Lights, Engines, Action!
Science and Technology at Sea

A Queensland Maritime Museum Education module addressing multiple-outcomes across Key Learning Areas for Lower Secondary students (Level 5)

Key Learning Areas by strands:

Key Learning Area	Strands
Science	Science and Society Energy and Change
Technology	Technology Practice Materials

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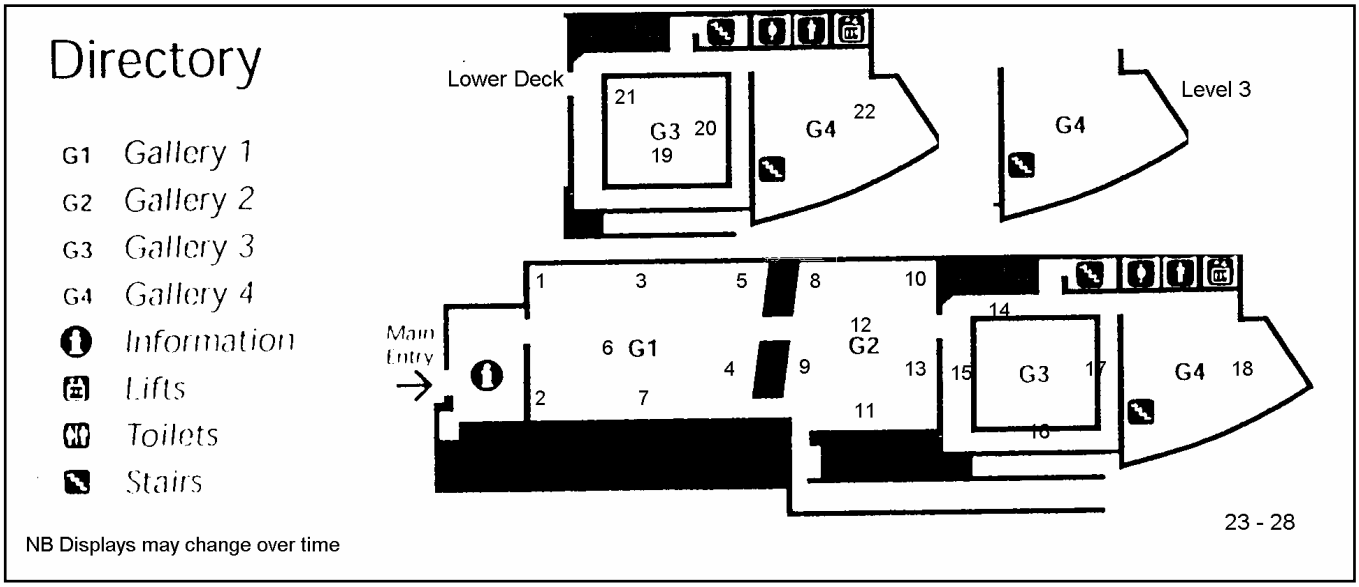
About the Queensland Maritime Museum

Background

The Queensland Maritime Museum was founded in 1971 and is run entirely by volunteers. It is situated on the Brisbane River at the southern end of Southbank Parklands and at the end of the Goodwill Bridge.

The collection is housed in a two storey building that contains a large range of artefacts in three galleries, a new extension and outside displays. The following themes and displays can be found at the museum:



Gallery 1

1. Early Navigators Display
2. Sailor's Lamp Posts (Fresnel lenses)
3. Handcrafted Sailing Ship Models by John McDonald
4. Mutiny on the Bounty Display
5. Queensland Government Vessels Display
6. Model of the *Otranto* (Orient/ P and O line)
7. Mock-up of a Ship's Bridge

Gallery 2

8. South Brisbane Dry Dock Photograph Display
9. Navigation Instruments
10. John Burke Ltd. Queensland Shipping Company Display
11. Pre-SCUBA Diving Display
12. Model of the *Orion* (Orient/ P and O line)
13. Queensland Shipwreck Map

Gallery 3

14. Mock-up of Ship Cabins
15. Maritime artefacts
16. Old Photographs of Brisbane
17. Sailing Trophies

Gallery 4

18. Oil Tankers

Gallery 3 (Lower Deck)

19. Pleasure Boats
20. Rigging and Sail making
21. Half Models

Gallery 4 (Lower Deck)

22. Engines and Motors

Outside Displays

23. Battle of the Coral Sea (On the HMAS *Diamantina*)
24. HMAS *Diamantina*
25. HMAS *Forceful*
26. *Carpentaria* Lightship
27. *Happy II*
28. Small boats, engines and guns

Pre-visit organization

The Queensland Maritime Museum is open everyday 9.30am—4.30pm (except Christmas Day, Good Friday and Anzac morning).

For more information prior to booking a visit make contact with museum staff by:

- Phoning (07) 3844 5361
- Faxing (07) 3846 1945
- Emailing info@maritimemuseum.com.au

To book an excursion to the Queensland Maritime Museum please complete the booking form found on the museum's website www.maritimemuseum.com.au

Purpose

This module provides a complete program of activities that focus on one aspect of the exhibits featured at the Queensland Maritime Museum. It includes activities that can be undertaken before a visit to the museum to provide an orientation to the theme; interactive activities conducted at the museum which make use of the primary and secondary sources available and enhance students' understandings of the theme; and post –visit activities to help students synthesise their understandings.

The theme of this module ties in with level 5 Science syllabus concepts of force, motion, energy and energy transformations and links it to the maritime contexts. Students will develop their understandings about the forces that act on boats and the effect this has on motion. Using this knowledge, students will be able to apply this to investigate how effective boat design helps a boat move through water.

Students will also investigate different forms of energy and energy transfer and transformations in the maritime context. Students will understand how these concepts assist with boat design and will apply these ideas technological innovations over time (e.g. engine development).

Energy is also examined in terms of the light energy used in light house technology; in particular the Fresnel lens is examined in theory and in practice with students being able to examine the Fresnel lens on display at the museum.

Overview of activities

Phases and activities	Core learning outcomes by phase of possible demonstration	Assessment opportunities
Pre-visit: 1. Why do boats float? 2. What makes a boat move in the water? 3. Forces acting on a boat: Friction 4. Developments in ship propulsion 5. Light and Lighthouses 6. Before you go	**Science:** Energy and Change 5.1 Energy and Change 5.2	Annotated diagram of forces acting on a boat. Group work: Types of energy and transformations on different boats. Timeline of developments in ship propulsion.
QMM visit: 1. Excursion Booklet	**Science:** Energy and Change 5.1 Energy and Change 5.2 Science and Society 5.1	Recording Information.
Post-visit: 1. Design your own boat 2. Nuclear Powered Submarines	**Science:** Energy and Change 5.3 Science and Society 5.1	Designing, making and appraising a model boat. Class debate

Core learning outcomes

The following table outlines the core learning outcomes included in this module. Please note that the outcomes printed in **bold** are the focus learning outcomes for this module, for which it may be possible to gather sufficient evidence to make judgments about student performance.

SCIENCE	TECHNOLOGY
Science and Society 5.1 Students consider how and why scientific ideas have changed over time.	**TP 5.1** **Students analyse links between the knowledge, ideas and data gathered to meet design challenges and the design and development of new and improved products.**
Energy and Change 5.1 **Students analyse situations where various forces (including balanced and unbalanced forces) act on objects.**	**TP 5.2** **Students generate design ideas and communicate these in design proposals that indicate an understanding of factors influencing production of the option(s) they have selected.**
Energy and Change 5.2 **Students explain how energy is transferred and transformed (including energy transfer by convection and conduction).**	**TP 5.3** **Students meet predetermined standards as they follow production procedures to make quality products.**

Energy and Change 5.3 Students discuss the consequences of different ways of obtaining and using energy (including nuclear energy).	**TP 5.4** **Students use predetermined criteria to judge how well processes and products meet the needs of specific users, and recommend modifications or improvements.**
	MAT 5.1 Students compare and contrast materials according to their characteristics to determine how effectively the materials meet predetermined standards.
	MAT 5.2 Students operate equipment and apply techniques for manipulating and processing materials to meet predetermined standards.

Planning, teaching and assessing with multiple outcomes across a number of key learning areas

Learning outcomes have a dual role - they inform planning and they provide a framework for assessment. Queensland Maritime Museum modules allow planning for multiple outcomes from more than one Key Learning Area. In such modules, there are a number of things that should be kept in mind in relation to planning and assessment.

Planning

Teachers will choose this module, *Lights, Engines, Action!* for a variety of reasons, including students' interests and the availability of resources. However, a number of factors need to be considered in relation to the implementation of this module.

Teachers will need to consider how the outcomes that may be developed and demonstrated in this module relate to the contribution of other modules and activities that form the entire continuum of planning and assessment. Introductory and developmental activities leading to students' demonstrations of the listed learning outcomes may differ depending on whether this module is planned for early Year 8 or mid- Year 9.

The activities in this module are intended to form an integrative set of learnings that may contribute to the demonstration of the core learning outcomes shown in bold in the table on pages 4 and 5. This set of learning outcomes has been selected because they are relevant to the contents and contexts of *Lights, Engines, Action!* Different activities in this module may contribute to the development of, and allow for the demonstration of one, or more than one, of this set of selected learning outcomes. Because learners may need multiple opportunities to develop and demonstrate learning outcomes, teachers may need to plan for the inclusion of other learning activities and assessment tasks before feeling confident of making a final judgment on the demonstration of learning outcomes.

Other planning considerations include:

- maintaining the integrity of each learning outcome (i.e. including the 'knowing and the doing with what is known' parts, the associated key concept/s and/or organizing ideas, and other characterising features of a Key Learning Area such as working scientifically, working technologically or the SOSE values);
- determining students' prior learnings related to the knowledge, practices and dispositions associated with the core learning outcomes and scaffolding or modifying the learning activities and assessment tasks accordingly

- being aware of the sequenced continua of all core learning outcomes and how these can support those students developing and demonstrating learning outcomes at the preceding or successive levels
- using multiple and varied assessment opportunities and the varying length of time that different students need to develop and demonstrate each of the selected learning outcomes, and
- the placement of this module within the overall sequence of the curriculum program.

With these considerations in mind, additional support or extension activities may be required for some students.

Assessment

In this module, some outcomes have been identified as the focus for demonstration. Activities derived from these outcomes provide opportunities for judgments of their demonstration. Typically it could be expected that most students in Years 8 and 9 will demonstrate these learning outcomes.

Continuous assessment allows for the monitoring of student progress over time. At appropriate points it may be possible to make judgments about student demonstration of these outcomes. However, for any individual student, judgments can be made at any time when the teacher is satisfied that sufficient evidence has been obtained.

In this module there are other outcomes that have been associated with the focus learning outcomes because of their appropriateness to the context. Assessment derived from these outcomes is insufficient in itself to provide evidence for judgment. However, judgment about the demonstration of these outcomes may be possible if enough evidence has been gathered in previous class work. If not, evidence gathered from this module will contribute to a later judgment about demonstration of these outcomes.

Other assessment considerations may include:

- offering (or negotiating) different assessment tasks for students who have not yet demonstrated one of the selected learning outcomes
- addressing individual learning styles
- providing learning support or extension opportunities for particular students, taking into account the related outcomes at the adjacent levels, or discretionary learning outcomes; and adapting the emphasis on certain outcomes, depending on the prior experience of students and the opportunities they have had to demonstrate the focus outcomes and the other outcomes associated with this module.

Background information

Terminology

Students will be able to understand these terms in the context of the activities in this module:

Diesel engine	Fresnel lens	Potential energy
Energy	Friction	Propulsion
Energy transformation	Kinetic energy	Reflection
Floating	Motion	Refraction
Force	Nuclear energy	Steam engine

Length of the module

This module provides a suggested sequence of pre-visit and post-visit activities that support a set program of activities conducted on an excursion to the Queensland Maritime Museum. In line with the advice regarding the demonstration of outcomes, teachers may decide that students require additional pre and post-visit activities to fully demonstrate the outcomes. It is therefore left to teachers' discretion the amount of time to be allocated to the pre-visit and post-visit activities. However, the excursion activities can be completed during a 2 hour visit to the museum.

Inclusion of other modules or module activities

There are a number of instances in this module where reference is made to modules (or activities within modules) that have been produced by the Queensland School Curriculum Council (now known as the Queensland Studies Authority) for specific key learning areas. These modules can be downloaded from the QSA website http://www.qsa.qld.edu.au. In particular, teachers should be aware of the possible additional requirements involved in the use of QSCC modules. They require extra materials and resource sheets that have not been included in this module.

Syllabus and cross curricular links

The Science Years 1-10 Syllabus

Two strands of the Science syllabus appears in this module. Teachers are referred to the description of the strands on pages 9 and 10 of the syllabus. It is also important that students understand the notion of science as a way of knowing and the process of working scientifically, both defined on page 1. The following **Core content** is addressed in the module:

- Floating, sinking
- Friction – opposing motion, everyday applications
- Balanced/ unbalanced forces – forces acting in pairs
- Newton's laws of motion – inertia action, reaction
- Kinetic energy
- Potential energy
- Transfer and transformation of energy types
- Sources of energy (fossil fuels, wind, nuclear)
- Applications of science (maritime)
- changes in scientific ideas over time

The Technology Years 1 – 10 Syllabus

The Technology key learning area challenges learners to respond to the technology demand of a range of different situations by working technologically. This involves developing products in response to needs, wants or opportunities in many contexts. The context of this module is changing maritime technology over time e.g. propulsion and boat design. The module focuses on outcomes from the Technology Practice and Materials strands, descriptions of which can be found in the syllabus document pp 13 - 14. The students will use investigation, ideation, production and evaluation and understand the importance of considering management and appropriateness in the development of a product (design of a model boat). In the creation of the product students will select appropriate materials and use appropriate techniques. The following **Core content** is addressed in the module:

- Identifying design requirements
- Sources of knowledge, ideas and data (museums)
- Generation of ideas to meet design challenges
- Communication of ideas
- Production procedures
- Products (make models)
- Evaluation of design ideas, processes and products

School authority policies

Teachers need to observe the guidelines of school authority policies that may be relevant to this module. Safety policies are of particular relevance to some activities. It is essential that

demonstrations and student activities are conducted according to procedures developed through appropriate risk assessment at the school. Teachers need to consider safety issues related to:

- Excursions
- Technology Practice

Evaluation of program

After completion of the activities in this module teachers will be able to collect information and make judgments about:

- Teaching strategies and activities used to progress student learning towards demonstrations of core learning outcomes
- Opportunities provided to gather evidence about students' demonstrations of core learning outcomes
- Future learning opportunities for students who have not yet demonstrated the core learning outcomes
- The extent to which activities matched needs of particular groups of students and reflected equity considerations
- The appropriateness of time allocations for particular activities
- The appropriateness of resources.

Lights, Engines, Action! Science and Technology at Sea

Activities

Phase 1 Pre- excursion Activities

Activity Set 1
Why do boats float?

Focus
This set of activities will help students understand that an object will float, be suspended or will sink, depending on the relationship of the forces acting on the object.

Materials

- Queensland Studies Authority, 2000, Science Module Level 5: *Forces in Everyday Life*.
- Resource 1: Forces Acting on a Boat
- Further investigations, online interactive demonstrations and explanations of these concepts can be found at:
  - http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID
  - http://www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID
  - http://science.howstuffworks.com/question254.htm

Teaching considerations
This set of activities make use of existing materials in the QSA modules that can be downloaded from the QSA website:
http://www.qsa.qld.edu.au/yrs1to10/kla/science/modules.html

Teaching sequence:

- Follow the instructions for QSA Module Activity 'Investigating Buoyancy' p 6.
- Follow the instructions for QSA Module Activity 'Clay Boats' p 7.
- Follow the instructions for QSA Module Activity 'Forces in Water' p 11.
- For extension of these concepts students can be referred to the websites listed above.
- Students label the forces acting on a boat (indicated by arrows) on Resource 1 and discuss their results as a class.

Gathering evidence about student learning
Some evidence may now have been gathered which may assist in making a judgement on the students' demonstration of Science Outcome Energy and Change 5.1.
Teachers may gather evidence by focussing on:

- Students' understanding of the forces acting on a floating boat.

Activity Set 2
What makes a boat move in the water?

Focus
This set of activities will help students understand the types of forces and energy that are required to make an object travel in the water.

Materials

- Queensland Studies Authority, 2000, Science Module Level 4: *Force and Motion*.
- Resource 2: Energy
- Resource 3: Types of Water Craft (cut up cards)

Teaching considerations
Teachers may wish to revise the concepts contained in the QSA Level 4 Module before starting this activity.

Teaching sequence:

- Students read through Resource 2.

- Divide students into six groups. Distribute one card (Resource 3) to each group. Students discuss the types of energy and transformations that would occur on their type of water craft and complete the table on Resource 2.
- Students share their results with the whole class and complete the rest of the table.

Gathering evidence about student learning
Some evidence may now have been gathered which may assist in making a judgement on the students' demonstration of Science Outcome Energy and Change 5.2.
Teachers may gather evidence by focussing on:

- Students' Identification of types and forms of energy
- Students' explanations of energy transformations.

Activity Set 3
Forces acting on a boat: Friction

Focus
This set of activities will help students understand that air resistance and water resistance are frictional forces that hinder the movement of a boat.
Materials

- Queensland Studies Authority, 2000, Science Module Level 5: *Forces in Everyday Life*.
- Resource 1: Forces Acting on a Boat

Teaching considerations
This set of activities make use of existing materials in the QSA modules that can be downloaded from the QSA website:
http://www.qsa.qld.edu.au/yrs1to10/kla/science/modules.html

Teaching sequence:

- Follow the instructions for QSA Module Activity 'Investigating Friction' p 13.
- Ask students to devise a fair test to investigate friction forces acting on model boats.
- Students label the forces acting on a boat (indicated by arrows) on Resource 1.

Gathering evidence about student learning
Some evidence may now have been gathered which may assist in making a judgement on the students' demonstration of Science Outcome Energy and Change 5.1.
Teachers may gather evidence by focussing on:

- Students' understanding of the forces acting on a floating boat.

Activity 4 Developments in ship propulsion

Focus
This set of activities will help students understand the concept of propulsion and the history of the development in propulsion technology.
Materials

- Resource 4: Developments in Ship Propulsion
- How Stuff Works http://science.howstuffworks.com/

Teaching considerations
Cut up the statements from Resource 4 and place them into envelopes.
The correct dates are:

- 3500BC Earliest record of ship with sails.
- 1783 First paddle-driven steam boat.
- 1840 Invention of screw propeller.
- 1897 First steam turbine driven ship.
- 1910 First sea vessel with diesel engine.
- 1951 First ship powered by gas turbine.
- 1954 First Nuclear powered submarine.
- 1968 First commercial Hovercraft.

Teaching sequence:

- As a class discuss and define propulsion in relation to the movement of boats through water.
- Divide students into groups and distribute an envelope containing the statements from Resource 4 to each group.
- Ask the students to discuss the statements in their groups and try to place the developments in chronological order. Ask them to mark the order in pencil on the back of the statements.

Teaching sequence:

- Stimulate the students' interest in the topic by showing excerpts from the film K19: The Widowmaker.
- Organise a class debate on the advantages and disadvantages of nuclear powered submarines. Students can access the websites listed above to develop their arguments.

Gathering evidence about student learning

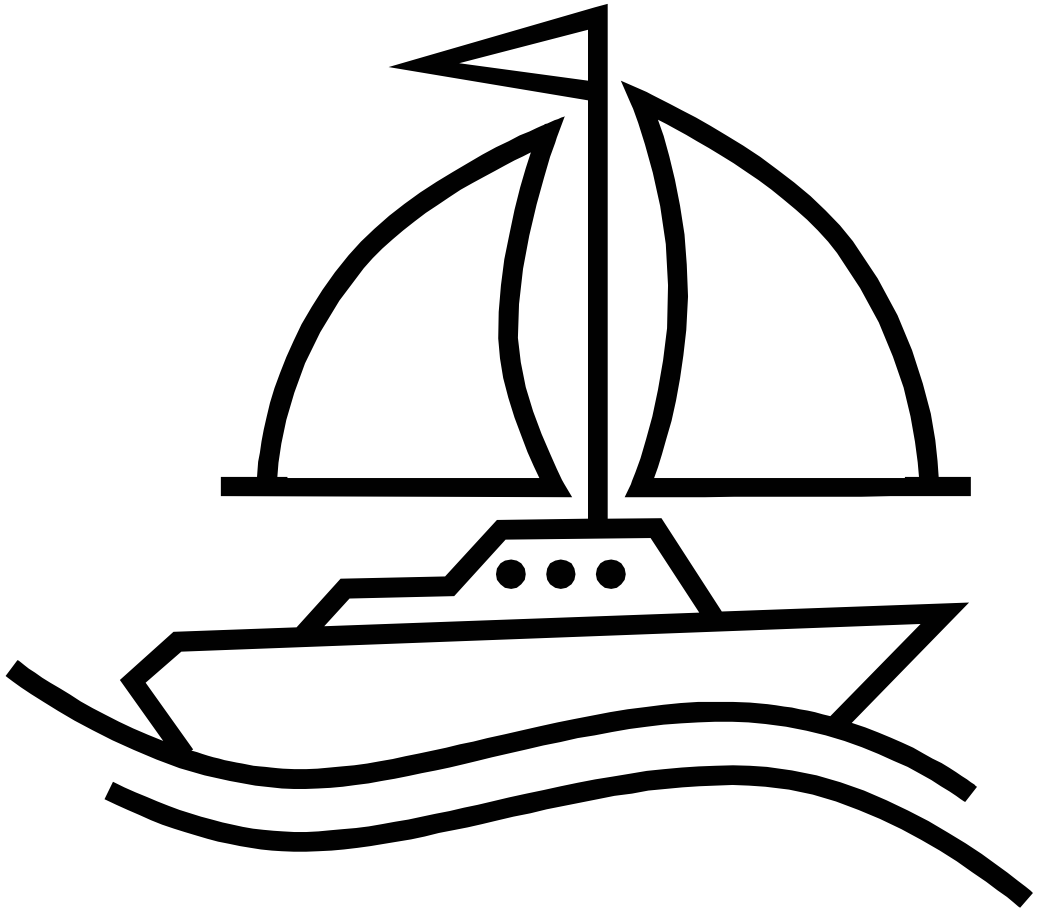
Some evidence may now have been gathered which may assist in making a judgement on the students' demonstration of Science outcome energy and Change 5.3.

Teachers may gather evidence by focussing on:

- Students' understanding of how nuclear powered submarines work.
- Student participation in debate presentation
- Student research of information relevant to the topic of discussion.

Resource 1

Forces Acting on a Boat



Resource 2

Energy

Energy is the ability to do work.

There are two types of energy:

- **Potential (stored) energy. Potential energy is work waiting to be done!**
- **Kinetic (movement) energy. Kinetic energy is work being done!**

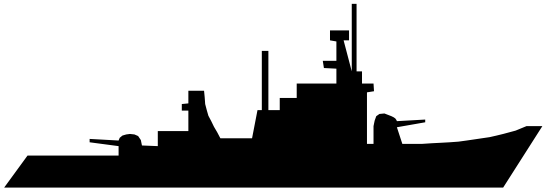
Energy exists in different forms:

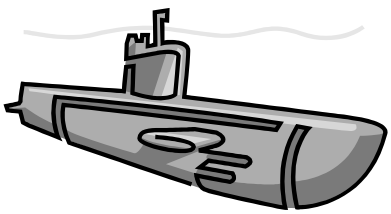
- ☑**Chemical**
- ☑**Electrical**
- ☑**Heat**
- ☑**Light**
- ☑**Mechanical**
- ☑**Nuclear**
- ☑**Sound**

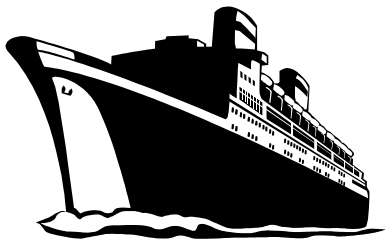
Energy can be transformed (changed) from one type to another but cannot be created or destroyed.

For example:
Electrical energy is transformed into light energy *and* heat energy when you switch on a light.

Resource 3







Activity: What makes a boat move in the water?

Examine the card you have been given. It shows one form of water craft. In groups discuss in terms of energy types, forms and transformations how the water craft moves through the water. Enter your conclusions in the following table:

	1	2	3	4	5	6
Type of water craft						
Energy forms						
Energy transformations						

Resource 4

Developments in ship Propulsion

The earliest record of a ship with sails (in Egypt).	The first paddle-driven steamboat (the *Pyroscaphe) was* constructed by Frenchman Marquis Claude de Jouffroy D'Abbans.
The screw propeller (patented by Francis Pettit Smith) was first used on the *Archimedes* an American River Steamer.	The worlds' first steam turbine driven ship the *Turbina* was developed by Sir Charles Parsons.
The first sea vessel with a diesel engine was the *Vulcanus* built for the Dutch East India company.	The first ship powered by a gas turbine was the Shell oil tanker *Auris*.
The worlds' first nuclear powered submarine was the USS *Nautilus*.	The first commercial Hovercraft was the *Mountbatten* operating as a ferry across the English Channel.

Resource 5

Light has always been used to guide ships or warn them of dangers. For example ancient people used fires on hills.

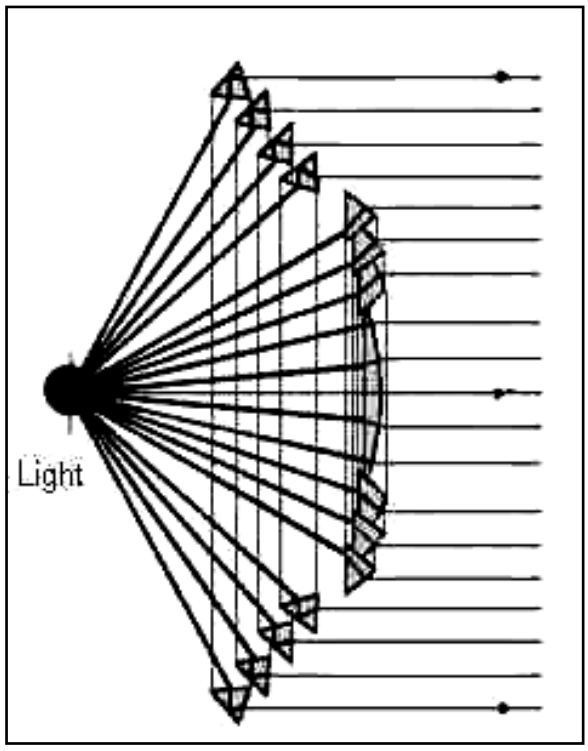
The first known famous lighthouse was built at Alexandria in Egypt about 280 BC. It was a tower with a fire burning on the roof the light from which could be seen up to 50 Km away. (Why do you think the Egyptians built a special tower? Hint: Think about the landscape at the mouth of the Nile).

After about 1500AD coal became the main source of fuel for lighthouses although some used oil.

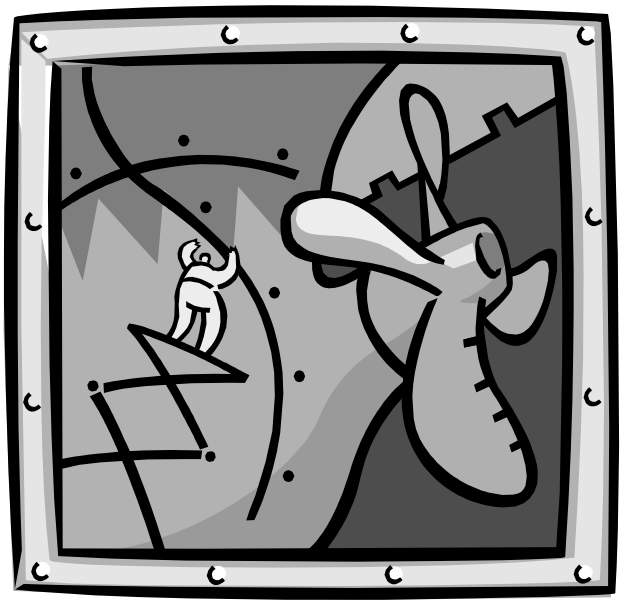
In 1781, a Swiss physicist and chemist Aimé Argand designed a new type of lamp for lighthouses in which a single wick was able to emit as much light as seven candles. The lamp consisted of a lens and parabolic reflector.

But in 1822, Augustin Fresnel invented the Fresnel lens which uses concentric prisms around a lens to focus scattered light from a source into parallel beams.

How a Fresnel lens works



Resource 6



Lights, Engines, Action!

Excursion to the Queensland Maritime Museum

Name _____

Date _____

As you tour the exhibits at the museum look for information to enable you to complete the tasks.

Select 3 vessels from different eras (an older and a newer vessel and one in between) and make a comparison of the technology and design feature of the boats. Use scientific concepts and terminology such as friction, propulsion and energy to make your comparisons and use the data table below to help you organise your information

Name of vessel	Technology	Design Features

What generalisations can you make from your observations?

Identify examples in the museum that illustrate the use of the following scientific concepts

Concept	Example
Friction	
Propulsion	
Light	
Energy transformation	

During your tour of HMAS *Diamantina*, identify examples of the use of different forms of energy

Energy form	Example
Chemical	
Electrical	
Heat	
Light	

Mechanical	
Sound	


Use the data table to collect data on the power, capacity and year of manufacture of the engines on display. Back at school, calculate the power / capacity ratio, plot this against the year on a graph and comment on any trends.

Year of manufacture	Power	Capacity


Devise a timeline showing the changes in lighthouse technology shown at the museum

Examine the half models of boats shown in Gallery 3 and comment on the principles of force and motion illustrated in the hull shape of three of the models.

Example	Comment

Sketch the shape of the hull which you think would be the fastest through water.

Examine the working model of the engine in Gallery 4 and make a sketch to show how it works.

Support material and references

Curriculum documents

Queensland School Curriculum Council 2000, Science Module Level 4: *Force and Motion*.
Queensland School Curriculum Council, 1999, *Science Years 1 – 10 Syllabus*, State of Queensland.
Queensland School Curriculum Council, 1999, *Science Years 1 – 10 Sourcebook Guidelines*, State of Queensland.
Queensland School Curriculum Council, 2000, Science Module Level 5: *Forces in Everyday Life.*
Queensland School Curriculum Council, 2001, *Literacy Position Paper*, State of Queensland.
Queensland School Curriculum Council, 2001, *Numeracy Position Paper*, State of Queensland.
Queensland Studies Authority, 2003, Technology Early Primary Sourcebook module: *Blast Off*, State of Queensland.
Queensland Studies Authority, 2003, Technology Lower Secondary Sourcebook module: *Solving a Problem*, State of Queensland.
Queensland Studies Authority, 2003, *Technology Years 1 – 10 Sourcebook Guidelines*, State of Queensland.
Queensland Studies Authority, 2003, *Technology Years 1 – 10 Syllabus*, State of Queensland.

Websites

Explore Science dot com http://www.explorescience.com/
How Stuff Works http://science.howstuffworks.com/
http://people.howstuffworks.com/submarine.htm/printable
K19 and other subs in peril: National Geographic Magazine http://www.ngmag.com/k19/
K19: The Story behind the movie
http://www.click2flicks.com/k19_widowmaker/k19_widowmaker_ch1.htm
Queensland Studies Authority http://www.qsa.qld.edu.au/index.html
Royal Australian Navy: Virtual Fleet http://www.navy.gov.au/vf/default.htm
See inside a submarine wgbh/nova/subsecrets/inside.html

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