**Stage 2 General Mathematics**

**AT2: Mathematical Investigation**

**Topic 1: Linear Programming**

**Introduction**

You need to select a scenario to investigate using linear programming techniques. The problem that you choose needs to investigate the optimal value for a combination of two items. The optimal value can be a minimum or maximum value. The two items need to have between 3 and 5 elements required.

**Mathematical Investigations**

1. Decide on the scenario you will investigate and determine the composition of each item so that there are between 3 and 5 active constraints apart the ***x*** or ***y***-axis.
2. Construct a table showing:

* the number of the elements required for each item
* the amount of each element available **or** the minimum requirements of each element.

1. State the objective function and determine the constraints for each element.
2. Produce a labelled graph showing the feasible region.
3. Find the optimal solution by considering the feasible points.
4. Determine the wastage or oversupply of elements for the optimal solution.
5. Now investigate changes to the original scenario such as:

* the impact on the optimal value when the objective function is changed
* the impact on the optimal value, and wastage and oversupply, when changes are made to the original constraints by:
  + changing the available amounts of minimal requirements
  + changing the number of elements or items required
  + adding a further constraint (such as a time limit).

Students are required to make and test predictions based on the mathematics that they are using to model the problem.

In the process of forming and testing predictions, students will need to:

* State the prediction
* Test the prediction mathematically
* Discuss the outcome of testing the prediction.

To reach the A grade band for RC5, students need to form and test more than one appropriate prediction.

**Analysis / Conclusion**

Critically analyse your results, considering:

* a comparison of the different scenarios investigated
* the optimal solution obtained
* the reasonableness of the optimal solution
* the best scenario for the efficient completion of the task
* the limitations of the model used.

**Scenario ideas**

Students may select an activity that is part of the context being studied, for example:

* determining a combination of two food items for a week when there are minimum or maximum dietary requirements
* producing two different food products for sale
* constructing two different products for sale (consider woodwork/metalwork or craft items)
* providing a car cleaning service with two sized vehicles.

**Possible extensions:**

* You may like to consider integer/non-integer solutions if the context is appropriate.
* You may like to consider multiple optimal solutions if they occur.

**The investigation report should be a maximum of 12 single-sided A4 pages if written, or the equivalent in multimodal form.**

**Report Format**

The report may take a variety of forms, but would usually include the following:

* an outline of the problem and context
* the method required to find a solution, in terms of the mathematical model or strategy used
* the application of the mathematical model or strategy, including
  + relevant data and/or information
  + mathematical calculations and results using appropriate representations
  + discussion and interpretation of results, including consideration of the reasonableness and limitations of the results
* the results and conclusions in the context of the problem.

A bibliography and appendices, as appropriate, may be used.

The format of an investigation report may be written or multimodal.

**Performance Standards for Stage 2 General Mathematics**

| - | **Concepts and Techniques** | **Reasoning and Communication** |
| --- | --- | --- |
| **A** | Comprehensive knowledge and understanding of concepts and relationships.  Highly effective selection and application of mathematical techniques and algorithms to find efficient and accurate solutions to routine and complex problems in a variety of contexts.  Successful development and application of mathematical models to find concise and accurate solutions.  Appropriate and effective use of electronic technology to find accurate solutions to routine and complex problems. | Comprehensive interpretation of mathematical results in the context of the problem.  Drawing logical conclusions from mathematical results, with a comprehensive understanding of their reasonableness and limitations.  Proficient and accurate use of appropriate mathematical notation, representations, and terminology.  Highly effective communication of mathematical ideas and reasoning to develop logical and concise arguments.  Formation and testing of appropriate predictions, using sound mathematical evidence. |
| **B** | Some depth of knowledge and understanding of concepts and relationships.  Mostly effective selection and application of mathematical techniques and algorithms to find mostly accurate solutions to routine and some complex problems in a variety of contexts.  Attempted development and successful application of mathematical models to find mostly accurate solutions.  Mostly appropriate and effective use of electronic technology to find mostly accurate solutions to routine and some complex problems. | Mostly appropriate interpretation of mathematical results in the context of the problem.  Drawing mostly logical conclusions from mathematical results, with some depth of understanding of their reasonableness and limitations.  Mostly accurate use of appropriate mathematical notation, representations, and terminology.  Mostly effective communication of mathematical ideas and reasoning to develop mostly logical arguments.  Formation and testing of mostly appropriate predictions, using some mathematical evidence. |
| **C** | Generally competent knowledge and understanding of concepts and relationships.  Generally effective selection and application of mathematical techniques and algorithms to find mostly accurate solutions to routine problems in different contexts.  Application of mathematical models to find generally accurate solutions.  Generally appropriate and effective use of electronic technology to find mostly accurate solutions to routine problems. | Generally appropriate interpretation of mathematical results in the context of the problem.  Drawing some logical conclusions from mathematical results, with some understanding of their reasonableness and limitations.  Generally appropriate use of mathematical notation, representations, and terminology, with reasonable accuracy.  Generally effective communication of mathematical ideas and reasoning to develop some logical arguments.  Formation of an appropriate prediction and some attempt to test it using mathematical evidence. |
| **D** | Basic knowledge and some understanding of concepts and relationships.  Some selection and application of mathematical techniques and algorithms to find some accurate solutions to routine problems in context.  Some application of mathematical models to find some accurate or partially accurate solutions.  Some appropriate use of electronic technology to find some accurate solutions to routine problems. | Some interpretation of mathematical results.  Drawing some conclusions from mathematical results, with some awareness of their reasonableness.  Some appropriate use of mathematical notation, representations, and terminology, with some accuracy.  Some communication of mathematical ideas, with attempted reasoning and/or arguments.  Attempted formation of a prediction with limited attempt to test it using mathematical evidence. |
| **E** | Limited knowledge or understanding of concepts and relationships.  Attempted selection and limited application of mathematical techniques or algorithms, with limited accuracy in solving routine problems.  Attempted application of mathematical models, with limited accuracy.  Attempted use of electronic technology, with limited accuracy in solving routine problems. | Limited interpretation of mathematical results.  Limited understanding of the meaning of mathematical results, their reasonableness or limitations.  Limited use of appropriate mathematical notation, representations, or terminology, with limited accuracy.  Attempted communication of mathematical ideas, with limited reasoning.  Limited attempt to form or test a prediction. |