YORK/SENECA INSTITUTE FOR SCIENCE, TECHNOLOGY AND EDUCATION

YSISTE

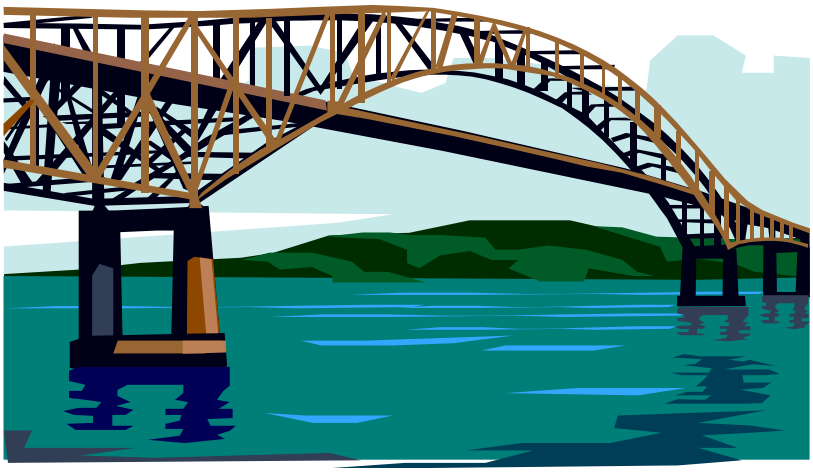
ASSESSMENT OF SCIENCE AND TECHNOLOGY ACHIEVEMENT PROJECT (ASAP)

Science and Technology Exemplars

Grade 7: Structures and Mechanisms – Structural Strength and Stability

Exemplar Task (7SMPT01/Dec 2000)

Bridges



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EDUCATION

Preface

This task is one of a series developed by the Assessment of Science and Technology Achievement Project (ASAP) which is being used for the ASAP Science and Technology Exemplars Project.

This task is organised in three parts:

A. Task Overview
B. Student task sheet – designed to be photocopied for the students
C. Teacher Information – providing essential information relating specifically to this task

For further information, contact the ASAP office at 416-736-5269 or email: asap@edu.yorku.ca

Task Overview

Description of the Task

In this task, students are asked to design and construct a bridge. The bridge should be able to support a 1kg load and span 15cm. Their materials will be limited

Suggested Timeline

- design, construct and test (2 x 60 minutes)
- writing the report (1 x 60 minutes)

Suggested Grouping

- design construct and test (groups of two)
- writing the report (individual)

This task assesses the following **specific expectations**:

Understanding Basic Concepts

- classify structures as solid structures, frame structures, or shell structures
- describe using their observations ways in which different forces can affect a structure
- identify forces within a structure that are affected by forces outside the structure

Developing Skills of Inquiry, Design and Communication

- formulate questions about and identify the needs and problems related to the strength of structures and explore possible answers and solutions
- use appropriate vocabulary, including correct science and technology terminology to communicate ideas, procedures and results
- communicate the procedures and results of investigations for specific purposes and to specific audiences, using media works, written notes and descriptions, charts, graphs, drawings and oral presentation

Relating Science and Technology to the World Outside the School

- describe using their observations the function of symmetrical designs in structures and mechanical systems
- use their knowledge of materials in designing and making structures that will stand up to stress

Materials & Equipment Needed

Legal size paper Scales Masking tape
1kg masses

Prior knowledge and skills

Students should have been taught the background knowledge required for this task (see appendix 1).

Students should also be familiar with:

- designing and constructing
- using and choosing materials and tools appropriately and safely
- evaluating their products

Introductory activities

Display the materials and equipment for the students.
Brainstorm with the whole class to allow them to explore possible designs of bridges and the disadvantages and advantages of certain designs and materials.
Allow the students to respond with ideas.
Review the background knowledge required for this task.
Read the scenario to the whole class, this may have to be repeated with individual students.

Discuss the assessment criteria with the students.

Assign the student work sheets.

Clarify how each student will be presenting his/her work (see Collecting the Evidence).

Safety First

Students should be reminded of safety procedures when using the materials.

Collecting the Evidence

Teachers will need to collect evidence to submit for the exemplars project. In this task students should produce the following:

- completed written responses on student task sheets
- scribed responses on task sheet if required
- a photograph (digital preferred) of the bridge
- if limited writing skills a video or audio tape of an oral presentation (A-V arrangements will be required)

We will also require a teacher completed observation checklist (Appendix 2) – this should be completed with brief comments and a circled level.
Please number student work to correspond with this checklist.

DRAFT RUBRIC FOR GRADE 7: BRIDGES

Knowledge/Skills	Level 1 The student:	Level 2 The student:	Level 3 The student:	Level 4 The student:
Understanding basic concepts	• classifies structures as solid, frame or shell with many errors • identifies few of the forces acting on their bridge • explains with many errors the affects of high winds, ice and temperature change on bridges	• classifies structures as solid, frame or shell with some errors • identifies some of the forces acting on their bridge • explains with some errors the affects of high winds, ice and temperature change on bridges	• classifies structures as solid, frame or shell with few errors • identifies most of the forces acting on their bridge • explains with few errors the affects of high winds, ice and temperature change on bridges	• classifies structures as solid, frame or shell with no errors • identifies all of the forces acting on their bridge • explains with no errors the affects of high winds, ice and temperature change on bridges
Inquiry skills				
Design skills	• develops and follows a limited plan • constructs bridge which is poorly built and partially functional	• develops and follows an adequate plan which may be unclear • constructs bridge which is adequately built and functional	• develops and follows an appropriate and clear plan • constructs bridge which is well built and functional	• develops and follows a detailed and efficient plan • constructs bridge which is well built and very functional
Communication of required knowledge	• communicates with limited clarity and precision • rarely uses science and technology terminology	• communicates with some clarity and precision • sometimes uses science and technology terminology	• communicates clearly and precisely in most of the task • often uses science and technology terminology	• communicates clearly and precisely through all of the task • always uses science and technology terminology
Relating science and technology to the world outside the school	• explains with many errors why the bridges are symmetrically designed	• explains with some errors why the bridges are symmetrically designed	• explains with few errors why the bridges are symmetrically designed	• explains with no errors why the bridges are symmetrically designed

Appendix 1

Background knowledge – Bridges

Students should be aware that structures can be classified as:

- solid - has only one part and no hollow spaces e.g., dam
- shell - a solid surface and a hollow interior e.g., helmet
- frame - formed from a combination of parts e.g., hydro towers

Students should have been taught the effects of forces on structures.
Magnitude – how strong the force is
Direction – which direction the force is pushing in
Point and Plane of Application – where the force is applied on the structure

Students should have been taught about the following forces:
Tension – when a load is placed on a board or a bridge the bottom edge becomes longer, the stretching force here is called tension.
Compression – while the bottom edge is being stretched the upper edge is being squeezed, the pushing force here is called compression.
Torsion – this force is applied when opposite rotational forces act on different parts of a structure.
Shear – this force acts when parallel forces push or pull in opposite directions on a part of a structure.

Students should have been taught that symmetrical design enhances the stability of structures. A structure that is symmetrical has its centre of gravity over the centre of its support base and can resist external forces better than a structure that does not.

Glossary

Gusset – a plate that is used to strengthen truss joints
Shear – two forces that act in opposite directions along the same line or plane
Stress – forces created inside a material or an object by other forces acting on it from outside
Structure – a supporting framework (e.g., a bridge or building that is built to sustain a load)
Strut – a part of a structure whose function is to resist compressive forces
Tie – a part of a structure that is under tension
Torsion – a force that causes an object to twist along its axis
Truss – a structural element made up of a series of triangular frames

Appendix 2

Teacher Observation checklist – Bridges
Please number student work to correspond with this checklist.

Student #	**Follows their plan**	**Student #**	**Follows their plan**
	1 2 3 4		1 2 3 4
	1 2 3 4		1 2 3 4
	1 2 3 4		1 2 3 4
	1 2 3 4		1 2 3 4
	1 2 3 4		1 2 3 4
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Science and Technology Exemplars Project

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Bridges

Student Task Sheets

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Bridges

You are a structural engineer applying to be hired by a construction company. As part of the interview process you have to show your skills of designing and constructing and your knowledge about the forces acting on structures.
At the interview you are asked to complete the following task:
Design and construct a model bridge using only the materials provided - 3 sheets of paper and 1m of masking tape.
Your bridge **must** be able to support a **1kg** mass and **must** span a **15cm** gap.

1. My Design:

Draw and label the design for your bridge. Use **scientific vocabulary** to highlight the important design features of your bridge.

2. My Plan:

Use words and/or sketches to explain how you will build your bridge.

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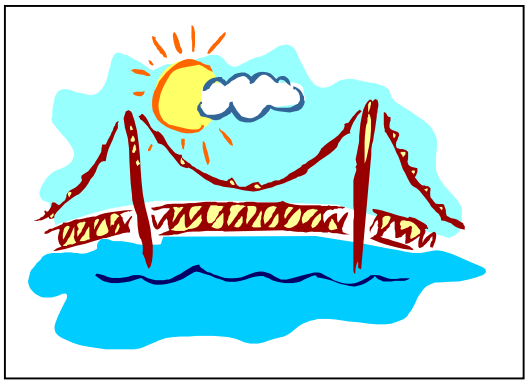
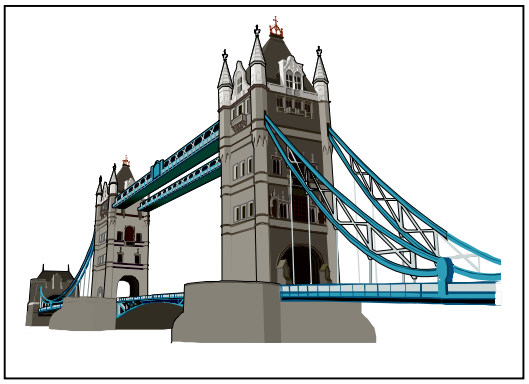
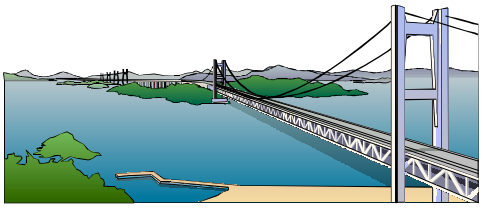
3. Build you bridge and test it with the 1kg mass.

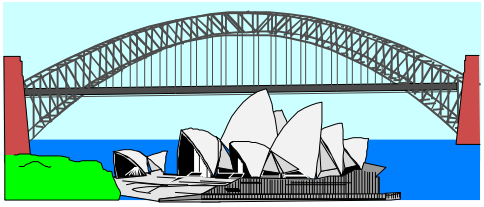
Draw your bridge and label with **arrows** all the different forces acting on it, use **scientific vocabulary** on your diagram.

4. Look at these pictures of bridges. You will notice that they are always symmetrically designed. Explain why they are designed this way.









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5. A structural engineer has to think about the effects of forces when designing a bridge.

Explain how ice would affect the forces acting on the bridge.

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Explain how high winds would affect the forces acting on the bridge.

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Explain how changes in temperature would affect the forces acting on the bridge.

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6. What type of structure is your bridge? _____

Complete the table below to classify the structures in the box.

bike helmet	hydro tower	airplane wings
goal posts	bicycle	dam

SHELL	SOLID	FRAME

Add some structures of your own.