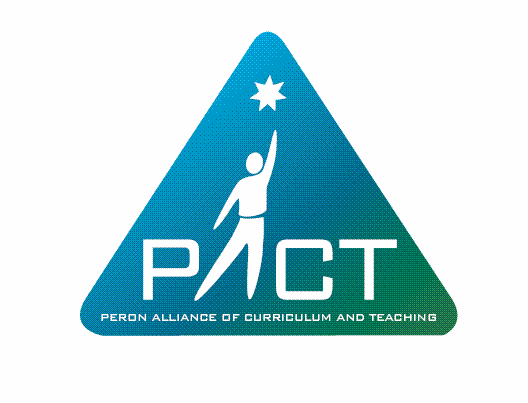
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| Baldivis logo cropped | **Mathematics Applications Unit 3 & 4 Year 12**  **Investigation 2, 2019**  **Topic – Networks Investigation** | | | |  |
| **Equipment:** | *SCSA Formula sheets, CAS calculator* | | | | |
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| **Date out:** | | *Week \_\_\_\_ Date \_\_\_\_\_\_\_\_* | **Date Due:** | *Week \_\_\_\_ Date \_\_\_\_\_\_\_\_* | |
| **Task Weighting:** | | *5% of the year* |  |  | |
| **Important Information:**  In this topic (Graphs and Networks) you have studied ways of constructing different types of networks to model practical situations. For this investigation you are required to decide on a tour around local places of interest. Your mathematical investigation will be recorded in a report, the suggested format of which is on page 3. | | | | | |

**Chinese postman problem:**

This problem involves minimising the total distance walked by a postman delivering mail. The postman must begin and end his journey at one vertex of the network and must visit each edge of the network at least once.

It is based on **Euler’s** findings of **travesable** graphs.

Remember that a traversable graph is one that can be drawn without taking a pen from the paper and without retracing an edge.

In graph theory you are trying to find an **Eulerian Trail** if one exists.

**Travelling salesman problem:**

This problem involves minimising the total distance travelled by a salesman to visit a range of different places. The salesman must begin and end his journey at one vertex within the network and must visit each vertex at least once.

Ideally, you want to find a **Hamiltonian Cycle** (where each vertex is visited exactly once, starting and finishing at the same vertex) of minimum weight.

**No one has yet found an algorithm to solve this problem!**

The only way to minimise the tour is to find all of them and pick the shortest, which in most cases is not practical as there are too many possibilities.

**Part 1: The Problem**

You are the Australian Parcel Post co-ordinator for Port Hedland. It is leading up to one of the busiest times of the year with Easter approaching as many people increase their online shopping particularly chocolate products. The courier assigned to deliveries in Port Hedland requires an efficient route starting at Port Hedland International Airport at 6:00AM without doubling back during deliveries. The area of delivery includes:

* Port Hedland Central Business District
* Port Hedland township which also includes Cooke Point and Pretty Pool

As it is a busy period, an additional flight is arriving to Port Hedland at 13:00 bringing additional freight. The courier must be back in time to collect and sort this additional freight ready for delivery the following day.

In addition to the delivery of parcels to residential properties and businesses in Port Hedland, the courier must also:

* Collect mail from the Port Hedland LPO, (Licensed Post Office), that needs to be placed on the additional afternoon flight that will be leaving at 14:00. This mail needs to be at the airport by 12:30. The mail is cleared from the Port Hedland mail box at 11:00 by Australia Post staff.
* Deliver overnight freight to BHP Nelson Point first before any other delivery is made.

You need to create a hard copy of the delivery route for this day that includes going past all buildings as it is not possible to predict when a resident or business will receive freight. Include clear instructions with directions of how this route will progress as well as distances between major ladmarks.

**Part 2: Solve the basic problem**

Create the network diagram from the basic information you have collected and solve the problem(s) you have posed.

**Part 3: Tropical Cyclone Wallace**

Tropical Cyclone Wallace passes nearby Port Hedland and causes severe flooding to Wilson Street between Coolinda Street and Wedge Street. There is also flooding to Sutherland Street from the Port Hedland Yacht Club through to St Cecilia’s Catholic Primary School.

It has been decided that the affected people from residential and business properties will need to collect their parcels from Port Hedland LPO. The remaining properties will still have their freight delivered.

What will the new route need to be while flooding subsides?

**Part 4: Conclusion**

Analyse and compare your results from Part 2 and 3, including the reasonableness of your prediction. Your discussion should include consideration of the effects of simplifying assumptions and the limitations on the practicality and reliability of your solution.

**Writing up your work**

* Provide an outline of the problem to be explored
* Explain how you identified and found the appropriate data
* Explain the method you used to find a solution
* Explain the application of the mathematics involved, including:
  + Generation or collection of relevant data and information, with a summary of the process of collection
  + Mathematical calculations and results, with appropriate representations
  + Discussion and interpretation of results, including consideration of the reasonableness of your results.
* Draw conclusions and summarise your findings
* A bibliography and appendices if appropriate

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

The report should be a maximum of six pages, including diagrams, if written or the equivalent in multimodal form.

SCSA Grade descriptions have been provided to give you information on what to include in your report in order to maximise your achievement.

### Topic 3.3: Graphs and networks (20 hours)

**The definition of a graph and associated terminology**

3.3.1 demonstrate the meanings of, and use, the terms: graph, edge, vertex, loop, degree of a vertex, subgraph, simple graph, complete graph, bipartite graph, directed graph (digraph), arc, weighted graph, and network

3.3.2 identify practical situations that can be represented by a network, and construct such networks

3.3.3 construct an adjacency matrix from a given graph or digraph and use the matrix to solve associated problems

**Planar graphs**

* + 1. demonstrate the meanings of, and use, the terms: planar graph and face

3.3.5 apply Euler’s formula, to solve problems relating to planar graphs

**Paths and cycles**

3.3.6 demonstrate the meanings of, and use, the terms: walk, trail, path, closed walk, closed trail, cycle, connected graph, and bridge

3.3.7 investigate and solve practical problems to determine the shortest path between two vertices in a weighted graph (by trial-and-error methods only)

3.3.8 demonstrate the meanings of, and use, the terms: Eulerian graph, Eulerian trail, semi-Eulerian graph, semi-Eulerian trail and the conditions for their existence, and use these concepts to investigate and solve practical problems

3.3.9 demonstrate the meanings of, and use, the terms: Hamiltonian graph and semi-Hamiltonian graph, and use these concepts to investigate and solve practical problems

**SCSA Grade Descriptors**

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| **A** | **Identifies and organises relevant information**  Identifies and organises relevant information for complex problems involving a series of steps or processes.  Defines variables from text to draw networks and diagrams.  Organises data in a concise, clear format and appropriately presents it in tabular, diagrammatic and/or graphical form.  Identifies the underlying assumptions related to the relevant mathematics of an investigation. |
| **Chooses effective models and methods and carries through the methods correctly**  Accurately applies mathematical knowledge and understanding to solve unstructured problems using sub-problems.  Generalises and extends models from previous parts of the question.  Translates between representations in unpractised ways.  Selects appropriate calculator techniques to solve multi-step problems in unfamiliar contexts.  Selects and appropriately uses numerical, graphical, symbolic and statistical methods to develop mathematical ideas.  Produces results, carries out analysis and generalises in situations requiring investigative techniques. |
| **Follows mathematical conventions and attends to accuracy**  Follows mathematical conventions and attends to accuracy in non-routine situations.  Provides concise and accurate solutions to mathematical problems set in applied and theoretical contexts.  Selects, extends and applies mathematical and/or statistical procedures to investigate a problem. |
| **Links mathematical results to data and contexts to reach reasonable conclusions**  Recognises implied conditions in real-life applications and defines and explains the limitations of models.  Interprets the result and draws the correct conclusion about the effect of changing conditions.  Considers the strengths and limitations of an investigation and refines the results to make sensible conclusions. |
| **Communicates mathematical reasoning, results and conclusions**  Sets out the steps of the solution in a clear and logical sequence, including suitable justification and explanation of methods and processes used.  Adds a detailed diagram to illustrate and use in the solution of a problem.  Presents work with the final answer clearly identified, using the correct units and relating to the context of the question.  Communicates investigation findings with a comprehensive interpretation of mathematical results in the context of the investigation. |

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| **B** | **Identifies and organises relevant information**  Identifies and organises relevant information for problems involving a few steps or processes.  Draws a network or diagram and labels with appropriate variables.  Organises data clearly and appropriately presents it in tabular, diagrammatic and/or graphical form.  Identifies suitable variables and constant parameters related to various aspects of an investigation. |
| **Chooses effective models and methods and carries through the methods correctly**  Selects an appropriate strategy and applies mathematical knowledge to solve problems that contain a few steps.  Translates between representations in practised ways.  Selects appropriate calculator techniques to solve multi-step problems.  Selects and appropriately uses numerical, graphical, symbolic and statistical methods to develop mathematical ideas.  Attempts to analyse and calculate specific cases of generalisation in situations requiring investigative techniques. |
| **Follows mathematical conventions and attends to accuracy**  Interprets and uses mathematical terminology, symbols and conventions in routine situations.  Rounds, unprompted, to suit context or correctly to specified accuracy.  Completes mostly accurate solutions to mathematical problems set in applied and theoretical contexts.  Selects and applies mathematical and/or statistical procedures previously learnt to investigate a problem. |
| **Links mathematical results to data and contexts to reach reasonable conclusions**  Identifies specified conditions in real-life applications, recognises and rejects inappropriate solutions.  Links the effect of changing conditions to the original solution.  Uses examples in mathematical analysis of an investigation and draws valid conclusions related to a given context. |
| **Communicates mathematical reasoning, results and conclusions**  Carries through calculations and simplifications in a clear sequence, showing a logical line of reasoning.  Defines variables associated with a given diagram and uses them in the working of a problem.  Presents work with the final answer clearly identified and using the correct units.  Communicates investigation findings in a systematic and concise way using mathematical language and relating the solution to the original problem or statement. |

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| **C** | **Identifies and organises relevant information**  Identifies and extracts key information needed to solve a familiar problem.  Identifies variables in a network or diagram.  Organises some data and presents it in tabular, diagrammatic and/or graphical form.  Identifies some mathematical content related to various aspects of an investigation in a given context. |
| **Chooses effective models and methods and carries through the methods correctly**  Selects a strategy and applies mathematical knowledge to answer structured questions that require short responses.  Recognises and uses information in different representations.  Uses familiar calculator applications to solve routine problems.  Selects appropriate numerical, graphical, symbolic and statistical methods to carry through a single thread of reasoning in situations requiring investigative techniques. |
| **Follows mathematical conventions and attends to accuracy**  Applies mathematical definitions, rules and procedures in practised situations.  Applies basic conventions for diagrams and graphs.  Rounds appropriately in a given context and to specified accuracy in short responses.  Generates some accurate and generally complete solutions to mathematical problems set in applied and theoretical contexts.  Selects and applies, with direction, mathematical and/or statistical procedures previously learnt to investigate a problem. |
| **Links mathematical results to data and contexts to reach reasonable conclusions**  Identifies specified conditions in real-life applications and recognises inappropriate solutions in routine problems.  Recognises that changing conditions will affect the outcome.  Makes inferences from analysis and uses these to draw conclusions related to an investigation. |
| **Communicates mathematical reasoning, results and conclusions**  Shows adequate working and supports answers with simple or routine statements.  Relates the working to a labelled diagram that has been given as part of the question.  Presents a solution but the final answer is not always clearly identified.  Communicates investigation findings in a systematic way using some mathematical expression and everyday language. |