Student Name: _____

GENERAL MATHEMATICS 2024

Unit 4
Key Topic Test 8 – Networks and Decision Mathematics: Matching Problems

Recommended writing time*: 45 minutes
Total number of marks available: 25 marks

QUESTION BOOK

* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions

- Students are permitted to bring into the room for this test: pens, pencils, highlighters, erasers, sharpeners and rulers, approved CAS calculator and one bound reference book.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 8 pages.

Instructions

- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

SECTION A – Multiple-choice questions

Instructions for Section A

- All questions are worth one mark.
- Answer all questions by circling the correct response.
- Marks are not deducted for incorrect answers.
- No marks will be awarded if more than one answer is completed for any question

Question 1

Five students were asked to nominate at least one sport they would like to play for school sports this semester. Their preferences are shown in the bipartite graph below. In order to allocate students to their preferences, Peter will need to play:

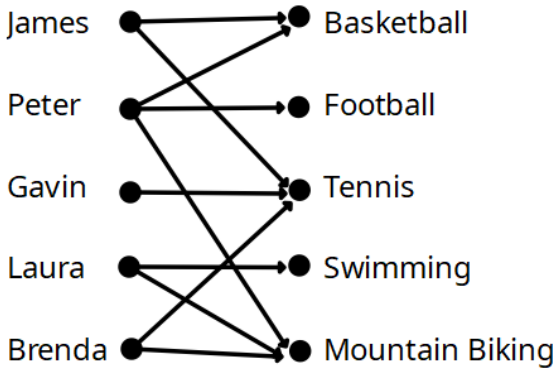
A. Basketball

B. Football

C. Tennis

D. Swimming

E. Mountain Biking



Question 2

The following table shows three tasks and three people. The numbers denote the time (minutes) taken to complete each task.

	Task 1	**Task 2**	**Task 3**
Ana	9	5	8
Ben	10	4	6
Camila	7	7	10

If each candidate must be assigned to only one task, which of the following allocations maximises the use of the task skills of these candidates?

A. Ana task 1, Ben task 2 and Camila Task 3

B. Ana task 3, Ben task 2 and Camila Task 1

C. Ana task 2, Ben task 1 and Camila Task 3

D. Ana task 1, Ben task 3 and Camila Task 2

E. Ana task 2, Ben task 3 and Camila Task 1

Use the following information to answer Questions 3, 4 and 5

A soft drink company decided to contract out the advertising for their new drink. Four companies gave quotes for four different advertising styles. The cost for each style (000's of dollars) is shown in the table below:

Style	Company 1	Company 2	Company 3	Company 4
1	4	6	7	6
2	1	4	6	3
3	2	3	3	3
4	10	11	12	9

Question 3

The cheapest quote for style 1 is:

A. \$4 **B.** \$6000 **C.** \$4000 **D.** \$2000 **E.** \$6000

Question 4

The company that gives the cheapest combined quote for styles 1 to 4 is:

A. Company 1

B. Company 2

C. Company 3

D. Company 4

E. Style 3

Question 5

If each style is allocated to one company only, the minimum advertising cost will be:

A. \$17 000

B. \$18 000

C. \$19 000

D. \$20 000

E. \$21 000

SECTION B - Short-answer questions

Instructions for Section B

- Answer each question in the space provided.
- Please provide appropriate workings and use exact answers unless otherwise specified.

Question 1 (9 marks)

The East Lakes swimming team consists of 4 swimmers. They will compete in a medley relay where each swimmer will swim one stroke only and they wish to determine who does each event to achieve the fastest time. The table below shows each swimmer's personal best in the four strokes of the medley relay.

Swimmer	Freestyle	Backstroke	Breaststroke	Butterfly
Kate	34.4	40.8	45.4	43.3
Tessa	31.3	38.1	46.3	36.5
Jasmine	32.2	40.6	45.2	35.4
Stacey	35.7	42.5	47.1	38.7

a. Following the Hungarian algorithm, row reduction has been started in the table below. Complete the table by filling in the shaded boxes.

0	6.4	11	8.9
0		15	5.2
0	8.4		3.2
0	6.8	11.4	3

2 marks

b. Explain why the first column of this table contains all zeros.

_____

_____

1 mark

After performing column reduction, the following table is left.

0	0	0	5.9
0	0.4	4	2.2
0	2	2	0.2
0	0.4	0.4	0

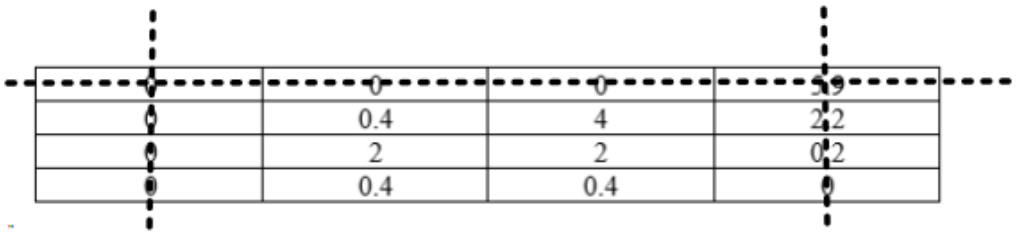
c. Explain why the swimmers can not yet be allocated to a stroke.

_____

_____

1 mark

The dotted lines shown below are used to cover the zeros.



d. The next iteration of the Hungarian algorithm prior to allocating is completed and the results shown in the table below. Complete the table by filling in the shaded boxes.

0.4	0	0	
0		3.6	2.2
0	1.6	1.6	0.2
0			0

2 marks

e. Allocate each swimmer with a stroke for the optimal allocation on the bipartite graph below.

Kate	●	●	Freestyle
Tessa	●	●	Backstroke
Jasmine	●	●	Breaststroke
Stacey	●	●	Butterfly

2 marks

f. If all swimmers are able to match their personal best times, find the completion time of the medley relay. (assume that no time is lost on change overs)

_____

1 mark

Question 2 (11 Marks)

Four builders are tendering the Australian Government to build new stadiums or renovate existing ones for a future Olympic games. The prices (in millions) for each builder and for each stadium are shown in the table below.

Builder:	Football	Beach Volleyball	Athlete Village	Skateboarding
Total Build	200	32	140	28
A Graded	180	35	145	26
Structures R Us	210	28	162	22
Shady Designs	195	28	138	30

a. Complete each step of the Hungarian Algorithm below.

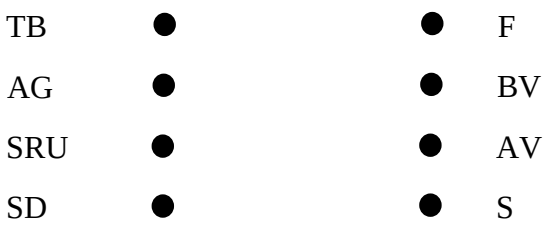
	F	**BV**	**AV**	**S**
TB				
AG				
SRU				
SD				

	F	**BV**	**AV**	**S**
TB				
AG				
SRU				
SD				

	F	**BV**	**AV**	**S**
TB				
AG				
SRU				
SD				

3 marks

b. If the Australian Government was to use a different builder for each of the 4 stadiums, show the allocation on the bipartite graph below and find the minimum total cost.



4 marks

c. If the Australian Government was to take the best bid for each of the four stadiums, how much would they save?

2 marks

d. Give a logistical reason why the option in c. may not be feasible.

1 mark

Assuming that the Australian Government decides to allocate one job only to each builder. They are able to reduce costs for **one builder only** by 10% through supplying some of the materials.

e. Which builder should they allocate this to, and how much will they save?

1 mark

END OF KEY TOPIC TEST