Engineer a Cane

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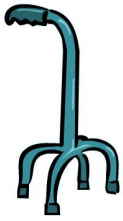


Lesson Focus

Lesson focuses on how engineers improve assistive devices such as a cane to meet the needs of the elderly. Students work in teams to re-engineer a cane for a "client." They are assigned a client profile, develop a design to suit the needs of the user, and those in older grades build a working prototype of their design.

Lesson Synopsis

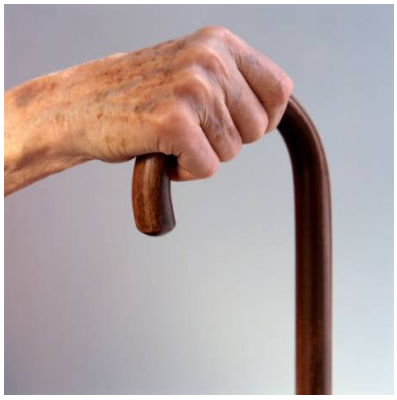
The "Engineer a Cane" activity explores customization of assistive devices. Students work in teams to reengineer an existing assistive device integrating technology to meet the needs of a "client." They present their new designs to the class; older students will build a prototype of their new device.

Year Levels

Year 5 – 10 Science Inquiry Skills and Science as a Human Endeavour

Objectives

- Learn about assistive devices and technology.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.



Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- assistive devices and technology
- interaction of technology and societal issues
- engineering design
- teamwork

Lesson Activities

Students explore the impact of assistive technology on meeting the needs of society. They work in teams to reengineer an assistive device -- in this case a cane -- to meet the needs of a client. They develop a new design with features to assist the client's specific needs, present new designs to their class, and older students will develop a prototype of their design.

Resources / Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

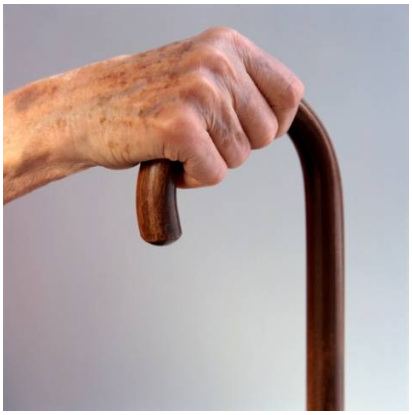
See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Assistive Technology Industry Association (www.atia.org)
- Microsoft Assistive Technology (www.microsoft.com/enable/at/types.aspx)
- Curriculum links (www.acara.edu.au)

Recommended Reading

- The Illustrated Guide to Assistive Technology and Devices: Tools and Gadgets for Living Independently (ISBN: 978-1932603804)
- 21st Century Complete Medical Guide to Assisted Living and Assistive Devices (ISBN: 978-1592486830)
- Assistive Devices, Adaptive Strategies, and Recreational Activities for Students with Disabilities (ISBN: 978-1571674999)



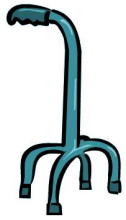
Optional Writing Activity

- Write an essay or a paragraph about how technology has improved assistive devices over the past ten years. How has technology and engineering improved the day to day lives of people or animals living with physical challenges?

Optional Extension Activity

- Involve a person at your school who may have physical challenges to participate in this project. Have them describe the tools they might need to help improve their mobility or the ability to accomplish a task such as picking up a cup, or carrying a package while walking with a cane or walker. Then have students work in teams to create a engineered support device.

Engineer a Cane



For Teachers:
Teacher Resources

◆ Lesson Goal

Lesson focuses on how engineers improve assistive devices such as a cane to meet the needs of the elderly. Students work in teams to re-engineer a cane for a "client." They are assigned a client profile, develop a design to suit the needs of the user, and those in older grades build a working prototype of their design.

◆ Lesson Objectives

- Learn about assistive devices and technology.
- Learn about engineering design and redesign.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

◆ Materials

- Student Resource Sheets
- Student Worksheets
- Wooden cane (about $10), additional materials based on student designs might include flashlights, bulbs, batteries, wires, GPS devices, fabric, rubber feet, pvc piping, tape, paint, buzzer device, or other materials.

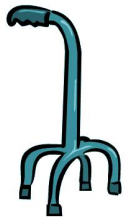
◆ Procedure

1. Show students the student reference sheet. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider asking the students how engineers develop assistive devices such as wheelchairs and walkers. Prompt them to think about someone they know who has challenges in movement, such as someone who has broken a leg, or an elderly person with arthritis. Have them consider how listening to someone who might use a product might impact the final product design.
3. If possible, have students discuss how at any age, people may need assistive devices to help them complete daily tasks. They may discuss individuals they know and consider the various devices and equipment they use to help them.
4. Assign each team of 2-3 students one of the "client" profiles which are attached. Explain that they are working as a team of engineers to reengineer a cane -- which is an assistive device -- to meet the specific needs of the client. Alternatively, you may have a real person in your school or community who could be the "client."
5. Teams consider their client's needs and determine what technology or other features could be added to the cane to help the individual. Teams research the cost of each addition and also draw a diagram of their cane either on paper or via design software.
6. Teams next present their designs to the class, along with an itemized cost for manufacture. You may wish to encourage student teams to add a consulting or engineering design fee to their design.
7. If budget allows, older students may build a prototype of their new cane to explore how the design may change during implementation.

◆ Time Needed

One to two 45 minute sessions.

Engineer a Cane



Student Resource:
What are Assistive Devices?

Assistive devices are used to help people with disabilities at various stages of life. Someone may break a leg and need crutches for mobility until their leg heals, or an elderly person may not have confidence in walking and need the support of a sturdy walker to maintain balance and to be able to walk with confidence.

Many are not designed as assistive devices for people with disabilities, but to make life easier for anyone--for instance, a sound sensitive light switch. In the kitchen, eating and cooking utensils can be fitted with oversized handles for easier gripping. This "assistive device" can enable an 85 year old with arthritic fingers and hands to continue to prepare meals for themselves.

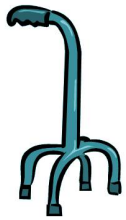
Another kitchen-related assistive device is an automatic feeder, controlled by a chin switch or and hand/foot switch, so that people who cannot hold eating utensils due to tremor or spasticity of the hands and arms can feed themselves.

Assistive devices are frequently found in the bathroom. Grab bars around the tub are easily installed and help prevent falls. Shower benches, bathtub lifts and a door on the bathtub not only alleviate some need for human assistance, but make it easier to shower and reduce the risk of slipping.

In the bedroom, guard rails around the bed can make it easier and safer get in and out of bed. Bedside controls for lights and other appliances increase the ability of mobility impaired people to control the lighting, temperature or other conditions of their home without getting out of bed.

For the functionally impaired elderly living in multi-level housing, wheelchair lifts and stair-climbs allow for full access and mobility throughout the house. Individuals with hearing impairments can benefit from a simple blinking light instead of a doorbell. Large handled combs and brushes and velcro fasteners for clothing help people with limited manual fine motor abilities.

Engineer a Cane



Student Resource:
What are Assistive Devices?

◆ Canes

A cane can serve several different functions to meet the needs of a user: it can aid in balance, it can support a weakened or painful limb or joint, and it can aid in sensing the environment. There are many types of canes, and they often are designed to meet the needs of a specific population of people. For example, "white canes" are designed to assist the visually impaired. They are longer and thinner and allow the user to "feel" the path ahead. They also alert others, such as motorists, to know the user is blind and therefore use caution. In the United Kingdom, red banding on a white cane indicates a deaf-blind user.

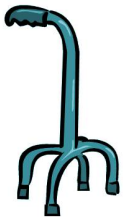
◆ Types of Canes

There are many types of canes, from basic wooden designs that can be manufactured inexpensively, to more technologically advanced devices. Basic types include folding canes that may have several joints and are usually connected by an internal elastic cord, quad canes that have four legs at the base so they can stand on their own and can be more stable, tripod canes which open in tripod fashion and sometimes include a seat for resting, adjustable canes that can be made shorter or taller to meet the height of the user, canes with straps so they cannot fall away from the user, lighted canes that help a user in dark places, and even some equipped with a buzzer or doorbell device that can alert others that the user needs help. And, there are many different handles available to match the size of the user's hands and their medical needs.

◆ Material Selection

The materials selected for manufacturing a cane can be determined by many factors including the strength, weight, and durability required. For example, an aluminum cane would be much lighter than one made of steel. This might be preferred by an elderly person without much strength in their arms.

Engineer a Cane



Student Resource:
United Nations News Centre Release

Palestinian girls take science project from UN school to Silicon Valley

Palestinian girls with prototype electronic cane that will be exhibited at Intel science fair in California

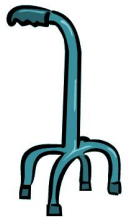
28 April 2010 – Three teenagers studying in a United Nations-funded school in a refugee camp in the West Bank have been chosen to join 1,500 finalists, Nobel Laureates and leading scientific minds in the world's largest pre-college science fair where their prototype of an electric cane could win a $50,000 grand prize.

"They are the Albert Einsteins of tomorrow," the UN News Centre was told today by Chris Gunness, spokesperson for the UN Relief and Works Agency for Palestine Refugees in the Near East, the agency that provides basic services to about 4.7 million registered refugees.

Asil Shaar, Nour Al-Arda and Asil Abu Lil, all aged 14, teamed up for a science project at UNRWA's Askar Girls' School in Nablus, after seeing one of their visually impaired uncles struggle to walk on the region's hilly terrain. While most electronic canes can tell what is in front, the girls devised a wooden walking stick that has a "seeing" sensor below – so it beeps when the surface changes, such as near stairs, holes or water, up to 30 inches away.
To perfect their prototype, the girls also visited organisations that work with visually impaired people and scoured electronic stores that were some 45 minutes and two Israeli checkpoints away from their homes. The idea was nurtured at the UNRWA school by the girls and their teacher, Jameela Khaled, who said she felt like she had planted a tree and "now I take the fruit."

The girls' cane was chosen out of 56 Palestinian projects to attend an Intel International Science and Engineering Fair in San Jose, California, where they will met with hundreds of leading scientists and researchers, and potential future employers. "Intel and UNRWA both believe that if you empower the next generation, they will be able to meet any global challenge," said Mr. Gunness.

Engineer a Cane



Student Worksheet:
Applying Technology to Solve Problems

You are a team of engineers who have been given an assignment to work with a client to develop a new assistive device to meet their needs. You'll start with a standard wooden cane and re-engineer it with additional devices and features to meet the client's specific needs. Likely the resulting device will be useful to a broader population as well, and could be marketed to others and become a profitable product for the company you work for. You'll need to develop a construction budget for your new cane so that the client can consider the cost of the new device. Sometimes engineers will develop prototypes and test a new design before moving into a broad manufacturing and marketing scheme.

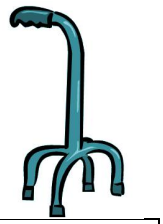
◆ Research/Preparation Phase

1. Review the various Student Reference Sheets to learn about assistive devices and how they help people. You'll also read a press release about a student group who actually invented a new product while working on an engineering challenge.
2. As a group, discuss how at any age people may need assistive devices to help them complete daily tasks. If you know of any individuals who use assistive devices, you can discuss the various devices and equipment they use to help them.

◆ Investigation Phase

1. You are on a team of 2-3 engineers and have been assigned a "client" who is seeking to reengineer their cane to meet their specific needs.
2. Review the profile you have been provided and discuss what technology or other features could be added to the cane to help the individual.
3. Research the cost of each addition and list each part in the box below, or use another sheet:

Parts You'll Need	Cost Per Needed Item



	Total:

Engineer a Cane

Student Worksheet:
Applying Technology to Solve Problems

◆ Design Phase

1. Draw a diagram of what your new cane will look like in the box below, and label each new part you have added or adjusted.

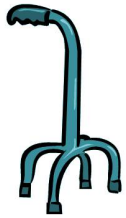
◆ Presentation Phase

1. Teams present their designs to the class, along with an itemised cost for manufacture. You may wish to encourage student teams to add a consulting or engineering design fee to their design.

◆ Optional Prototype Phase

1. If budget allows, older students may build a prototype of their new cane to explore how the design may change during implementation.

Engineer a Cane



Student Worksheet (continued):

◆ Evaluation

Complete the evaluation questions below:

1. Did your team develop a solution to your client's situation? What did you think was the most innovative change you made to the cane?

2. Do you think that this activity was more rewarding to do as a team, or would you have preferred to work alone on it? Why?

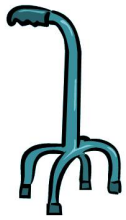
3. Do you think your new cane design might be useful to real people? Why?

4. Can you think of other assistive devices that could be improved through re-engineering?

5. Do you think that engineers work in teams or alone? Why?

6. If you made a prototype of your new design, did you find that the design had to be adapted when you were working with real materials instead of drawing your plan?

Engineer a Cane



Student Worksheet:
Client Profile - Suzanne MacMillan

◆ Situation

Suzanne is an 80 year old woman living in a retirement home in Australia. Like many others her age, she has some difficulty moving around, yet wishes to remain active in her community. She was a talented actress when younger and now acts in a short play every few months within her retirement home.

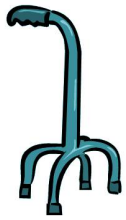
During rehearsals and performances, Suzanne needs to move quickly around on the tile floor of the cafeteria where the play will be performed. She often uses a walker to move from her room to the lobby, but she would prefer to use a cane for performances. Sometimes it is dark with only a spotlight on certain actors, so it is hard for her to see the floor when she is moving around.

Suzanne is right handed, and will be wearing gloves during the upcoming play she is in. She also is not expected to memorise her lines, but can carry note cards with her to read from. She is five feet tall, and slim. She uses reading glasses to read fine print words.

Can you help Suzanne design a cane that will be perfect for the performance?

Notes/Observations:

Engineer a Cane



Student Worksheet:
Client Profile - Mark Burkson

◆ Situation

Mark is 74 years old and has led a very active life. He has hiked in three countries, and as he has aged, still enjoys taking long walks and camping. He cannot carry a backpack any longer, but still likes to get out by himself without relying on someone else to carry his belongings for him.

Mark is 6' tall and is of average weight.

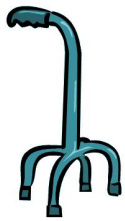
Mark uses a cane just as an extra support and to give him a little more confidence on long treks. But he fears that he may get lost at some point while in the woods and not be able to find his way back or reach someone for help. He likes to listen to music, and also is a wildlife photographer. He used to carry a few cameras with him on hikes, but this is no longer possible as he is not as strong as he used to be.

On a perfect hike, Mark would plan on walking for about two hours, resting with some lunch, and then returning. It is a long day but with certain provisions and perhaps a custom designed cane, he should be able to enjoy a safe hike by himself.

Can you help him design a cane with features that will help Mark keep up an activity he enjoys so well?

Notes/Observations:

Engineer a Cane



Student Worksheet:
Client Profile - Rene Shea

◆ Situation

Rene is 62 years old and is looking forward to attending her daughter's wedding in a few weeks. Unfortunately she has sprained her leg and needs to use a cane for additional support. She has never used a cane before and has found that the single footed cane she has been provided doesn't feel sturdy enough for her.

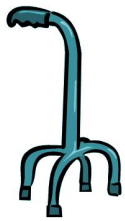
She is also self conscious because she had a beautiful pink dress made to coordinate with the bridesmaids dresses. She feels that the wooden cane she was given will look bad, and she doesn't want to use it. She also wanted to take lots of photos at the wedding, and it will be hard to carry a camera and hold the cane at the same time. She is also supposed to make a short speech at the wedding reception, and is concerned about using the cane to walk up a short flight of stairs as they are not well lighted.

Rene knows that she needs to use the cane for safety reasons, but she wished it were more functional and more attractive too.

Can you help Rene by engineering a cane with features that will help her enjoy her daughter's wedding safely?

Notes/Observations:

Engineer a Cane



For Teachers:
Alignment to Curriculum Frameworks

Science Inquiry Skills
Year 5
With guidance, select appropriate investigation methods to answer questions or solve problems (**ACSIS086**)

Use equipment and materials safely, identifying potential risks (**ACSIS088**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS091**)

Year 6
With guidance, select appropriate investigation methods to answer questions or solve problems. (**ACSIS103**)

Use equipment and materials safely, identifying potential risks (**ACSIS105**)

Suggest improvements to the methods used to investigate a question or solve a problem (**ACSIS108**)

Year 7
Collaboratively and individually plan and conduct a range of investigation types including fieldwork and experiments, ensuring safety and ethical guidelines are followed (**ACSIS125**)

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS126)**

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of data collected, and identify improvements to the method **(ACSIS131)**

Year 8

Collaboratively and individually plan and conduct a range of investigation types including fieldwork and experiments, ensuring safety and ethical guidelines are followed (**ACSIS140**)

In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task **(ACSIS141)**

Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of data collected, and identify improvements to the method **(ACSIS146)**

Year 9

Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS165)**

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSIS166)**

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS171)**

Year 10

Plan, select and use appropriate investigation methods, including fieldwork and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods **(ACSIS199)**

Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data **(ACSIS200)**

Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data **(ACSIS205)**

Science as a Human Endeavour

Year 5

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE081)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE083)**

Year 6

Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena **(ACSHE098)**

Scientific understandings, discoveries and inventions are used to solve problems and directly affect people's lives **(ACSHE100)**

Year 7

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE223)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE224)**

Year 8

Science knowledge can develop through collaboration and connecting ideas across the disciplines of science **(ACSHE226)**

People use understanding and skills from across the disciplines of science in their occupations **(ACSHE227)**

Year 9

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE158)**

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities **(ACSHE161)**

Year 10

Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries **(ACSHE192)**

Advances in science and emerging sciences and technologies can significantly affect people's lives, including generating new career opportunities **(ACSHE195)**

Mathematics Links with Science Curriculum (Skills used in this activity)	General Capabilities	Cross-Curriculum Priorities
• Process data using simple tables • Data analysis skills (graphs) • Analysis of patterns and trends • Use of metric units	• Literacy • Numeracy • Critical and creative thinking • Personal and social capacity • ICT capability	• Sustainability

Science Achievement Standards

Year 5

By the end of Year 5, students classify substances according to their observable properties and behaviours. They explain everyday phenomena associated with the transfer of light. They describe the key features of our solar system. They analyse how the form of living things enables them to function in their environments. Students discuss how scientific developments have affected people's lives and how science knowledge develops from many people's contributions.

Students follow instructions to pose questions for investigation, predict what might happen when variables are changed, and plan investigation methods. They use equipment in ways that are safe and improve the accuracy of their observations. Students construct tables and graphs to organise and identify patterns. They use patterns in their data to suggest explanations and refer to data when they report their findings. They describe ways to improve the fairness of their methods and communicate their ideas, methods and findings using a range of texts.

Year 6

By the end of Year 6, students compare and classify different types of observable changes in materials. They analyse requirements for the transfer of electricity and describe how energy can be transformed from one form to another to generate electricity. They explain how natural events cause rapid changes to the Earth's surface. They decide and predict the effect of environmental changes on individual living things. Students explain how scientific knowledge is used in decision making and identify contributions to the development of science by people from a range of cultures.

Students follow procedures to develop investigable questions and design investigations into simple cause-and-effect relationships. They identify variables to be changed and measured and describe potential safety risks when planning methods. They collect, organise and interpret their data, identifying where improvements to their methods or research could improve the data. They describe and analyse relationships in data using graphic representations and construct multi-modal texts to communicate ideas, methods and findings.

Year 7

By the end of Year 7, students describe techniques to separate pure substances from mixtures. They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of the Earth, sun and moon affect phenomena on Earth. They analyse how the sustainable use of resources depends on the way they are formed and cycled through Earth systems. They predict the effect of environmental changes on feeding relationships and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines has been used to solve a real-world problem. They explain how the solution was viewed by, and impacted on, different groups in society.

Students identify questions that can be investigated scientifically. ***They plan fair experimental methods, identify variables to be changed and measured. They***

select equipment that improves fairness and accuracy and describe how they considered safety. Students draw on evidence to support their conclusions. They summarise data from different sources, describe trends and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.

Year 8

By the end of Year 8, students compare physical and chemical changes and use the particle model to explain and predict the properties and behaviours of substances. They identify different forms of energy and describe how energy transfers and transformations cause change in simple systems. They compare processes of rock formation, including the time scales involved. They analyse the relationship between structure and function at cell, organ and body system levels. Students examine the different science knowledge used in occupations. They explain how evidence has led to an improved understanding of a scientific idea and describe situations in which scientists collaborate to generate solutions to contemporary problems.

Students identify and construct questions and problems that they can investigate scientifically. ***They consider safety and ethics when planning investigations, including designing field or experimental methods. They identify variables to be changed, measured and controlled***. Students construct representations of their data to reveal and analyse patterns and trends, and use these when justifying their conclusions. ***They explain how modifications to methods could improve the quality of their data and apply their own scientific knowledge and investigation findings to evaluate claims made by others***. They use appropriate language and representations to communicate science ideas, methods and findings in a range of texts types.

Year 9

By the end of Year 9, students explain chemical processes and natural radioactivity in terms of atoms and energy transfers and describe examples of important chemical reactions. They describe models of energy transfer and apply these to explain phenomena. They explain global features and events in terms of geological processes and timescales. They analyse how biological systems function and respond to external changes with reference to interdependencies, energy transfers and flows of matter. They describe social and technological factors that have influenced scientific developments and predict how future applications of science and technology may affect people's lives.

Students design questions that can be investigated using a range of inquiry skills. ***They design methods that include the control and accurate measurement of variables and systematic collection of data and describe how they considered ethics and safety. They analyse trend in data, identify relationships between variables and reveal inconsistencies in results. They analyse their methods and the quality of their data, and explain specific actions to improve the quality of their evidence***. They evaluate others 'methods and explanations from a scientific perspective and use appropriate language and representations when communicating their findings and ideas to specific audiences.

Year 10

By the end of Year 10, students analyse how the periodic table organises elements and use it to make predictions about the properties of elements. They explain how chemical reactions are used to produce particular products and how different factors influence the rate of reactions. They explain the concept of energy conservation and represent energy transfer and transformation within systems. They apply relationships between force, mass and acceleration to predict changes in the motions of objects. Students describe and analyse interactions and cycles within and between Earth's spheres. They evaluate the evidence for scientific theories that explain the origin of the universe and the diversity of life on Earth. They explain the processes that underpin heredity and evolution. Students analyse how the models and theories they use have developed over time and discuss the factors that prompted their view.

Students develop questions and hypotheses and independently design and improve appropriate methods of investigation, including field work and laboratory experimentation. They explain how they have considered reliability, safety, fairness and ethical actions in their methods and identify where digital technologies can be used to enhance the quality of their data. When analysing data, selecting evidence and developing and justifying conclusions, they identify alternative explanations for findings and explain any sources of uncertainty. Students evaluate the validity and reliability of claims made in secondary sources with reference to currently held scientific views, the quality of methodology and the evidence cited. They construct evidence-based arguments and select appropriate representations and text types to communicate science ideas for specific purposes.