How much water should I drink?

Student booklet

9

Science

Queensland Comparable
Assessment Tasks
(QCATs) 2011

Given name: .....

Family name: .....

School: .....

Queensland Government

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Setting the scene: Group discussion

Six die on Kokoda track

Since 2006, six Australians have died from unknown causes while walking the Kokoda track, a gruelling 96 km trek through rugged mountains in the tropics of Papua New Guinea.

Theirs were not the only Kokoda deaths; a number of walkers have died from dehydration. What made these six deaths a mystery was that the six walkers were fit and healthy, and drank plenty of water.

The mystery was solved in 2010 when two Queensland doctors decided to test their theory that some walkers were drinking too much water.

The doctors took blood samples from almost 200 trekkers who had walked for a full day. They found that a small number had severely low sodium concentrations in their blood and had developed headaches. These trekkers had consumed large amounts of fluids.

The doctors advised the walkers to stop drinking water until their sodium concentrations returned to normal, and then to drink only when they were thirsty.

Adapted from Life in the Fastlane.com, "Kokoda Medicine", 7 Jun 2010, accessed 7 Apr 2011, <http://lifeinthefastlane.com/2010/06/kokoda-medicine>.

We are often reminded to keep well hydrated and are warned of the dangers of dehydration.

- How is it possible to die from drinking too much water?
- How does our body control the correct amount of water?
- What does sodium have to do with water balance?

In this assessment, you will:

- observe the effects of changing salt concentration on living tissue
- use your results and your understanding of cells and water balance to provide an explanation for the Kokoda deaths
- reflect on your understandings to provide advice and evaluate claims made about water needs.

At Kokoda, the Queensland doctors showed that drinking too much water reduces the sodium concentration in the blood and in the fluid surrounding the cells.

The investigation below models the effect of changing sodium concentration on living tissue.

- Plant tissue (potato) is used because it is not practical or ethical to use human tissue.
- Salt is used as a source of sodium.

Investigating the effect of changing salt concentration on living tissue

Follow your teacher's directions to carry out the investigation.

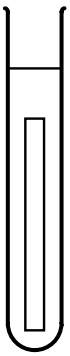
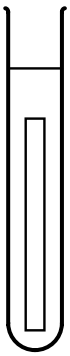
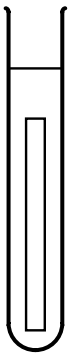
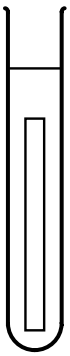
Aim: To measure the effect of changing salt concentration on the length of a potato slice.

Method

1. Label 5 test tubes A to E.
2. Obtain 5 freshly cut, narrow potato slices, all the same length.
3. Measure the length of each slice, to the nearest mm, and record in Table 1 (Original length).
4. Place each slice in a test tube.
5. Into test tube A, pour pure water until the potato slice is covered.
6. Into each of test tubes B to E pour salt solution corresponding to the concentration shown in Diagram 1 until each potato slice is covered.
7. Leave the potato slices to soak overnight.
8. Pour out the solutions and measure the length of each potato slice to the nearest mm.
9. Record the length of each slice in Table 1 (Final length).
10. Calculate the change in length of each slice and record in Table 1 (Change in length).
11. Observe any other changes to the potato slice and record in Table 1 (Other changes).

The chemical name for salt is sodium chloride (NaCl).

Diagram 1: Investigation set-up

Test tube	A	B	C	D	E
Water/solution Potato slice					
Salt concentration in grams/Litre (g/L)	0	5	10	15	20

Stop here: Leave your potato slices in the solutions until the next lesson.

Table 1: Investigation results

	Test tube	A	B	C	D	E
	Salt concentration (g/L)	0	5	10	15	20
Potato slice	Original length (mm)					
	Final length (mm)					
	Change in length (+/– mm)					
	Other changes					

Stop here: Discuss your results.

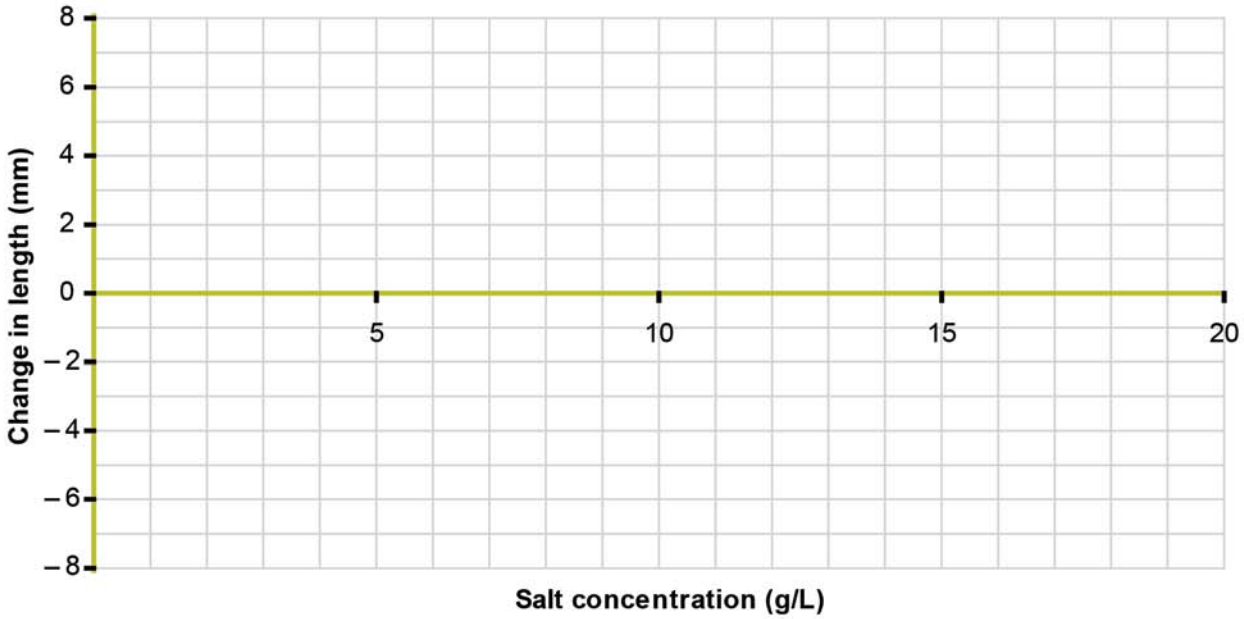
Analysing and explaining the results

Individual work

Work on your own to complete the assessment.

1. Present the data from the investigation as a line graph below.

Graph 1: Effect of salt concentration on length of potato slice



2. a) What is the independent variable? .....

b) What is the dependent variable? .....

c) Complete Table 2 to show how other variables were controlled.

Table 2: Other variables

Variable	Controlled or not controlled?	Explain how it was controlled (or not controlled)
temperature	controlled	salt solutions and potato slices were all at room temperature

3. **Is the investigation an example of a fair test? Explain by referring to Question 2.**

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4. **What do your results tell you about the effect of high and low salt concentrations on the length of a potato slice?**

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5. **At what salt concentration would the length of the potato slice not change?**

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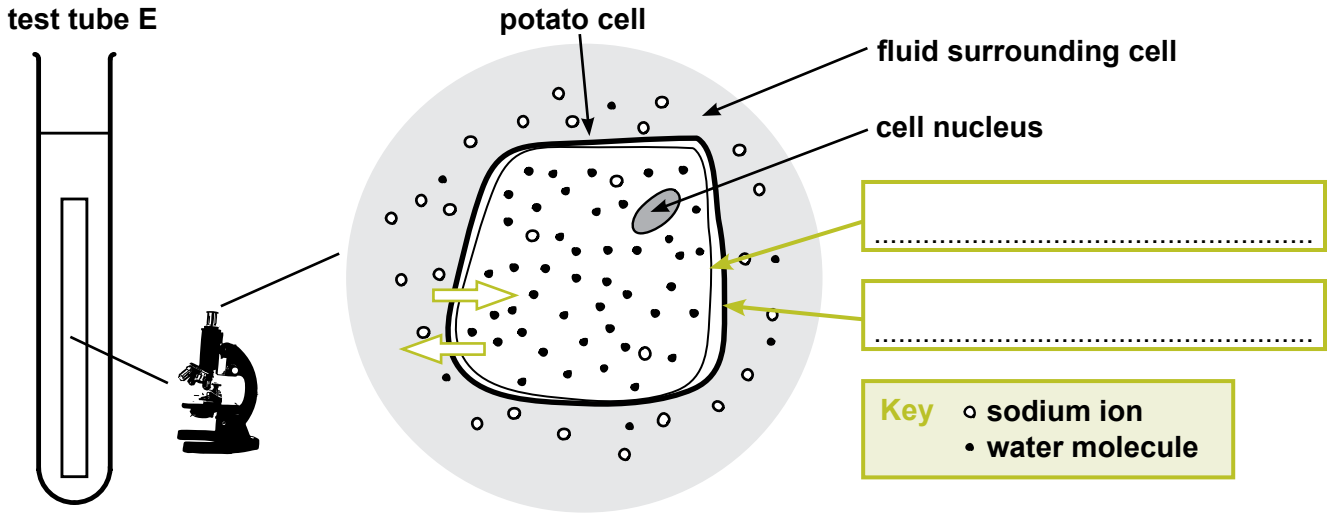
Diagram 2: Potato cell from the potato slice in test tube E (high salt concentration)



6. a) **Complete the missing labels in the potato cell in Diagram 2.**

   b) **Circle the arrow on Diagram 2 (⇦ or ⇨) that shows the overall direction that water molecules will move between the cell and the surrounding fluid.**

   c) **What effect would the movement of water have on the potato cell?**

   .....

7. **What common structure of plant and animal cells allows us to use potato cells to model water movement in human cells? Explain.**

Hint

Look at Diagram 2 on page 7.

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Stop here: Wait for your teacher's directions.

Explaining the Kokoda deaths

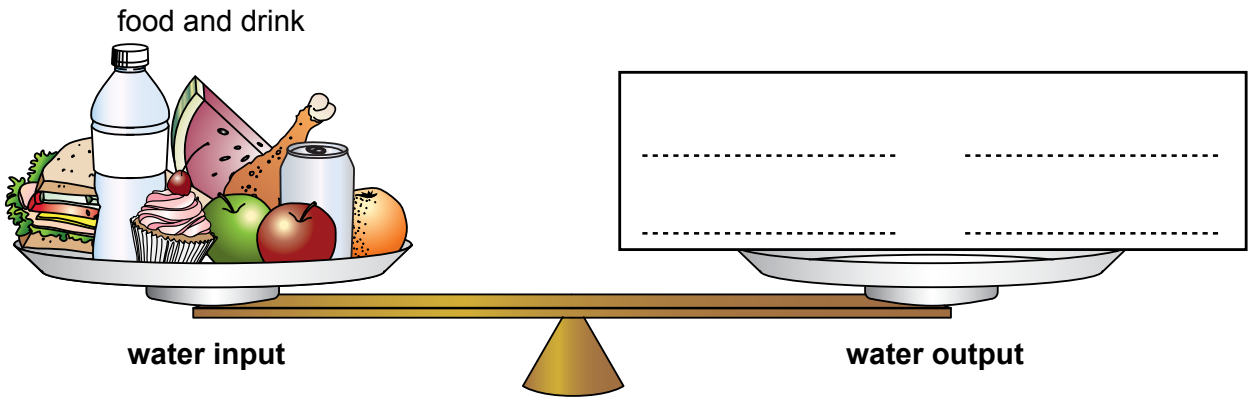
The doctors at Kokoda thought that the walkers who died were drinking too much water.

Our body systems work together to balance water inputs and outputs, so that cells have the amount of water they need to function normally.

Diagram 3 illustrates how the human body balances water input and output.

8. **Complete Diagram 3 by listing ways water is removed from the body (water output).**

Diagram 3: Balancing water input and output in the human body

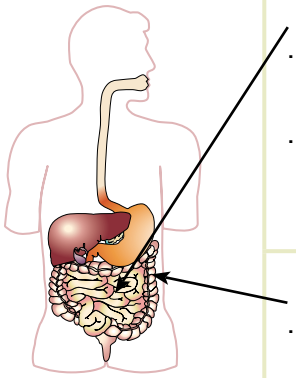
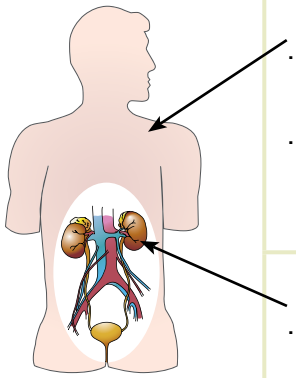
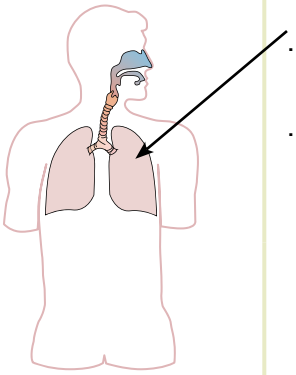


In addition to drinks, food can contribute 1 to 2 litres of water to the human body a day.

9. Complete Table 3 below.

- Name each body system.
- Label the organs, and describe their role in water input or output.

Table 3: Water input and output in the human body

Body system	Organ	Role in water input or output
 ..... system	....	....
	....	....
 ..... system	....	....
	....	....
 ..... system	....	....

10. Describe how the Kokoda walkers' water inputs and outputs became unbalanced.

Refer to each of the body systems in Table 3 on page 9 in your answer.

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- The walkers who drank too much water had severely low sodium concentrations in their blood and in the fluid surrounding their cells.
- The doctors advised Kokoda walkers to drink only when they were thirsty.

11. Suggest one other way that Kokoda walkers could avoid low sodium concentrations.

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12. Complete the flowchart below to show how unbalanced water input and output may have caused the Kokoda walkers' deaths.

When the walkers' water input greatly exceeded their water output

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the sodium concentration in the fluid surrounding the cells of their bodies became very low.

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Hint

Think about your investigation results, and Diagram 2 on page 7.

This caused the cells to ..... in size because .....

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As a result, walkers experienced headaches, possibly due to .....

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The walkers' symptoms became worse.

They lost consciousness and eventually died.

Stop here: Wait for your teacher's directions.

Reflecting on water and sodium needs

Aaron walks for 30 minutes

Samantha plays tennis for 2 hours

Use the information below to answer questions about Aaron and Samantha's water and sodium needs.

- The data was gathered through scientific investigations.
- The data shows average or approximate values and should be used as a guide only.
- Actual values vary between people and depend on humidity.

Table 4: Water loss during activity at 28 ºC

Activity	Examples	Typical water loss (mL/hour)		
		Sweat	Breath	Urine produced
Resting	watching TV sleeping	35	15	50
Mild physical activity	walking ten-pin bowling	300	25	30
Moderate physical activity	jogging skateboarding	1000	50	20
Intense physical activity	football match tennis tournament	2000	100	10

Table 5: Typical sodium measures

Sodium content of sweat	1.2 g/L
Sodium loss without affecting cell function	3 g

Table 6: Sodium content in some popular drinks

Drink	water	sports drink	fruit juice
Sodium content (g/L)	0.0	0.5	0.03

Sources of data: <www.jacn.org/cgi/content/full/25/suppl_3/231S#T1>, <http://journals.lww.com/acsm-msse/_layouts/oaks.journals/ImageView.aspx?k=acsm-msse:2007:02000:00022&i=TT2>, <www.water.org.uk/home/water-for-health/medical-facts/adults>.

13. Provide advice to Aaron and Samantha about how much and what to drink to balance their water and sodium needs.

Justify your answer by using:

- your knowledge of water balance
- the information in Tables 4, 5 and 6 on page 12
- any other relevant information in the task.

a) Aaron walks for 30 minutes at 28 ºC.

How much would Aaron need to drink for his walk?
What should Aaron drink?

b) Samantha plays 2 hours of intense competitive tennis in one afternoon at 28 ºC.

How much would Samantha need to drink during the afternoon?
What should Samantha drink?

14. Do you agree with the statement made in the advertisement above?

Justify your answer by referring to relevant information in the task.

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Many advertisements make claims to persuade you to buy a product.

15. Make a generalisation about how scientific methods can be used to test claims made in advertisements.

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Guide to making judgments — Year 9 Science

Name .....

Focus: Evaluate an investigation, analyse data and use understandings to provide explanations and reflect on applications of science.

Investigating	Knowledge and understanding	Investigating Reflecting	
Identifies and classifies variables and evaluates the fairness of an investigation. Presents and analyses experimental data to draw conclusions. Questions 1–5	Demonstrates an understanding of water movement in cells and how body systems balance water inputs and outputs. Questions 6–9	Interprets data and uses scientific understandings to provide explanations. Reflects on understandings to determine water needs and evaluate claims. Questions 10–15	
◀ Considers all relevant variables to justify an evaluation of the fairness of an investigation.	◀ Identifies cell structures, the direction of water movement and its effects. Lists all methods of water output and names all body systems. Names and describes the role of each organ in maintaining water balance.	◀ Clearly justifies advice about water and sodium needs during exercise. Considers all relevant data and understandings to evaluate advice in an advertisement and to generalise about the use of scientific methods to test claims.	**A**
◀ Draws valid conclusions from the results of an investigation.		◀ Uses understanding of body systems to explain Kokoda walkers' water imbalance. Provides a valid explanation for headaches, and justifies advice about water needs during exercise.	**B**
◀ Correctly graphs data. Identifies independent and dependent variables and explains how one relevant variable is controlled. Partially justifies an evaluation of the fairness of an investigation and draws a valid conclusion.	◀ Identifies most of the following: cell structures, methods of water output and names of body systems and organs. Describes the role of some organs in maintaining water balance.	◀ Suggests a valid way of avoiding low sodium concentrations. Completes the following with some justification: correctly predicts changes to Kokoda walkers' cells, provides advice about water needs during exercise, evaluates advice given in an advertisement.	**C**
		◀ Makes statements with little justification.	**D**
◀ Graphs data or identifies variables with some success.	◀ Identifies a method of water output. Correctly names a system or organ.		**E**

Feedback .....

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