9. Tower Geometry

Classroom Activity:

To build the tallest tower that will support a tennis ball for at least 30 seconds. The activity is designed to show students the value of triangles in physical structures and that cost, time, planning, modeling, designs, teamwork and applications are important in construction projects.

Grade(s): 5, 7, 9 and 10

Strand(s): Understanding Structures and Mechanisms (Grades 5 and 7)

This task addresses the following grade 5 overall expectations:

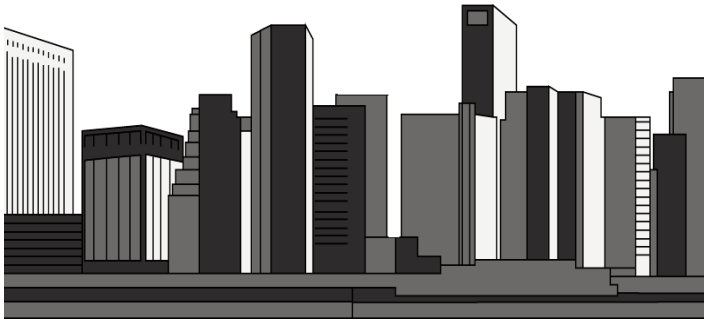
- investigate forces that act on structures and mechanisms;
- identify forces that act on and within structures and mechanisms, and describe the effects of these forces on structures and mechanisms.

and the following grade 5 specific expectations:

- follow established safety procedures for working with tools and materials;
- use scientific inquiry/research to investigate how structures are built to withstand forces;
- use technological problem-solving skills to design, build, and test a frame structure that will withstand the application of an external force or a mechanical system that performs a specific function;
- use appropriate science and technology vocabulary, including tension, compression, torque, system, and load, in oral and written communication;
- use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes;
- identify internal forces acting on a structure, and describe their effects on the structure;
- identify external forces acting on a structure and describe their effects on the structure, using diagrams.

This task addresses the following grade 7 overall expectations:

- design and construct a variety of structures, and investigate the relationship between the design and function of these structures and the forces that act on them;
- demonstrate an understanding of the relationship between structural forms and the forces that act on and within them.



and the following grade 7 specific expectations:

- follow established safety procedures for using tools and handling materials;
- design, construct, and use physical models to investigate the effects of various forces on structures;
- investigate the factors that determine the ability of a structure to support a load;
- use technological problem-solving skills to determine the most efficient way for a structure to support a given load;
- use appropriate science and technology vocabulary, including truss, beam, ergonomics, shear, and torsion), in oral and written communication;
- use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes
- describe ways in which the centre of gravity of a structure affects the structure's stability;
- identify the magnitude, direction, point of a pplication, and plane of application of the forces applied to a structure;
- distinguish between external forces and internal forces (tension, compression, shear, and torsion) acting on a structure;

- identify and describe factors that can cause a structure to fail.

Course(s) and Strand(s): Technological Education

Exploring Technologies, Grade 9 Open

B. Technological Skills

Construction Technology, Grade 10 Open

B. Design, Layout and Planning Skills

See supplementary document Ontario Curriculum Alignment for Engineer-in-Residence Secondary Classroom Activities: Science and Technological Education for relevant overall and specific expectations.

Assessment Categories:

- Thinking and Investigation
- Communication
- Application

Type of Activity: Classroom

Preparation: (approx. 30 minutes)

Prepare material for demonstration

Time needed to complete the task: 60 minutes

Materials/Resources for teachers:

meter stick or measuring tape

clock or timer

tennis balls

drinking straws

paper clips pins

masking tape

Materials/Resources for students:

30 plastic drinking straws

1 box of small paper clips

1 box of straight pins

1 roll of masking tape

1 tape measure/meter stick

1 pen or pencil

cost list for materials (straws $1.00/each; paper clips $0.20/each; straight pins $0.10/each

tape $0.20/cm

cost work sheet

scissors

1 calculator (optional)

Activity Description:

For the whole class:

The teacher should demonstrate the basic construction techniques, showing how to fasten straws together with bent paper clips. Make a square and show that it is not very stable. Make a triangle and show that it is very strong. Take the square and tape a straw from corner to opposite corner to show that there are two triangles and it is much stronger. Stress the need for a good foundation. A short practice period before the actual construction is helpful.

Divide students into groups of 3 or 4, and distribute materials. One member of each group should be designated the accountant to keep track of construction costs. Groups should be allowed a few minutes to brainstorm before the signal to begin is given.

Students should be reminded to build some kind of holder for the tennis ball. It may not be taped onto the tower. All work must stop after 30 minutes, and they must keep a record of construction costs during the building process.

Measuring the Tower

The tower with the tennis ball must stand by itself for at least thirty seconds. After that it may be held while it is measured. If the ball falls off the holder it is as if the tower had toppled. The tower is measured straight up from the floor. The ball need not be on top of the tower, but the measurement is taken from the location of the ball. In the event of a tie, costs are compared and the smallest cost/height ratio wins.

Tips:

- As this activity requires a certain degree of manual dexterity, students whose skills lie in this area can enjoy and excel at this activity.
- Students are also interested in which tower can support the most mass. A similar tower can be built with a cup in place of a tennis ball holder, and the cup that hold the most water determines the winner.