Should I drink bottled water?

Year 7

This unit is aligned with the following Australian Curriculum learning areas: Science, supported by English, Geography and Economics and Business

Australian Government

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Note: All links were correct at the time of publication. If, however, you find a link is not working, please use the search feature within the website instead.

Should I drink bottled water?

Year level 7

Duration of unit 10 hours*

Learning areas Science, supported by English, Geography and Economics and Business

Unit description

This unit gives students opportunities to develop an understanding of the importance of water for the environment and potable water for human consumption.

They will:

- consider water availability and use from an individual, national and international perspective
- explain the natural processes in the water cycle that enable clean water to be obtained and the processes humans carry out to treat water so that it is potable
- gain an understanding of the cost of drinking bottled water compared to tap water
- consider the environmental impact of bottled water and the factors that impact on consumer choices.

Students may be given the opportunity to fundraise for an organisation such as Water Wells for Africa (WWFA), possibly with money saved by drinking water from bubblers or reusable bottles.

Knowledge and understandings

- Trends in consumer behaviour may be based on personal preferences rather than scientific evidence of a better product.
- Packaging and convenience come with a cost.
- Processes in nature purify and store fresh water.
- Separation of the components of mixtures is an important application of science.

Pre-requisite knowledge

- To undertake this unit student's need to have an understanding of:
    - units of measurement and conversion between units – gram, kilogram, tonne and millilitre, litre, kilolitre
    - proportion.

** Timings are provided as a guide only. Teachers will tailor the activities to suit the capabilities and interests of their class. The unit and student worksheets can be adapted to your needs.*

Unit plan

Links

The following table provides the relevant links to the Australian Curriculum learning areas, achievement standards and general capabilities.

Australian Curriculum learning areas and achievement standards	
Science	**Content Descriptions**
	• Strand: Science Understanding — Sub-strand: Chemical Sciences o Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113) — Sub-strand: Earth and space sciences o Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable (ACSSU116) • Strand: Science as Human Endeavour — Sub-strand: Use and influence of science o Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120) • Strand: Science Inquiry Skills — Sub-strand: Processing and analysing data and information o Summarise data from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions (ACSIS130) — Sub-strand: Evaluating o Use scientific knowledge and findings from investigations to evaluate claims (ACSIS132) — Sub-strand: Communicating o Communicate ideas, findings and evidence-based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)
	Achievement Standards
	By the end of Year 7, students describe techniques to separate pure substances from mixtures. They represent and predict the effects of unbalanced forces, including Earth's gravity, on motion. They explain how the relative positions of Earth, the sun and moon affect phenomena on Earth. **They analyse how the sustainable use of resources depends on the way they are formed and cycle through Earth systems.** They predict the effect of human

	and environmental changes on interactions between organisms and classify and organise diverse organisms based on observable differences. Students describe situations where scientific knowledge from different science disciplines and diverse cultures has been used to solve a real-world problem. They explain possible implications of the solution for different groups in society. Students identify questions that can be investigated scientifically. They plan fair experimental methods, identifying variables to be changed and measured. They select equipment that improves fairness and accuracy and describe how they considered safety. **Students draw on evidence to support their conclusions. They summarise data from different sources,** describe trends **and refer to the quality of their data when suggesting improvements to their methods. They communicate their ideas, methods and findings using scientific language and appropriate representations.**
English	**Content Descriptions**
	• Strand: Language — Sub-strand: Expressing and developing ideas o Investigate vocabulary typical of extended and more academic texts and the role of abstract nouns, classification, description and generalisation in building specialised knowledge through language (ACELA1537) • Strand: Literacy — Sub-strand: Interacting with others o Use interaction skills when discussing and presenting ideas and information, selecting body language, voice qualities and other elements, (for example music and sound) to add interest and meaning (ACELY1804) o Plan, rehearse and deliver presentations, selecting and sequencing appropriate content and multimodal elements to promote a point of view or enable a new way of seeing (ACELY1720) — Sub-strand: Interpreting, analysing, evaluating o Use prior knowledge and text processing strategies to interpret a range of types of texts (ACELY1722) o Use comprehension strategies to interpret, analyse and synthesise ideas and information, critiquing ideas and issues from a variety of textual sources (ACELY1723) — Sub-strand: Creating texts o Plan, draft and publish imaginative, informative and persuasive texts, selecting aspects of subject matter and particular language, visual, and audio features to convey information and ideas (ACELY1725)
	Achievement Standards

	By the end of Year 7, students understand how text structures can influence the complexity of a text and are dependent on audience, purpose and context. They demonstrate understanding of how the choice of language features, images and vocabulary affects meaning. Students **explain issues and ideas from a variety of sources, analysing supporting evidence and implied meaning.** **They select specific details from texts to develop their own response,** recognising that texts reflect different viewpoints. They listen for and explain different perspectives in texts. Students understand how the selection of a variety of language features can influence an audience. They understand how to draw on personal knowledge, textual analysis and other sources to express or challenge a point of view. **They create texts showing how language features and images from other texts can be combined for effect. Students create structured and coherent texts for a range of purposes and audiences. They make presentations and contribute actively to class and group discussions, using language features to engage the audience.** When creating and editing texts they demonstrate understanding of grammar, use a variety of more specialised vocabulary and accurate spelling and punctuation.
Geography	**Content Descriptions**
	• Strand: Geographical Knowledge and Understanding — Unit 1: Water in the world o Classification of environmental resources and the forms that water takes as a resource (ACHGK037) o The way that flows of water connects places as it moves through the environment and the way this affects places (ACHGK038) o The quantity and variability of Australia's water resources compared with other continents (ACHGK039) o The nature of water scarcity and ways of overcoming it, including studies drawn from Australia and West Asia and/or North Africa (ACHGK040) • Strand: Geographical Inquiry and Skills — Sub-strand: Observing, questioning and planning o Develop geographically significant questions and plan an inquiry, using appropriate geographical methodologies and concepts (ACHGS047) — Sub-strand: Collecting, recording, evaluating and representing o Evaluate sources for their reliability and usefulness and select, collect and record relevant geographical data and information, using ethical protocols, from appropriate primary and secondary sources (ACHGS048) — Sub-strand: Interpreting, analysing and conducting

	- Interpret geographical data and other information using qualitative and quantitative methods, and digital and spatial technologies as appropriate, to identify and propose explanations for spatial distributions, patterns and trends, and infer relationships (ACHGS051) - Apply geographical concepts to draw conclusions based on the analysis of the data and information collected (ACHGS052) — Sub-strand: Communicating - Present findings, arguments and ideas in a range of communication forms selected to suit a particular audience and purpose; using geographical terminology and digital technologies as appropriate (ACHGS053) — Sub-strand: Reflecting and responding - Reflect on their learning to propose individual and collective action in response to a contemporary geographical challenge, taking account of environmental, economic and social considerations, and predict the expected outcomes of their proposal (ACHGS054)
	Achievement Standards
	By the end of Year 7, students describe geographical processes that influence the characteristics of places and how the characteristics of places are perceived and valued differently. **They explain interconnections between people** and places and environments and describe how these interconnections change places and environments. They describe alternative strategies to a geographical challenge referring to environmental, economic and social factors. Students identify geographically significant questions to frame an inquiry. **They evaluate a range of primary and secondary sources to locate useful information and data. They record and represent data** and the location and distribution of geographical phenomena **in a range of forms**, including large-scale and small-scale maps that conform to cartographic conventions. **They interpret** and analyse geographical maps, **data and other information to propose simple explanations for spatial distributions, patterns, trends and relationships, and draw conclusions. Students present findings and arguments using relevant geographical terminology** and digital technologies **in a range of communication forms. They propose action in response to a geographical challenge, taking account of environmental, economic and social factors, and describe the expected effects of their proposal.**

Economics and business	Content Descriptions
	- Strand: Knowledge and Understanding - The ways consumers and producers interact and respond to each other in the market (ACHEK017) - Strand: Skills — Sub-strand: Questioning and research - Develop questions about an economic or business issue or event, and plan and conduct an investigation or project (ACHES021) - Gather relevant data and information from a range of digital, online and print sources (ACHES022) — Sub-strand: Interpretation and analysis - Interpret data and information displayed in different formats to identify relationships and trends (ACHES023) — Sub-strand: Economic reasoning, decision-making and application - Generate a range of alternatives in response to an observed economic or business issue or event, and evaluate the potential costs and benefits of each alternative (ACHES024) - Apply economics and business knowledge, skills and concepts in familiar and new situations (ACHES025) — Sub-strand: Communication and reflection - Present evidence-based conclusions using economics and business language and concepts in a range of appropriate formats, and reflect on the consequences of alternative actions (ACHES026)
	Achievement Standards
	By the end of Year 7, students describe the interdependence of consumers and producers in the market. They **explain the importance of short- and long-term planning to individual and business success and identify different strategies that may be used.** They describe the characteristics of successful businesses and explain how entrepreneurial capabilities contribute to this success. Students identify the reasons individuals choose to work and describe the various sources of income that exist. **When researching, students develop questions and gather data and information from different sources to investigate an economic or business issue. They interpret data to identify trends. They propose alternative responses to an issue and assess the costs and benefits of each alternative. They apply economics and business knowledge, skills and concepts to familiar problems. Students develop and present conclusions using appropriate texts, terms and concepts. They identify the effects of their decisions and the possible effects of alternative actions.**

General Capabilities Typically, by the end of Year 8 students:	
Literacy	• navigate, read and view a variety of challenging subject-specific texts with a wide range of graphic representations • interpret and evaluate information, identify main ideas and supporting evidence, and analyse different perspectives using comprehension strategies • compose and edit longer sustained learning area texts • use pair, group and class discussions and formal and informal debates as learning tools to explore ideas, test possibilities, compare solutions, rehearse ideas and arguments in preparation for creating texts • use wide knowledge of the structure and features of learning area texts to comprehend and compose texts, using creative adaptations of text structures and conventions for citing others • recognise and use aspects of language to suggest possibility, probability, obligation and conditionality • use language to evaluate an object, action or text, and language that is designed to persuade the reader/viewer • use a wide range of new specialist and topic vocabulary to contribute to the specificity, authority and abstraction of texts
Numeracy	• solve complex problems by estimating and calculating using efficient mental, written and digital strategies • identify trends using number rules and relationships • visualise and describe the proportions of percentages, ratios and rates • create and interpret 2D and 3D maps, models and diagrams • convert between common metric units for volume and capacity and use perimeter, area and volume formulas to solve authentic problems
ICT	• locate, retrieve or generate information using search facilities and organise information in meaningful ways • design and modify simple digital solutions, or multimodal creative outputs or data transformations for particular audiences and purposes following recognised conventions • use appropriate ICT to collaboratively generate ideas and develop plans
Creative & Critical Thinking	• pose questions to probe assumptions and investigate complex issues • clarify information and ideas from texts or images when exploring challenging issues • draw parallels between known and new ideas to create new ways of

	achieving goals • generate alternatives and innovative solutions, and adapt ideas, including when information is limited or conflicting • predict possibilities, and identify and test consequences when seeking solutions and putting ideas into action • identify gaps in reasoning and missing elements in information • differentiate the components of a designed course of action and tolerate ambiguities when drawing conclusions • explain intentions and justify ideas, methods and courses of action, and account for expected and unexpected outcomes against criteria they have identified
Personal & Social Capability	• analyse personal and social roles and responsibilities in planning and implementing ways of contributing to their communities • assess the extent to which individual roles and responsibilities enhance group cohesion and the achievement of personal and group objectives
Ethical Understanding	• analyse the ethical dimensions of beliefs and the need for action in a range of settings • analyse inconsistencies in personal reasoning and societal ethical decision making • investigate scenarios that highlight ways that personal dispositions and actions can affect consequences • analyse rights and responsibilities in relation to the duties of a responsible citizen • draw conclusions from a range of points of view associated with challenging ethical dilemmas
Intercultural Understanding	• assess diverse perspectives and the assumptions on which they are based • imagine and describe the feelings and motivations of people in challenging situations

Cross-curriculum priorities

Sustainability, Aboriginal and Torres Strait Islander histories and cultures

Diversity of learners

The Australian Curriculum is based on the assumptions that each student can learn and that the needs of every student are important. These needs are shaped by individual learning histories and abilities as well as personal, cultural and language backgrounds, and socio-economic factors. Teachers may adapt or plan additional learning activities depending on the multiple, diverse and changing needs of their students.

National Consumer and Financial Literacy Framework	
(Note: the student learnings in the National Consumer and Financial Literacy Framework are divided into, and are applicable over, bands covering two chronological years.)	
Dimension	**Student learnings by the end of Year 8**
Knowledge and understanding	• Research, identify and discuss the rights and responsibilities of consumers in a range of 'real-life' contexts • Analyse and explain the range of factors affecting consumer choices
Competence	• Justify the selection of a range of goods and services in a variety of 'real-life' contexts
Responsibility and enterprise	• Explain how individual and collective consumer decisions may have an impact on the broader community and/or the environment • Apply consumer and financial knowledge and skills in relevant class and/or school activities such as student investigations, charity fundraising, product design and development, business ventures and special events • Apply informed and assertive consumer decision-making in a range of 'real-life' contexts • Demonstrate awareness that family, community and socio-cultural values and customs can influence consumer behaviour and financial decision-making

Sequenced teaching and learning activities

Introducing	Resources
Activity 1: Issues in the world of water *(90 minutes)* Through a series of activities awareness is raised of the water issues facing individuals, society and the world.	• Print resource 1: Water quiz • 12 'letterboxes' e.g. shoeboxes • Print resource 2: Letterbox quiz questions • Worksheet 1: Survey about bottled water use
Assessment: Diagnostic Student survey of bottled water shows prior understanding about financial literacy. Letterbox quiz shows the students' scientific understanding.	

Developing	Resources
Activity 2: Watch, read and answer *(45 minutes)* Students use their literary skills to explore global issues and events about water and local issues.	• Worksheet 2: World Water Day video • Video: UNESCO 2012, 'The world is thirsty because we are hungry' (2:32)
Activity 3: Understanding water management in Australia *(180 minutes)* Students investigate the water cycle, water issues in Australia and the Great Artesian Basin to gain an understanding of the changes water undergoes in the natural world, as well as issues of water management in Australia.	• The water cycle websites: — Earthguide — US EPA online • Sydney Water – The water cycle • Gallery Walk – how to conduct one • Videos: Water down under – the Great Artesian Basin story (32:43) — Great Artesian Basin (2:23) Worksheet 3: 'Water down under – the Great Artesian Basin story'
Assessment: Formative Students write answers to questions based on a video about the Great Artesian Basin and then get feedback from the teacher.	
Activity 4: Pure water *(90 minutes)* Students view a demonstration of distillation, then conduct filtration activities	• Bottle of distilled water • Eucalyptus oil, tea tree oil or kerosene • Distillation equipment – filter funnels, beakers,

Developing	Resources
on muddy water. They will learn about separation techniques that can be applied to purify water.	conical flask, filter paper, sand and gravel, muddy water and other separation equipment as required • Scales – either triple beam balances or electronic balances
Activity 5 Tap versus bottled water *(90 minutes)* Students research and compare processes of water purification in suburban water supplies with treatments of bottled water. They will gain a scientific understanding of the differences (or lack of differences) between types of drinking water.	• Websites: — Sydney Water — Melbourne Water — Mount Franklin Water — Evian Water • Student Worksheet 4: How to construct a flow chart • Print resource: article – 'World Science Festival" Why do people buy bottled water when it's free from a tap?'

Culminating	Resources
Activity 6: Should I drink bottled water? Looking at the facts *(120 minutes)* Students investigate whether they can taste the difference between bottled water and tap water. They calculate personal costs of drinking water and assess the environmental impacts of disposing of plastic water bottles.	• Worksheet 5: Should I drink bottled water? • Range of bottled water and tap water • Disposable plastic cups • Sticky labels for cups • Scales – either triple beam balances or electronic balances
Assessment: *Summative* — Students draw conclusions from evidence collected during investigations and complete calculations, a simple measuring activity and a written paragraph to display their learning.	
Activity 7: Optional task Students are encouraged to drink only tap water for a year and to donate the money they would normally have spent on bottled water to a third-world country experiencing problems resulting from lack of access to potable water.	

Assessment rubric

This rubric aligns with Year 7 Australian Curriculum: Science, which is the focus of this unit. Teachers may wish to expand to include other learning areas. This rubric is intended as a guide only. It can be modified to suit teachers' needs and to be integrated into existing assessment systems.

Teachers may also wish to collect the worksheets as work samples for individual student folios.

Student's name:

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can use a separation technique to filter muddy water.	Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)	Activity 4	The student independently selects appropriate equipment and plans and conducts the experiment successfully. The student identifies and accurately measures residue and filtrate and follows the example to provide a correct, fully justified calculation. The student uses appropriate scientific language and fully labelled diagrams to communicate procedure and results.	The student selects appropriate equipment and plans and conducts the experiment with some teacher prompting/assistance. The student measures residue and filtrate and follows the example to provide a calculation. The student uses some scientific language and diagrams to communicate procedure and results.	With significant teacher guidance and support, the student: – selects appropriate equipment and conducts the experiment – measures residue and filtrate – follows the example to attempt a calculation. The student uses everyday language and drawings to communicate procedure and results.	
The student can investigate the water cycle.	Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable (ACSSU116)	Activity 3 Worksheet 3	The student accurately labels a diagram representing all processes in the water cycle with appropriate scientific terms displayed. The student identifies and explains the places where	The student labels a diagram representing most processes in the water cycle with most scientific terms displayed.	The student labels a diagram showing some processes in the water cycle with some scientific terms displayed.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
			potable water is found and identifies how humans have 'tapped into' the cycle by drilling bores and building dams.			
The student can explore how human management of water impacts on the water cycle.	See ACSSU116 above.	Activity 5 Worksheet 4	The student constructs detailed flow charts that compare the processes involved in producing potable water by tap and bottle. Communication is concise and coherent using appropriate scientific language sourced from thorough research.	The student constructs flow charts of the processes involved in producing potable water by tap and bottle. Communication is generally coherent using appropriate scientific language sourced from research.	The student constructs partial flow charts using the teacher's model as a guide. Communication is fragmented and uses everyday language.	
The student can analyse information and data from different sources about global and local water issues.	Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations (ACSHE120)	Activity 2 Worksheet 2	The student analyses information and data presented in a video and newspaper article in detail to complete all questions accurately. The student demonstrates a thorough understanding of the need for sustainable choices by providing a clear explanation of	The student analyses information and data presented in a video and newspaper article in some detail to complete questions. The student demonstrates a sound understanding of the need for sustainable choices by providing a satisfactory explanation of the	The student views information and data presented in a video and newspaper article and answers some questions by restating given facts. The student attempts an explanation of the statement: 'The world is thirsty because we are hungry', but it is unclear/incomplete due	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
			the statement: 'The world is thirsty because we are hungry'. The student identifies the trend in bottled water sales in Australia and cites relevant evidence to support conclusions.	statement: 'The world is thirsty because we are hungry'. The student identifies the trend in bottled water sales in Australia and cites a piece of evidence.	to only a partial/limited understanding of the need for sustainable choices. The student describes the trend in bottled water sales in Australia without citing evidence.	
The student can select and summarise information about issues in science that affect individuals and communities.	See ACSHE120 above.	Activity 3 Worksheet 3	The student selects and summarises relevant information to: – complete a PMI chart that clearly and concisely explains the use of bore water in the Great Artesian Basin – clearly explain how a range of management issues in the GAB have been addressed – give a comprehensive explanation of the advantages and disadvantages of bore water – accurately record and communicate what they have learnt about the sustainable use of water in the GAB.	The student selects information to: – complete a PMI chart that describes the use of bore water in the Great Artesian Basin – describe how some management issues in the GAB have been addressed – list some advantages and/or disadvantages of bore water – record some statements about what they have learnt about the sustainable use of water in the GAB.	The student records isolated statements about: – the use of bore water in the Great Artesian Basin in a PMI chart – how management issues in the GAB have been addressed – advantages and/or disadvantages of bore water – what they have learnt about the sustainable use of water in the GAB.	

Skill	Relevant content description(s)	Relevant activities and worksheets	Competent	Developing at level	Needs further development	Notes
The student can conduct a scientific investigation and collect and use evidence to support a conclusion.	Use scientific knowledge and findings from investigations to evaluate claims based on evidence (ACSIS132)	Activity 6 (suggested summative assessment) Worksheet 5 (student assessment task, includes marking criteria)	Part A – The student: • accurately summarises and conveys results using an appropriate form of representation • draws a conclusion that is consistent with data and related to initial question • reflects on effectiveness of the investigation method and explains modifications for improvement with reference to the quality of the data. Part B – The student: • calculates all costs accurately • justifies a conclusion based on evidence.	Part A – The student: • summarises and conveys results using a suitable form of representation • draws a conclusion that is linked to data and initial question • reflects on effectiveness of the investigation method and suggests a modification for improvement. Part B – The student: • calculates all costs • draws a conclusion that is consistent with some evidence. Part C – The student: • measures mass and calculates	Part A – The student: • restates results using a form of representation • states a conclusion that is not linked to data or initial question • suggests no modifications for improvement. Part B – The student: • attempts calculations but makes errors • restates information as a conclusion. Part C – The student: • measures mass but doesn't link calculation to required data from Part B • draws a diagram of the water cycle but fails to	

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			Part C – The student: • measures mass and calculates accurately • constructs a clearly labelled diagram of the water cycle that identifies places where and ways in which humans remove or add water.	with some accuracy • constructs a labelled diagram of the water cycle that identifies some places where and ways in which humans remove or add water. Part D – The student: • draws on one or two findings to support a relevant conclusion.	identify places where and/or ways in which humans remove or add water. Part D – The student: • writes a conclusion as 'yes/no', but fails to justify or an attempt to justify is unclear.	
			Part D – The student: • draws on relevant findings (at least two) to make a valid and justified conclusion based on reflection of investigation methods and evidence.			

Teacher notes

Activity 1: Issues in the world of water (90 mins)

Introduction

We take for granted that we are never thirsty because safe drinking (potable) water is readily available on tap and in bottles in our modern society. Water is used in cleaning, agriculture, industry, transport, power generation and for cooling. An overview of the unit is presented below, together with some interesting facts on water and its importance, which can be used as discussion starters and to stimulate students' interest in the unit.

- The importance of water worldwide is reflected in the emphasis placed on water by the United Nations (UN). The UN article 'The right to water' states that about 884 million people do not have access to safe drinking water and approximately 1.5 million children under five die each year from waterborne disease. The United Nations proclaimed 2005–2015 as the International Decade for Action, 'Water for Life'.
- Most students learn about the water cycle in primary school. This unit revisits the water cycle and the processes and changes of physical state that water undergoes in nature but with an emphasis on human management of water. Sustainable use of water from the water cycle is essential for the ongoing availability of fresh water. The Great Artesian Basin will be used as a case study of water management in Australia. Domestic water supplies are also examples of human management of the water cycle. Droughts and floods are part of the natural water cycle in Australia. Students may recall some government responses to water shortages in drought times, such as building desalination plants to ensure domestic supplies. At the height of the 2006 drought, when Toowoomba's water supplies were critically low, a proposal to pipe treated water from sewage (recycled water) into the town storage was debated. This was highly contentious and voted down in a referendum.
- Students apply their understanding of the water cycle to see the similarities and differences between bottled water and treated domestic water from a tap. Their decision as consumers about whether to drink bottled water will be further informed by comparing costs and calculating the mass of plastic that is added to landfill.

Optional fundraising activity

Teachers are encouraged to give students the opportunity to consider problems resulting from lack of access to potable water in third-world communities and to raise funds to support an appropriate charity by class fundraising (e.g. the money saved in one year from drinking tap water rather than bottled water).

For more information see the video from Water Wells for Africa called 'Water is essential for life' (3:45) or read the article at Water wells for Africa.

Print resource 1: Water quiz

This quiz of ten multiple-choice questions raises awareness about the importance of water. See Print **Print resource 1: Water quiz**. Present the quiz in such a way as to get students interested and engaged in the unit. This could be by using an interactive whiteboard, team challenge or making it an online quiz.

After students have answered the questions, go through them together and discuss answers. Discussion suggestions are provided.

Print resource 2: Letterbox quiz questions

Twelve ‘letterboxes’ are placed around the room. Each letterbox has a question attached to the top and a slot for posting the answers. Students move around the boxes, read the questions and post their answers anonymously. The teacher discusses the answers with the class and collates student answers to determine the proportion of the class who have a prior understanding of water and its importance for life. See **Print resource 2** for letterbox quiz questions.

Additional interesting facts on water: Blue Planet (nsw.edu.au)

Survey about bottled water use

- Students complete Worksheet 1: Survey about bottled water use.
- The teacher assists students to collate the class data and discuss the results.
- Collating class results will determine:
  - how many students drink bottled water and how often
  - the proportion of students in the class who drink bottled water.
- Assume the proportion of students drinking bottled water is the same for the school as for your class and that each student drinks one bottle of water per day. How many bottles of water would the students at your school consume in a year?
- If each bottle of water cost $4.00, how much is spent by students at your school each year on bottled water?

Optional additional activities

Further science investigations of water are described in ‘Global water experiment’ (5:35), a video from the 2011 International Year of Chemistry. Four experiments completed by students from over 80 countries can be found at:

- water.chemistry2011.org/web/iyc
- Global water experiment (Youtube)

Activity 2: Watch, read and answer (45 mins)

UNESCO World Water Day 2012 video (2:32)

Students watch the World Water Day, March 2012 UNESCO video The world is thirsty because we are hungry and answer the questions on **Worksheet 2: World Water Day video**.

Answers to **Worksheet 2: World Water Day video** are provided in the Solutions section at the end of the unit.

Additional information for teachers can be found at the following links:

- The Right to Water
- Global Water Experiment

Activity 3: Understanding water management in Australia (180 mins)

The water cycle

In order to decide whether we should drink bottled water, we need to understand the **water cycle** and how it is managed, as it is the ultimate source of our water.

- Students explore websites that explain the water cycle. These include:
  - Earthguide
  - US EPA online
  - The Sydney Water website has a simple explanation of the water cycle, key terms and a simple interactive game. It also has a link to the managed water cycle (see 'urban water cycle') that discusses suburban practices to ensure water supply to a city. This is discussed later in Activity 5.
- Check that students understand the terms evaporation, precipitation, condensation, freezing, melting and groundwater. If using the Earthguide water cycle interactive, explain infiltration (absorption into the soil to become groundwater), run-off, evapotranspiration (evaporation from the leaves of plants) and capillary action (upward movement of water in the narrow tubes that make up the veins of plants).
- Discuss the water cycle in Australia and the concept of managing the water cycle. Information can be found at the Sydney Water website link above.
- On completion of research and discussion, students display their understanding of processes in the water cycle and identify and explain the places where potable water is found.
- Students brainstorm and develop a list of the problems that Australia faces with the supply of fresh water. Class discussion could include issues such as:
  - Most of Australia is arid, so while many of the plants and animals have adapted, humans in these areas need to carefully manage water use. Aridity may increase with climate change.
  - Competition between using water for irrigation, hydroelectricity and maintaining river flows to retain healthy natural ecosystems.
  - Droughts and floods present challenges to maintaining urban water supplies and safe river flow rates.
  - Salinity and rising water tables resulting from tree removal and other agricultural practices.
- Pose the question: 'Where does our tap water come from?'

  Students from some large cities will instantly answer 'dams' and may be unaware of the high dependence on bore water in many towns. Recall the protests in Toowoomba when it was proposed that treated recycled wastewater would become part of the town supply and mention that many cities such as London rely on recycled water.
- Students write a diary entry for a molecule of water in Australia and construct a diagram to display where the water molecule travelled. Do a Gallery Walk to give students the opportunity to see where other water molecules travelled. (See https://www.facinghistory.org/resource-library/teaching-strategies/gallery-walk for an explanation of how to conduct a Gallery Walk.)

The Great Artesian Basin

Use the Great Artesian Basin as a case study of rural water management. The teacher highlights the movement and storage of subterranean water and the reasons why some spring or bore water is hot. Relate this to water issues in Australia – the use of bore water and the Great Artesian Basin.

- Show the video Water down under – the Great Artesian Basin story (32:43)
    - Students complete **Worksheet 3: 'Water down under – the Great Artesian Basin story'**.
    - The teacher marks the answers and gives feedback to students. (Answers to Worksheet 3 are provided in the Solutions section at the end of this unit.)
    - There is also an abbreviated version of this video Great Artesian Basin (2:23). The questions on Worksheet 3 may need to be adjusted for the abbreviated version.
- Find a clear diagram of the water cycle online or in a reference book. Provide each student with a copy. Students use post-it notes to add comments to the diagram of the water cycle to show how humans have 'tapped into' the cycle by drilling bores and building dams.

Extension *(optional)*

- Students could build a model of a borehole.
- Check student understanding of why the sea is salty (and hence why groundwater is sometimes also rich in mineral salts). Students could add a friend (salt ions) to their diagram of a day in the life of a water molecule.

Activity 4: Pure water (90 mins)

Teachers may wish to engage students in exploring a variety of separation techniques in this activity and ensure they have an understanding of associated terms. These techniques include: sedimentation, decantation, filtration, centrifugation, evaporation and distillation.

- Explain that at home we often have to separate components of mixtures of solids and liquids. Ask students:
    - — How do workers get chips out of the hot oil in a fast food restaurant?
    - — How do you make tea so it does not have tea leaves in it?
- Students brainstorm examples of separating insoluble matter using filtration. Discuss how the size of the pores in the filter barrier have an impact on the filtration process.
- Discuss the differences that result from an increase in scale. What volume would a home water filter treat compared to how much water would be treated in a major capital city?
- Demonstrate or have students experiment with muddy water to understand the separation techniques of sedimentation, decanting and filtration.

  Allow muddy water to settle for a time to show that letting sedimentation occur naturally results in water that can be filtered more easily. Then decant and/or filter the remaining liquid. Highlight the layering that occurs in the sediment with the heavier particles on the bottom.

  Pumping water from near the surface of a dam is really decanting on a much larger scale.

- Explain to students that pure substances, such as pure water that has nothing else present except the pure elements of hydrogen and oxygen (H_2O), are usually obtained by distillation and can be used in the following ways:
    - a bottle of distilled water purchased from a grocery or hardware store. Explain its use in car batteries and irons and cases when pure water (with no dissolved substances) is needed.
    - some eucalyptus oil, tea tree oil or kerosene. Explain how these substances are produced using distillation. Fractional distillation separates liquids that have widely different boiling temperatures. Distillation can also be used to separate a solvent (e.g. water) from the solute (e.g. salt) that has been dissolved to form a solution.
- Either demonstrate or have students investigate distillation of a solution to show how evaporation is used to purify water. Discuss the differences between distilled water, dam water and spring water.

Muddy water investigation

Prior to the following activities, revise measurements of mass and volume. Students do calculation exercises converting litres to kilolitres and kilolitres to litres. They also convert grams to kilograms and tonnes, and the reverse.

- Give each student group a beaker containing a fixed volume of muddy water. Tell them to imagine they are in a situation where they need to drink this water. Provide a range of equipment. Students plan and conduct an investigation to filter muddy water. Students then dry the material they remove (the residue), measure its mass to see which group was able to get the most mud out of the water and measure the volume of the filtrate (water that passed through the filter).
- If 1 million litres of clean water was required from this muddy water, calculate the volume of muddy water that would be needed and the mass of the residue mud that would be extracted from the muddy water.

  Calculation example: if a student filtered 700mL of muddy water to achieve 500mL of clean water filtrate, they would need to filter 0.7/0.5 x 1 000 000 = 1 400 000L of muddy water to achieve 1 000 000L of clean water.

Extension (optional)

- Explore different types of filters (e.g. the use of sand and gravel) and their effect on the clarity of the filtrate. As a class, discuss the places in the water cycle where 'natural' filtration or purification of water may occur. For example, compare evaporation in the water cycle with the distillation of salty water. Explore how water percolating through swamps into the water table compares with filtration.
- Ask students:
    - Just because the water looks clear, is it safe to drink?
    - Does boiling water always make it safe?
- Discuss the possibility of dissolved toxins and microorganisms in water. Scientific analysis is needed to be absolutely certain that water is potable.
- Students research the use of water purification tablets for hikers or the use of sunlight-powered purifiers to clean water: http://www.sciencemag.org/news/2017/02/sunlight-powered-purifier-could-clean-water-impoverished

Activity 5: Tap versus bottled water (90 mins)

Students have learnt about the water cycle and how it is managed in the Great Artesian Basin. They have also learnt how water can be treated to ensure that it is potable. They now investigate how the water cycle is managed in supplying water to large cities. They compare those processes and products with the water available in bottled water supplies.

Students research how suburban water supplies are treated, for example

- Sydney Water education
- Melbourne water education
- Check that students know how to construct a flow chart. Use **Worksheet 4: How to construct a flow chart**. Model the construction of a flow chart for part of the water cycle; for example, water is in the ocean, water cools and turns to sea ice, water is heated and turns to water vapour. Students construct a flow chart of the processes involved in ensuring suburban water is safe to drink.

The pros and cons of bottled water

- Students read the following articles:
  - World Science Festival: Why do people buy bottled water when it's free from a tap?
  - Bottled water
  - Is bottled water worth the cost?
- After reading these articles, students brainstorm as a class and then work in cooperative groups to research specific aspects of bottled water or other aspects of interest. Each group then reports their findings to the class. The aspects include:
  - a list of brands of bottled water
  - the range of sources of bottled water
  - the processes used to obtain bottled water
  - cost of bottled water as compared to tap water
  - the positives and negatives of drinking tap water as compared to bottled water
  - why there has been such an increase in the sale of bottled water over the past 10 years.
- You may also wish to extend this activity and ask students to apply their scientific understanding of the water cycle and analyse the advertising videos on many of these websites. For example the Mount Franklin website describes how the spring water is triple filtered, and Evian says that their water has exceptional qualities from the purity of its source.
- Students brainstorm a list of questions they might ask in the process of producing potable water either in bottles or by tap. For example:
  - Does the water contain suspended solids?
  - Does the water contain harmful microorganisms?
- Students construct a flow chart for one brand of bottled water each or per group. The class collates and compares information from the different flow charts and discusses the differences between the processes used to produce bottled water and tap water.

- Discuss the concept of 'travel miles' and how much extra demand on the environment drinking bottled water imported from France might cause.
- Explain that according to the information presented in the article: Bottled water (see 'Bottled water – did you know?'):
  — The average cost of a litre of tap water in Australia is 0.001 cents per litre.
  — The average cost of a litre of bottled water in Australia is $2.83 per litre.
  — The average Australian drinks 14 litres of bottled water a year.

  Based on these figures:
  — How much does the average Australian spend on bottled water each year?
  — Approximately how much would your family spend on bottled water each year, if your family conformed to this average? (Include all members of your family.)
- The data and figures quoted are statistical averages. Do your family's water-drinking habits align with the Australian average? Provide information to support your answer. The teacher may need to model how to calculate the cost per litre of bottled water and tap water (calculating conversions from kL to L and mL to L).

Extension (optional)

- Explore how desalination plants work and the advantages and disadvantages of this form of water processing.
- Use this article on Drinking recycled water to research the need for recycled water, the challenges encountered in recycling water and what strides are being made to make recycled water available.
- Students apply their understanding of water cycle management in the Catchment Detox online game.
- Use this additional resource to support student understanding of cloud formation: Bill Nye, 'Water cycle' video (2:57).

Activity 6: Should I drink bottled water? Looking at the facts (120 mins)

The task is to answer the question: 'Should I drink bottled water?' As a result of student investigation and analysis of four specific considerations as set out in Parts A, B, C and D, students will come to a decision as to whether or not they should drink bottled water. Each part is set out **Worksheet 5: Should I drink bottled water?**

— Part A – Is there a detectable difference between the types of water based on taste?
— Part B – What is the difference between bottled water and tap water based on cost to the individual?
— Part C – Is there a difference in the impact on the environment between bottled water and tap water?
— Part D – Answer the question: 'Should I drink bottled water?'

Part A

Students participate in an investigation to determine whether they can taste the difference between a range of bottled waters and tap water. Students record findings in **Worksheet 5: Should I drink bottled water? – Part A**.

The teacher explains a 'blind' test. Students will be given four samples of a range of bottled and tap water to taste. The water will be placed in plastic cups and labelled with letters A to D. Neither the students nor the teacher will know which is the bottled water and which is the tap water if it is possible for the teacher to enlist the assistance of another adult to pour the water samples into the labelled cups. (This is called a 'double blind' experiment. If the teacher or administrator of a test knows what the products are, their body language may inadvertently convey the information to the participants.) Students make notes on their taste test and predict which sample they think is the tap water and identify whether they can detect the difference between bottled and tap water. They also record which sample they prefer on the basis of taste. The class results are collated and conclusions are drawn as to which samples were tap water and which were bottled water. These results are then compared to the identified water sample sources.

Part B

Students use figures provided in **Worksheet 5: Should I drink bottled water? – Part B** to calculate the cost of drinking bottled water and tap water over a year. Revise and check that students can determine the mass of an empty water bottle and can convert litres to kilolitres. Assuming students drink 3L of water per day, they calculate the cost of tap water versus bottled water over one week and one year.

Part C

Students calculate the mass of plastic that would be disposed of in a year if each 600mL bottle of water were bought new. Record calculations in **Worksheet 5: Should I drink bottled water? – Part C**. Students also construct a diagram of the water cycle and show the ways that humans 'tap into' the water cycle in Australia.

Part D

Students draw together different findings and make a conclusion based on a reflection about investigation methods and evidence gained throughout the unit. Students record at least two reasons for their opinion.

Activity 7: Optional task

Teachers are encouraged to give students the opportunity to consider problems resulting from lack of access to potable water in third-world communities and to raise funds to support an appropriate charity by class fundraising (e.g. the money saved in one year from drinking tap water rather than bottled water).

For more information, see the video from Water Wells for Africa called Water is essential for life' (3:45) or read the article at waterwellsforafrica.org/the-need.

Resources

Print resource 1: Water quiz

Questions

1. Two-thirds of the Earth's surface is covered by water. How much of it is fresh?
   A 1%
   B 20%
   C 97%

2. How long can a human survive without water?
   A Less than a week
   B One to two weeks
   C Up to three weeks

3. People in Sub-Saharan Africa use as much water in a day as someone in a developing country does while:
   A Brushing their teeth for two minutes with the water running
   B Running the sprinkler for 10 minutes
   C Either of the above

4. Toilets account for how much of the water used in the home?
   A 15%
   B 23%
   C 30%

5. How much of the 1600 million litres of water used in Sydney every day becomes wastewater?
   A Two-thirds
   B Half
   C Three-quarters

6. How much water does it take to produce one kilogram of meat?
   A 23 500 litres
   B 41 500 litres
   C 60 500 litres

7. How much water does it take to make a pair of pantyhose?
   A 20 litres
   B 200 litres
   D 2000 litres

8. How much of Australia's land is arid?
   A 50%
   B 60%
   C 70%

9. Where does the most irrigation occur in Australia?
   A Burdekin-Haughton irrigation area
   B Ord irrigation district
   C Murray-Darling Basin

10. Lake Argyle, part of the Ord River irrigation scheme in Western Australia, contains the amount of water equivalent to how many Sydney Harbours?
   A One
   B Five
   C Eleven

Print resource 2: Letterbox quiz questions

Photocopy the questions below and place on letterboxes for students to answer anonymously.

Questions
1. Bottled drinking water is a pure substance. True/False
2. Water is essential for life. True/False
3. Water is a very good solvent. This means that ___________________________
4. Water flowing in a stream or river is always safe for drinking. True/False
5. A filter will remove all harmful things from water. True/False
6. Groundwater is the water that is contained within the soil and rocks (lithosphere) of Earth. True/False
7. Water is the only substance that exists naturally on Earth in the solid, liquid and gaseous states. True/False
8. Drinking water helps us to maintain our body temperatures at the correct level. True/False
9. Water is needed to carry toxins out of our bodies. True/False
10. All spring water is potable (good to drink). True/False
11. If I use 1.5 litres of water for drinking per day, how many litres and kilolitres would I drink in a year?
12. If I had 1.23 tonnes of sandstone, how many kilograms would I have?

Worksheets

Name: .... Class: .... Date: ....

Worksheet 1: Survey about bottled water use

1. Approximately how many litres of water do you drink each day?
(A cup of water is approximately 250 millilitres.)

____

2. a. Complete the table by ticking in the box – first for yourself and then asking other class members. In order to record how many class members respond to the various categories, use a marking system such as the following. Record each response with a (I), then when you have five responses the same, mark the fifth response with a line across, e.g. ~~IIII~~. This symbolises five similar responses.

	Never		**Sometimes**		**Often**		**Most of the time**		**Always**	
	Me	Class	Me	Class	Me	Class	Me	Class	Me	Class
I drink water from the tap.										
Total for class										
I drink bottled water.										
Total for class										

b. From the results above, how many students in your class drink bottled water? (Include figures for never, sometimes, often, most of the time and always.)

Never: ______________Sometimes: ________________

Often:_______________Most of the time: ____________ Always: ___________

3. a. How many students in your class? _______________________

b. From the results above, calculate the proportion of students in your class who drink bottled water.

____

c. What proportion of students do not drink bottled water at all?___________

Name: .... Class: .... Date: ....

Worksheet 1: Survey about bottled water use (cont)

4. Consider the factors that influence the type of drinking water you choose.

   a. Complete the table yourself and then ask other class members what factors they consider before choosing the water they drink. Use the same recording system as you used in Question 2.

	Never		**Sometimes**		**Often**		**Most of the time**		**Always**	
	Me	Class	Me	Class	Me	Class	Me	Class	Me	Class
Health										
Cost										
Taste										
Convenience										
Packaging										
Image										
What friends and others drink										
Environmental impact										
Other (please specify)										

   b. Which factor is most important for your class when choosing what type of water to drink?

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____

Name: .... Class: .... Date: ....

Worksheet 2: World Water Day video

Carefully watch the video ‘The world is thirsty because we are hungry’, produced for the United Nations, and answer these questions:

1. What is the size of the world population (in numbers and words)?

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2. What is the projected size of the population in 2050?

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3. How much water do humans drink per day?

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Name: .... Class: .... Date: ....

4. How much water is used per person per day to produce food?

5. What percentage of human water consumption is used in food production?

6. Compare the water used to produce wheat with that used to produce red meat.

7. What proportion of food produced is wasted?

Name: .... **Class:** .... **Date:** ....

8. What proportion of the world's population will be 'water stressed' by 2025?

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9. What are two things that individuals can do to reduce the amount of water needed for food consumption?

   i ____

   ii ____

10. Explain the statement 'The world is thirsty because we are hungry'.

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Name: .... Class: .... Date: ....

Worksheet 3: 'Water down under – the Great Artesian Basin story'

Watch the video and answer the questions below. Use scientific terms and language correctly and include diagrams where appropriate.

1. The steps in the formation of the Great Artesian Basin are listed below. Use numbers to place them in the correct order.

   ☐ Gondwana broke up and Australia drifted away from Antarctica.

   ☐ The deposits of sand, silt and clay had formed into layers of rock that became tilted into a basin shape.

   ☐ Sea levels rose and the depression that is now the Great Artesian Basin became a sea with deposits of clay and silt, which eventually formed rocks.

   ☐ Sea levels fell and rivers deposited sand that would eventually form sandstone.

   ☐ Australia was part of a much larger land mass called Gondwana.

2. What is the difference between impermeable and permeable (porous) rocks? Give an example of each.

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3. Name other solid materials that are permeable and impermeable.

   permeable ______________________________________

   impermeable ____________________________________

Name: .... **Class:** .... **Date:** ....

4. Is the demonstration of the difference between the impermeable and permeable rocks an example of a fair test? Explain.

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5. Fill in the gaps.

An aquifer results from a layer of _______________________ rock underneath a layer of permeable ____________________________. The permeable rock, e.g. ___________________, soaks up and holds __________________. The water can move through the _______________. An aquifer is like a sponge on top of a frisbee because ____

____

____

Name: .... Class: .... Date: ....

6. Describe the size and location of the Great Artesian Basin. Draw the outline of the Great Artesian Basin on a map of Australia.

Name: .... **Class:** .... **Date:** ....

7. What are recharge beds and where are they located?

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8. Why did Indigenous groups depend on the springs of the Great Artesian Basin?

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9. How did the discovery and use of the Great Artesian Basin by Europeans change that part of Australia?

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10. How did the discovery and use of the Great Artesian Basin by Europeans change the rest of Australia?

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Name: .... Class: .... Date: ....

11. What is the difference between a spring and a bore?

13. Construct a Plus, Minus and Interesting table about the use of bore water in the Great Artesian Basin.

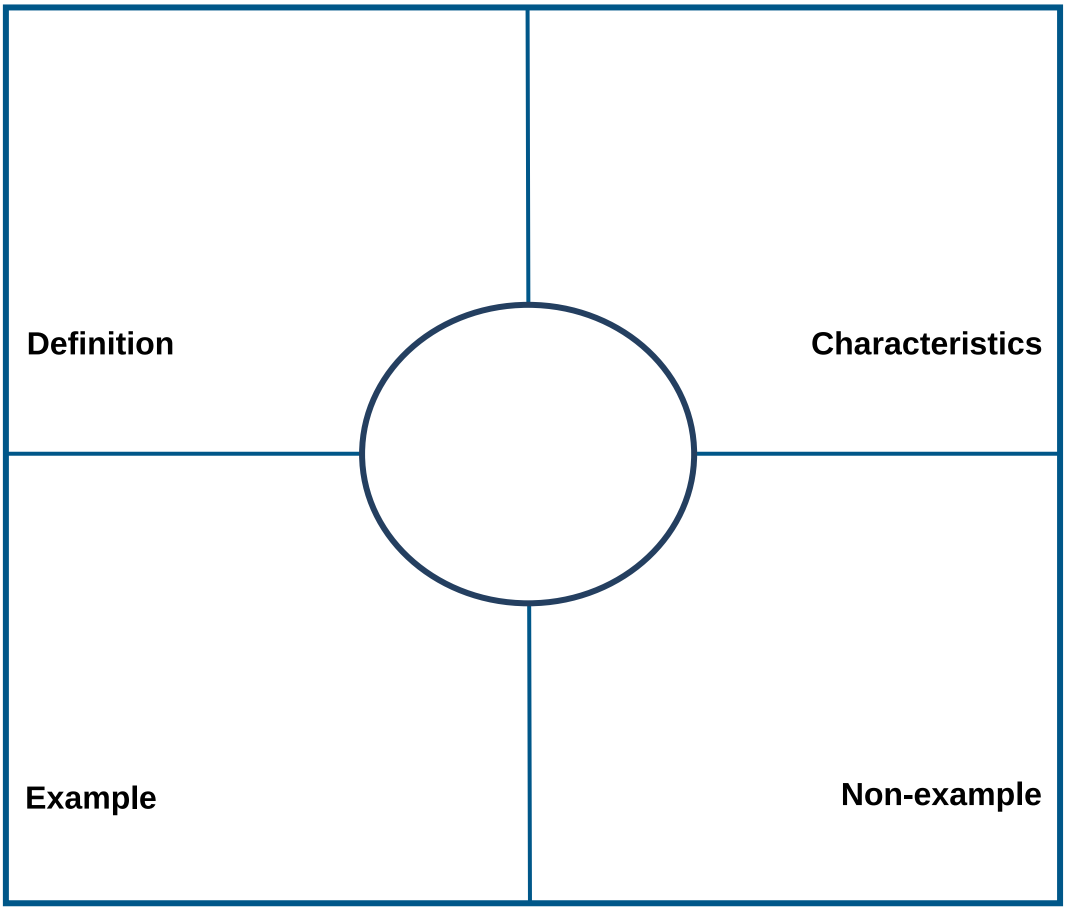
Name: .... Class: .... Date: ....

13. How have the management issues in the Great Artesian Basin been addressed? (Include an explanation of piping and capping.)

14. What are the advantages and disadvantages of bore water?

Name: .... Class: .... Date: ....

15. Use the diagram to summarise what you have learnt about the sustainable use of water in the Great Artesian Basin.



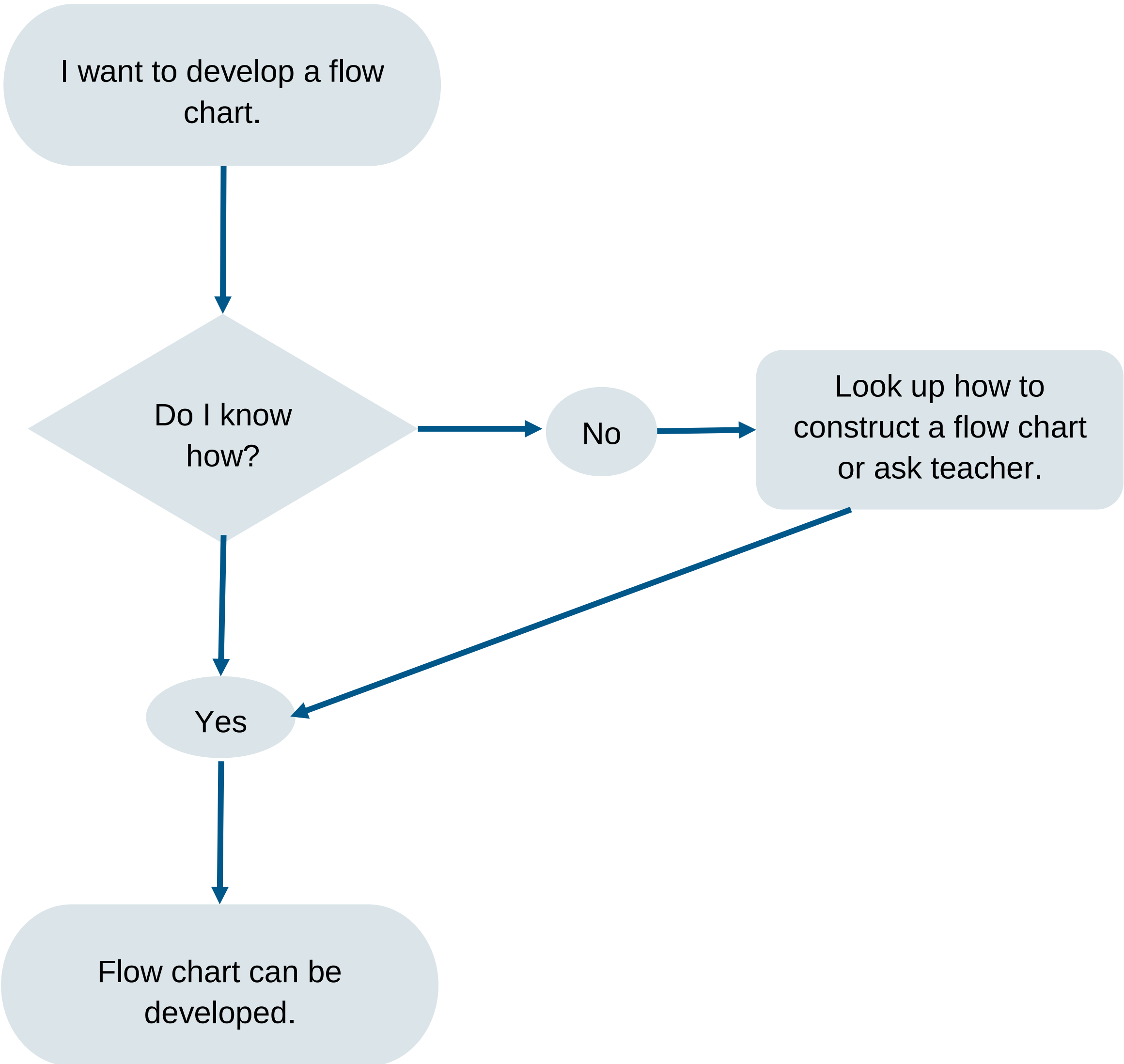
Sustainable use of water in the Great Artesian Basin

Name: .... Class: .... Date: ....

Worksheet 4: How to construct a flow chart

1. Start with a problem.
2. Ask a yes/no question.
3. Follow through the implications of the answers.
4. Solve the problem.

For a short tutorial on how to use Word to develop a flow chart



Name: .... **Class:** .... **Date:** ....

Worksheet 5: Should I drink bottled water?

Part A: Can I tell the difference between bottled water and tap water?

You will be provided with four disposable plastic cups of water each labelled either A, B, C or D.

- Taste each of the liquids and record your observations of taste.
- Predict whether each sample was tap water or bottled water.

	Water – A	Water – B	Water – C	Water – D
Tasting notes				
Could I taste the difference?				
Did I prefer one type?				
Prediction: tap or bottled?				
Actual source of water				

- Collate results of the class members.

Success of prediction	Number of students
No correct predictions	
One correct prediction	
Two correct predictions	
Three correct predictions	
All samples identified correctly	

- How could you have improved this investigation into the difference between the taste of bottled water and tap water?

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Name: .... Class: .... Date: ....

Summarise the results and draw a conclusion using graphs, tables and/or diagrams.

Name: .... Class: .... Date: ....

Part B: How much does my drinking water cost?

Assuming you drink 3L of water per day, calculate the cost based on prices of tap water and bottled water. (You may use a calculator here.)

Hint: *There are 1000L (litres) in 1kL (kilolitre). To convert litres to kilolitres, divide the litres by 1000.*

Tap water: if Sydney Water quotes the cost of water usage at $2.13 per kL, complete the table below.

	In a week	**In a year (365 days)**
Water consumed at 3L per day in L		
Water consumed at 3L per day in kL		
Cost at $2.13 per kL		

Bottled water: if the vending machine cost of 600mL bottle = $3.00, complete the table below.

	In a week	**In a year (365 days)**
Water consumed at 3L per day in L		
Number of 600mL bottles consumed		
Cost at $3.00 per bottle (taken to the nearest bottle)		

What can you conclude about the cost of drinking water?

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Name: .... Class: .... Date: ....

Part C: How much does my drinking water cost the environment?

Measure the mass of plastic in one 600mL water bottle. Calculate the total mass of plastic that would require waste disposal from drinking bottled water for one year. Show your working and calculations.

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Construct a diagram of the water cycle and show the ways that humans ‘tap into’ the water cycle in Australia.

Name: .... **Class:** .... **Date:** ....

Part D: Should I drink bottled water?

My opinion about drinking bottled water is:

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My reasons for this opinion are (list at least two reasons):

1. ____

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2. ____

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Solutions

Solutions to Print resource 1: Answers to water quiz

1. Only 1% of the Earth's water is fresh.
   Teacher follow-up question: What is the implication of this fact for supplies of safe drinking water?
2. People can survive without water for less than one week.
   Teacher follow-up question: What should you do/not do if lost in the bush without access to water?
3. Both brushing teeth for two minutes and running a sprinkler for 10 minutes use as much water as people in Sub-Saharan Africa use in a day.
4. Flushing toilets accounts for 23% of household water use.
   Teacher follow-up question: What changes have resulted from awareness of this wastage of water in, for example, dual flush toilets and using tank water in toilets?
5. Three-quarters of the 1600 million litres of water used every day in Sydney becomes wastewater.
   Discussion: Would this be the same in all areas of Australia? Which is the greater problem – water supply or wastewater disposal?
6. The production of one kilogram of meat requires 41 500 litres of water.
7. The production of one pair of pantyhose requires 200 litres of water.
8. Seventy per cent of Australia is arid.
9. Most irrigation in Australia occurs in the Murray-Darling Basin.
10. Lake Argyle in WA contains the amount of water equivalent to approximately eleven Sydney Harbours.

Solutions to Print resource 2: Answers to letterbox quiz

1. False. Unless it is distilled, water contains some dissolved substances. Bottled water is not distilled. It is a mixture and therefore not pure.
2. True
3. Many substances dissolve readily in water.
4. False. Water in streams may have agricultural run-off, industrial waste or other pollutants.
5. False. Some bacteria are very small and fit through most filters; this is why ozone or chlorine is often used to disinfect town water supplies.
6. True
7. True
8. True. Water is vital for life because of its ability to absorb and release heat with only a small change in temperature.
9. True. Urine contains water that carries out toxic urea.
10. False. Some spring water has many dissolved minerals that make it unsuitable for drinking. Some spring water can be polluted from nearby rubbish dumps and activities; for example, fracking for natural gas extraction has the potential to contaminate groundwater.
11. 547.5 litres and 0.55 kilolitres
12. 1230 kilograms of sandstone

Solutions to Worksheet 1: Survey about bottled water use

Students firstly record individual responses and then use class responses to complete a survey on their use of tap and bottled water.

Solutions to Worksheet 2: World Water Day video

Answers to Worksheet 2: World Water Day video – 'The world is thirsty because we are hungry'

1. What is the size of the world population (in numbers and words)? (7 billion, 7 000 000 000, seven thousand million)
2. What is the projected size of the population in 2050? (9 billion)
3. How much water do humans drink per day? (2–4L per day)
4. How much water is used per person per day to produce food? (Between 2000 and 5000L)
5. What percentage of human water consumption is used in food production? (90%)
6. Compare the water used to produce wheat with that used to produce red meat. (Ten times more water is required to produce 1 kilogram of red meat compared to 1 kilogram of wheat.)
7. What proportion of food produced is wasted? (One-third)
8. What proportion of the world's population will be 'water stressed' by 2025? (Two-thirds)
9. What are two things that individuals can do to reduce the amount of water needed for food consumption?
   i. Waste less food
   ii. Eat more sustainably, i.e. less red meat and more cereals
10. Explain the statement 'The world is thirsty because we are hungry'.

    Water is a finite resource. Water used for the production of food will not be available for drinking. If we wasted less food and ate foods that took less water to produce, more water would be available for drinking.

    This answer may seem counterintuitive to students from suburban areas as their food production areas are so far removed from their drinking water supply.

    Note: this video states that 15 000L is needed for the production of 1kg of meat, whereas the ABC quiz in Activity 1 states 41 500L. Remind students that they often need to compare information from different sources. The difference could be that the ABC figure may take into account agricultural practices in Australia and the fact that most cattle in Australia are raised in more arid conditions and often brought to the coast only briefly for fattening.

Solutions to Worksheet 3: 'Water down under – the Great Artesian Basin story'

Students watch the video 'Water down under – the Great Artesian Basin story' and answer the questions on this worksheet.

Answers to 'Water down under – the Great Artesian Basin story'

1. The steps in the formation of the Great Artesian Basin are listed below. Use numbers to place them in the correct order.

   (2) Gondwana broke up and Australia drifted away from Antarctica.

(5) The deposits of sand, silt and clay had formed into layers of rock that became tilted into a basin shape.

(3) Sea levels rose and the depression that is now the Great Artesian Basin became a sea with deposits of clay and silt, which eventually formed rocks.

(4) Sea levels fell and rivers deposited sand that would eventually form sandstone.

(1) Australia was part of a much larger land mass called Gondwana.

2. What is the difference between impermeable and permeable (porous) rocks? Give an example of each.

   Permeable rocks e.g. sandstone, allow water to soak through them. Impermeable rocks cannot be penetrated by liquids e.g. siltstone, granite.

3. Name other solid materials that are permeable and impermeable.

   Permeable: wood, bricks. Impermeable: glass, plastic. Note: some impermeable substances can be made to contain pores that make them permeable, e.g. a sponge made from plastic.

4. Is the demonstration of the difference between the impermeable and permeable rocks an example of a fair test? Explain.

   No, the shape and size of the sandstone are different from the other granite-like rock that was used. (It also appeared to be polished.) To be a fair test they would have been the same shape and size. The main point was still made: sandstone is porous and some other rocks are not.

5. Fill in the gaps (answers are in bold type).

   An aquifer results from a layer of **impermeable** rock underneath a layer of permeable **rock**. The permeable rock, e.g. **sandstone**, soaks up and holds **water**. The water can move through the **rock/aquifer**. An aquifer is like a sponge on top of a frisbee because **the sponge is porous and the frisbee is impermeable, so the water is trapped in the sponge and moves sideways like in an aquifer**.

6. Describe the size and location of the Great Artesian Basin.

   The Great Artesian Basin covers almost one-quarter of Australia and occupies a large part of Queensland, northern NSW, north-eastern South Australia and south-eastern Northern Territory. It is outlined by Cape York, Dubbo and Coober Pedy.

   Drawings of the location may vary. View a range of locations found via Google search.

7. What are recharge beds and where are they located?

   Recharge beds are the places where the permeable sandstone aquifer is close to the surface, and run-off or groundwater enters the aquifer and then percolates through it. Many of the recharge beds are along the Great Dividing Range (map shown in video).

8. Why did Indigenous groups depend on the springs of the Great Artesian Basin?

   The springs provided fresh water and food in the form of birds, mammals and reptiles that came to drink and crustaceans and insects that lived in the water. Plants that grew in and around springs also provided food and medicine, materials and shelter. They were also spiritual centres.

9. How did the discovery and use of the Great Artesian Basin by Europeans change that part of Australia?

   Initially the Great Artesian Basin wetlands of the Macquarie Marshes were a barrier to John Oxley’s expedition. Ten years later, Charles Sturt found the springs an invaluable water supply and a key to the use of the desert by stockmen. The major clue to the existence of the Great Artesian Basin was the successful drilling for bore water at Kallara Station near Bourke in 1878.

That opened up large sections of the Great Artesian Basin to farming. Eventually other activities included mining and tourism (hot springs). The telegraph line and rail transport could be developed across the Great Artesian Basin.

10. How did the discovery and use of the Great Artesian Basin by Europeans change the rest of Australia?

    The initial use of the Great Artesian Basin by Europeans brought wealth to the country, allowed better transport and communications.

11. What is the difference between a spring and a bore?

    The aquifer is near the surface and water naturally flows out of a spring. A bore has been drilled down into a deep aquifer and water may flow out under pressure, or in some cases is pumped out (e.g. using a windmill).

12. Construct a Plus, Minus and Interesting table about the use of bore water in the Great Artesian Basin.

    Possible pluses: irrigated agriculture results in greater food and fibre production, mines provide metals and coal, transport, communications and relaxation places

    Possible minuses: deterioration of ecosystems around springs, reduction in biodiversity, drop in water pressure and depletion of aquifers, more weeds and feral animals

    Interesting: the way humans continue to use finite resources as if they were limitless, and then get surprised when they run out

13. How have management issues in the Great Artesian Basin been addressed? (Include an explanation of piping and capping.)

    Government funding to support farmers to reduce water wastage and the impacts of open drains on weed and feral animal problems. Largely achieved by:

    — replacing open drains where most of the water was lost through evaporation by piping and containing drinking water for cattle in metal vessels
    — capping the bores to stop water flowing endlessly and so controlling flow of water.

14. What are the advantages and disadvantages of bore water?

    Use of bore water has meant large parts of arid Australia have been able to be used to produce food and materials we need. Bore water can contain dissolved minerals that make it unsuitable for some uses and it is a limited resource. By using bore water we are changing ecosystems in ways that we do not fully understand.

15. Use the diagram to summarise what you have learnt about the sustainable use of water in the Great Artesian Basin. *(The following answers can be placed on the diagram provided on the worksheet.)*

    Definition of sustainable use of the GAB: using the water available from the GAB in a way that it will continue to be available indefinitely

    Characteristics: minimal extraction of water through bores, efficient use of water, e.g. recycling, monitoring of water pressure so changes can be quickly detected

    Example: capping and piping of bores

    Non-example: water flowing freely out of bores into open irrigation channels

Solutions to Worksheet 4: How to construct a flow chart

Students follow instructions to complete a flow chart. The teacher models the construction of a flow chart for part of the water cycle. Students construct a flow chart of the processes involved in ensuring suburban water is safe to drink. Examples of flow charts can be used for reference.

One example is Space Place (NASA). More examples can be researched online.

Solutions to Worksheet 5: Should I drink bottled water?

Part A:

Students process results of class taste test and draw conclusions based on these.

Part B:

Tap water: if Sydney Water quotes the cost of water usage at $2.13 per kL, complete the table below.

	In a week	In a year (365 days)
Water consumed at 3L per day in L	7 x 3 = 21L	3L x 365 = 1095L
Water consumed at 3L per day in kL	21 ÷ 1000 = 0.021kL	1095L ÷ 1000 = 1.095kL
Cost at $2.13 per kL	$2.13 x 0.021 = $0.04473	$2.13 x 1.095 = $2.33

Bottled water: if vending machine cost of 600mL bottle = $3.00, complete the table below.

	In a week	In a year (365 days)
Water consumed at 3L per day in L	7 x 3 = 21L	3L x 365 = 1095L
Number of 600mL bottles consumed	21 x 1000 ÷ 600 = 35	1095L x 1000 ÷ 600 = 1825
Cost at $3.00 per bottle (taken to the nearest bottle)	$3.00 x 35 = $105	$3.00 x 1825 = $5475

What can you conclude about the cost of drinking water?

The results above show that it costs approximately 2350 times more to drink bottled water than tap water in a year using the given rates of consumption and prices. $5475 ÷ $2.33 = 2349.79

Part C:

Mass of one 600mL water bottle = 25g
(example only, students will measure the mass of their sample bottle)

Total mass of plastic waste disposal for 1 year = 25g x 1825 bottles = 45 625g or 45.625kg

Students draw a diagram showing ways that humans 'tap into' the water cycle in Australia.

An example of a diagram about how rainwater can be use is found on the Testbig website. More examples can be researched online.

Diagrams can also be represented as flow charts.

Rivers collect water from their catchment area, then it is stored in dams and pumped to water filtration and treatment plants and reservoirs. From there it is pumped to homes, businesses and schools etc. through water mains. Water from the oceans can also be turned into drinking water through treatment at desalination plants. Groundwater is tapped to supply bores and wells in some areas. Stormwater is piped to creeks, oceans or rivers, and wastewater is treated at plants for recycling purposes.

Part D:

Students draw together different findings and make a justified conclusion about whether they should drink bottled water. See Assessment rubric for marking criteria.