

Unit 10

**“Pioneer Australians
(& Resourcefulness)”**

Grades
7-10



SCIENCE



Science & Technology (Grades 7-10) – Unit 10

“Pioneer Australians (& Resourcefulness)”

SUMMARY:

This 8-week Science & Technology course for Years 7–10 explores how principles of energy, materials, forces, and design can be applied in practical and resourceful ways, especially in off-grid or pioneer-style living. Each week connects scientific concepts with real-world challenges faced by early Australians – such as sourcing clean water, staying warm, cooking without modern appliances, building simple machines, and signalling for help. Students investigate electricity and magnetism through hands-on tasks and invented tools using basic circuits, switches, and magnetic force. The focus was always on using science to solve problems with creativity and efficiency.

Rooted in the theme of *resourcefulness*, the course encourages students to think like pioneers and survivalists – working with what they have, thinking critically, and inventing solutions for shelter, warmth, safety, and communication. Biblical connections in each lesson affirm that using our God-given intellect and creativity to serve others and steward the earth is a way of reflecting His wisdom and provision. The course ends with a final invention challenge that brings together everything students have learned, empowering them to design, build, and reflect as young innovators equipped for both science and life.

RESOURCES:

All the information you need is included within the informational story in each lesson plan. The hands-on or creative activities are designed to use materials you will likely have already in your home, but you should maintain some art and craft materials. Each child will also need a Science Journal (i.e., a lined exercise book or Botany book for writing responses to questions, nature-study or experiment notes, and planning creative projects. It is also helpful to have a good dictionary.

Three lessons a week will provide the basic learning. To enjoy a richer learning experience, you could supplement the lessons with extra books about the topics in this unit, from your local library.

Some suggestions for extra reading include but are not limited to...

- To be advised

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TOPIC 1	PIONEER RESOURCEFULNESS

Lesson 1.1: How the Pioneers Built Their Homes

Theme: Structures & Materials

Focus Trait: Resourcefulness – Designing with limited materials

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions
- **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies

Lesson Overview

In this lesson, students explore how early Australian pioneers used local materials to construct weather-resistant, functional homes. Students will apply knowledge of **materials science**, **structural engineering**, and **environmental design** to analyse and redesign a pioneer-era shelter for modern use, using the principle of **resourcefulness** – making the most of what is available.

Learning Intentions

Students will:

- Understand the constraints and challenges faced by pioneer builders
- Investigate material properties such as durability, insulation, water resistance, and availability
- Design a functional small shelter using limited materials and natural environmental advantages
- Reflect on how constraints can lead to innovation

Introduction (*Tutor or Self-Study Prompt*)

“In the early days of colonisation, pioneers had no access to hardware shops, steel beams, or imported timber. They had to use what they could find (such as bark, mud, stone, and bush timber) to build homes that kept them safe from rain, wind, heat, and insects. Let’s explore how design thinking, environmental knowledge, and resourcefulness came together to shape their solutions.”

Science & Tech Background

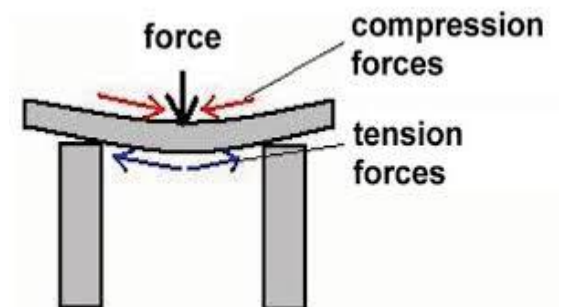
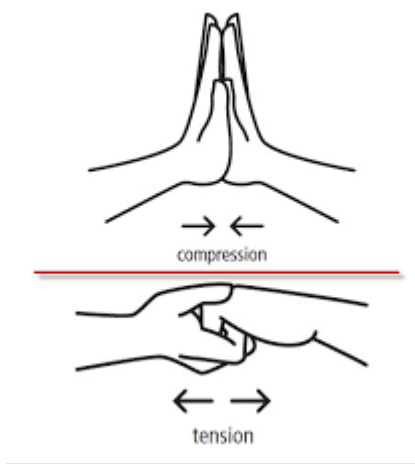
In this section, students will explore four key science and technology concepts that pioneer builders used, often intuitively, when creating homes that were safe, strong, and suited to the Australian environment.

1. Structural Strength and Stability

When building a home or shelter, you can't merely stack materials. You also need to understand **how force is distributed** and how materials hold weight or resist pressure.

- **Compression and Tension:**

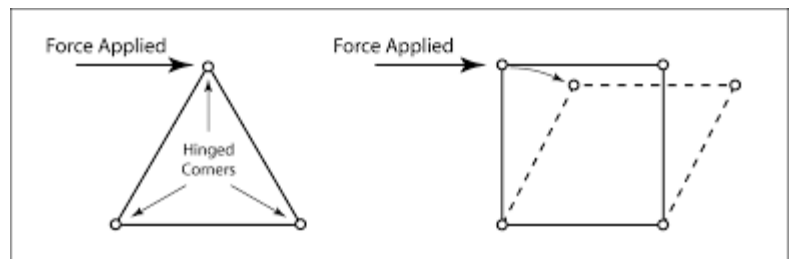
- Compression pushes things together (e.g., weight on a roof compresses the walls).
- Tension pulls things apart (e.g., the wind pulling on a roof or a wall leaning outward).



- Good shelter design balances both.

- **Shapes That Support Weight:**

- **Triangles** are stronger than squares. A square frame can collapse into a rhombus without support, but a triangle stays rigid.



- Pioneers often used **cross-bracing** – placing sticks or beams diagonally – to prevent wobbling or collapse.

- **Foundations:**

- A flat, solid base prevents structures from leaning or sinking.
- Pioneers used stone or timber footings to keep walls off the ground and prevent rot or insect damage.

Hands-on Tip: Use paper straws or matchsticks to build triangle vs. square frames and test with weights.

◆ 2. Material Properties and Selection

Different materials behave differently depending on their **physical properties**. Pioneers had to choose materials based on availability and performance.

Property	Why it matters for building	Example Materials Used by Pioneers
Durability	Resistance to weather, pests	Ironbark, stringybark, stone
Flexibility	Bending without breaking	Saplings, green branches
Insulation	Keeping heat in or out	Mud bricks, bark, grass thatch
Weight	Affects portability, stability	Stone (heavy), bark sheets (light)
Water Resistance	Prevents rotting or leaks	Tree resin, layered bark, corrugated iron (later periods)



- Many pioneer homes were made from **wattle and daub**: woven branches (wattle) plastered with mud (daub) for wall insulation.
- **Thatch roofs** were made from long grass or bark sheets laid in overlapping layers to shed water.

◆ 3. Thermal Properties and Environmental Adaptation

Australian pioneers faced **extreme weather**: scorching heat, freezing nights, strong winds, and heavy rain.

- **Thermal Mass:**
Materials like stone, brick, or mud absorb heat during the day and release it at night. This helps **regulate indoor temperature**.
- **Insulation:**
Air pockets in materials like grass, fur, or layered bark slow down heat transfer, keeping homes warmer in winter and cooler in summer.
- **Ventilation and Shade:**
 - Openings near the roof allowed hot air to escape.
 - Verandas and eaves shaded walls and windows.
 - Bush homes were often oriented to **catch breezes** and **avoid direct western sun**.
- **Earth Berming:**
Building partially into hillsides or with thick earthen walls improved insulation and temperature stability.

◆ 4. Sustainable Design and Local Materials

Because resources were limited, pioneers used what was on hand – and this often led to **early forms of sustainable design**.

- **Minimising Transport:**
 - Building materials were usually sourced from the immediate area (e.g., trees from the property, mud from the riverbank).
 - This reduced energy use and was a necessity due to transport limitations.
- **Using Renewable Materials:**
 - Bark regrows, saplings replenish, and stone is abundant.
 - No plastics or synthetic insulation – everything came from the natural world.
- **Repurposing and Repair:**
 - Broken tools or wagon parts were reused in homes or sheds.
 - Old tin, fencing wire, or sacks might become roofing patches, insulation, or curtains.

Connection to Today:

Modern sustainable housing often reuses these same principles – local materials, natural insulation, passive heating/cooling, and low-waste design.

Summary for Students

Pioneer homes were built not just with wood and stone, but with **ingenuity, observation, and creativity**. The science behind their building choices can teach us how to:

- Think about forces and shapes
 - Choose the right material for the job
 - Work with – not against – the environment
 - Design with limited tools and abundant thought
-

Practical Task – Design & Build a Shelter Model

Challenge:

Design a small-scale model of a pioneer shelter that could withstand **rain, wind, and heat** using only a limited selection of materials.

Materials (choose 5–7):

- Bark (or paper as a stand-in)
- Twigs, leaves, cardboard
- Mud/clay (or modelling clay)
- Cloth/fabric
- Stones
- String or thread
- Glue, tape (to simulate fastenings)

Example Model:



Steps:

1. **Plan:** Draw a design based on your understanding of insulation, structural strength, and local materials. Label features that improve the shelter's function.
 2. **Build:** Construct a model to scale (shoebox-size or smaller).
 3. **Test:** Simulate wind (fan), rain (spray bottle), and sun (warm light or heater at distance).
 4. **Evaluate:** How did your design perform under conditions? What would you improve?
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Engineer's Reflection Report (Years 9–10)

Write a one-paragraph explanation covering:

- What materials you used and why
 - How the shape/structure supported strength and weather resistance
 - What parts failed or succeeded in your test
 - How you would improve the design with more time or resources
-

Thinking Questions

- How did pioneers use natural insulation and shade to stay warm or cool?
 - What are modern examples of homes built with local, renewable materials?
 - What role does **resourcefulness** play in today's sustainable design and disaster housing?
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Biblical Connection

Proverbs 24:3–4 – “By wisdom a house is built, and through understanding it is established; through knowledge its rooms are filled with rare and beautiful treasures.”

Resourcefulness, creativity, and wisdom go hand-in-hand. When we use the materials God has provided wisely and generously, we reflect His design and care.

Assessment Opportunities

- Group discussion or journal entry on structural design decisions
 - Model construction and documentation
 - Peer feedback or oral explanation of design choices
-

Lesson 1.2: Cooking Without a Kitchen

Theme: Heat Transfer & Chemical Change

Focus Trait: Resourcefulness – Creating heat and meals with minimal equipment

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U03** – Investigate changes that can be observed as materials are heated and cooled, and whether the changes are reversible
 - **AC9TDE8K02** – Analyse how food and fibre are produced when designing managed environments
 - **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies
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Learning Intentions

Students will:

- Understand how heat is transferred through different materials and methods
 - Identify physical and chemical changes in cooking processes
 - Use design thinking to simulate bush-cooking techniques without access to conventional kitchen tools
 - Develop a practical appreciation for safe, resourceful methods of food preparation in remote or emergency settings
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Introduction (*Tutor or Self-Study Prompt*)

“Imagine it’s the 1800s. You’re in the bush with no kitchen, no microwave, no saucepan, and no electric stove. How would you boil water, roast food, or keep things warm? Early pioneers had to invent ways to cook using sticks, hot stones, foil, coals, and clever heat-trapping methods. In this lesson, you’ll learn how to cook using only what nature (and your brain) provides.”

Science & Tech Background

This section introduces students to key scientific principles involved in bush-style cooking.

◆ 1. Heat Transfer Methods

Heat moves in three ways:

- **Conduction:** Direct contact with a hot object
– e.g., placing foil-wrapped damper into hot coals
- **Convection:** Heat transfer through moving fluids or gases
– e.g., hot air circulating around food in a bush oven

- **Radiation:** Heat traveling through electromagnetic waves
– e.g., sunlight warming a dark rock or food cooked near flames

Materials conduct heat differently:

- Metals like iron and aluminium conduct heat quickly
 - Wood and clay are slow conductors (good for insulation)
 - Water stores and distributes heat through convection
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♦ 2. Physical vs. Chemical Change in Cooking

Cooking often involves changes that cannot be reversed:

- **Boiling water:** Physical change (reversible) – change of state
- **Cooking damper or meat:** Chemical change (irreversible) – new substances are formed (browning, bubbling, texture change)

Chemical indicators in cooking:

- Change in colour (e.g. golden brown crust)
 - Change in smell (e.g. cooked aroma)
 - Release of gas (e.g. steam from batter)
 - Change in structure (e.g. from soft dough to solid bread)
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♦ 3. Thermal Insulation and Bush Oven Design

Pioneers and Aboriginal peoples used simple but effective thermal design:

- **Hot rocks** heated in fire were used to cook food in pits (like steam ovens)
- **Tripods** made from sticks allowed food to be suspended over flames or coals
- **Earth insulation** (burying food or surrounding it with mud or clay) helped retain heat
- **Foil or clay wrappings** protected food and trapped moisture

Design tip: Cooking over **coals** rather than open flame gives more even, gentle heat.

♦ 4. Fuel Sources and Safety

Bushfires and burns were real risks for early settlers. They learned:

- Which woods burned hottest and longest (e.g., hardwood vs. softwood)

- How to control airflow with rocks and pit walls
- To always cook in cleared areas away from grass, wind, or loose bark

Modern bush-crafters still use these safety techniques in survival scenarios.

Practical Task – Bush Cooking Simulation

Task Options (Choose One):

Option A: Build a Bush Cooking Setup

- Design a tripod stand, suspended grill, or cooking foil packet.
- Use natural or recycled materials (sticks, coat hangers, rocks, foil).
- You may simulate the heat source (e.g., lamp or warm rocks) for safety.



Option B: Cook a Simple Damper

- Mix flour, salt, and water into dough.
- Wrap in foil or place on a stick and cook over coals or simulate with oven.
- Observe how the dough changes and write about the science behind it.



Option C: Design a Bush Oven

- Draw a diagram of a traditional bush cooking setup (e.g. stone oven, hot rock pit).
 - Label heat sources, methods of heat transfer, and materials used.
 - Explain in 1 paragraph how it works and what makes it efficient.
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Reflection Journal Prompts

- What materials helped conduct or retain heat in your design?
 - What cooking method (boiling, roasting, steaming) worked best and why?
 - How could this system be improved if you had different materials?
-

Discussion Questions

- Why is resourcefulness important when cooking in survival or remote conditions?
 - What are the risks of using fire for cooking, and how can they be reduced?
 - How can we apply bush-cooking science in emergency or low-income settings today?
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Biblical Connection

John 21:9–12 – “When they landed, they saw a fire of burning coals there with fish on it, and some bread... Jesus said to them, ‘Come and have breakfast.’”

Even the Son of God used simple tools – fire, fish, and bread – to feed and care for others. When we cook with gratitude and ingenuity, we reflect His resourcefulness and hospitality.

Assessment Opportunities

- Observation of cooking demonstration or build task
- Engineering-style report on cooking method or oven design
- Scientific explanation of the heat transfer process during cooking

Lesson 1.3: Water Supply and Rainwater Collection

Theme: Hydrology, Filtration, and Environmental Design

Focus Trait: Resourcefulness – Finding, collecting, and purifying water in rural or emergency settings

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8H01** – Investigate water as an important resource, the water cycle, and the influence of environmental factors on water availability
- **AC9TDE8P02** – Generate and communicate design ideas, plan and evaluate designed solutions
- **AC9S8U01** – Examine physical and chemical properties of materials used in water filtration and storage

Learning Intentions

Students will:

- Understand how water can be sourced, collected, stored, and purified using simple technology
- Identify environmental factors affecting water availability and quality
- Explore filtration and evaporation techniques appropriate for pioneer or off-grid conditions
- Design a working or model rainwater collection and purification system

Introduction (*Tutor or Self-Study Prompt*)

"Imagine living on a remote pioneer homestead – no plumbing, no water delivery, and no town taps. If it didn't rain, your water didn't come. Pioneers had to build clever rainwater tanks, dig soaks near creeks, and filter their water using charcoal and sand. Today we'll explore how water can be collected and purified without electricity or modern filters – just smart thinking and basic materials."

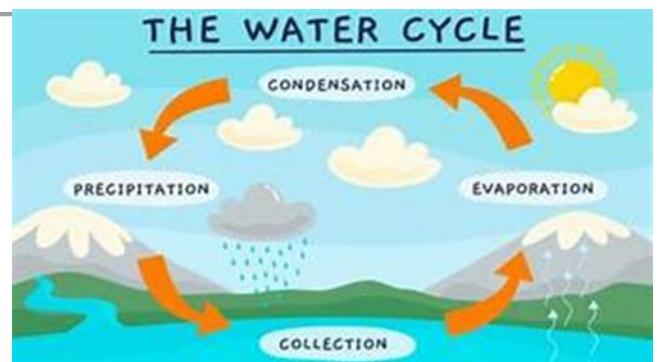
Science & Tech Background

This lesson covers concepts from **hydrology**, **material science**, and **environmental engineering**, showing students how to manage and purify water in real-world conditions.

◆ 1. Water Availability and the Natural Water Cycle

Water moves through Earth's systems via:

- **Evaporation** – sun heats water into vapour
- **Condensation** – water vapour cools into clouds
- **Precipitation** – water falls as rain, snow, etc.



- **Runoff and Infiltration** – water flows over land or soaks into the ground

Pioneer settlers relied on:

- **Rainwater tanks** to collect roof runoff
- **Creeks and rivers** for surface water
- **Wells** for groundwater
- **Dams** for livestock and basic irrigation

But these sources were vulnerable to drought, pollution, and evaporation.

♦ 2. Design Principles for Rainwater Collection

To collect water effectively, three things are needed:

1. **Catchment Surface** – e.g. roof or tarpaulin
2. **Guttering/Channels** – to direct water into storage
3. **Storage** – barrels, clay pots, underground tanks

Water collection is improved by:

- Placing storage tanks at a low point (gravity-fed)
 - Using first-flush diverters to remove roof debris
 - Shading tanks to reduce algae growth
-

♦ 3. Filtration and Purification Techniques

Water purification involves removing:

- Physical contaminants (dirt, leaves, insects)
- Chemical residues (pesticides, heavy metals)
- Microorganisms (bacteria, viruses)

Simple bush filters use:

- **Gravel** – traps large particles
- **Sand** – removes smaller particles
- **Charcoal** – absorbs impurities and odours
- **Cloth or mesh** – for initial straining



Boiling kills pathogens. **Solar stills** can purify water via evaporation and condensation.

◆ 4. Modern Applications from Historical Ideas

Many pioneer techniques still inform rural or survival water systems:

- Off-grid properties use rain tanks and sand filters
 - Emergency kits include charcoal filter straws
 - Solar stills are used in remote and arid regions
-

Practical Task – Build or Design a Water System

Option A: Build a Rainwater Filter (with adult supervision)

Materials: Plastic bottles, gravel, sand, activated charcoal, cloth, rubber bands

1. Cut the bottle and invert it as a funnel
2. Layer gravel, sand, and charcoal inside
3. Pour muddy water through and observe
4. Optional: Use food dye, oil, or small leaves to test filtration

Option B: Design a Rainwater Collection System

Draw a labelled diagram of:

- A sloped roof or tarp for collection
- Guttering or tubes
- First-flush diverter
- Covered tank
- Optional filtration stage

Include a 1-paragraph explanation of how it works and what makes it resourceful.

Option C: Make a Solar Still (advanced/supervised)

Use plastic wrap, a bowl, and a cup in a sunny spot to show water evaporation and condensation.

Reflection Journal Prompts

- What method worked best to clean or collect water?
 - How could you improve this system for a longer stay in the bush?
 - What risks or challenges would pioneers have faced when using these methods?
-

Discussion Questions

- Why is clean water one of the first priorities in survival or remote living?
 - How do the water challenges pioneers faced relate to water shortages today?
 - Can you think of other natural materials that might help purify or store water?
-

Biblical Connection

Isaiah 41:17–18 – “I will make rivers flow on barren heights, and springs within the valleys. I will turn the desert into pools of water, and the parched ground into springs.”

God promises to provide even in dry places – and calls us to be wise and grateful stewards of the water He gives. Learning how to collect and protect water is an act of honouring His provision.

Assessment Opportunities

- Working filter system (functionality and structure)
- Diagram and written design explanation
- Written scientific explanation of the filtration process
- Comparison of pre- and post-filtration water samples (visually or via pH strips)

Lesson 2.1: The Science of Lifting Heavy Things (Levers)

Theme: Mechanical Advantage & Force

Focus Trait: Resourcefulness – Using simple tools to do difficult work

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S7U04** – Investigate the effects of applying different forces to familiar objects
- **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions
- **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies

Learning Intentions

Students will:

- Understand how **levers** reduce effort and increase lifting power
- Investigate the relationship between **force, load, fulcrum, and distance**
- Apply design thinking to create a working lever that pioneers might have used
- Learn how simple machines contribute to modern mechanical engineering

Introduction (*Tutor or Self-Study Prompt*)

“When pioneers needed to move heavy rocks, lift timber beams, or raise buckets from a well, they didn’t have motors or hydraulics – they used simple machines. One of the most powerful was the **lever**. With just a plank and a pivot point, they could lift something many times their weight. Let’s explore how these clever tools work.”

Science & Tech Background

◆ 1. What is a Lever?

A **lever** is a rigid bar resting on a pivot point called a **fulcrum**. When you push down on one end (effort), the other end moves up (load). The further the effort is from the fulcrum, the **less force** is needed.

Key parts of a lever:

- **Load** – The object being lifted
 - **Effort** – The force you apply
 - **Fulcrum** – The pivot point the bar turns on
-

◆ 2. The Three Classes of Levers

Class	Example	Order of Parts (E, F, L)
1st	Seesaw, crowbar	Effort – Fulcrum – Load
2nd	Wheelbarrow	Fulcrum – Load – Effort
3rd	Fishing rod	Fulcrum – Effort – Load

- **First-class levers** are balanced and adjustable
 - **Second-class levers** reduce effort needed for heavy loads
 - **Third-class levers** give speed or precision but require more force
-

◆ 3. Mechanical Advantage

Mechanical Advantage (MA) is a measure of how much a machine multiplies your effort.

For levers:

$$\text{MA} = \text{Effort arm length} \div \text{Load arm length}$$

So:

- If your effort arm is longer, it's easier to lift the load
 - Pioneers used long branches and logs to lift heavy items by positioning fulcrums wisely
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◆ 4. Material Strength and Lever Design

- A lever must be **strong** enough not to snap
- The fulcrum must be **stable** to avoid tipping
- Early settlers used hardwood, rocks, fence posts, or logs
- They reused wagon axles or branches for tools and lifts

Today, engineers apply the same lever principles in tools, excavators, gym equipment, and robotics.

Practical Task – Build and Test a Lever

Option A: Build a Simple Lever Materials: ruler or plank, rubber, rock or book for fulcrum, weights (rocks, washers, coins)

1. Set up a first-class lever with a centre fulcrum
2. Measure and adjust the arm lengths
3. Try lifting various objects
4. Record:
 - Arm lengths
 - Object weight
 - Force required

Option B: Pioneer Challenge – Lift a Heavy Load Design a lever to lift a 2–5kg object (e.g., a brick, full bottle).

- Use only basic materials: wood, string, rocks
- Experiment with arm lengths and fulcrum positions
- Can it lift with one finger?

Option C: Diagram and Analysis Draw diagrams of all 3 classes of levers.

Label:

- Fulcrum, load, effort
- Direction of force
- Mechanical advantage type (speed vs force)

Engineer's Reflection Prompt

- What type of lever did you build?
- Where was the fulcrum and how did its position affect the effort?
- What could be improved in your design?
- How did pioneers solve heavy lifting problems using what was available?

Discussion Questions

- Why do longer effort arms make lifting easier?
 - How is a lever different from just pushing something with brute force?
 - What tools today are based on simple lever designs?
-

Biblical Connection

Ecclesiastes 10:10 – “If the axe is dull and its edge unsharpened, more strength is needed, but skill will bring success.”

God calls us to use wisdom – not just strength – to do our work. The lever is a perfect picture of using **intelligence and design** to work efficiently. Resourcefulness means using our minds as well as our muscles.

Assessment Opportunities

- Video or photo of lever in action with measured outcomes
 - Report calculating mechanical advantage
 - Comparison of different lever types with real-world examples
 - Peer feedback on design and improvements
-

Lesson 2.2: Water Wheels and Cranes (Pulleys and Gears)

Theme: Mechanical Systems & Energy Transfer

Focus Trait: Resourcefulness – Using simple machines to harness power and move loads

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
- **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions
- **AC9TDE10P02** – Develop, modify and communicate design ideas for effective solutions to problems

Learning Intentions

Students will:

- Understand how **pulleys, gears, and water wheels** transform and transfer energy
- Identify how mechanical advantage makes lifting or powering easier
- Build or simulate a basic pulley system or water-powered machine
- Reflect on how early pioneers used simple machines to power work using nature

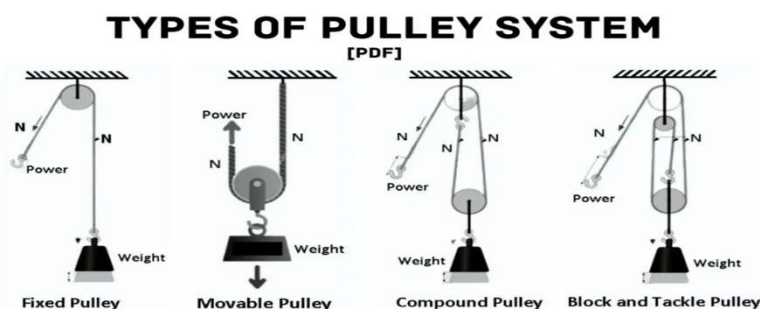
Introduction (*Tutor or Self-Study Prompt*)

"Pioneers didn't have electricity. But they still needed to lift hay into lofts, haul water from deep wells, and move heavy loads. And sometimes, they even used the flowing creek to power small machines. By using **pulleys, gears, and water wheels**, they turned basic physics into farm solutions. In this lesson, we'll explore how they did it – and how we still use the same principles today."

Science & Tech Background

◆ 1. Pulleys: Changing the Direction of Force

A **pulley** is a wheel with a groove for rope or chain. It's used to lift loads.



- **Fixed Pulley:** Changes direction of force (you pull down to lift up)
- **Movable Pulley:** Reduces the amount of force needed
- **Compound Pulley (Block and Tackle):** Combines both for large mechanical advantage

Mechanical Advantage of Pulleys:

Number of rope sections supporting the load = Force multiplier
(E.g., 2 supporting ropes = lift with half the force)

Pioneers used pulleys to:

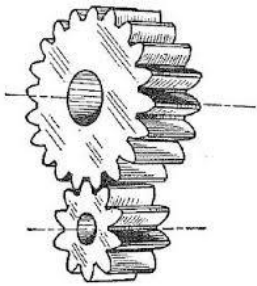
- Haul water from deep wells
- Lift hay into barns
- Raise loads into carts or wagons

◆ 2. Gears: Transferring Force and Changing Speed

Gears are wheels with teeth that mesh together.

- **Large gear to small gear** = more speed, less torque (a force that tends to cause rotation)
- **Small gear to large gear** = more force, less speed
- **Same size gears in opposite directions**
- **Idler gears** transmit motion between non-touching gears

Gears were used in:



- Hand-powered grindstones
- Early sewing machines
- Water-powered mills

Gear Ratio = Teeth on output gear ÷ Teeth on input gear

◆ 3. Water Wheels: Capturing Natural Energy

Water wheels turn flowing water into rotary motion.

- **Undershot wheel:** Flowing water pushes the bottom paddles
- **Overshot wheel:** Water pours over the top for more power (gravity + flow)
- **Breastshot wheel:** Water hits the middle

Water wheels powered:

- Millstones for grinding grain
- Bellows for forges
- Simple fans or machines

They used **no fuel**, just flowing water – an early example of **renewable energy**.



◆ 4. Systems Thinking: Combining Machines

Pioneers combined machines for practical work:

- **Pulley + Windlass** to raise heavy buckets
- **Gear + Crank** for hand-grinding or turning tools
- **Water Wheel + Gear Train** for rotational work

Understanding **how machines connect and convert energy** is a key engineering skill.

Practical Task – Build a Machine Model

Option A: Build a Simple Pulley Lift

Materials: String, spools or toy wheels, coat hangers, small weights

1. Set up a fixed pulley and try lifting
2. Add a movable pulley and compare effort
3. Record number of supporting ropes and force required

Option B: Design and Build a Model Water Wheel

Materials: Cardboard, skewers, spoons, plastic lids, cup of water

1. Build a wheel that turns with falling or flowing water
2. Connect it to turn a simple crank or fan
3. Observe how flow affects speed and torque

Option C: Gear Demo

1. Create paper or cardboard gears with interlocking teeth
 2. Show how gear size and direction change speed or effort
 3. Optional: use LEGO gears if available
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Engineer's Reflection Prompt

- Which machine (pulley, gear, or water wheel) was most effective or interesting?
 - What materials worked well or failed in your build?
 - How might a pioneer have built this same machine with only what was around them?
 - Could your system be scaled up to do real work?
-

Discussion Questions

- How do machines make work easier without adding strength?
 - What are the benefits of using water power instead of fire or fuel?
 - How is a pulley like a modern-day crane or elevator?
 - Where do we still see water wheels or gears today?
-

Biblical Connection

Proverbs 14:23 – “All hard work brings a profit, but mere talk leads only to poverty.”

Machines don't remove the need for work – but they make it **more fruitful**. Resourcefulness means working wisely – not just hard – and using God's creation in thoughtful, creative ways.

Assessment Opportunities

- Build-and-test demonstration of a pulley or wheel
- Design drawing and system explanation
- Oral presentation or written report describing energy transfer
- Peer feedback and engineering iteration journal

Lesson 2.3: Make Your Own Machine – Invent Like a Pioneer

Theme: Engineering Design & Applied Mechanics

Focus Trait: Resourcefulness – Solving problems creatively using simple systems

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies
 - **AC9TDE10P02** – Develop, modify and communicate design ideas for effective solutions to problems
 - **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
-

Learning Intentions

Students will:

- Combine prior knowledge of levers, pulleys, and gears to develop a custom-designed simple machine
 - Follow an iterative engineering process to solve a practical challenge
 - Use visual communication (diagrams, models, labels) to present ideas
 - Reflect on how limitations (materials, tools, environment) encourage creativity
-

Introduction (*Tutor or Self-Study Prompt*)

“Pioneers didn’t have factories or warehouses – but they were surrounded by **needs**. They needed to lift hay, haul water, grind grain, open heavy gates, or power simple tools. When there was no machine to help, they made one. In this challenge, you’ll invent a new machine – just like a pioneer might have – with the knowledge and materials you already have.”

Science & Tech Background

This final lesson in the unit brings together everything learned about simple machines, energy, and design.

♦ 1. Engineering Design Cycle

The process followed by engineers (and pioneers!) is:

1. **Identify the Problem** – What needs to be done? (e.g. lift, move, grind, power)
2. **Imagine and Plan** – What machines could help? What materials are available?
3. **Create and Build** – Test your idea, build a model
4. **Evaluate** – Did it work? What could be better?
5. **Improve** – Adjust and rebuild for better performance

◆ 2. Combining Simple Machines into Systems

You may choose to combine:

- **Levers** for lifting or prying
- **Pulleys** for lowering/raising
- **Gears** for changing speed or direction
- **Cranks** to turn motion into rotation
- **Wheels and axles** for movement

These combinations appear in:

- Well lifting systems
- Horse-powered grain mills
- Clothes wringers
- Wagon mechanisms

◆ 3. Energy Transfer in Mechanical Systems

Energy in your machine may come from:

- **Human power** (pushing, pulling, cranking)
- **Gravity** (falling objects, counterweights)
- **Elastic energy** (rubber bands, spring sticks)
- **Flowing water or wind** (optional or theoretical)

Look for where energy enters, moves, changes direction, or is used to do work.

Practical Task – Invent Like a Pioneer

The Challenge:

Design and build a working model of a pioneer-style machine that solves a useful problem.

Examples:

- A **crane** to lift a bucket (pulleys + levers)
- A **grain grinder** using gears
- A **log lifter** using a long lever
- A **door or gate opener**
- A **simple fan** powered by a hand crank

Materials (choose based on safety/availability):

- Cardboard, dowels, string, spools, paper, pegs, rubber bands
- LEGO or recycled building kits
- Optional: Water flow (outdoors), fans, clay weights

Steps:

1. **Sketch** your idea first (label parts and energy flow)
 2. **Build** a prototype (small model is fine)
 3. **Test** it for function
 4. **Evaluate** and suggest improvements
-

Engineer's Project Report (Years 7–10)

In your report, include:

- What problem your machine solves
 - How it works (use scientific terms)
 - What simple machines or mechanisms are included
 - What didn't work and what you'd improve
 - A diagram or labelled photo of the final model
-

Discussion Questions

- What problem did you solve with your machine?
 - How did your design reflect the principle of resourcefulness?
 - If you lived 150 years ago, what materials might you have used instead?
 - What modern inventions use similar systems today?
-

Biblical Connection

Exodus 35:31–32 – “[The Lord] has filled him with the Spirit of God... to make artistic designs... to work in wood, and to engage in all kinds of crafts.”

Creativity, problem-solving, and practical skill are gifts from God. When we invent with purpose – to help, build, or improve life – we reflect His wisdom and care for others.

Assessment Opportunities

- Final machine build (model or drawing)
- Oral or written report explaining the design
- Diagram showing energy flow or machine parts
- Peer evaluation: "Would this be useful on a pioneer farm?"

TOPIC 3	ABORIGINAL TOOLS & MEDICINES

Lesson 3.1: Aboriginal Tools, Weapons & Tracking

Theme: Physics of Motion, Material Science, and Traditional Engineering

Focus Trait: Resourcefulness – Using natural materials and deep observation to design effective tools

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S7H01** – Investigate how First Nations Australians’ knowledge systems and technologies inform scientific understanding
- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
- **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions

Learning Intentions

Students will:

- Investigate how Aboriginal peoples used natural materials and energy principles to craft highly effective tools and weapons
- Explore the science of force, flight, motion, and balance in traditional technologies such as spears, woomeras, and boomerangs
- Understand tracking as an advanced form of environmental observation and pattern analysis
- Reflect on the role of resourcefulness, precision, and deep environmental knowledge in Indigenous innovation

Introduction (*Tutor or Self-Study Prompt*)

"Long before pioneers arrived, Aboriginal peoples were using sophisticated technologies to survive, hunt, build, and communicate. Without factories or metal, they designed tools that could fly, spin, dig, and strike with precision. They read the land like a storybook and used physics in ways we still study today. This lesson explores the traditional knowledge and science behind some of these remarkable inventions."

Science & Tech Background

◆ 1. Projectile Motion and Aboriginal Weapons

Aboriginal weapons were carefully designed based on the physics of **force**, **trajectory**, **rotation**, and **aerodynamics**.

- **Spears** – Thrown by hand or using a **woomera** (spear-thrower), which adds leverage.
 - A woomera increases the throwing arm's length, multiplying force and distance.
 - This is a real-world use of a **third-class lever**.
- **Boomerangs** – Often curved and asymmetrical for stable flight.
 - Returning boomerangs use **aerodynamic lift** and **angular momentum** (spinning motion) to curve back.
 - Non-returning boomerangs were used for hunting and hitting targets.



Physics principles involved:

- Newton's Laws of Motion
- Lever mechanics
- Spinning torque and gyroscopic stability
- Energy transfer from the thrower to the object

◆ 2. Material Selection and Adaptation

Every tool was made using **locally available** materials. Design was adapted to the local environment and species.

Tool	Common Material	Reason for Selection
Spears	Hardwood, reeds	Lightweight, strong, straight
Boomerangs	Mulga, Blackwood	Dense, can be shaped and balanced
Woomera	Light hardwood, resin, sinew	Flexible but strong
Stone Axes	Basalt or greenstone	Tough and hard for cutting
Glue	Plant resin or spinifex	Flexible, heat-mouldable
Cordage	Animal sinew, tree bark fibre	Strong, flexible

Students learn how **material properties** (hardness, elasticity, density) influence performance.

◆ 3. Tracking: Applied Observation and Inference

Aboriginal trackers read tiny signs in the landscape – animal prints, broken twigs, disturbed sand, and even scent trails.

This requires:

- **Pattern recognition**
- **Environmental awareness**
- **Deductive reasoning**

In science, this mirrors how we:

- Form and test hypotheses
- Gather clues and data
- Reconstruct sequences of events (like in forensic science or ecology)

Tracking is both an **art** and an advanced form of **environmental data analysis**.

◆ 4. Respecting Indigenous Knowledge Systems

Aboriginal engineering and observation are forms of scientific knowledge passed down through story, practice, and experience – not textbooks.

These systems:

- Are deeply **place-based** (adapted to local landforms, animals, and plants)
 - Demonstrate **sustainability** and resource stewardship
 - Involve **trial, refinement, and innovation** over generations
-

Practical Task – Build or Analyse a Traditional Tool

Option A: Build a Mini Boomerang or Throwing Stick

- Use cardboard or thin balsa wood
- Test how shape and angle affect flight
- Record: flight distance, return curve, and stability
- Reflect: Why do some shapes spin better than others?

Option B: Spear and Woomera Model

- Build a model using skewers or sticks
- Add an extended throwing arm (like a woomera)
- Test with soft weights (e.g. rubber or clay tip)

- Measure and compare throw distance with and without the woomera

Option C: Environmental Tracking Challenge

- Create a “tracking trail” in soil or sand with various animal feet, tools, or hidden signs
- Trade trails and try to interpret what happened
- Reflect on the types of evidence used to reconstruct movement or events

Reflection Prompts

- What did your model reveal about force or motion?
- How does traditional engineering compare to modern design?
- How did Aboriginal peoples show ingenuity and resourcefulness using only what was around them?

Discussion Questions

- Why are spinning and balance important in throwing tools?
- How do you think Indigenous tools were tested and refined over generations?
- What can modern engineers learn from Aboriginal knowledge systems?

Biblical Connection

Job 12:7–9 – “Ask the animals, and they will teach you... or speak to the earth, and it will instruct you.”

God teaches through creation. Aboriginal peoples learned by attentiveness, respect, and observation – wisdom that reflects a deep awareness of how God's world works. When we honour traditional knowledge, we also honour the Creator who designed it.

Assessment Opportunities

- Working tool model and performance notes
- Written explanation of the physics and material choice
- Tracking report: clues, conclusions, and reasoning
- Comparative diagram showing traditional vs modern equivalent tools

Lesson 2.2: Bush Medicines and Plant Knowledge

Theme: Chemistry of Natural Compounds & Sustainable Health Technologies

Focus Trait: Resourcefulness – Using observation and tradition to discover natural healing methods

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U01** – Examine the chemical properties of substances and their uses in everyday life
- **AC9S7H01** – Investigate how First Nations Australians' knowledge systems and technologies inform scientific understanding
- **AC9TDE8K02** – Analyse how food and fibre are produced and used sustainably in managed environments

Learning Intentions

Students will:

- Explore how Aboriginal peoples identified, processed, and applied medicinal plants
- Understand basic chemical concepts behind antiseptics, anti-inflammatory agents, and inhalants
- Investigate how traditional knowledge systems guide sustainable and ethical resource use
- Evaluate the relationship between natural chemistry and modern pharmacology

Introduction (*Tutor or Self-Study Prompt*)

"Long before laboratories and pharmacies, Aboriginal peoples were treating infection, pain, and sickness with natural remedies found in the bush. How did they know what plants to use? Careful observation, intergenerational wisdom, and respect for God's creation gave them deep insight into how plants could help the body. Today we'll explore bush medicine as a form of chemistry, healing, and resourcefulness."

Science & Tech Background

◆ 1. What Is Bush Medicine?



Bush medicine refers to the **traditional medical knowledge** of Aboriginal peoples – using native plants, resins, minerals, and animal products to treat illness and injury.

Treatments include:

- **Topical applications** (e.g. sap on wounds)
- **Inhalants** (e.g. steam from eucalyptus)
- **Teas and decoctions** (boiled leaves or bark)
- **Poultices** (crushed leaves wrapped on skin)

These are based on **chemical compounds** found in nature – some of which are used in modern medicine today.



◆ 2. Key Active Compounds in Plants

Natural Compound	Effect	Found In
Eucalyptol (cineole)	Clears airways, anti-inflammatory	Eucalyptus leaves
Tannins	Antiseptic, dries wounds	Wattle bark, tea tree
Menthol	Cooling, opens sinuses	Mint, some native mints
Alkaloids	Pain relief, anti-microbial	Some desert herbs
Saponins	Foaming, cleansing	Soap tree bark

Important chemistry terms:

- **Soluble** – Can dissolve in water (used in teas)
- **Volatile** – Evaporates easily (used in steam inhalants)
- **Antimicrobial** – Kills or slows bacteria or fungi
- **Astringent** – Tightens skin and reduces bleeding

◆ 3. Processing Techniques Used by Aboriginal Peoples

Processing methods were often **chemical in nature**, though done without modern lab tools:

- **Boiling**: To release volatile compounds (inhalants, teas)
- **Burning**: To release fumes and drive off harmful compounds
- **Soaking**: To soften bark, leach bitterness, or activate compounds
- **Grinding**: To break down fibres and release saps or oils
- **Fermenting**: In some regions, to preserve or activate nutrients

These methods demonstrate an understanding of **solubility**, **extraction**, and **reaction**.

◆ 4. Sustainability and Respect for the Environment

Traditional bush medicine was:

- **Sustainable** – Only small amounts harvested, with care
- **Contextual** – Based on what was growing in a region
- **Spiritual and practical** – Healing involved respect, story, and community

Modern science is increasingly turning back to **ethnobotany** – studying traditional plant use to develop new drugs, while also learning **ethical research** from First Nations communities.

Practical Task – Investigate Natural Compounds

Option A: Simulate a Traditional Tea or Inhalant (Supervised)

- Use mint, lemon myrtle, eucalyptus leaves (or store-bought equivalents)
- Steep in hot water and observe aroma, colour, taste
- Try inhaling steam with eucalyptus (careful of heat)
- Identify: What effects are felt? What might the compounds be?

Option B: Bush Medicine Research Poster

Choose a native Australian plant traditionally used as medicine.

Research:

- Where it grows
 - What part was used (leaf, bark, root)
 - What it treated
 - What modern science says about its chemistry
- Create a 1-page illustrated report or poster.

Option C: Chemistry Connection Table

List 5 everyday medicinal or hygiene products.

For each, find:

- Active chemical ingredient
 - What natural plant/compound it originally came from
 - Similarities to traditional Aboriginal use
-

Reflection Prompts

- How did traditional knowledge systems use chemistry without formal science tools?
 - What chemical properties make a plant useful for healing?
 - How should we respect and credit Indigenous knowledge in science?
-

Discussion Questions

- Why is boiling or steeping used in medicine preparation?
 - How can plant-based knowledge be both practical and sacred?
 - What are the risks and benefits of applying traditional knowledge in modern science?
-

Biblical Connection

Revelation 22:2 – “The leaves of the tree were for the healing of the nations.”

Psalms 104:14 – “He makes grass grow for the cattle, and plants for people to cultivate – bringing forth food from the earth.”

God has provided healing in creation. When we explore and use plants with humility and wisdom – like Aboriginal peoples have done for thousands of years – we honour both the creation and the Creator.

Assessment Opportunities

- Tea or inhalant test with recorded observations
- Research poster or infographic on native plant medicine
- Chemistry chart comparing traditional and modern remedies
- Journal reflection on Indigenous science and ethics

Lesson 2.3: Aboriginal Shelter and Survival Design

Theme: Environmental Engineering, Thermal Insulation, and Cultural Sustainability

Focus Trait: Resourcefulness – Adapting shelter design to climate, landscape, and local materials

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
 - **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions
 - **AC9S7H01** – Investigate how First Nations Australians’ knowledge systems and technologies inform scientific understanding
-

Learning Intentions

Students will:

- Explore how Aboriginal shelter designs reflect a deep understanding of thermal regulation, structural strength, and seasonal adaptation
 - Investigate materials and construction techniques based on geography and climate
 - Analyse traditional shelters using concepts of insulation, airflow, shading, and durability
 - Apply sustainable, climate-responsive design thinking to model a shelter
-

Introduction (*Tutor or Self-Study Prompt*)

“Aboriginal peoples lived successfully in every environment across Australia – deserts, rainforests, coasts, and highlands – without permanent buildings. Their shelters weren’t crude – they were **climate-adapted**, **locally sourced**, and **easily moved** when needed. In this lesson, we’ll explore how traditional shelter design applies principles of heat transfer, airflow, material science, and sustainability. You’ll design your own version of a survival shelter based on these ingenious ideas.”

Science & Tech Background

◆ 1. What Makes a Shelter Effective?

An effective shelter:

- Protects from **wind, rain, sun, and cold**
- Stays **cool in heat** and **warm in cold**
- Is built from **local, available materials**
- Can be **repaired or rebuilt** with ease
- Is **culturally and environmentally appropriate**

These goals are all solved using **simple science principles**.

◆ 2. Thermal Regulation in Shelters

Aboriginal shelters apply concepts of **heat transfer**:

Climate Type	Shelter Design	Science Principle
Desert	Open windbreaks with shade	Promote convection and radiation cooling
Rainforest	Elevated shelters with thatch roofs	Water runoff, airflow, and insulation
Temperate bush	Low domes with thick bark or grass	Thermal insulation, wind resistance
Alpine	Rock overhangs and wind shields	Retain radiant body heat, reduce conduction

Scientific concepts include:

- **Conduction** – Heat loss through ground or walls
- **Convection** – Managing airflow to cool or retain warmth
- **Radiation** – Blocking sun or reflecting body heat inward
- **Insulation** – Trapping air to slow heat exchange

◆ 3. Material Properties of Natural Shelter Resources

Traditional materials were:

- **Free** – harvested locally
- **Renewable** – reeds regrow, bark could be taken from live trees
- **Effective** – not chosen at random, but tested over time

Material	Use	Properties
Bark sheets	Roofs/walls	Water-resistant, insulative, light
Spinifex grass	Thatch	Airy insulation, dries quickly
Wattle branches	Frames	Flexible yet strong
Clay/mud	Wind shields	Mass for insulation and wind-blocking
Stone	Base, heat storage	Thermal mass and stability

◆ 4. Cultural and Seasonal Knowledge Systems

Aboriginal housing was:

- **Seasonal** – shelters changed with the weather
- **Minimalist and mobile** – for hunting, ceremony, movement
- **Landscape-based** – always connected to Country

This shows a **systems design mindset** – balancing comfort, movement, environmental care, and culture.

Modern architecture increasingly returns to:

- Passive heating/cooling

- Use of natural materials
- Localised climate response
- Minimal environmental impact

Practical Task – Design or Build a Survival Shelter

Option A: Build a Model Shelter

Materials: cardboard, twigs, leaves, string, cloth, paper, bark
Design your shelter for one of the following environments:

- Hot dry outback
- Tropical rainforest
- Windy grassland
- Cold alpine region

Design to manage heat, wind, and water.

Label:

- Insulating elements
- Water-shedding roof angles
- Airflow design
- Material choices



Option B: Draw a Shelter Diagram with Labels and Science Callouts

Sketch and annotate:

- Materials used and their properties
- Scientific strategies used (convection, radiation control, insulation)
- Cultural practices respected (mobility, local design)

Option C: Compare with Modern Shelter Design

Choose a tent, hut, or emergency shelter and compare:

- Weight and portability
- Weather resistance
- Energy efficiency
- Cultural/environmental impact

Write a short report: “What can modern design learn from traditional Aboriginal shelter knowledge?”

Reflection Prompts

- What part of your shelter design worked best to control heat or weather?
- How did Aboriginal knowledge show deep understanding of the land?
- How might your shelter change if you had to move it often?

Discussion Questions

- What challenges did traditional builders face without nails or synthetic materials?
 - Why are local solutions often more effective than imported ones?
 - How is the idea of shelter connected to both science and culture?
-

Biblical Connection

Isaiah 4:6 – “It will be a shelter and shade from the heat of the day, and a refuge and hiding place from the storm and rain.”

Psalms 91:1 – “Whoever dwells in the shelter of the Most High will rest in the shadow of the Almighty.”

God is a shelter to His people – and He also gives wisdom to design shelters in harmony with creation. Aboriginal peoples displayed resourceful, respectful shelter design that modern engineers can still learn from.

Assessment Opportunities

- Shelter model or diagram labelled with scientific features
- Report comparing traditional and modern designs
- Reflection journal on shelter effectiveness and design reasoning
- Oral presentation or peer critique of models

TOPIC 4

PIONEER INVENTIONS AND HOME-MADE GADGETS

Lesson 4.1: Pioneer Tools and Home-Made Gadgets

Theme: Mechanical Systems, Materials Engineering, and Design Thinking

Focus Trait: Resourcefulness – Building useful gadgets from scrap using engineering principles

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, components, tools and equipment can be combined to create designed solutions
- **AC9TDE10P02** – Develop, modify and communicate design ideas for effective solutions to problems
- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems

Learning Intentions

Students will:

- Investigate how pioneers solved daily problems with handmade mechanical tools
- Identify the mechanical principles (levers, gears, springs, cams, linkages) in historical bush gadgets
- Apply the design process to build a small working device using limited materials
- Reflect on the role of necessity and problem-solving in engineering and invention

Introduction (*Tutor or Self-Study Prompt*)

“Pioneer families often couldn’t afford tools from town – or town was too far away. Instead, they built what they needed using fence wire, timber offcuts, scrap metal, or old wagon parts. These gadgets weren’t just clever – they worked. In today’s lesson, you’ll study how simple machines were used in bush invention, and you’ll invent your own gadget using the materials around you.”

Science & Tech Background

◆ 1. The Engineering Design Cycle

All pioneer gadgets were made using what we now call the **engineering design cycle**:

1. **Identify the problem** – What needs to be lifted, opened, turned, or moved?
2. **Explore options** – What simple systems might work?
3. **Build a prototype** – Use recycled or natural materials
4. **Test and adjust** – What works? What doesn't?
5. **Refine** – Make it stronger, simpler, or safer

This process encourages **resilience**, **adaptability**, and **resourcefulness**.

◆ 2. Mechanical Systems in Home-Made Tools

Pioneer gadgets often used combinations of:

- **Levers** – For pumping water or lifting lids
- **Pulleys** – For moving buckets, gates, or clotheslines
- **Springs** – Using bent wood, animal sinew, or steel wire
- **Cams and Linkages** – For motion control (e.g. in foot treadles)
- **Ratchets or Stops** – To control one-way motion

Energy inputs were almost always manual: hand, foot, or wind-powered.

◆ 3. Materials Engineering in the Bush

Without plastics or motors, pioneers selected materials based on properties like:

- **Toughness** (metal, gum tree hardwoods)
- **Flexibility** (green saplings, leather)
- **Rigidity** (dry timber, iron rods)
- **Friction** (greased axles, wooden bearings)

Examples of real bush gadgets:

- Fence-wire clotheslines with pulleys
 - Foot treadle butter churns
 - Crank-operated grain grinders
 - Wind-up gate latches
 - Spring-loaded window openers
-

◆ 4. Relevance to Modern Engineering

Modern inventors still use these systems in:

- Assistive devices
- Sustainable tools in remote areas
- Recycled-material engineering (e.g. Makerspaces, disaster relief design)

Studying pioneer design helps develop **STEM creativity** without relying on expensive parts.

Practical Task – Build a Useful Mechanical Gadget

The Challenge:

Invent a bush-style mechanical gadget to solve a basic problem (e.g. lifting, turning, locking, grinding, scooping, mixing).

Examples:

- A string-powered clothesline model
- A crank-and-pulley well bucket
- A scoop with a trigger-release
- A flap gate or door operated by lever
- A mixing machine powered by rotation

Materials:

- Cardboard, string, sticks, straws, coat hangers
- Rubber bands, paperclips, tape, plastic spoons
- Recycled items (lids, spools, wheels, corks)

Steps:

1. Sketch your idea
 2. Build your prototype
 3. Test it: What motion is created?
 4. Improve: Can it be made smaller, stronger, smoother?
-

Reflection Questions

- What motion does your gadget use? (lift, rotate, open, close)
 - What simple machines are involved?
 - How did your material choice affect performance?
 - What part of the design process helped you most?
-

Discussion Questions

- What advantages did the pioneers have by building their own gadgets?
 - How do limitation and scarcity lead to creativity?
 - Could your design be scaled up for real-world use?
-

Biblical Connection

Exodus 31:3–5 – “[God] filled him with the Spirit of God, with wisdom, with understanding, with knowledge... to make artistic designs... to work in wood, with metal and with stone.”

Invention is a form of wisdom. When we use our hands and minds to solve problems and help others, we honour the God who gave us creativity and skill.

Assessment Opportunities

- Gadget prototype and function test
 - Design sketch with annotations
 - Written explanation of the simple machines used
 - Peer feedback and improvement plan
-

Lesson 4.2: Homestead Inventions and Ingenuity in the Kitchen

Theme: Heat Transfer, Chemistry in Cooking, and Domestic Invention

Focus Trait: Resourcefulness – Solving practical problems in food preparation and household tasks

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U03** – Investigate changes that can be observed as materials are heated and cooled, and whether the changes are reversible
 - **AC9TDE8K02** – Analyse how food and fibre are produced and how their production can be designed for sustainability
 - **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies
-

Learning Intentions

Students will:

- Investigate how pioneer women and families developed ingenious tools and methods in the home, especially for cooking
 - Understand chemical and physical changes that occur during common food preparation processes
 - Explore how design thinking and material knowledge were used in creating or adapting domestic tools
 - Analyse how principles of insulation, heat control, and transformation were applied in the bush kitchen
-

Introduction (*Tutor or Self-Study Prompt*)

“Homestead kitchens were centres of invention. Without modern stoves, mixers, or electric kettles, families had to heat water, bake bread, and preserve food using what they had – fireplaces, ashes, wooden paddles, and heavy iron pots. They made soap, cheese, butter, candles, and even thermoses – all by understanding how materials behave. Today, we’ll explore the clever chemistry and design of everyday kitchen inventions on the pioneer homestead.”

Science & Tech Background

◆ 1. Thermal Energy and Heat Control

Pioneer cooking relied on:

- **Open fire heat** – less precise than a gas flame or oven
- **Radiant heat** – emitted directly from coals and cast iron
- **Conduction** – through pans, kettles, oven walls
- **Insulation** – to slow cooling or keep food warm

Homemakers learned:

- To cook over coals, not flames, for even heating
 - To bury food near the fire to slow-cook
 - To wrap hot items in cloth or hay boxes to retain heat (early thermos)
-

◆ 2. Reversible and Irreversible Changes in Food

Type of Change	Process	Scientific Explanation
Physical (Reversible)	Melting butter, freezing water	Change of state
Chemical (Irreversible)	Baking damper, making soap, souring milk	New substances formed

Indicators of chemical change:

- Colour change
 - Gas released (bubbling)
 - Temperature change (exothermic or endothermic)
 - Change in smell or texture
-

◆ 3. Homestead Inventions Based on Material Properties

Invention	Science Behind It
Butter churn	Mechanical energy to separate fat from liquid
Hay box cooker	Heat insulation using air pockets in straw
Fireplace oven	Uses thermal mass (stones, bricks) to store and radiate heat
Soap making	Saponification = chemical reaction between fat and lye
Iron kettle	High heat capacity, transfers energy efficiently
Water filter	Gravel, sand, charcoal remove debris and odours

Materials used were often scrap: tins, wire, wood, ashes, clay, and animal by-products.

◆ 4. Design Thinking in the Kitchen

Pioneers didn't buy gadgets – they made them:

- Egg beaters from bent wire and wood
- Bread tins from used cans
- Soap moulds carved from timber
- Cheese presses from rocks and boards

This demonstrated **systems design**: recognising a need, using available materials, and testing results.

Practical Task – Kitchen Science and Invention

Option A: Simulate a Haybox Cooker (Heat Retention Test)

- Find your **PPE** (personal protective equipment- goggles, gloves, shoes] and put it on whenever you're doing activities that have the potential to harm]
- Boil water and place in a jar or thermos
- Wrap it in layers of cloth, paper, straw, or wool
- Measure the temperature every 5–10 minutes for an hour
- Graph the temperature drop and evaluate insulation performance

Option B: Invent a Kitchen Tool from Recycled Materials

- Use cardboard, sticks, elastic, or spoons to create a:
 - Mixer
 - Egg separator
 - Bottle opener
 - Crank-based stirring tool
- Draw or test your device and explain how it saves time/effort

Option C: Kitchen Chemistry Test (Supervised) [PPE]

- Make a baking soda + vinegar reaction
 - Mix lemon juice and milk (curdling test)
 - Try melting butter, chocolate, or sugar and observe changes
 - Identify which are physical vs chemical changes
-

Reflection Prompts

- Which invention or process from the pioneer kitchen showed the cleverest thinking?
 - How does understanding material behaviour help in cooking and toolmaking?
 - Could your kitchen invention be used in a real survival or homestead setting?
-

Discussion Questions

- What makes some changes in cooking irreversible?
 - How did pioneers judge temperature or timing without thermometers or timers?
 - How are modern kitchen tools still using the same scientific ideas?
-

Biblical Connection

Proverbs 31:13, 27 – “She selects wool and flax and works with eager hands... She watches over the affairs of her household and does not eat the bread of idleness.”

Pioneer women showed faithfulness and resourcefulness, serving their families with wisdom and skill. When we use science to care for others and work diligently, we honour God's design and our calling.

Assessment Opportunities

- Heat retention graph and analysis
- Invention prototype or design diagram
- Journal reflection on chemistry in cooking
- Peer review of kitchen tool effectiveness

Lesson 4.3: Soap, Candles, and Useful Chemistry

Theme: Chemical Reactions, Heat Transfer, and Everyday Materials Science

Focus Trait: Resourcefulness – Creating essential products using chemistry and simple materials

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U03** – Investigate how substances change through chemical reactions, including combustion and neutralisation
 - **AC9S8U01** – Examine the properties and interactions of materials and the changes they undergo
 - **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies
-

Learning Intentions

Students will:

- Understand the chemistry behind soap and candle making, including chemical and physical changes
 - Explore the role of fats, lye, waxes, and wicks in common household products
 - Identify signs of chemical reactions such as saponification and combustion
 - Apply scientific thinking to evaluate material properties and efficiency in practical solutions
-

Introduction (*Tutor or Self-Study Prompt*)

“In a pioneer household, you couldn’t buy soap or candles from the shop – you had to make them. That meant learning how to melt, mix, and transform natural materials into useful items through chemical change. This was science in action – practical, purposeful, and often messy. Today, we’ll explore how the chemistry of soap and candles made everyday life cleaner, brighter, and more resourceful.”

Science & Tech Background

◆ 1. Soap Making – The Chemistry of Saponification



Soap is made by a chemical reaction between:

- **Fats or oils** (animal or plant-based)
- **Lye** (sodium hydroxide or potash from ash)

Saponification Reaction: Fat + Lye → Soap + Glycerol
(This is an **exothermic reaction** – it releases heat.)

The process involves:

- Melting the fat
- Mixing with lye water (carefully!)
- Stirring until trace (thickening)
- Pouring into moulds
- Letting it cure and harden over weeks



Scientific concepts:

- **Chemical change** – New substances formed
- **pH** – Soap is basic (alkaline)
- **Solubility** – Soap molecules bond with grease and rinse off in water
- **Emulsification** – Breaking up fat into tiny droplets

♦ 2. Candle Making – Combustion and Phase Change

Traditional candles were made from:

- **Beeswax or tallow** (animal fat)
- **Wicks** of string, cotton, or plant fibre

Steps:

1. Melt the wax or fat (physical change)
2. Dip or pour over the wick
3. Cool and harden (reversible change)
4. Light the wick – **Combustion** begins



Combustion Reaction: Fuel (wax/fat) + Oxygen → Carbon dioxide + Water + Heat + Light

Scientific concepts:

- **Exothermic reaction** – Releases energy as heat and light
- **Capillary action** – Wax moves up the wick as it burns
- **Energy transformation** – Chemical to thermal and radiant

♦ 3. Material Properties and Product Design

Good soap:

- Cleans effectively
- Is firm, not crumbly
- Rinses off without residue
- Is gentle on skin (pH balance matters)

Good candles:

- Burn evenly
- Don't smoke excessively
- Last a long time
- Smell neutral or pleasant

Pioneers often added:

- Clay or salt for firmness (soap)
 - Herbs for scent (lavender, rosemary)
 - Sand or grit for scrubbing soap
-

Practical Task – Simulate Soap or Candle Chemistry

Option A: Soap Simulation (Without Caustic Soda)

- Use grated soap + warm water + oil + dried herbs
 - Mix and press into moulds
 - Let harden and compare textures and scents
- Optional (Advanced/Supervised):* Perform safe cold-process soap-making with lye using strict safety protocols

Option B: Make a Simple Candle (Supervised with Heat)

- Melt wax (from candles or beeswax) in a jar
- Secure a wick in a mould (jar, cup, tin)
- Pour in wax and let it harden
- Test: burn time, brightness, and smoke level
- Observe and record: flame colour, heat, and behaviour

Option C: Design a Resourceful Hygiene Kit

Draw or write a design for a kit that pioneers might carry:

- Soap
 - Tallow candle
 - Washing cloth
 - Optional: homemade ash paste (alkaline cleaner)
- Explain the science behind each item.
-

Reflection Prompts

- What science was involved in your candle or soap activity?
 - What made these products “work”?
 - How did pioneers apply chemistry without formal training?
 - What could modern chemists learn from historical processes?
-

Discussion Questions

- What safety risks were involved in these pioneer chemical processes?
 - How is soap both a cleaner and a chemical product?
 - How did the ability to make soap and candles change daily life?
-

Biblical Connection

Malachi 3:2 – “He will be like a refiner’s fire or a launderer’s soap.”

Matthew 5:14–16 – “You are the light of the world... Let your light shine before others.”

Soap and candles are symbols of purity and light – both physical and spiritual. Just as pioneers used chemistry to clean and brighten their homes, God gives us wisdom to purify our lives and bring light to others. Practical invention is part of faithful, thoughtful living.

Assessment Opportunities

- Soap or candle prototype (real or simulated)
- Written explanation of the science involved
- Comparison chart: physical vs chemical changes
- Journal or poster: “The Chemistry of Clean and Bright”

TOPIC 5

HEALING AND CLEANLINESS ON THE FRONTIER

Lesson 5.1: Healing on the Frontier

Theme: Applied Biology, Natural Remedies, and Early Medical Science

Focus Trait: Resourcefulness – Using local knowledge and scientific reasoning to treat illness and injury

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U01** – Examine the properties and uses of substances in relation to their chemical and biological behaviour
- **AC9S8U02** – Investigate how the body responds to infection and injury, and how treatments support recovery
- **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies

Learning Intentions

Students will:

- Understand how pioneers treated injuries, pain, and illness using local resources and limited tools
- Explore the biological responses to infection and healing in the human body
- Evaluate the scientific reasoning behind natural treatments, poultices, and surgical improvisation
- Reflect on how necessity, experimentation, and faith guided early medical practice in remote settings

Introduction (*Tutor or Self-Study Prompt*)

“In pioneer days, there were no hospitals nearby, and trained doctors were rare. Cuts, infections, or broken bones had to be treated at home, often using home-grown herbs, kitchen ingredients, and a good deal of courage. But people used what they had – and what they understood about the human body. In this lesson, we’ll look at the biology behind injury and healing, and the creative solutions pioneers used to survive and thrive.”

Science & Tech Background

◆ 1. How the Body Heals Itself

When injured or sick, the body responds in predictable ways:

Stage	What Happens	Purpose
Inflammation	Swelling, redness, heat	Brings white blood cells to fight infection
Clotting	Platelets form scabs	Stops bleeding and seals wounds
Regeneration	New tissue grows	Heals and replaces damaged skin
Fever (in illness)	Raised body temperature	Slows bacterial growth, boosts immune response

Scientific Concepts:

- Immune system activation
 - Cell regeneration
 - Infection vs inflammation
 - Natural vs acquired immunity
-

◆ 2. Pioneer Remedies and Their Scientific Basis

Pioneers often used:

- **Poultices** (mushy herbal paste) to draw out infection
- **Salt water** or vinegar for wound cleaning (antiseptic properties)
- **Honey** to seal wounds (antibacterial, moist environment)
- **Willow bark tea** for pain (contains salicin, a natural form of aspirin)
- **Boiled onion, mustard plasters, eucalyptus steam** for chest infections

These remedies were often passed down, tested through observation, and sometimes aligned closely with modern pharmacology.

◆ 3. Improvised Tools and Hygiene Practices

Without sterile instruments, pioneers used:

- Boiled knives or needles
- Bandages made from boiled cloth or animal fat
- Hot irons to cauterise wounds
- Animal bones or whittled wood as splints
- Leather or bark as slings and supports

They also learned to:

- Boil water before use
- Wash hands with ash or lye soap
- Isolate sick family members to avoid spread

These practices show an **intuitive grasp of germ theory** – even before it was formalised.

◆ 4. Case Studies in Resourceful Healing

Condition	Treatment	Scientific Understanding
Infection	Honey or saltwater	Kills bacteria, draws fluid
Pain	Willow bark, cold compress	Anti-inflammatory, numbs nerve endings
Burns	Aloe or grease	Cools and protects skin
Broken limb	Wooden splint	Immobilisation supports healing
Fever	Damp cloth, herbal tea	Supports thermoregulation

Even simple actions – like rest, hydration, and food – were critical in aiding the body’s **natural repair systems**.

Practical Task – Healing Simulation & First Aid Innovation

Option A: Design a Pioneer First Aid Kit

Create a list or model of:

- 6–8 items a pioneer might carry
- Their function and scientific justification
E.g. Clean cloth, salt, honey, knife, herbs, vinegar
Label each item with how it supports the body’s healing response

Option B: Poultice or Herbal Infusion (Simulated)

Mix herbs like chamomile, tea leaves, eucalyptus, or mint with warm water and soft oats

- Describe: texture, smell, effect
- Apply to a cloth and test on the skin (for warmth or comfort)
- Write a report on the **properties of the ingredients** and what symptoms they might relieve

Option C: Body Systems and Healing Poster

Choose a body part (e.g. skin, bone, lungs)

Illustrate how the body heals when it’s injured

Show how an improvised pioneer treatment would support this process

Reflection Prompts

- How do natural remedies align with how the body heals itself?

- What limitations did pioneer healers face – and how did they overcome them?
 - In what ways was early healing a mix of science, tradition, and faith?
-

Discussion Questions

- Which traditional or home remedy surprised you the most?
 - What signs show a wound is healing properly – or not?
 - What would you do today if you were injured in a remote place with no doctor nearby?
-

Biblical Connection

Luke 10:34 – “[The Good Samaritan] went to him and bandaged his wounds, pouring on oil and wine.”

James 5:14 – “Is anyone among you sick? Let them call the elders... and pray over them, anointing with oil in the name of the Lord.”

Healing is both practical and spiritual. God gave us minds to understand His creation – and also hearts to care for the hurting. Pioneer medicine reflected both faith and resourcefulness in action.

Assessment Opportunities

- Pioneer first aid kit model with scientific annotations
- Research report on a bush remedy or early treatment
- Illustrated healing process linked to pioneer practices
- Reflection journal or class discussion notes

Lesson 5.2: Cleanliness, Germs, and Survival

Theme: Microbiology, Disease Prevention, and the Science of Hygiene

Focus Trait: Resourcefulness – Maintaining health through simple but effective cleanliness practices

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U02** – Investigate how the body responds to infection and how practices support health and recovery
 - **AC9S7H01** – Investigate how First Nations Australians’ knowledge systems and technologies inform scientific understanding
 - **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies
-

Learning Intentions

Students will:

- Understand the basic science of how germs spread and how cleanliness prevents disease
 - Explore pioneer and Indigenous hygiene practices and their scientific merit
 - Investigate how simple technologies (boiling, soap, separation, airflow) reduce infection risk
 - Reflect on how everyday survival depends on knowledge of invisible microorganisms
-

Introduction (*Tutor or Self-Study Prompt*)

“In the days before modern medicine, many lives were lost not from injury but from infection. On the frontier, cleanliness wasn’t about being fussy – it was about staying alive. Boiling water, washing hands, using ash or vinegar, and keeping sick people apart were all resourceful ways to fight disease – even before people knew about bacteria. Today we’ll explore the science behind these smart survival habits.”

Science & Tech Background

◆ 1. What Are Germs?

Germs = microscopic organisms that can cause illness.

Type	Description	Examples
Bacteria	Single-celled organisms	E. coli, Salmonella
Viruses	Tiny particles that infect cells	Flu, smallpox
Fungi	Plant-like spores	Athlete’s foot, mould
Parasites	Live in/on hosts	Worms, lice

Germ spread by:

- Dirty hands
 - Contaminated food/water
 - Shared tools/clothes
 - Air droplets (coughing)
-

♦ 2. Body's Defence System

The immune system protects the body:

- **Skin** – physical barrier
- **Mucus** – traps germs in nose/throat
- **Stomach acid** – kills ingested bacteria
- **White blood cells** – attack invaders

Symptoms like fever, swelling, or pus are part of this defence.

♦ 3. Cleanliness Practices that Save Lives

Pioneer strategies (often based on trial and error):

- **Boiling** water, knives, bandages
- **Handwashing** with soap or ash
- **Washing clothes** regularly
- **Sun-drying** bedding and garments
- **Isolating** the sick
- **Keeping food covered**
- **Cleaning wounds** with salt, vinegar, or honey

These reduce **bacterial load** and stop the **chain of infection**.

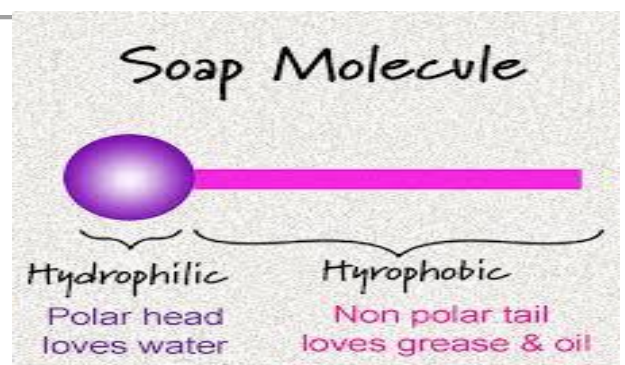
Indigenous knowledge systems also promoted:

- Clean water sources
 - Rotating campsites
 - Herbal smoke cleansing
 - Personal washing with native soaps or clays
-

♦ 4. How Soap Works

Soap molecules have two ends:

- One end binds to **water** (hydrophilic)
- One end binds to **oil/dirt/germs** (hydrophobic)



When you lather and rinse, the soap **lifts away** dirt and germs and washes them off. This is both a **chemical and mechanical** process.

Practical Task – Germ Awareness & Hygiene Engineering

Option A: Design a Pioneer Hygiene Station

Draw or build a model of:

- A handwashing area with water storage
 - Soap made from fat, ash, or plants
 - A clothes-washing setup
 - Waste or dirty water disposal
- Label: what each part does and why it helps keep people healthy

Option B: Germ Spread Simulation (Classroom Activity)

Use glitter, flour, or safe lotion with dye to simulate germs

- One student shakes hands or touches items
- Others see how “germs” spread
- Discuss: how many people were affected? How could this be prevented?

Option C: Clean vs Dirty Surfaces (Microbe Growth Test – Optional)

Wipe slices of bread on clean and dirty surfaces

Store in sealed bags and observe for a week

- Record and analyse mould growth
- Discuss: what caused the difference?

Reflection Prompts

- How did pioneers use basic materials to fight germs?
- What science is involved in preventing illness before it starts?
- How might survival change in the absence of hygiene knowledge?

Discussion Questions

- Which cleanliness habits are most important today?
- How did people’s understanding of hygiene change after germ theory was discovered?
- What could be done if no soap or sanitiser was available?

Biblical Connection

Leviticus 11–15 outlines early cleanliness laws in Israel, including handwashing, isolation, and cleanliness after illness – long before microscopes existed.

Psalm 24:3–4 – “Who may stand in His holy place? The one who has clean hands and a pure heart.”

God designed the world with order and wisdom – even unseen things like germs. Learning to care for ourselves and others through cleanliness is part of honouring His design.

Assessment Opportunities

- Model/design of a hygiene system
- Written explanation of germ prevention strategies
- Observation chart from a spread simulation or microbe test
- Peer discussion: “What would you do to stay clean with no modern supplies?”

Lesson 5.3: Water Safety and Clean Water Design

Theme: Water Filtration, Contamination, and Practical Environmental Science

Focus Trait: Resourcefulness – Creating systems for clean, safe water using simple materials

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U01** – Examine the physical and chemical properties of materials and how they can be used to separate mixtures
 - **AC9S7H01** – Investigate how First Nations Australians’ knowledge systems and technologies inform scientific understanding
 - **AC9TDE10P01** – Critique needs or opportunities to develop design briefs and investigate and select suitable materials and technologies
-

Learning Intentions

Students will:

- Understand the risks of contaminated water and how to make it safer
 - Explore water filtration and purification methods using everyday materials
 - Build a working model that filters dirty water
 - Reflect on how pioneers and Indigenous peoples created systems to access and clean water in remote environments
-

Introduction (*Tutor or Self-Study Prompt*)

“We can’t survive long without water – but not all water is safe to drink. In pioneer days, water from creeks, dams, or rain barrels had to be used wisely. It might carry dirt, animal waste, or even disease. But people found clever ways to clean it – by filtering, boiling, or using natural materials. Today, you’ll become a survival engineer: your job is to build a simple system that turns dirty water into clean, usable water.”

Science & Tech Background

◆ 1. Why Water Needs to Be Treated

Untreated water may contain:

- **Physical contaminants** – mud, leaves, twigs
- **Biological contaminants** – bacteria, parasites, viruses
- **Chemical contaminants** – fertilisers, metal ions, soap

Symptoms from bad water: vomiting, diarrhoea, fever, fatigue

Infections from water include:

- Dysentery
- Typhoid
- Cholera
- Giardia

♦ 2. Separation Methods in Science

Method	What It Removes	How It Works
Filtration	Solids	Traps large particles in porous material
Sedimentation	Heavier solids	Solids settle to the bottom
Boiling	Microbes	High heat kills bacteria and viruses
Distillation	All solutes(materials dissolved in the water)	Evaporates and re-condenses water
Charcoal filtering	Odours and some chemicals	Adsorbs impurities

Each step removes a different kind of contaminant. Combining methods improves results.

♦ 3. Traditional and Pioneer Methods of Water Cleaning

Culture	Technique	Science Behind It
Aboriginal	Dug wells near rivers	Natural filtration through sand
Pioneers	Boiled water in pots	Heat sterilisation
Aboriginal	Used stringybark or paperbark to catch rain	Clean source, physical filtration
Pioneers	Used sand/gravel/cloth filters	Layered mechanical separation

These systems reflected local knowledge and practical science.

Practical Task – Build a Water Filtration System

Challenge:

Design a small model that filters dirty water using safe, natural, or recycled materials.

Materials (choose from):

- Gravel
- Sand
- Activated charcoal (or burnt wood)
- Coffee filters / fabric / cotton
- Plastic bottle or jar
- Dirty water (mud + safe items only: tea leaves, soil, grass)



Steps:

1. Cut a bottle in half (or use a funnel)
2. Layer: cotton, sand, gravel, charcoal
3. Pour dirty water through and collect filtered water
4. Observe and record:
 - Colour clarity
 - Odour change
 - Speed of filtering
 - What contaminants were removed?

Optional: Boil filtered water to simulate sterilisation

Reflection Prompts

- Which part of your filter worked best?
 - What didn't your filter remove?
 - How might you improve it for real-world use?
 - How would you clean water with no materials at all?
-

Discussion Questions

- Why is clean water essential for survival?
 - How does nature filter water on its own?
 - How do modern water treatment systems still use the same science?
-

Biblical Connection

Isaiah 41:17–18 – “The poor and needy search for water... I will make rivers flow on barren heights... I will turn the desert into pools of water.”

John 4:14 – “Whoever drinks the water I give them will never thirst.”

God provides life-giving water for the body and spirit. When we use His creation wisely – purifying, protecting, and sharing water – we reflect His care and wisdom.

Assessment Opportunities

- Filter model: function, design, and test results
- Chart comparing separation methods
- Written plan for survival water sourcing in the bush
- Self-reflection journal: “What I Learned About Water Safety”

TOPIC 6	SURVIVAL IN THE BUSH

Lesson 6.1: Fire for Survival – Cooking, Heating, and Signals

Theme: Combustion, Energy Transformation, and Survival Engineering

Focus Trait: Resourcefulness – Using controlled fire for life-saving functions in the bush

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U03** – Investigate how substances change through chemical reactions, including combustion
- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
- **AC9TDE8K01** – Analyse how characteristics and properties of materials, systems, and tools can be combined to create designed solutions

Learning Intentions

Students will:

- Understand the science behind fire – what it needs, how it burns, and how to control it
- Explore how fire was used by pioneers and Aboriginal peoples for warmth, cooking, protection, and signalling
- Evaluate the safety, sustainability, and practical use of fire in survival scenarios
- Design and test a model or plan that uses fire or heat transfer in a life-saving or energy-efficient way

Introduction (*Tutor or Self-Study Prompt*)

“Fire is one of the most powerful tools in human history. It cooks food, keeps us warm, purifies water, and sends signals across long distances. But fire is also dangerous and must be controlled. In the bush, both pioneers and Indigenous peoples learned to use fire wisely and respectfully. Today we’ll explore how fire works, how to use it safely, and how it can be a life-saving tool in a survival situation.”

Science & Tech Background

◆ 1. What Is Fire?

Fire is a **chemical reaction** called **combustion**.
It requires three things – the **fire triangle**:

1. **Fuel** – something to burn (wood, paper, grass)
2. **Heat** – enough to start the reaction
3. **Oxygen** – usually from the air

When these combine, the fuel reacts with oxygen to release:

- **Heat**
- **Light**
- **Smoke and gases** (carbon dioxide, water vapour, etc.)

Combustion equation (simplified):

Fuel + Oxygen → Carbon dioxide + Water + Energy (heat and light)

◆ 2. Energy Transformations in Fire Use

Fire transforms **chemical energy** in fuel into:

- **Thermal energy** (heat for cooking or warming)
- **Radiant energy** (light for seeing or signalling)
- **Kinetic energy** (e.g., heating air currents)

These transformations were used for:

- **Boiling water** (kills bacteria)
 - **Cooking food** (makes it safe and digestible)
 - **Drying clothes**
 - **Signalling for help** (smoke or light)
 - **Heating shelters** (retained in stones or walls)
-

◆ 3. Aboriginal and Pioneer Use of Fire

Group	Use of Fire	Science Behind It
Aboriginal	Cool burning to manage land	Low-temp controlled fire, fuel reduction
Pioneer	Campfires for heat and food	Radiant and conductive heat transfer



Group	Use of Fire	Science Behind It
Aboriginal	Smoking tools and shelter	Smoke as antiseptic and insect repellent
Pioneer	Fire signals or flares	Light, colour, and pattern used to communicate

Traditional knowledge included:

- **Fire lay structure** (teepee, star, trench)
- **Fuel type** (hardwood for coals, softwood for fast flames)
- **Wind awareness**
- **Ash use for cleaning or cooking insulation**

Practical Task – Model, Test, or Plan a Fire-Based Survival Tool

Option A: Build a Model Heat Retention Cooking System

Simulate a bush oven using:

- Foil
- Rocks or bricks (thermal mass)
- Enclosure made of cardboard, dirt, or clay
- Heat source (candle or hot water bottle)

Test:

- How long does it retain heat?
- Could it cook or warm food without constant flame?

Option B: Fire Signal System (Safe Simulation)

Design a signalling system:

- Mirror or torch for light reflection
- Coloured paper smoke simulation
- Morse code messages using light flashes

Explain:

- How would someone use this in a survival situation?
- What science helps it work?



Option C: Investigate the Science of Tinder and Fuel

Test (supervised or as research):

- What burns easily? (Dry leaves, bark, paper, etc.)
- Which fuel lasts longest? (Twigs vs sticks vs coals)
- What makes a fire safer or more efficient?

Record:

- Type of material
- Burn rate
- Smoke, flame size, duration

Reflection Prompts

- What did you learn about how fire transforms energy?
- How do real-world needs (like cooking or warmth) guide fire design?
- What fire safety principles must be followed in any situation?

Discussion Questions

- Why does controlling fire make it a useful tool?
- How can fire be both life-saving and dangerous?
- How might modern survivalists still rely on ancient fire knowledge?

Biblical Connection

Exodus 3:2 – “The angel of the Lord appeared to him in flames of fire from within a bush.”

Isaiah 43:2 – “When you walk through the fire, you shall not be burned.”

Fire in the Bible is a symbol of both power and purification. God gave fire as a blessing – but also gave wisdom to use it safely. When we understand the science of fire and use it for good, we honour both creation and the Creator.

Assessment Opportunities

- Fire-based invention model or drawing
- Test log: burn material comparison
- Explanation of energy transformations in a real survival context
- Journal: “What I Learned About Fire and Survival”

Lesson 6.2: Keeping Warm – Insulation, Clothing, and Shelter Design

Theme: Heat Transfer, Materials Science, and Energy Conservation

Focus Trait: Resourcefulness – Preserving body heat with natural and improvised solutions

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
 - **AC9TDE8K01** – Analyse how materials, systems, and tools can be combined for designed solutions
 - **AC9TDE10P02** – Develop, modify and communicate design ideas for effective solutions to problems
-

Learning Intentions

Students will:

- Understand how heat is lost from the human body and how to prevent that loss in survival settings
 - Investigate how natural and improvised materials reduce heat transfer
 - Explore insulation strategies in clothing, shelter, and bush survival
 - Apply scientific knowledge to design a heat-retaining solution using limited resources
-

Introduction (*Tutor or Self-Study Prompt*)

“Staying warm in the bush can mean the difference between survival and danger. Heat escapes from the human body through radiation, conduction, convection, and evaporation – but smart design can reduce this. Pioneers used wool, fur, bark, and layered shelters to trap warmth. Today, you’ll become an insulation expert – discovering how materials protect body heat and how to design for warmth when supplies are scarce.”

Science & Tech Background

◆ 1. How the Body Loses Heat

Heat Transfer Type	Example	How It Happens
Radiation	Body emits heat into cold air	Heat radiates from skin
Conduction	Lying on cold ground	Heat flows into cooler material
Convection	Wind pulls heat off skin	Moving air removes warmth
Evaporation	Sweating	Body cools as sweat turns to gas

◆ 2. Insulation: Slowing Down Heat Loss

Insulators reduce heat transfer by trapping **air**, which is a poor conductor.

Examples:

- Wool, feathers, dry leaves
- Bark, grass, moss
- Modern equivalents: foam, fleece, fibreglass, newspaper, cardboard

Effective insulation:

- Creates **air pockets**
 - Stays **dry**
 - Covers **high heat-loss areas** (head, torso, feet)
-

◆ 3. Survival Clothing and Shelter

Pioneer/Aboriginal Material	Use	Science Behind It
Kangaroo or possum skin	Clothing/blankets	Traps air, repels water
Wool	Coats, underlayers	Natural crimp traps heat
Bark sheets	Shelter insulation	Dense and windproof
Grass or reeds	Shelter walls	Air gaps reduce conduction

Layering = multiple air zones = better warmth

Shelters often had low entrances to trap heat and prevent draughts.

◆ 4. Modern vs Traditional Heat Strategies

Situation	Traditional Solution	Modern Parallel
Windy bush night	Low shelter + fire + cloak	Tent + sleeping bag
Wet clothes	Dry by fire + rub with ash	Quick-dry synthetics
Cold ground	Layered bark/moss bed	Foam mat

These methods show **applied physics** – even without technical language.

Practical Task – Build or Test an Insulation Solution

Option A: Insulation Test with Water Bottles

1. Fill 2–3 bottles with warm water (same temp)
2. Wrap each in a different material:
 - Wool or cloth
 - Paper or bark
 - Nothing (control)
3. Record temperature drop every 10 mins for 1 hour
4. Graph the results
5. Discuss: Which retained heat best? Why?

Option B: Design an Emergency Warmth Kit

Create a resourceful warmth kit using only recycled or bush-found materials:

- What could be used as insulation?
- What layers are needed?
- Include drawings, labels, and science notes

Option C: Shelter Warmth Modification Plan

Draw a basic bush shelter (e.g. lean-to or dome)

- Add warmth features: low door, thick wall material, sleeping mat
- Label where heat is retained and how you'd stay dry
- Write: "How My Shelter Reduces Heat Loss"

Reflection Prompts

- What material surprised you most as an insulator?
- How would you modify your shelter or clothes if it began to rain?
- How does science help us understand and improve survival methods?

Discussion Questions

- Why is moisture a major enemy of warmth?
- What would you do if you had to keep warm with no coat or blanket?
- How did pioneers and Indigenous Australians stay warm without synthetic gear?

Biblical Connection

Isaiah 32:2 – “Each one will be like a shelter from the wind and a refuge from the storm.”

Proverbs 31:21 – “She is not afraid of snow for her household, for all are clothed in scarlet.”

God provides warmth through nature – and through wisdom. When we design well, care for others, and use our knowledge wisely, we reflect God's order and kindness.

Assessment Opportunities

- Temperature graphs with analysis
- Design poster of shelter/clothing system
- Practical test log: insulation effectiveness
- Journal reflection on survival and thermal science

Lesson 6.3: Survival Signalling and Emergency Planning

Theme: Communication Technology, Energy Transformation, and Emergency Systems

Focus Trait: Resourcefulness – Creating effective systems to get help using light, sound, and design

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
 - **AC9TDE10P02** – Develop and modify design ideas for effective solutions to real-world problems
 - **AC9TDE8K01** – Analyse how systems, tools and materials can be combined in survival or design technology
-

Learning Intentions

Students will:

- Explore the scientific principles behind visual and auditory signalling systems
 - Evaluate how light, sound, motion, and pattern are used to send emergency messages
 - Design and build a survival signalling device or system
 - Reflect on the importance of planning and design in emergency survival scenarios
-

Introduction (*Tutor or Self-Study Prompt*)

“When you’re lost or injured in the bush, communication is everything. A well-designed signal can bring help fast. But what if you don’t have a phone or radio? What if all you have is your mind, your hands, and the environment around you? Pioneers and explorers learned to use mirrors, smoke, whistles, and fire to send clear messages. Today you’ll become a survival systems designer – using science to build a plan that could save lives.”

Science & Tech Background

◆ 1. What Makes a Good Signal?

A good survival signal is:

- **Visible or audible** over long distances
- **Recognisable** – uses known patterns (e.g. SOS, mirror flashes, smoke columns)
- **Repeated or sustained** – not a one-off
- **Simple to operate**

Types of Signals:

- **Visual** – fire, mirror, torch, flags, bright colour
- **Auditory** – whistle, horn, banging metal

- **Movement** – waving, mirror flashes, **semaphore arms**
- **Symbolic** – ground markings like “HELP” or arrows

◆ 2. Energy in Signalling Systems

Type of Energy	Example	Energy Transformation
Light	Torch, fire, mirror	Chemical → Light
Sound	Whistle, bell	Kinetic → Sound
Mechanical	Waving arms, flapping cloth	Muscle → Motion
Heat	Smoke or flame	Chemical → Heat + Light

Understanding these transformations helps us **maximise effect using minimal tools**.

◆ 3. Using Science for Better Signalling

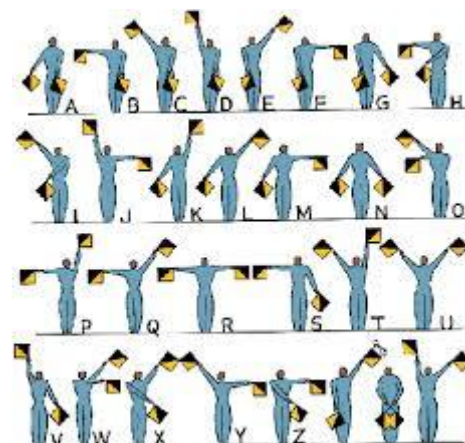
Strategy	Scientific Reason
Mirror flashes	Reflect sunlight – bright, travels far
Three fires in a triangle	Universal SOS symbol
Contrast colours	Easier for helicopters/planes to see
High-pitched whistle	Travels further than voice
Large ground patterns	Recognised from air, use of scale and contrast
Smoke signals	Column vs puffs to send messages

Physics of light and sound guide what works best based on environment and resources.

Practical Task – Build a Signal or Design an Emergency Plan

Option A: Build a Survival Signal Device

- **Reflector:** Use a mirror, foil, or CD to reflect light. Practice mirror-flashing technique.
- **Whistle:** Create a working whistle from paper, plastic, or a bottle top.
- **Flag or Semaphore:** Make a simple signalling flag using cloth and a stick. Use colour contrast and big movements.



Write a short plan:

- What energy does it use?
- How is it best seen or heard?
- When would you use it?

Option B: Design an Emergency Signalling Plan

Imagine you are camping and lose contact.

- What signals would you prepare in advance?
- What patterns would you use? (E.g. “HELP”, “X”, “→”)
- How would you increase visibility or sound in your location?

Present your plan as a **poster or flowchart**.

Option C: Energy Systems Poster – "How Signals Use Science"

Choose 3 signalling methods (fire, mirror, whistle, flare).

For each, show:

- Input energy
 - Output energy
 - Transformation type
 - Efficiency in day/night conditions
- Add labels and symbols to show direction and communication flow.
-

Reflection Prompts

- Which type of signal is easiest to build?
 - What are the limits of sound and light in different environments?
 - Why is planning a signal system before emergency hits so important?
-

Discussion Questions

- What should be included in every bush survival kit for communication?
 - How can pattern and repetition increase signal effectiveness?
 - How do Aboriginal or pioneer signalling systems show scientific understanding?
-

Biblical Connection

Psalms 18:6 – “In my distress I called to the Lord; I cried to my God for help... He heard my voice.”

Matthew 5:14 – “You are the light of the world... Let your light shine before others.”

God has made us communicators – and given us tools to connect and call for help. When we learn to use light, sound, and science wisely, we reflect both His creativity and His concern for others.

Assessment Opportunities

- Signal device with labelled design
- Emergency plan poster with explanation
- Energy flow chart for signal types
- Reflection journal: “If I Were Lost in the Bush, I Would...”

TOPIC 7

ENERGY AND BUSH COOKING

Lesson 7.1: Solar Energy – Cooking and Heating with the Sun

Theme: Renewable Energy, Heat Transfer, and Sustainable Design

Focus Trait: Resourcefulness – Harnessing the sun’s energy to meet survival needs without electricity

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
- **AC9TDE10K01** – Examine how emerging technologies use renewable energy sources
- **AC9TDE10P02** – Develop and modify design ideas for solutions that meet human needs

Learning Intentions

Students will:

- Understand how solar energy can be used to heat, cook, and sustain life without fuel or electricity
- Investigate the principles of heat absorption, reflection, and insulation
- Design and construct a working solar heating or cooking device
- Reflect on the benefits and limitations of using the sun as a survival energy source

Introduction (*Tutor or Self-Study Prompt*)

“The sun gives us more free energy than we could ever use – but in the bush, it’s only useful if you know how to capture it. Pioneers dried fruit and clothes in the sun. Today, survivalists, off-grid dwellers, and eco-inventors use solar ovens to cook food, sterilise water, or heat spaces. In this lesson, we’ll study the science of solar energy – and use it to create something practical and life-sustaining.”

Science & Tech Background

◆ 1. What Is Solar Energy?

The sun emits **radiant energy** that can be converted to:

- **Thermal energy** (heat)
- **Chemical energy** (photosynthesis or battery charging)

- **Electrical energy** (solar panels – PV systems)

In this lesson, we focus on **thermal solar energy** – using heat from sunlight to warm or cook.

♦ 2. How Solar Cooking Works

A solar cooker works by:

1. **Collecting sunlight** – using reflectors or dark surfaces
2. **Converting light to heat** – dark colours absorb radiant energy
3. **Trapping heat** – using transparent lids or insulation to reduce heat loss

Key scientific principles:

- **Absorption** – black surfaces absorb more energy
 - **Reflection** – mirrors and foil direct sunlight
 - **Insulation** – air gaps, glass, or plastic trap heat inside
 - **Conduction** – heat moves into food or water via the container
-

♦ 3. Types of Solar Cooking Devices

Type	Description	Science Focus
Box Cooker	Insulated box with clear lid and dark interior	Traps radiant heat
Panel Cooker	Reflective panels aimed at a dark pot	Focuses light, heats surface
Parabolic Cooker	Curved mirror that focuses sunlight on a point	Maximises intensity
Solar Still	Evaporates and condenses water for drinking	Phase change and condensation

♦ 4. Benefits and Limitations

Advantages:

- No fuel needed
- Silent and non-polluting
- Simple to build
- Works anywhere with sun

Limitations:

- Slower than regular cooking
 - Doesn't work in cloudy weather
 - Requires precise alignment
 - Limited heat output (usually under 150°C)
-

Practical Task – Build a Solar Cooking or Heating Device

Option A: Build a Solar Oven (Box or Panel Style)

Materials:

- Cardboard box, foil, cling wrap, black paper, tape
- Optional: clear plastic lid, thermometer, dark pot or container

Steps:

1. Line the inside with black paper or card
2. Add foil reflectors (angled panels or flaps)
3. Cover the top with plastic wrap or a clear lid to trap heat
4. Place inside: a marshmallow, chocolate, or small pot of water
5. Measure and record:
 - Temperature change
 - Time taken to melt or warm
 - Sun angle and weather conditions

Option B: Design a Portable Solar Heater Plan

Draw or model a bush survival solar device:

- Water warmer
 - Mini greenhouse or dryer
 - Portable personal heater
- Label:
- What materials it uses
 - Where energy enters, transforms, and escapes
 - Safety features and limitations

Option C: Compare Surfaces – Absorption Test

Cover small jars or cans in:

- Black paper
 - White paper
 - Foil
- Place all in the sun with same water amount
- Measure temperature after 30 minutes
 - Graph and analyse: Which colour absorbed most heat? Why?

Reflection Prompts

- What design feature had the biggest effect on temperature?
 - How could your solar cooker be improved for bad weather?
 - How can solar cooking help people in disaster or remote areas?
-

Discussion Questions

- Why is insulation just as important as sunlight in a solar cooker?
 - How are First Nations fire pits or drying racks similar in principle?
 - What other survival tasks could be powered by the sun?
-

Biblical Connection

Ecclesiastes 11:7 – “Light is sweet, and it pleases the eyes to see the sun.”

Psalms 74:16 – “The day is yours, and yours also the night; you established the sun and moon.”

God gave the sun not only for beauty and rhythm, but also for power. When we harness solar energy with thankfulness and wisdom, we’re caring for creation and reflecting His resourceful design.

Assessment Opportunities

- Working solar cooker or model design
- Test data: temperature and effectiveness
- Explanation of energy transfers and insulation design
- Journal entry: “How I Used the Sun to Cook or Heat”

Lesson 7.2: Eco-Friendly Fuels and Sustainable Fire-Making

Theme: Combustion, Fuel Efficiency, and Environmental Impact

Focus Trait: Resourcefulness – Using cleaner, safer fuels to meet needs without waste or harm

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U03** – Investigate how substances change through chemical reactions, including combustion
 - **AC9TDE10K01** – Examine how designed solutions consider impacts on sustainability and the environment
 - **AC9TDE8K01** – Analyse how the properties of materials affect performance and outcomes in design
-

Learning Intentions

Students will:

- Explore different types of natural and man-made fuels used for cooking and heating
 - Investigate the combustion process and how fuel type affects efficiency and pollution
 - Analyse the sustainability of traditional fuels and test alternative options
 - Design or test a fire-making method that is safer and more environmentally friendly
-

Introduction (*Tutor or Self-Study Prompt*)

“Not all fires are equal. Some smoke and pollute, some burn too fast, and some are nearly invisible but very efficient. Pioneers used wood, coal, tallow, and charcoal. Aboriginal people knew which fuels burned clean and hot. Today, you’ll explore the science of fuels – what burns best, what burns cleanest, and how to use fire responsibly in a survival situation or off-grid lifestyle.”

Science & Tech Background

◆ 1. What Is a Fuel?

A **fuel** is a material that can be burned to release energy.

Common bush fuels:

- **Wood** (dry branches, bark, sticks)
- **Charcoal** (partially burned wood)
- **Fat or tallow** (animal fat for lamps or slow-burning fire)
- **Dung or plant matter** (compressed or dried)

Combustion reaction (simplified):

Fuel + Oxygen → Heat + Light + Carbon dioxide + (sometimes Smoke)

◆ 2. Fuel Efficiency and Pollution

Good fuels:

- Burn hot and long
- Are lightweight or easy to find
- Produce little smoke
- Leave little ash

Bad fuels:

- Smoke heavily
- Leave sticky residue (creosote)
- Smell unpleasant or contain toxins (e.g., plastics, green leaves)

Efficient combustion = complete burning = fewer particles in the air

Indicators of good combustion:

- Steady blue or yellow flame
 - Little visible smoke
 - Fast ignition
 - Consistent burn
-

◆ 3. Sustainable and Renewable Fuel Sources

Fuel Type	Source	Environmental Impact
Dry wood	Dead branches, sticks	Renewable if gathered carefully
Charcoal	Controlled burning of wood	Cleaner burn, reusable
Dried dung	Animal waste	Low-tech, low smoke, renewable
Fat or wax	Animal or kitchen waste	Slow burn, reusable
Alcohol gel / wax stubs	Man-made or recycled	Controlled, portable
Plant briquettes	Compressed leaves/stalks	Low emissions, renewable

Aboriginal fire knowledge included:

- Selecting specific hardwoods
- Avoiding live or green fuel
- Controlled cool burning to avoid bushfire risk

◆ 4. Fire-Making Methods

Fire Starting Tool	Science Involved
Flint and steel	Friction → spark → ignition
Magnifying glass	Light → focused heat → combustion
Bow drill	Friction → heat → ember
Firelighter or gel	Chemical ignition, portable heat source
Wax + cotton ball	Slow-release fuel, easy to light

Modern survival kits often combine **low smoke**, **sustainable**, and **long-lasting** fuels.

Practical Task – Compare Fuels or Build a Low-Smoke Fire Plan

Option A: Fuel Burn Comparison (Outdoor Supervised Activity)

Use 2–3 fuel types:

- Dry twigs
- Charcoal
- Waxed cotton ball or natural fat

Compare:

- Time to light
- Burn duration
- Smoke level
- Heat output (hand test or temperature sensor)

Graph and analyse results:

- Which was best for cooking?
- Which burned cleanest?

Option B: Design a “Bush Fuel Kit” for Survival

Include:

- Safe starter
 - Primary fuel
 - Backup heat source
- Add explanation:
- Why is each fuel included?
 - What makes them efficient, safe, or sustainable?

Option C: Fire-Making Poster or Model

Draw or construct a simple model:

- Rocket stove (efficient, low-smoke)
 - Dakota fire hole (hidden, windproof)
- Label:

- Airflow system
 - Fuel zone
 - Efficiency features
 - Smoke reduction techniques
-

Reflection Prompts

- What made one fuel burn more efficiently than another?
 - How does the choice of fuel affect both survival and sustainability?
 - How can fire-making be both respectful to the land and effective?
-

Discussion Questions

- Why does wet or green wood smoke more than dry wood?
 - How could you carry or create fire in a survival emergency?
 - How might Aboriginal fire practices inform safer modern fuel use?
-

Biblical Connection

Isaiah 30:24 – “...the oxen and donkeys that work the soil will eat well... seasoned with winnowing shovel and fork.”

Genesis 22:6–7 – “Abraham took the wood for the burnt offering... and the fire and the knife.”

Fire was essential in the Bible for survival, sacrifice, and worship. Like the pioneers, we can learn to use it wisely – not wastefully – honouring God by caring for creation and using His resources with skill and reverence.

Assessment Opportunities

- Burn test data log and analysis
- Survival fuel kit design with justification
- Poster/model of an efficient, eco-friendly fire system
- Reflection journal: “What I Learned About Fuel and Fire”

Lesson 7.3: Cooking Without a Stove – Innovation and Heat Control

Theme: Thermal Energy, Heat Transfer, and Cooking Systems Design

Focus Trait: Resourcefulness – Using practical science to cook with fire, hot coals, and improvised methods

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U04** – Investigate how energy can be transferred and transformed in systems
- **AC9TDE10P02** – Develop and modify design ideas for effective, real-world solutions
- **AC9TDE8K01** – Analyse how materials and tools can be used to meet human needs in constrained environments

Learning Intentions

Students will:

- Understand the science behind different cooking methods using fire and heat
- Explore how pioneers and Aboriginal peoples used earth, stone, and metal to regulate cooking temperature
- Investigate techniques for heat control, insulation, and food safety
- Design or simulate an efficient cooking system for outdoor or off-grid situations

Introduction (*Tutor or Self-Study Prompt*)

“Before gas stoves and electric ovens, cooking meant understanding fire. Too close, and your food burns. Too far, and it stays raw. Pioneers cooked in pots, wrapped foil in coals, and used heated rocks. Aboriginal peoples used earth ovens, ash cooking, and hot stones for even, natural heating. Today, we’ll explore how heat flows into food – and how smart, simple designs make the most of it.”

Science & Tech Background

◆ 1. How Cooking Transfers Energy

Heat transfer in cooking happens through:

Type of Transfer	Example	Description
Conduction	Pan on coals	Heat moves through solid surfaces
Convection	Pot of soup	Heat circulates in liquid or air
Radiation	Roasting by fire	Infrared heat waves travel through space

Factors that affect cooking:

- **Material** of the pot (metal conducts better than clay)
 - **Distance** from heat source
 - **Insulation** (trapping heat)
 - **Fuel type** (steady coals vs quick flame)
 - **Moisture content** of food and fuel
-

♦ 2. Historical and Cultural Cooking Techniques

Method	Used By	Science Behind It
Foil cooking	Pioneers	Reflects heat inward; traps steam
Earth oven (pit or mound)	Aboriginal peoples	Heat retained by stones and earth; slow-cooks via conduction
Hot rock cooking	Both	Transfers heat directly to food; maintains stable temp
Pot on tripod or hook	Pioneers	Adjusts convection and radiation by distance from fire

♦ 3. Design Features for Heat Control

To cook well without a stove, systems must:

- Regulate **distance from flame**
- Contain or reflect **heat**
- Protect from **wind** and heat loss
- Allow for **safe handling** (tools, tongs, etc.)
- Avoid contaminating the food (ashes, dirt)

Materials often used:

- Stones (thermal mass)
 - Clay/earth (insulation)
 - Green wood (resistant to burning)
 - Foil or metal (heat reflection and wrapping)
-

Practical Task – Test, Design, or Simulate Cooking Without a Stove

Option A: Simulate a Foil Packet Cooking System

Wrap a small food item (e.g. banana, chocolate, marshmallow) in foil

- Place near a safe heat source (e.g. candle, campfire, heated brick)
- Observe melting, warming, and time taken
- Record: What worked best? Where did the heat come from?

Option B: Design a Bush Cooking Rig

Draw or model a cooking frame, tripod, trench oven, or stone circle

Label:

- Where heat is applied
- Where convection or insulation is used
- What makes it fuel-efficient and safe

Optional: Include real-world adaptations (wind protection, rain resistance)

Option C: Compare Cooking Surfaces

Test safe food items (or small water containers) on:

- Hot metal tray
- Warm stone
- Wrapped in foil and left in sun

Compare time to heat, smell, effectiveness

Graph your results and write what design you'd use for a real survival situation

Reflection Prompts

- How did different materials affect cooking time or heat distribution?
 - Why are some primitive methods still used today in survival and cultural settings?
 - How can cooking systems be safe, effective, and fuel-smart?
-

Discussion Questions

- What science helps us cook food evenly without a stove?
 - Why did pioneers and Aboriginal peoples often choose slower cooking methods?
 - What design lessons can modern survivalists learn from the past?
-

Biblical Connection

John 21:9–13 – “When they landed, they saw a fire of burning coals with fish on it... Jesus said, ‘Come and have breakfast.’”

1 Kings 17:12–16 – The widow of Zarephath cooked a final meal with flour and oil, and God provided more.

Jesus and Elijah both showed that meals cooked with care – even on simple fires – can nourish body and soul. When we cook resourcefully, gratefully, and creatively, we honour the provision and design God has given.

Assessment Opportunities

- Foil cooking test with observation log
- Illustrated bush cooking plan with scientific annotations
- Heat transfer chart for different surfaces
- Reflection journal: “How to Cook Without a Stove”

TOPIC 8	ELECTRICITY, MAGNETISM, AND INVENTION

Lesson 8.1: Circuits and Inventions – Off-Grid Electricity

Theme: Electrical Circuits, Energy Transfer, and Inventive Systems

Focus Trait: Resourcefulness – Building simple, practical devices using basic electricity

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S8U05** – Investigate how electric circuits transfer energy to produce heat, light, sound, or movement
- **AC9TDE10P02** – Develop and modify designed solutions for practical problems
- **AC9TDE8K01** – Analyse how tools, materials and systems are used in product development

Learning Intentions

Students will:

- Understand how electricity flows through a closed circuit
- Identify components that convert electrical energy into heat, light, sound, or motion
- Build or design simple devices that use battery power in off-grid environments
- Reflect on how pioneers and modern bush users solve problems without wall outlets

Introduction (*Tutor or Self-Study Prompt*)

“Out on a remote property or in a pioneer hut, there were no power points – just sunlight by day and candles by night. But some clever pioneers and tinkerers built buzzers, lights, and even alarms using simple electrical parts. Today, off-grid inventors still create tools using batteries, wires, and switches. In this lesson, we’ll explore how energy moves through circuits – and how to use it to create something truly helpful.”

Science & Tech Background

◆ 1. What Is an Electric Circuit?

An **electric circuit** is a closed path that allows electricity to flow. For the device to work, the circuit must be closed.

main parts:

Component	Function
Battery	Source of energy (electrical potential)
Wires	Conduct electricity
Switch	Opens/closes the circuit
Load (e.g. bulb, buzzer, fan)	Converts energy into light, sound, heat, or movement

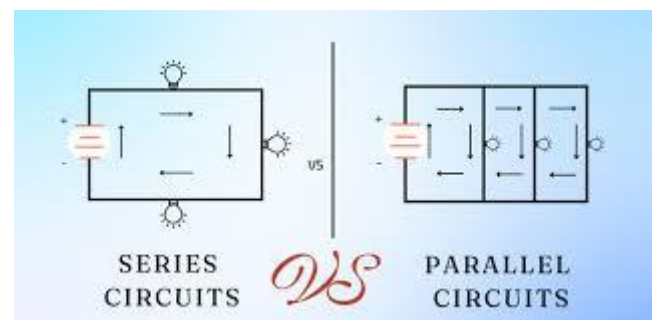
◆ 2. Types of Circuits

Type	Description
Series Circuit	One path – all components in a row
Parallel Circuit	Multiple paths – more consistent power

Energy transformations:

- **Light** – e.g. torch bulb
- **Sound** – buzzer
- **Movement** – motor or fan
- **Heat** – resistance in wires or coils

The flow is powered by the battery and controlled by the switch.



◆ 3. Off-Grid and Bush Inventions Using Electricity

Invention	Function	Electrical Concept
Bell/signal wire	Alerts from distance	Switch + buzzer
Torch or lantern	Light source	Bulb + battery + switch
Magnet finder	Electromagnet activates light or sound	Coil + power = field

Invention	Function	Electrical Concept
Trip alarm	Breaks circuit to trigger sound/light	Interruption of closed path

Such devices show **practical science** using common items:

- Foil as a switch
- Paperclip as connector
- Bicycle light bulbs
- AA/AAA/9V batteries

Practical Task – Build or Design a Battery-Powered Invention

Option A: Build a Simple Circuit Device

Use:

- Battery pack
- Wires or foil
- Small bulb, buzzer, or motor
- Switch (paperclip, metal tab, or push button)

Create:

- A torch
- A buzzer alert
- A fan

Test:

- Does it complete a circuit?
- What energy is produced?
- Can you add a switch?

Option B: Design a Bush Invention with Electricity

Imagine:

- You need a signal, light, or alert in the bush

Design a system with:

- Power source
- Circuit diagram
- Labels for energy transfer
- Purpose and safety features

Write a builder's explanation:

- "How my invention helps in an off-grid environment"

Option C: Troubleshoot a Faulty Circuit Simulation

Create (or draw) a broken circuit:

- Wire not connected
- Battery wrong way
- Broken switch

Identify:

- What's wrong?

- How would you fix it?
Write: “3 Common Mistakes When Making Circuits”
-

Reflection Prompts

- What was most difficult about completing a working circuit?
 - How does the energy in a battery become useful work?
 - Why is this kind of technology helpful in emergencies?
-

Discussion Questions

- How did pioneers use early electricity without the grid?
 - Why is battery-powered technology important today in disasters?
 - What are the dangers and safety rules for basic electrical work?
-

Biblical Connection

James 1:17 – “Every good and perfect gift is from above, coming down from the Father of lights...”

Electricity is part of God’s created world – powerful, invisible, and useful. When we harness it for good – light, warmth, help, and care – we reflect the resourcefulness and order He built into nature.

Assessment Opportunities

- Working model of a battery-powered circuit
- Annotated circuit diagram
- Troubleshooting checklist
- Reflection: “If I Had No Electricity, I Would...”

Lesson 8.2: Magnetism – Attraction, Repulsion, and Real-World Use

Theme: Magnetic Fields, Force, and Functional Invention

Focus Trait: Resourcefulness – Applying the hidden forces of magnetism to solve practical problems

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9S7U04** – Investigate the effects of applying forces, including magnetic force, on the motion or shape of objects
 - **AC9TDE8K01** – Analyse how systems and tools use invisible forces (like magnetism) to perform useful work
 - **AC9TDE10P01** – Critique and develop ideas for designed solutions that make use of forces and materials
-

Learning Intentions

Students will:

- Understand how magnetic fields create force without contact
 - Explore the uses of magnets in practical inventions, survival tools, and mechanical devices
 - Investigate the principles of magnetic attraction, repulsion, polarity, and field strength
 - Design or build a device that uses magnetism to complete a task or solve a problem
-

Introduction (*Tutor or Self-Study Prompt*)

“Magnets can pull or push objects without touching them. That sounds like magic – but it’s really science. Magnetism is part of the invisible forces in God’s world that help us sort, move, lift, and power things. From finding nails in the grass to building motors, magnetism plays a role in many bush and pioneer tools. Today, you’ll become a magnetic inventor – learning how to use this silent force to solve problems.”

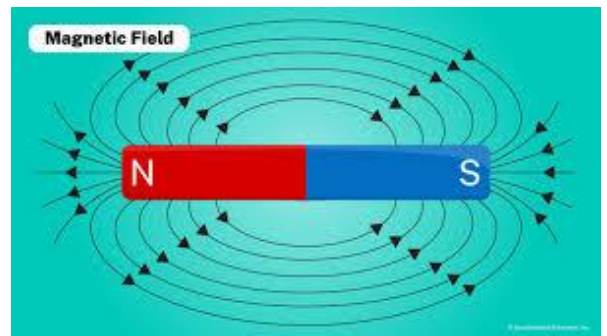
Science & Tech Background

◆ 1. What Is Magnetism?

Magnetism is a force caused by moving electric charges – usually in iron, nickel, or cobalt atoms. A magnet has:

- A **north** and **south** pole
- An **invisible field** where it pulls (attracts) or pushes (repels) certain materials

Magnetic field lines go from the north to south pole and curve around the magnet.



◆ 2. Forces of Attraction and Repulsion



Scenario	What Happens
North to South poles	Attract – come together
North to North / South to South	Repel – push apart
Non-magnetic object (plastic, wood)	No effect
Ferromagnetic object (iron nail, steel)	Attracts

The force gets stronger:

- With closer distance
- With stronger magnet
- With thinner barriers

◆ 3. Magnetism in Real-World Inventions

Application	Function	Magnetic Principle
Magnetic pickup tools	Retrieve lost screws/nails	Attraction
Compass	Finds direction using Earth's field	Field alignment
Magnetic latches	Hold doors/drawers shut	Constant pull
Electromagnets	Turn magnetism on/off	Current controls field
Motors & buzzers	Movement or vibration	Repulsion/pulse switching

Magnetism is clean, reusable, and silent – ideal for bush inventions!

◆ 4. Pioneer and Survival Uses of Magnetism

While pioneers didn't have modern neodymium magnets, they still used:

- **Compass navigation**
- **Iron filings** for study or repairs
- **Metal sorting** via hand-held magnets

Modern survival uses include:

- Magnetic retrieval tools
- Ferrofluid demos for science kits
- Electromagnetic switches or alarms

Practical Task – Build, Test, or Design a Magnet Tool

Option A: Build a Magnetic Retriever or Sorter

Use:

- A strong magnet
- String, handle, or stick
- Metal items (paper clips, screws, washers)

Test:

- What objects stick? Which don't?
- Can you lift through paper or cloth?
- What happens with barriers like plastic?

Record:

- What the tool picks up
- How far it works
- What materials block or allow force

Option B: Create a Magnetic Game or Device

Ideas:

- Fishing game (magnet and paperclips)
- Obstacle maze using magnets under the table
- Magnetic sensor switch (with foil contact)

Label:

- Which parts use attraction or repulsion
- What purpose the magnet serves
- How the force is transferred

Option C: Design a Magnet-Based Invention

Sketch or model:

- A bush tool using a magnet (e.g. nail retriever, compass, latch)
 - Label the forces involved
 - Write: “How This Invention Uses Magnetism to Help in Real Life”
-

Reflection Prompts

- What surprised you about how magnets work?
 - What materials were affected by the magnetic field?
 - How could you improve your tool or design for bush conditions?
-

Discussion Questions

- Why is magnetism useful in survival situations?
 - How is magnetism different from other forces (gravity, push/pull)?
 - What role does magnetism play in modern tools and machines?
-

Biblical Connection

Colossians 1:17 – “He is before all things, and in Him all things hold together.”

Just like magnetism holds parts together invisibly, God holds creation together in ways we cannot always see. When we discover and use these forces wisely, we join in the Creator’s design.

Assessment Opportunities

- Working model or demonstration tool using magnets
- Lab journal of attraction/repulsion tests
- Diagram of invention with magnetic labels
- Reflection: “How I Used an Invisible Force to Create Something Useful”

Lesson 8.3: Magnetic and Electric Innovation

Challenge – Build Something Useful

Theme: Integrated Technologies, Invention, and Practical Application

Focus Trait: Resourcefulness – Using what you’ve learned to create a real working solution

Year Level: Years 7–10 (adaptable)

Australian Curriculum v9 Links:

- **AC9TDE10P02** – Develop, modify, and communicate designed solutions to improve real-world systems
 - **AC9S8U05** – Investigate how electric circuits transfer energy to produce heat, light, sound, or movement
 - **AC9S7U04** – Investigate the effects of magnetic force on motion and its use in practical applications
-

Learning Intentions

Students will:

- Combine their knowledge of circuits and magnetism into a practical, original invention
 - Use simple materials to design and test a working device that solves a real problem
 - Demonstrate how energy is transferred and controlled within their creation
 - Reflect on how scientific thinking and hands-on design can serve others
-

Introduction (*Tutor or Self-Study Prompt*)

“You’ve learned how to create circuits, control electricity, and use magnetic force to move, attract, or alert. Now, it’s your turn to invent. Today’s challenge is to build something useful using magnetism, electricity, or both. It doesn’t have to be fancy – just functional. Like pioneers and modern inventors, you’ll use what you’ve got to solve a problem. That’s true resourcefulness.”

Science & Tech Background Review

◆ Key Concepts to Apply:

Concept	Description
Closed circuit	Power flows in a loop to activate devices
Electromagnet	Coil of wire becomes magnetic with current
Magnetic field	Invisible force that can move, attract, or repel
Energy transfer	From battery to sound, heat, light, or motion
Switches and sensors	Control when energy flows

◆ Example Inventions to Inspire You:

Device	Purpose	Technology Used
Trip wire alarm	Alerts if someone enters a space	Circuit, buzzer, switch
Lost nail retriever	Picks up metal bits from grass	Magnet on a string
Mini torch	Lights up dark spaces	Battery, bulb, switch
Magnet maze	Moves pieces without touching	Magnet attraction
Signal bell	Sends message over distance	Switch, wire, sound

All can be built from:

- Wires or foil
 - Small light bulbs or LEDs
 - Buzzers or motors
 - Batteries
 - Magnets
 - Tape, paper, string, pegs, recycled parts
-

Practical Task – Invention Challenge

Your Challenge:

Design, build, and test a helpful tool that uses **electricity**, **magnetism**, or **both**.

Steps:

1. **Choose a real-world problem or use:**
 - Need for light, sound, detection, lifting, or movement
 - Survival signalling or bush communication
 - Retrieving or holding objects
 - Creating energy from limited materials
 2. **Plan it:**
 - What materials will you need?
 - What force (magnetic or electrical) will be used?
 - What is the input energy and the output effect?
 3. **Build it:**
 - Assemble components
 - Ensure circuits are closed
 - Test switches, magnets, or sensors
 4. **Document it:**
 - Draw a labelled diagram
 - Take photos or video if possible
 - Explain how it works in writing
-

Reflection Prompts

- What did I learn about applying energy systems practically?
 - What part of the invention worked best? What was tricky?
 - How did I solve problems using resourcefulness during design or testing?
 - What other inventions could I build with the same knowledge?
-

Discussion Questions

- How do inventions like this serve others or improve life off-grid?
 - What everyday problems can be solved with small-scale engineering?
 - How might your invention inspire further improvement or design?
-

Biblical Connection

Exodus 35:31–32 – “He has filled him with the Spirit of God, with wisdom, understanding, and knowledge... to make artistic designs for work in gold, silver, and bronze.”

God equips His people with minds to build, hands to shape, and wisdom to serve. When we invent with purpose – especially to meet real needs – we reflect His creativity and care.

Assessment Opportunities

- Working model or detailed plan of a magnet/electricity-based invention
- Diagram with labelled parts and explanation of forces used
- Written “Inventor’s Report” including problem, process, result
- Reflection journal: “What My Invention Says About Creative Science”

TOPIC 9	CULMINATING PROJECT OR ASSESSMENT

Assessment:

The final assessment task is still to be advised. We will include this in future editions..

We aim to continually improve these study guides and make them more family-friendly, so we value your comments.

To provide valuable feedback on the lessons in this study guide, contact Homeward Education Support 2226 Murphys Creek Rd., Ballard, Qld 4352 or via email at info@hesupport.com.au or 0438614452.
