
- At what pressure is the oil or gas?

Drilling involves a lot of special equipment, some of it designed to make drilling easier, faster and safer, and some of it designed to take scientific measurements. The scientific measurements involve collecting data from in and around the hole, deep under the ground, so that the geoscientists and engineers can answer the questions listed above.

Drilling rigs on land are relatively simple, as shown in the diagram below.

Drilling engineers (drillers) raise and lower the “drill pipe” as required using powerful engines, within the “derrick” structure, shown above. At the bottom end of the drill pipe is a “drill bit”, which is a hard metal cutting tool. The rotary drive makes the drill pipe and drill bit rotate and this action causes the drill bit to cut down and make a hole into the earth. As the well is drilled deeper and deeper it encounters higher and higher pressures.

Drillers have to prevent high pressure water, oil and gas unexpectedly moving violently up the hole to the surface, causing what is called a “blow-out”. They pump heavy mud down the hole from the “mud pits”, using the “mud pumps” to force the water, oil and gas to stay underground. Special equipment called “blow-out prevention equipment” is also installed, which is used to close off the well if water, oil and gas starts to shoot up the drill pipe. To stop the sides of the hole collapsing inwards, drillers insert a metal tube called the “casing” into the hole and held in place using cement pumped down from the surface.

In order to collect physical measurements of the rock that has been drilled through, and of the oil and gas that has been found, special electronic measuring devices are lowered down the well, either attached to the drill pipe, or attached to metal cables. This activity is called “logging” and the measuring devices are called “logging tools”. Small broken chips of rock, which come up the hole to the surface and are known as “cuttings”, are collected at the surface. Special down-hole cutting equipment can also be used to produce solid rock “cores”. Geologists use the logging, cuttings and core results together to describe the properties of the rock, such as its type, age, density, porosity and which kinds of fluids it contains- whether water, oil or gas.
When drilling at sea, equipment similar to that shown and described above is mounted on a floating vessel, together with accommodation for the geoscientists, engineers, and crew. In shallow water, “jack-up” rigs are used, in which the platform holding the equipment and accommodation rests on three or four strong steel legs. The legs can be raised and lowered, depending on the water depth. In deeper water, “semi-submersible” rigs are used, in which the legs have floating pontoons attached, so that the rig actually floats. There is also an engine, so that the rig can be propelled around like a boat from one drilling location to the next. Whilst a well is being drilled, anchors are used to make sure the rig does not move too much in the wind and sea currents.

In very deep water, typically greater than 1500 m, drilling ships are used. In this case, the drilling equipment is mounted on a ship. Rather than using anchors, the ship uses special water thrusters and GPS technology to make sure the ship stays relatively still whilst drilling.

Wells used to explore for new accumulations of gas and oil are called “exploration wells”. Once an accumulation has been discovered, further wells are drilled to collect more data on the properties of the field, such as those listed above. These are called “appraisal wells”. Finally, if the company decides to produce hydrocarbons from the field, then “production wells” are drilled. At the bottom of such wells, perforations or meshes are constructed using special tools, which allow the oil and gas out of the rocks and up the well bore to the surface, where they may be produced and transported to the refinery or gas plant for processing. Often, the oil or gas will come out of its own accord, due to the high pressure found at these great depths below the surface. If the pressure too low, the oil and gas may need a little help. With oil fields, this is done by injecting water, gas or even steam into the reservoir down additional wells called “injection wells” to push the oil out. Gas at low pressure is often extracted by ‘sucking’ it out, using huge turbine engines at the surface. The following experimental activity illustrates how some of these processes work.

A driller works the drill on a ship

The drill cuts a hole through the rock, while the mud carries the rock cutting back up
Objectives:
1. To demonstrate how a fluid such as oil or water can flow out of an underground reservoir and up to the surface via a well.
2. To discover the characteristics of a reservoir (porosity/permeability) and the important characteristics of a seal.
3. To investigate removal of fluids using a well.

Background Information:
Some sedimentary rocks are filled with fluid. At the time of deposition, water associated with the sediment grains is trapped within the pores. Burial and subsequent hardening will seal much of the water within the sediment. The migration of hydrocarbons will often displace the water where porosity and permeability permits.

Movement of fluids within a sediment layer which possesses permeability is primarily controlled by pressure. Fluids will flow upward (toward lower pressure) until they reach an impermeable layer (seal).

Materials:
- a clear container preferably 12-15 cm (minimum) across the bottom (large beaker, juice bottle or small aquarium);
- 2 glass tubes or transparent drinking straws
- a funnel
- a piece of plastic (rubber) tubing which will fit both the tubing (straws) and the funnel
- aquarium or garden gravel (approx. 5 mm sized grains)
- sand
- Plasticine or “Play Dough” to simulate clay
- water (food colouring should be added)
- cooking oil

Source: http://earthnet-geonet.ca/activities/activity9_e.php
Procedure:

1. Fit one tube (straw) with the rubber tubing and funnel.
2. Place the aquarium gravel (coarse sand) in the bottom of the container and fill to a height of 8-10 cm.
3. Make a layer of “clay” at least 2 cm in thickness that approximately fits the shape of the container. Shape holes in the clay on opposite sides of the layer, that fit around the tubing.
4. Place the “clay” layer on top of the gravel. Push each piece of tubing through the holes to a depth of 2 cm below the base of the clay. The tubes should be at opposite sides of the container, next to the outside so the fluid may be observed.
5. Seal carefully around each tube and against the side of the container, ensuring that there are no visible gaps or cracks.
6. Add a layer of sand (3-4 cm) on top of the “clay” layer.
7. Pour coloured water into the funnel and observe the flow of water. Add more water until it fills one third of the gravel layer. Observe the results.
8. Gradually add cooking oil to the funnel until the fluid level reaches the base of the “clay” layer. Observe the initial results and again after 5-10 minutes.

Questions:

1. Make a sketch of the model and show the path of the water. What happened to the air between the pores of the gravel as you poured in the water?
2. What role did the “clay” layer play? What would have happened if it was not there?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

3. What happened to the oil initially, then after a few minutes? Explain your observations.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

4. What effect did you have when you blew into the funnel? Explain your observations.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

5. What happened when you blew harder into the funnel? Explain your observations.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

6. Assuming the liquid was already in the gravel layer, what other means could be used to remove it?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
Conceptual Area 2: Oil and Gas Fields

LEARNING AREA: Science

Society and Environment

OUTCOME/S: Earth and Beyond (Sci)

Energy and Change (Sci)

Resources (S&E)

PHASE OF DEVELOPMENT: Early Adolescence

CONCEPTUAL AREA: Oil and Gas Fields

KEY UNDERSTANDINGS: Students will be able to explain what happens after oil and gas is discovered.

<table>
<thead>
<tr>
<th>CONCEPTUAL UNDERSTANDINGS</th>
<th>SKILLS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The exploration and production lifecycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Key considerations of oil companies once oil or gas is discovered.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• note-taking/research</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• group work (jigsaw activity)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 – 1.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 – 2.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 – 3.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1, 4.2, 4.4, 4.7, 4.8, 4.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2, 5.3, 5.4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TEACHER INFORMATION:

This series of learning experiences aims to develop student understanding of the stages of oil and gas exploration and production. Students also consider the main factors oil companies have to take into account when developing a gas field.

It is important for students to understand that oil exploration and production is an extremely costly exercise, thus oil companies need to know a lot about an oil reservoir before they start drilling a lot of expensive wells. It typically costs $20-50 million to drill one well offshore, although onshore wells are usually much cheaper.

RESOURCES

Class sets of worksheets attached to Learning Experiences.

EQUIPMENT

Computer access/internet

A3 poster card

Photocopy of articles attached to Learning Experience 2.1 and 2.2

Student Prior Knowledge: Essentially it is presumed that through completing Module 2 and Conceptual Area 1 of Module 3 students will be able to explain how oil and gas are formed, how reservoirs are formed and their characteristics, and how oil companies locate these reservoirs. Conceptual Area 2 develops this understanding by further investigating what oil companies have to do to bring discoveries into production.
Learning Experiences:

Learning Experience 2.1: ‘The Exploration and Production Lifecycle’
This learning experience refers to the text provided. It describes the five stages in the Exploration and Production ‘lifecycle’: Exploration, Appraisal, Development, Production and Decommissioning. These stages step through how hydrocarbons are discovered to what happens when an oil or gas field is decommissioned.

Students use the text provided to answer questions that follow. They then create a poster called ‘Life of an Oil or Gas Field’ to show what they have learned about the Exploration and Production lifecycle. Encourage the students to be as creative and comprehensive as possible: they could download appropriate illustrations from the web, incorporate answers to the questions accompanying this Learning Experience, as well as learning from Conceptual Area 1 or 3. The teacher should determine the extent to which this activity is developed and the time allocated to it, as well as whether students work individually or in groups.

→ go to Learning Experience 2.1 worksheet

Learning Experience 2.2: ‘Developing an Oil or Gas Field’
The extent of this Learning Experience should be determined by the teacher. It may be an option to complete all stages in class time, or certain tasks may be assigned for homework or not completed.

The learning experience focuses on four main issues/questions that oil companies focus upon once oil and gas are discovered, they are:
1. How should the reservoir be developed?
2. What should be the design of the production wells?
3. What should be the design of the production facilities?
4. Which is the best export route for the oil and gas?

The task is based around using a jigsaw activity for students to become 1 of 4 expert groups (each focusing on one focus question). In their expert groups students need to determine the top 5 considerations for their allocated technical areas (focus question). Two different note taking frameworks are provided for students to record their expert groups 5 points. When students return to their original groups each should report back and other group members should record their information in the other three sections. The structured overview provides a more independent option with each student recording all aspects of information. The placemat should be used as a group based recording system where each person’s top 5 points are recorded. In the centre the group may ask clarifying questions or identify points they thought were most interesting or important.

Either as an in-class activity or homework task students should demonstrate their understanding by completing the ‘So what do I now know?’ worksheet. This requires them to record key information and use pictures/diagrams to support their representation of their learning.

→ go to Learning Experience 2.2 worksheet
Monitoring and Evaluation:
Teachers should utilise informal assessment methods to monitor and consolidate student learning of key understanding attached to this conceptual area. The extent to which each learning experience is developed should be determined by the teacher. Essentially each can be delivered concisely over one teaching session, or developed to be more comprehensive and include both in class and homework based task requirements.

The student’s ability to demonstrate their knowledge of key understandings explored in this conceptual area will be essential in the student’s ability to complete the major assessment task (research task) included in Conceptual Area 3.
The Exploration and Production Lifecycle

WHAT NEXT?
Stepping through the Life of an Oil or Gas Field

There are five stages in the exploration and production ‘lifecycle’. These stages step through how hydrocarbons are discovered to what happens after an oil or gas field is decommissioned. Each stage is described below in terms of the activities, jobs, cost and time involved. There are also risks at every stage, which need to be managed responsibly by oil and gas companies.

1. Exploration

Oil and gas exploration is the search by petroleum geologists and geophysicists for hydrocarbon deposits (oil and gas) beneath the Earth’s surface. It involves locating oil and gas reservoirs using primarily seismic surveys (Learning Experience 1.5) and drilling wells (Learning Experience 1.6). Exploration is an expensive, high-risk operation because the cost runs into many tens of millions of dollars and every two out of three wells, on average, contain no hydrocarbons. It may therefore require companies to drill multiple wells in one area before finding an oil or gas discovery, which can take several years. However, explorers can also find that some sedimentary basins do not contain any hydrocarbons at all.

During exploration drilling, information and samples are collected about the rocks and fluids (water, gas and oil) encountered by the well in order to find out:
- Whether there are any hydrocarbons at that location
- How much oil or gas might be present
- What depth the oil or gas occurs at

Exploration activities can also be risky because of:
- The location – remote or difficult terrain, or a sensitive ecosystem
- Safety – people can have accidents while acquiring seismic surveys or drilling wells, even though safety is always a top priority

2. Appraisal

If a company is successful with their exploration drilling and make an oil or gas discovery, then they move into the appraisal phase of the lifecycle. The purpose of this phase is to reduce the uncertainty about the size of the oil or gas field and its properties.

During appraisal, more wells are drilled to collect information and samples from the reservoir. Another seismic survey might also be acquired in order to better image the reservoir. These activities can take several more years and cost tens to hundreds of millions of dollars.

More seismic surveys and wells help petroleum geologists, geophysicists and reservoir engineers understand the reservoir better. For example, they try to find out whether rock or fluid properties change away from the discovery well, how much oil or gas might be in the reservoir, and how fast oil or gas will move through the reservoir.
The appraisal stage is successful if a company decides that the oil or gas field can be developed. One risk that companies face is even after investing time and money in the appraisal stage, they might not find a way to develop the field safely, profitably and responsibly (in terms of communities and the environment).

3. Development
The development stage takes place after successful appraisal and before full-scale production. The main activities (and people involved) are (see also Learning Experience 2.2):

• To form a plan to develop the oil or gas field, including how many wells need to be drilled to produce the oil or gas (geologists, geophysicists and reservoir engineers)
• To decide the best design for the production wells (drilling engineers)
• To decide what production facilities are required to process the oil/gas before it is sent to a refinery or customer (facilities engineers)
• To decide what the best export route might be for the oil and gas (logistics engineers)

Executing the development plan involves drilling engineers who drill the first phase of production wells and project engineers who build the planned facilities. Many thousands of people can be involved in building production facilities, and safety is a top priority. The risk of accidents is highest in this phase because of the number of people involved at construction sites.

It costs hundreds of millions, sometimes even billions of dollars and typically 5-10 years to develop an oil or gas field, depending on the location, size and complexity of the facilities, and the number of wells needed. Onshore developments are typically much cheaper than offshore developments.

No oil or gas field will be developed unless the company believes that they will make enough money to pay back their exploration, appraisal and development costs, as well as profit from selling the hydrocarbons. Even more importantly, developments will only happen if the communities or ecosystems affected can be protected (Learning Experience 3.5).

4. Production
Production is the phase during which hydrocarbons are extracted from an oil or gas field and the first money (or revenue) comes from selling the oil or gas. After a number of years, the revenue exceeds the company’s investment and they begin to make a profit.

Production can last several years up to 40 years, depending on the size of the oil or gas field and how expensive it is to keep the wells and production facilities running. Every year millions of dollars will be spent on operating and maintaining the field. Safe production operations is critical, otherwise companies risk harming people or the damaging the environment, eg. through an oil spill, or explosion.

Operators work in shifts to keep production going. Engineers will usually be located full-time at the production facilities in order to operate and maintain them. Reservoir engineers will check on the health and performance of the field to plan how best to maintain production. Additional wells might need to be drilled or the production facilities improved to maximise recovery of the oil or gas.

5. Decommissioning
Decommissioning is the term used for removing the production facilities and restoring oil and gas sites that are no longer profitable. The term is usually used to refer to offshore facilities. Offshore oil and gas platforms can be vast structures requiring large amounts of materials in their construction. By bringing the facilities onshore for dismantling and disposal, these materials can be reclaimed.
Decommissioning not only involves removing the main platform, but pipelines and cables as well. The aim is to reduce the risk to the marine environment and to reuse or recycle materials. In the majority of cases, all equipment is removed and the site returned to its condition before development began. Some installations can be reused as oil and gas facilities at another location or reused in place for another purpose (e.g., as a wind farm or aid to navigation). Occasionally, part of the platform may be left in place because they benefit the marine environment, e.g., steel legs of tension leg platforms that are used to create artificial reefs in the Gulf of Mexico.

Project, logistics and environmental engineers will be involved in decommissioning a production facility. This vital step takes several years and many millions of dollars. Government requirements and community views will be taken on board during decommissioning.

Use the text above to answer the following questions:
In your own words, explain the purpose of each of the 5 stages in the Exploration and Production Lifecycle.

1. Exploration

2. Appraisal

3. Development

4. Production

5. Decommissioning
Describe in your own words one risk for each of the phases of the Lifecycle.

1. Exploration risk

2. Appraisal risk

3. Development risk

4. Production risk

5. Decommissioning risk

‘Life of an Oil or Gas Field’

Create an A3 poster called the ‘Life of an Oil or Gas Field’ to show what you have learned about the Exploration and Production lifecycle.

Be as creative as possible with your illustrations.

Try to summarise the activities, jobs, risks, cost and time involved at each stage. You might like to incorporate your learning from other learning experiences in this module.
How to Develop an Oil or Gas Field

After an oil or gas discovery has been made, there is an enormous amount of evaluation and planning to be done before an energy company can decide on the best way to produce oil products and develop the oil or gas field. There are four key technical areas where important decisions will have to be made and these will determine how the oil or gas field will be developed.

Your group has been employed by BP to provide advice on these four key technical areas. Each of you will become an expert of one of the areas. The four key technical areas are:

1. How should the reservoir be developed?
2. What should be the design of the production wells?
3. What should be the design of the production facilities?
4. Which is the best export route for the oil and gas?

In your group randomly allocate yourselves to join expert groups 1, 2, 3 or 4.

Your task is to meet with your expert group to determine what should be the top 5 considerations in your allocated technical area.

1. How should the reservoir be developed?

Text adapted from BP’s Energy Business Booklet “Oil and Gas Formation and Production”

Seismic surveys, plus the exploration and appraisal wells provide a lot of information on the amounts of oil and gas present in the field, how the oil and gas are spread out and how much they can recover.

Small amounts of oil and gas can be pushed to the surface by the natural pressure of the reservoir (primary production). The amount produced can be raised by increasing the pressure in the reservoir. This can be done either by injecting water, gas or both down specially drilled injection wells (secondary production). In addition, the injected water or gas will help move the oil and gas towards the production wells.
Experts use advanced computer programmes to simulate the reservoir and the wells. These are used to assess the performance of the reservoir, predict flow rates and calculate the best locations for production wells. By simulating many different scenarios, the team of experts can determine the best way to manage the reservoir and estimate how much oil and gas can be recovered from the field. They can then make the key decisions on how to manage the reservoir the best.

The work of these experts does not finish when the field starts producing oil or gas (or both). As an oilfield can carry on producing oil and/or gas for up to 40 years, reservoirs can also benefit from regular checkups to stay healthy and productive. One of the most modern ways of finding out whether an oilfield is healthy and performing as predicted is to use ‘4D seismic’ technology – the fourth dimension being time. 3D seismic surveys over the field are repeated at regular intervals and the differences between the surveys highlight where the oil has moved to. By using 4D seismic in the North Sea BP was able to produce, on average, an extra 30,000 barrels of oil per day and access an additional 95 million barrels of oil reserves; the equivalent of finding a whole new field. Therefore, throughout the field’s life, how the reservoir is managed is kept under review in order to maximise recovery and production.

2. What should be the design of the production wells?

Text adapted from BP’s Energy Business Booklet “Oil and Gas Formation and Production”

Because wells are very expensive to drill, experts need to decide on the best type and design.

Drilling techniques have made big advances in recent years. To reach the oil and gas at the very edges of the reservoir, wells can be drilled out at any angle. This could involve anything from vertical to horizontal wells through the reservoir and increasing the number of drainage holes within a reservoir, all of which feed into a single well to carry the fluids between the reservoir and the surface.

At the bottom of the well you need to be able to let the oil into the well (pipe) without letting any sand or other solid material in. The team chooses whether any specialised equipment will be needed to hold the reservoir rock in place, improve the flow of fluids between the reservoir and the wells, and to assist the flow of the petroleum from the reservoir to the surface.

As an example, at BP’s Wytch Farm oilfield in the UK it was possible to reach an underground reservoir more than 10 kilometres away from the surface drilling site, by drilling horizontally. Not only did this save the cost of drilling additional wells, it also meant that there was less impact on the landscape. Deep within these wells, and just above the reservoir, electrically driven pumps have been installed to aid the flow of the reservoir fluids to surface.

3. What should be the design of the production facilities?

Text adapted from BP’s Energy Business Booklet “Oil and Gas Formation and Production”

At the surface the oil, gas and water that have been produced from the reservoir are separated. Water is removed from the oil and the gas, and both are treated until they are of the right quality to be marketed. Normally, some of the gas that has been produced from the reservoir is used as a fuel to run the production equipment and facilities.
Many new oil and gas fields are offshore and in deeper waters, and this presents some major challenges. To produce oil or gas offshore, energy companies have to invest hundreds of millions of dollars in offshore production facilities, which have all the equipment needed to process the produced fluids and pump the oil and gas to an export route.

When the first offshore oilfields were developed, the production facilities were rigid steel or concrete structures called platforms, which were secured to the seabed. As oil and gas development has moved into much deeper waters, new production facilities have been designed. These include tension leg platforms (TLP), held in position by long cables, and floating production, storage and off loading vessels (FPSOs). FPSOs are giant ships that are connected to the wells on the seabed by flexible pipes; they are like oil tankers and can often store millions of litres of crude oil ready for export. New offshore developments are often based on a combination of various types of production facilities to maximise the commercial recovery of oil and gas. Planning for onshore oil production can also present big technical and environmental challenges – for example in the Alaskan tundra with its fragile ecosystem, or in the intense heat of the Algerian desert, or the rainforest of Papua New Guinea. Regardless of the location or conditions, companies have to take every reasonable precaution to minimise environmental impacts.
4. Which is the best export route for the oil and gas?

Text adapted from BP’s Energy Business Booklet “Oil and Gas Formation and Production”

Crude oil cannot be used in its raw form; it has to be processed at a refinery in order to turn it into useful products. Refineries are often located close to major centres of population where the demand for oil products is highest. Likewise, the market for gas as a fuel is also where there are major centres of population. This all means that, when planning a new oil and/or gas development, one of the key decisions will be how best to move the oil and gas to where it will be sold.

Where oil production is high enough, and either onshore or close enough to shore, a pipeline is likely to be the most economic way of moving the oil either directly to the refinery or to where it can be loaded onto an oil tanker truck or train to be taken to the refinery. For smaller fields where it would be too expensive to construct new pipelines, or large fields very far offshore, shuttle tankers take the oil from the production facilities to a refinery.

In Alaska, the oilfields are in the far north of the country. To move the oil to the southern terminal for export by sea to markets on the west coast of the USA, a 1,280 kilometre pipeline was built to withstand Arctic conditions, yet at the same time have the least possible effect on the environment.

Meanwhile, the oil refinery in Kwinana, Western Australia receives most of its crude oil by ship and a small amount by truck.

When the oilfields are many thousands of kilometres from the markets for oil, transport by sea is the only practicable way of moving crude oil. The giant oilfields of the Middle East are far from the main markets in North America, Europe and the Far East. The oil is moved in very large crude carriers, ships capable of carrying 300,000 tonnes or more of crude oil.

For a long time, gas could only be consumed in the country where it was produced, or sent to nearby countries by pipeline. For example in Western Australia, some of the gas from the North West Shelf is sent to Perth and the south-west via the Dampier to Bunbury pipeline which is 1596km long with ten compressor stations along the way. It is one of the longest and largest capacity natural gas pipelines in Australia, supplying gas to industrial, commercial and residential customers in Perth and major regional centres along the pipeline route.

However, the growing world demand for gas has justified the huge investments in the facilities for treating and transporting natural gas overseas by ship. Before the gas can be transported in economic amounts, it is liquefied in special facilities by reducing its temperature to -161°C, which reduces its volume 600 times. It can then be transported by sea as a liquid in special liquefied natural gas (LNG) carriers. The carriers dock at regasification terminals in the countries where the gas will be used, and the LNG is turned back into gas then fed into the local pipeline distribution network.

The North West Shelf currently exports 16.4 million tonnes of LNG to south east Asia every year. That is 250-260 cargoes per year.
**Learning Experience 2.2 (contd.)**

*LNG tanker*

*Three ships berth at the BP Refinery in Kwinana, Western Australia*
WHAT NEXT? What happens after oil and gas is discovered?

1. How should the reservoir be developed?
2. What should be the design of the production wells?
3. What should be the design of the production facilities?
4. Which is the best export route for the oil and gas?
Learning Experience 2.2 (contd.)

Structured Overview

<table>
<thead>
<tr>
<th>How should the reservoir be developed?</th>
<th>What should be the design of the production wells?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What should be the design of the production facilities</th>
<th>Which is the best export route for the oil and gas?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
What happens after oil and gas is discovered

Using the information you have collected, produce an annotated (that’s labelled) pictorial (that’s diagrams and pictures) account that shows some of the things that happen when oil and gas are discovered.

<table>
<thead>
<tr>
<th>KEY POINTS</th>
<th>SUPPORTING PICTURES/DIAGRAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Seismic Surveys and Exploratory Wells</td>
<td></td>
</tr>
<tr>
<td>2. Drilling a Well</td>
<td></td>
</tr>
<tr>
<td>3. Production Facilities</td>
<td></td>
</tr>
<tr>
<td>4. Moving Oil and Gas to Refineries</td>
<td></td>
</tr>
</tbody>
</table>
# Conceptual Area 3: Environmental Management

**LEARNING AREA:**

- Society and Environment
- Science

**OUTCOME/S:**

- Investigation, Communication and Participation (S&E)
- Place and Space (S&E)
- Earth and Beyond (Sci)
- Energy and Change (Sci)

**PHASE OF DEVELOPMENT:**

- Early Adolescence

**CONCEPTUAL AREA:**

- Environmental Management

**KEY UNDERSTANDINGS:**

Students will be able to identify areas where BP is exploring and producing oil and gas and examine the impact and environmental management of these operations.

Students may explore career pathways of the oil and gas exploration industry.

<table>
<thead>
<tr>
<th>CONCEPTUAL UNDERSTANDINGS</th>
<th>SKILLS</th>
<th>VALUES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locations where BP is exploring and producing oil and gas.</td>
<td>Atlas and mapping skills.</td>
<td>1.3 – 1.7</td>
</tr>
<tr>
<td>Action BP is taking to manage their global operations.</td>
<td>Internet research.</td>
<td>2.1 – 2.5</td>
</tr>
<tr>
<td>Case study examples of projects BP is involved with around the world.</td>
<td>Note-taking</td>
<td>3.1 – 3.7</td>
</tr>
<tr>
<td>The causes, effects and management plans of environmental impacts as a result of oil exploration and production.</td>
<td>3 Levels of focus questions.</td>
<td>4.1, 4.2, 4.4, 4.7, 4.8, 4.9</td>
</tr>
<tr>
<td></td>
<td>Paragraphing.</td>
<td>5.2, 5.3, 5.4</td>
</tr>
<tr>
<td></td>
<td>Editing and proofreading.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Self reflection and time management.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oral communication and listening.</td>
<td></td>
</tr>
</tbody>
</table>

**TEACHER INFORMATION:**

This series of learning experiences aims to explore the environmental impact and management that is required as a result of oil companies exploring and extracting oil and gas.

For the purpose of this Learning Experience teachers are encouraged to adopt a cross curricular planning approach between science and society and environment. If this is not feasible the assessment piece can be completed and assessed by either learning area.

**RESOURCES**

Class sets of worksheets.

Resources from appendix section of BPEEP file:

- ICP Ladder
- ICP A3 Planning Sheet
- Paragraph Framework (blank)
- Edit and Proofreading Checklist

**EQUIPMENT**

Class set of Atlases.

Access to computers/internet

**Student Prior Knowledge:** Conceptual Area 3 is primarily concerned about the oil industry’s environmental management as a result of its oil exploration and production operations. It is presumed students have completed aspects of Module 2 ‘Oil Formation’ and all, or parts of, Conceptual Areas 1 and 2 of Module 3.
Learning Experiences:

Learning Experience 3.1: ‘Where is BP exploring and producing oil and gas?’
This is an introductory mapping task that can be completed prior to the ‘BP around the World’ research based learning experience. Teachers are encouraged to refer to basic mapping and atlas skills before the students complete the task. Students should be encouraged to use pencil only, uniform horizontal lettering and include the following mapping elements: title, legend/key and north point.

→ go to Learning Experience 3.1 worksheet

Learning Experience 3.2: ‘BP around the world’
The ‘BP around the world’ learning experience is primarily research based. Students will need access to computers to use the internet to research one project that BP is involved with to improve conditions for the environment, people, land or surrounding region for one of the locations listed.

The website: www.bp.com provides a good starting point for initial research. Students should collect their information using the note taking framework provided. Using the ‘Think, Plan, Write, Edit and Present’ paragraph framework students, under test conditions, answer the following focus question:

‘Explain how a BP project has contributed to the region of one of its oil production interests’

To enhance student application of the editing process it is suggested students take their drafted paragraph (THINK, PLAN and WRITE stages of framework) home to complete the EDIT and PRESENT stages. A rubric is provided in the appendix section of the BPEEP file to assess student’s application of the paragraph framework (numerically based). Teachers may opt to use ‘one off’ paragraphs as further evidence of student attainment of levels in certain aspects of Learning Area outcomes.

Once edited and completed each student should share their paragraph (hence their research) with the class. The information should include the project title, the location, its aim and the results of the project. When listening to their classmates students should record an overview of different projects using the framework provided.
Paragraph Framework – Explanation:

- The initial part of the paragraph framework requires the students to brainstorm all relevant information to the main idea of the paragraph. This is the ‘THINK’ component.
- With a set of initial thoughts students plan the structure of the content in their paragraph. Using the ‘hamburger’ framework students sort ideas into the four main types of sentences: Statement (or Topic Sentence), Explanation (or Developing Sentence/s), Examples (or Supporting Sentence/s) and Conclusion (or Concluding Sentence). This is the ‘PLAN’ component.
- Students draft their paragraph at this stage, using their Plan as a guide. Emphasis should be placed on the students identifying each type of sentence to ensure the paragraph is correctly structured. This can be done by a colour a scheme for each sentence type or simply labelling after sentences with TS (Topic Sentence), DS (Developing Sentence), SS (Supporting Sentence) and CS (Concluding Sentence). This is the ‘WRITE’ component.
- Once drafted, students should edit their paragraph. Spelling, grammar and punctuation should all be a focus, as well as ensuring all four types of sentences correctly structure the paragraph. As well as self, peer or parental editing should be encouraged. This is the ‘EDIT’ component.

Once a full edit process is completed the student is ready to present their paragraph. All corrections should be made and sentence identification (i.e. TS, DS, SS and CS) removed. This is the ‘PRESENT’ component.

Learning Experience 3.3: Guest Speaker

Teachers may make contact with BP to request a guest speaker to come to the school to talk on the topic of oil and gas exploration and production. A guest speaker handout is provided for students to record and use the information provided in the presentation.

NOTE: If organising a guest speaker the teacher may opt to also request the coverage of topics such as Oil and Natural Gas Formation (Module 2) or Oil Refining (Module 4) in the one presentation visit. This will largely be determined by availability of and your proximity to a BP representative and the students’ knowledge of the additional concepts.

To request a guest speaker please contact the BPEEP Coordinator on (08) 9419 9623.

Learning Experience 3.4: Energy Careers

As an additional focus during the guest speaker presentation the teacher may opt to incorporate an Energy Careers focus in which students question and gain specific details of the speaker’s career, using the framework provided. Likewise students can access resources such as those listed below to gain this information about a range of careers involved in the energy industry:

Jobguide
Websites
BP resource

The teacher may opt to randomly allocate 3-5 careers to students who research their allocated career then report back to a small group comprising each career.
Careers relevant to this module include:

- Geologist
- Geophysicist
- Petroleum or Reservoir Engineer
- Petrophysicist
- Drilling Engineer
- Chemical Engineer
- Environmental Engineer
- Civil Engineer
- Materials Engineer
- Project Engineer
- Facilities Engineer
- Logistics
- Procurement
- Surveyors
- Petroleum Technologist
- Marketers

Learning Experience 3.5: Research Assessment Task

The major assessment task for Module 3 “Oil and Gas Exploration and Production” is a research based task. The time allocated to this task should be decided by the teacher and will largely be determined by approach taken (cross-curricular/individual learning area) and the ability of the students. If integrating with Society and Environment the process outcome: ‘Investigation, Communication and Participation’ should guide the assessment process (see ICP support – ICP Ladder and planning sheet in appendix section of BPEEP file).

The Task:

Two statements are provided that comment on major potential impacts oil exploration and production can have on the global environment. Students research either the statement made about ‘Endangered Marine Life’ or ‘The Risk of Oil Spill’.

The students should consider the following focus areas:

- The causes of the selected environmental concern.
- The effects (impacts) of the selected environmental concern.
- The subsequent action that is taken by oil companies to manage the environmental concern.
- Specific reference to examples where the environmental concern is evident or being managed.
- A personal viewpoint toward the statement; does their research lead them to agree or disagree with the statement?
STATEMENT 1: Endangered Marine Life.
Oil companies have been criticised in the past for the continued use of seismic testing to assist in the location of oil and gas fields due to the impact it has on whales and other marine life. However due to the proactive approaches adopted by oil companies in recent years this impact has become increasingly minimal as compared to other human activities that threaten whale stocks and other marine life.

STATEMENT 2: The Risk of Oil Spill.
Oil companies have been criticised in the past for the risk their operations present to the environment as a result of oil spills. However due to the proactive approaches adopted by oil companies in recent years this risk has decreased significantly as compared to other human activities that threaten our oceans and coastlines.

PRESENTATION:
Students should present their findings as a pamphlet that intends to clarify the issue with environmental groups on behalf of an oil company.

As part of the ICP Outcome assessment students will need to submit all aspects of the I.C.P. ladder process, including:
- A3 Planning Sheet (task in own words, goals, 3-Levels of Questioning, brainstorm, reference list).
- All your note-taking (including the use of a variety of frameworks: H.A.K.D., structured overview, PMI, SWOT, keyword summary ...).
- A learning journal (including initial prediction, mid-way review, final self-evaluation and on-going daily progress reflections).
- All their draft work (including all paragraphs drafted using the paragraph framework).
- Their good copy (be proud of what you submit).

Teachers should provide students with a blank ICP ladder that guides the student through the research assessment process. This is initially supported in the planning stage by the ICP planning sheet (should be photocopied A3 size). The planning sheet provides a framework for students to explain the task in their own words, consider the outcomes they may cover, set their assessment goals, develop their literal, inferential and evaluative focus research questions and consider the sources they will utilise and the note-taking frameworks they will use to collect their information.

The teacher should encourage students to use appropriate note-taking frameworks for collecting their information. To ensure students seek information that enables a viewpoint to be developed about their chosen statement that should use frameworks including: PMI (Pluses, Minuses and Interesting), SWOT (Strengths, Weaknesses, Opportunities and Threats) and table summary (For, Against, Neutral). Students should utilise all sources of information available to them: library, newspaper, internet, questionnaire, guest speaker, TV documentaries, letters to industry requesting information packs.

The BP website (www.bp.com) is a good starting point; here students can access management plans, strategic business operation plans/statements and the BP Energy Information Booklets.

An assessment rubric is provided incorporating both science and society and environment outcomes.
Monitoring and Evaluation:

Student understanding of oil and gas industry operations and resultant environmental management is assessed through:

- The completion of learning experience tasks (including guest speaker participation).
- A paragraph task for which a rubric is provided in the appendix section of the BPEEP resource file to assess the student’s ability to construct a well structured paragraph. Paragraphs should be used by the teacher as evidence toward the attainment of conceptual outcome levels.
- A major research task incorporating both the Science and Society and Environment learning areas. A rubric is provided.

Teachers are encouraged to utilise informal assessment practices throughout the module to continually monitor and consolidate student understandings.
Where is BP exploring for and producing oil and gas?

BP is one of the world’s largest energy companies and is the largest producer of oil and gas from both the UK’s North Sea and the USA.

Elsewhere in the world it has oil production interests in the Norwegian North Sea, Egypt, Colombia, Trinidad, Abu Dhabi in the Arabian Gulf, and in Azerbaijan, offshore in the Caspian Sea and other places. The company continues to explore for and develop new oil reserves in these countries as well as in Angola and parts of the former Soviet Union.

BP’s interest in the exploration, development and production of natural gas extends from the North Sea, the United States, Canada and Trinidad to Algeria, the Arabian Gulf, Australia, Indonesia and Vietnam.

Use an atlas to map the locations of interest for BP oil and gas exploration.
Learning Experience 3.1 (contd.)

![Map of the World](image-url)

- 180°
- 150°W
- 120°W
- 90°W
- 60°W
- 30°W
- 0°
- 30°E
- 60°E
- 90°E
- 120°E
- 150°E
- 180°

- 0°
- 30°S
- 60°N
- 60°S

**Note:** The map shows the distribution of oil and gas exploration and production regions around the world, with key locations and boundaries marked.

---

**BP energy education program**

**Module 3: Oil and Gas Exploration and Production**

©BP Australia Pty Ltd 2008
BP Around the World

Use the internet (www.bp.com) to research one project that BP is involved with to improve conditions for the environment, people, land or surrounding region for one of the locations listed. Collect your information using the note taking framework provided and write an explanatory paragraph using the paragraph framework. Be prepared to share your paragraph (hence your research) with the class. Your information should include the project title, the location, its aim and the results of the project.

For example: You could find out more about a project such as:

**Community investment:**
“As part of BP’s commitment to promote education and access to energy in remote locations, they continue to support the Environmental Educators’ Initiative in China.”

or

“In India, Tata BP Solar is bringing power to villagers in Ladakh through the provision of solar panels.”

Name of BP’s Project: ___________________________

Location: ___________________________

<table>
<thead>
<tr>
<th>Subheading</th>
<th>Keywords or Key Ideas</th>
<th>Explanation of Key Points in my own words</th>
</tr>
</thead>
</table>
Learning Experience 3.2 (contd.)

Paragraph Framework

The main idea of the paragraph is ...

Explain how a BP Project has contributed to the region of one of its oil production interests.

THINK

PLAN

Statement (Topic Sentence T.S.)

Explanation (Developing Sentence D.S.)

Examples (Supporting Sentence S.S.)

Conclusion (Concluding Sentence C.S.)
Learning Experience 3.2 (contd.)

WRITE

(Identify each type of sentence using T.S.[ST], D.S.[EXP], S.S.[EG], C.S.[CON]).

EDIT

☐ Spelling  ☐ Punctuation  ☐ Grammar  ☐ Sentences  ☐ Keywords

PRESENT
BP Around the World

As you listen to your class mates present their findings about a BP project record a summary of the information in the table provided.

<table>
<thead>
<tr>
<th>Name of Project</th>
<th>Location</th>
<th>Aim</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example. Tata BP Solar</td>
<td>India</td>
<td>Provide power to villagers in Ladakh.</td>
<td>Through the provision of solar panels Tata BP Solar is now able to provide power to the villagers of Ladakh.</td>
</tr>
</tbody>
</table>


Guest Speaker

Complete the following section before the guest speaker arrives

The guest presenter is a

What do I think their job entails them doing day-to-day?

What do I think their job has to do with what I am learning about in school?

What are three questions I would like to ask the guest speaker in order to find out more about they do?

1) 

2) 

3) 

What are three questions I would like to ask the guest speaker in order to find out more about the topic I am studying at the moment?

4) 

5) 

6)
Complete the following section while the guest speaker is presenting to your class.

Guest Presenter’s Name:

___________________________________________________________

Guest Presenter’s Role:

___________________________________________________________

Where do they work?

___________________________________________________________

What training did they have to do to get the role?

___________________________________________________________

___________________________________________________________

___________________________________________________________

Use the space below to record any interesting information the guest speaker may tell your class and to record the answers to any questions they may answer.

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________

___________________________________________________________
Complete this T-Chart after the guest speaker has finished their presentation

<table>
<thead>
<tr>
<th>What I learnt</th>
<th>How my ideas changed</th>
<th>What I’d still like to know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy Careers

Research a career related to Exploration or Production from the following list:

- Geologist
- Geophysicist
- Petroleum or Reservoir Engineer
- Petrophysicist
- Drilling Engineer
- Chemical Engineer
- Environmental Engineer
- Civil Engineer
- Materials Engineer
- Project Engineer
- Facilities Engineer
- Logistics
- Procurement
- Surveyors
- Petroleum Technologist
- Marketers

Job Title: ____________________________

Job Description: ______________________

Qualifications: ________________________
Learning Experience 3.4 (contd.)

Opportunities:

Work Conditions:

Salary:
Research task

Oil Production and the Environment

Some initial points for consideration...

- Oil production can have an adverse effect on the environment in various ways.
- BP aims to cause no damage to the environment across all of its activities. For every major activity, the company sets clear annual targets for reducing the impact of its operations on the air, water and ground.
- Before any major hydrocarbon developments are allowed to go ahead, independent environmental impact assessments are conducted. These establish the ecological and environmental conditions of the area proposed for the development and assess the risks to the environment from the development.
- Particular attention is paid to the effect oil and gas developments might have on endangered species.
- Oil companies also have detailed contingency plans to take immediate and effective action in the event of an oil spill, at each of its oil exploration and production operations.

Task description:

Two statements are provided that comment on major potential impacts oil exploration and production can have on the global environment. Your assessment task requires you to research either the statement made about ‘Endangered Marine Life’ or ‘The Risk of Oil Spill’.

You should consider the following focus areas:

- The causes of your selected environmental concern.
- The effects (impacts) of your selected environmental concern.
- The subsequent action that is taken by oil companies to manage the environmental concern.
- Specific reference to examples where the environmental concern is evident or being managed.
- A personal viewpoint toward the statement: does your research lead you to agree or disagree with the statement?

STATEMENT 1: Endangered Marine Life.

Oil companies have been criticised in the past for the continued use of seismic testing to assist in the location of oil and gas fields due to the impact it has on whales and other marine life. However due to the proactive approaches adopted by oil companies in recent years this impact has decreased significantly as compared to other human activities that threaten whale stocks and other marine life.

STATEMENT 2: The Risk of Oil Spill.

Oil companies have been criticised in the past for the risk their operations present to the environment as a result of oil spills. However due to the proactive approaches adopted by oil companies in recent years this risk has decreased significantly as compared to other human activities that threaten our oceans and coastlines.
Presentation:
Present your findings as a pamphlet that intends to clarify the issue with environmental groups on behalf of an oil company.

Assessment Rubric

<table>
<thead>
<tr>
<th>Level</th>
<th>ICP</th>
<th>Place and Space</th>
<th>Life and Living</th>
<th>Earth and Beyond</th>
</tr>
</thead>
</table>
| 2     | The student:  
   • With teacher direction, can follow an investigation and collect information.  
   • Can describe what they have found out and present this from their own point of view.  
|       | The student:  
   • Can identify ways people interact with a place.  
   • Can name ways people interact with a place  
   • Can identify rules that exist to ensure the care of places.  
|       | The student:  
   • Can identify the different needs of living things  
|       | The student:  
   • Understands how some changes in the observable environment, including the sky, land or ocean, influence life:  
   • Can describe an environmental concern that occurs  
   • Can draw a simple diagram of the environmental concern.  
   • Can describe the effect of the cause on the environment.  |
| 3     | The student:  
   • With teacher guidance you can select aspects of a topic to investigate and record information from more than one source.  
   • Can draw simple inferences from their information to support a point of view.  
|       | The student:  
   • Can explain patterns formed by natural and built features of a place.  
   • Can identify and make generalisations about how patterns and processes affect built environments.  
   • Can describe how people use natural features to support human activity.  
   • Can recognise how and why caring for the environment is important.  
   • Can identify conflicting values and viewpoints about the care of places.  
|       | The student  
   • Can make connections between living things and the environment  
   • Can predict the likely consequences for a species of removing its habitat such as the effect of oil spills on marine life.  
|       | The student:  
   • Understands changes and patterns in different environments and space, and relates them to resource use.  
   Can describe how the actions of industry can impact the environment i.e. the transport of oil can lead to oil spills  
   Can make connections between events and changes in the environment.  |
### Learning Experience 3.5 (contd.)

<table>
<thead>
<tr>
<th>Level</th>
<th>ICP</th>
<th>Place and Space</th>
<th>Life and Living</th>
<th>Earth and Beyond</th>
</tr>
</thead>
</table>
| 4     | The student:  
- Can negotiate an investigation and collect and record accurate information from different sources and points of view.  
- Can combine this information to support and make simple generalisations in their presentation which presents an informed opinion. | The student:  
- Can examine how patterns of places are a result of both human and natural interactions.  
- Can examine how people’s relationship with a place is interdependent.  
- Can clarify that there are conflicting values evident in people’s use of places.  
- Can investigate changes in landscapes and examine how to care for a range of environments. | The student:  
- Understands how changing aspects of the environment can affect organisms.  
- Can describe the effects of change on an ecosystem. | The student:  
- Understands processes that can help explain and predict interactions and changes in physical systems and environments.  
- Can explain the relationship between human activities and the effect on the environment i.e. seismic interacts with marine life.  
- Can describe how information is gathered about the effects on the environment.  
- Can predict the consequences of future events on the environment i.e. oil spills on the coastline.  
- Can use a simple model to describe the cause and effect of human activities. |
| 5     | The student:  
- Can plan an investigation and use appropriate data collecting and recording techniques.  
- Can use discipline language to explain patterns in the evidence and to draw conclusions. Their presentation shows that you have considered facts, opinions and motives for particular viewpoints. | The student:  
- Can determine that patterns are caused by interrelationships between various processes.  
- Can suggest what similarities and differences exist between places and the interrelationships.  
- Can formulate reasons for variations and/or similarities between places.  
- Can categorise and discuss different ways individuals and groups act to sustain the environment.  
- Can propose how people’s differing values determine their interaction with the environment. | The Student  
- Can explain the impact of environmental changes of a system over time.  
- Can predict the ongoing effects of change on an ecosystem over a period of time. | The student:  
- Understands models and concepts that explain earth and space systems and that resource use is related to the geological and environmental history of the earth and universe.  
- Can explain how a particular system of exploration is related to the shape and depth of an oil accumulation and how the features of this accumulation are influenced by the geological past.  
- Can use scientific concepts and models to show how human activity can impact on the environment. |
### Learning Experience 3.5 (contd.)

<table>
<thead>
<tr>
<th>Level</th>
<th>ICP</th>
<th>Place and Space</th>
<th>Life and Living</th>
<th>Earth and Beyond</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level Demonstrated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Teacher Comment:**

_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
References for Module 3


American Petroleum Institute http://www.api.org/story/ AND
http://www.adventuresinenergy.org/index.html

American Association of Petroleum Geologists http://www.aapg.org/k12resources/

BP Energy Business Booklet ‘Oil Formation and Exploration’

About BP http://www.bp.com OR http://www.bp.com/extendedsectiongenericarticle.do?categoryId=5&contentId=7044157


Energy Information Administration
http://www.eia.doe.gov/kids/energyfacts/sources/non-renewable/nonrenewable.html

California Energy Commission http://www.energyquest.ca.gov/story/chapter08.html

California Department of Conservation http://www.consrv.ca.gov/DOG/picture_a_well/Pages/qh_drill_rig.aspx

Canadian Centre for Energy http://www.centreforenergy.com/silos/ONG/ET-ONG.asp

Earth Net Activities http://earthnet-geonet.ca/activities/oil_e.php


UK Institute of Petroleum http://www.energyinst.org.uk/education/oilandgas/energy.htm

US Department of Energy


This book has been produced using paper from mills that have ISO4001 (International Environment Management Standard) accreditation and FSC (Forest Stewardship Council) accreditation. These standards promote forest certification and product labeling to allow papermakers to identify wood pulp that comes from well managed forests with sustainable reforestation policies. FSC is the only eco label endorsed by WWF Friends of the Earth and Greenpeace.