**Stage 2 General Mathematics**

**and  
Stage 2 Essential Mathematics**

(for teaching in 2017)

Implementation Workshop Booklet

2016



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**Stage 2 Assessment Design Criteria and Specific Features**

The assessment design criteria are based on the learning requirements and are used by teachers to:

* clarify for the student what he or she needs to learn
* design opportunities for the student to provide evidence of his or her learning at the highest level of achievement.

The assessment design criteria consist of specific features that:

* students need to demonstrate in their evidence of learning
* teachers look for as evidence that students have met the learning requirements.

The set of assessments, as a whole give students opportunities to demonstrate each of the specific features by the completion of study of the subject.

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| **Current Mathematical Applications and Mathematical Pathways (2016)** | | | | | |
| Mathematical Knowledge and Skills and Their Application | | Mathematical Modelling and Problem-solving | | Communication of Mathematical Information | |
| MKSA1  MKSA2  MKSA3 | Knowledge of content and understanding of mathematical concepts and relationships.  Use of mathematical algorithms and techniques (implemented electronically where appropriate) to find solutions to routine and complex questions.  Application of knowledge and skills to answer questions set in applied contexts. | MMP1  MMP2  MMP3  MMP4 | Application of mathematical models.  Development of solutions to mathematical problems set in applied contexts.  Interpretation of the mathematical results in the context of the problem.  Understanding of the reasonableness and possible limitations of the interpreted results, and recognition of assumptions made. | CMI1  CMI2 | Communication of mathematical ideas and reasoning to develop logical arguments.  Use of appropriate mathematical notation, representations, and terminology. |

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| **General Mathematics and Essential Mathematics (from 2017)** | | | |
| Concepts and Techniques | | Reasoning and Communication | |
| CT1  CT2  CT3  CT4 | The specific features are as follows:  Knowledge and understanding of concepts and relationships  Selection and application of mathematical techniques and algorithms to find solutions to problems in a variety of contexts  Application of mathematical models  Use of electronic technology to find solutions to mathematical problems | RC1  RC2  RC3  RC4  RC5 | The specific features are as follows:  Interpretation of mathematical results  Drawing conclusions from mathematical results, with an understanding of their reasonableness and limitations  Use of appropriate mathematical notation, representations, and terminology  Communication of mathematical ideas and reasoning to develop logical arguments  Forming and testing of predictions\*  \* In this subject the forming and testing of predictions (RC5) is not intended to include formal mathematical proof. |

Performance Standards for Stage 2 General Mathematics and Essential 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. |

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| **SACE Stage 1 and Stage 2 General Mathematics** | |
| **Stage 1 General Mathematics** | |
| Topic 1: Investing and Borrowing   * 1. Investing for Interest   2. Investing in Shares   3. Return on Investment   4. Costs of Borrowing   Topic 2: Measurement   * 1. Application of measuring devices and units of measurement   2. Perimeter and area of plane shapes   3. Volume and surface area of solids   4. Scale and rates   Topic 3: Statistical Investigation   * 1. The statistical investigation process   2. Sampling and collecting data   3. Classifying and organising data   4. The shape, location and spread of distributions of numerical data   5. Forming and supporting conjectures across two or more groups | Topic 4: Applications of Trigonometry   * 1. Similarity   2. Right triangle geometry   3. Area of triangles   4. Solving problems with non-right triangles   Topic 5: Linear and Exponential Functions and their Graphs   * 1. Linear functions and graphs   2. Exponential functions and graphs   Topic 6: Matrices and Networks   * 1. Matrix arithmetic and costing applications   2. Networks   Topic 7: Open Topic |
| **Stage 2 General Mathematics** | |
| Topic 1: Modelling with Linear Relationships   * 1. Simultaneous Linear Equations   2. Linear Programming   Topic 2: Modelling with Matrices   * 1. Application of Matrices to Network Problems   2. Application of Matrices to Transition Problems   Topic 3: Statistical Models \*   * 1. Bivariate Statistics   2. The Normal Distribution   Topic 4: Financial Models \*   * 1. Models for Saving   2. Models for Borrowing   Topic 5: Discrete Models \*   * 1. Critical Path Analysis   2. Assignment Problems   Topic 6: Open Topic  Students study five topics from the list of six topics above. All students must study topics 1, 3, 4 and 5.  **\* Examined topics** |  |

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| **SACE Stage 1 and Stage 2 Essential Mathematics** | |
| **Stage 1 Essential Mathematics** | |
| Topic 1: Calculations, Time and Ratio   * 1. Calculations   2. Time and Rates   3. Ratio and Scale   Topic 2: Earning and Spending   * 1. Earning   2. Spending   3. Budgeting   **Topic 3: Geometry**  3.1 Shapes  3.2 Angle Geometry  3.3 Geometry and Construction | Topic 4: Data in Context   * 1. Classifying data   2. Reading and Interpreting Graphs   3. Drawing Graphs   4. Summarising and Interpreting Data   5. Comparing Data Sets   Topic 5: Measurement   * 1. Linear Measure   2. Area Measure   3. Mass   4. Volume and Capacity   5. Power and Energy   Topic 6: Investing   * 1. Simple interest   2. Compound interest   3. Investing for interest (effective rates and other ways to compare SI and CI rates)   Topic 7: Open Topic |
| **Stage 2 Essential Mathematics** | |
| Topic 1: Scales, Plans, and Models   * 1. Geometry   2. Scale Diagrams   Topic 2: Measurement \*   * 1. Linear Measure   2. Area Measure   3. Mass, Volume and Capacity   Topic 3: Business Applications   * 1. Planning a Business Premises   2. Costing Calculations   3. Business Structures and Taxation   Topic 4: Statistics \*   * 1. Sampling from Populations   2. Analysing and Representation of Sets of Data   3. Linear Correlation   Topic 5: Investments and Loans \*   * 1. Lump Sum Investments   2. Annuity Investments   3. Loan Annuities   Topic 6: Open Topic  Students study five topics from the list of six topics above. All students must study topics 2, 4 and 5.  **\* Examined topics** |  |

| **Stage 2 General Mathematics and Essential Mathematics**  **Assessment Overview from 2017** |
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|  | **Stage 2 General Mathematics** | **Stage 2 Essential Mathematics** |
| School Assessment:  Assessment Type 1 | **Skills and Applications Tasks (40%)**   * *Five* SATs * Equivalent of 1 SAT without the use of a calculator or notes * Remaining SATs (or parts of SATs): up to one A4 sheet of handwritten notes (one side only) and electronic technology * At least one skills and applications task from the two non-examined topics (one task per topic) | **Skills and Applications Tasks (30%)**   * *Four* SATs * Equivalent of 1 SAT without the use of a calculator or notes * Remaining SATs (or parts of SATs): up to one A4 sheet of handwritten notes (one side only) and electronic technology * At least one skills and applications task from the two non-examined topics (one task per topic) |
| School Assessment:  Assessment Type 2 | **Mathematical Investigation (30%)**   * *Two* mathematical investigations * Maximum of 12 A4 pages * The maximum page limit is for single-sided A4 pages with minimum font size 10. Page reduction such as 2 A4 reduced to fit on 1 A4 is not acceptable. | **Folio (40%)**   * *Three* folio tasks * Maximum of 8 A4 pages * The maximum page limit is for single-sided A4 pages with minimum font size 10. Page reduction such as 2 A4 reduced to fit on 1 A4 is not acceptable. |
| External Assessment:  Assessment Type 3 | **Examination (30%) – 2 hours**   * Based on the key questions and key concepts in the three examined topics – Topics 3, 4 and 5 * With access to approved electronic technology * 1 unfolded A4 sheet handwritten notes (i.e. 2 sides of 1 A4 sheet) | **Examination (30%) – 2 hours**   * Based on the key questions and key concepts in the three examined topics – Topics 2, 4 and 5 * With access to approved electronic technology * 1 unfolded A4 sheet handwritten notes (i.e. 2 sides of 1 A4 sheet) |

Stage 2 General Mathematics

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of both assessment design criteria.

| Assessment Type and Weighting | Details of assessment | Assessment Design Criteria | | Assessment conditions (e.g. task type, page limit, time allocated, supervision) |
| --- | --- | --- | --- | --- |
| CT | RC |
| Skills and Applications Tasks  Weighting 40% |  |  |  |  |
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| Mathematical Investigation  Weighting 30% |  |  |  |  |
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| *Examination*  *Weighting 30*% | *Students undertake a 2-hour external examination in which they answer questions on the following three topics:*  *Topic 3: Statistical Models Topic 4: Financial Models Topic 5: Discrete Models.*  *The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.* | *All the specific features of the assessment design criteria may be assessed in the external examination.* | | *2-hour external examination*  *Access to electronic technology required.*  *Students may refer to one unfolded A4 sheet (two sides) of hand-written notes.* |

***Eight assessments.*** *Please refer to the Stage 2 General Mathematics subject outline.*

Stage 2 Essential Mathematics

Assessment Overview

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of both assessment design criteria.

| Assessment Type and Weighting | Details of assessment | Assessment Design Criteria | | Assessment conditions (e.g. task type, page limit, time allocated, supervision) |
| --- | --- | --- | --- | --- |
| CT | RC |
| Skills and Applications Tasks  Weighting 30% |  |  |  |  |
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| Folio  Weighting 40% |  |  |  |  |
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| *Examination*  *Weighting 30%* | *Students undertake a 2-hour external examination in which they answer questions on the following three topics:*  Topic 2: Measurement Topic 4: Statistics Topic 5: Investment and Loans  *The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.* | *All the specific features of the assessment design criteria may be assessed in the external examination.* | | *2-hour external examination*  *Access to electronic technology required.*  *Students may refer to one unfolded A4 sheet (two sides) of hand-written notes.* |

***Eight assessments.*** *Please refer to the Stage 2 Essential Mathematics subject outline.*

**Stage 2 General Mathematics**

**Program 1**

This program is for a cohort of students studying Stage 2 General Mathematics. It is assumed that students have completed Topics 1 – 6 from Stage 1 General Mathematics.

**Topic 1 – Modelling with Linear Relationships (5 weeks)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content**  Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 1-1 | 1.1  Simultaneous Linear Equations | Graphical solution  Trial and error and substitution methods  Problems in context |  |
| 1-2 | 1.2  Linear Programming | Setting up constraints and the objective function  Graphing the feasible region |  |
| 1-3 | Finding the optimal solution |  |
| 1-4 | Considering wastage |  |
| 1-5 | Dealing with discrete only solutions  Changing the original parameters | **SAT 1 – Modelling with Linear Relationships. Calculator permitted.** |

**Topic 2 – Modelling with Matrices (5 weeks)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content**  Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 1-6 | 2.1  Application of Matrices to Network Problems | Connectivity matrices |  |
| 1-7 | Powers of matrices and multi-stage connections |  |
| 1-8 | Dominance matrices | **Investigation 1: Dominance Matrices** |
| 1-9 | 2.2  Applications of Matrices to Transition Problems | What is a transition matrix?  The steady state |  |
| 1-10 | 3 x 3 and higher systems  Limitations/assumptions of the transition model | **SAT 2 – Matrices. Calculator permitted.** |

**Topic 3 – Statistical Models (8 weeks)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **Week** | **Subtopic** | **Concepts and Content**  Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 2-1 | 3.1  Bivariate Statistics | The statistical investigation process  Explanatory and response variables  Scatter plots |  |
| 2-2 | Correlation coefficients  The effects of outliers  Causality |  |
| 2-3 | Linear regression |
| 2-4 | Residual plots |  |
| 2-5 | Exponential regression | **Investigation 2: Rates of Cooling** |
| 2-6 | Interpolation and extrapolation |  |
| 2-7 | 3.2  The Normal Distribution | Properties of the bell shaped curve  68%-95%-99.7% properties |  |
| 2-8 | Finding probabilities of both integral and non-integral standard deviations from the mean.  Inverse normal problems | **SAT 3 – Statistical Models.**  **Calculator permitted.** |

**Topic 4 – Financial Models (6 weeks)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content**  Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 2-9 | 4.1  Models for Saving | Compound interest  Finding FV, PV, n and I |  |
| 2-10 | Future value annuities  Effects of changing payments, rates, times  Taxation/inflation/charges  Effective rate of interest |  |
| 3-1 | Superannuation |  |
| 3-2 | 4.2  Models for Borrowing | The cost of borrowing money  Interest only loans and sinking funds |  |
| 3-3 | Reducing balance loans |  |
| 3-4 | Strategies to reduce the amount of interest paid on a loan  Comparison interest rates | **SAT 4 – Financial Models.**  **Calculator permitted.** |

**Topic 5 – Discrete Models (5 weeks)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content**  Technology is incorporated into all aspects of this topic as appropriate | **Assessment Task** |
| 3-5 | 5.1  Critical Path Analysis | Precedence tables  Drawing networks |  |
| 3-6 | Dummy links  Forward and backward scan |  |
| 3-7 | Minimum completion time  Critical path  Earliest/latest starting times  Slack time |  |
| 3-8 | 5.2  Assignment Problems | The Hungarian algorithm  Minimum cost |  |
| 3-9 | Maximum profit  Non-square arrays | **SAT 5: Discrete Models.**  **Calculator and notes not permitted.** |

**Revision**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content** | **Assessment Task** |
| 3-10 |  | Revision |  |
| 4-1 |  | Revision |  |
| 4-2 |  | Revision |  |
| 4-3 |  | Swot Vac |  |
| 4-4 |  | Exam |  |

**NOTES AND COMMENTS**Please note that this is a working document and will change as the course progresses.

**SUGGESTED ALLOCATION OF TIME**Topic 1: Modelling with Linear Relationships (5 weeks)  
Topic 2: Modelling with Matrices (5 weeks)  
Topic 3: Statistical Models (8 weeks)   
Topic 4: Financial Models (6 weeks)  
Topic 5: Discrete Models (5 weeks)

Stage 2 - General Mathematics Program 2

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Term One**  **Week 1** | **Course Overview and Expectations** | **TOPIC ONE: MODELLING WITH LINEAR RELATIONSHIPS**  How to represent linear functions (Review from Stage 1)   * Contextual description * Numerical sequence * Graph * Algebraic formula | How to represent linear functions (Review from Stage 1)   * Contextual description * Numerical sequence * Graph * Algebraic formula |
| **Week 2** | Simultaneous equations   * Trial by error solving | Simultaneous equations   * Graphically * Equation solver | Simultaneous equations   * Non-unique solutions |
| **Week 3** | Introduction to linear programming  (practical problem that students attempt to solve without using linear programming techniques) | Introduction to linear programming  (practical problem that students attempt to solve without using linear programming techniques) | Going from solving by trial and error to using linear programming techniques   * How to set up constraints * How to graph constraints and the feasible region * Vertices * Creating the objective function * Finding the optimal solution |
| **Week 4** | Linear programming problems | Wastage consideration | How to deal with a non-integer optimal solution |
| **Week 5** | Changes to parameters and the effect on the optimal solution | Putting everything together in linear programming | Putting everything together in linear programming  **REVISION** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 6** | **SAT 1 - MODELLING LINEAR RELATIONSHIPS**  **Non – Calculator Section – 30 min**  **Calculator Section – 20 min** | **TOPIC TWO: MODELLING WITH MATRICES**  Connectivity matrices   * Creating a connectivity matrix from a network * Creating a network from a matrix | Connectivity matrices   * Powers of matrices and multi-stage connections * Limitation of using higher powers |
| **Week 7** | Weighted sums of the powers of connectivity matrices   * Measures of efficiency or redundancy * Reasonableness and limitations | Weighted sums of the powers of connectivity matrices   * Measures of efficiency or redundancy * Reasonableness and limitations | Weighted sums of the powers of connectivity matrices   * Dominance * Reasonableness and limitations |
| **Week 8** | Weighted sums of the powers of connectivity matrices   * Dominance * Reasonableness and limitations | Transition matrix   * 2 x 2 systems * Predicting future trends | Transition matrix   * 2 x 2 systems * Predicting future trends |
| **Week 9** | Transition matrix   * Steady state | Transition matrix   * Do change of conditions effect the steady state | Transition matrix   * 3 x 3 systems and higher |
| **Week 10** | Transition matrix   * Putting it all together * Limitations of transition matrix models | **REVISION** | **SAT 2 - MODELLING WITH MATRICES** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 11** | **TOPIC FOUR: FINANCIAL MODELS**  Compound interest review   * Solving by graphic calculator for FV, PV, n, and I | Compound interest review   * Solving by graphic calculator for FV, PV, n, and I | “What if …?” questions around solving for:   * Future value * Regular deposit * Number of periods * Interest rate * Value of the accumulating savings after a given period * Total interest earned |
| **Term Two**  **Week 1** | “What if …?” questions around solving for:   * Future value * Regular deposit * Number of periods * Interest rate * Value of the accumulating savings after a given period * Total interest earned | “What if …?” questions around solving for:   * Future value * Regular deposit * Number of periods * Interest rate * Value of the accumulating savings after a given period * Total interest earned | Factors to consider when looking at an investment   * Interest as part of taxable income * Institution and government charges * Effects of inflation |
| **Week 2** | Comparing investments (effective rate) | Comparing investments (effective rate) | How can regular income be provided from savings?   * Annuities * Superannuation |
| **Week 3** | Costs associated with borrowing money | Interest only loans and sinking funds | Interest only loans and sinking funds  **MATHEMATICAL INVESTIGATION ONE** |
| **Week 4** | Reducing balance loans   * Finding the repayment needed * Total interest paid * Size of the debt after given time | How can the interest paid on a loan be reduced?   * Increasing the value of the payments * Reducing the term of the loan | How can the interest paid on a loan be reduced?   * Increasing the frequency of payments * Paying a lump sum off the principal owing * Changing interest rates * Offset accounts   **MATHEMATICAL INVESTIGATION ONE** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 5** | How can the interest paid on a loan be reduced?   * Increasing the frequency of payments * Paying a lump sum off the principal owing * Changing interest rates * Offset accounts | **MATHEMATICAL INVESTIGATION ONE** | Nominal rate of interest quoted – what is really being paid?   * Discussion of loan interest rates (fixed/variable) * Interest paid * Calculation to compare two or more loans |
| **Week 6** | **REVISION** | **SAT 3 – FINANCIAL MODELS** | **TOPIC FIVE: DISCRETE MODELS**  Critical path analysis problems   * Precedence tables * What can we tell from precedence tables |
| **Week 7** | Critical path analysis problems   * Drawing networks | Critical path analysis problems   * Understanding dummy links | Forward and backward scan   * Minimum completion time * Critical path |
| **Week 8** | Forward and backward scan   * Earliest and latest starting times * Slack time | Forward and backward scan   * Earliest and latest starting times * Slack time | The effects of changing initial parameters on   * Minimum completion time * Critical path |
| **Week 9** | **MID YEAR EXAM WEEK** *(formative tasks and flexibility in program)* | | |
| **Week 10** | Assignment problems:  The Hungarian algorithm   * Finding minimum cost | Assignment problems:  The Hungarian algorithm   * Finding minimum cost | Assignment problems: The Hungarian algorithm   * Finding maximum profit   **MATHEMATICAL INVESTIGATION TWO** |
| **Term Three**  **Week 1** | Assignment problems:  The Hungarian algorithm   * Finding maximum profit | Assignment problems:  The Hungarian algorithm   * Non-square arrays | Assignment problems: The Hungarian algorithm   * Non-square arrays   **MATHEMATICAL INVESTIGATION TWO** |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 2** | Further practice with assignment problems | **REVISION** | **SAT 4 - DISCRETE MODELS**  **Non-Calculator test**  **MATHEMATICAL INVESTIGATION TWO** |
| **Week 3** | **TOPIC THREE: STATISTICAL MODELS**  Review the statistical investigation process and work through an example of paired data | How do we model bivariate data?   * Explanatory and response variables * Scatterplots * Association | Correlation coefficients |
| **Week 4** | The effect of outliers | Causality | Linear regression   * Interpretation of a and b |
| **Week 5** | Linear regression   * Residual plots | Linear regression   * Residual plots | Exponential regression   * Interpretation of a and b |
| **Week 6** | * Interpolation and extrapolation | Linear and exponential regression   * Putting it all together | Linear and exponential regression   * Putting it all together |
| **Week 7** | Linear and exponential regression   * Putting it all together | The normal distribution   * Parameters µ and σ * Bell Shape * Symmetry about the mean | The normal distribution   * Building the spreadsheet * Investigation of properties of the resulting distribution |
| **Week 8** | Area under the curve   * 68%, 95%, 99.7% rule * Calculations of one, two, and three standard deviations from the mean | Calculation of probabilities using electronic technology | Inverse normal calculations |
| **Week 9** | **REVISION** | **REVISION** | **SAT 3 - STATISTICAL MODELS** |
| **Week 10** | *Flexibility in program* | *Flexibility in program* | *Flexibility in program* |
| **Term Four**  **Week 1 and 2** | **Examination revision** | | |
| **Week 3** | **SWOT VAC** | | |
| **Week 4** | **EXAM** | | |

Stage 2 General Mathematics

Assessment Overview

Complete the table below to show details of the planned tasks. Use numbers to show where students will have the opportunity to provide evidence for each of the specific features for all assessment design criteria.

| Assessment Type and Weighting | Name and details of assessment | Assessment Design Criteria | | Assessment conditions (e.g. task type, page limit, time allocated, supervision) |
| --- | --- | --- | --- | --- |
| CT | RC |
| Skills and Applications Tasks  Weighting 40% | Students demonstrate mathematical knowledge and skills from **Topic One: Modelling with Linear Relationships (non-examined topic)**. The content covers key questions and key concepts within subtopics 1.1 and 1.2. Students apply their knowledge and skills to a range of routine and complex questions in a variety of contexts, with some requiring interpretation of the results.  Appropriate and effective use of electronic technology is expected. Clear and logical communication of solutions and correct use of notation and terminology are required. | 1,2,4 | 1,2,3 | Supervised written assessment.  One A4 page of handwritten notes permitted. Use of graphics calculator is permitted.  Total time: 50 minutes |
| **Topic Two: Modelling with Matrices (non-examined topic)** is the focus of a range of routine and complex questions posed in a variety of contexts. Students demonstrate mathematical knowledge and skills of key questions and key concepts from subtopics 2.1 and 2.2. Appropriate and effective use of electronic technology is expected. Correct use of notation and terminology are required. | 1,2,4 | 1,2,3 | Supervised written assessment.  One A4 page of handwritten notes permitted. Use of graphics calculator is permitted.  Total time: 50 minutes |
| **Topic Three: Statistical Models**  Students are required to show mathematical knowledge and skills based upon the key questions and key concepts from Subtopics 3.1 and 3.2. The assessment includes both routine and complex problems, some requiring interpretation and comparison of two or more sets of data.  Appropriate and effective use of electronic technology is expected. Clear and logical communication of solutions and correct use of notation and terminology are required. | 1,2,4 | 1,2,3 | Supervised written assessment.  One A4 page of handwritten notes permitted. Use of graphics calculator is permitted.  Total time: 50 minutes |
| Mathematical knowledge and skills based upon the key questions and key concepts from **Topic Four: Financial Models** subtopics 4.1 and 4.2 will be assessed. The assessment includes both routine and complex problems, some requiring interpretation and comparison.  Appropriate and effective use of electronic technology is expected. Clear and logical communication of solutions and correct use of notation and terminology are required. | 1,2,4 | 1,2,3 | Supervised written assessment.  One A4 page of handwritten notes permitted. Use of graphics calculator is permitted.  Total time: 50 minutes |
| Mathematical knowledge and skills based upon the key questions and key concepts from **Topic Five: Discrete Models**. Subtopics 5.1 and 5.2 will be assessed. The assessment includes both routine and complex problems, some requiring interpretation and comparison of answers, particularly when initial conditions or parameters of problems are varied.  Clear and logical communication of solutions and correct use of notation and terminology are required. | 1,2 | 1,2,3 | Supervised written assessment.  **Use of graphics calculator and handwritten notes are not permitted**.  Total time: 50 minutes |
| Mathematical Investigation  Weighting 30% | **Topic Two: Modelling with Matrices**  In this task students investigate dominance matrices and how they can be used to rank teams based on a win/loss game scenario. Students select a skill-based game and collect data for a round robin tournament. Dominance matrices are used to make predictions of the final outcome of the round robin tournament. The actual results are compared with the predictions made. Students are required to consider the reasonableness of their results by examining the underlying assumptions of their mathematical model and its usefulness. | 1,2,3,4 | 1,2,3,4,5 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 12 single-sided A4 pages**.  Appropriate investigation report format as described in the General Mathematics subject outline. |
| **Topic Three: Statistical Models**  In this task students are required to investigate the rate of cooling of a cup of coffee. They display the data collected graphically and then use their graphics calculator to apply an appropriate model to the data they have collected. Students make predictions using the graph and compare these predicted values with those found using the model applied. They then explore another factor that may affect the rate of cooling. Students are required to consider the reasonableness of their results by examining the underlying assumptions of their mathematical models. | 1,2,3,4 | 1,2,3,4,5 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 12 single-sided A4 pages**.  Appropriate investigation report format as described in the General Mathematics subject outline. |
| *Examination*  *Weighting 30%* | *Students undertake a 2-hour external examination in which they answer questions on the following three topics:*  *Topic 3: Statistical Models Topic 4: Financial Models Topic 5: Discrete Models.*  *The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.* | *All the specific features of the assessment design criteria may be assessed in the external examination.* | | *2-hour external examination*  *Access to electronic technology required.*  *Students may refer to one unfolded A4 sheet (two sides) of hand-written notes.* |

***Eight assessments.*** *Please refer to the Stage 2 General Mathematics subject outline.*

Stage 2 General Mathematics

Assessment Overview

Complete the table below to show details of the planned tasks. Use numbers to show where students will have the opportunity to provide evidence for each of the specific features for all assessment design criteria.

| Assessment Type and Weighting | Name and details of assessment | Assessment Design Criteria | | Assessment conditions (e.g. task type, page limit, time allocated, supervision) |
| --- | --- | --- | --- | --- |
| CT | RC |
| Skills and Applications Tasks  Weighting 40% | **Topic One: Modelling with Linear Relationships**  The content covers key questions and key concepts within all subtopics. Students apply their knowledge and skills to a range of routine and complex questions. The complex questions require students to apply the key concepts to solve problems in a variety of contexts and some require interpretation of the results.  **Part A:** Non-calculator section (30 minutes) – Subtopic 1.1 and 1.2  **Part B:** Calculator section (20 minutes) – Subtopic 1.1  Clear and logical communication of solutions and correct use of terminology are required. | 1, 2 | 1, 3 | Supervised written assessment.  One A5 page of handwritten notes permitted for calculator section only.  Total time: 50 minutes |
| **Topic Two: Modelling with Matrices**  Mathematical knowledge and skills based upon the key questions and key concepts from all subtopics are assessed. The assessment includes both routine and complex problems. Students require access to technology to solve a range of modelling with matrices problems. Clear and logical communication of solutions and correct use of notation and terminology are required. | 1, 2, 4 | 1, 2, 3, 4 | Supervised written assessment.  One A4 page of handwritten notes permitted.  Total time: 50 minutes |
| **Topic Four: Financial Models**  Mathematical knowledge and skills based upon the key questions and key concepts from all subtopics are assessed. Problems will be set in context and opportunities for interpretation of the mathematical results will be provided throughout the test. Students require access to technology to solve a range of financial calculations. Correct use of notation and terminology are required. | 1, 2, 4 | 1, 2, 3, 4 | Supervised written assessment.  One A4 page of handwritten notes permitted.  Total time: 50 minutes |
| **Topic Five: Discrete Models**  Mathematical knowledge and skills based upon the key questions and key concepts from all subtopics are assessed. Students are required to complete both routine and complex questions without access to technology or notes. Problems will be set in context and opportunities for interpretation of the mathematical results will be provided throughout the test. Correct use of notation and terminology are required. | 1, 2 | 1, 2, 3 | Supervised written assessment.  No notes or calculator permitted.  Total time: 50 minutes |
| **Topic Three: Statistical Models**  Students demonstrate mathematical knowledge and skills of key questions and key concepts from Statistical Models subtopics 3.1 and 3.2. Students apply their knowledge and skills to a range of routine and complex questions in a variety of contexts. The complex questions require students to apply the key concepts to solve problems in a variety of contexts and some require interpretation of the results. Most questions require the aid of electronic technology. Correct use of notation and terminology are required. | 1, 2, 4 | 1, 2, 3, 4 | Supervised written assessment.  One A4 page of handwritten notes permitted.  Total time: 50 minutes |

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| Mathematical Investigation  Weighting 30% | **Topic Four: Financial Models**  In this task students are required to investigate how a regular income can be provided for in retirement through superannuation. Scope for complexity is provided through the student’s choice of scenarios to investigate mathematically. These investigations could include methods to increase the final superannuation payout, consideration of periods of time of unemployment and changing the retirement age. Investigations also include how much money the individual would need to live off at retirement and the impact of inflation on the regular income. Students are required to consider the reasonableness of their results by examining the underlying assumptions and limitations of their mathematical model. | 1, 2, 3 | 1, 2, 3, 4 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 12 single-sided A4 pages.**  Appropriate investigation report format as described in the General Mathematics subject outline. |
| **Topic Five: Discrete Models**  In this task students utilise skills that they have developed in Subtopic 5.2. They use the data for 4 members of the team to predict who should complete which stroke in a swimming relay. The times each participant takes for each stroke is randomly generated in a spreadsheet to fit specified criteria. They then use the Hungarian algorithm to see how accurate their predictions were. Further explorations of the team composition are undertaken, including a second team of four being selected, and an injury requiring re-composition of the team. Students are required to consider the reasonableness of their results by examining the underlying assumptions and limitations of their mathematical model. | 1, 2, 3 | 1, 2, 3, 4, 5 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 12 single-sided A4 pages.**  Appropriate investigation report format as described in the General Mathematics subject outline. |
| *Examination*  *Weighting 30%* | *Students undertake a 2-hour external examination in which they answer questions on the following three topics:*  *Topic 3: Statistical Models Topic 4: Financial Models Topic 5: Discrete Models.*  *The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.* | *All the specific features of the assessment design criteria may be assessed in the external examination.* | | *2-hour external examination*  *Access to electronic technology required.*  *Students may refer to one unfolded A4 sheet (two sides) of hand-written notes.* |

***Eight assessments.*** *Please refer to the Stage 2 General Mathematics subject outline.*

**Stage 2 GENERAL MathematicS**

**Assessment Type 1: Skills and Applications Tasks**

**TOPIC 1: MODELLING WITH LINEAR RELATIONSHIPS**

**Purpose**

To demonstrate your ability to:

* understand mathematical concepts and relationships from within Topic 1: Modelling with Linear Relationships
* select and apply mathematical techniques and algorithms to find solutions to problems
* interpret results, draw conclusions, and consider the reasonableness of solutions in context
* communicate mathematically and present mathematical information.

This assessment allows you to show your skills in understanding and appropriate use of the mathematical concepts, process and strategies in the following:

1. Subtopic 1.1: Simultaneous Linear Equations
2. Subtopic 1.2: Linear Programming

**Assessment Conditions**

This is a supervised assessment.

NO CALCULATOR, ELECTRONIC TECHNOLOGY or NOTES are to be used for Part A.

Provide complete working for all calculations.

This task is of 55 minutes working time, conducted in a 100 minute lesson.

* Part A: 30 minutes (non-calculator)
* Part B: 25 minutes (calculator)

Time will be set aside to collect Part A before access to calculators, for Part B, is provided.

**Assessment Design Criteria**

**Concepts and Techniques**

CT 1 Knowledge and understanding of concepts and relationships.

CT 2 Selection and application of mathematical techniques and algorithms to find solutions to problems in a variety of contexts.

CT 4 Use of electronic technology to find solutions to mathematical problems.

**Reasoning and Communication**

RC 1 Interpretation of mathematical results.

RC 2 Drawing conclusions from mathematical results with an understanding of their reasonableness and limitations.

RC 3 Use of appropriate notations representations and terminology.

RC 4 Communication of mathematical ideas and reasoning to develop logical arguments.

**Stage 2 GENERAL MathematicS**

**TOPIC 1: MODELLING WITH LINEAR RELATIONSHIPS**

**Skills and Applications Task**

**Answer all questions in the spaces provided, showing all calculations.**

**PART A: NO CALCULATOR, ELECTRONIC TECHNOLOGY or NOTES are to be used. TOTAL [ /27]**

**QUESTION 1:** Jed is a Primary school teacher and is stocking up on classroom stationery supplies. “Cheapy’s Warehouse” is selling stationery packs.

Pack A: 10 pencils with 12 pens for $9.28, and Pack B: 7 pencils with 3 pens for $3.58.

Jed wants to know if the cost of the pencils and pens in these ‘pack’ options are cheaper than the individual unit price of a pencil @ 30c each and pen @ 55c each.

1. Calculate the cost of each item in the packs and state if the packs are cheaper. [ /5]

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1. A “sales” notice advertises a package of 25 pencils with 30 pens for $23.20. Would Jed be better off buying in bulk? Provide calculations and justify. [ /3]

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**QUESTION 2:** Frieda’s class is running a “Juicy-Fruits’ Juice Bar” at their school’s fete. Customers buy freshly juiced fruit. They’ve plenty of donated fruit but have to buy their pineapples and bananas.

The local grocer has decided to support the school by charging a discounted price of $2 for each cored and peeled pineapple and a bag of bananas for $1.50 per bag. Frieda has $15 to spend and wants to spend it all.

a) If Frieda bought:

1. only bananas how many could she buy?
2. 3 pineapples, how many bags of bananas would she purchase? [ /3]

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1. Calculate the other option that uses all of Frieda’s $15 (by trial and error). [ /3]

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1. Frieda decides she wants to reserve some money for other purchases. The grocer insists that Frieda buys more than two bags of bananas and at least two pineapples to get the discounted prices. Graph the grocer’s constraints and the line made by your solutions in parts (a) and (b), on the axes below, and shade the feasible region. Provide an appropriate scale for each axis. [5 marks]

*bananas*

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|  | *y* |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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*pineapples*

d) List the purchase combinations that meet the grocer’s constraints. [ /3]

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1. Show mathematically that if Frieda purchases 4 pineapples and 3 bags of bananas she will have enough cash to buy a 350ml drink of Coconut Milk costing $2. [ /2]

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1. Using the graph in part c), determine the combination which meets the grocer’s constraints and that leaves Frieda with the most change. Show using calculations how much change Frieda will have. [ /3]

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**Stage 2 GENERAL MathematicS**

**TOPIC 1: MODELLING WITH LINEAR RELATIONSHIPS**

**Skills and Applications Task**

**PART B: CALCULATOR/ELECTRONIC TECHNOLOGY and notes may be used. TOTAL [ /23]**

**QUESTION 1:** Barry’s Gourmet Butcher sells “Turducken”, a Christmas meat made of a mixture of Turkey, Duck and Chicken. He makes two Turducken blends, Deluxe and Light. Each week only 1800g of turkey, 2100g of duck and 1800g of chicken are available to make his Turduckens.

Deluxe uses at most 200g of turkey, 300g of duck and 300g of chicken.

Light uses at most 200g turkey, 200g of duck and 100g of chicken.

1. Complete the table below and write the constraints that represent this information.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type | Turkey | Duck | Chicken |  |
| Deluxe |  |  |  | *x* |
| Light |  |  |  | *y* |
| At most |  |  |  |  |

[ /4]

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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1. One of the constraints and its label has been provided on the axis below. Graph all of the remaining constraints and label them (including x≥0 and y≥0). Shade the feasible region.

*y* Light (x100g) [ /5]

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*x* + *y* = 9 Deluxe (x100g) *x*

1. Barry’s profit is determined by the following equation: Profit = 4*x* + 2.5*y*

List the coordinates of the vertices for the feasible region. Showing calculations, determine how many of each blend of Turducken Barry should make to maximise his profit. [ /9]

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1. Is it reasonable to make decisions about the quantity of each blend of Turducken to make based only on the result of this linear programming investigation? [ /2]

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1. The “Light” blend is exceedingly popular, always quickly selling out. Should Barry consider one of the other options? Justify your answer. [ /3]

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**Stage 2 General Mathematics**

**Assessment Type 2: Mathematical Investigation**

**Modelling with Matrices**

**Using data from a sporting context to rank teams**

Dominance matrices can be useful in round robin sporting competitions. The dominance model can be used to make predictions based on current season performances about which team might win a competition. You will choose a sport or competition played in a ‘round robin’ format where results can be easily obtained for a completed season so the final ranking of the teams is known.

(Note: the word ‘round’ can be used in many senses in sports, however in this task the term ‘round’ is taken to mean that each team has played every other team once.)

1. Choose the sport for which you will be using dominance matrices to make predictions about the outcomes of the season. Some suggestions of sports leagues you could consider are: SANFL, NBA, Australian Netball League or Hyundai A-League soccer. (Note: Competitions in which there are large numbers of teams will mean very large matrices. If a competition that has a smaller number of participating teams cannot be found or you wish to investigate a larger competition, you should select a subset of the teams from which to collect data – e.g. from all of the AFL competition you could collect data for eight of the teams.)
2. Gather results for your chosen sport for the first complete round of games. Some websites which provide data for specific sports are given below:

<https://en.wikipedia.org/wiki/2015_SANFL_season>

<http://www.scorespro.com/basketball/australia/nbl/2014-2015/results/>

<http://www.a-league.com.au/results/214/2015/2319/1>

1. Select three games at random to be removed from the data (i.e. assume these games are yet to be played). Create a dominance matrix from the rest of the results. Explain how you have represented win/loss (and draws if necessary) in your dominance matrix.
2. Use your dominance matrix to rank the teams on the results so far and make predictions about the outcomes of the three games yet to be played. Discuss the usefulness and limitations of using the dominance matrix alone for making these predictions and make a comparison with what actually happened.
3. Discuss second and third order influences and their significance. Choose a supremacy model to use with your data and compare its predictions to those made for the three games yet to be played in part 4.
4. Use your supremacy model to make a prediction of the final ladder placings of all the teams in your sample. Compare your result with the actual ranking at the end of the season and discuss the result.
5. Investigate ways of refining your dominance model which might improve the predictions made. You could consider:
   * different supremacy models
   * adding further game outcomes to the dominance matrix
   * some way of incorporating winning margins
6. Using your results from above, summarise your findings. Comment on how accurately your models relate to the real situation. Discuss any limitations of the models, and the reasonableness of the solutions found.

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.

**Stage 2 General Mathematics**

**Assessment Type 2: Mathematical Investigation**

**Statistical Models – Rates of Cooling**

**Description**

The following data represents the temperature above room temperature of a cup of flat white coffee as it cools.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| *t* (mins) | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
| *A* (°C) | 71 | 61 | 51.5 | 45 | 39 | 35 | 31 |

Where: *A* is the number of degrees above room temperature, and

*t* is the time in minutes that have passed since the coffee was poured.

In this task you will develop formulae to model the relationship between the number of degrees above room temperature of a cup of coffee and the time in minutes that have passed since the coffee was poured.

**Section 1**

1. Examine the data in the table above and predict, using only your ‘intuition’, what the temperature difference will be 2.5 minutes, 13 minutes, 35 minutes and 60 minutes after the coffee is poured. Predict how long it might take for the coffee to reach 5°C above room temperature.
2. On a large set of axes accurately plot the graph of *A* against *t*. Describe the shape of the graph and any of its significant features. Discuss whether it make sense to connect the dots with a continuous curve.
3. Use your graph to estimate the temperature of the coffee above room temperature at the four different times given in part 1 above. Compare your predictions from part 1 with these answers.
4. Enter the tabled data into your graphics calculator and fit an appropriate model to it. Give the algebraic formula for this model. Discuss your reasons for choosing the particular model you used with reference to the features and behaviour of its graph.
5. Use your model to predict the temperature of the coffee above room temperature for the same four times that were used in parts 1 and 3, as well as the time it would take for the coffee to reach 5°C above room temperature.
6. Comment on similarities/differences in the temperature of the coffee as predicted using the three methods in parts 1, 3 and 5. Which values would you consider the most and least accurate predictions? Give clear reasons for your answers. Compare the two predictions made for the time it would take for the coffee to cool to 5°C above room temperature and comment on any difference between these two estimates.

**Section 2**

1. Consider what other factors might affect the rate of cooling of the coffee (e.g. size of the cup, what the cup is made of, initial temperature of the empty cup before the coffee is poured, ambient temperature of the room, type of coffee etc.). **Choose one** factor to investigate and describe in detail how you expect it might affect the graph of cooling of the coffee over time.
2. Design an experiment where two variations of your chosen factor are used and all other parameters are kept consistent (e.g. you could make a cappuccino coffee and then a long black coffee keeping everything else about the experiment the same). Through **direct measurement** produce a table similar to the table above for each of these two new situations.
3. Analyse your data using appropriate graphs and algebraic models. Compare any similarities and differences between the three models investigated. Conclude your investigation by summarising the important points discovered. Include discussion of the assumptions made in the investigation and the reasonableness of the models used.

**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.

**Stage 2 General Mathematics**

**Assessment Type 2: Mathematical Investigation**

**Topic 4: Financial Models – Preparing for retirement**

**The Task**

At 23, Katarina has come to you for financial advice. She has just finished her university studies and started full time work, earning $55,000 per annum. She realises that she needs to provide for her retirement. She has advised you that that she plans to retire at 65, and wants to be able to live for at least 20 years off the money that has built up in her superannuation account.

**Part 1: Superannuation**

Select a superannuation fund site to investigate and select an investment option into which Katarina’s money will be invested. Select a rate of return that you will use for your original calculations, and provide brief reasons for your selection. Decide on the frequency of payments being made into the account by the employer. Include evidence of the investment information in your appendix.

Sites such as the one found at the link below provide a range of superannuation fund rate of return information:

http://www.supersa.sa.gov.au/our\_products/triple\_s/investment\_performance

Include evidence of the rate information in your appendix.

**Part 2: Account balance at retirement (how much Katarina will have at age 65 years)**

Calculate the account balance at retirement that Katarina would have in her superannuation fund if only the compulsory employer contributions were being made into the account until her retirement. Assume that the compulsory employer contributions are 9.5% of salary.

**Part 3: Living off the income in retirement**

Calculate how much money Katarina will have to live off if she places all of the account balance in her superannuation fund into an annuity to provide a regular income.

Sites such as the one found at the link below provide a range of rate of return information:

http://www.supersa.sa.gov.au/our\_products/income\_stream/investment\_performance/yearly\_rates\_of\_return

Include evidence of the rate information in your appendix.

**Part 4: Effect of inflation**

Katarina currently takes home $1,700 pay a fortnight after tax. Calculate how much Katarina would need to receive from her annuity at 65 years of age to be receiving an equivalent amount, taking into account inflation over this period. Include evidence of the CPI rate chosen in your appendix.

Compare this to the regular income you found that Katarina would have in Part 3. Will Katarina be able to live comfortably in her retirement?

**Part 5: Further investigations**

Undertake further investigations for Katarina to provide her with advice on what might affect the final account balance in her superannuation fund. Your investigations may include:

* Making personal contributions to her superannuation fund
* Investing in different investment options over her career, e.g. a growth option in the beginning and a conservative option near retirement
* The effect of wage increases/decreases
* A change of retirement age
* The effect of taking time off work e.g. to travel or for a change of career
* A change to the CPI rate and if it will affect the amount that Katarina would need to receive in retirement.

These calculations should look at both how much her account balance will be at retirement age as well as how much she will be able to draw as a regular income over the 20 years throughout retirement.

**The Report**

**Introduction**

Read the whole task and write an introduction that outlines the task in your own words.

**Mathematical Investigations**

Complete Parts 1 to 5.

**Discussion**

Discuss and compare the different superannuation scenarios you investigated.

Make a recommendation to Katarina about which of the superannuation strategies you investigated she should consider when making her final choice.

Discuss any assumptions you have made in making this recommendation or any limitations to the information you could access that may affect the reasonableness of your recommendation.

**Conclusion**

Drawing on the information and mathematical calculations that you have investigated, recommend the most appropriate retirement strategy for Katarina.

**Appendix**

Include evidence such as:

* information collected on superannuation and using a lump sum as a regular income
* rate of return information.

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

**Stage 2 General Mathematics**

**Assessment Type 2: Mathematical Investigation**

**The Hungarian Algorithm**

**The Task**

A school swimming coach has asked for volunteers to swim the 4 x 50m medley relay at the interschool swim meet. Altogether 9 students have put their names down (R - Z). The coach must decide how to form the best team and whether to make a second team for this race.

**Part 1:**

The range of average times for students to swim 50 metres of each of the strokes is:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Freestyle | Breaststroke | Backstroke | Butterfly |
| Avg time (secs) | 28 - 38 | 40 - 50 | 35 - 45 | 32 - 42 |

Construct a spreadsheet which will randomly assign times for each of the nine students in each leg of the relay using these guidelines. Times should be calculated in whole seconds.

|  |  |  |  |  |  |  |  |  |  |
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|  | R | S | T | U | V | W | X | Y | Z |
| Freestyle |  |  |  |  |  |  |  |  |  |
| Breaststroke |  |  |  |  |  |  |  |  |  |
| Backstroke |  |  |  |  |  |  |  |  |  |
| Butterfly |  |  |  |  |  |  |  |  |  |

**Part 2:**

The coach decides to put the first four students who put their names down (R – U) in the relay team (A-team).

Make a prediction, with some discussion of your reasoning, of how you think these students should be assigned to the four different sections of the race.

Determine, using the Hungarian Algorithm, which of these students should swim each stroke. Compare your answer with the prediction you made.

The coach wants to create a second medley team (B-team) from the remaining five students (V – Z). Determine, using the Hungarian Algorithm, who should be in this team and which stroke each one should swim. Which student misses out on a place?

**\*\*NOTE: If either of the problems above can be done simply ‘by inspection’ (i.e. does not require the use of the Hungarian Algorithm for its solution) you should recalculate your spreadsheet until this is no longer so.**

**Discuss and compare** the resulting relay times for the two teams.

**Part 3:**

Can the coach create a better A-team than the one found in Part 2 if (s)he selects the team from all nine students? Investigate this question and discuss the implications for the two teams and their total relay times.

**Part 4:**

The ninth student who did not make either of the teams in Part 3 has been kept as a reserve. Suppose one of the A-team is injured on the day of the race and cannot swim (your choice of who this is). Investigate the choices the coach has for assignment of the swimmers and the effects of these choices on the expected race times of the two teams. (*The coach could simply substitute the reserve for the injured swimmer, (s)he could reassign the swimmers within the A-team using the reserve or (s)he could reassign both teams using the eight swimmers available*).

**The Report**

Write a report in the appropriate format which introduces the task, shows your mathematical investigation and your discussion of the results and conclusions drawn. Include a discussion of underlying assumptions made and the possible limitations imposed by them on the solutions.

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

**STAGE 2 ESSENTIAL MATHEMATICS PROGRAM 1**

This program is for a cohort of students studying Stage 2 Essential Mathematics. It is assumed that students have completed Topics 1-6 from Stage 1 Essential Mathematics.

**Topic 1 – Scales, Plans, and Models (4 Weeks) – Non-examined topic**

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| **Term**  **week** | **Subtopic** | **Concepts and Content -** Discerning use of technology. Some course components are calculated without technology as appropriate. | **Assessment Task** |
| 1-1 | 1.1  Geometry | Properties of shapes:   * 2D shapes: vertices and edges * 3D shapes: faces, vertices, and edges. |  |
| 1-2 | 1.1 and 1.2 | Nets: Use of nets to construct 3D solids – naming solids, recognition of 2D shapes used to form each solid, drawing a net for a given 3D solid.  Scale: Terminology Notations: symbols and abbreviations |  |
| 1-3 | 1.2  Scale | Displaying measurements from field observations with an appropriate scale.  Bearings: applied to scaled information in context e.g. search and rescue.  Error: accuracy of instruments and effects of error on calculations. |  |
| 1-4 | 1.1 and 1.2 | Problem solving with scaled representations and construction of scaled representations. | **SAT 1 Scales, Plans, and Models (1.1 and 1.2)**  **No calculator - No notes** |

**Topic 3 – Business Applications (6 weeks) – Non-examined topic**

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| --- | --- | --- | --- |
| **Term**  **Week** | **Subtopic** | **Concepts and Content -** Discerning use of technology. Some course components are calculated without technology as appropriate. | **Assessment Task** |
| 1-5 | 3.1  Planning a Business Premises  3.2  Costing Calculations | Planning a business:   * consideration of location and facilities for variety of retail businesses * cost of premises (without ET\*) per time period (e.g. weekly, fortnightly, etc.)   Costing of goods:   * manufacturer to wholesaler to retail * terminology - GST / Input Tax Credits / profit margin etc. | \* ET = electronic technology |
| 1-6 | 3.2  Costing Calculations | Pricing structures calculations:   * Trade discount based on payment terms e.g. 7/10, 5/21, n/30 * Series discount e.g. trade, end-of-line sale, etc. * GST * Profit margin.   Other factors affecting viability:   * depreciation – calculation for straight-line and reducing balance and construction of graphs * discussion of insurance - WorkCover and public liability, etc. * input tax credits. |  |
| 1-7 | 3.2 | Costing calculations and introduction to fixed and variable costs |  |
| 1-8 | 3.2 | Calculating break-even point:   * graphically * marginal income.   Business viability:   * constructing profit/loss statements (including COGS) * profit projections. | **FOLIO 1: Break-even investigation** |
| 1-9 | 3.2 and 3.3  Business Structures and Taxation | Breakeven, profit/loss and taxation calculations and comparisons   * Compare tax payable under sole/partnership structures with varying proportioning of ownership |  |
| 1-10 | 3.3 | Taxation calculations and comparisons   * Sole, partnership and company business structures * Compare tax payable under sole/partnership structures with varying proportioning of ownership. | **SAT 2 – Business Applications (3.1-3.3)**  **Calculator permitted + 1 side of one A4 page notes** |

**Topic 2 – Measurement (6 Weeks)**

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| **Term**  **week** | **Subtopic** | **Concepts and Content -** Discerning use of technology. Some course components are calculated without technology as appropriate. | **Assessment Task** |
| 1-11 | 2.1  Linear Measure | Conversions: linear unit metric conversions. Discuss link between metric and imperial units and conversions (e.g. yard, m, 1m = 3’ = 1yd, etc.)  Estimation: measure lengths in the field assessing student accuracy.  Perimeter: calculations of simple and composite shapes. |  |
| 2-1 | 2.1  Linear Measure | Calculating lengths of missing sides:   * Pythagoras Theorem * Right-angled triangle trigonometric ratios – sine, cosine and tangent * Non right-angled triangles: sine and cosine rules.   Calculating unknown angles using sine and cosine rules. |  |
| 2-2 | 2.2  Area Measure | Conversions: metric area unit conversions and between metric and imperial units (e.g. km2 to Ha, etc.)  Calculations of area.  Regular and irregular triangles, quadrilaterals, sectors, circles and composites of these shapes.  Irregular non-polygonal shapes: use Simpson’s rule to calculate irregular areas (with curved outlines) e.g. fish ponds, garden beds, golf greens, dams. |  |
| 2-3 | 2.2  Area Measure | Calculation of surface area of cubes, prisms, pyramids, and spheres  Simple composites of these. |  |
| 2-4 | 2.3  Mass, Volume, and Capacity | Conversions: units of mass, volume, and capacity  Calculations: volume of cubes, prisms, pyramids, cones, and spheres  Density: Units, e.g. g/cm3  Calculations: Use density to determine volume or mass of a specified material. |  |
| 2-5 | 2.3  Mass, Volume, and Capacity | Density: Units, e.g. g/cm3  Calculations: Use density to determine volume or mass of a specified material | **SAT 3 – Measurement (2.1-2.3)**  **Part A – No calculator or notes**  **Part B – Calculator permitted and formula sheet provided.** |

**Topic 4 – Statistics (6 weeks)**

|  |  |  |  |
| --- | --- | --- | --- |
| Term  week | **Subtopic** | **Concepts and Content -** Discerning use of technology. Some course components are calculated without technology as appropriate. | **Assessment Task** |
| 2-6 | 4.1  Sampling from Populations | Terminology  Sampling methods  Bias and errors |  |
| 2-7 | 4.2  Analysis and Representation of Sets of Data | Measures of centre and spread  Outliers  Stem-and-leaf plots and Box-and-whisker diagrams | **SAT 4 – Statistics (4.1, 4.2)**  **Calculator permitted 1 A4 page notes** |
| 2-8 | 4.3  Linear Correlation | Terminology: dependent and independent variables  Scatterplots: Association strength, form, and direction; Effect of outliers  Causality, Validity  Degree of relationship: Pearson’s correlation coefficient (***r***), Least squares regression (“line of best fit”), Coefficient of determination (***r2***). |  |
| 2-9 | Revision | FORMATIVE mid-year EXAM REVISION |  |
| 2-10 | Revision | FORMATIVE mid-year EXAM |  |

**Topic 4 – Statistics (6 weeks) continued**

|  |  |  |  |
| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content -** Discerning use of technology. Some course components are calculated without technology as appropriate. | **Assessment Task** |
| 3-1 | 4.3  Linear Correlation | Applying least squares regression line: extrapolate and interpolate values (making predictions). |  |
| 3-2 | 4.3  Linear Correlation | Folio 2: Students choose a theme to investigate and compare primary data sources and secondary data sources (eg ABS Censusatschool [*www.abs.gov.au/****censusatschool***](http://www.abs.gov.au/censusatschool)). | **FOLIO 2: Correlation investigation**  **Students choose a theme to investigate and compare primary data sources and secondary data sources (eg ABS Censusatschool)** |
| 3-3 | 4.3  Linear Correlation | Folio 2 |

**Topic 5 – Investments and Loans (6 weeks)**

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| --- | --- | --- | --- |
| **Term**  **week** | **Subtopic** | **Concepts and Content -** Discerning use of technology. Some course components are calculated without technology as appropriate. | **Assessment Task** |
| 3-4 | 5.1  Lump-sum Investments | Investing: Terminology  Interest: Simple and Compound  Tax on interest earned  Inflation |  |
| 3-5 | 5.2  Annuity Investments | Investing: Annuities  Calculations: Future value, time (number of periods), interest rate, interest earned.  Assumptions over the long term, effects of, for example, a rate change, regular deposit increased, etc. |  |
| 3-6 | 5.2  Annuity Investments | Investing: Applications:   * Long-term investments * Superannuation * Effects of taxation and Inflation |  |
| 3-7 | 5.3  Loan Annuities | Loans: Terminology  Calculations: Present value, regular payment, interest rate, interest paid.  Assumptions over the long term, effects of, for example, a rate change, regular payment increased, etc. |  |
| 3-8 | 5.3  Loan Annuities | Loans: costs of borrowing  Charges on loan accounts  Comparison rates (no calculations required)  Interest minimisation strategies | **FOLIO 3: Car Purchase: Save Up/Borrow**  Students investigate using an unsecured loan to purchase a car. They examine ways to minimise interest, examine the validity of bank and online simulator, and compare with saving for the car. |
| 3-9 | 5.2, 5.3 | Folio 3: Students investigate an unsecured loan to purchase a car. They examine ways to minimise interest, and examine the validity of online simulators. |
| 3-10 |  | Revision |  |

**Revision**

|  |  |  |  |
| --- | --- | --- | --- |
| Term  week | **Subtopic** |  | **Assessment Task** |
| 4-1 |  | Revision |  |
| 4-2 |  | Revision |  |
| 4-3 |  | Swot Vac |  |
| 4-4 |  | Exam |  |

**NOTES AND COMMENTS**

Please note that this is a working document and may need flexibility to adapt to varying school commitments and requirements.

**SUGGESTED ALLOCATION OF TIME**Topic 1: Scales, Plans, and Models (4 weeks)

Topic 2: Measurement (6 weeks)

Topic 3: Business Applications (6 weeks)

Topic 4: Statistics (6 weeks)

Topic 5: Investments and Loans (6 weeks)

**Stage 2 Essential Mathematics Program 2**

Topic 1: Scales, Plans, and Models, Topic 2: Measurement, Topic 3: Business Applications, Topic 4: Statistics,

Topic 5: Investments and Loans

|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| --- | --- | --- | --- |
| **Term One**  **Week 1** | **Course Overview and Expectations** | **TOPIC ONE: SCALES, PLANS, AND MODELS**  Review 2D shapes and their properties including vertices and edges.  (square, rectangle, rhombus, parallelogram, trapezium, circle, triangles, and polygons) | Review 3D shapes and their properties including faces, vertices and edges.  (cube, sphere, prisms, pyramids, cylinder and cones) |
| **Week 2** | Recognising 3D shapes from 2D representations  Net 🡪 3D solid | Creating Scaled Diagrams   * Taking measurements within school to construct a scaled diagram | Creating Scaled Diagrams   * Commonly used symbols, labelling * What are appropriate scales to use * Accuracy of measurements and the effect of errors |
| **Week 3** | Reading and Interpreting Scaled Diagrams   * Finding lengths, perimeters and area * Can scaled diagrams tell us everything, e.g. steepness of hills * Accuracy of measurements and the effect of errors on calculations | Reading and Interpreting Scaled Diagrams   * Finding lengths, perimeters and area * Can scaled diagrams tell us everything, e.g. steepness of hills * Accuracy of measurements and the effect of errors on calculations | Using bearings to solve problems |
| **Week 4** | REVISION | **SCALES, PLANS, AND MODELS – SAT ONE**  **30 minutes Non Calculator**  **20 minutes Calculator** | **TOPIC TWO: MEASUREMENT**  Review:   * Linear measurement units * Conversion between units km, m, cm, and mm * Conversion between metric and imperial * Perimeter of polygons, triangles, squares, and rectangles * Calculating circumference of circles and perimeter of arcs |
| **Week 5** | Given perimeter rearrange formula to find unknown lengths (e.g. Find the radius of a circle given the circumference) | Perimeter of composite shapes | Finding missing sides of right-angled triangles   * Using Pythagoras Theorem   (Including questions involving angle of elevation/depression) |
| **Week 6** | Finding missing sides of right-angled triangles   * Using sine, cosine and tangent ratios   (Including questions involving angle of elevation/depression) | Finding missing sides of right-angled triangles   * Using sine, cosine and tangent ratios   (Including questions involving angle of elevation/depression) | Finding missing sides of non-right-angled triangles using sine rule |
| **Week 7** | Finding missing sides of non-right-angled triangles using cosine rule | Finding missing sides of non-right-angled triangles using cosine rule | What are the appropriate units for area and how do we convert between them.?  (including hectare and acres)  Areas of regular shapes  (triangles, squares, rectangles, parallelograms, trapeziums, circles, and sectors) |
| **Week 8** | Areas of composite shapes | Areas of composite shapes | Area of irregular shapes   * Using simple shapes * Simpson’s rule |
| **Week 9** | Calculating surface area of cubes, rectangular and triangular based prisms, pyramids, cylinders and spheres | Calculating surface area of cubes, rectangular and triangular based prisms, pyramids, cylinders and spheres | Calculating surface area simple composite 3D shapes |

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|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 10** | **FOLIO ONE** | Converting metric units of mass  The connection between volume and capacity and conversion between them (e.g. 1cm3= 1mL and 1m3=1kL)  The connection between volume and mass   * Units of measurement for density * Calculating density | Calculating the volume of cubes, rectangular and triangular prisms, pyramids, cones, cylinders, and spheres |
| **Week 11** | REVISION | **MEASUREMENT – SAT TWO**  **20 minutes Non Calculator**  **30 minutes Calculator** | **FOLIO ONE** |
| Term Two  **Week 1** | **TOPIC THREE: BUSINESS APPLICATIONS**  Factors that affect location of a business  Calculating the cost of business premises | Introduction to the pricing of goods to be sold and key terms – manufacturer’s cost, wholesaler’s cost, retail cost, profit margin, discount, GST, and input tax credits. | Trade discount, series discount |
| **Week 2** | GST  (The whole process from manufacturer to retailer) | GST  (The whole process from manufacturer to retailer) | Calculating selling price given profit margins |
| **Week 3** | Depreciation methods   * Straight-line method | Depreciation methods   * Reducing balance depreciation | Depreciation graphs |
| **Week 4** | Discussion of other business costs e.g. insurance, WorkCover, public liability, and their importance. | Input tax credit calculations | Fixed and variable costs |
| **Week 5** | Break-even point   * Graphically | Break-even point   * Marginal income | Profit-and-loss statements and profit projections by hand and via Excel |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 6** | Introduction to business structures and tax advantages for different types:   * Sole trader * Partnership * Company | Tax calculations for sole trader and partnership business structures. | Tax calculations for sole trader and partnership business structures.  REVISION |
| **Week 7** | **BUSINESS APPLICATIONS –**  **SAT THREE** | **TOPIC FOUR: STATISTICS**  Understanding the key terms of sampling and why we sample.  Census, Population, Sample, Survey | Sampling methods and their advantages and disadvantages:   * Simple random * Stratified * Systematic * Self-selected |
| **Week 8** | Sample size and its impact on reliability | Bias in sampling (faults and errors)   * Sampling errors * Measurement errors * Coverage errors * Non-response errors | Calculation of measures of central tendency and spread.   * Mean * Median * Range |
| **Week 9** | MID YEAR EXAMS | | |
| **Week 10** | Calculation of measures of central tendency and spread.   * Interquartile range * Standard Deviation | Outliers and the effect on distributions | **FOLIO TWO** |

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|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| Term Three  **Week 1** | Review Stem-and-leaf plots | Review Box-and-whisker diagrams | Graphing linear relationships to see if there is a connection between two variables   * Independent and dependent variables * How to draw scatter plots * Patterns and features of scatter plots * Description of association (direction, form, and strength) * Causality |
| **Week 2** | Pearson’s correlation coefficient | When do we create a line of best fit:   * Coefficient of determination * Least squares regression line | When do we create a line of best fit:   * Coefficient of determination * Least squares regression line |
| **Week 3** | Using the line of best fit to interpolate and extrapolate. | Outliers effect on linear relationship. | **FOLIO TWO** |
| **Week 4** | **TOPIC FIVE: INVESTMENTS AND LOANS**  Review investing money via simple interest investments  (focus on rearranging formula) | Review investing money via compound interest investments | What impacts earnings of investments?   * Inflation * Taxation |

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 5** | Introduction to future-value annuities  Future-value annuity calculations:   * Future values * Regular deposit * Number of periods * Interest rate * Interest earned   (Including assumptions made in these calculations) | Future-value annuity calculations:   * Future values * Regular deposit * Number of periods * Interest rate * Interest earned   (Including assumptions made in these calculations) | Future-value annuity calculations:   * Future values * Regular deposit * Number of periods * Interest rate * Interest earned   (Including assumptions made in these calculations) |
| **Week 6** | Applications of Annuities   * Long-term investments * Superannuation | Applications of Annuities   * Long-term investments * Superannuation | Impact on investment   * Taxation * Inflation |
| **Week 7** | Introduction to present-value annuities  Cost of a loan calculations:   * Present value * Regular payment * Number of periods * Interest rate * Interest paid   (Including assumptions made in these calculations) | Cost of a loan calculations:   * Present value * Regular payment * Number of periods * Interest rate * Interest paid   (Including assumptions made in these calculations) | Cost of a loan calculations:   * Present value * Regular payment * Number of periods * Interest rate * Interest paid   (Including assumptions made in these calculations) |
| **Week 8** | What is the best loan option?   * Charges on loan * Comparison rates (no calculations) | What is the best loan option?   * Charges on loan * Comparison rates (no calculations) | **FOLIO THREE** |

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|  | **Lesson 1 – Single Lesson** | **Lesson 2 – Single Lesson** | **Lesson 3 – Double Lesson** |
| **Week 9** | REVISION | **INVESTMENT AND LOANS**  **– SAT FOUR** | **FOLIO THREE** |
| **Week 10** | EXAM REVISION | EXAM REVISION | EXAM REVISION |
| Term Four  **Week 1** | EXAM REVISION | EXAM REVISION | EXAM REVISION |
| **Week 2** | EXAM REVISION | EXAM REVISION | EXAM REVISION |
| **Week 3** | **SWOT VAC – NO CLASSES** | | |
| **Week 4** | **EXAMINATIONS START** | | |
| **Week 5** |

Stage 2 Essential Mathematics

Assessment Overview Aligns with Program 1

The table below provides details of the planned tasks and shows where students have the opportunity to provide evidence for each of the specific features of both assessment design criteria.

| Assessment Type and Weighting | Details of assessment | Assessment Design Criteria | | Assessment conditions (e.g. task type, page limit, time allocated, supervision) |
| --- | --- | --- | --- | --- |
| CT | RC |
| Skills and Applications Tasks  Weighting 30% | **Scales, Plans, and Models (non-examined topic):** Students demonstrate knowledge of key questions and key concepts from subtopics 1.1 and 1.2. Questions require knowledge of two and three dimensional shapes and their properties, constructing scaled representations and gaining information from scaled representations. Use of appropriate equipment for construction of scaled representations is required. Clear and logical communication of solutions and correct use of notation and terminology are required. | 1,2 | 1,2,3,4 | Supervised test of 60 min (within double lesson).  No calculator permitted.  No handwritten notes. |
| **Business Applications (non-examined topic)**: Students demonstrate their knowledge and skills in responding to questions of both of routine and complex nature from the key questions and key concepts within subtopics 3.1 to 3.3. Some questions are more efficiently solved with the aid of electronic technology. Clear and logical communication of solutions and correct use of notation and terminology are required in these assessments. | 1,2,4 | 1,3,4 | Supervised test of 60 min (within double lesson).  Calculator allowed and 1 side of a single A4 page of notes. |
| **Measurement (examined topic)**: Students demonstrate their knowledge and skills of key questions and key concepts from within subtopics 2.1 to 2.3.  Questions in Part A include converting metric units of length and area. Perimeter and area calculations (including for composite figures) and solving for the length of a missing side in right-angled triangle problems using Pythagoras’ theorem are also included with consideration given to the numerical values involved given no access to calculators.  Questions in Part B include solving problems with right-angled and non-right-angled triangles requiring calculator access, calculations with more complicated numerical figures covering area (including composite shapes), and conversions and calculations with mass, volume, and capacity. Clear and logical communication of solutions and correct use of notation and terminology are required. Construction of diagrams may be required to support problem-solving strategies. | 1,2,4 | 1,3,4 | Supervised test of 60 min (within double lesson).  Part A without calculator or notes (20 min).  Part B with calculator (40min)   * formula sheet provided * no notes permitted. |
| **Statistics (examined topic)**: Students demonstrate their knowledge and skills in responding to questions covering key questions and key concepts from within subtopics 4.1 and 4.2. Some questions are better solved with the aid of electronic technology. Clear and logical communication of solutions and correct use of notation and terminology are required in these assessments. | 1,2,4 | 1,2,3,4 | Supervised test of 60 min (within double lesson).  Calculator allowed and 1 side of a single A4 page of notes. |
| Folio  Weighting 40% | **Topic 2: Business Applications**  Students use skills from subtopic 3.2 to investigate the costs involved in making a product for sale at a country market or similar venue, carry out a break-even analysis and investigate the number of the product that needs to be made and sold to reach varying levels of profit. They make predictions about how many would need to be sold to reach varying levels of profit, and then check using graphical or marginal income methods to see how appropriate their predictions were. They then investigate scenarios of their own choice to see what impact is made on the profit through a series of changes to the original scenario (e.g. varying the selling price and finding a cheaper way of purchasing materials to make the product). | 1,3,4 | 1,2,3,4,5 | 3 weeks to complete.  Folio format: multimodal or written.  Page limit of a maximum of 8 A4 pages - font size minimum of 10 point. |
| **Topic 4: Statistics**  Students use skills from subtopic 4.3: Linear Correlation to determine if evidence of a causal link exists between two variables of their choice (e.g. age vs reaction time). Students seek approval of their choice of data to investigate before proceeding. Students make a prediction about the strength of the causal link before they collect or source data to investigate. They collect primary data to analyse then compare with a sample from another source such as another student or an online data base (e.g. Census at School: *www.abs.gov.au/censusatschool*). Students discuss the strength of the relationship and hence the validity of using the least squares regression line for making predictions, and where valid, use it to interpolate and extrapolate values. Consideration should be given to outliers, their impact on the results and appropriateness of removing them. | 1,2,3,4 | 1,2,3,4,5 | 3 weeks to complete.  Folio format: multimodal or written.  Page limit of a maximum of 8 single-sided A4 pages - font size minimum of 10 point. |
| **Topic 5: Investments and Loans**  Students compare the overall expenditure when taking out a loan to purchase a car with saving to purchase a car. They examine the cost of a loan, and using calculations investigate several methods that can be used to minimise the interest paid on the loan. They discuss the reasonableness of the methods investigated and any limitations to the results. Students extend this to include an investigation of making regular payments to save the money required to purchase the car. A comparison of the total cost of the car using all methods investigated should be made. Discussion of the reasonableness of the methods investigated and any limitations to the results found should be included. | 1,2,3,4 | 1,2,3,4 | 3 weeks to complete.  Appropriate Folio format is required.  Multimodal or written response.  Page limit of a maximum of 8 single-sided A4 pages - font size minimum of 10 point. |
| *Examination*  *Weighting 30%* | *Students undertake a 2-hour external examination in which they answer questions on the following three topics:*  Topic 2: Measurement Topic 4: Statistics Topic 5: Investment and Loans  *The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.* | *All the specific features of the assessment design criteria may be assessed in the external examination.* | | *2-hour external examination.*  *Access to electronic technology required.*  *Students may refer to one unfolded A4 sheet (two sides) of hand-written notes.* |

***Eight assessments.*** *Please refer to the Stage 2 Essential Mathematics subject outline.*

**Stage 2 Essential Mathematics**

**Assessment Overview Aligns with Program 2**

Complete the table below to show details of the planned tasks. Use numbers to show where students will have the opportunity to provide evidence for each of the specific features for all assessment design criteria.

| **Assessment Type and Weighting** | **Name and details of assessment** | **Assessment Design Criteria** | | **Assessment conditions** (e.g. task type, page limit, time allocated, supervision) |
| --- | --- | --- | --- | --- |
| **CT** | **RC** |
| **Skills and Applications Tasks**  **Weighting 30%** | **Topic One: Scales, Plans, and Models**  The content covers key questions and key concepts within subtopics 1.1 and 1.2. Students apply their knowledge and skills to a range of routine and complex questions.  **Part A:** Non-calculator section (30 minutes) – Subtopic 1.1 to 1.2  **Part B:** Calculator section (20 minutes) – Subtopic 1.2  Clear and logical communication of solutions and correct use of notation and terminology are required. Use of appropriate equipment for constructing and taking measurements from scaled representations is required. | 1, 2, 4 | 1, 3 | Supervised written assessment.  Part A: no calculator, no notes  Part B: calculator access.  One A5 page of handwritten notes permitted for calculator section only.  **Total time: 50 minutes** |
| **Topic Two: Measurement**  Mathematical knowledge and skills based upon the key questions and key concepts from all subtopics are assessed. The assessment includes both routine and complex problems, some requiring the rearrangement of formulas.  **Part A:** Non-calculator section (20 Minutes) – Parts of Subtopic 2.1 to 2.3  **Part B:** Calculator section (30 minutes) –Subtopic 2.1 to 2.3. The formula sheet will include formulae for circumference, area, volume, surface area, Simpsons rule, Pythagoras’ theorem, sine, cos and tan ratios and the sine and cosine rule.  Clear and logical communication of solutions and correct use of notation and terminology are required. | 1, 2, 4 | 1, 2, 3, 4 | Supervised written assessment.  Part A: no calculator, no notes  Part B: calculator access allowed and a formulae sheet is provided.  **Total time: 50 minutes** |
| **Topic Three: Business Applications**  Students demonstrate mathematical knowledge and skills of key questions and key concepts from Business Applications subtopics 3.1, 3.2 and 3.3. Students apply their knowledge and skills to a range of routine and complex questions in a variety of contexts. The complex questions require students to apply the key concepts to solve problems and interpret results in a variety of contexts. Most questions require the aid of electronic technology. Correct use of notation and terminology are required. | 1, 2, 4 | 1, 2, 3, 4 | Supervised written assessment.  One A4 page of handwritten notes permitted.  **Total time: 50 minutes** |
| **Topic Five: Investments and Loans**  Mathematical knowledge and skills based upon the key questions and key concepts from all subtopics are assessed. Students require access to technology to solve a range of financial calculations on investments using both simple and compound interest. Problems will be set in context and opportunities for interpretation of the mathematical results will be provided throughout the test. Correct use of notation and terminology are required. | 1, 2, 4 | 1, 3 | Supervised written assessment.  One A4 page of handwritten notes permitted.  **Total time: 50 minutes** |
| **Folio**  **Weighting 40%** | **Topics One and Two: Scales, Plans, and Models and Measurement**  In this folio task students utilise skills that they have developed in Subtopics 1.2, 2.1 and 2.2. They design and cost a cubby house for a backyard. Students first design and draw scale diagrams. From these they calculate the materials needed. They will then cost the construction. Students are required to consider the reasonableness of their results by examining the underlying assumptions and limitations of their mathematical model. | 2, 3 | 1, 2, 3, 5 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 8 A4 pages.**  Appropriate format as described in the Stage 2 Essential Mathematics subject outline. |
| **Topic Four: Statistics**  In this task students are required to use their knowledge of the key content from subtopics of 4.1 to 4.3 to explore the connection between kilometres travelled and the selling price of a specific brand/model of car. Students’ use a sampling technique to select a sample of data for car prices and the distance travelled for two different brands/models of car. The data should be collected from a variety of sources including internet advertisements and/or newspapers etc. They analyse the data collected on the selling price of the cars and the respective distance they have travelled, and determine if there is a causal link between distance travelled and the selling price of each model/brand of car using correlation techniques. Students consider if one brand/model holds its value better than the other investigated. They discuss the reasonableness of their results by examining the limitations of their mathematical model. | 1, 2, 3, 4 | 1, 2, 3, 4, 5 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 8 single-sided A4 pages.**  Appropriate format as described in the Stage 2 Essential Mathematics subject outline. |
| **Topic Five: Investments and Loans**  In this task students investigate home loan options considering charges on loan accounts and comparison rates. After choosing a bank loan they investigate how the interest paid for a particular loan amount for a home can be minimised. Investigations include reducing the term of the loan, making greater payments, making a lump sum payment and increasing the frequency of payments and possibly combinations of these. They also consider the full cost of the loan for each of the interest minimisation methods considered, and consider the reasonableness of their results, and discuss any limitations to their mathematical model. | 1, 3 | 1, 2, 3, 4, 5 | 3 weeks to complete. Some class time is allowed to support verification.  **Maximum of 8 single-sided A4 pages.**  Appropriate format as described in the Stage 2 Essential Mathematics subject outline. |
| ***Examination***  ***Weighting 30%*** | *Students undertake a 2-hour external examination in which they answer questions on the following three topics:*  *Topic 2: Measurement Topic 4: Statistics Topic 5: Investment and Loans*  *The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.* | *All the specific features of the assessment design criteria may be assessed in the external examination.* | | *2-hour external examination*  *Access to electronic technology required.*  *Students may refer to one unfolded A4 sheet (two sides) of hand-written notes.* |

***Eight assessments.*** *Please refer to the Stage 2 Essential Mathematics subject outline.*

**Stage 2 Essential Mathematics**

**Assessment Type 1: Skills and Applications Tasks**

**Topic 1: Scales, Plans, and Models**

**Purpose**

To demonstrate your ability to:

* understand mathematical concepts and relationships from within Topic 1: Scales, Plans, and Models
* select and apply mathematical techniques and algorithms to find solutions to problems
* interpret results, draw conclusions, and consider the reasonableness of solutions in context
* communicate mathematically and present mathematical information.

**Assessment conditions**

This is a supervised assessment.

NO CALCULATOR, ELECTRONIC TECHNOLOGY or NOTES are to be used.

Provide complete working for all calculations.

This task is of 40 minutes duration.

**Assessment Design Criteria**

**Concepts and Techniques**

CT 1 Knowledge and understanding of concepts and relationships.

CT 2 Selection and application of mathematical techniques and algorithms to find solutions to problems in a variety of contexts.

**Reasoning and Communication**

RC 1 Interpretation of mathematical results.

RC 2 Drawing conclusions from mathematical results with an understanding of their reasonableness and limitations.

RC 3 Use of appropriate notations, representations, and terminology.

RC 4 Communication of mathematical ideas and reasoning to develop logical arguments.

**Stage 2 Essential Mathematics**

**Assessment Type 1: Skills and Applications Tasks**

**Topic 1: Scales, Plans, and Models**

**Total [ /36]**

Answer all questions in the spaces provided, showing all calculations.

NO CALCULATOR, ELECTRONIC TECHNOLOGY or NOTES are to be used.

**QUESTION 1**

Consider the shapes below:

A B C D

1. Is shape C a rhombus, parallelogram, ellipse or none of these? Give a reason for your choice. [ /2]

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1. Which shape is a trapezium? [ /1]
2. Shape D is the cross section of which 3D solid? [ /1]
3. Name shape B if all of the sides are the same length.

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1. Explain the difference between a prism and a pyramid. [ /2]

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**QUESTION 2**

Go-Green Gardens sells parts for frames that vines can be grown over to provide shelter in summer. The frame’s ends form a regular hexagon and the overall frame forms a prism once constructed. All sections of the frame are metal tubing, each section being 2.5m long. The metal tubing sections are joined with connectors which are purchased separately.

1. Sketch a perspective diagram of the frame that will be constructed from the information provided.

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[ /4]

1. Each connector allows three pieces of frame to be connected together forming the vertices of the prism. How many connectors will need to be purchased? [ /1]
2. The ends are regular hexagons. What shape are all other faces? [ /1]
3. If the metal tubing for a complete frame costs $81, how much would it cost to replace one damaged edge? Justify. [ /3]

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1. You decide instead of growing vines over the frame that you will cover the top and sides with shade cloth, and purchase a water-proof lining for the base. You need to make a pattern to work out how much shade cloth and water-proof lining to buy. Construct a scale drawing of the net you’d apply as a pattern. Use a scale of 1:50. [ /5]

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**QUESTION 3**

City **B** is due east of city **A**. The mine **M** is north of both cities as shown on the scale diagram below.

The scale is 1cm = 50km.

**M**

**•**

**A** **B**

1. Use the scale diagram to show the bearing from the mine **M** to city **A** is approximately 210oT.

[ /1]

1. Town **C**, the site of the mine worker’s camp, is 50km **south east** of the mine. Locate town **C** on the scale diagram above.

[ /1]

1. An emergency happens at the mine workers’ camp. Using the scale diagram, determine which city, **A** or **B**, is located closest to the mine workers’ camp to send its rescue helicopter? Show any working out below. [ /3]

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1. What factors affect the reasonableness of your results in b) and c)? [ /2]

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1. What bearing will the helicopter fly to reach the injured/sick worker at the mine workers’ camp? Show construction lines on the scale diagram. [ /2]

Bearing: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Show the possible lines of flight of the helicopter if the pilot’s bearing has a ±5o error.

[ /2]

1. Approximately how far away from the mine will the helicopter be when it is either directly east or west of the mine workers’ camp, if it is flying along the possible lines of flight in   
   part (f)? Is the distance the same both to the East and to the West? [ /3]

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**STAGE 2 ESSENTIAL MATHEMATICS**

**ASSESSMENT TYPE 2: FOLIO**

**Topic 3: Business Applications**

http://www.stockfreeimages.com/Biscuits-thumb13892113.jpg

**Break-even Analysis**

**Introduction**

In this task you are to investigate the costs involved in making a product that could be sold at a country market or other market-style location. You investigate the costs involved in making the product, carry out a break-even analysis and investigate the number of the product that you need to sell to reach varying levels of profit.

Assume that you will make and sell the product for a full year. Some examples of the type of products to consider are:

* making and selling biscuits using a favourite family recipe
* making a simple item for a house or garden (e.g. a craft item or novelty garden item)
* making a pet product (e.g. a cat scratching pole)
* making a particular kind of gift basket.

**Note:** Pinterest or similar websites are a great place to find ideas for products that can be made.

You carry out the mathematical investigations described in parts 1 to 9 on the following page, and then prepare a response which, excluding bibliography and appendices if used, must be a maximum of 8 single-sided A4 pages if written, or the equivalent in multimodal form.

The folio task response may take a variety of forms, but should include the following:

* an outline of the problem to be explored
* the method used to find a solution
* the application of the mathematics, including, for example:
* generation or collection of relevant data and/or information, with a summary of the process of collection
* 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.

http://www.stockfreeimages.com/17717871/Colorful-bird-houses-under-the-roof.html

**Mathematical Investigations**

1. Carry out some basic research and decide on the product that you will investigate making.

2. Create a list of all of the components needed to make your product (e.g. ingredients or products required for construction such as wood, nails, glue, etc.) and investigate their costs. Use this information to determine the **Variable Cost** for the product you are selling.

**Note:** If you are making a product in which you will sell a number of the item at a time (e.g. making and selling biscuits in packets of four), the variable cost will need to cover the cost of making the number of items sold in the one product (e.g. one packet of four biscuits).

3. Decide on a **Selling Price** for your product. **Predict** how many you would need to sell at this price to break-even.

4. List the fixed costs that are likely to contribute to the costs of producing your chosen product (e.g. electricity if baking or using power tools, purchase of equipment needed for making the items etc.) and determine a reasonable **Fixed Cost** for a whole year.

5. Determine the number of your product you will need to sell over the year to break even using the figures that you have determined in parts 2 to 4.

6. Discuss the reasonableness of the answer that you calculated in part 5. Consider:

* how close your prediction in part 3 was to the calculated break-even number
* the number of your product that you will need to make and sell each week or month
* the assumptions you made when calculating the variable and fixed costs
* limitations of the model that you are using.

7. Now, considering the variable costs from above, **make a prediction** about how many of your product you would need to sell to make a profit in each of the following categories. Specify the profit you will make for each category, and how many you think you will need to sell to make that profit. Do not carry out break-even calculations.

a) Between $100 and $500 profit

b) Between $1 000 and $5 000 profit

c) Over $10 000 profit.

Describe how you made these predictions. How accurate do you think your predictions are?

8. Use calculations to determine the actual number of your product that needs to be sold to make the profits of your choice in each category above. How close were your predictions?

9. Next, calculate the profit or loss made when considering changes to the original scenario. For each scenario you investigate, describe the change that you are making in a real life context. In each of these investigations the number of your product that you sell will remain the same. Choose the number that you will sell from those you calculated in part 8.

You should investigate:

* varying the selling price of your product
* finding a cheaper way of making your product (buying items on special or in bulk so that the variable price decreases)
* the cost of one of your variable items increasing
* a combination of two or more of these changes.

10. In your conclusion, discuss the viability of making money from selling your product at markets.

**Stage 2 Essential Mathematics**

**Assessment Type 2 Folio – Topic 5: Investments and Loans**

**Buying a car**

**The Task**

You are to investigate the cost of buying your first car. The car that you choose to buy should cost at least $10 000. You will investigate two different ways of paying for the car:

1. saving the entire amount in a savings account
2. taking out a loan to purchase the car.

Assume that you have just started your first full time job.

You need to make some decisions and find some information to proceed with the task:

* Choose a realistic starting wage = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Choose a realistic amount to pay for a car = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Choose a length of time for the investment and loan. You will use this length of time as a starting point in both the investment and loan investigations.

Investment/Loan term = \_\_\_\_\_\_\_\_\_\_\_\_\_ years

Part 1: Saving to buy the car

You are to investigate saving to buy your car. You should consider several different investment types, and work out how much you have had to invest to reach the full cost of the car. You could consider:

* Making a deposit of a sum into a term deposit
* Making regular payments into a savings account
* Making regular payments into an account into which you were able to make a significant initial deposit (e.g. 20% of the value of the car).

Part 2: Taking out a loan to buy the car

i) Investigate unsecured loans and select one for your loan investigations. State its interest rate and calculate:

* your minimum periodic payment
* how much the loan will cost you in total, and how much interest you have paid.

ii) Now investigate mathematically some strategies to minimise the interest you pay. You could consider investigating:

* making more frequent payments
* paying extra per period
* other (perhaps a combination of two strategies).

For each strategy you investigate calculate how much the loan will cost you in total, and how much interest you have paid.

Part 3: Discussion and conclusion

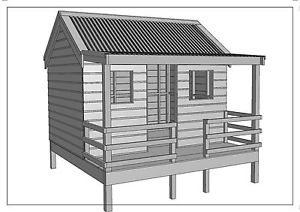
Discuss your results, and in particular consider what is good and what is bad about each method you have investigated. You should include discussion of any assumptions you had to make in carrying out your investigations, and also discuss how reasonable you think they are as a method of buying a car.

**The Response**

Carry out the mathematical investigations described in parts 1 and 2 and then prepare a response which, excluding bibliography and appendices if used, must be a maximum of 8 single-sided A4 pages if written, or the equivalent in multimodal form.

The folio task response may take a variety of forms, but should include the following:

* an outline of the problem to be explored
* the method used to find a solution
* the application of the mathematics, including, for example:
* generation or collection of relevant data and/or information, with a summary of the process of collection
* 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.

**Stage 2 Essential Mathematics**

**Assessment Type 2: Folio**

**Topic 1: Scales, Plans, and Models, and Topic 2: Measurement – Cubby House**

**The Task**

Your task is to design and cost a cubby house for a family backyard.

Your cubby house design needs to take into consideration the following guidelines:

* the area available in the yard for the cubby house is 5m x 3m
* the cubby house needs to be painted with more than one colour
* the family would like to have a door that can be opened and closed
* the family have a maximum budget of $2000 to spend on the cubby house
* the family have an additional $2000 to spend on sturdy equipment such as a slippery dip and rock climbing fittings or netting for a climbing wall.

The complexity of your design will determine the complexity of the calculations you need to carry out. Using only simple shapes like squares and rectangles may lead to calculations that are routine in nature.

To ensure that you have calculations that are complex in nature you should consider including in your design one or more of the following:

* composite shapes for doors or windows (e.g. a window that is formed from a rectangular pane with an isosceles triangle pane at the top)
* a pitched roof
* an fence for safety that has varying heights if the cubby is built off the ground.

The following link may be useful in explaining the basics of building a cubby house:

http://www.bunnings.co.nz/diy-advice/outdoor/outdoor-living/how-to-build-a-cubby-house

**Part 1 – The Design**

Create a design following the guidelines above. Draw sketches of your cubby house, including individual representations of the front, back, sides and the floor plan (the view of the cubby house from above). Include the relevant measurements and indicate what paint colour will be used to paint each main surface. Also indicate where the sturdy equipment (such as a slippery dip) will be attached.

**Note:** no calculations are needed at this point. This initial design will be placed in your appendix.

*Have your design approved by your teacher before you proceed with the investigation.*

**Part 2 – Materials needed to build the cubby house**

Investigate what materials you would like to use for the cubby house and the associated dimensions and the costs for each product that you are considering e.g. timber posts, treated pine, nails, hinges for doors and or windows, fast set concrete, paint, exterior board, iron sheeting. Place all of this information into the appendix.

**Part 3 – Sturdy equipment to be built onto the cubby house**

Investigate what sturdy equipment you would like to purchase for the cubby house and the costs for each product that you are considering. Place all of this information into the appendix.

**Part 4 – Scaled plan**

Draw scaled plans of the front and back views, side views, and floor plan of the cubby house.

**Part 5 – Make a prediction about the cost of your cubby house**

Use the information in Parts 2 and 4 to make a rough estimate of the cost of building the cubby house you have designed. Make a prediction about whether $2000 will be enough. Do not carry out extensive or accurate calculations at this point of time.

**Part 6 – Mathematical calculations for the materials you need to purchase**

Using the information in Parts 2 and 4, work out the amount of each material needed to build your cubby house. Clearly show all working out, including formulas used and appropriate measurement units. You should consider things such as:

* the volume of cement needed to concrete all the support poles into the ground
* the length of all different types of wood that needs to be bought for building the frame
* the area of wall cladding material that needs to be purchased
* the cost of fixtures such as doors and windows
* the amount of paint required to paint each of the surfaces
* the area of the roofing material needed.

**Part 7 – Calculating cost**

Use the calculations in Part 6 and the costs you have already collected in Part 2 to determine an accurate cost for the materials required to build and paint your cubby house design. Make sure you allow for error margins when costing materials. Discuss how close your prediction in Part 5 was to the cost calculated here.

**Part 8 – Discussion of the results and conclusion**

Discuss the outcome of your mathematical investigations, including any assumptions you have made, and things which may affect the accuracy of your calculations. If you went over (or spent less than) the $2 000 budget allowed for building the cubby house, how might you deal with this (consider where you could save or spend more money on the build or consider changes to the budget for the sturdy equipment).

**The report**

The response must be a maximum of **8 single-sided A4 pages** if written, or the equivalent in multimodal form. This excludes appendices and a bibliography if used.

**Introduction**

Read the whole task and write an introduction that outlines what you will be doing in this task in your own words. Explain what you are planning on constructing.

**Planning**

Complete Parts 1, 2 and 3, and place in the appendix.

**Mathematical Investigations**

Complete Parts 4 through to 7.

All products used in making the cubby house should be clearly identified on your scale diagrams and costed appropriately. The **location** of each piece of **sturdy equipment** on the cubby house needs to be clearly identified on the scale diagram. You do not need to include scale diagrams of the sturdy equipment.

**Discussion**

Discuss things such as

* any assumptions you made when designing the cubby house
* the overall cost of the cubby house
* things that could affect the accuracy of the calculations.

**Conclusion**

Summarise how you went with the budget of $2000 and if you went over how you would manage this within your overall budget?

**Appendix**

Include evidence of your costings and original design.

**Stage 2 Essential Mathematics**

**Assessment Type 2: Folio**

**Topic 4: Statistics – Is it a good buy?**

**The Task**

You wish to purchase a used car. You want to use your maths knowledge to investigate if there is a connection between the number of kilometres that a car has travelled and its selling price, and determine if one brand of car appears to hold its value better than another.

**Part 1: Population of cars**

Choose two different brands/models of cars, and the year of manufacture that you wish to investigate. Using car sale websites (such as [www.carsales.com.au](http://www.carsales.com.au) ) or newspapers or other sources, collect data for the second hand cars for sale for the two brands/models you have chosen. When collecting your data, make sure that the population is large enough that you can choose an appropriate sample. Also make sure that you keep the two sets of data separate.

From these two populations of cars choose **the one** that you would like to purchase. Looking at the data that you have collected – **predict** if this car that you would like to purchase has a good price when considering the number of kilometres that it has travelled.

**Part 2: Getting a sample**

Explain what sampling technique you will use (Stratified, Simple random or Systematic) and take an appropriate sized sample from the two populations. These samples will now be used for all further calculations.

A copy of both populations should be placed in the appendix.

**Part 3: Linear correlation**

For the two models of car for which you have collected data, investigate if there is a correlation between the kilometres travelled by the vehicles and the selling price.

In your mathematical investigations you may choose to consider:

* + effect of sample size used
  + outliers and their effect on the result
  + using the least squares regression line to make predictions.

**Part 4: Analysis/Discussion**

Critically analyse your results for the two models of car that you have investigated. You should consider:

* + is there a strong enough relationship for your sets of data for you to be able to make predictions
  + the appropriateness of the size of the samples used
  + the validity of any selling price predictions made using the least squares regression line you have determined for each car model
  + any assumptions and limitations of the investigation.

**Part 5: Was your prediction about the car you chose correct?**

Does the correlation that you determined for the model of the car you wished to purchase confirm your prediction about it being a good buy when considering the number of kilometres it has travelled?

**The Response**

**Introduction**

Read the whole task and write an introduction that outlines the task in your own words. Include what car you would like to purchase.

**Mathematical Investigations**

Complete Parts 2 and 3 and include your mathematical investigations in your response. If you cannot fit all of your correlation investigations in the main body of the response, consider including them in your appendices. Make sure that you refer to the results of any correlation investigations that are included in the appendices in the main body of your response, and include discussion of what each extra investigation shows.

**Discussion and conclusion**

Complete Parts 4 and 5.

**Appendix**

Include evidence such as:

* population of cars.

**The response must be a maximum of 8 single-sided A4 pages if written, or the equivalent in multimodal form. This excludes the bibliography and appendices if used.**

Stage 2 General Mathematics

Open Topic 6: Applied Geometry

This topic will replace Topic 2: Modelling with Matrices.

Geometry is everywhere — in the structure of the natural environment, in the way people navigate and communicate, in what they construct, and in their artistic and sporting endeavours.

This topic should be approached by posing problems, preferably with an encompassing theme or context. The most common areas of application are navigation, building construction, surveying, and manufacture and design. There may be others, however, that would provide a suitable medium through which to learn this topic. The problems chosen should allow for a practical approach in which the solutions found by students can be tested or verified by an alternative method.

Once a problem has been posed, students consider what needs to be measured to provide data for the geometric model they will use in its solution. Implicit in this process is the consideration of which implement will best do the job and what limitations there will be to the accuracy of the measurement it gives.

The geometric models that students apply to the solution of the problems posed require skills in solving triangles of all types, as well as the calculation of length, area, and volume for a variety of two-dimensional and three-dimensional shapes. Students quantify the level of error implicit in their answers, and interpret the appropriateness of these answers in the original context of the problem.

Subtopic 6.1: Right and Non-right Triangle Geometry

| Key Questions and Key Concepts | Considerations for Developing Teaching and Learning Strategies |
| --- | --- |
| What mathematics is needed in calculations from measurement? | Finding solutions to the problems posed in the scenarios at the beginning of the topic is the driving force for learning the techniques in this subtopic. |
| Review of right-angled triangle geometry   * Pythagoras’ theorem * Sine, cosine, and tangent | Right-angled triangles are most commonly encountered in construction problems such as roof designs and trusses and the tree protector. Problems are presented in 2D and 3D contexts and with practical activities where appropriate. |
| Non-right-angled trigonometry   * Sine rule * Cosine rule | Triangles that are not right-angled occur somewhere in most of the problems. |

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| Solving problems involving direction and bearings | Students understand bearings and how to interpret them so that practical problems involving navigation and angles of elevation and depression can be solved by applying trigonometry. |
| What are the effects of absolute and relative errors?   * Discussion of accuracy of measurements * Calculation of absolute and relative errors * Effect of errors on the calculations | Students calculate the tolerance of their result with either an absolute error or a relative error (i.e. ) and discuss the implications of errors. The effect of a small error in an angle measurement is magnified by distance (as in search-and-rescue problems). Students consider the reliability of their answers in the context of the problem. |

| **Subtopic 6.2: Area and Volume** | |
| --- | --- |
| Key Questions and Key Concepts | Considerations for Developing Teaching and Learning Strategies |
| Area and volume   * Area of compound shapes * Volume of compound solids * Area of irregular shapes using * Simpson’s rule * an approximation using simple mathematical shapes (e.g. circles, rectangles, triangles) * Volume of irregular solids | Students calculate areas and volumes of plane shapes. The focus is on solving practical problems set in familiar contexts, with increasing complexity of the shapes involved. The problems involving tendering and finding the capacity of a dam or lake require students to find the area and/or volume of irregular shapes or solids. The problems involving a beach umbrella, a tree protector, roof designs, the search area for a ship, and a layout of a car park or playground require students to find areas of simpler shapes. The dam problems provide the most challenging calculations of volume; however, the volume of materials such as grass clippings for compost and pine bark for a playground also needs to be worked out.  The area of irregular shapes like kidney-shaped garden beds or golfing greens can be calculated by finding an average radius and then applying, where *r* is the average radius. The average radius can be calculated by selecting a central point and measuring to the edge of the shape at 10° intervals. The sum of the measurements is then divided by the number of measurements.  Calculations of the area of irregular shapes could also be done using Pick’s rule or the Monte Carlo method. |
| What are the effects of absolute and relative errors?   * Discussion of accuracy of measurements * Calculation of absolute and relative errors * Effect of errors on the calculations | Students calculate the tolerance of their result with either an absolute error or a relative error (i.e. ) and discuss the implications of errors. |

**Stage 2 Essential Mathematics**

**Exemplar Open Topic 6: Optimisation**

**This topic may replace Topic 1: Scales, Plans, and Models, or Topic 3: Business Applications**

The focus of this topic is on the many aspects of everyday life and business management where efficiency and the finding of optimal strategies are significant considerations. The decisions that individuals and organisations make are often driven by determining the shortest, cheapest, most profitable etc. ways of completing a task.

In this topic students study a range of network problems, which can be represented by graphical means as a network. Algorithms are developed that enable them to find the number of paths, shortest or longest path, and minimum connection or maximum flow in a network.

Students are encouraged to investigate the effects of changing the initial parameters of problems with a view to improving the solutions. For instance, in a critical path analysis, which jobs could be shortened to improve the minimum completion time? In a problem of maximum flow, which connections could be added or upgraded to improve the flow?

The arithmetic computations required for the solution of the problems presented in this topic can be conducted without electronic technology.

**Subtopic 6.1: Networks**

| **Key Questions and Key Concepts** | **Considerations for Developing Teaching and Learning Strategies** |
| --- | --- |
| What are networks and what information do they provide?   * Reading information from a network diagram | Students examine network diagrams drawn from a variety of contexts. They interpret information presented in both weighted and directed network diagrams and answer specific questions about contextual situations. Networks to be considered could include the distance between nodes, time of travel, direction of travel, capacity of an arc. |
| * Using appropriate terminology | The correct terminology is taught where it is relevant to the problems studied (e.g. arcs, nodes, directed and undirected networks, trees, circuits) to enable consistent and concise communication in the discussion of networks and network problems. |
| How can networks be used to represent situations in which there is a problem to be solved?   * Connectivity networks * Flow networks | Students are assisted to see how the information in problems can be represented in network form.  For example:  We have to drive between two given places. Which is the best way to go? Why?  The local council is planning road upgrades because a lot of traffic passes through our area on its way to somewhere else. Which are the best roads to upgrade, and why?  Students have asked for drinking fountains to be installed in specific locations at the school. What is the best way to connect them all to the rainwater supply? |
| How many paths are there through a directed network?   * With and without restrictions | By beginning with using trial and error to find the number of paths through a directed network, students appreciate the efficiency of using the algorithm. The problems are extended to include restrictions. For example, avoiding a node or an arc (e.g. because of an accident or a burst water main) or having to use a specified node or arc (e.g. because someone has to be picked up on the way). |
| What is the shortest or longest path through a network?   * With and without restrictions | Students consider weighted networks where each arc incurs a ‘cost’ or ‘profit’. They explore the idea of an optimal or shortest path which uses the least cost or gains the most profit (with and without restrictions) and apply the algorithm for finding it. They interpret the meaning and understand the limitations of the answers gained using this kind of simplified mathematical model. |
| What is the cheapest way to connect up a set of points if there is more than one option available?   * Minimum spanning tree problems | Explore the idea of a tree being a connected network with no circuits (i.e. no redundancy).  Students explore both scaled and unscaled representations of minimum spanning tree problems when seeking a solution. More than one algorithm is available and students consider which might be best in a given situation.  Extensions to these problems take practical considerations into account. For instance:   * What if a connection cannot be made in a straight line? * What happens to the best solution if extra nodes are connected to the system later? * Is the optimal solution practical if there are limitations on how far any node in the network can be from a source node? |
| What is the maximum flow that can be achieved through a network of conduits?  Use of an algorithm to find maximum flow | The flow considered could be freight, people, water, telephone calls, Internet connections, or traffic.  The algorithm using the exhaustion of paths is easier than the Dedekind ‘cuts’ method for all but the simplest networks. The cuts method is, however, useful when considering upgrades to a system of flow. Extensions of these problems would deal mainly with upgrading a system by either creating a new connection or improving an existing one. |

**Subtopic 6.2: Critical Path Analysis**

| **Key Questions and Key Concepts** | **Considerations for Developing Teaching and Learning Strategies** |
| --- | --- |
| If a job requires the completion of a series of tasks with set precedence, what is the minimum time in which this job can be finished? | Students become acquainted with the idea of precedence in the flow of jobs that make up a complex task. Through a practical example, they explore how to create a precedence table that indicates which other jobs must be completed before a given job can start. |
| Precedence tables  Drawing networks | From a precedence table, a network can be drawn to represent the task. For straightforward networks this can be done by trial and error; however, students may benefit from being taught how to use a bipartite graph to work out the order in which to construct the nodes. |
| Dummy links | It is sometimes necessary to use ‘dummy’ arcs in the network to show a given precedence correctly (e.g. when job *E* requires both *A* and *B* to be complete but job *C* requires only *B* to be complete). Students gain an understanding that two different-looking networks may be topologically identical. |
| For which of the tasks is it critical that there is no delay?   * Forward and backward scan * Minimum completion time * Critical path * Earliest and latest starting times for individual tasks * Slack time | Once a network representation is available for a problem, students can determine the minimum completion time and critical jobs by finding the longest path through the network. They discuss the amount of leeway available in the starting time for a given job in the network, and what happens if time for a specific job is shortened or lengthened. They look for ways of reducing the minimum completion time in the context of a specific problem. Students discuss the reasonableness of their results and any limitations to the model in the context of the problem. |

**Stage 2 General Mathematics**

**Assessment Type 3: Examination (from 2017)**

*(See subject outline: General Mathematics page 32)*

Students undertake a 2-hour external examination in which they answer questions on the following three topics:

Topic 3: Statistical Models

Topic 4: Financial Models

Topic 5: Discrete Models.

The examination is based on the key questions and key concepts in Topics 3, 4, and 5. The considerations for developing teaching and learning strategies are provided as a guide only, although applications described under this heading may provide contexts for examination questions.

The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representations throughout the examination.

Students may take one unfolded A4 sheet (two sides) of handwritten notes into the examination room.

Students may use approved electronic technology during the external examination. However, students need to be discerning in their use of electronic technology to find solutions to questions/problems in examinations.

The SACE Board will provide a list of approved graphics calculators that meet the following criteria: … (*see further information in the draft subject outline*)

Graphics calculators that currently meet these criteria are as follows:

*Casio fx-9860G AU*

*Casio fx-9860G AU Plus*

*Casio fx-CG20AU*

*Hewlett Packard HP 39GS*

*Sharp EL-9900*

*Texas Instruments TI-83 Plus*

*Texas Instruments TI-84 Plus*

*Texas Instruments — TI 84 Plus C — Silver Edition*

*Texas Instruments — TI 84 Plus CE.*

**Stage 2 Sample Examinations (from 2017)**

The purpose of these sample examinations is to provide an opportunity for teachers to familiarise themselves with the structure of the examination and the style and depth of questions to be expected.

**Stage 2 Essential Mathematics**

**Assessment Type 3: Examination (from 2017)**

*(See subject outline: Essential Mathematics page 39)*

Students undertake a 2-hour external examination in which they answer questions on the following three topics:

Topic 2: Measurement

Topic 4: Statistics

Topic 5: Investment and Loans.

The examination is based on the key questions and key concepts in topics 2, 4, and 5. The considerations for developing teaching and learning strategies are provided as a guide only, although applications described under this heading may provide contexts for examination questions.

The examination consists of a range of problems, some focusing on knowledge, routine skills, and applications, and others focusing on analysis and interpretation. Students provide explanations and arguments, and use correct mathematical notation, terminology, and representation throughout the examination.

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