 Chain reaction

**Stage 3 sample STEM activity**

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**Driving question**

How can I design a series of events that use a combination of forces to knock over a 50cm block tower?

## ****Activity****

Students design a solution to a simple problem: to knock over a 50 cm tower using a combination of forces. They identify the characteristics of objects that roll and move. They investigate and apply their knowledge of contact and non-contact forces. Students collect and interpret data to support their design.

## Syllabus outcomes

Science and technology:

**ST3-2DP-T** – plans and uses materials, tools and equipment to develop solutions for a need or opportunity

**ST3-9PW-ST** – investigates the effects of increasing or decreasing the strength of a specific contact or non-contact force

Mathematics:

**MA3-2WM –** selects and applies appropriate problem-solving strategies, including the use of digital technologies, in undertaking investigations

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## Context

This Stage 3 STEM activity may form part of a broader study of contact and non-contact forces. Through this activity, students deepen their understanding of forces affecting movement and the transfer of energy from one object to another. Prior to this activity, students may have explored strength of specific forces and the transformation of energy. This activity also draws on prior knowledge of methods of data collection and data displays. Students will be challenged to design data collection and display methods and interpret the data presented.

## Learning experiences

### Part 1 (30 mins)

Students are learning to:

* review a system for cause and effect
* observe the transformation of gravitational energy to energy of movement.

#### Learning experience – 1

As an introduction for the activity, students **v**iew a short video [Rube Goldberg machines (1:03)](Rube%20Goldberg%20Machine%20-%20Pop%20the%20balloon%20-%20YouTube%20(1:03)).Predict with the class the success of the machine and the need for many iterations to achieve a successful outcome.

Play video to the end. Discuss with the class what created the movement and what was the effect; link to science and technology investigations using contact and non-contact forces and the effect of push and pull on an object.

Explore with the class other simple machines. [Simple machines animation (0:41)](https://www.forteachersforstudents.com.au/site/themed-curriculum/simple-machines/extra-resources/)

Direct student observations to the use of a wedge, levers, inclined planes, pulleys and axles/wheels. Provide opportunities for students to experiment with objects.

Discussion and demonstrations of types of forces:

* Contact forces – interactions between objects that touch
  + Applied force – striking a ball
  + Spring force – to deflect or stretch through a distance to absorb the energy applied to the spring
  + Drag force – a force which tends to slow the movement of an object through a liquid or gas
  + Frictional force – force generated by two surfaces that contacts and slide against each other
* Non-contact forces – attract or repel, even from a distance
  + Magnetic force – produce fields which attract or repel other metallic objects
  + Gravitational force – a pulling force that works across space, example, the Sun, which is millions of kilometres from Earth, pulls on Earth and the other planets and objects in the solar system.

Explore movement related to force – magnets attracting each other.

Explain that gravity is a force that can be measured through weight.

Establish that forces can be measured.

Examine how forces are balanced and objects fall steadily. Correct misconceptions that heavy objects fall faster than light ones

##### Resources

* [Rube Goldberg machines (1:03)](file:///D:\2021\STEM\hub%20updates\Rube%20Goldberg%20Machine%20-%20Pop%20the%20balloon%20-%20YouTube%20(1:03)).
* [Simple machines animation](https://www.forteachersforstudents.com.au/site/themed-curriculum/simple-machines/extra-resources/) (0:41)
* A selection of materials such as wedges, levers, inclined planes, pulleys and axles/wheels

### Part 2 (40 mins)

Students are learning to:

* describe contact and non-contact forces
* identify and clarify relevant information and prioritise ideas
* plan a chain-reaction system to achieve a solution
* select materials to construct a system
* identify a method to collect data on the effectiveness of the system.

#### Learning sequence – 1

* Introduce the driving question: How can I design a series of events that use a combination of forces to knock over a 50cm block tower?
* Discuss terminology: series of events, combination of forces.
* Break the students into groups using a random group generator such as [Class Dojo](https://www.classdojo.com/toolkit/groupmaker) or [TeachStarter](https://www.teachstarter.com/au/widget/random-name-selector/).
* Assign student roles.
  + **Project manager**: manages the team to work efficiently, stay on time, records decisions.
  + **Technician**: manages the building and materials.
  + **Data analyst:** records and guides the analysis of the data.
  + **Reporter**: summarises the findings, presents designs and final project.
* Explain to students that they make a system of connected forces to demonstrate a machine intentionally designed to perform a simple task in an indirect and overly complicated way.
* To begin, a plan must be developed. Students are to draw an annotated diagram providing details of their system including:
  + points of contact and non-contact forces
  + height, length, position and angles within the system
  + materials needed
  + method of testing the effectiveness of their solution against the criteria of the driving question: to knock over a 50cm block tower using a combination of forces (time taken, distance travelled, number of times it took to get it right)
  + method of recording the effectiveness of the system

##### Resources

* Random name selector
* STEM learning journals

#### Learning sequence – 2 Opportunity to monitor student progress

Within groups, students discuss ideas for their chain-reaction system.

* The **project manager** guides the discussion and decision-making as the group identifies their preferred plan, materials, testing and recording.
* The **technician** takes responsibility for organising the materials needed to construct the system.
* The **reporter** takes responsibility for organising the testing of the solution.
* The **data analyst** takes responsibility for organising recording the effectiveness.

Group members record in individual STEM learning journals:

* annotated diagrams providing details of the system including
  + points of contact and non-contact forces
  + height, length, position and angles within the system
* materials needed
* method of testing the effectiveness of their solution against the criteria of the driving question: to knock over a 50cm block tower using a combination of forces.
* method of recording the effectiveness of the system.

##### Resource

* STEM learning journals

### Part 3 (40 mins or Day 2)

Students are learning to:

* combine ideas in a variety of ways and from a range of sources to create new possibilities
* test the effectiveness of their system
* modify their system of connected forces based on the results of testing.

#### Learning sequence – 1

Allocate spaces around the room for groups of students and set time limits for completion of construction and refinement.

The **technician** leads the students as they work as a team to create the first iteration of their system.

Ask questions of the groups such as:

* How can you increase the speed of your machine?
* How can you control the accuracy of your machine?
* What is the impact of increasing/decreasing the angle of the slope?

Students test and refine the effectiveness of their system using the criteria developed in part 2.

The **project manager** encourages the team as they test and refine their chain-reaction system.

The **data analyst** ensures the test results are accurately recorded.

The **reporter** takes responsibility for recording the progress on a digital device or with notetaking.

##### Resources

* Building blocks for each group to make a 50 cm tower
* Things that roll – marbles, balls, wheels
* Things that move – toy cars, dominoes
* Ramps – Lego, books, strong cardboard, trays, PVC pipe
* Pulleys, axles/wheels
* Making box – collection of materials such as recyclable boxes, bottles, foil; cardboard tubes; sticky tape, string, scissors, pop sticks, wrapping paper

#### Learning sequence – 2 – Opportunity to monitor student progress

* Video record the iterations of the solution development on digital device with students’ explanations of energy transformation

##### Resource

* digital device

### Part 4 (40 minutes)

Students are learning to:

* demonstrate their learning
* scrutinise ideas or concepts, and use evidence when drawing a conclusion to share learning
* share their struggles and successes
* provide effective feedback

#### Learning sequence

* Students update their STEM learning journals and provide input to the reporter on their specified roles.
* The **reporter** from each group shares the design and the findings from their data. Each member of the team shares a struggle and success from their learning.
* As a group, the students showcase their solution to their peers as a celebration of learning.

Challenge:

* Students create one large collaborative system by combining all group design solutions into one sequence.

NOTE: students will need to cooperate, negotiate and adapt their solutions (beginning and end points) to facilitate the success of one larger system.

##### Resource

* STEM learning journals

### Reflection and evaluation

Ask simple questions to focus students’ learning and plan for next steps.

• What worked well and why?

• What did not work and why?

• What might I do differently next time?

• What are the next steps for student learning based on the evidence gathered?

#### Resources

* [What did we learn today](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/558#.XumUv7nO2cM.link)
* [Parking lot](https://app.education.nsw.gov.au/digital-learning-selector/LearningActivity/Card/570#.XumUv-qlkcA.link)