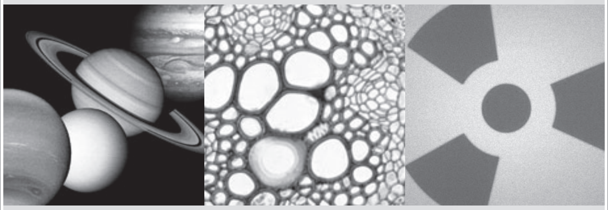
MCEETYA



# National Year 6 Science Literacy School Assessment

2003

Ministerial Council on Education, Employment, Training and Youth Affairs

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# Preface

In 2003, the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) conducted an assessment of a sample of Year 6 students across Australia to assess their proficiency in scientific literacy. The assessment of scientific literacy is part of a national plan that is being put progressively in place to monitor and report on student achievement against the National Goals for Schooling in the Twenty-first Century. The National Goals - and the importance of monitoring student achievement in relation to them were agreed to by all State, Territory and Federal Education Ministers in 1999.

Under the national plan, student performance is being assessed in science, civics and citizenship and information and communication technology (ICT) in three-yearly cycles. The results are being reported against proficiency levels and standards that are established after the first round of testing in each of the three priority areas.

The scientific literacy assessment domain, which defined the scope of the National Science Assessment materials, was developed in consultation with a number of national committees that were established to ensure that the domain was inclusive of the different State and Territory curricula and that the items in the assessments were fair for students, irrespective of where they attended school.

The information and assessment materials in this document have been designed to assist teachers to gauge their own students' proficiency in scientific literacy.

By replicating components of the National Year 6 Science Assessment in the classroom, teachers will be able to compare the results of the classes and individual students with the Year 6 national proficiency levels and standards in scientific literacy.

It is anticipated that teachers will be able to reflect on this information to enhance teaching and monitoring programs in our schools.

# Chapter 1
# Overview of the National Year 6 Science Literacy Assessment

## Background

In 1999, the State, Territory and Commonwealth Ministers for Education agreed to the Adelaide Declaration on National Goals for Schooling in the Twenty-first Century (MCEETYA, 1999) (http://www.mceetya.edu.au/nationalgoals/natgoals.htm).

The National Goals provide the framework for reporting on student achievement through the annual MCEETYA publication, the National Report on Schooling in Australia (ANR).

The Education Ministers also established the National Education Performance Monitoring Taskforce (NEPMT) in 1999 to develop key performance measures to monitor and report on progress toward the achievement of the Goals on a nationally-comparable basis.

They identified eight priority areas for the initial development of performance measures: literacy, numeracy, science, civics and citizenship, information technology, vocational education and training in schools, enterprise education and participation and attainment.

As a first step in early 2000, NEPMT commissioned a project to develop options for the assessment and reporting of the achievements of primary school students in science.

The outcome of this process was a report to the NEPMT entitled *Options for the assessment and reporting of primary students in* *the key learning area of science to be used for the reporting of nationally comparable outcomes of schooling within the context of the National Goals for Schooling in the Twenty-First Century* (Ball et al., 2000).

The Ball report recommended that students' achievement of scientific literacy (that is, science concepts and science process skills) rather than their acquisition of factual information, be assessed and reported at the primary level. In particular, the report advocated adoption of the definition of scientific literacy used in the OECD's Programme for International Student Assessment (PISA) for the purposes monitoring of primary science.

In July 2001, MCEETYA agreed to the development of assessment instruments and key performance measures for reporting on student skills, knowledge and understandings in primary science. It directed the Performance Measurement and Reporting Taskforce (PMRT), which by then had replaced NEPMT, to undertake the national assessment program. The PMRT commissioned the assessment in July 2001 and the Australian Council for Educational Research (ACER) was the successful tenderer.

The PMRT set the policy objectives and established a steering committee to manage the assessment and a consultative committee to facilitate discussion among the jurisdictions and school sectors. The latter also provided feedback about the appropriateness of the conceptual framework and reviewed the assessment items to ensure that they were inclusive of all the States and Territories' curricula.

The National Year 6 Science Assessment is the first assessment program designed specifically to provide information about performance against the National Goals. MCEETYA has also endorsed similar assessment programs to be conducted for civics and citizenship and ICT.

The intention is that each assessment program will be repeated every three years so that performance can be monitored over time. The first cycle of the program provides the baseline against which future performance will be compared.

Apart from being the first subject area assessment, science is unique because it focuses entirely on primary school performance. The others will assess Year 6 and Year 10 students, but MCEETYA has agreed to use PISA as the measure of performance for secondary science. The Ball report recommended strongly that the assessment of science be conducted at the end of primary schooling because:

> *…delay until the end of primary schooling has the advantages of being able to assess a more mature learner who has had greater opportunity to develop scientific skills and processes and develop a better understanding of basic scientific principles.*
>
> (Ball et al., 2000, p.44)

# Implementation of the 2003 National Year 6 Science Assessment

Implementation of the National Assessment involved a large number of separate but related steps, including the development of an assessment domain and items and instruments to assess that domain; the trialling of those items and instruments; the development of key performance measures; the administration of the assessment to a sample of students; and the marking, analysis and reporting of the results.

The report of the National Assessment is available at http://www.mceetya.edu.au. It provides details of the school and student samples used, describes the testing process and presents the results at the National, State and Territory levels.

# What did the National Science Assessment measure?

The National Assessment measured scientific literacy. Scientific literacy is a construct that:

> *...encompasses the use of broad conceptual understandings of science for making sense of the world, understanding natural phenomena, and interpreting media reports about scientific issues. It also encompasses competencies related to asking investigable questions, conducting investigations, collecting and interpreting data and making decisions.*
>
> (Hackling, 2002, p.1).

This construct has evolved from the definition of scientific literacy used by PISA:

> *...the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about that natural world and the changes made to it through human activity.*
>
> (OECD, 1999, p.60)

The science items and instruments therefore assess outcomes that contribute to scientific literacy (such as conceptual understandings) rather than focussing soley on facts. They also assess students' competence in carrying out investigations in realistic situations.

The National Assessment relates to the ability to think scientifically in a world in which science and technology are increasingly shaping children's lives.

An assessment domain was developed in consultation with curriculum experts from each State and Territory and representatives of the Catholic and independent school sectors. This domain includes the definition of scientific literacy and outlines the development of scientific literacy across three main strands.

The domain is available at http://www.mceetya.edu.au.

# What aspects of scientific literacy were assessed?

Three strands of scientific literacy were assessed:

| | |
|---|---|
| STRAND A: | formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence. |
| STRAND B: | interpreting evidence and drawing conclusions, critiquing the trustworthiness of evidence and claims made by others, and communicating findings. |
| STRAND C: | using science understandings for describing and explaining natural phenomena, interpreting reports and making decisions. |

A conscious effort was made to develop assessment items that related to everyday contexts rather than to laboratory situations.

The items drew on four concept areas: Life and Living; Earth and Beyond; Natural and Processed Materials; and Energy and Change. These evolved from a review of the National Statements and Profiles and were common across Australian curricula. It is interesting to note that the same concept areas are also used widely in other countries.

Identification of the strands of scientific literacy and the concepts to be assessed by a thorough analysis and mapping of current curriculum documents of all States and Territories. The intention was to ensure that all Year 6 students were familiar with the materials and experiences to be used in the National Science Assessment and so avoid any systematic bias in the instruments being developed.

# Who participated in the National Science assessment?

Approximately 6 per cent of the total Australian Year 6 student population was sampled randomly and assessed.   All States and Territories and government, Catholic and independent schools participated. Table 1.1 shows the number of schools and students in the final sample from which performance comparisons were reported.

A grade-based population of students enrolled at schools was chosen. This is consistent with the reporting of literacy and numeracy performance in the ANR. Information about structural differences that may assist interpretation of the results of the testing is summarised in the report of the National Science Literacy Assessment.

**Table 1.1** Number of schools and students in the final sample by State and Territory

| State/Territory | Number of Schools in Target Sample | Number and %* of Schools in Final Sample | Number of Students in Final Sample |
|---|---|---|---|
| NSW | 122 | 103 (84%) | 2 466 |
| VIC | 122 | 100 (82%) | 2 130 |
| QLD | 122 | 110 (90%) | 2 607 |
| SA | 130 | 115 (88%) | 2 032 |
| WA | 126 | 103 (81%) | 2 347 |
| TAS | 64 | 60 (94%) | 1 240 |
| NT | 32 | 23 (72%) | 496 |
| ACT | 44 | 36 (82%) | 854 |
| ALL | 762 | 650 (85%) | 14 172 |

* 'Percentage of schools' is calculated by dividing the number of schools in the final sample by the number of schools in the target sample for each State and Territory and multiplying by 100.

# How was the National Science Assessment reported?

The National Science Assessment was designed to provide as much information as possible about student performance in scientific Literacy at the Year 6 level. To achieve this, several different test forms were used.

The National Science Literacy School Assessment materials provided here are representative of the items contained in the National Science Assessment.

In order to produce comparable results among students who had completed different tests, statistical analyses were performed and scaled scores generated for all students.

To add meaning to these scores, a panel of curriculum experts and practising teachers developed a set of proficiency standards by reviewing the items and making judgements about the performance expected of students on the assessments.

The standards are described in terms of the understandings and skills that students demonstrated in the National Science Assessment.
These understandings and skills have been mapped against the scientific literacy assessment framework.

Five levels of proficiency in scientific literacy are defined and described and defined in Chapter 8.

The tables produced in Chapters 7 and 8 enable the raw scores achieved by students in the National Science Literacy School Assessment to be converted into equivalent scaled scores and compared with the standards framework developed to report the performance of students in the National Assessment.

# Chapter 2
# National Science Literacy School Assessment materials

## Overview

The assessment of scientific literacy comprises two tasks:

- an objective assessment, with multiple-choice and short-answer type questions; and
- a practical task requiring students to conduct an experiment in groups of three and then respond individually to a set of questions about the experiment.

Some assessment items in the National Science Literacy School Assessment materials have been released from the 2003 National Assessment to enable teachers to administer the tasks under similar conditions and gauge their own students' proficiency in relation to the national standards.

The remaining 2003 assessment items have been secured for the purpose of equating the next National Assessment (which is to be undertaken in 2006), with the 2003 assessment, so that longitudinal data on student performance can be obtained.

# Resource materials

The print materials required to conduct the National Science Literacy School Assessment, analyse the performance of students and gauge their proficiency against the national science literacy standards, are all provided in this document and may be reproduced freely.

The print assessment materials include:
- Two assessment tasks - Part A (objective assessment) and Part B (practical task)
- Assessment administration guidelines
- Class record sheet
- Item analysis sheet
- Class analysis sheet

# Using the results from the National Science Literacy School Assessment

Although the major scientific concepts tested - Earth and Beyond, Energy and Change, Life and Living and Natural and Processed Materials-were common to all jurisdictions, the manner in which they were taught varied according to the teaching strategies used in individual classrooms, teachers' own science backgrounds and enthusiasm for science, and the student outcomes established by the curriculum frameworks in use in particular States and Territories.

Also due to differences between jurisdictions in the way in which primary schooling is structured, there were variations in the average age of students and the length of prior schooling at the time of testing.

However, although the ways in which these test materials will be used will inevitably vary, they can provide very valuable information at the classroom, school and system levels.

It is important to remember that these are standardised tests, developed through a rigorous consultative process that included input from educational experts and reference groups, subjected to intensive development and trialled and administered under strict conditions to ensure the soundness of the National Sample Assessment.

Users can therefore be confident that these tests meet the highest possible professional and ethical criteria.

The tests are standards-based. They allow inferences to be made about students' levels of achievement in the concepts, the mean level performance of a class and/or cohort and the range of levels that a class or cohort achieves.

Some teachers may use the tests to obtain information about students' existing skills or understandings: for example, a Year 7 teacher might use the Year 6 materials for diagnostic purposes. This information could then assist the teacher's planning for the year. However, before doing so, the teacher should determine whether students have previously sat the National Assessment. If they have, their results could be inflated and therefore not an accurate estimation of performance-or they might not engage with the test for a second time and the results could be disappointing.

At the classroom level, the test materials can be used to:

- diagnose individual students' strengths and weaknesses in terms of their demonstrated skills and understandings in science;
- ascertain the strengths and weaknesses in science of the class as a whole;
- help teachers to analyse the effectiveness of their own science teaching and learning strategies;
- provide models of sound assessment tasks; and
- moderate individual teachers' judgements with those of the National Assessment.

At the whole-school level, they can be used to:

- infer levels of student science achievement in the particular State or Territory's curriculum framework;
- make comparisons between science performance in the school and the State or Territory mean;
- make comparisons between the range in science performance in the school and the State or Territory range;
- report to the school community on students' achievements in science;
- report to school authorities on students' achievements in science.
- set priorities for school development planning; and
- provide continuity for students moving from other schools.

In using the test materials, it should be borne in mind that:

- The National Sample Assessment assesses much- but not all-important science knowledge and skills.
- Test results are one source of information about students' progress and information from other sources is necessary for accurate assessments to be made.
- The materials cannot be used to compare teachers and schools.

The assessment administration guidelines must be followed carefully.

# Chapter 3
# Assessment Tasks

This assessment of scientific literacy comprises two tasks:

- Part A: Objective Assessment (a pencil-and-paper), with 25 multiple-choice and short-answer type questions. These items assess Levels 2 and 3 of the national scientific literacy assessment domain (Appendix A) and cover 3 scientific strands; *Natural and Processed Materials, Life and Living and Energy and Change;* and
- Part B: Practical Tasks, from the *Earth and Beyond* strand, requiring students to conduct an experiment in groups of three and then respond individually to a set of questions about the experiment.

Teachers can decide whether they want to administer both the Objective Assessment and the Practical Tasks (as in the National Assessment) or administer only the Objective Assessment. No provision has been made for using the results of the Practical Tasks alone.

When photocopying the test for the class, it is important to ensure that the format displayed in the resources is maintained in the back-to-back mode, and with pages 2 and 3 facing one another.

A summary of the assessment structure, including the unit topics, the science strands and a brief description of the processes being assessed is provided in Table 3.1.

**Table 3.1** Summary of assessment structure

| **Part A: Objective Assessment Assessing Individual Student Work** | | | |
|---|---|---|---|
| **Qu no** | **Question** | **Strand** | **Item descriptor** |
| 1 | Ice Cubes | Natural and Processed materials | Interprets information in a contextualised report by application of relevant scientific knowledge. |
| 2 | Ice Cubes | Natural and Processed materials | Explains a choice based on first hand, concrete experience requiring the application of limited knowledge. |
| 3 | Floors | Natural and Processed materials | Chooses among properties based on events that have been experienced or reported. |
| 4 | Floors | Natural and Processed materials | Identifies and summarises patterns in scientific data and applies rule to predict. |
| 5 | Floors | Natural and Processed materials | Explains differences between properties and events. |
| 6 | Echidnas | Life and Living | Interprets diagram containing interrelated elements to identify key elements. |
| 7 | Echidnas | Life and Living | Interprets simple data from an image focusing on single aspect. |
| 8 | Echidnas | Life and Living | Interprets information in a conceptualized environment by the application of scientific knowledge. |
| 9 | Mosquitoes | Life and Living | Recognises the reasons for a diagrammatic use of data. |
| 10 | Mosquitoes | Life and Living | Demonstrates an understanding of what is required for fair testing. |
| 11 | Mosquitoes | Life and Living | Summarises patterns in the data. |
| 12a | Mosquitoes | Life and Living ( 1 mark) | Identifies the anomaly in the table of data and forms a prediction or reason. |
| 12b | Mosquitoes | Life and Living ( 2 marks) | Identifies the anomaly in the table of data and forms a prediction or reason. |
| 13 | Paper Clips | Natural and Processed materials | Generalises from collected data presented in a table. |
| 14 | Paper Clips | Natural and Processed materials | Explaning the principles of conducting an investigation and controlling variables. |
| 15 | Bush pond | Life and Living | Makes conclusions and presents summary of scientific data. |
| 16 | Bush pond | Life and Living | Interprets reports and predicts changes in interrelationships. |
| 17a | Bush pond | Life and Living (1 mark) | Interprets reports and predicts changes in interrelationships. |
| 17b | Bush pond | Life and Living (2 marks) | Interprets reports and predicts changes in interrelationships. |
| 18a | Wood Burning | Natural and Processed materials (1 mark) | Applies knowledge of relationships to explain observed phenomenon. |
| 18b | Wood Burning | Natural and Processed materials (2 marks) | Applies knowledge of relationships to explain observed phenomenon. |
| 19 | Wood Burning | Natural and Processed materials | Application of the principles of conducting an investigation and controlling variables to select most appropriate methodology. |
| 20 | Sandpaper | Energy and Change | Identifies the difference between properties that have been experienced. |
| 21 | Sandpaper | Energy and Change | Explains interactions that have been reported in terms of an observable property. |
| 22 | Toy Train | Energy and Change | Suggests questions for testing. |
| 23 | Toy Train | Energy and Change | Performs simple tests in the form of comparisons. The planning of experiments is defined as a Level 5 response. |
| 24 | Toy Train | Energy and Change | Identifies a pattern in the table. |
| 25 | Toy Train | Energy and Change | Predicts a relationship between the pattern and the cause. |
| **Part B: Objective Assessment Assessing Individual Student Work** | | | |
| P1 | Craters | Earth and Beyond | Explains outcome of scientific investigation. |
| P2 | Craters | Earth and Beyond | Explains outcome of scientific investigation. |
| P3 | Craters | Earth and Beyond | Explains the principles of conducting an investigation and controlling variables. |
| P4 | Craters | Earth and Beyond | Extrapolates from experimental evidence to describe a different environment ( multiple variables). |

**Table 3.1** Summary of assessment structure (cont)

| | | |
|---|---|---|
| **Part B**<br>**Practical task** | Student group work | Student Practical Activity and discussions<br><br>You will need per group of 3 students:<br>• a sheet of newspaper<br>• a 30 cm ruler<br>• 4 large round patty pans (about 6-8 cm diameter)<br>• 4 marbles ('normal' 1 cm diameter size)<br>• 1 plastic spoon<br>• 1 empty plastic cup<br>• 1 cup flour<br><br>Teacher needs:<br>• 1 sieve for the class<br>• 3/4 cup powdered drinking chocolate for each group of students (i.e. about 3 cups in total) |
| **Part B**<br>**Practical**<br>**Assessment**<br>Student booklet<br>Pencil/pen<br>eraser | Individual student work | QP1 Earth and Beyond<br>QP2 Earth and Beyond<br>QP3 Earth and Beyond<br>QP4 Earth and Beyond |

National Science Literacy School Assessment

***Part A: Objective Assessment***

***Part B: Practical Tasks***

# SCIENCE

## Year 6: 2003 Released Items

Please print your name here. (Use CAPITALS)

First name | Last name

Next, print the name of your school. (Use CAPITALS)

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# PART A: OBJECTIVE

## PRACTICE QUESTIONS

There are **four types** of questions in the Science Tasks.

**Type one** is **Multiple Choice**.
In these questions you must **shade in a square** next to the correct answer. For example try this one:

**Q1** The colour of blood is

- ☐ blue.
- ☐ green.
- ☐ red.
- ☐ yellow.

**Type two** is **Circle the Word or Words**.
In these questions you must **circle the word or words** which are correct.
For example:

**Q2** Circle the words which are correct.

An elephant is (a bit smaller / much bigger) than a human.

**Type three** is a **One or Two Word Answer**.
In these questions you only need to **write one or two words**. For example:

**Q3** On a clear, sunny day the colour of the sky is ____________________ .

**Type four** is a **Long Answer**.
You may need to **write two or three lines or sentences** to give the best answer.
For example:

**Q4** What happens to a balloon when you blow it up? Explain.

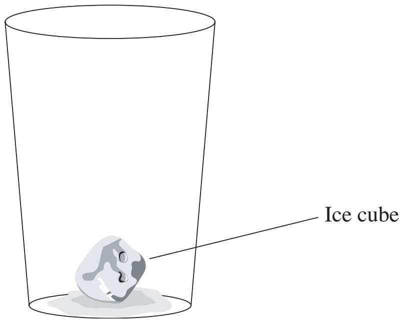
______________________________________________

______________________________________________

Read *Ice Cubes* and answer Questions 1 and 2.

## ICE CUBES

Sarela and her friend were each given an ice cube in a **plastic** cup. They decided to see who could **melt** their ice cubes more quickly.




**Q1** How could Sarela speed up the melting of her ice cube?

M 0 1

**Q2** Sarela changed the water in the plastic cup back to ice by placing the cup in the freezer of the refrigerator.

Describe **or** draw the shape of the ice.

M 0 1

Read *Floors* and answer Questions 3, 4 and 5.

## FLOORS

Jim's house has several rooms. Each room has a different floor surface.
Jim's father noticed differences between each type of floor.

| **Surface 1** | **Surface 2** | **Surface 3** |
|---|---|---|
| very hard | hard | soft |
| will not let water through | can get damp if water is spilled | hard to dry out if water is spilled |
| cool in summer | warm in summer, cool in winter | warm in winter |
| easy to clean | easy to clean | hard to clean |

**Q3** Which type of floor surface do you think is the best for a laundry?

- ☐ Surface 1
- ☐ Surface 2
- ☐ Surface 3

**Q4** Which type of floor surface do you think is the best for a bedroom?

Explain why you chose that type of floor surface for the bedroom.

M 0 1

Jim had a new basketball.  He tested it by bouncing it from the same height on each of the floor surfaces.

**Q5** On which type of surface do you think Jim's basketball bounced highest?

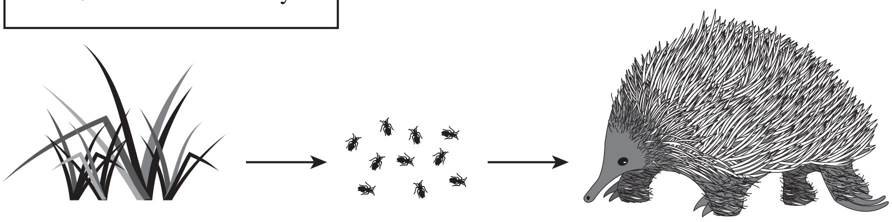
☐ Surface 1
☐ Surface 2
☐ Surface 3

Read *Echnidas* and answer Questions 6, 7 and 8.

## ECHIDNAS

The echidna is an Australian animal with special features. It has pointy spines, a long sticky tongue, small eyes and large strong claws. It also has short hair between its spines. Echidnas eat ants and termites. The ants and termites eat grass and other plants.

→ Means ‘eaten by’



Grass  Ants and termites  Echidna

Echidnas can burrow into the ground very quickly when they want to. An enlarged picture of an echidna's back foot is shown here. Note its digging claws.

**Q6** Which features do you think would be used to find and eat ants and termites?

- ☐ spines and small eyes
- ☐ large strong claws and long sticky tongue
- ☐ short hair and long sticky tongue
- ☐ large strong claws and spines

**Q7** What would an echidna use its spines for?

- ☐ digging up ants and termites
- ☐ keeping itself warm
- ☐ protection from other animals
- ☐ digging holes to hide in

One year a park ranger found only half the number of echidnas in the park. There had been a drought that year. However, there was still plenty of water in the river for echidnas to drink.

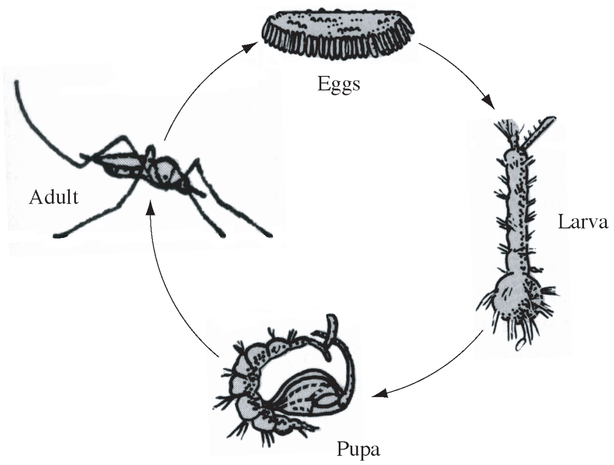
**Q8** What do you think **best** explains the low number of echidnas?

- ☐ Trees died from lack of water so the echidnas had no shelter.
- ☐ Lack of rain caused less grass to grow so there were fewer ants.
- ☐ There was not enough water for all the echidnas to drink.
- ☐ The heat killed some of the echidnas.

Look at the information about *Mosquitoes* and answer Questions 9, 10, 11 and 12.

## MOSQUITOES

*Life Cycle of a Mosquito*




**Q9** The life cycle diagram is shown in a **circle**. What does this tell you?

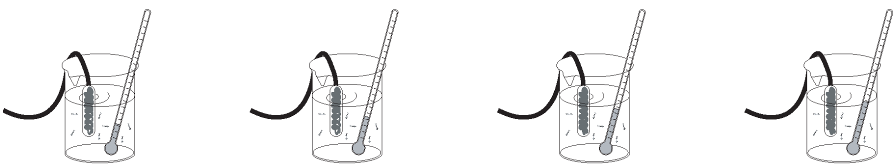
________________________________________

________________________________________

M 0 1

Year 6 students collected mosquito larvae from a pond near the school.

- The larvae were divided into four separate groups.
- Each group was placed in a large jar containing water from the pond.
- A thermometer to measure temperature was placed in each jar.
- Small heaters were used to control the temperature in each jar.



| 10°C Jar 1 | 16°C Jar 2 | 22°C Jar 3 | 28°C Jar 4 |
|---|---|---|---|

The larvae were examined each day for nine days. Each day three larvae were taken from each jar and their length measured (in millimetres).

| **Jar** | **Temperature** | **Average length of larvae (mm)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Day | | | | | | | | |
| | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 1 | 10°C | 4 | 4.5 | 5 | 5 | 5.5 | 5.5 | 6 | 6 | 6 |
| 2 | 16°C | 4 | 5 | 6 | 7 | 8 | 9 | 10 | pupae | pupae |
| 3 | 22°C | 4 | 5.5 | 7 | 8.5 | 10 | 10 | pupae | pupae | pupae |
| 4 | 28°C | 4 | 6 | 8 | 10 | 10 | 10 | pupae | pupae | pupae |

**Q10** Look at the pattern in the data. As the temperature went up what happened to the growth of the larvae?

M 0 1

**Q11** Compare the **results** for Jar 1 with the other jars. Give one reason why the time taken for the pupae to form is different.

M 0 1

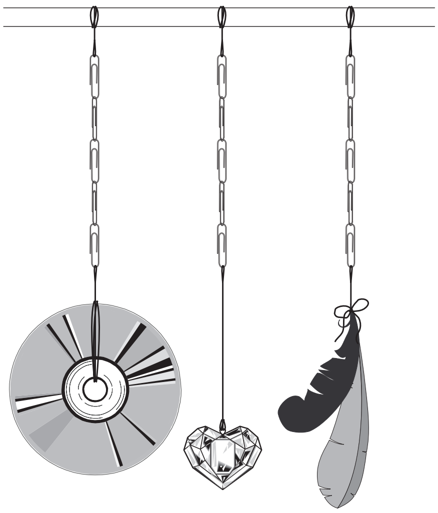
**Q12** Look at the table. What two things must occur before a larva can change into a pupa?

M 0 1 2

Read *Paper Clips* and answer Questions 13 and 14.

## PAPER CLIPS

Jill and Tracey wanted to make a mobile. They decided to use paper clips to make chains from which to hang decorations. The mobile would look something like this.



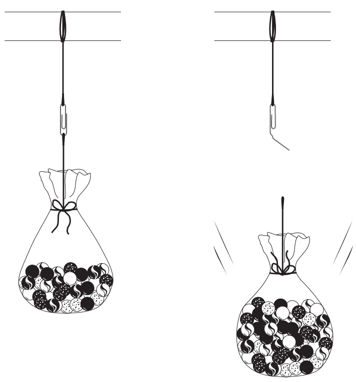
Each chain was made of 5 paper clips.

Jill and Tracey had been given four types of paper clip. Each paper clip type was made of a different metal.

Jill and Tracey designed an experiment to test the strength of the paper clips. They hung a bag of marbles from each clip.

More marbles were added until the clip bent and the bag dropped.

They did the test three times for each type of paper clip. The results are shown in the table on the next page.



Number of marbles when the bag dropped

| Paper clip type | First Test | Second Test | Third Test |
|---|---|---|---|
| Holdall | 52 | 50 | 49 |
| Clipon | 73 | 72 | 74 |
| Plastico | 41 | 44 | 42 |
| Slippet | 69 | 68 | 69 |

**Q13** Which paper clip type was the strongest?

- ☐ Holdall
- ☐ Clipon
- ☐ Plastico
- ☐ Slippet

**Q14** Jill and Tracey carried out the experiment three times for each type of paper clip.

Why did they do that?

________________________________________

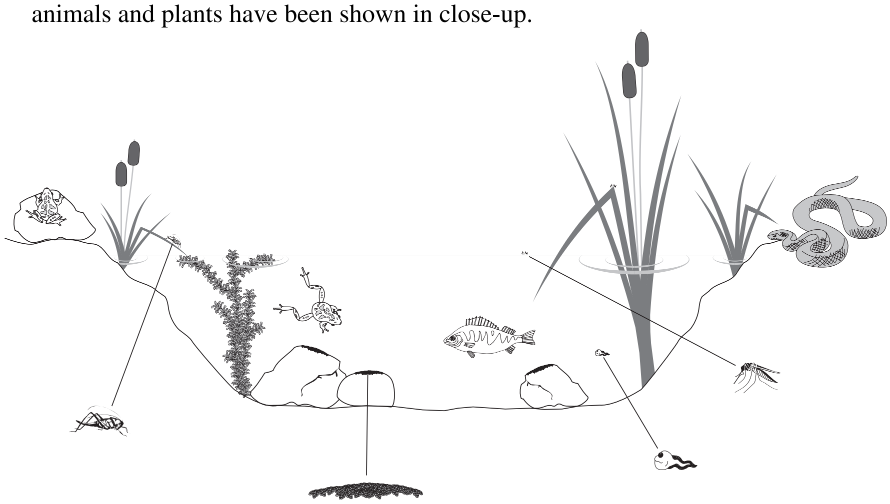
________________________________________

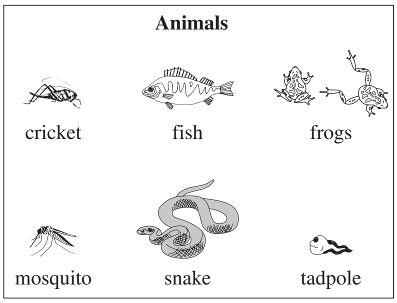
○ ○ ○
M 0 1

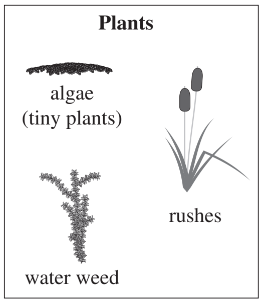
Read *Bush Pond* and answer Questions 15, 16 and 17.

## BUSH POND

The picture shows animals and plants that live in or around a bush pond. The tiny animals and plants have been shown in close-up.






Here are some facts about the food eaten by the animals in **this** pond.

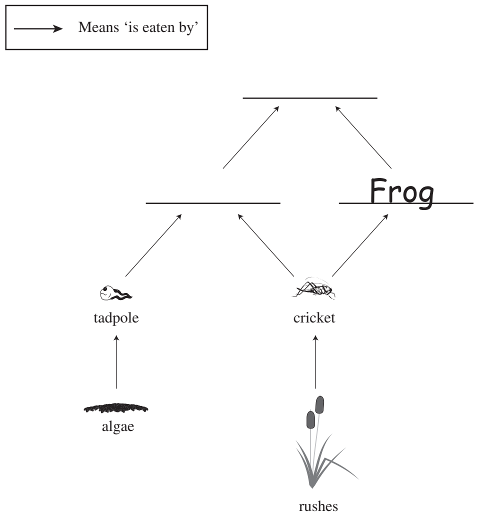
| | Animals | | | | | |
|---|---|---|---|---|---|---|
| Food | **snake** | **frog** | **tadpole** | **mosquito** | **cricket** | **fish** |
| tiny pond plants | | | ✓ | | | |
| some animals but not insects or tadpoles | ✓ | | | | | |
| animal material but animal is not killed | | | | ✓ | | |
| tadpoles | | | | | | ✓ |
| insects | | ✓ | ✓ | | | ✓ |
| large pond plants | | | | | ✓ | |

**Producers** are living things that make their own food. **Consumers** get their food by eating other living things.

**Q15** Which of the following lists **only** consumers?

☐ tadpole, water weed, fish
☐ frog, cricket, snake
☐ algae, fish, mosquito
☐ snake, frog, water weed

**Q16** Complete this food web for the pond life. Fill in the blank spaces.




M 0 1

**Q17** If mosquitoes, crickets and algae disappeared, name all the animals that would have less food.

M 0 1 2

Read *Wood Burning* and answer Questions 18 and 19.

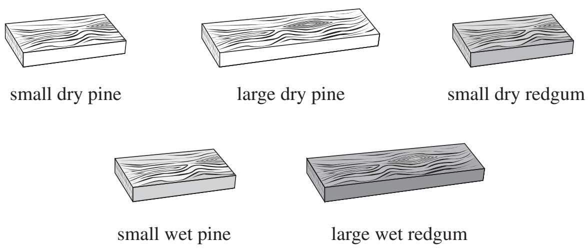
## WOOD BURNING

Some students are on a school camp. They collect dry wood for a campfire. Before dinner, they heat water in a metal can to make soup. The metal can has a wooden handle.

**Q18** Why is it better for the metal can to have a wooden handle?

M 0 1 2

Back at school, students want to find out whether redgum or pine burns better. They have the following pieces of wood:



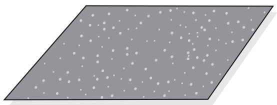

**Q19** Which two pieces should the students test to compare redgum and pine?

- ☐ small dry pine and small dry redgum
- ☐ small dry pine and small wet redgum
- ☐ large dry pine and large wet redgum
- ☐ large wet redgum and small wet pine

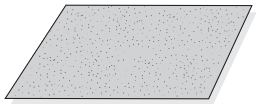
Read *Sandpaper* and answer Questions 20 and 21.

## SANDPAPER

Sandpaper is used to smooth wooden surfaces. There are different types of sandpaper. Sandpaper can be 'heavy duty' for very rough surfaces. 'Heavy duty' sandpaper has larger grains on its surface.
Sandpaper can also be 'light' for surfaces that need very fine smoothing. 'Light' sandpaper has very small grains.



Heavy duty
sandpaper - large grain



Light
sandpaper - small grain

**Q20** Imagine you brushed your hand across the surface of each type of sandpaper. Which would feel rougher?

M 0 1

**Q21** You are helping to make a wooden garden seat. It needs to be very smooth. You decide to use the 'heavy duty' sandpaper to start smoothing the wood and you then finish with the 'light' sandpaper. Why is this the better choice?

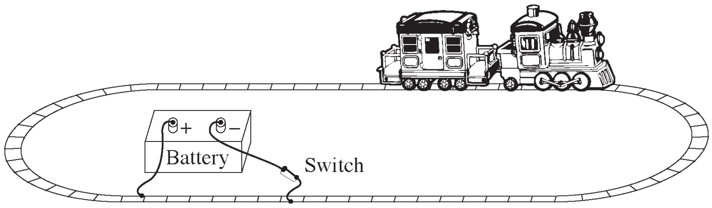
M 0 1 2

Read *Toy Train* and answer Questions 22, 23, 24 and 25.

## TOY TRAIN

Jillian has a battery-operated, electric train set.

The train suddenly stopped while the switch was 'on'. The train was still on the tracks.




**Q22** What could Jillian have done to find out if the battery was flat?

M 0 1

**Q23** Jillian tested the battery and found it was not flat. Name one other thing that Jillian should check.

M 0 1

Jillian fixed the problem. She started the train and then kept it running. She wanted to find out how long it would take for the train to complete one lap. She timed the train on every tenth (10th) lap.

| Lap Number from start | Time for lap (s) |
|---|---|
| 10 | 42 |
| 20 | 43 |
| 30 | 45 |
| 40 | 48 |
| 50 | 52 |

**Q24** What do the results in the table show?

M 0 1

**Q25** Suggest a reason for your answer to **Question 24**.

M 0 1

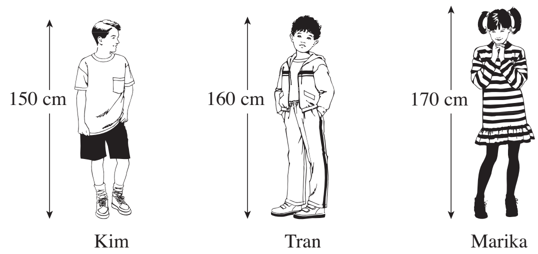
# PART B: PRACTICAL

## PRACTICE QUESTIONS

There are **three types** of questions in the Science Practical Task.

**Type 1**
Complete a results table.

**Q1** Sam measured the height of three students.




Put this information into this table.

| Person | Height (cm) |
|---|---|
| Kim | |
| Tran | |
| Marika | |

**Type 2**
Look at the information table to answer the question.

**Q2**

| 100 m race | Time (s) |
|---|---|
| Kim | 20 |
| Tran | 25 |
| Marika | 30 |

Kim was the fastest. What was his time? ________________ seconds

**Type 3** is a **Long Answer**.
You may need to **write two or three lines or sentences** to give the best answer. For example:

**Q3** What happens to a balloon when you blow it up? Explain.

## CRATERS

**Introduction:**

Have you seen pictures of craters on the Moon? What caused these craters? What makes them the size and shape that they are?

This experiment will help you understand how craters are formed. You will create craters by dropping marbles from different heights into small pans of flour.

**What to do:**

Complete Part A of the activity in your group. Answer the questions as you go.

Complete the Part B questions by yourself.

You must hand in your booklet at the end.

**What you will need per group of 3 students:**

- a sheet of newspaper
- a 30 cm ruler
- 4 large round patty pans (about 6-8 cm diameter)
- 4 marbles ('normal' 1 cm diameter size)
- 1 plastic spoon
- 1 empty plastic cup
- 1 cup flour

**Teacher needs:**

- 1 sieve for the class
- ¼ cup powdered drinking chocolate for each group of students (about 3 cups in total)

**Practical Task A: Group work (work as part of a group of 3 students).**

*Setting up the patty pans*

1 Place the newspaper flat on your work area.

2 Collect flour from your teacher in your plastic cup.

3 Place the 4 patty pans on the newspaper. They should be at least 10 cm apart. Make sure the patty pans are as round as possible.

4 ¾ fill each patty pan with flour.

5 Gently shake the patty pans to make the flour level. Do **not** push down on the flour.
Do not touch the flour after it is level.

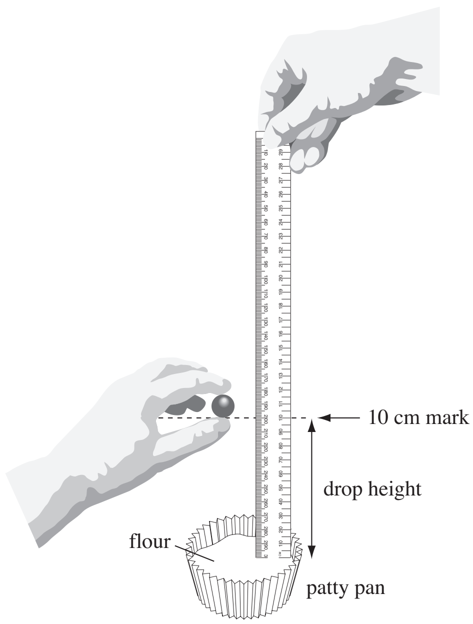
6 Check that the patty pans are still round. Do not move the patty pans.

*Dropping the marble*

7 One person holds a ruler just inside one of the patty pans. The bottom of the ruler should be at the top of the flour surface.

A second person holds a marble over the centre of the patty pan. Look down from **above** the marble to make sure it will fall into the patty pan.

The third person makes sure the bottom of the marble is next to the 10 cm mark on the ruler.



8 ***Drop*** the marble. Practise this again with the **same** patty pan until you can get the marble into the patty pan nearly every time.

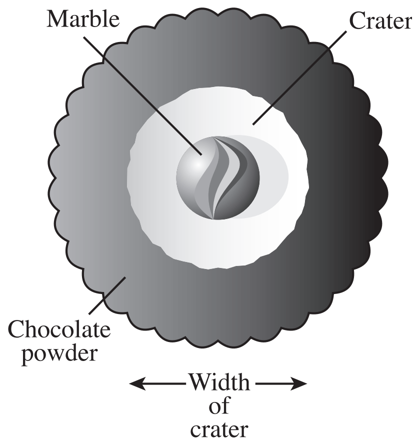
9 Get your teacher to use a sieve to add a layer of chocolate powder to just cover the flour in each of the other three patty pans.

10 Drop a marble from the 10 cm mark on the ruler onto the chocolate surface. Leave the marble where it falls.

11 Take another marble, another patty pan and the ruler.
Drop the marble from the 20 cm mark on the ruler.
Leave the marble where it falls.

12 Take another marble, another patty pan and the ruler.
Repeat the procedure, this time dropping the marble from the 30 cm mark.
Again, leave the marble where it falls.

13 Look at all of the patty pans but do not move them. You should see something like this.




Measure the width of each crater (the white section) and complete the table.

| **Drop height** | **Crater width** |
|---|---|
| 10 cm | |
| 20 cm | |
| 30 cm | |

14 Look at how far the marble sinks into the flour each time.

**Practical Task B: Individual work (Answer these questions by yourself).**

**QP1** What effect did drop height have on how far the marble sank into the flour?

M 0 1

**QP2** What effect did drop height have on the width of the crater?

M 0 1

**QP3** Why should the bottom of each marble be lined up carefully with the 10, 20 and 30 cm marks before it is dropped?

M 0 1

**QP4** Craters have been formed by asteroids and meteors (large rocks) hitting the moon's surface.

Why are the craters of different widths and depths?

M 0 1

**Hand your booklet to your teacher at the end of this activity.**

# Chapter 4
# Assessment administration guidelines

## Before conducting the assessment

Make yourself familiar with these guidelines. They must be followed closely if the results of testing in your school are to be comparable with the national data.

### Time Allocation

The assessment will take a total of 2 hours to complete:

- 10 minutes to explain the assessment and distribute the materials
- 45 minutes to complete Part A (Objective Assessment)
- 20 minutes break between tasks
- 45 minutes to complete Part B (Practical Tasks).

## Materials required

- Students
  - Objective Assessment — Pen/pencil and eraser
    One booklet per student
  - Practical Tasks — Materials as specified for group work
    Pen/pencil and eraser
    One booklet per student
- Teachers
  - Objective Assessment — Administration guide
  - Practical Tasks — Administration guide
    Materials as specified for group work.

## Group work

The Practical Tasks have been prepared on the assumption that students will work in groups of three for the activity component of the tasks.

If classes are used to working in groups of this size then normal class groups should be used.

If they are not, students will need to be assigned to a group of three. For the National Assessment groups were constructed by random assignment to avoid friends in 'like ability' groups working together on the Practical Tasks.

To construct groups in this way, count the number of students in the class who are present and will be participating in the Tasks. Divide by three to obtain the number of workgroups. If there is a remainder, up to two groups may have four members each.

Arrange the students in alphabetical order by surname from 'A' to 'Z' and assign them to groups by counting them off, e.g. a class of 22 students would have seven groups of three students and 1 remainder.
Hence Student 1 is assigned to Group 1; Student 2 to Group 2; Student 3 to Group 3; Student 7 to Group 7; Student 8 to Group 1; Student 9 to Group 2; etc.;
Student 22 may be assigned to any group.

# Assistance

When completing the assessment, students should be given every opportunity to demonstrate their understandings. You can read part or all of a question for a student if he or she is experiencing difficulty in reading it. It is important, however, not to interpret the question for the student.

Students should be encouraged to attempt all questions in the assessment. If a student finds a question difficult, suggest that he or she skip it and move on to other questions. The student can return to the original question if time permits.

ACER

Improving Learning

# National Science Literacy School Assessment

## 2003 PSAP Released Items

# ASSESSMENT ADMINISTRATOR'S MANUAL

This manual contains selected extracts from the full version of the PSAP 2003 Administrators Manual to enable the classroom teacher to replicate the conditions under which the national sample was administered.

Sections removed relate to background information from the National Assessment and the administrative procedures for the securing of the test and the return of materials for central marking.

**Australia**

Part A: Objective Assessment

Part B: Practical Tasks (Craters)

Ministerial Council on Education, Employment, Training and Youth Affairs

## TABLE OF CONTENTS

## 1. CONDUCTING THE ASSESSMENT SESSION

### The Assessment Day

It will be necessary to set up the room and assessment materials. The materials you will need are:

- this manual, open to the script for administering the session;
- a watch or clock;
- your 'Survival Kit' – spare assessment booklets, spare pencils, spare rulers and so on;
- a clock visible to the students; and
- books or other reading materials to lend to students who finish the assessment early.

### Distributing Materials to the Students

You may distribute the materials either before the students arrive, as described below, or at the beginning of the session.

### Timing the Assessment Sessions

It is expected that the assessment will take approximately 2 hours to administer, including time to read the instructions, distribute the materials and allow for student breaks between the objective and practical sections of the assessment. The timing of the assessment is as follows:

- Reading the instructions and distributing the materials, completing the student information page, normal class routine issues etc will take 10-15 minutes;
- The ObjectiveAssessment session will take approximately 1 hour, with a break before commencing the practical task;
- The Practical Task should take about 45 minutes. It should be given on the same day as the Objective Assessment after a short break. However if this is not possible, it can be given on a different day; and
- Collecting the materials and ending the session will take 3-5 minutes.

### Reading the Script

The script you will need to administer the sessions begins on page 7. To ensure that all assessments throughout Australia are conducted in the same way and that all students hear the same instructions, the script must be read **WORD-FOR-WORD** without omissions or additions.

### Supervising the Session

You are responsible for monitoring the assessment session and the following points need to be observed:

- Once the assessment instructions have begun, it is advisable not to admit other students to the session.
- Make sure that all students understand how to record answers. You may read questions to students but must not help the students with the interpretation of any of the items in the Assessment Booklet. Students should not leave the session unless it is necessary.
- Students finishing early should be encouraged to review their work. Students who are completely finished may be permitted to read a book.

### Ending the Session

After you have completed the session, collect the Assessment Booklets. All Assessment Booklets must be accounted for before the students are dismissed. Thank the students for their participation and dismiss them according to school policy.

# SCRIPT TO BE READ FOR THE SESSIONS

## INTRODUCING THE STUDY

The only text to be read to the students is in shaded boxes, and must be read word for word. The un-shaded text is background information and instructions for the test administrator.

Say:

This class is taking part in an assessment based on a study called the NSLA Project.
Its goal was to find out what students your age know about science.
About 18,000 students throughout Australia have attempted this test. The results of the study help education authorities and governments determine what students are learning. By doing the very best you can on this test you will help your teacher to plan science programs for your class.

Distribute the materials, if you have not done so already, then say:

You should have an Assessment Booklet on your desk. Please do not turn it over yet. Put up your hand if you do not have an Assessment Booklet and a pencil.

Give students who do not have all the materials the booklet and/or a pen or pencil as necessary.

Then say:

If you find you need a ruler, or an eraser or pencil sharpener during the session, please raise your hand and I will assist you.

Resolve any other problems with the distribution of the material. Remind students that they should not have anything on their desks apart from their Assessment Booklet and the equipment they need for doing the assessment.

Do not admit any more students to the session.

## BEGINNING THE TEST SESSION

To make sure that all students doing this test throughout Australia receive exactly the same instructions, I will be reading them to you.

If you need another pencil during the session, please raise your hand.

Please turn over your Assessment Booklet and look at the cover page.

I am going to read these directions aloud, while you read them to yourself.

**Instruct the students to fill in their names on the cover page of the test.**

- Remind them to PRINT neatly when filling in their names in the spaces provided
- Ensure that the students do not move onto the Practice Questions until you are ready to commence the assessment.

# COMPLETING THE OBJECTIVE ASSESSMENT

In this booklet, you will find questions about science and general problem solving. Read each question carefully and answer it as well as you can.

You may find some of the questions in this assessment easy and some difficult. Answer as many questions as you can.

Do not start working through the test questions yet. You will be told when to begin.

First you will do some practice questions so you know what kinds of questions to expect in the test. Now we will do some practice questions together. There are four types of questions in the Science Tasks.

Look at Practice Question 1.

**Type 1** is **Multiple Choice**.
In these questions you must shade in a square next to the correct answer.
For example, try this one:

**Q1** The colour of blood is

☐ blue
☐ green
☐ red
☐ yellow

Shade the square that you think gives the correct answer.

Allow time for the students to answer Practice Question 1.

The answer is ‘red’ so we would shade the third square.

Check that students have shaded the square for ‘**red**’.
Deal with any questions or problems.

**Look at Practice Question 2.**

**Type 2** is **Circle the Word or Words**.
In these questions you must **circle the word or words** which are correct.
For example:

**Q2** Circle the words which are correct.

An elephant is (a bit bigger / much bigger) than a human.

**Now circle the words that you think are correct in the sentence.**

Allow time for students to answer Practice Question 2.

The answer is '**much bigger**' so we would circle those words in the sentence.

Check that students have circled '**much bigger**' for the second part.
Deal with any questions or problems.

**Look at Practice Question 3.**

Type 3 is a One or Two word answer.
In these questions you only need to write one or two words.
For example:

**Q3** On a clear, sunny day the colour of the sky is _____________.

Allow time for students to answer Practice Question 3.

What answers would you suggest?

Respond to the student answers as they are given. Typical answers would be 'blue', 'azure'.

Remind the students that answers that repeat information in the question would not be rewarded. e.g. 'clear'.
Deal with any questions or problems.

**Look at Practice Question 4.**

'Explain' means give a full explanation for your answer.

**Type** 4 is a **Long Answer**.
You may need to **write two** or **three lines or sentences** to give the best answer.
For example:

**Q4** What happens to a balloon when you blow it up? Explain.

____________________________________________________________________________

____________________________________________________________________________

Allow time for students to answer Practice Question 4.

What answers would you suggest?

Respond to the student answers as they are given. Typical answers would be 'it gets bigger', 'it explodes'.

Encourage students to provide well considered and complete answers such as; 'the air pressure causes the rubber to expand and the volume of the balloon increases. If the air pressure in the balloon is greater than the rubber can withstand then the balloon breaks '.

Explain that answers that give more information may be rewarded with higher marks.

Explain that there are clues in the layout of the questions about how many marks can be achieved. For the longer answer questions like Practice Question 3 and Practice Question 4, the number of lines is a guide to how much you will need to write.

Deal with any questions or problems.

Are there any questions about how to record your answers?

Please **STOP** here.

**DO NOT TURN TO THE NEXT PAGE UNTIL YOU ARE TOLD TO DO SO.**

**PART A: OBJECTIVE ASSESSMENT**

You have now finished the Practice Questions.

You will have 1 hour to complete the first section of the Assessment Booklet. We will have a break before we start the Practical Tasks.

You will work on your own to answer the questions in the booklet.

If you make a mistake and want to change your answer, erase it and write your new answer.

You should try each question but don't spend too long on any one question. If you don't know the answer to a question, try the next one. If you have time, go back to any question you didn't finish.

Do not start until I tell you to. Are there any questions?

Now turn to the next page.

Use your time carefully and do as much as you can. Please begin.

Note the start time for the Objective Assessment..

Use a watch or clock to time the session.

Monitor the students.

After 55 minutes say:

You have about 5 minutes to go.

After 60 minutes, say:

Please stop. Close your booklet and turn your booklet over. We shall now have a break.

The break does not have to be timed exactly and it is at the discretion of the teacher, to align it with normal school or breaks. It should be no less than 20 minutes.

PART B: PRACTICAL TASKS

# TEACHER PREPARATION

## 'Craters'

This task will take approximately 45 minutes for the students to complete. It comprises 10 minutes for instructions, distribution and collection of materials, and 35 minutes to complete the task (20 minutes for the Part A group work and 15 minutes for the Part B individual work). If a significant number of students appear to need more time, this is acceptable.

**Before the task, the teacher must:**
- Read carefully through this guide and prepare the task materials.
- It is ideal if the equipment can be set up beforehand on a table at the side of the room. One student from each group can then get the equipment when told to do so.
- Ensure that the students will have pens, pencils, erasers, rulers and the following equipment:

**per group of 3 students:**
1 sheet of newspaper
1 30 cm ruler
4 patty pans (about 6-8 cm diameter)
3 marbles ('normal' 1 cm diameter size)
1 plastic spoon
1 empty plastic cup
1 cup flour

**teacher only:**
teacher needs 1 sieve for the class, and
¼ cup powdered drinking chocolate for each group of students (about 3 cups in total).

It may be advisable for the teacher to sieve a small amount of the powdered drinking chocolate onto the flour in the patty pan for each group of students when required.

- Arrange a venue where students will not be disturbed (Students work in groups of three for Part A (the practical task) of the task and individually for Part B).
- Organise a quiet activity, such as reading, for any children who finish early.

### ARRANGING GROUPS FOR THE PRACTICAL TASK

The practical task has been prepared on the assumption that students will work in groups of three for the activity component of the task. The assignment of students to groups is discussed in detail on page 35.

## PREPARING THE STUDENTS FOR THE TASK

After the break, when the students are seated quietly in the assigned groups, say:

Today you will be doing a science practical task about 'Craters'. You will work in your new group for the Practical Task A. You must work alone for Practical Task B when you write your answers to the questions.

First we will record your name and the group number you have been put into in the booklet on page 18.

Now we will do some practice questions together.

There are three types of questions in the Science Tasks.

Look at Practice Question 1.

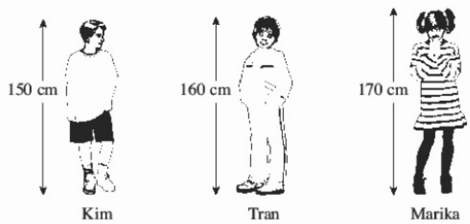
# Form A: Practical

### PRACTICE QUESTIONS

There are **three types** of questions in the Science Practical Tasks.

**Type 1**
Complete a results table.

**Q1** Sam measured the height of three students.




Put this information into this table.

| Person | Height (cm) |
|---|---|
| Kim | |
| Tran | |
| Marika | |

Fill in the table to answer Practice Question 1 in your own booklet.

Allow time for the students to answer Practice Question 1.

Check that students have filled in the table correctly showing Kim 150 cm, Tran 160 cm and Marika 170 cm.
Answer any questions and deal with any problems or issues.

Look at Practice Question 2.

**Type 2**
Look at an information table to answer the questions.

**Q2**

| 100 m race | Time (s) |
|---|---|
| Kim | 20 |
| Tran | 25 |
| Marika | 30 |

Kim was the fastest. What was his time? ____________________ seconds

Complete your answer for Practice Question 2 in the space provided in your own booklet.

Allow time for students to answer Practice Question 2.
Check that students have written 20.

Answer any questions and deal with any problems or issues.

Look at Practice Question 3.

'Explain' means give a **full** explanation for your answer.

**Type 3** is a **Long Answer**.
You may need to **write two or three lines or sentences** to give the best answer. For example:

**Q3** What happens to a balloon when you blow it up? Explain.

_______________________________________________________________

_______________________________________________________________

Allow time for students to answer Practice Question 3.

Respond to the student answers as they are given. Typical answers would be 'it gets bigger', 'it explodes'.
Encourage students to provide well considered and complete answers such as; 'the air pressure causes the rubber to expand and the volume of the balloon increases. If the air pressure in the balloon is greater than the rubber can withstand then the balloon breaks'.

Explain that answers that provide more information may be rewarded with higher marks.
Explain that there are clues in the layout of the questions about how many marks can be achieved.
For the longer answer questions like Practice Question 3, the number of lines is a guide to how much you will need to write.

Deal with any questions or problems.

You will do Part A of the booklet in your group. You will need to read through the instructions carefully and do the task as a group. You may discuss the task quietly as a group while you are completing the task.

If you make a mistake and want to change your answer, erase it and write your new answer.

You should try each question but don't spend too long on any one question. If you don't know the answer to a question, try the next one. If you have time, go back to any question you didn't finish.

Do not start until I tell you to. Are there any questions?

Deal with any questions.

## STARTING THE STUDENTS ON THE TASK

**Begin the assessment task when the students are ready.**

Have one student from each group get the equipment from the side table.

Before you start the task, we will check that each group has all the materials and I will read through the task.

Using a student test booklet, read through the list of materials and check that each group has everything.
Then read through the task procedure.

You may start Part A (Group work) of the Task now.

You have 30 minutes to complete Practical Task A. Use your time carefully and do as much as you can. Please begin. Do not start Practical Task B until I tell you.

Note the start time for the Practical Task A.

Monitor the students.

After 25 minutes remind the students that they should be nearly finished with the practical activity. After 30 minutes (provided all the students have finished the activities) ask the students to sit at their desks and individually answer the questions in Part B of the booklet.

Answer the questions in Practical Task B (Individual work) now.

You must work on your own to answer the questions.

You have 15 minutes remaining to complete Practical Task B.
.

As the end time approaches, watch for students who appear to have finished and remind them to check their work. Once you are satisfied that a student has finished all that he or she can do, you may give him or her a book or magazine to read.

After a total of 45 minutes say:

> Please stop.
>
> Thank you for doing your best on this assesment.

Monitor the students. At your discretion you may allow them a minute or two extra to finish answering the question they are working on.

## CONCLUDING THE ASSESSMENT SESSION

Collect all the materials.

Dismiss the students according to the policy of the school.

# Chapter 5
# Marking Guide

The guide below reflects the final marking guide used for the National Assessment and provides a standardised means of scoring student responses. Use of this rubric in scoring class responses will allow valid comparisons to be made of your students' results with the results of the National Science Assessment presented in Chapters 9 and 10.

Most questions are scored as correct (1) or incorrect (zero), but for Questions 12, 17 and 18 a maximum of 2 marks is possible.

The marking guide provides examples of the type of responses that would be awarded 1 mark or 2 marks. There are no part marks.

**National Science Literacy School Assessment**

Part A: Objective Assessment

# SCIENCE

Year 6

**PSAP 2003 Released Items**

# Marking Guide

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Ministerial Council on Education,
Employment, Training and Youth Affairs

**MARKING GUIDE**

PART A (OBJECTIVE ASSESSMENT)

Markers have been instructed to award responses that are ‘other’ than those indicated in the examples/information below a mark of zero, ‘0’.

The multiple response questions are coded sequentially 1,2,3,4. All multiple choice questions are marked as 1 mark or zero ('0') marks.

Questions that require teacher judgement have a grid in which to award the mark (0/1/2) to assist the teacher.

| Question | Score | Response: Answers/Examples/Information |
|---|---|---|
| **ICE CUBES** | | |
| Q1 | 1 | Any method of heating the ice in the plastic cup except those would the cup e.g. breathing into the cup, wrapping one’s hands around the cup, wrapping the cup in a warm cloth, moving into a heated room, pouring warm/ hot water into the cup, using a microwave oven.<br>**Not accepted:** Adding salt |
| Q2 | 1 | Any reasonable description of the shape of the cup e.g. cylinder, round.<br>**or**<br>Any diagram should closely approximate the shape of the bottom section of the cup.<br>**Not accepted:** Any diagram that had any ‘lump” or ‘solid” form that was inside or protruded above the horizontal line. |

| | | |
|---|---|---|
| **FLOORS** | | |
| Q3 | 1 | Multiple-choice Response 1: Surface 1 |
| Q4 | 1 | The explanation to this question must be consistent with the choice made as well as giving reasons appropriate to the function of a bedroom e.g. warm in winter if surface 3 was the chosen option. Any surface as long as justified OR any surface in which there was justification for the other surfaces being inappropriate. |
| Q5 | 1 | Multiple-choice Response 1: Surface 1 |

| | | |
|---|---|---|
| **ECHIDNAS** | | |
| Q6 | 1 | Multiple-choice Response 2: large strong claws and long sticky tongue |
| Q7 | 1 | Multiple-choice Response 3: protection from other animals |
| Q8 | 1 | Multiple-choice Response 2: Lack of rain caused less grass to grow so there were fewer ants. |

| MOSQUITOES | | |
|---|---|---|
| Q9 | 1 | A response must show the life cycle diagram as indicating a fixed sequence of stages, e.g. ‘Eggs change into larvae, larvae into pupae, pupae into adult mosquitoes and mosquitoes lay eggs.’ Follows a cycle through stages.<br>**Accepted**: The answer mentioned ‘cycle’ OR that the process repeated itself OR that the process moved through stages.<br>**Not accepted**: simply naming the stages. |
| Q10 | 1 | As the temperature rises, the larvae grow more quickly.<br>**or**<br>as the temperature increases the pupa stage is reached more quickly.<br>**Not accepted**: the pupa is reached after 6 days. |
| Q11 | 1 | A reason for the larva not changing into a pupa is sought. Examples:<br>‘The larva is stuck at 6 mm. The water is too cold for it to develop further.’<br>**or**<br>‘The water must be warmer for the larva to develop.’<br>**or**<br>‘The minimum temperature has to be 16 degrees.’<br>**Not accepted**: It is not enough to state that the lava hasn’t changed into a pupa. |
| Q12 | 2 | Two factors must be present: length and time for development,<br>e.g. ‘The length of a larva must be at least 10 mm **and** have been developing for six days.’ |
| | 1 | Length must be at least 10 mm. |

| PAPER CLIPS | | |
|---|---|---|
| Q13 | 1 | Multiple-choice Response 2: Clipon |
| Q14 | 1 | Each paper clip type might vary a bit, so you need more measurements.<br>You need an average and you need several measurements to be sure, or similar reasoning.<br>To reduce the ‘chance factor’<br>To be more reliable.<br>**Not accepted**: It is not enough to simply state ‘to get an average’. |

| **BUSH POND** | | |
|---|---|---|
| Q15 | 1 | Multiple-choice Response 2: frog, cricket, snake |
| Q16 | 1 | Fish and snake in correct positions.<br>(snake at top of food web) |
| Q17 | 2 | Tadpoles, frogs, fish, and snakes. |
| | 1 | Any two or three of the above with no incorrect parts, e.g. fish and tadpoles.<br>**Not accepted**: If any incorrect part is included, e.g two or three of the above with any incorrect response (cricket) would be awarded zero marks. |

| **WOOD BURNING** | | |
|---|---|---|
| Q18 | 2 | The wooden handle will not heat up like the metal can so it can be picked up when hot.<br>Wooden handle does not transmit (transfer, conduct) as much heat.<br>Answers expressed in the opposite were also accepted, e.g. if the handle was metal it would heat up like the can. |
| | 1 | **Examples**:<br>'It's easier to pick up'.<br>**or**<br>'So I can pick it up'. |
| Q19 | 1 | Multiple-choice Response 1: small dry pine and small dry redgum |

| **SANDPAPER** | | |
|---|---|---|
| Q20 | 1 | Heavy duty |
| Q21 | 1 | 'Heavy duty' sandpaper takes off more rough bits and then 'light sandpaper' will take off small amounts to get a smooth wood surface for sitting on.<br>'Heavy duty sandpaper takes off more rough bits'.<br>'Light sandpaper is only good for smoothing at the end'.<br>'Light sandpaper won't work on getting rid of the rough bits'. |

| TOY TRAINS | | |
|---|---|---|
| Q22 | 1 | To test if the battery was flat, a replacement battery could be tried or a voltmeter used.<br>Test the battery in another device.<br>**Not accepted**: Testing with tongue.<br>Check if the terminal is loose because it does not address the battery being ‘flat’. |
| Q23 | 1 | Any one of the following:<br>• check the switch<br>• check for a loose wire<br>• check for a faulty wire or loose connections<br>• check the train motor<br>• clean the tracks<br>**Not accepted**: Broken track (unless isolated by two breaks) is incorrect as contact is via wheel contact.<br>‘See if terminals are on the right way.’<br>‘See if the train was off the track’. |
| Q24 | 1 | The more the train circles the track the slower it gets.<br>Reference to taking longer or taking more time.<br>‘The battery was running down’ or reference to less power. |
| Q25 | 1 | This may be due to the battery losing its power (other innovative answers may be acceptable and must be judged on their applicability, e.g. as the engine of the train gets hot, it slows down.)<br>NOTE: Some students gave answer to Question 24 and Question 25 within the response to Question 24. Marks were awarded to Question 25 in these cases. |

**MARKING GUIDE**

FORM B (PRACTICAL TASK)

In practical tasks, only Task B questions are marked.
Responses which are ‘other’ than those indicated in the examples/information are given ‘0’.

| Question | Score | Response: Answers/Examples/Information |
|---|---|---|
| **CRATERS** | | |
| Q1 | 1 | Greater drop height gives deeper crater. |
| Q2 | 1 | The greater the drop height, the wider the crater. |
| Q3 | 1 | It is the height from surface to marble which we want to measure and each trial should be the same for a fair test and for accurate results. |
| Q4 | 1 | The craters are different widths and depths because of the size of the meteors and how fast they were moving when they hit.<br>Only one factor needed to be mentioned to be awarded one mark: ‘The asteroids were of different sizes’. |

# Chapter 6
# Class Record Sheet

This class record sheet provided here is to be used in conjunction with the marking guide (see Chapter 5). It provides a template for recording student marks and a format for recording information for later analysis.

The record sheet can be used to:

- record the scores for each student for each item;
- calculate the total score for each student for comparison with the information provided in Chapter 8, 'Student Performance Profile'; and
- record the number of students who score each category of the item for use in the analysis in Chapter 7, 'Item Analysis Sheet'.

# Year 6 Class record sheet

| | Question | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 | Q17 | Q18 | Q19 | Q20 | Q21 | Q22 | Q23 | Q24 | Q25 | QP1 | QP2 | QP3 | QP4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Possible score | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| No | Name | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 27 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. scoring zero | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. scoring 1 mark | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| No. scoring 2 marks | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# Chapter 7
# Item analysis sheet

The item analysis sheet provides a tool for comparing class performance against the results reported in the National Science Assessment.

The details for the column headed 'Number of students' can be obtained from the summary recorded at the bottom of the class record sheet (Chapter 6).

## Percentages

The percentage of students who have achieved the correct answer on an item can be calculated using the formula:

$$\frac{\text{number of students scoring full marks}}{\text{number of students assessed}} \times \frac{100}{1}$$

The percentage can be compared with the results reported in the National Science Assessment, which are shown in the column headed 'National Sample'. In making comparisons, teachers are advised to consider the items in relation to the schools curriculum and the school context.

**Table 7.1** Item Analysis Sheet

## Year 6 Item Analysis Sheet

Scientific Literacy

| Number of students assessed | |
|---|---|

| Question | Proficiency Level | Number of Students | (%) of students | National sample |
|---|---|---|---|---|
| Q1 | 2 | | | 95% |
| Q2 | 3.1 | | | 68% |
| Q3 | 3.1 | | | 88% |
| Q4 | 3.1 | | | 88% |
| Q5 | 2 | | | 90% |
| Q6 | 3.1 | | | 83% |
| Q7 | 2 | | | 95% |
| Q8 | 3.2 | | | 59% |
| Q9 | 3.1 | | | 69% |
| Q10 | 3.2 | | | 48% |
| Q11 | 3.2 | | | 68% |
| Q12(1)* | 3.3 | | | 42% |
| Q12(2)* | 4 | | | 7% |
| Q13 | 3.1 | | | 84% |
| Q14 | 3.3 | | | 43% |
| Q15 | 3.2 | | | 60% |
| Q16 | 3.1 | | | 80% |
| Q17(1)* | 3.1 | | | 64% |
| Q17(2)* | 3.2 | | | 23% |
| Q18(1)* | 3.1 | | | 41% |
| Q18(2)* | 3.2 | | | 49% |
| Q19 | 3.1 | | | 79% |
| Q20 | 2 | | | 92% |
| Q21 | 3.1 | | | 83% |
| Q22 | 3.2 | | | 46% |
| Q23 | 3.1 | | | 72% |
| Q24 | 3.3 | | | 40% |
| Q25 | 3.3 | | | 35% |
| QP1 | 3.2 | | | 60% |
| QP2 | 3.2 | | | 52% |
| QP3 | 3.2 | | | 46% |
| QP4 | 3.3 | | | 20% |

* Indicates the question has more than one (1) mark possible.

## Sample items and proficiency levels

As shown in Table 7.1, items comprising the scientific literacy assessment have been partitioned into proficiency levels.

To establish proficiency levels, a combination of expert knowledge of the skills required to answer each of the science items and results from the analysis of student's responses was used.

Items located within one of the five proficiency levels were judged by subject experts to share similar features and requirements and to differ in recognisable ways from items at other levels.

Table 7.2 provides a description of the level of knowledge and skills assessed by items operating at each proficiency level. Items at the higher proficiency levels require more demanding skills and understandings to answer them than do items with lower proficiency levels.

In relation to the item analysis sheet, it may be expected that the percentage correct for the items increases as the proficiency level decreases.

**Table 7. 2** Description of Skills Assessed at Each Proficiency Level

| Proficiency Level | Level Descriptors |
|---|---|
| Level 2 or below | • Describes a choice for a situation based on first-hand concrete experience, or requiring the application of limited knowledge.<br>• Identifies the difference between properties that have been experienced.<br>• Makes measurements or comparisons involving information or stimulus in a familiar context.<br>• Identifies simple patterns in data and/or interpret a dataset containing some interrelated elements. |
| Level 3.1<br>Beginning level 3 | • Selects appropriate reason to explain reported observation related to personal experience.<br>• Identifies the relationship between events that have been observed or experienced.<br>• Identifies the variable to be measured or controlled.<br>• Describes the findings of an experiment in simple terms focusing on one variable.<br>• Interprets simple data set requiring an element of comparison. |
| Level 3.2 | • Interprets information in a contextualised report by application of relevant science knowledge.<br>• Uses observed data, personal experience and applies rules to describe expected outcome.<br>• Collates and compares data set of collected information.<br>• Gives reason for controlling a single variable.<br>• Interprets diagrams and graphical data situated in a common or familiar context.<br>• Makes conclusions and makes comparisons of scientific data. |
| Level 3.3<br>Consolidated level 3 | • Applies knowledge of relationships to explain reported phenomenon.<br>• Demonstrates an awareness of the principles of conducting an experiment and controlling variables.<br>• Proposes suitable method for fair collection of data.<br>• Describes key features of a collected set of data, and can predict outcome of next event in series.<br>• Extrapolates from an observed pattern to describe an expected outcome or event. |
| Level 4 and Above | • Explains interactions that have been observed in terms of an abstract scientific concept.<br>• Interprets abstract diagrams situated within an unfamiliar context.<br>• Demonstrates awareness of the need for fair testing by explaining how specific variables must be controlled.<br>• Uses repeated trials and replicates in testing.<br>• Critiques investigations noting design flaws.<br>• Makes general suggestions for improving an investigation. |

In terms of the proficiency levels described in Table 8.2, the standard for proficiency in scientific literacy was found to be equivalent to Level 3.2. Therefore, students achieving at Level 3.2 are considered to have a sound understanding of Year 6 science.

Chapter 8 further describes student proficiency in relation to the standard and provides information for determining a student's proficiency level in scientific literacy.

# Chapter 8
# Student performance profile

The National Science Assessment 2003 involved a sample of over 14,000 students and was used to obtain information about the performance of Year 6 students in scientific literacy across the nation. The data collected enabled the development of student ability estimates and descriptions of the proficiency standards for Year 6 science.

## The standard for Year 6 science literacy

A standard for scientific literacy has been established as part of the first cycle of national assessment to provide parents, educators and the community with a clear picture of the proficiency students are expected to demonstrate by the end of Year 6.

To identify what students should know and be able to do by the end of Year 6, university science educators, curriculum officers and experienced primary teachers from government, Catholic and independent schools in all States and Territories were brought together.

The members of the expert group used their classroom experience and knowledge of the science curriculum in the various jurisdictions to examine the test items from the National Science Assessment.

The crucial science literacy skills and understandings needed by students for the next phase of science learning at school were discussed and debated before consensus was reached on a 'proficient' standard for Year 6.

The 'proficient' standard is a challenging level of performance, with students needing to demonstrate more than minimal or elementary skills.

With respect to Table 7.2, the standard was found to be equivalent to Level 3.2: that is, students achieving at Level 3.2 are considered to have a sound understanding of Year 6 science. Students at this level demonstrate considerably more skill and understanding than those performing at Levels 3.1 and below.

Year 6 students who exceed the proficient standard (those who perform at Level 3.3 and above) show exemplary performance.

## Student performance and the Year 6 standard

One of the main objectives of the National Science Assessment is to monitor trends in scientific literacy performance over time. One convenient and informative way of doing so is to reference the results to the proficiency levels.

Table 8.1 and Table 8.2 enable teachers to determine whether their students have demonstrated proficiency in science by reaching Level 3.2 or better on the scientific literacy scale.

The tables can be used to convert students' raw scores on the National Science Literacy School Assessment materials to corresponding scale scores on the National Science Assessment. In the latter, the students' raw scores on the scientific literacy scale were transformed into a scale with a mean of 400 and a standard deviation of 100.

This transformation was applied to assist in the interpretation of the raw scores and the assignment of proficiency levels. Therefore the tables shown below can be used to determine the proficiency level of a student by matching his or her raw score with the scaled score and corresponding proficiency level.

If your students have attempted only the Objective Assessment, Table 8.1 provides the information to convert their scores to the national scale.

If your students have attempted both the Objective Assessment and the Practical Tasks, Table 8.2 provides the information to convert their scores to the national scale.

**Table 8. 1** Objective Assessment ONLY

| Student Raw Score | Equivalent sample Scaled score | Level Attained | Level Descriptors |
|---|---|---|---|
| 0<br>1<br>2<br>3<br>4<br>5<br>6<br>7 | 0<br>33<br>94<br>137<br>172<br>202<br>228<br>252 | Level 2 or below | Describes a choice for a situation based on first-hand concrete experience, or requiring the application of limited knowledge.<br>Identifies the difference between properties that have been experienced.<br>Makes measurements or comparisons involving information or stimulus in a familiar context.<br>Identifies simple patterns in data and/or interprets a dataset containing some interrelated elements. |
| 8<br>9<br>10<br>11<br>12<br>13<br>14 | 274<br>295<br>315<br>334<br>353<br>372<br>390 | Level 3.1 Beginning Level 3 | Selects appropriate reason to explain reported observation related to personal experience.<br>Identifies the relationship between events that have been observed or experienced.<br>Identifies the variable to be measured or controlled<br>Describes the findings of an experiment in simple terms focusing on one variable.<br>Interprets simple data set requiring an element of comparison. |
| 15<br>16<br>17<br>18<br>19<br>20 | 409<br>428<br>447<br>467<br>487<br>509 | Level 3.2 At Level 3 | Interprets information in a contextualised report by application of relevant science knowledge.<br>Uses observed data and personal experience and applies rule to describe expected outcome.<br>Collates and compares data set of collected information.<br>Gives reason for controlling a single variable.<br>Interprets diagrams and graphical data situated in a common or familiar context.<br>Draws conclusions and makes comparisons of scientific data. |
| 21<br>22<br>23<br>24 | 531<br>556<br>583<br>614 | Level 3.3 Consolidated Level 3 | Applies knowledge of relationships to explain reported phenomenon.<br>Demonstrates an awareness of the principles of conducting an experiment and controlling variables.<br>Proposes suitable method for fair collection of data.<br>Describes key features of a collected set of data, and can predict outcome of next event in series.<br>Extrapolates from an observed pattern to describe an expected outcome or event. |
| 25<br>26<br>27<br>28 | 650<br>695<br>758<br>848 | Level 4 or above | Explains interactions that have been observed in terms of an abstract scientific concept.<br>Interprets abstract diagrams situated within an unfamiliar context.<br>Demonstrates awareness of the need for fair testing by explaining how specific variables must be controlled.<br>Uses repeated trials and replicates in testing.<br>Critiques investigations noting design flaws.<br>Makes general suggestions for improving an investigation. |

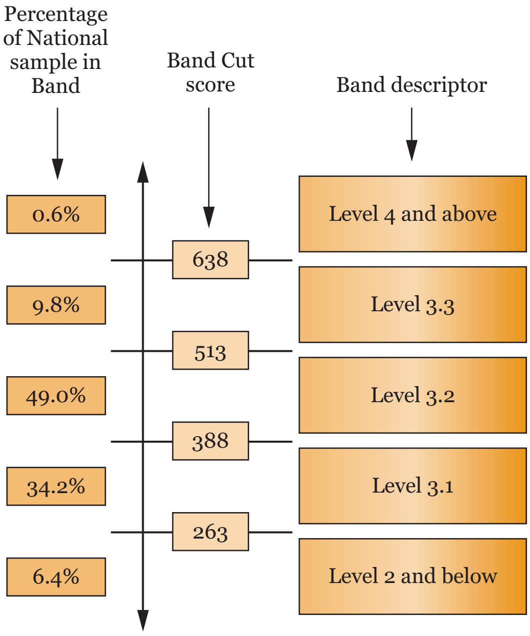
**Table 8.2** Objective Assessment AND Practical Task

| Student Raw Score | Equivalent sample Scaled score | Level Attained | Level Descriptors |
|---|---|---|---|
| 0<br>1<br>2<br>3<br>4<br>5<br>6<br>7<br>8 | 0<br>25<br>86<br>128<br>162<br>191<br>217<br>240<br>261 | Level 2 or below | Describes a choice for a situation based on first-hand concrete experience, or requiring the application of limited knowledge.;<br>Identifies the difference between properties that have been experienced.<br>Makes measurements or comparisons involving information or stimulus in a familiar context.<br>Identifies simple patterns in data and/or interprets a dataset containing some interrelated elements. |
| 9<br>10<br>11<br>12<br>13<br>14<br>15 | 281<br>300<br>318<br>335<br>352<br>369<br>385 | Level 3.1 Beginning Level 3 | Selects appropriate reason to explain reported observation related to personal experience.<br>Identifies the relationship between events that have been observed or experienced.<br>Identifies the variable to be measured or controlled<br>Describes the findings of an experiment in simple terms focusing on one variable.<br>Interprets simple data set requiring an element of comparison. |
| 16<br>17<br>18<br>19<br>20<br>21<br>22 | 402<br>418<br>434<br>451<br>468<br>486<br>504 | Level 3.2 At Level 3 | Interprets information in a contextualised report by application of relevant science knowledge.<br>Uses observed data and personal experience and applies rule to describe expected outcome.<br>Collates and compares data set of collected information.<br>Gives reason for controlling a single variable<br>Interprets diagrams and graphical data situated in a common or familiar context.<br>Draws conclusions and makes comparisons of scientific data. |
| 23<br>24<br>25<br>26<br>27 | 523<br>543<br>564<br>587<br>613 | Level 3.3 Consolidated Level 3 | Applies knowledge of relationships to explain reported phenomenon.<br>Demonstrates an awareness of the principles of conducting an experiment and controlling variables.<br>Proposes suitable method for fair collection of data.<br>Describes key features of a collected set of data, and can predict outcome of next event in series.<br>Extrapolates from an observed pattern to describe an expected outcome or event. |
| 28<br>29<br>30<br>31<br>32 | 642<br>676<br>719<br>781<br>867 | Level 4 or above | Explains interactions that have been observed in terms of an abstract scientific concept.<br>Interprets abstract diagrams situated within an unfamiliar context.<br>Demonstrates awareness of the need for fair testing by explaining how specific variables must be controlled.<br>Uses repeated trials and replicates in testing.<br>Critiques investigations noting design flaws.<br>Makes general suggestions for improving an investigation. |

## Distribution of Year 6 student performance

Figure 8.1 below shows the distribution of students who achieved each proficiency level in the National Science Assessment. The information draws on the distribution of students' performances across proficiency levels as presented in Chapter 4 of the 2003 National Science Assessment report.

**Figure 8.1** Percentage of Students from the National 2003 Sample at each Proficiency Level and the Corresponding Scaled-Score



# Chapter 9
# Class analysis sheet

The class analysis sheet is designed to assist you in drawing a graph of class or school performance that enables comparisons to be made between your student group and the National Science Assessment.

The graph is a simple pictorial presentation of the data that enables visual comparisons of the performance of a student group with the sample study findings, including the national mean and distribution estimates.

However, teachers should use these as indicators only. The National Science Assessment was constructed and implemented scientifically to provide a representative estimate of the national year 6 population. Small groups such as schools or classes may have quite abnormal distributions that are unique to them at the time they use this material.

## Using the class analysis sheet

The graph can be constructed as a simple histogram by shading the cells vertically to represent the number of students who have achieved a particular score. A line can then be drawn by joining the midpoints of the maximum cell for each score to form the frequency polygram.

## National sample mean and distribution

The shaded vertical column at the scaled score of 409 (raw score = 15) represents the best estimate of the mean for the national sample.

The shaded bars entitled ‘National distribution' indicate the proportions of students falling within the lower 25th percentile, the middle 50th percent and top 25th the middle 50th and top 25th percentile in the 2003 sample study.

## Student proficiency

With respect to proficiency levels, the shaded bars entitled 'Level distribution' indicate the proportions of students falling within each of the standards levels defined in the scientific literacy assessment domain. Level 3 has been divided into 3 sub-levels (beginning Level 3, atLevel 3 and consolidated Level 3) for the purpose of providing a more precise descriptor of the level of performance than that provided by the global Level 3 descriptor.

The overlaps in the proficiency bars represent a degree of uncertainty (measurement error) of the estimates around the cut scores that have been used to define achievement at each Level.

**Table 9.1** Class Analysis Sheet (refer to Table 8.1 for students who have attempted the Objective Assessment only)

| Number of students achieving score | | | | | | | | | | | | | | | sample mean | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scaled score | 0 | 33 | 94 | 137 | 172 | 202 | 228 | 252 | 274 | 295 | 315 | 334 | 353 | 372 | 390 | 409 | 428 | 447 | 467 | 487 | 509 | 531 | 556 | 583 | 614 | 650 | 695 | 758 | 848 |
| Raw score | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| Level distribution | Level 2 or below | | | | | | | | | | | | | | At Level 3 (3.2) | | | | | | | | | | Level 4 or above | | | | |
| | | | | | | | | | Beginning Level 3 (3.1) | | | | | | | | | | | | Consolidated Level 3 (3.3) | | | | | | | | |
| National distribution | 25% of National sample | | | | | | | | | | | | 50% of National sample | | | | | | | 25% of National sample | | | | | | | | | |

Maximum Score

**Table 9.2** Class Analysis Sheet (refer to Table 8.2 for students who have attempted both the Objective Assessment and the Practical Task)

| Number of students achieving score | | | | | | | | | | | | | | | | | sample mean | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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| 22 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Scaled score | 0 | 25 | 86 | 128 | 162 | 191 | 217 | 240 | 261 | 281 | 300 | 318 | 335 | 352 | 369 | 385 | 402 | 418 | 434 | 451 | 468 | 486 | 504 | 523 | 543 | 564 | 587 | 613 | 642 | 676 | 719 | 781 | 867 |
| Raw score | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 Maximum Score |
| Level distribution | Level 2 or below | | | | | | | | | | | | | | | At Level 3 (3.2) | | | | | | | | | | | | | Level 4 or above | | | | |
| | | | | | | | | | Beginning Level 3 (3.1) | | | | | | | | | | | | | | Consolidated Level 3 (3.3) | | | | | | | | | | |
| National distribution | 25% of National sample | | | | | | | | | | | | | 50% of National sample | | | | | | | | 25% of National sample | | | | | | | | | | | |

# Appendix A

# MCEETYA
# Performance Measurement and Reporting Taskforce

## NATIONAL YEAR 6 PRIMARY SCIENCE SAMPLE ASSESSMENT: ASSESSMENT DOMAIN AND PROGRESS MAP

### Assessment Domain: Scientific literacy

The national review of the status and quality of teaching and learning of science in Australian schools (Goodrum, Hackling, & Rennie, 2001) argued that the broad purpose of science in the compulsory years of schooling is to develop scientific literacy for all students.

Scientific literacy is a high priority for all citizens, helping them

- to be interested in, and understand the world around them,
- to engage in the discourses of and about science,
- to be sceptical and questioning of claims made by others about scientific matters,
- to be able to identify questions, investigate and draw evidence-based conclusions, and
- to make informed decisions about the environment and their own health and well-being (Hackling, Goodrum, & Rennie, 2001, p. 7).

Scientific literacy is important as it contributes to the economic and social well-being of the nation, and improved decision-making at public and personal levels (Laugksch, 2000). The OECD PISA assessments focus on aspects of preparedness for adult life in terms of functional knowledge and skills that allow citizens to participate actively in society. It is argued that scientifically literate persons are “able to use scientific knowledge and processes not just to understand the natural world but (also) to participate in decisions that affect it” (OECD Programme for International Student Assessment, 1999, p. 13).

The OECD PISA (1999) has defined scientific literacy as:

*…the capacity to use scientific knowledge, to identify questions (investigate)*[1] *and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity (p. 60)*

This definition has been adopted for the National Yr 6 Primary Science Sample Assessment in accord with the Ball, Rae and Tognolini (2000) Report recommendation.

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[1] Due to the constraints of large scale testing, PISA is not able to include performance tasks such as conducting investigations. Consequently, the PISA definition has omitted reference to investigating. The word ‘investigate’ has been inserted into the definition for the purpose of the National Yr 6 Primary Science Sample Assessment project as the sample testing methodology to be used allows for performance assessments of conducting investigations.

## Scientific Literacy: Progress Map

A scientific literacy progress map (Appendix 1) has been developed based on the construct of scientific literacy and on an analysis of State and Territory curriculum and assessment frameworks. The progress map describes the development of scientific literacy across three domains of knowledge which are inclusive of Ball et al.'s concepts and processes and the elements of the OECD PISA definition.

The five elements of scientific literacy, including concepts and processes, used in PISA 2000 (OECD PISA 1999) include:

- demonstrating understanding of scientific concepts,
- recognising scientifically investigable questions,
- identifying evidence needed in a scientific investigation
- drawing or evaluating conclusions, and
- communicating valid conclusions.

These elements have been clustered into three more holistic domains described below. Elements 2 and 3 and conducting investigations to collect data are encompassed in Domain A; Elements 4 and 5 are included in Domain B; and, Element 1 is included in Domain C.

A. *Formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence.*
This process domain includes: posing questions or hypotheses for investigation or recognising scientifically investigable questions; planning investigations by identifying variables and devising procedures where variables are controlled; gathering evidence through measurement and observation; and making records of data in the form of descriptions, drawings, tables and graphs using a range of information and communication technologies.

B. *Interpreting evidence and drawing conclusions, critiquing the trustworthiness of evidence and claims made by others, and communicating findings.*
This process domain includes: identifying, describing and explaining the patterns and relationships between variables in scientific data; drawing conclusions that are evidence-based and related to the questions or hypotheses posed; critiquing the trustworthiness of evidence and claims made by others; and, communicating findings using a range of scientific genres and information and communication technologies.

C. *Demonstrating science understandings by describing and explaining natural phenomena, making sense of reports, and making decisions.*
This conceptual domain includes demonstrating conceptual understandings by being able to: describe, explain and make sense of natural phenomena; understand and interpret reports (eg TV documentaries, newspaper or magazine articles or conversations) related to scientific matters; and, make decisions about scientific matters in students' own lives which may involve some consideration of social, environmental and economic costs and benefits.

Scientific literacy has been described here in three domains to facilitate the interpretation of student responses to assessment tasks, however, authentic tasks should require students to apply concepts and processes together to address problems set in real-world contexts. These tasks may involve ethical decision-making about scientific matters in students' own lives and some consideration of social, environmental and economic costs and benefits.

The progress map describes progression in six levels from levels 1 to 6 in terms of three aspects:

- increasing complexity, from explanations that involve one aspect, to several aspects, and then through to relationships between aspects of a phenomenon;
- progression from explanations that refer to and are limited to directly experienced phenomena (concrete) to explanations that go beyond that which can be directly observed and involve abstract scientific concepts (abstract); and
- increasing complexity in descriptions of 'what' happened in terms of the objects and events, in explanations of 'how' it happened in terms of processes, and in explanations of 'why' it happened in terms of science concepts.

The progress map has been linked to the SOLO taxonomy (Biggs & Collis, 1982). The acronym SOLO refers to the Structure of Observed Learning Outcomes. The taxonomy was written to describe levels of student responses to assessment tasks. The basic SOLO categories include:

- prestructural - no logical response;
- unistructural - refers to only one aspect;
- multistructural - refers to several independent aspects;
- relational - can generalise (describe relationships between aspects) within the given or experienced context; and
- extended abstract - can generalise to situations not experienced.

The three main categories of unistructural, multistructural and relational can also be applied, as cycles of learning, to the four modes of representation:

- sensorimotor- the world is understood and represented through motor activity;
- ikonic - the world is represented as internal images;
- concrete - writing and other symbols are used to represent and describe the experienced world; and
- formal - the world is represented and explained using abstract conceptual systems.

The progress map therefore makes links to the SOLO categories of concrete unistructural (level 1), concrete multistructural (level 2), concrete relational (level 3), abstract unistructural (level 4), abstract multistructural (level 5) and abstract relational (level 6).

The SOLO levels of performance should not be confused with Piagetian levels of cognitive development. Biggs and Collis (1982, p. 22) explain that the relationship between Piagetian stages and SOLO levels "is exactly analogous to that between ability and attainment" and that level of performance depends on quality of instruction, the student's motivation to perform, prior knowledge and familiarity with the context. Consequently performance is highly variable for a given individual and is often sub-optimal.

Columns one and two of the progress map set out possible standards. For example, it would be expected that 50% of Year 6 students would be at level 3. These standards are tentative and may be somewhat optimistic. The standards have been provided as a very general guide for item writers as they develop items and tasks for the Primary Science Assessment Project. **Note: The progress map will be revised using empirical evidence from the analysis of data from the first National Yr 6 Primary Science Sample Assessment in 2003.**

## Scientific Concepts Appropriate to the National Yr 6 Primary Science Sample Assessment

A table of the major scientific concepts found most widely in the various State and Territory documents has been developed to accompany the Scientific Literacy Progress Map (Appendix 2). These major concepts are broad statements of scientific understandings Year 6 students would be expected to demonstrate and provide item writers with a specific context in which scientific literacy would be assessed. An illustrative list of examples for each of the major concepts provides elaboration of these broad conceptual statements, and in conjunction with the Scientific Literacy Progress Map, which describes the developmental stages for scientific literacy, would be used as a guide in the development of assessment items.

It should be noted that given the National Yr 6 Primary Science Sample Assessment test instruments are constructed within constraints of test length, it may not be practical to include all listed concepts in the instruments constructed for any particular testing cycle.

## References


Ball, S., Rae, I., & Tognolini, J. (2000). *Options for the assessment and reporting of primary students in the key learning area of science to be used for the reporting of nationally comparable outcomes of schooling within the context of the National Goals for Schooling in the Twenty-First Century*: National Education Performance Monitoring Taskforce.

Biggs, J. B., & Collis, K. F. (1982). *Evaluating the quality of learning: The SOLO taxonomy*. New York: Academic Press.

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Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. *Science Education, 84*(1), 71-94.

OECD Programme for International Student Assessment. (1999). *Measuring student knowledge and skills: A new framework for assessment*. Paris: OECD.

# Appendix 1

## Scientific Literacy Progress Map

| Level | Year level at which 50% of the population would be expected to reach the standard | Solo taxonomy | Domains of scientific literacy | | |
|---|---|---|---|---|---|
| | | | **Domain A** Formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence | **Domain B** Interpreting evidence and drawing conclusions, critiquing the trustworthiness of evidence and claims made by others, and communicating findings | **Domain C** Demonstrating science understandings by describing and explaining natural phenomena, making sense of reports, and making decisions. |
| 1 | 2 | C-U | Responds to the teacher's questions, observes and describes | Describes what happened | Describes an aspect or property of an individual object or event that has been experienced or reported |
| 2 | 4 | C-M | Given a question in a familiar context, identifies a variable to be considered, observes and describes or makes non-standard measurements and limited records of data | Makes comparisons between objects or events observed | Describes changes to, differences between or properties of objects or events that have been experienced or reported |
| 3 | 6 | C-R | Formulates scientific questions for testing and makes predictions. Demonstrates awareness of the need for fair testing. Makes simple standard measurements. Records data as tables, diagrams or descriptions. | Displays data as tables or bar graphs, identifies and summarises patterns in science data. Applies the rule by extrapolating or predicting. | Explains the relationships between individual events that have been experienced or reported and can generalise and apply the rule by predicting future events |
| 4 | 8 | A-U | Identifies the variable to be changed, the variable to be measured and several variables to be controlled. Uses repeated trials or replicates. | Calculates averages from repeat trials or replicates, plots line graphs where appropriate. Conclusions summarise and explain the patterns in the data. Able to make general suggestions for improving an investigation (eg. make more measurements) | Explains interactions, processes or effects, that have been experienced or reported, in terms of a non-observable property or abstract science concept |

| | | | | | |
|---|---|---|---|---|---|
| 5 | 10 | A-M | Formulates scientific questions or hypotheses for testing and plans experiments in which most variables are controlled. Selects equipment that is appropriate and trials measurement procedure to improve techniques and ensure safety. | Conclusions explain the patterns in the data using science concepts, and are consistent with the data. Critiques reports of investigations noting any major flaw in design or inconsistencies in data. | Explains phenomena, or interprets reports about phenomena, using several abstract scientific concepts |
| 6 | 12 | A-R | Uses scientific knowledge to formulate questions, hypotheses and predictions and to identify the variables to be changed, measured and controlled. Trials and modifies techniques to enhance reliability of data collection. | Selects graph type and scales that display the data effectively. Conclusions are consistent with the data, explain the patterns and relationships in terms of scientific concepts and principles, and relate to the question, hypothesis or prediction. Critiques the trustworthiness of reported data (eg. adequate control of variables, sample or consistency of measurements), and consistency between data and claims. | Explains complex interactions, systems or relationships using several abstract scientific concepts or principles and the relationships between them |

# Appendix 2

## Major Scientific Concepts
## for the National Yr 6 Primary Science Sample Assessment

| Major Scientific Concepts | Examples |
|---|---|
| **Earth and beyond**<br><br>Earth, sky and people: Our lives depend on air, water and materials from the ground; the ways we live depend on landscape, weather and climate.<br><br>The changing Earth: The Earth is composed of materials that are altered by forces within and upon its surface.<br><br>Our place in space: The Earth and life on Earth are part of an immense system called the universe. | <br><br>▪ Features of weather, soil and sky and affects on me.<br>▪ Changes in weather, weather data, seasons, soil landscape and sky (e.g. moon phases), weathering and erosion, movement of the Sun and shadows, bush fires, land clearing.<br>▪ People use resources from the earth; need to use them wisely.<br>▪ Rotation of the Earth and night/day, spatial relationships between Sun, Earth and Moon.<br>▪ Planets of our solar system and their characteristics. |
| **Energy and change**<br><br>Energy and us: Energy is vital to our existence and our quality of life as individuals and as a society.<br><br>Transferring energy: Interaction and change involve energy transfers; control of energy transfer enables particular changes to be achieved.<br><br>Energy sources and receivers: Observed change in an object or system is indicated by the form and amount of energy transferred to or from it. | <br><br>▪ Uses of energy, patterns of energy use and variations with time of day and season.<br>▪ Sources, transfers, carriers and receivers of energy, energy and change.<br>▪ Types of energy, energy of motion – toys and other simple machines – light, sound.<br>▪ Forces as pushes and pulls, magnetic attraction and repulsion. |
| **Life and living**<br><br>Living together: Organisms in a particular environment are interdependent.<br><br>Structure and function: Living things can | <br><br>▪ Living vs non-living.<br>▪ Plant vs animal and major groups.<br>▪ Major structures and systems and their functions.<br>▪ Dependence on the environment: |

| | |
|---|---|
| be understood in terms of functional units and systems.<br><br>Biodiversity, change and continuity: Life on Earth has a history of change and disruption, yet continues generation to generation. | Survival needs – food, space and shelter.<br>▪ Change over lifetime, reproductions and lifecycles.<br>▪ Interactions between organisms and interdependence e.g. simple food chains.<br>▪ Adaptation to physical environment. |
| **Natural and processed materials**<br><br>Materials and their uses: The properties of materials determine their uses; properties can be modified.<br><br>Structure and properties: The substructure of materials determines their behaviour and properties.<br><br>Reactions and change: Patterns of interaction of materials enable us to understand and control those interactions. | ▪ Materials have different properties and uses<br>▪ The properties of materials can be explained in terms of their visible substructure such as fibres.<br>▪ Materials can change their state and properties.<br>▪ Solids, liquids and gases |