



**Mathematics Applications Unit 3/4
Test 6 2021**

**Section 1 Calculator Free
Networks and Decision Mathematics**

STUDENT'S NAME Solutions P.H.

DATE: Thursday 9th September

TIME: 30 minutes

MARKS: 26

INSTRUCTIONS:

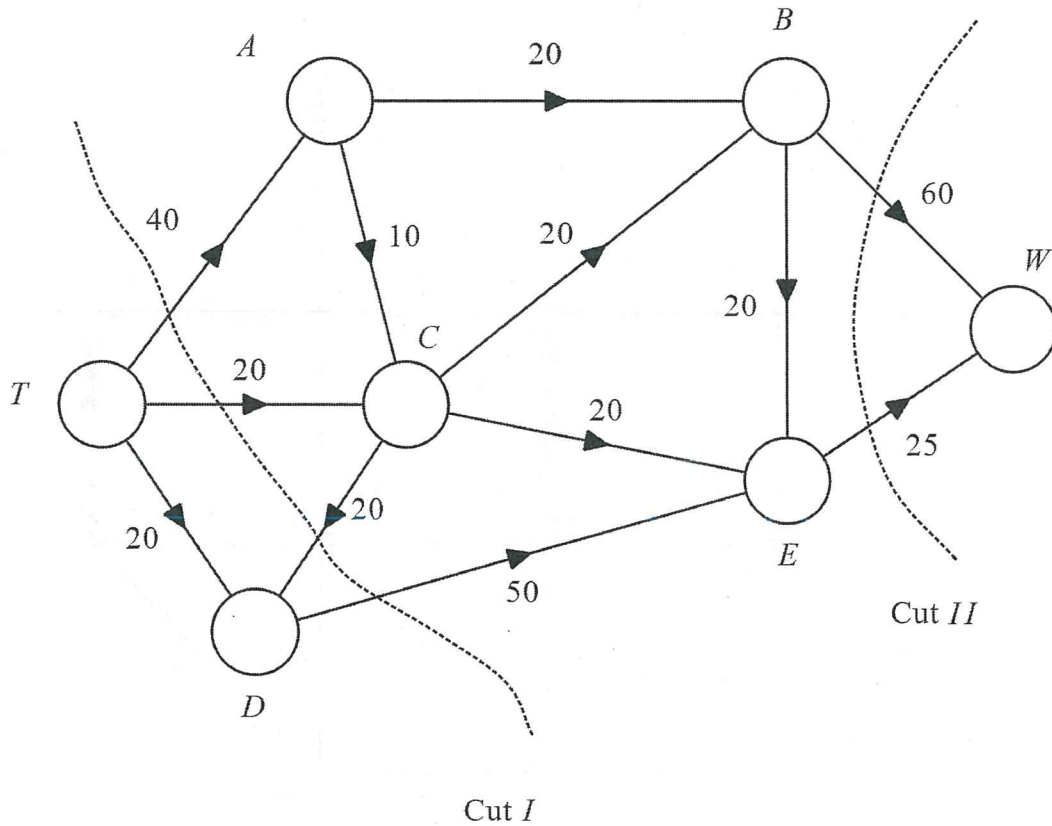
Standard Items: Pens, pencils, drawing templates, eraser

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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2. (10 marks)

The number of cars that can travel on different roads between Trinity College (T) and Waterford (W), in 100s per hour, is given in the network below.



(a) Determine the value of the cuts marked I and II. [2]

$$I = 110 \quad \checkmark$$

$$II = 85 \quad \checkmark$$

(b) By systematically listing paths, determine the maximum number of cars that can travel between T and W each hour. [4]

$$TABW = 20$$

$$TACBW = 10 \quad \checkmark \checkmark$$

$$TCBW = 10$$

$$TCEW = 10$$

$$TDEW = 15$$

$$\underline{\underline{65}} \quad \checkmark$$

$\therefore 6500$ cars. \checkmark

\checkmark 2 correct paths listed with max value

\checkmark All correct paths listed with max value

\checkmark Sums total = 65

\checkmark $\times 100 = 6500$ cars.

The local council has received complaints regarding the amount of traffic between C and D . They plan to install a traffic calming measure that reduces the road capacity to 500 cars per hour.

- (c) What affect does this have on the maximum number of cars that can now travel between T and W each hour. Explain your answer. [2]

No affect.

CD is not used in the maximum flow.

✓ No affect.
✓ Comments on edge not included in max flow

The local council decide not to proceed with the traffic calming measure. Instead, they decide to upgrade a road.

- (d) Which road should they upgrade to increase the amount of traffic that can travel between Trinity College and Waterford. Explain how this will impact the flow. [2]

Upgrade AB .

Increases maximum flow on network by 10.

∴ 1000 cars increased.

✓ Identifies edge AB
✓ Increase in Max flow by 1000 cars.

3. (9 marks)

At Brother Ollie's Wheelchairs for Kids in Wangara, there are 4 workstations. Five volunteers have turned up today. From previous data, Brother Ollie knows how many wheelchairs each person can complete per day on each of the different machines.

	Machine 1	Machine 2	Machine 3	Machine 4
Adam	10	15	27	4
Bob	8	3	11	3
Cam	4	18	18	2
Daniel	4	10	7	4
Edward	8	3	10	10

- (a) By first completing the matrix below and using the Hungarian algorithm, determine the appropriate allocation of volunteers to machines that will maximise the number of wheelchairs assembled. [6]

$$\begin{array}{l}
 \text{Adam} \\
 \text{Bob} \\
 \text{C} \sim \text{Cam} \\
 \text{Daniel} \\
 \text{Edward}
 \end{array}
 \left[\begin{array}{ccccc}
 10 & 15 & 27 & 4 & 0 \\
 8 & 3 & 11 & 3 & 0 \\
 4 & 18 & 18 & 2 & 0 \\
 4 & 10 & 7 & 4 & 0 \\
 8 & 3 & 10 & 10 & 0
 \end{array} \right]$$

✓ Completes matrix.

$$\left[\begin{array}{ccccc}
 17 & 12 & 0 & 23 & 27 \\
 19 & 24 & 16 & 24 & 27 \\
 23 & 9 & 9 & 25 & 27 \\
 23 & 17 & 20 & 23 & 27 \\
 19 & 24 & 17 & 17 & 27
 \end{array} \right]$$

✓ Subtracts each entry from Max Value in Matrix.

$$\left[\begin{array}{ccccc}
 17 & 12 & 0 & 23 & 27 \\
 3 & 8 & 0 & 8 & 11 \\
 14 & 0 & 0 & 16 & 18 \\
 6 & 0 & 3 & 6 & 10 \\
 2 & 7 & 0 & 0 & 10
 \end{array} \right]$$

✓ Row Reduction

$$\left[\begin{array}{ccccc}
 15 & 12 & 0 & 23 & 17 \\
 1 & 8 & 0 & 8 & 1 \\
 \hline
 12 & 0 & 0 & 16 & 8 \\
 4 & 0 & 3 & 6 & 0 \\
 \hline
 0 & 7 & 0 & 0 & 0
 \end{array} \right]$$

✓ Column Reduction

$$n < 5$$

14	11	22	16
7	7	7	7
12	16	8	
4	6	8	
0	1	0	

$n = 5$

✓ Tests for Optimality and allocates zeros.

	Adam	Bob	Cam	Daniel	Edward
Machine	3	1	2	N/A	4

✓ Allocates correctly.

(b) Determine the maximum number of wheelchairs that can be assembled in a day. [1]

$$27 + 8 + 18 + 10 = 63 \text{ wheelchairs}$$

✓ 63 wheelchairs.

(c) Due to circumstances beyond their control, Adam must use machine 2 and Bob must use machine 3. Explain how this will change your allocation found in part (a) and what affect this will have on the number of wheelchairs assembled. [2]

Allocations:

Edward → Machine 4

Cam or Daniel → Machine 1.

New Total :

$$15 + 10 + 11 + 4$$

$$= 40$$

✓ correct new allocation

✓ Reduction of 23 wheelchairs assembled.

∴ 23 less wheelchairs will be made.

Mathematics Applications Unit 3/4
Test 6 2021

Section 2 Calculator Assumed
Networks and decision mathematics

STUDENT'S NAME Solutions P.H.

DATE: Thursday 9th September

TIME: 20 minutes

MARKS: 17

INSTRUCTIONS:

Standard Items: Pens, pencils, drawing templates, eraser

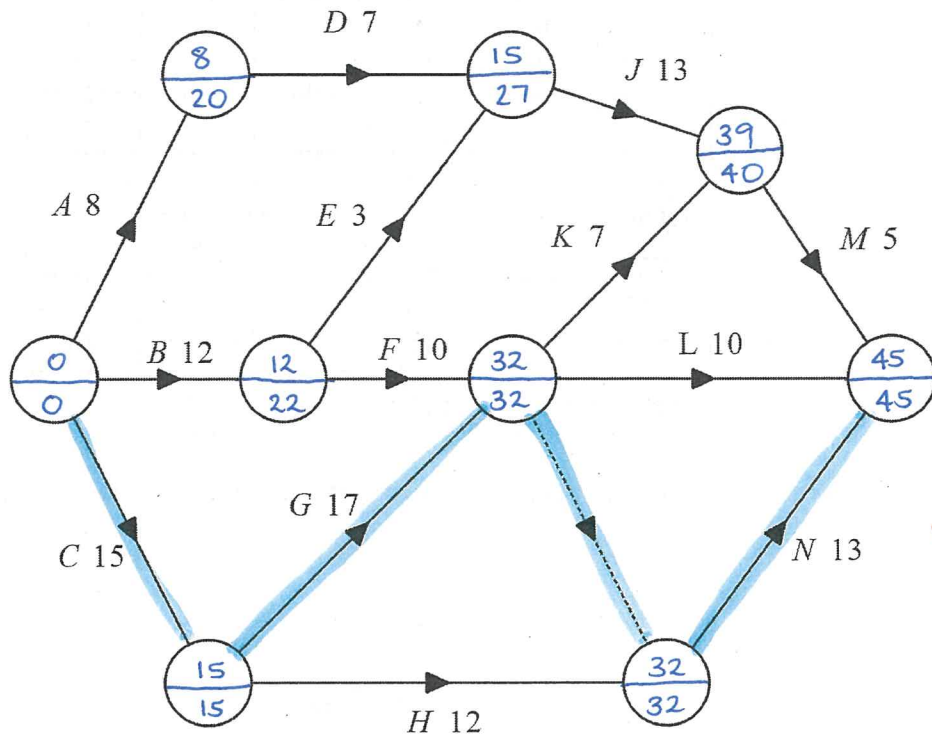
Special Items: Three calculators, notes on one side of a single A4 page (these notes to be handed in with this assessment)

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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4. (9 marks)

Noah and Peter are coordinating a model building project. The number on each edge gives the time, in minutes, to complete each task. Each task requires one person.



(a) Complete the precedence table below. [2]

Activity	A	B	C	D	E	F	G	H	J	K	L	M	N
Time (mins)	8	12	15	7	3	10	17	13	14	10	17	18	13
Immediate predecessor	-	-	-	A	B	B	C	D	D,E	F,G	F,G	K,J	F,H,G

(b) By demonstrating on the network above, determine the critical path and the minimum completion time for the project. [3]

$$\text{MCT} = 45 \text{ mins} \quad \checkmark$$

$$\text{CP} : \text{CGN} \quad \checkmark$$

(c) Determine the float time for activity:

(i) F $32 - 12 - 10 = 10 \text{ mins} \quad \checkmark$ [1]

(ii) M $45 - 39 - 5 = 1 \text{ min} \quad \checkmark$ [1]

(d) The building project starts at 7 am, determine the latest time that activity H could start without changing the completion time. [2]

$$32 - 12 = 20 \quad \checkmark$$

$$\therefore 7:20 \text{ am} \quad \checkmark$$

$$\checkmark 20$$

$$\checkmark 7:20 \text{ am}$$

5. (5 marks)

The distance between stalls, in metres, for Unfair Day are given in the table below. Power must be provided to every stall with the main power junction box located at stall E.

	↓ A	↓ B	↓ C	↓ D	↓ E	↓ F
A	-	25	15	20	35	25
B	25	-	20	35	18	26
C	15	20	-	33	45	24
D	20	35	33	-	27	31
E	35	18	45	27	-	40
F	25	26	24	31	40	-

✓ Working on Table correct values identified.

- (a) Using Prim's algorithm, determine the minimum length of cable required to power all stalls. [3]

$$15 + 20 + 20 + 18 + 24 = 97 \text{ m}$$

✓ Sums identified values
✓ Total = 97m

- (b) If 20 m of 250V 10A Heavy Duty Extension Lead costs \$19, determine the minimum cost of connecting each stall. Each stall has a junction that a lead can plug into. Extension leads may not be cut but can be joined. [2]

$$6 \text{ leads} \times \$19$$

$$\$114.00$$

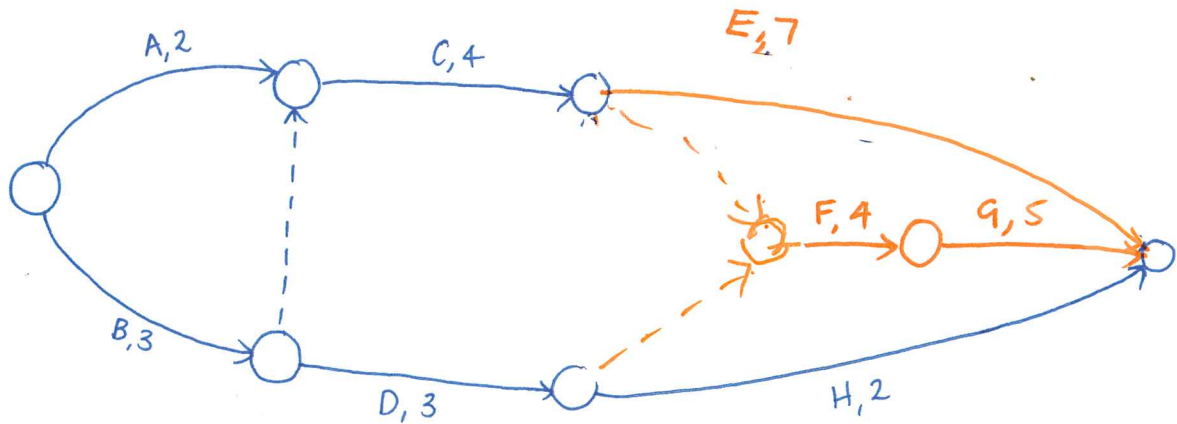
✓ Identifies 6 leads required
✓ cost = \$101.

6. (3 marks)

Liam and Nick are planning a small building project. The table below shows the required activities, together with the times taken (in days) and the immediate predecessors for each activity.

Activity	A ✓	B ✓	C ✓	D ✓	E ✓	F	G	H
Time (days)	2	3	4	3	7	4	5	2
Immediate predecessors	-	-	A, B	B	C	C, D	F	D

Draw the project network below, showing all activities and durations.



✓ All vertices/edges listed with correct weights

✓ Dummy between A and B

✓ Dummy between C-F
D-F.

C-F
≠
D-F.

