TRINITY ⛨ COLLEGE

YEAR 12
MATHEMATICS
APPLICATIONS

Test 4, 2023
Section One: Calculator Free
Networks and Assignment

STUDENT'S NAME: Solutions (Ristovsky)

DATE: Monday 4th September   **TIME:** 20 minutes   **MARKS:** 20
ASSESSMENT %: 10

INSTRUCTIONS:
Standard Items: Pens, pencils, drawing templates, eraser
Special Items:

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

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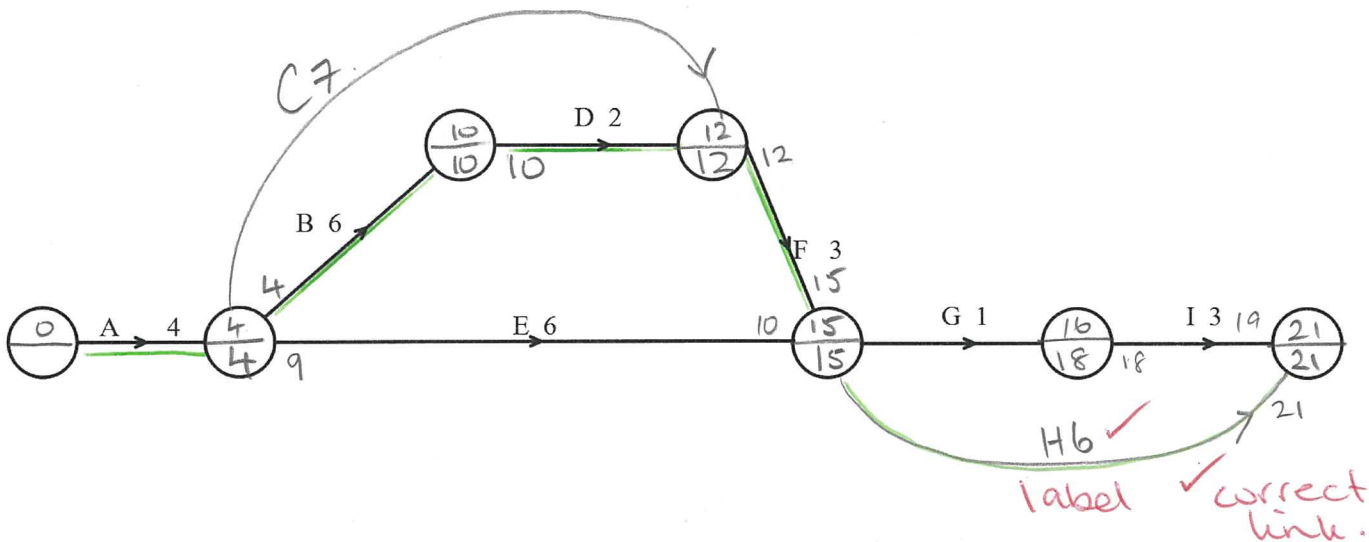**Question 1**   **(11 marks)**

To prepare an aircraft for a new flight there are several tasks which need to take place prior to passengers boarding. Each task and the time need to complete the task and predecessors are given in the table and diagram below.

Task	Duration (hours)	Immediate Predecessor(s)
A	4	---
B	6	A
C	7	A
D	2	B
E	6	A
F	3	C, D
G	1	EF ✓ *must have E,F.*
H	6	E, F
I	3	G

(a)   In the network above there are two activities missing from the schedule. Draw and label these activities on the network.   (2 marks)

(b)   The immediate predecessors for activity G must be included, complete the table to include these activities.   (1 mark)

(c) State the critical pathway and the minimum completion time for the aircraft to be prepared.   (2 marks)

CP: A B D F H   ✓

MCT : 21 hrs.   ✓

(d) State the earliest starting time for activity G.   (1 mark)

15 hrs ✓

(e) State the float time for activity E.   (1 mark)

5 hrs. ✓

(f) If the time to complete activity I is increased by 3 hours, then explain the effect this would have on the minimum completion time and the critical path.   (2 marks)

increase by 1hr MCT : 22hrs.

CP: A B D F G I.   ✓ increases by 1hr

✓ correct path.

(g) The passengers are schedule to commence boarding the flight at 6 am on Saturday, September 30th, 2023, what would be the appropriate time and date for initiating the preparation process?   (2 mark)

MCT : 21 hrs.

9am   Friday 29th sept 2023.

✓ time 9am

✓ correct date.

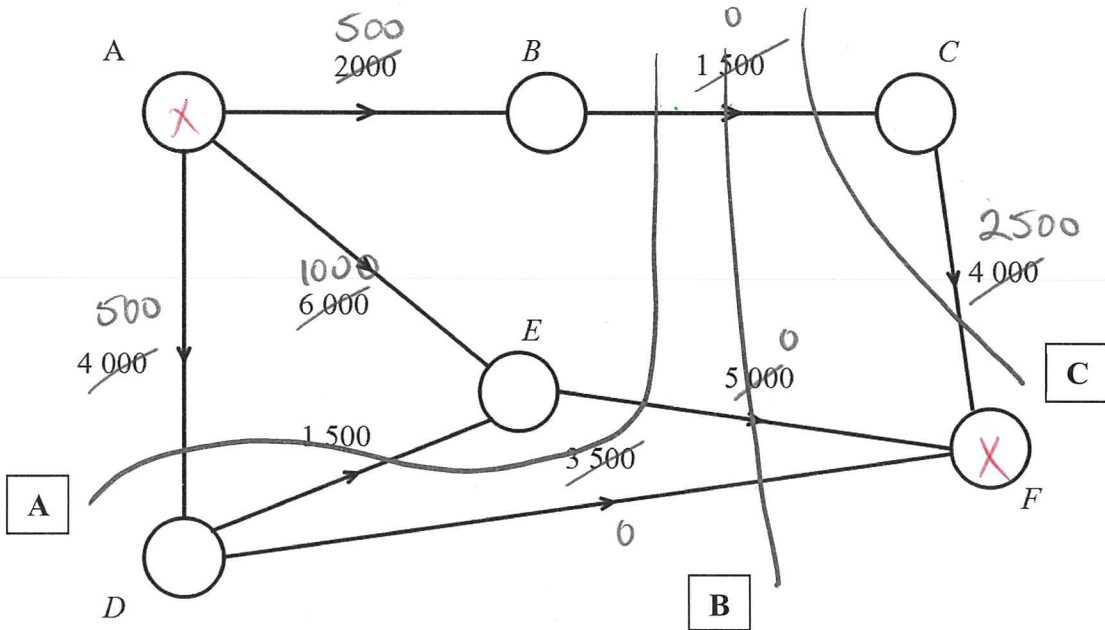**Question 2**   **(9 marks)**

The network below displays the maximum tonnage that can be trucked through a system of roads designed specifically for the movement of large hauls.
The numbers on the paths represent the capacity of the road in units of tonnes per minute. The arrows indicate direction and flow.

(a)   Determine the value of each cutS A, B, C.   (2 marks)

$$A = 12\,000, \quad B = 10\,000, \quad C = 5500 \quad \checkmark\; 2\,\text{correct}$$

not suitable cut. $\checkmark$ all correct.
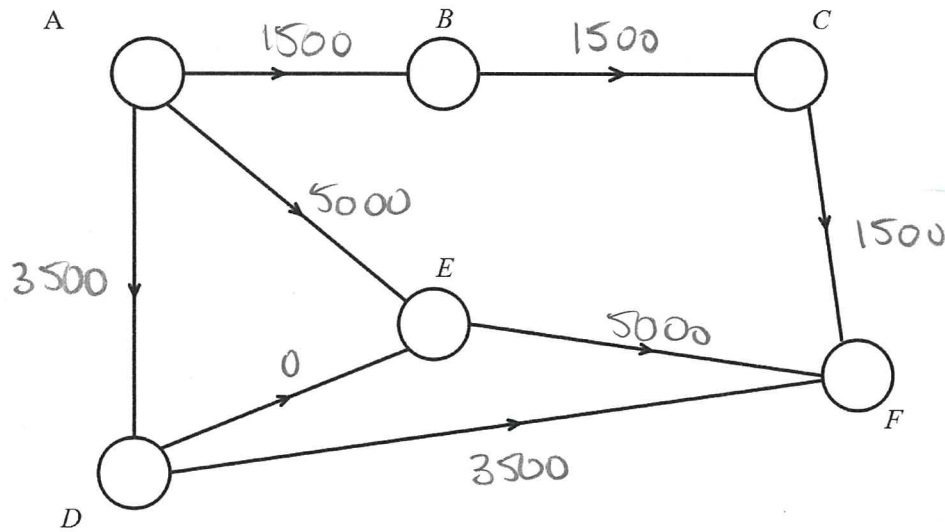
(b)   What is the maximum amount of tonnage that can be moved from A to F? Show systematic working to allow your solution to be check.   (3 marks)

$$ABCF = 1500$$
$$AEF = 5000$$
$$AD F = 3500$$
$$\overline{}$$
$$10\,000$$

$\checkmark$ working on diagram.
$\checkmark$ states flow on each section.
$\checkmark$ states maximum flow.

(c)   Use the diagram below to draw the flow on each path that will result in this maximum flow.
                                                                                    (2 marks)

A   1500   B   1500   C

                     5000   1500

3500   E

                     0   5000

                                                            F

                     3500

D

✓4 correct.
✓ all correct.

(d)   The network is due for an upgrade in one of the roads, which road should be upgraded and
       determine the new maximum flow of the network?   (2 marks)

EF from 5000 to 6000.   ✓states road

increasing the flow to 11000. ✓states max
                                            flow.

END OF QUESTIONS

TRINITY COLLEGE

YEAR 12
MATHEMATICS
APPLICATIONS

Networks and Assignment

STUDENT'S NAME: Solutions (Risbrsky

DATE: Monday 28th August   TIME: 30 minutes   MARKS: 32
ASSESSMENT %: 10

INSTRUCTIONS:
Standard Items: Pens, pencils, drawing templates, eraser
Special Items: 1 A4 page notes, Classpad, Scientific Calculator

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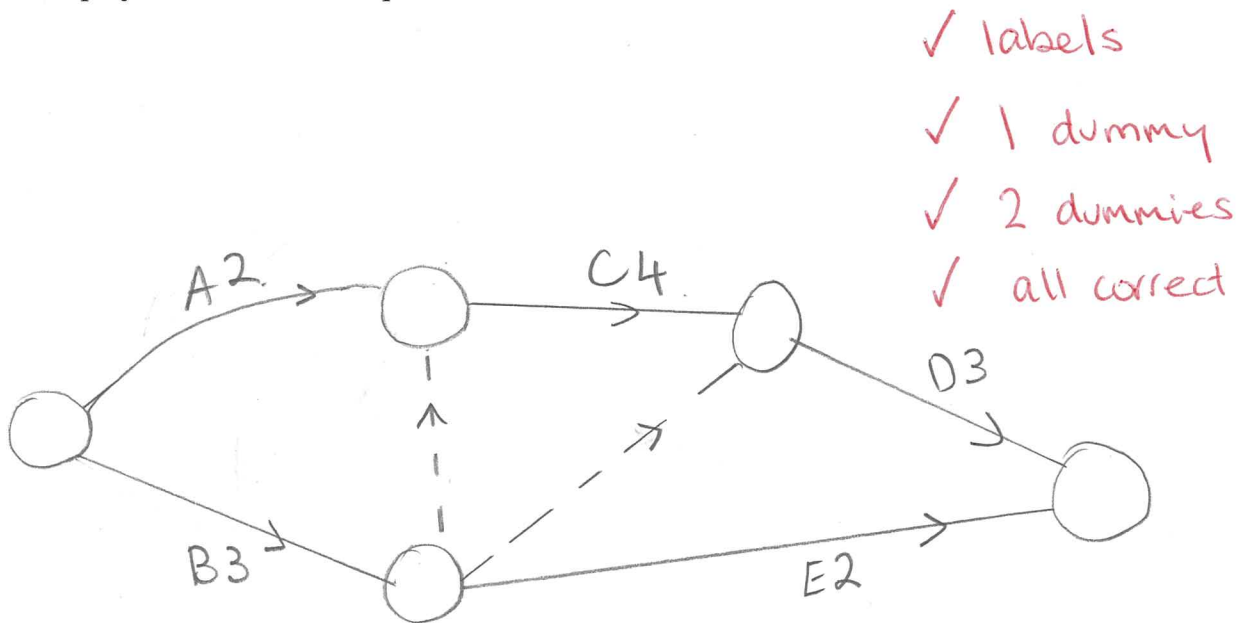

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Question 3   **(4 marks)**

The following table consists of five activities containing information for a project in a small manufacturing company.

Activity	Immediate Predecessors	Time (hours)
A	-	2
B	-	3
C	AB	4
D	BC	3
E	B	2

Construct the project network in the space below.

✓ labels
✓ 1 dummy
✓ 2 dummies
✓ all correct

**Question 4**   (7 marks)

The table below shows the cost of building direct 'light rail' links between seven different locations in Perth, in millions of dollars.

	A	B	C	D	E	F	G
A	-	50	58	-	-	54	35
B	50	-	44	65	32	33	58
C	58	44	-	42	43	-	-
D	-	65	42	-	45	68	-
E	-	32	43	45	-	32	61
F	54	33	-	68	32	-	49
G	35	58	-	-	61	49	-

↓ ↓4 ↓5 ↓6 ↓3 ↓2 ↓1

✓ uses correct lines
✓ correct circles.
✓ uses arrows.

(a)   Use Prim's Algorithm to determine the minimum spanning tree for this network, draw this minimal spanning tree on the graph below, and clearly state the cost of building light rail.

(5 marks)
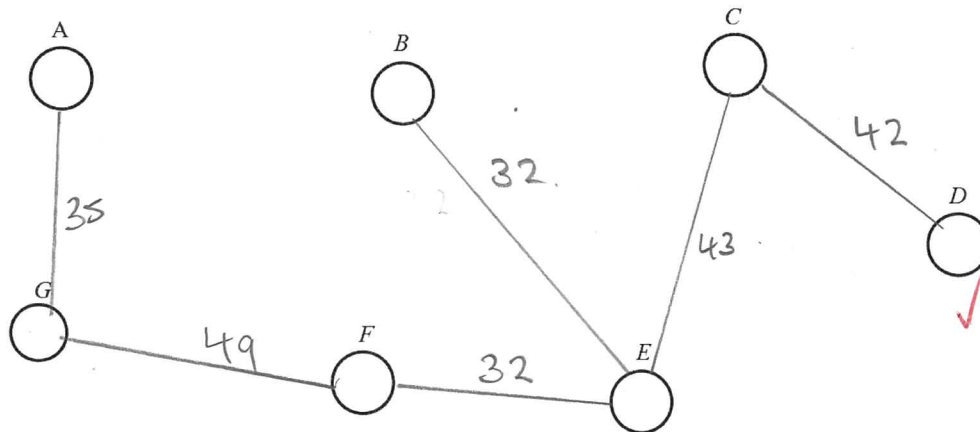
✓ correct spanning tree.

Cost = $233 million ✓ cost.

(b)   An option exists to use an existing rail line between locations A and F, making it possible to halve the costs of this link. If this option is taken then describe the effect, if any, on the cost of building the light rail and state this cost.

(2 marks)

A → F = 54.

A → F = $27 million.

GF replaced by AF.

New cost = 233 - 49 + 27.

= $211 million.

✓ states replaces GF.

✓ new cost.

Question 5   **(7 marks)**

A store specialising in cars and parts employs staff who have been trained within specific areas of the store. The average daily sales for each of the four employees in each specific area is shown in the table below.
The four employees have demonstrated they perform better in different areas.

Table 1

	Tyres	Tools	4x4	Electrical
Aaron	580	550	360	440
Brian	340	590	420	530
Carl	550	480	380	410
Dane	510	550	540	290

590 – each value.

(a)   Management would like to <u>maximise</u> the total daily sales and some of the results from the first step are shown in the Table 2 below. Complete the table for the first step of the algorithm.

                                                                                                    (1 mark)

Table 2

	Tyres	Tools	4x4	Electrical
Aaron	10	40	230	150
Brian	250	0	170	260
Carl	40	110	210	180
Dane	80	40	50	300

✓ all correct.

(b)   Table 3 shows the result of all steps of the Hungarian algorithm.   (3 marks)
        Allocate the four areas to maximise output display your working in Table 3.

Table 3

	Tyres	Tools	4x4	Electrical
Aaron	0	30	210	0
Brian	250	0	160	220
Carl	0	70	160	0
Dane	40	0	0	220

✓ uses four lines.

✓ identifies allocation.

Aaron	Brian	Carl	Dane
Tyres	Tools	Elect.	4x4

✓

OR   Elect   Tools   Tyres   4∧4.

(c)   Determine the maximum daily sales and present the manager with all the best option(s)?   (1 mark)

= 580 + 590 + 410 + 540.

= 2120 sales.

(d)   Aaron phones in saying he is not well and will not be coming into work for the day. How does this affect the allocation of jobs and the maximum sales?   (2 marks)

Aaron = 580. swap with Carl.   ✓ states swap with Carl.

Carl now goes to tyres where he can have 550 sales rather than 410 on electrical.   ✓ states decreases or new sales figure.

sales will decrease Sales = 2120 − 580 − 410 + 550

= 1680

Question 6   **(8 marks)**

An East Perth IGA provides a delivery service to its elderly customers. Each morning there are four deliveries to be made. Each of the four drivers, Erin, Frank, George, and Helen, is available to do one of the deliveries.

The table below shows the time, in minutes, that each driver would take to complete each of the four deliveries.

Delivery number	Erin	Frank	George	Helen	
1	35	31	41	36	−31
2	25	26	33	36	− 25
3	32	28	25	24	−24
4	27	30	31	28	−27

The store manager will allocate the deliveries so that the total delivery time is at a minimum. He decides to use the Hungarian algorithm to determine the allocation of deliveries to the drivers.

(a)   Determine the optimum allocation of the delivery drivers so that their travel time is minimised.

                                                                                      (5 marks)

Step 1
$$\begin{bmatrix} 4 & 0 & 10 & 5 \\ 0 & 1 & 8 & 11 \\ 8 & 4 & 1 & 0 \\ 0 & 3 & 4 & 1 \end{bmatrix} \longrightarrow$$

0 0 −1 0

Step 2
$$\begin{bmatrix} 4 & 0 & 9 & 5 \\ 0 & 1 & 7 & 11 \\ 8 & 4 & 0 & 0 \\ 0 & 3 & 3 & 1 \end{bmatrix}$$ −1

✓ step 1

✓ step 2.

✓ correct
min no.
of lines.

✓ step 3.

Step 3.
$$\begin{bmatrix} 5 & \boxed{0} & 9 & 5 \\ \boxed{0} & 0 & 6 & 10 \\ 9 & 4 & \boxed{0} & 0 \\ 0 & 2 & 2 & \boxed{0} \end{bmatrix}$$

(b)   State the minimum delivery time. and the allocation of   (2 marks)
delivery drivers.

Erin	Frank	George	Helen
2	1	3	4.

$$25 + 31 + 25 + 28$$

$$= 109 \text{ minutes.}$$

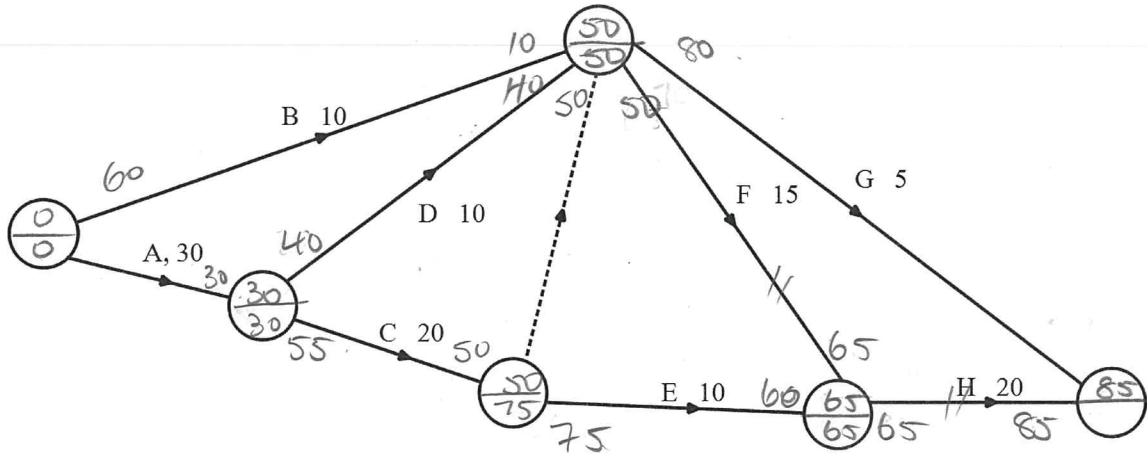✓ states allocation.
correctly.

✓ min. delivery
time.

Question 7   **(7 marks)**

The network shown below is a schedule for the construction of a new Theatre room. The duration of each activity is in hours.

(a)   Complete the precedence table.   (3 marks)

Task	Duration	Immediate Predecessor(s)
A	30	–
B	10	–
C	20	A
D	10	A
E	10	C
F	15	BCD
G	5	BCD
H	20	EF

✓ A+B correct.

✓ FG correct.

✓ all correct

(b)   The network shows a dummy activity. What is the purpose of the dummy activity?   (2 marks)

provides a link to F+G. ✓
not critical to B+D.

(c)   Assuming that no activities are delayed, determine how long each of the following activities could be delayed without affecting the minimum completion time of the Theatre room.
                                                                 (2 marks)

(i)   Activity D   10 hrs.   ✓ zero delay.

(ii)   Activity G

          30 hours.   ✓.

END OF QUESTIONS