

Grade 8  
**Structures  
and Mechanisms**

# Rescuing Whales

## The Task

Students were asked to use their knowledge and understanding of simple machines and mechanical advantage to design and construct a lifting mechanism that would achieve a mechanical advantage of at least 4 to facilitate the rescue and release of stranded whales. Specifically, they were to:

- rephrase the problem;
- record several different ideas as sketches with suggested dimensions;
- choose one of the ideas as the best solution and explain the reason for the choice;
- gather appropriate materials to execute their plan;
- construct the lifting mechanism;
- test their mechanism and make necessary revisions;
- observe results and record data and observations in a written reflection;
- prepare and deliver a four-minute oral presentation about their design processes and the results.

## Expectations

This task gave students the opportunity to demonstrate achievement of all or part of each of the following selected overall and specific expectations from the strand Structures and Mechanisms: Grade 8 – Mechanical Efficiency. (The codes that follow the expectations are from the Ministry of Education's *Curriculum Unit Planner*.)

## Students will:

1. demonstrate an understanding of the factors that contribute to the efficient operation of mechanisms and systems (8s87);
2. design and make systems of structures and mechanisms, and investigate the efficiency of the mechanical devices within them (8s88);
3. determine the velocity ratio of devices with pulleys and gears (8s97);
4. formulate questions about and identify needs and problems related to the efficient operation of mechanical systems, and explore possible answers and solutions (8s99);
5. produce technical drawings and layout diagrams of a structure or a mechanical system that they are designing, using a variety of resources (8s106);
6. describe how the components and subsystems of a product used by humans enable the product to function (8s109);
7. evaluate their own designs against the original need, and propose modifications to improve the quality of the products (8s118).

### **Prior Knowledge and Skills**

To complete this task, students were expected to have some knowledge and/or skills related to the following:

- the design process
- the functions of simple machines (e.g., levers, pulleys, gears)
- calculations involving mechanical advantage
- ways of combining various structural components to create structures and mechanisms
- the safe and appropriate use of tools

*In the teacher's notes and comments accompanying the student samples that follow, the examples cited are either from the student worksheets (indicated by a "P", for "print") or from the videotape (indicated by a "V").*

*For information on the process used to prepare students for the exemplar task and on the materials and equipment required, see the Teacher Package reproduced on pages 88–99 of this document.*

## Task Rubric – Grade 8: Rescuing Whales

Expectations*	Level 1	Level 2	Level 3	Level 4
<b>Understanding of Basic Concepts</b>				
The student:				
1, 3	– demonstrates limited understanding in applying, calculating, and explaining mechanical advantage	– demonstrates some understanding in applying, calculating, and explaining mechanical advantage	– demonstrates general understanding in applying, calculating, and explaining mechanical advantage	– demonstrates thorough understanding in applying, calculating, and explaining mechanical advantage
<b>Design Skills</b>				
2				
The student:				
– identifying the problem/need 4	– rephrases the problem/need with limited clarity	– rephrases the problem/need with some clarity	– rephrases the problem/need clearly	– rephrases the problem/need clearly and precisely
– making the plan 2, 5	– explores potential solutions in a limited way – selects a solution and provides a limited explanation for the choice – creates a simple design sketch	– explores potential solutions in a somewhat appropriate way – selects a solution and provides some explanation for the choice – creates a somewhat organized and labelled design sketch	– explores potential solutions in an appropriate way – selects a solution and provides a clear explanation for the choice – creates an organized and labelled design sketch	– explores potential solutions in an insightful way – selects a solution and provides an in-depth explanation for the choice – creates a highly organized and fully labelled design sketch (e.g., orthographic or isometric)
– executing and evaluating the plan 2, 7	– outlines a few steps of the construction plan – constructs a solution that meets the task criteria to a limited extent	– outlines some steps of the construction plan – constructs a solution that meets the task criteria to some extent	– outlines most steps of the construction plan – constructs a solution that meets the task criteria	– outlines all or almost all steps of the construction plan – constructs a solution that meets the task criteria in insightful ways
<b>Communication of Required Knowledge</b>				
The student:				
5, 6	– presents the solution with limited clarity  – demonstrates with limited supporting evidence how the solution meets the task criteria	– presents the solution with some clarity  – demonstrates with some supporting evidence how the solution meets the task criteria	– presents the solution with clarity and accuracy  – demonstrates with considerable supporting evidence how the solution meets the task criteria	– presents the solution concisely and with clarity and accuracy  – demonstrates with extensive supporting evidence how the solution meets the task criteria

Expectations*	Level 1	Level 2	Level 3	Level 4
<b>Relating of Science and Technology to Each Other and to the World Outside the School</b>				
The student:				
6, 7	<ul style="list-style-type: none"> <li>– provides a limited reflection on the strengths and weaknesses of the model</li> <li>– suggests minimally appropriate improvements</li> </ul>	<ul style="list-style-type: none"> <li>– provides a somewhat reasonable reflection on the strengths and weaknesses of the model</li> <li>– suggests somewhat appropriate improvements</li> </ul>	<ul style="list-style-type: none"> <li>– provides a reasonable and balanced reflection on the strengths and weaknesses of the model</li> <li>– suggests appropriate improvements</li> </ul>	<ul style="list-style-type: none"> <li>– provides a detailed and extensive reflection on the strengths and weaknesses of the model</li> <li>– suggests insightful improvements</li> </ul>

\*The expectations that correspond to the numbers given in this chart are listed on page 50.

*Note:* This rubric does not include criteria for assessing student performance that falls below level 1.

# Student Task Description

Students were presented with the following scenario and set of instructions:

## Scenario: “Whales Forever” Design Competition

Throughout the world, whales get stranded on seaside beaches from time to time. Whales Forever, an environmental group, is concerned about the low survival rate of beached whales. They know that beached whales must be able to swim in open water within a short time or they will perish. Whales Forever has announced a design competition for students to create a prototype device that can safely lift a stranded whale onto a hovercraft to allow for both medical attention and release.

In your role as a designer, you are challenged to design and construct a lifting mechanism that:

- achieves a mechanical advantage (MA) of at least 4;
- uses one of the types of simple machines (e.g., lever, pulley, gear) or a system combining two or more simple machines.

You will make a four-minute presentation to the Whales Forever board of directors demonstrating your model's effectiveness in lifting the “whale” (simulated by a resealable plastic bag filled with sand) a height of 10 cm and lowering it 5 cm onto a simulated hovercraft platform. Since only the lifting mechanism is involved in the design competition, you may hand-position your “whale” in whatever harness you decide to use. It is recommended that, wherever possible, you use readily available materials (e.g., desks, tables, stools, retort stands) as the supports for your lifting device. If time and your skill level permit, you may be given permission to create a support structure that works best with your solution.

Your presentation must also include the following:

- exploratory sketches and a labelled sketch of your chosen design, with measurements, indicating the critical components
- mechanical advantage measurements, calculations, estimations, explanations, and verifications
- a written reflection on the strengths and weaknesses of your design
- suggestions for improving your solution