



2011 MATHEMATICAL APPLICATIONS, Semester 1

FOR OFFICE USE ONLY

SUPERVISOR CHECK

RE-MARKED

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

Graphics calculator <input type="checkbox"/>
Brand _____
Model _____
Computer software <input type="checkbox"/>

Thursday 9 June: 9 a.m.

Time: 1½ hours

Pages: 10
Questions: 3

Topic 5: Optimisation

Examination material: two question booklets
two SACE registration number labels

Approved dictionaries, notes, calculators, and computer software may be used.

Instructions to Students

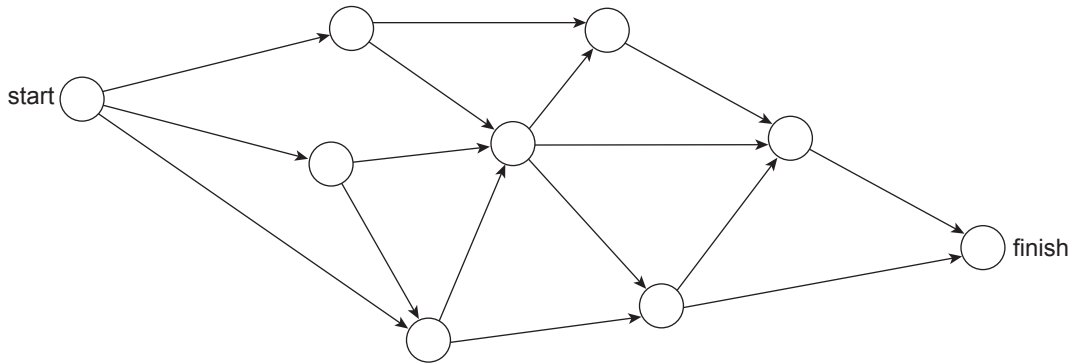
- You will have 10 minutes to read the question booklets. You must not write in your question booklets or use a calculator during this reading time but you may make notes on the scribbling paper provided.
- Each of the following five topics is printed in a separate question booklet. **Tick the boxes by the two topics you have studied in Semester 1:**
 - Topic 2: Investment and Loans
 - Topic 4: Matrices
 - Topic 5: Optimisation
 - Topic 6: Share Investments
 - Topic 7: Statistics and Working with Data.
- The total mark for each topic is 35.
- Answer **all** parts of Questions 1 to 3 in the spaces provided in this question booklet. There is no need to fill all the space provided.
- Show all working in this booklet. (You are strongly advised **not** to use scribbling paper. Work that you consider incorrect should be crossed out with a single line.)
- Write on page 10 if you need more space. Make sure to label each answer carefully.
- Use only black or blue pens for all work other than graphs and diagrams, for which you may use a sharp dark pencil.
- Appropriate steps of logic and correct answers are required.
- Marks may be deducted if you do not clearly show all steps in the solution of problems, if your answers have an inappropriate number of decimal places, or if you use incorrect units.
- Diagrams, where given, are not necessarily drawn to scale.
- Complete the box on the top right-hand side of this page with information about the electronic technology you are using in this examination.
- Attach one of your SACE registration number labels to the box at the top of this page.
- At the end of the examination, place one question booklet inside the back cover of the other question booklet.

QUESTION 1

At sheepdog trials the dogs must complete an obstacle course, from start to finish. Each arc of the networks in this question represents a different obstacle. The owners can choose the path their dogs will take. However, no backtracking is allowed.

- (a) How many different paths can the dogs take through the following network?

Write the number of paths in the box below.



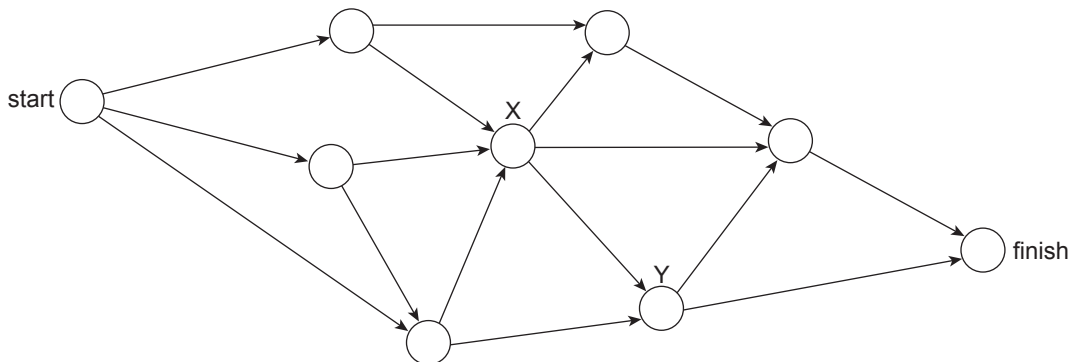
Number of paths:

(2 marks)

- (b) One owner wants his dog to go through node X but he knows that the obstacle on the arc between X and Y is too difficult for the dog.

On the following network, find the number of paths the dog could take to complete the course.

Write the number of paths in the box below.



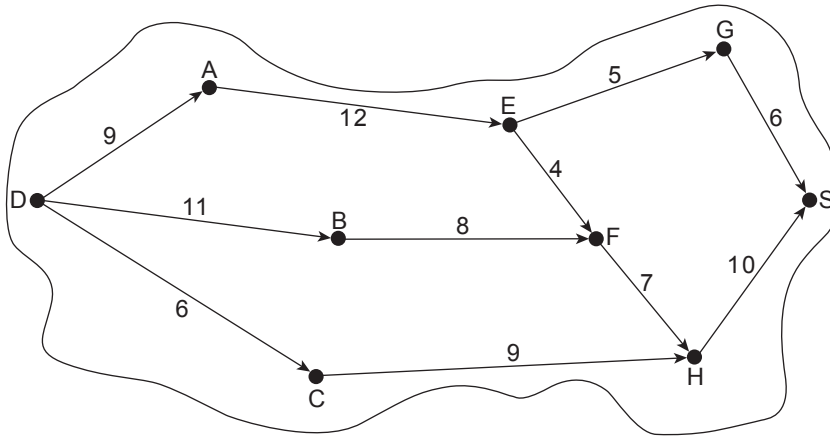
Number of paths:

(2 marks)

- (b) The second option involves pumping water from a dam on the western side of the garden (D) into a stream that flows past the eastern end of the garden (S). The size of the pump needed will depend on the total amount of flow that can be handled by the pipe network.

The capacity of each pipe (in litres per minute) is shown in the network below.

Find the maximum flow from D to S in the network below. Show your working on the network.



(3 marks)

- (c) The owners want to increase the maximum flow through the network in part (b) and are prepared to upgrade one of the existing pipes.
- (i) Identify which pipe the owners should upgrade to get the best possible increase in flow.

(1 mark)

- (ii) State the upgraded flow of the pipe.

(1 mark)

QUESTION 3

Henrik owns a block of land that is planted with native trees. Native trees need adequate amounts of the nutrients nitrogen (N) and potassium (K) in order to grow well. However, if they get too much phosphorus (P), they will die. Henrik's trees need at least 90 units of nitrogen and 40 units of potassium but no more than 132 units of phosphorus.

Henrik has supplies of two different fertilisers (A and B) that he wants to use on his trees. The concentration of the three nutrients (N, K, and P) in each scoop of fertiliser is shown in the table below:

Fertiliser	Nitrogen (N)	Potassium (K)	Phosphorus (P)
A	11	1	6
B	5	5	6
nutrient limit	90	40	132

Henrik intends to use a mixture of the two fertilisers on his trees.

Let x represent the amount of Fertiliser A (in scoops) and y represent the amount of Fertiliser B (in scoops).

(a) Five constraints are used to model this situation.

Complete the list below.

$$x \geq 0$$

$$y \geq 0$$

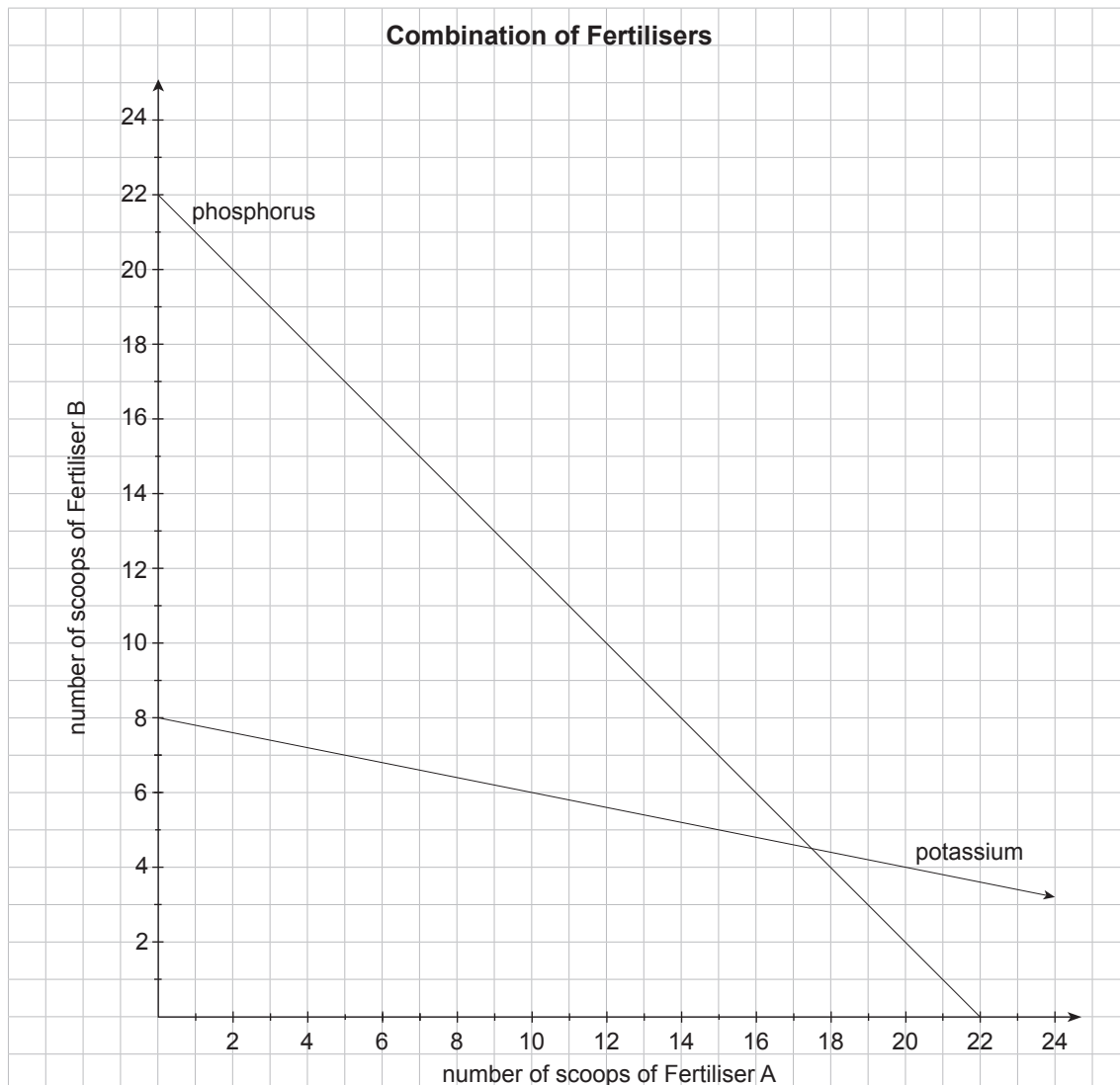
Nitrogen $11x + 5y \geq 90 \longrightarrow y \geq (90 - 11x) \div 5$

Potassium _____ \longrightarrow _____

Phosphorus $6x + 6y \leq 132 \longrightarrow$ _____

(3 marks)

- (b) On the graph below:
- add the missing constraint line for nitrogen and label it
 - shade the feasible region
 - label the vertices of the feasible region.



(4 marks)

- (c) Can the requirements of the native trees be met by using only one of the fertilisers? Explain your answer.

(2 marks)

You may write on this page if you need more space to finish your answers to Topic 5.
Make sure to label each answer carefully (e.g. 'Question 3(c) continued').

A large grid of graph paper, consisting of 20 columns and 30 rows of small squares, intended for writing answers.