Flight Club

FUTURE MAKERS TEACHER RESOURCE

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum Network and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

Cover image: Black-winged Kite (Elanus caeruleus) in flight. Queensland Museum, Gary Cranitch.

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This teacher resource is produced by Future Makers, a partnership between Queensland Museum Network and Shell's QGC business, with support from the Australian Research Council and other parties to ARC Linkage Project LP160101374: The University of Queensland, Australian Catholic University Limited and Queensland Department of Education.

Thank you to the University of Queensland School of Education for contributing to a number of the activities included in this workbook.

Contents

Workshop Overview

"For once you have tasted flight you will walk the earth with your eyes turned skywards, for there you have been and there you will long to return." Leonardo da Vinci

The ability to take to and remain in the skies has captivated humans for thousands of years. Our efforts to achieve flight have often been inspired by the natural world, including the unique features and adaptations of the animal kingdom.

This workshop investigates how members of the animal kingdom achieve flight, and how biological understandings can be combined with design and technologies concepts to support and extend student engagement with science.

This workshop has been structured using the 5E's instructional model.

The following topics and concepts are explored in each aspect of the workshop:

ENGAGE	**What is Flight?** Introduce and explore the overarching inquiry question: What is flight?
EXPLORE	**Does it Fly?** Explore, challenge and refine understandings of flight. Categorise a variety of stimuli using prior knowledge and understanding to determine if they definitely, maybe or do not fly.
EXPLAIN	**Flight Adaptations** Develop knowledge and understandings about the flight-related adaptations of specific animals, and how these adaptations support survival within diverse environments. Explore and identify the forces that affect flight.
ELABORATE	**Flight Club Design Challenge** Students complete the Flight Club Design Challenge. With challenge course: Design and construct a 'flying' creature with the adaptations needed to survive in and move through the challenge habitat. Without challenge course: Design, create and present a bird with adaptations suitable for survival in an Australian habitat.
EVALUATE	**Helium Balloon Investigation** Investigate how much mass a helium balloon can lift, and then use this data to determine how many helium balloons it would take to lift a person off the ground.
EVALUATE	**Who should Get the Helium?** Consider the ethical implications of helium use as a non-renewable resource across various industries.
EVALUATE	**Inspired by Nature** Examine developments in science and technology by selecting and improving on an innovation or object whose design has been inspired by nature.

ENGAGE

What is Flight?

Teacher Resource

In this activity, students participate in a community of inquiry to unpack the significant elements of flight. This process provides students with an opportunity to reach a deep, shared understanding of the concepts and issues underpinning the inquiry topic.

The community of inquiry is a process of discussion where participants pose open-ended questions, listen to the viewpoints of others, and share their own ideas. Disputed or contestable issues and concepts are considered collaboratively within a supportive and respectful classroom environment where all views are considered and respected. It is important that all participants reflect on their thinking.

The following ways of working are used during the community inquiry process. These should be put up on a wall for all students to refer to throughout the process:

- Listen attentively to others
- Build upon and connect ideas
- Have respect for others, yourself and place
- Disagree reasonably and respectfully
- Many responses and opinions may be considered to be correct

In this activity, students firstly consider how they would respond to the overarching inquiry question: **What is flight?**

Students may choose to respond to this question with a definition, a single word or phrase, or use their own life experiences to provide a context for their response/s.

Students then share their response/s with a peer, before participating in a whole-class discussion. Key points, words and phrases should be recorded throughout the discussion and remain on display for the entire unit of work. This provides students with an opportunity to refer back to, edit and refine their response to the inquiry question. The aim here is to develop a strong conceptual definition of flight by the end of the unit.

A similar process can be applied to a variety of inquiry topics using different question stems, including: What is...? Why might we...? How might we...?

Curriculum Links

General Capabilities

Literacy

Composing texts through speaking, writing and creating

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

EXPLORE

Does it Fly?

Teacher Resource

Students test their thoughts and ideas about what constitutes flying. In this activity, students categorise a variety of stimuli to determine if the stimuli definitely, maybe or do not fly. Stimuli can include objects and specimens, as well as text excerpts, videos and images. This categorising ideas activity should result in good discussion and debate as students tease apart what flight is and what flight is not.

In order to begin this activity, a wall or floor space is divided into three sections, and each section is provided a heading - 'Definitely' 'Maybe' and 'No'. Divide students into small groups of two or three and supply each group with at least two stimulus items to categorise.

After receiving the stimulus, students should determine if the stimulus definitely, maybe or does not fly. Students use their prior knowledge about each stimulus and recall past discussions about flight in order to complete this task. Students should also provide reasons to justify their decision. Student groups then take turns to share their decision with the class group, and add their stimuli to the relevant category.

The ability for stimulus material to change categories throughout the sharing process, and even throughout the unit of work, should be emphasised to the class group. Students should also be encouraged to reflect on the position of their stimuli after all have been categorised, and have an opportunity to change their minds, again justifying reasons for changes, if deemed necessary. Particular attention should be paid to stimulus in the 'Maybe' category, as the goal is to have no stimulus in this section by the end of the unit.

At the conclusion of this activity, students can return to and extend their initial definition of flight.

Does it Fly Stimulus Material

The following resources can be used to support student engagement with this activity. You may choose to select other resources that better suit your classroom context and learner needs.

Digital

Aeroplane – Avro Baby
Queensland Museum Network, Collection Online.

The Flying Fish Woodcut Illustration
Guillaume Rondelet. 1554.
Queensland Museum Network, Google Arts and Culture.

Wingsuit Gliding through the 'Crack' Gorge in Switzerland
Red Bull. YouTube. 27 December, 2011.

A Robot that Flies like a Bird
Markys Fischer, TED Talk. YouTube. 22 July, 2011.

Mobula Rays
BBC. YouTube. 13 May, 2015.

Objects

Paper plane

Whirly bird

Seeds from the Rosewood or Tipuana tree, *Tipuana tipu* (see below)

Images

Gliding animal

Insect

Pterosaur

Drone

Hot air balloon

Catapult

Asteroid

Spacecraft

Curriculum Links

General Capabilities

Literacy

Composing texts through speaking, writing and creating

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Analysing, synthesising and evaluating reasoning and procedures

Does it Fly?

Student Activity

In pairs, decide if the animal or object shown in the image flies by placing it in one of the categories: definitely, maybe or no.

Pterosaur

Southern flying squirrel, Glaucomys volans

Dainty swallowtail, Papilio anactus. QM, Jeff Wright

Drone

Hot air balloon

Catapult

Asteroid

Spacecraft

EXPLAIN

Flight Adaptations

Teacher Resource

Students develop knowledge and understanding about the flight-related adaptations of specific animals, and how these adaptations support survival in various environments. Students use the following table to research and record information about these adaptations, classifying the adaptation as structural, functional or behavioural, then identify how the adaptation helps the animal move through the air and/or survive in its environment. Students could begin their research by viewing the flight adaptations video presented by Dr Paul Oliver, Senior Curator of Vertebrates at Queensland Museum.

Students could also identify the forces that are acting on these animals as they move through the air, including lift, drag, thrust and gravity. Students can represent the forces acting on different animals in various stages of flight using force-arrow diagrams. They can also identify how researched features and adaptations serve to increase or decrease the effects of these forces.

Curriculum Links

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 6

Science Understanding

The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

YEAR 7

Science Understanding

Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

General Capabilities

ICT Capability

Investigating with ICT

Flight Adaptations

Student Activity

Research Task

- Record the adaptation that allows the animal to move through the air.
- Classify the adaptation based on its type (structural, functional or behavioural).
- Identify how the adaptation helps the animal move through the air and/or survive in its environment.

Adaptation	Type of Adaptation	Survival Adaptation

Flight Adaptations

Student Activity

Draw force-arrow diagrams to represent the forces acting on the bird at each stage of flight. Include lift, drag, thrust and gravity.

ELABORATE

Flight Club Design Challenge

Teacher Resource

In the Flight Club Design Challenge, students connect biological understandings of flight adaptations with design and technologies concepts to design, construct and evaluate 'flying' creatures. This design challenge can be completed with or without movement through a challenge course, inspired by Queensland habitats; both options are described in further detail below.

1. Divide students into small groups. Assign each group an Australian habitat: Arid Outback, Open Forest, Rainforest and/or Coastal Intertidal. Students view the habitat images, and share their knowledge and experiences about each with their group. Depending on their year level, students can also answer the following questions:

    - What are the biotic (living) and abiotic (non-living) features of this habitat?
    - What adaptations would an animal need to survive in this habitat?

Queensland Museum, Gary Cranitch

Queensland Museum, Jeff Wright

Queensland Museum, Gary Cranitch

Queensland Museum, Gary Cranitch

Students record the main points from their conversation about the habitat and share their learning with the class. Alternatively, students could participate in a jigsaw activity, whereby new groups are formed featuring a representative student from each original habitat group. Students then become the 'expert' about their habitat and take turns sharing their learning with a smaller group of their peers.

2. Students are introduced to the design challenge:

   Without challenge course:

   Design, create and present a bird with adaptations suitable for survival in their identified Australian habitat.

   OR

   With challenge course:

   Design and construct a 'flying' creature with the adaptations needed to survive in and move through the challenge habitat.

   If engaging with the challenge course option, please note the following:

   - Students should be inspired by all animals that are capable of moving through the air (i.e. those that are capable of unpowered and powered flight).
   - The challenge course can be constructed in a variety of ways. For example, the course could be based around the school playground. Alternatively, the course could be constructed using classroom furniture or recyclable materials. Students could even be involved in the design process, using digital systems, classroom resources and design and technologies tools, equipment and techniques to complete this task.
   - Specific obstacles featured in the challenge course could involve:
     - Movement between objects
     - Movement up, under, around and through objects
     - Picking up and dropping off items
   - Helium, helium-grade balloons and balloon pumps are required to complete the challenge course. Two balloons filled with helium are attached to the 'flying creature' – the helium-filled balloons represent the creature's ability to 'fly'. Two balloon pumps are used to move the creature through the challenge course.

3. Share or negotiate any specific challenge requirements, restrictions or criteria for success with students. These may include:

   - Size of student groups.
   - Type of animal to be created. This could be quite general (i.e. a real or imagined animal capable of powered or unpowered flight) or specific (i.e. a bird).
   - Materials to complete challenge, including number of balloons or balloon pumps.
   - If a monetary value is assigned to various materials, how much each material will cost to purchase and the total budget for each group.
   - Time limit to complete challenge.

4. Students work in their groups to complete the challenge. During this phase, students brainstorm and generate ideas and solutions to the challenge, and experiment with the implementation of these ideas.

   Students should consider the features and structural, functional and/or behavioural adaptations their animal will need to have to survive in the chosen habitat such as body shape, wing shape and size, beak, feet, bone density. They generate a labelled diagram of their animal, including an explanation of each feature and how these will help the animal survive in its habitat or how the adaptations respond to the biotic and abiotic factors within the habitat. Students could also provide their animal with a scientific name. Students then construct their animal from recycled materials.

Queensland Museum, Peter Waddington

   If engaging with the challenge course option, students should be encouraged to test and refine their design as often as possible through the course within the allocated time limit. They can also identify the forces acting on their designed animal as it moves through the course, and how these forces could be increased or decreased in different ways. Students could also construct force-arrow diagrams that identify the type, size and direction of forces that are acting on their creature as it moves through the course.

Students moving their 'flying creatures' through the challenge course, using helium-filled balloons and balloon pumps. Queensland Museum, Peter Waddington

5. Students reflect on and evaluate their designs. The following questions may be used to guide this process:

    - What new knowledge/understandings helped you to make decisions about your animal design?
    - Are there any further adaptations that could improve your design?
    - What were the main challenges you experienced during the design process? How did you overcome these?
    - What key science/design learning have you taken from this experience?
    - How could you apply this knowledge and understanding to your learning in other contexts?
    - What more would we like to know about flight?

Curriculum Links

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 6

Science Understanding

The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

YEAR 7

Science Understanding

Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

Design and Technologies

YEAR 5 AND 6

Design and Technologies: Knowledge and Understanding

Investigate characteristics and properties of a range of materials, systems, components, tools and equipment and evaluate the impact of their use (ACTDEK023)

Design and Technologies: Process and Production Skills

Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions (ACTDEP024)

Generate, develop and communicate design ideas and processes for audiences using appropriate technical terms and graphical representation techniques (ACTDEP025)

Select appropriate materials, components, tools, equipment and techniques and apply safe procedures to make designed solutions (ACTDEP026)

Negotiate criteria for success that include sustainability to evaluate design ideas, processes and solutions (ACTDEP027)

Develop project plans that include consideration of resources when making designed solutions individually and collaboratively (ACTDEP028)

YEAR 7 AND 8

Design and Technologies: Knowledge and Understanding

Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment (ACTDEK034)

Design and Technologies: Process and Production Skills

Critique needs or opportunities for designing, and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas (ACTDEP035)

Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies, including graphical representation techniques (ACTDEP036)

Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions (ACTDEP037)

Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability (ACTDEP038)

Use project management processes when working individually and collaboratively to coordinate production of designed solutions (ACTDEP039)

General Capabilities

Numeracy

Estimating and calculating with whole numbers

Using spatial reasoning

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Generating ideas, possibilities and actions

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Flight Club Design Challenge

Student Activity

Australian Habitats

Arid Outback

Queensland Museum, Gary Cranitch

Open Forest

Queensland Museum, Jeff Wright

Rainforest

Queensland Museum, Gary Cranitch

Coastal Intertidal

Queensland Museum, Gary Cranitch

Flight Club Design Challenge

Student Activity

Task: Challenge Course

Design and construct a 'flying' creature with the adaptations needed to survive in and move through the challenge habitat.

You must:

- **Investigate** how different types of animals achieve flight. This can be powered or unpowered flight. You should also identify the features of the habitat in which your 'flying' creature must survive.
- **Design** your 'flying' creature. Draw a labelled diagram of your creature. Make sure you explain its features and adaptations and how these help the creature survive in its habitat.
- **Create** your creature from recyclable materials supplied by your teacher.
- **Test** your creature through the challenge habitat.
- **Refine** your creature so that it moves better through the challenge habitat.
- **Collaborate** in teams of two.
- **Evaluate** continuously to construct a 'flying' creature with the adaptations needed to survive in and move through the challenge habitat.

Flight Club Design Challenge

Student Activity

Task: Without Challenge Course

Design, create and present a bird with adaptations suitable for survival in their identified Australian habitat.

You must:

- **Investigate** how different types of animals achieve flight. This can be powered or unpowered flight. You should also identify the features of the habitat in which your 'flying' creature must survive.
- **Design** your 'flying' creature. Draw a labelled diagram of your creature. Make sure you explain its features and adaptations and how these help the creature survive in its habitat.
- **Collaborate** in teams of two.
- **Evaluate** your design and learning you have taken from this experience.
- **Present** your design to the class.

Investigate

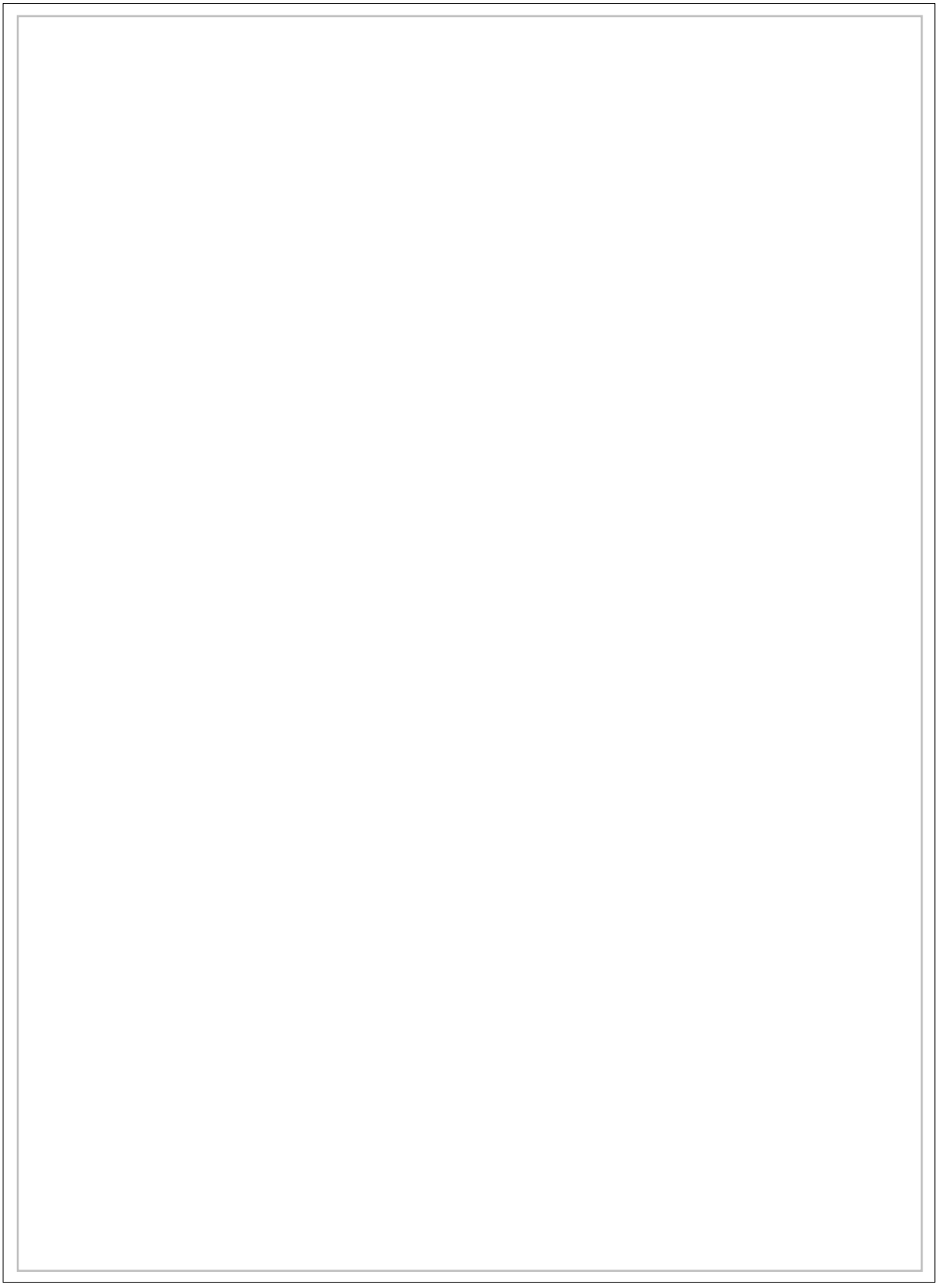
Identify the characteristics of the habitat in which your 'flying' creature must survive. Describe the adaptations that will allow your animal to fly and survive within this habitat.

Habitat	
Characteristics of Habitat	

Adaptation	Type of Adaptation	Survival Advantage

Design

Draw a labelled diagram of your creature. Make sure you explain its features and adaptations and how these help the creature survive in its habitat.



Create

Construct your creature, making sure to keep a record of the materials used and their cost. It is important to meet the budget requirements set by your teacher!

Total Budget	

Item	**Cost per item**	**Number of items**	**Total cost**
		GRAND TOTAL	

Test and Refine

Test your creature's ability to move through the challenge habitat. How well did your creature move through the habitat? What modifications do you need to make to help it move through the habitat better? Record any modifications made, and reasons for these modifications, below.

Modification	Reason

Evaluate

Reflect on your actions with your team or class after you have completed the design challenge. You might like to think about the following questions to assist with your reflection:

- What new knowledge/understandings helped you to make decisions about your animal design?
- Are there any further adaptations that could improve your design?
- What were the main challenges you experienced during the design process? How did you overcome these?
- What key science/design learning have you taken from this experience?
- How could you apply this knowledge and understanding to your learning in other contexts?
- What more would you like to know about flight?

After the challenge, construct a force-arrow diagram to record the type, size and direction of forces that acted on your creature as it moved through the habitat.

How could you increase or decrease the effects of:

Gravity	
Thrust	
Drag	
Buoyancy	

EVALUATE

Helium Balloon Investigation

Teacher Resource

Students investigate how much mass a helium balloon can lift, and then use this data to determine how many helium balloons it would take to lift them off the ground. Students use various weights to complete this task, record their observations and draw force-arrow diagrams to represent the forces acting on a helium balloon at various stages of the investigation. Students also consider the reasons for variations in collected data, and suggest changes that could be made to the investigation to increase the consistency of results.

Alternatively, to practice precise measurement, students could use a scale to identify material/s with the required mass. These materials can then be attached to the balloon rather than using the weights.

Curriculum Links

Science

YEAR 7

Science Understanding

Change to an object's motion is caused by unbalanced forces, including Earth's gravitational attraction, acting on the object (ACSSU117)

Science Inquiry Skills

Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

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

Measure and control variables, select equipment appropriate to the task and collect data with accuracy (ACSIS126)

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS129)

Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence (ACSIS130)

Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements (ACSIS131)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

Helium Balloon Investigation

Student Activity

Have you ever wondered how many helium balloons it would take to lift you off the ground? Now is your chance to find out! Working in small groups of three or four, you will attach helium balloons, one at a time, to a weight until neutral buoyancy is achieved. Neutral buoyancy is achieved when an object neither sinks (negative buoyancy) nor rises (positive buoyancy). Instead the object will stay in place, hovering in mid-air until acted on by another force.

Aim

To identify how much mass a helium balloon can lift.

Materials

- Helium tank, operated by your teacher only
- Helium balloons, 30 cm diameter
- String or ribbon, one per helium balloon, 60 cm long
- 2 gram weight
- 5 gram weight
- 10 gram weight
- 20 gram weight

OR

- Various materials of different masses
- Scales, kitchen and bathroom

Method

1. Your teacher will inflate a helium balloon for your group. After the helium balloon is inflated, tie a knot in the balloon. Then tie a 60 cm length of string or ribbon to the balloon.

2. Attach a 2 gram weight to the string or ribbon. What happened? Record any observations. (Alternatively, you could use a scale to identify material/s with a total mass of 2 grams, and then attach material/s to the string or ribbon.)

3. Predict how many balloons it will take for the 2 gram weight to achieve neutral buoyancy. Record your prediction.

4. Continue to attach helium balloons to the 2 gram weight until neutral buoyancy is achieved. Record how many balloons were required to achieve neutral buoyancy.

5. Attach a 5 gram weight to the string or ribbon. What happened? Record any observations.

6. Predict how many balloons it will take to achieve neutral buoyancy. Record your prediction.

7. Continue to attach helium balloons to the 5 gram weight until neutral buoyancy is achieved. Record how many balloons were required to achieve neutral buoyancy.

8. Attach a 10 gram weight to the string or ribbon. What happened? Record any observations.

9. Predict how many balloons it will take to achieve neutral buoyancy. Record your prediction.

10. Continue to attach helium balloons to the 10 gram weight until neutral buoyancy is achieved. Record how many balloons were required to achieve neutral buoyancy.

11. Attach a 20 gram weight to the string or ribbon. What happened? Record any observations.

12. Predict how many balloons it will take to achieve neutral buoyancy. Record your prediction.

13. Continue to attach helium balloons to the 20 gram weight until neutral buoyancy is achieved. Record how many balloons were required to achieve neutral buoyancy.

Results

1. Record your observations and results.

Mass	Number of Balloons	Observations
2 grams		
5 grams Prediction:		
10 grams Prediction:		
10 grams Prediction:		

2. Draw a force-arrow diagram to represent the forces acting on a helium balloon in each of the following situations.

Neutral buoyancy	**Negative buoyancy**
Positive buoyancy	**A gust of wind**

3. In the movie ‘Up’, an old man uses helium balloons to lift himself and his house. Use the data you have collected to calculate how many helium balloons this would take. Record your working out in the space below.

4. Share your results with your class. Explore any variations in data. Why might these variations exist? How could the investigation be altered to gather more consistent data?

5. How many helium balloons would it take to lift you off the ground?

EVALUATE

Who Should Get the Helium? Community of Inquiry

Teacher Resource

Students consider the ethical implications of helium use as a non-renewable resource across various industries. Students may either participate in a community of inquiry or a jigsaw activity to investigate:

- How helium is used by various industries.
- The helium shortages have been and/or are currently experienced by industry.
- Why there is a helium shortage.
- If it is possible to resolve this problem, and, if so in what ways.

The community of inquiry is a structured, dialogic process that requires participants to ask open inquiry questions, listen and think, share ideas and consider alternative viewpoints. Problematic issues and concepts are discussed collaboratively within a supportive learning environment where all views are considered and respected. Reflecting on thinking is integral to the process.

The following engagement protocols are used during the community inquiry process, and these should be included on the walls for all students to see.

- Listen attentively
- Build on and connect ideas
- Respect self, others and place
- Disagree reasonably and respectfully
- There may be many responses considered to be correct

Detailed step-by-step instructions for the community of inquiry can be seen below.

1. Prior to conducting the whole-class community of inquiry, you may like students to consider and/or research the following questions:
    - What helium shortages have been and/or are currently experienced by industry?
    - Why is there a shortage?
    - Can the problem be resolved? In what ways?

2. Share the following stimulus quote and helium uses with students.

   Stimulus

   "Helium supplies are tightening up. Hiccups in global helium supply lines, along with increasing demand in a growing economy, are leading to shortages of the noble gas.

   According to the industrial gas firm Linde, helium supply interruptions in the Middle East and allocations of helium from the U.S. Bureau of Land Management's Texas helium reserves have restricted the company's ability to supply customers with this gas. Linde says it is now allocating helium in 'a fair and reasonable way.'

   There is not enough helium to go around. As representatives of Linde, how will you define 'fair and reasonable'?"

   Uses of helium

   - Filling balloons (balloon rides, party balloons, blimps, meteorological research)
   - Gas-cooled nuclear reactors
   - Some neon lights
   - MRI machines (can be replaced by hydrogen)
   - In diving apparatus
   - Breathing mixtures
   - Pressurising agent (rockets)
   - Purge systems of unwanted gas
   - Leak detection
   - Shielding gas for arc welding
   - Inert atmosphere in welding
   - Food preservation
   - Cryogenics
   - Protective gas when growing silicon
   - Semi-conductors – fibre optics
   - Gas for supersonic wind tunnels

3. Inform students that it is their task is to prioritise the uses of helium in order from most to least fair and reasonable allocation of helium in times of a global shortage.

   Before making this list, students should consider and discuss a selection of community of inquiry questions (see below); these questions should be selected based on your student group and their respective needs.

   Ensure ways of working are shared and discussed with students prior to engaging in the community of inquiry. When answering questions, students should always provide reasons for their responses.

Community of Inquiry Questions

- Is it possible to solve the problem of the helium shortage by fair and reasonable allocation of helium?
- Are there alternatives to helium that could be considered for some of the listed uses (e.g. MRI and hydrogen)?
- Should these uses still be considered for helium allocation? Why/Why not?
- In what ways could the problem of helium shortage be solved fairly and reasonably?
- Fair and reasonable for whom? Who will the allocation benefit?
- Are these benefits widespread (i.e. for a wide range of people/communities)? How do you know that?
- What flow-on benefits might the allocation have? In what ways are the flow-on benefits significant?
- If allocations are considered to be fair and reasonable, does that mean they are also ethical? Why/Why not?
- How could an ethical approach to helium allocation be achieved or maintained?
- Should global need be prioritised over local need when considering helium allocation? Why do you think that?
- Are there some helium uses that would be considered less ethical/less important than others? Why do you think that?
- How would the amount of helium allocated to each group/use be decided upon?
- Who should have the right to make decisions regarding the allocation of helium? Why do you think that?

Following the community of inquiry, students prioritise the uses of helium using the Prioritising Helium table. Ask students to only complete the first two columns at this stage of the activity (Helium Use and Justification).

4. Return to the whole-class community of inquiry. Ensure students have their priority lists placed in front of them, so the lists are visible to all members of the community.

   Students take turns to share their lists. During this time, their peers share any disagreements, including reasons for disagreement with the community. Record disagreements and reasons for disagreements as they are voiced.

   After all groups have shared their lists, ask students: How would the amount of helium allocated to each group be decided upon?

5. Following the community of inquiry, ask student groups to reflect on the following questions:

    - On consideration of the shared disagreement/s, should we change our priority order?
    - Were the reasons we put forward ethically and logically considered?
    - What have we taken away from this activity that will remain with us in future? Why do we consider this important?
    - What action could we take as individuals or as a community to make a difference?

Curriculum Links

Science

YEAR 7

Science as a Human Endeavour

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE223)

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Word knowledge

ICT Capability

Investigating with ICT

Managing and operating ICT

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Self-management

Social awareness

Social management

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Explain values, rights and responsibilities

Who Should Get the Helium? Community of Inquiry

Student Activity

Prioritising Helium Use

Priority	Helium Use	Justification	Disagreement
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

EVALUATE

Who Should Get the Helium? Jigsaw Activity

Teacher Resource

Students consider the ethical implications of helium use as a non-renewable resource across various industries. Students may either participate in a community of inquiry or a jigsaw activity to investigate:

- How helium is used by various industries.
- The helium shortages have been and/or are currently experienced by industry.
- Why there is a helium shortage.
- If it is possible to resolve this problem, and, if so in what ways.

Detailed step-by-step instructions for the jigsaw activity can be seen below.

1. Select stimulus material for students to view in relation to the worldwide helium shortage. Stimulus material could include the following:

    - We Need Helium More Than Ever (And We're Running Out)
      The Good Stuff. YouTube. 30 June, 2017.

    - Huge Helium Gas Find in East Africa Averts Medical Shortage
      Ian Sample. The Guardian. 29 June, 2016.

    - Uses of helium:

      Filling balloons (balloon rides, party balloons, blimps, meteorological research)

      Gas-cooled nuclear reactors

      Some neon lights

      MRI machines (can be replaced by hydrogen)

      In diving apparatus

      Breathing mixtures

      Pressurising agent (rockets)

      Purge systems of unwanted gas

      Leak detection

      Shielding gas for arc welding

      Inert atmosphere in welding

      Food preservation

      Cryogenics

Protective gas when growing silicon

Semi-conductors – fibre optics

Gas for supersonic wind tunnels

2. After viewing the stimulus material, ask students:

   - What helium shortages have been and/or are currently experienced by industry?
   - Why is there a shortage?
   - Can the problem be resolved? In what ways?

3. Set up a jigsaw activity. Roles are designated for groups to research. Alternatively, groups could use relevant media articles to derive answers from their role's perspective. Each group will use their research findings to create five main points of view to communicate as 'experts' in the next jigsaw configuration, with all responding to the same question: Why is helium important to 'me'?

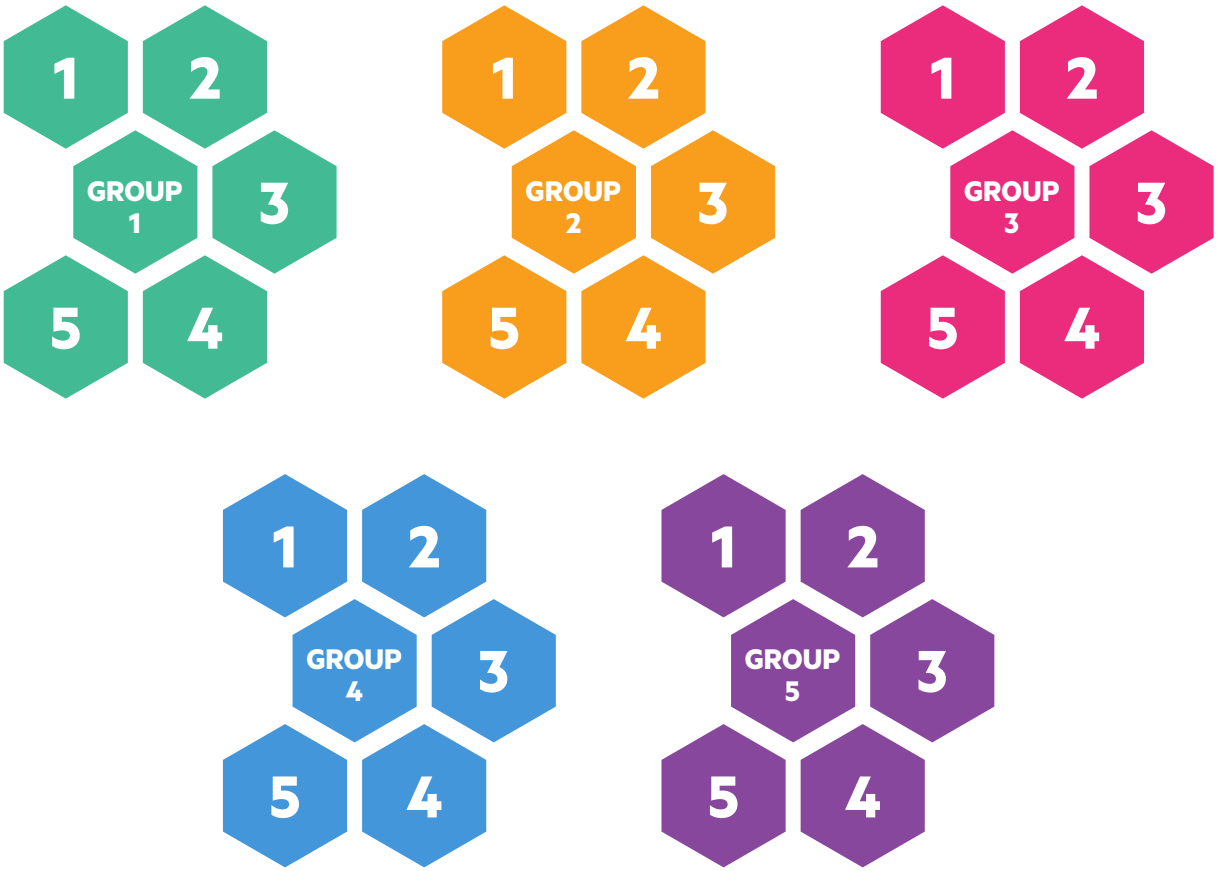
Group 1 Meteorologists

Group 2 Sustainable chemists

Group 3 Party suppliers

Group 4 NASA representatives

Group 5 Technical scuba divers



ROLE 1

Meteorologists

FOLD

As a meteorologist, you work closely with the data that weather balloons collect.

Weather balloons filled with helium take off twice a day in over 200 places around the globe to measure current weather conditions and collect data.

This data, collected by the attached instrument called a sonde, is transmitted back via radio signal for analysis and shared internationally. You understand the vital importance of weather balloons as the most effective data collection method for weather pattern analysis and extreme storm warnings.

Annual usage in weather balloons around the world (2010):
140 million cubic feet of helium (~4 million cubic meters)

CUT OUT THIS TABLE TOP CARD

ROLE 2

Sustainable Chemists

FOLD

As a chemist who specialises in sustainability, you are concerned that the helium used in life-saving medical equipment such as MRIs is being used for trivial purposes such as filling party balloons.

Each MRI needs around 10,000L to function. The gas is the second most abundant element in the observable universe, but Earth has lost its initial helium as it is lighter than air, it just floats into space.

What is available today is produced inside rocks through radioactive decay of uranium and other elements, and it is difficult to locate where the gas builds up into useful reserves. You understand that helium is a precious non-renewable resource.

Annual usage by MRIs around the world (2016):
1.2 billion cubic feet of helium (34 million cubic meters)

CUT OUT THIS TABLE TOP CARD

Party Suppliers

ROLE 3

FOLD FOLD

As a small business owner, you know how hard it is to cover costs and make a living, only making a couple of dollars per helium balloon that you sell.

The price of helium has increased around 10% per year since you started the business and customers are unhappy when you put up prices, which also affects your sales. Sometimes your helium supplier does not provide your regular order because they have a limited helium supply.

Annual usage for latex and foil balloons around the world (2012):
360 million cubic feet of helium (~10 million cubic meters)

CUT OUT THIS TABLE TOP CARD

NASA Representatives

ROLE 4

FOLD FOLD

NASA can use up to 100 million cubic feet of helium per year, costing millions of dollars. Helium is used throughout NASA as a cryogenic agent for cooling various materials, in precision welding applications, as well as lab use.

Helium is also used as an inert (unreactive) purge gas for hydrogen systems and as a pressurising agent for ground and flight fluid systems of space vehicles. As a representative of NASA, you are aware of the huge volume and vital role that helium plays in your agency.

NASA's Annual usage of helium (2015):
100 million cubic feet (~2.8 million cubic meters)

CUT OUT THIS TABLE TOP CARD

ROLE 5

Technical Scuba Divers

FOLD FOLD

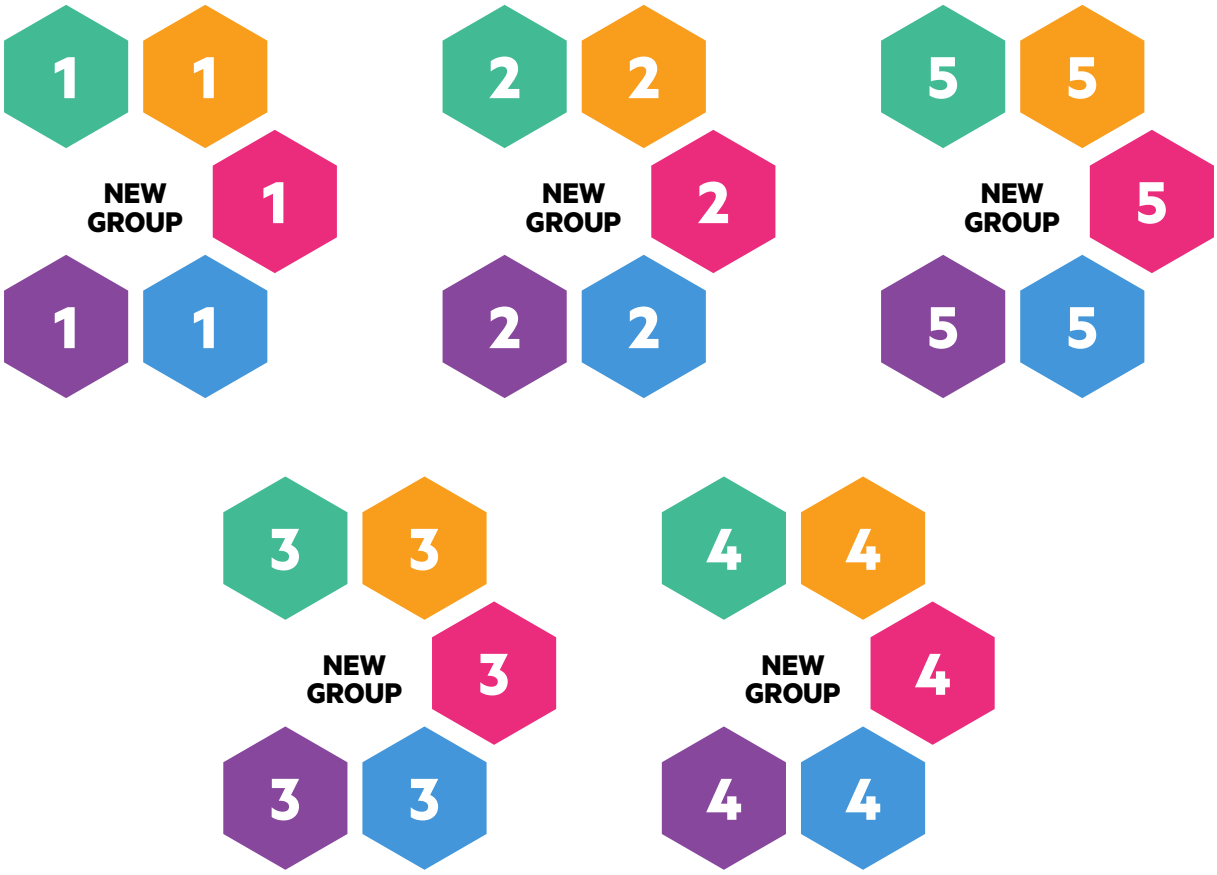
You are a technical diver that is part of a research team investigating ongoing changes in the Great Barrier Reef. Helium is an inert (unreactive) gas that is used instead of nitrogen in oxygen tanks because it does not induce narcosis.

There are predictions in Diver Magazine (2011) that your usual tank cost of US$65 could increase to US$1300. That's about US$25 per minute of diving. With funding only just covering the costs of the research you support, you are concerned that you will no longer have a job in research or in the diving industry in the future.

Annual usage of helium for scuba diving around the world (2016):
360 million cubic feet (~10 million cubic meters)

CUT OUT THIS TABLE TOP CARD

4. Students move into ‘shared knowledge groups’ where each ‘expert’ shares why helium is important to them.



5. Students remain in ‘shared knowledge groups’ as expert representatives of their role. The following scenario is given to each group for evaluation:

   Helium supplies are tightening up. Hiccups in global helium supply lines, along with increasing demand in a growing economy, are leading to shortages of the noble gas.

   According to the industrial gas firm Linde, helium supply interruptions in the Middle East and allocations of helium from the U.S. Bureau of Land Management’s Texas helium reserves have restricted the company’s ability to supply customers with this gas. Linde says it is now allocating helium in 'a fair and reasonable way.

   There is not enough helium to go around; you only have 80% of your usual stock. As representatives of Linde, how will you define ‘fair and reasonable’ allocation of helium in times of a global shortage?

   In order to answer this question, groups should consider the following questions:

   - Is it possible to solve the problem of the helium shortage by fair and reasonable allocation of helium?

- Are there alternatives to helium that could be considered for some of the listed uses? Should these uses still be considered for helium allocation? Why/Why not?
- In what ways could the problem of helium shortage be solved fairly and reasonably?
- Fair and reasonable for whom? Who will the allocation benefit?
- Are these benefits widespread (a wide range of people/communities)? How do you know that?
- What flow-on benefits might the allocation have? In what ways are the flow-on benefits significant?
- If allocations are considered to be fair and reasonable, does that mean they are also ethical? Why/Why not?
- How could an ethical approach to helium allocation be achieved or maintained?
- Should global need be prioritised over local need when considering helium allocation? Why do you think that?
- Are there some helium uses that would be considered less ethical/less important than others? Why do you think that?
- How would the amount of helium allocated to each group/use be decided upon?
- Who should have the right to make decisions regarding the allocation of helium? Why do you think that?

6. Students move back to their original 'expert' groups to share how Linde's various decisions will affect their roles.

Curriculum Links

Science

YEAR 7

Science as a Human Endeavour

Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures (ACSHE223)

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

Composing texts through speaking, writing and creating

Word knowledge

ICT Capability

Investigating with ICT

Managing and operating ICT

Critical and Creative Thinking

Inquiring – identifying, exploring and organising information and ideas

Reflecting on thinking and processes

Analysing, synthesising and evaluating reasoning and procedures

Personal and Social Capability

Self-management

Social awareness

Social management

Ethical Understanding

Understanding ethical concepts and issues

Reasoning in decision making and actions

Explain values, rights and responsibilities

Cross-Curriculum Priorities

Sustainability

Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments. (OI.7)

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts. (OI.8)

EVALUATE

Inspired by Nature

Teacher Resource

Students examine developments in science and technology by selecting an innovation or object whose design has been inspired by nature. They explore why the innovation or object was developed, its design and function, then determine how the item has impacted society. The Question Answer Relationship (QAR) strategy may be used to guide this process.

Students then work to improve the selected innovation or object in some way. They identify the features that they would keep, improve or remove to enhance the item, and then begin the redesign process by identifying a new user, establishing a refined set of user needs and explaining the final design solution.

Curriculum Links

Science

YEAR 5

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

YEAR 6

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

YEAR 7

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE121)

YEAR 8

Science as a Human Endeavour

Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE135)

People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity (ACSHE136)

YEAR 9

Science as a Human Endeavour

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE160)

Design and Technologies

YEAR 5 AND 6

Design and Technologies: Knowledge and Understanding

Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use (ACTDEK019)

YEAR 7 AND 8

Design and Technologies: Knowledge and Understanding

Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures (ACTDEK029)

YEAR 9 AND 10

Design and Technologies: Knowledge and Understanding

Investigate and make judgments, within a range of technologies specialisations, on how technologies can be combined to create designed solutions (ACTDEK047)

Cross-Curriculum Priorities

Sustainability

Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments. (OI.7)

Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgements based on projected future economic, social and environmental impacts. (OI.8)

Inspired by Nature

Student Activity

Sustainability

Select an innovation or object whose development has been inspired by nature, then use your selection to answer the following questions.

My Selection:	

In The Resource	**In My Head**
Right There What does the object do? Who was involved in the design and production of the object?	**Author and You** What solutions does this object offer? How did people in different occupations work together to develop this object?
Think and Search What has inspired the development of this object?	**On My Own** What sustainability issues may arise as a result of using this object? Explain your answer. How could these issues be resolved?

Inspired by Nature

Student Activity

Ethics

Select an innovation or object whose development has been inspired by nature, then use your selection to answer the following questions.

My Selection:	

In The Resource	**In My Head**
Right There What does the object do? Who was involved in the design and production of the object?	**Author and You** What solutions does this object offer? How did people in different occupations work together to develop this object?
Think and Search What has inspired the development of this object?	**On My Own** What ethical issues may arise as a result of using this object? Explain your answer. How could these issues be resolved?

Appendix 1: Additional Resources

Queensland Museum Learning Resources

STEM Video: Adaptations and the Environment, Dr Paul Oliver
Explore the various adaptations that allow animals, particularly birds, to fly. This video is presented by Dr Paul Oliver, Senior Curator of Vertebrates at Queensland Museum and features specimens from the Museum's Mammals and Birds Collection.

On the Wing: Exploring Aspect Ratio
Calculate the aspect ratio of various wings from Queensland Museum's Mammals and Birds collection, then explore how aspect ratio influences the flight of birds and improves their chances of survival within their environment.

Wild State Teacher Resource
Contains an overview of the *Wild State* exhibition space, key teaching points for each habitat, a glossary, and curriculum links.

Queensland Museum Loans Kits

Animals in Flight
Explore the features of Australian animals in flight.

Animals in Disguise
Explore features of Australian animals that help them to hide in their environment.

Arid Adaptations
Investigate adaptations of plants and animals that survive in Queensland's arid environments.

Skulls: Queensland Birds
Explore the skulls of Queensland birds.

Queensland Museum Publications

Raptors of Southern Queensland
Contains information about almost 50 species of raptor living in Southern Queensland.

Queensland Museum Apps

Queensland Museum Network Field Guide to Queensland Fauna
This app holds descriptions of over 560 species encompassing birds, fishes, frogs, lizards, snakes, mammals, turtles, freshwater, marine and terrestrial invertebrates, spiders and insects. Detailed descriptions of animals, maps of distribution and endangered species status combine with images to provide a valuable reference that can be used in urban, bush and coastal environments.
Our scientists will continue to add new species and refine this app over time.


QGC | FUTUREMAKERS | QUEENSLAND MUSEUM NETWORK | Queensland Government