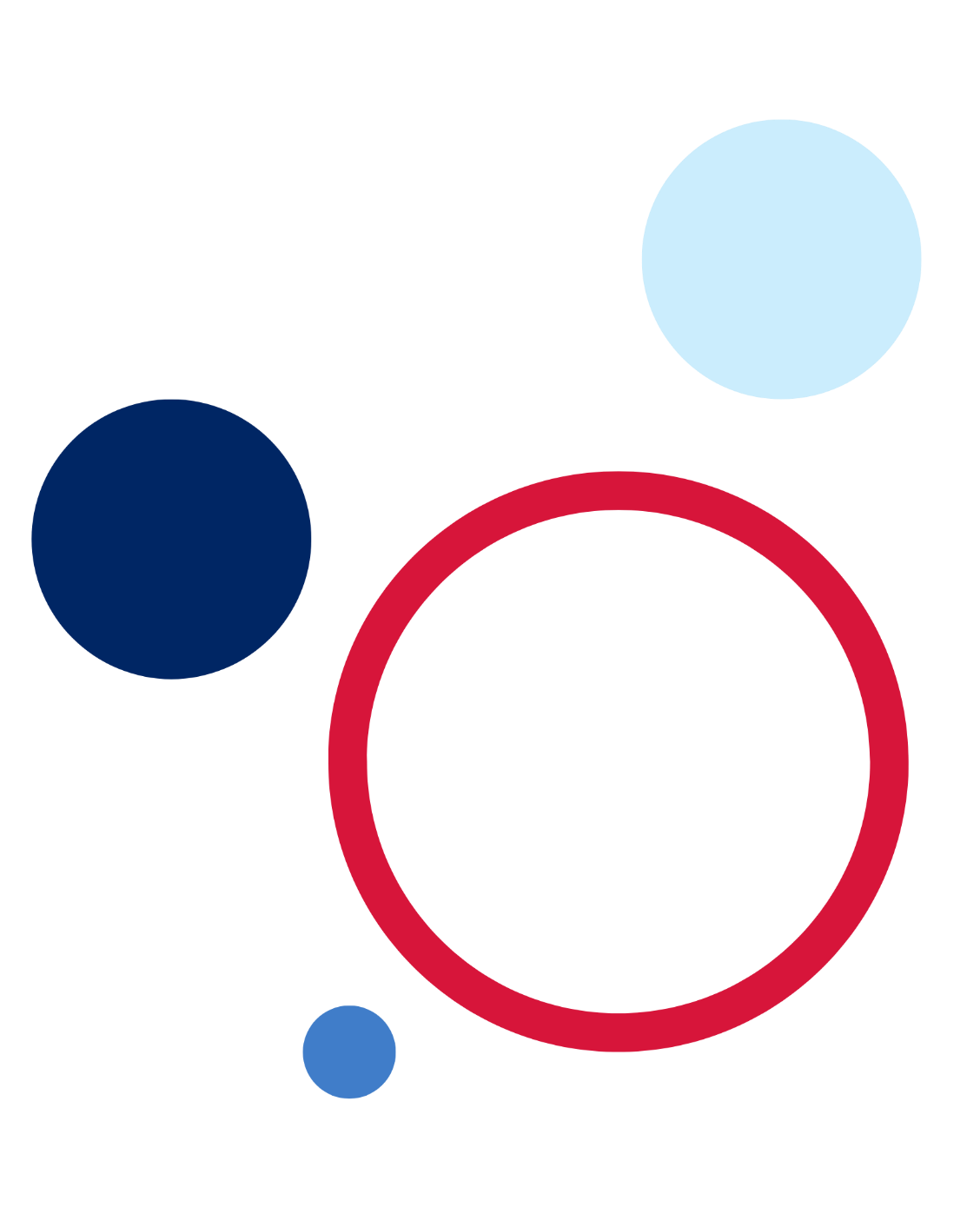
# Science Stage 5 assessment task – temperature and reaction rate



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## Overview

**Stage and Learning Area:** Stage 5 Science

**Description:** this assessment task has been designed to address various Working Scientifically outcomes, including planning investigations, conducting investigations, processing and analysing data and information, and communicating. This resource also addresses content within Chemical World, specifically, CW4c: describe the effects of factors, such as temperature, on the rate of some chemical reactions. The assessment task also has a writing focus to assess the grammatical features of the final report.

This assessment task builds upon students’ understanding of conducting valid and reliable experiments and writing scientific reports.

**Duration:** while timing will vary based on the needs of the students, differentiation strategies employed and class or school context, this assessment task would take approximately three 1-hour lessons.

## Information for teachers

### Introduction

This assessment task is designed for Stage 5 and may be suitable to complete before the Student Research Project to improve communication through scientific report writing. The investigation involves a starch-iodine clock reaction and the effect of temperature on the time taken to react.

Before this assessment task, students should have learnt about the factors that affect a chemical reaction, experimental design, how to identify and control risks in an experiment and how to write scientific reports.

In this assessment task, students will:

* design and conduct an investigation to observe the effect of temperature on the rate of a chemical reaction
* write a scientific report on the investigation.

### Outcomes

A student:

* **SC5-4WS** develops questions or hypotheses to be investigated scientifically
* **SC5-5WS** produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively
* **SC5-7WS** processes, analyses and evaluates data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions
* **SC5-9WS** presents science ideas and evidence for a particular purpose and to a specific audience, using appropriate scientific language, conventions and representations
* **SC5-17CW** discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

### Learning intentions and success criteria

Students:

* design and conduct an investigation on the effect of temperature on the rate of a chemical reaction.
* process, analyse and evaluate collected data to develop an evidence-based conclusion.
* present science ideas and evidence using appropriate language, conventions and representations.

Students can/will:

* explain how temperature affects the rate of a chemical reaction
* identify the dependent, independent and controlled variables for an investigation
* use appropriate units to measure physical quantities
* describe the relationship between variables
* assess the validity and reliability of collected data
* use grammatical features, including theme and rheme, and text connectives to improve the overall cohesion of their report.

**Inclusive practice**: learning intentions should not be differentiated. All students need access to the same core content, big ideas and concepts. Differentiation should be evident in the success criteria, or the activities/support needed to achieve the success criteria (Wiliam and Leahy 2015). Teachers may co-construct the success criteria with students or adjust them to suit their class context, for example, using the strategies and resources for curriculum planning on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

## Assessment task notification

|  |  |
| --- | --- |
| **Course** | Stage 5 Science |
| **Year** | *9 or 10* |
| **Task title** | Temperature and reaction rate investigation and report |
| **Weighting** | Insert task weighting |
| **Notification date** | Insert task notification date |
| **Due date** | Insert task due date |

### Outcomes

A student:

* **SC5-4WS** develops questions or hypotheses to be investigated scientifically
* **SC5-5WS** produces a plan to investigate identified questions, hypotheses or problems, individually and collaboratively
* **SC5-7WS** processes, analyses and evaluates data from first-hand investigations and secondary sources to develop evidence-based arguments and conclusions
* **SC5-9WS** presents science ideas and evidence for a particular purpose and to a specific audience, using appropriate scientific language, conventions and representations
* **SC5-17CW** discusses the importance of chemical reactions in the production of a range of substances, and the influence of society on the development of new materials

### Task description

As a science student, you have been tasked with designing and conducting an investigation to determine the effect of temperature on reaction rate.

You must design a suitable method, carry out the investigation, collect data, and analyse your results. Finally, you will produce a scientific report which contains the following sections: aim, introduction, hypothesis, method, risk assessment, results, discussion, conclusion, and references.

The audience for your report is your science teacher. Therefore, the report should use appropriate scientific language and terminology. You will be assessed based on your ability to structure your report and write cohesively. In the method section, you will also be assessed on how well you can write in passive voice and past tense.

You will have 3 periods of class time to work on the assessment task.

1. In the first lesson, your teacher will demonstrate the procedure, and then you will plan the investigation with your team of 2–3 others. Your team will need a suitable method and a table to record your results before the next lesson.
2. In the second lesson, you and your team will conduct the investigation. You will receive the chemicals and equipment listed in the investigation outline. You must work collaboratively and efficiently to complete all the trials in the given time.
3. In the third lesson, you will have time to analyse your data and work on writing your scientific report. The report is your own work, and only the initial planning information and results should be shared with your peers. You are also expected to write and refine your report at home.

### Submission details

You should use the marking criteria to self-assess your work prior to submission.

Insert school-determined submission details. Include information related to draft submission if required.

### Investigation outline

**Inquiry question:** How is a chemical reaction affected by temperature?

**Equipment**

* 50 mL Solution A
* 50 mL Solution B
* 2 x 200 mL beakers
* Water (hot and room temperature)
* Ice
* Thermometer
* 4 x test tubes
* 4 x test tube stoppers
* 2 x 10 mL measuring cylinders

Figure 1 – diagram showing the experiment setup

Image one shows two test tubes, one containing 4 mL of solution A, and the other containing 4 mL of solution B. 
Image 2 shows how a beaker can be used as a water bath to warm or cool the solutions in the test tubes. Image 3 shows the mixed solutions in a test tube have reacted and the temperature is being recorded. 

There are labels under each image. 

Image 1's label says: 4mL solution A.
Image 2's label says: 4mL solution B.
Image 3's label says: Pour solution A into solution B, stopper, and invert 3 times to mix. Start the stopwatch as soon as the solutions are combined. Stop the stopwatch when a colour change is observed.

### Marking criteria

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Component | 1 mark | 2 marks | 3 marks | 4 marks | 5 marks |
| Title/Aim | Clear title/aim which relates the variables being tested. | n/a | n/a | n/a | n/a |
| Hypothesis | Poorly worded hypothesis. May not have referred to the variables correctly. | A statement of prediction of the relationship between the variables. | The hypothesis is valid. It is testable, includes a prediction and is based on scientific theory. | n/a | n/a |
| Introduction | The introduction is very brief and provides limited background information. | The introduction provides relevant background information and demonstrates an understanding of the investigation. | The introduction identifies the nature of the investigation and provides relevant background information. In addition, the introduction demonstrates an understanding of the content of the investigation. | The introduction provides a detailed and clear explanation of the nature of the investigation. In addition, the introduction demonstrates an excellent understanding of the content of the investigation. | n/a |
| Variables | Correctly identifies one or 2 of the following: dependent, independent, or controlled variables. | Correctly identifies the dependent and independent variables. Controlled variables are listed. However, how they are kept constant may not be described or are not suitable. | Correctly identifies the dependent and independent variables. All controlled variables have been identified, and strategies to keep the controlled variables constant are valid. | n/a | n/a |
| Method | The method is poorly written, with sections missing. It could not be accurately repeated by someone else. No attempt to write in passive voice and past tense. | The method is missing information. Units and or quantities may be incorrect or absent. It may not be written in the third person or past tense. | The method has minor details missing. It may be difficult for another person to repeat without consultation. It may not be written in passive voice or past tense. | Appropriate method. Well written, although some minor details may be missing. May jump between active and passive voice and or present and past tense. | Excellent method, written so that it could be repeated precisely by another person without prior knowledge of the experiment. Written in passive voice, past tense. |
| Results: Table | Data is poorly displayed or unorganised. Some components of the table are missing. | Data is displayed in a well-organised table which includes headings and units. Data is accurately recorded. | n/a | n/a | n/a |
| Results: Graph | Attempts were made to graph the results. May have used an inappropriate graph type. It may contain significant omissions or errors, such as incorrect scale. | Results are presented in an appropriate graph. However, some components may be missing (eg heading, axis labels). | Results are clearly and accurately presented in an appropriate graph. In addition, the graph has correctly labelled axis, heading and units. | n/a | n/a |
| Discussion: Analysis of results | Limited analysis and discussion of results. Ideas are not clearly expressed. | Results have been interpreted (possibly incorrectly), and basic analysis and discussion of data are provided. | Results are correctly interpreted and discussed. In addition, trends, patterns and relationships in the data have been identified. | Results have been correctly interpreted, and some analysis is provided. In addition, results have been related to findings in research. | Analysis of the results is clearly and precisely stated. Identifies trends, patterns and relationships in the data and information. Links findings back to research. |
| Discussion: Sources of error and further research | One possible source of error has been identified. May have suggested improvements. | Some sources of error have been identified, and improvements have been suggested. However, they may be inadequate. | Some sources of error have been identified, and adequate improvements have been suggested. | Possible sources of error have been identified, and adequate improvements have been suggested to improve the accuracy, reliability and validity. | n/a |
| Conclusion | The conclusion does not state if the hypothesis was supported or refuted. Alternatively, the conclusion drawn is not supported by the results. | The conclusion lacks detail. It states if the hypothesis is supported or refuted; however, limited reasons are given. | An acceptable conclusion is drawn which correctly states how the hypothesis has been supported or refuted. | Correctly identifies and explains how the evidence supports or refutes the hypothesis. Provides some justification of inferences and conclusions. | An outstanding conclusion is drawn. Correctly identifies and explains how the evidence supports or refutes the hypothesis. Justifies inferences and conclusions. |
| References | Sources referenced are not reliable, and information may be missing. | Some sources are referenced but may have information missing. | Several relevant sources are referenced in the correct format. However, there may be minor errors. | The reference list is comprehensive. All references are relevant and in the correct format. | n/a |
| Report structure | Report formatting is basic, with some attempts to structure the report. Sections may be missing. | The report is clearly set out with headings and subheadings. Sections may be missing. | Report formatting is excellent and is set out in a clear and logical order with headings and subheadings. | n/a | n/a |
| Writing cohesion | Limited use of subject-specific terminology. The introduction lacks cohesion between sentences and or paragraphs. | Sound use of subject-specific terminology. Attempts to create cohesion between sentences and paragraphs. | Excellent use of relevant subject-specific terminology. Effective use of text connective to the signal connection between sentences. Uses ‘given and new’ sentence structure to create cohesion between sentences and paragraphs. | n/a | n/a |
| Comment: |  |  |  | **Total marks:** | /45 |

## Teacher information

### Chemical preparation information

**Note**: the instructions below are for preparing the solutions required for the investigation. They explain how to prepare 1 L of each chemical. The quantities required for a class will differ based on class sizes and the number of students working in each group. Allow for some additional chemicals for students who make an error.

**Materials**

* 0.2 g sodium metabisulfite
* 4.3 g potassium iodate
* 5 mL 1 M sulfuric acid
* 4 g soluble starch
* 2 L distilled water
* 2 x 1 L conical flasks
* 1 L beaker
* 1 L measuring cylinder
* Spatula
* Heating mantle
* Stirring rod

**Solution A**

1. Weigh 4.3 g of potassium iodate.
2. Place into a 1 L conical flask and dissolve in 500 mL of distilled water.
3. Top up to 1 L with distilled water.

**Solution B**

1. Make a paste with the starch and distilled water in a 1 L beaker.
2. Add approximately 800 mL of boiling water and stir to combine.
3. Boil for a few minutes and then allow to cool.
4. Pour into a conical flask. Add 0.2 g sodium metabisulfite and 5 mL 1 M sulfuric acid.
5. Make up solution to 1 L with distilled water.

**Preparation note:** the reaction should be tested before use in the classroom. If the reaction at room temperature takes less than 20 seconds, you may wish to dilute the solution to reduce its concentration and increase the time taken to complete the reaction.

### Coordinating the assessment task

#### Lesson 1 – planning

**Risk assessment:** a suitable risk assessment must be conducted for this investigation. The risk assessment must include all chemicals (used and produced) and equipment. Care must be taken to ensure that the risk assessment is implemented while planning and conducting this investigation.

In this lesson, you will need access to a set of equipment and chemicals so that the procedure for adjusting the temperature and mixing the chemicals and how to time and record the reaction time can be demonstrated. In addition, a risk assessment should be completed with the class to ensure they understand how to eliminate or reduce risks.

Students should observe the demonstration by the teacher and then work in groups of 3 to 4 to plan their procedure with the given materials and quantities outlined on the assessment task notification.

Students need to consider the following questions:

* What is the aim of my investigation?
* What is my hypothesis?
* How many trials will I conduct?
* How am I going to manage my time so that I can complete all the trials in the provided time? (For example, by having one lot of chemicals tempering in the water bath while another set is being mixed)
* Who will do what during the practical lesson? (For example, mix chemicals, and record the time)
* How will I record my results? (Students will need to create a suitable table)
* How can I reduce any possible errors?

##### Sample procedure

1. Collect the equipment and materials listed on the assessment notification.
2. Label 2 test tubes and one 10 mL measuring cylinder with A. Label 2 test tubes and one 10 mL measuring cylinder with B. **Note:** the beakers of solutions A and B should also be clearly labelled.
3. Measure 4 mL of solution A and pour it into each ‘A’ test tube.
4. Measure 4 mL of solution B and pour it into each ‘B’ test tube.
5. Make a water bath using a 200 mL beaker. Adjust the temperature using warm water or ice. Place the test tubes into the water bath.
6. Take one test tube labelled A and one test tube labelled B from the water bath. Carefully pour solution A into solution B, stopper, and invert 3 times. Start the stopwatch as soon as the chemicals touch.
7. Stop the stopwatch when the colour changes from clear/white to blue/black. Immediately measure the temperature and record it.
8. Repeat using various temperatures until all the solution has been used up.

**Things to note:**

Students often feel the need to measure the temperature of the water bath. This should be discouraged, as the chemicals have not necessarily reached the same temperature as the water bath.

If stoppers are not available or are not creating a good seal, students could use a small piece of Parafilm over their thumb to invert the test tubes.

Getting the same temperature for each trial is difficult in this investigation. Therefore, students should gather data across the whole range of temperatures and plot it on a scatterplot instead of trying to calculate the average for each specific temperature.

#### Lesson 2 – practical investigation

Good organisation is key in ensuring that this task runs smoothly. Students need to understand how to conduct the investigation before the practical day. In their groups, students will need to work independently to collect up to 12 pieces of data in one lesson while the teacher moves between groups to help if needed.

To ensure that time on task is maximised, the equipment could be prepared so that each group has the required equipment and materials.

#### Lesson 3 – report writing

This lesson is dedicated to students working independently on their scientific reports. Students should use the marking criteria provided with the assessment task notification to ensure they have included all sections of the report and covered the criteria to the best of their ability.

It is unlikely that a student will be able to complete a whole scientific report in one lesson. Therefore, depending on the students’ needs, you may wish to provide additional class time or allow students to work on the task in their own time prior to submission.

**Differentiation consideration:**

You may wish to provide sections of the report to the students (for example, the introduction and method) so that they may focus on the other sections. If so, these components should be removed from the marking criteria.

A scaffold could be provided to students who require additional prompts to complete the report. If a scaffold is used, then the ‘report structure’ component of the marking criteria should be removed.

Students could be extended by not demonstrating the method and having them devise the entire procedure using the given equipment.

**Absent students:** some students will inevitably be absent for one or more lessons. If the student cannot complete the practical investigation in the following lesson, they should be provided with sample data to report on.

### Making grammar explicit

Prior to the assessment task, students should be taught the skills required to write a scientific report. Making grammar explicit helps students learn to write a scientific report. Scientific reports require cohesion, clarity, and accuracy in their language to ensure that the results and findings are communicated effectively. Correct grammar use helps ensure the intended meaning is conveyed clearly and accurately. Correct use of grammar can also enhance the credibility of a scientific report. Conversely, grammatical errors can undermine the reader’s confidence in the author’s ability to conduct rigorous research, analyse data, and draw evidence-based conclusions.

[Jointly constructing](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Joint-Construction.aspx) parts of the scientific report before this assessment task will give students the skills to improve their writing. The marking rubric identifies specific grammatical features, including given and new (theme and rheme), text connectives and writing in passive voice and past tense. These must be explicitly taught before they are formally assessed in this assessment task.

#### Creating a cohesive report

A well-written report will contain a logical flow of information. When the writing flows well, readers can easily follow the author’s thinking and understand the meaning of the text. This can be achieved at the paragraph level by explicitly teaching the ‘[Given and New](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Given-and-new.aspx?ga=1)’ strategy. Also known as theme and rheme, this strategy supports the logical progression of ideas in a text. In a scientific report, theme and rheme are particularly important in the introduction and discussion sections.

The table below demonstrates a strategy for teaching students’ theme and rheme.

1. Start with a topic sentence.
2. Take information from the previous sentence to start the next.

Table 1 – model strategy for theme and rheme (given and new) writing strategy

|  |  |
| --- | --- |
| Theme (given) | Rheme (new) |
| n/a | The pancreas plays a crucial role in releasing energy from our food. |
| When you consume foods | that contain sugar, your body breaks down the sugar into glucose. |
| The glucose | is then released into the bloodstream. |
| This increase in blood glucose level | triggers your pancreas to release insulin, a hormone that helps cells absorb and use glucose for energy. |
| Without this hormone, | the cells cannot get enough energy from food. |

Adapted from Polias (2016).

[Text connectives](https://schoolsnsw.sharepoint.com/sites/PR0Y5Q3H/SiteAssets/WiS/Grammar%20Guide/story.aspx) are also useful in creating cohesion in a text. For example, they can signal a connection between sentences and paragraphs or sections of a text by showing cause or results (Department of Education n.d.). The table below outlines examples of the various types of connectives that could be used in a scientific report.

Table 2 – types of connectives that may be useful when writing a scientific report

|  |  |
| --- | --- |
| Type of connective | Examples |
| Time | Afterwards, finally, meanwhile, firstly, initially, subsequently |
| Causality | Due to, since, consequently, therefore, as a result, hence, thus |
| Addition | In addition, along with, also, furthermore |
| Comparison | Equally, similarly, in comparison |
| Clarification | To illustrate, in other words, namely, for example |
| Contrast | If, instead, however, in contrast, whereas |

## Support and alignment

**Resource evaluation and support**: all curriculum resources are prepared through a rigorous process. Resources are periodically reviewed as part of our ongoing evaluation plan to ensure currency, relevance and effectiveness. For additional support or advice, or to provide feedback, contact the Science Curriculum team by emailing [Science7-12@det.nsw.edu.au](mailto:Science7-12@det.nsw.edu.au).

**Differentiation:** further advice to support Aboriginal and Torres Strait Islander students, EALD students, students with a disability and/or additional needs and High Potential and gifted students can be found on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

**Assessment**: further advice to support formative assessment is available on the [Planning, programming and assessing 7-12](https://education.nsw.gov.au/teaching-and-learning/curriculum/planning-programming-and-assessing-k-12/planning-programming-and-assessing-7-12) webpage.

**Professional learning**: relevant professional learning is available on the [Science statewide staffroom](https://education.nsw.gov.au/teaching-and-learning/curriculum/statewide-staffrooms), and the [Writing in Secondary resource hub](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Professional-Learning.aspx).

**Related resources**: further resources to support Stage 5 can be found on the [Science Curriculum page](https://education.nsw.gov.au/teaching-and-learning/curriculum/science) and the [Science statewide staffroom website](https://schoolsnsw.sharepoint.com/sites/NSWDoEScienceCurriculumTeam/SitePages/Professional%20learning.aspx).

**Consulted with**: Writing in Secondary, Multicultural Education, and subject matter experts.

**Alignment to system priorities and/or needs**: [School Excellence Policy](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468), [School Success Model](https://education.nsw.gov.au/public-schools/school-success-model/school-success-model-explained).

**Alignment to the School Excellence Framework**: this resource supports the [School Excellence Framework](https://education.nsw.gov.au/policy-library/policies/pd-2016-0468) elements of curriculum (curriculum provision) and effective classroom practice (lesson planning, explicit teaching).

**Alignment to Australian Professional Teaching Standards**: this resource supports teachers to address [Australian Professional Teaching Standards](https://educationstandards.nsw.edu.au/wps/portal/nesa/teacher-accreditation/meeting-requirements/the-standards/proficient-teacher) 3.2.2, 3.3.2, 3.4.2, 5.1.2.

**Author**: Science 7-12 Curriculum Team.

**Resource**: Assessment task

**Creation date**: 8 May 2023

## References

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[Science Years 7-10 Syllabus](https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/science/science-7-10-2018) © NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales, 2018.

CESE (Centre for Education Statistics and Evaluation) (2020) [*What works best: 2020 update*](https://education.nsw.gov.au/about-us/education-data-and-research/cese/publications/research-reports/what-works-best-2020-update), NSW Department of Education, accessed 23 May 2023.

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Polias J (2016) *Apprenticing Students Into Science: Doing, Talking & Writing Scientifically*, Lexis Education, Australia.

State of New South Wales (Department of Education) (n.d.) [*Given and new*](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Given-and-new.aspx?ga=1), Writing in Secondary Resource Hub SharePoint website, accessed 24 April 2023.

State of New South Wales (Department of Education) (n.d.) [*Joint construction*](https://schoolsnsw.sharepoint.com/sites/WiSresourcehub/SitePages/Joint-Construction.aspx), Writing in Secondary Resource Hub SharePoint website, accessed 24 April 2023.

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Wiliam D and Leahy S (2015) *Embedding Formative Assessment: Practical Techniques for K-12 Classrooms*, Learning Sciences International, US.

### Further reading

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State of New South Wales (Department of Education) (n.d.) ‘[Literacy and numeracy priorities](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy)’, *Literacy and numeracy*, NSW Department of Education website, accessed 24 February 2023.

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