

**Year 12 Mathematics Applications Unit 4  
Test 6 2022**

Section 1 Calculator Free  
Networks and Decision Making

**STUDENT'S NAME**

*Solutions.*

**DATE:** Monday 5<sup>th</sup> September

**TIME:** 15 minutes

**MARKS:** 16

**INSTRUCTIONS:**

Standard Items: Pens, pencils, drawing templates, eraser, approved Formula sheet

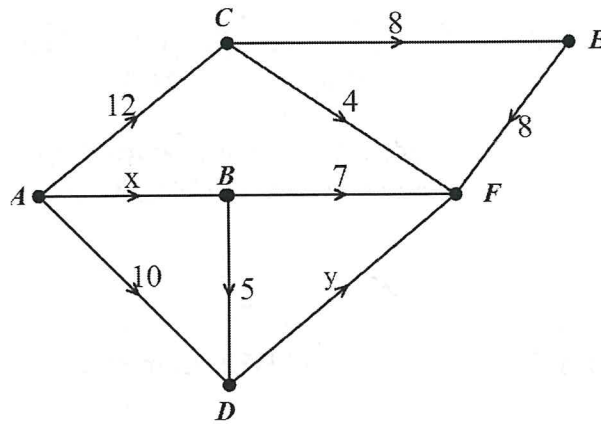
Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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1. (3 marks)

The diagram below shows the flow along each arc to achieve a maximum flow, in metres from the source to the sink.



(a) Find the values of  $x$  and  $y$

[2]

$x = 12$  ✓ correct  $x$  value.  
 $y = 15$  ✓ correct  $y$  value.

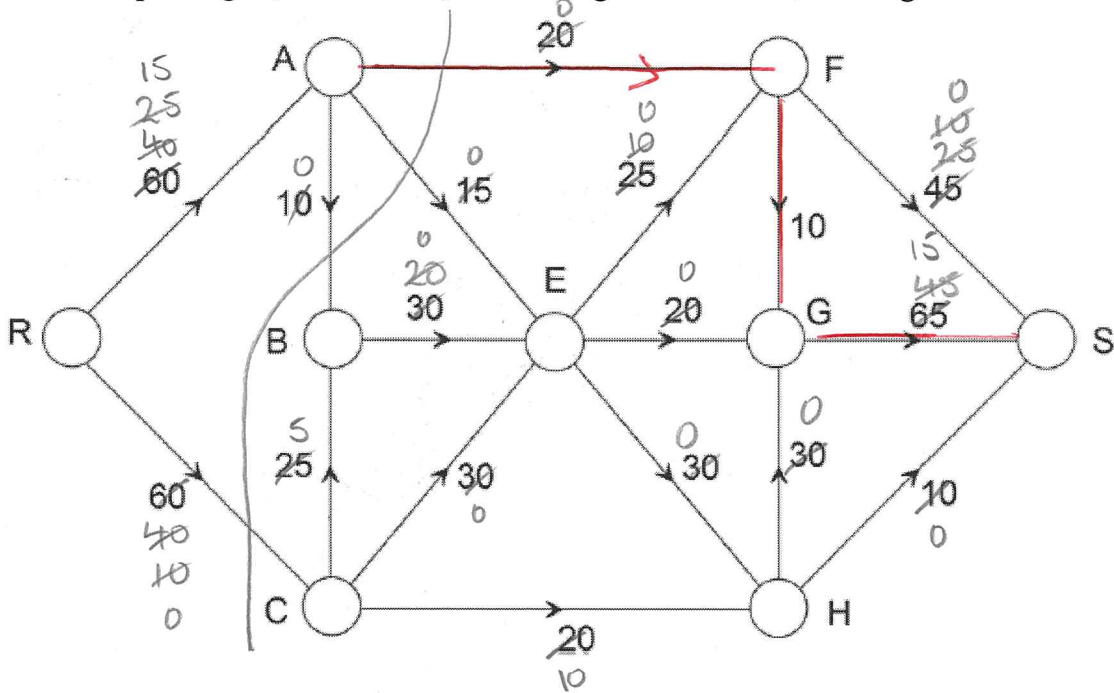
(b) Calculate the maximum flow through this system.

[1]

34m. ✓ correct maximum flow

2. (7 marks)

The network for a airline running flights connecting nine cities is shown below. The maximum number of passengers, in hundreds, on each flight is shown on each edge.



- (a) What is the maximum number of passengers that can be transferred from city R to city S? To obtain full marks, you must show systematic working. [4]

RAFS = 20  
 RAEFS = 15  
 RABEFS = 10  
 RCBEFS = 20  
 RCEHGS = 30  
 RCHS = 10

= 10500 passengers

✓ demonstrates working on diagram  
 ✓ 2 correct.  
 ✓ all correct.  
 ✓ correct total.

- (b) The owners of the company have identified one route between two cities that can be stopped without affecting the maximum flow. State which link this is. [1]

FG ✓ path

- (c) The route from city A to city F is to have an aeroplane upgrade so that the numbers of passengers for this route will increase. Determine the largest possible increase in the overall maximum passenger flow once the upgrade is complete. [1]

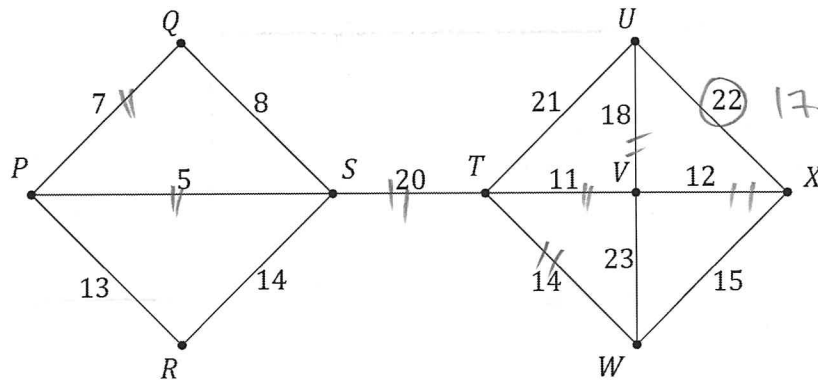
maximum 1000 passengers.

- (d) Find the minimum cut and mark it clearly on the diagram. [1]

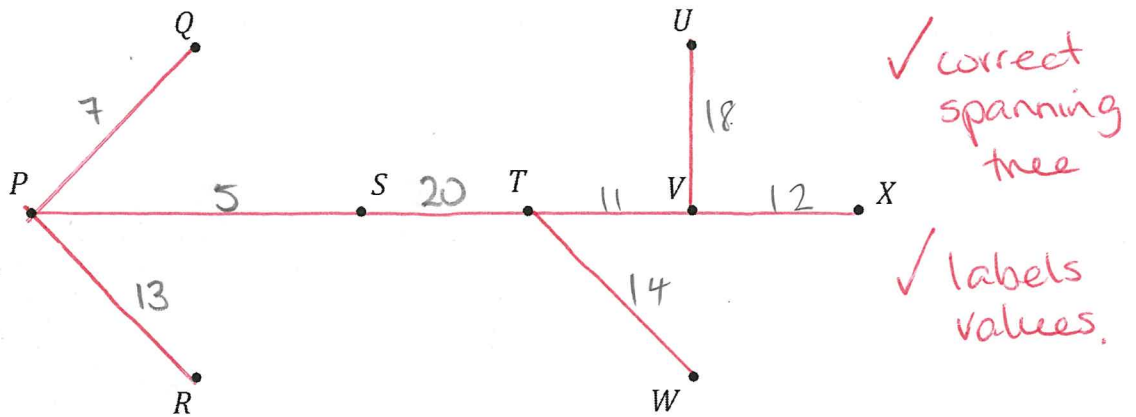
✓ correct minimum cut

3. (6 marks)

The network below shows the cost, in millions of dollars, of establishing the National Broadband Network (NBN) between nine suburbs,  $P, Q, R, \dots, X$ .



(a) Determine a minimum spanning tree for the network and draw the minimum spanning tree below. [2]



(b) State the minimum cost of establishing the NBN across the network. [2]

\$100 million ✓ \$100 million.  
 (\$100 000 000) ✓ million.

(c) The cost of constructing the NBN along  $UX$  has been overestimated by \$5 million. By how much does this information change the minimum cost of constructing the network? Justify your solution. [2]

$UX = 17$  million. (under current span of \$18 mill) ✓ states new span  
 $UV = 18$  million. ✓ states new cost.  
 reduces cost to \$99 million

**Year 12 Mathematics Applications Unit 4  
Test 6 2022**

**Section 2 Calculator Assumed  
Networks and Decision Making**

**STUDENT'S NAME** \_\_\_\_\_

**DATE:** Monday 5<sup>th</sup> September

**TIME:** 30 minutes

**MARKS:** 28

**INSTRUCTIONS:**

Standard Items: Pens, pencils, drawing templates, eraser, approved Formula sheet

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

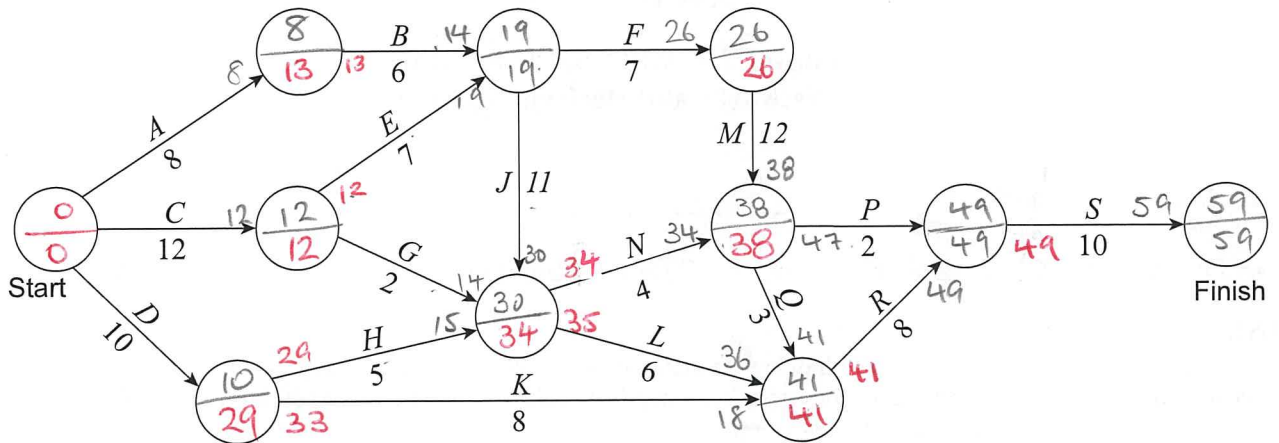
Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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4. (10 marks)

An engineering company has designed a super-fast battery charger. For the product to be manufactured it needs to go through several processes. The times needed to complete each process (in minutes) and the order of completion are shown on the following network:



(a) List all the processes that need to be undertaken before process N can start. [2]

A, B, C, D, E, G, H, J.

✓ 4 correct  
✓ all correct.

(b) Using the network diagram above, determine the critical path and the minimum completion time for the battery charger to be manufactured. [3]

C, E, F, M, Q, R, S. = 59 mins

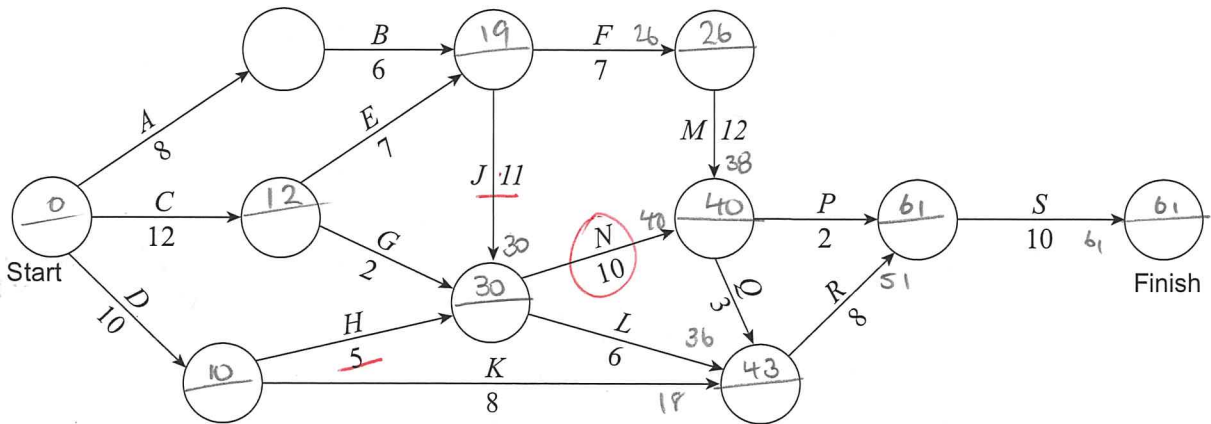
✓ appropriate working out.  
✓ list C.P.  
✓ states M.C.T.

(c) Calculate the amount of float time for process P. [1]

$47 - 38 = 9$  mins.

✓ correct mins.

- (d) The engineer in charge has redesigned the battery charger slightly, and as a result the time to complete process  $N$  has now increased from 4 minutes to 10 minutes:



- (i) State the new critical path for the network diagram above. [1]

C E J N Q R S

✓ states C.P.

- (ii) Calculate the difference between the original minimum completion time and the new minimum completion time. [1]

2 mins.

✓ correct number of mins.

- (iii) The engineer can also change either process  $J$  or process  $H$  to make either process 3 minutes faster to complete. State which process the engineer should change. Justify your answer. [2]

J, because it is on the critical path.

✓ states J.

J = 8 min making it 3 minutes faster. ✓ reasoning i.e. on the critical path.

5. (7 marks)

The following table shows the lengths, in kilometres, of pipe-lines between six water-pumping stations  $A - F$ .

	↓ <sup>1</sup>	↓ <sup>5</sup>	↓ <sup>2</sup>	↓ <sup>4</sup>	↓ <sup>3</sup>	↓ <sup>6</sup>
	A	B	C	D	E	F
A	<del>×</del>	<del>23</del>	<del>17</del>	<del>19</del>	<del>18</del>	<del>22</del>
B	<del>23</del>	<del>×</del>	<del>(20)</del>	<del>24</del>	<del>23</del>	<del>21</del>
C	<del>(17)</del>	<del>(20)</del>	<del>×</del>	<del>24</del>	<del>19</del>	<del>23</del>
D	<del>(19)</del>	<del>24</del>	<del>24</del>	<del>×</del>	<del>20</del>	<del>24</del>
E	<del>(18)</del>	<del>23</del>	<del>19</del>	<del>20</del>	<del>×</del>	<del>24</del>
F	<del>22</del>	<del>(21)</del>	<del>23</del>	<del>24</del>	<del>24</del>	<del>×</del>

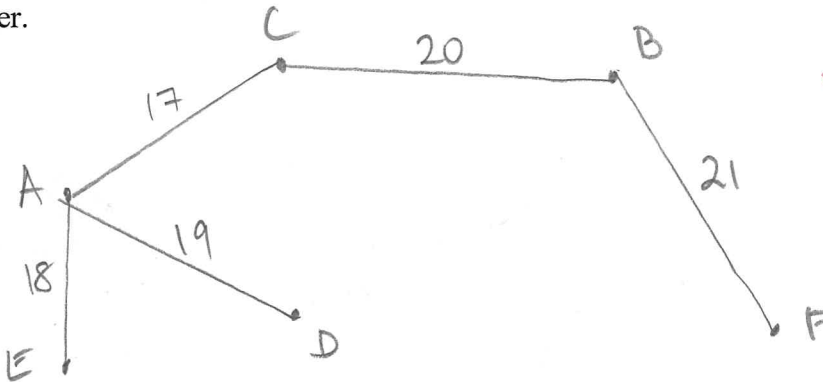
✓ all correct

- (a) The authorities decide to disconnect some of the pipe-lines. Use Prim's algorithm on the table above to find the minimum total length of pipe-lines which need to be kept open in order for all the pumping stations to remain linked together and state the length. [3]

Min length =  $17 + 19 + 18 + 21 + 20$   
 $= 95 \text{ km}$

✓ demonstrated Prim's Alg.

- (b) Draw a minimum spanning tree showing the pipe-lines that need to remain linked together. [2]



✓ correct spanning tree (F.T.)  
 ✓ labelled correctly.

- (c) The pipe-line from  $B$  to  $C$  is found to be faulty. So when choosing the pipe-lines to keep open the authorities must not include  $BC$ . Describe the effect this change has on the total length of pipe-lines which need to be kept open. [2]

Use  $AF$  instead of  $CB$ .

This will increase the pipe length by 2m.

✓ states increase or uses  $AF$ .

✓ states 2m.



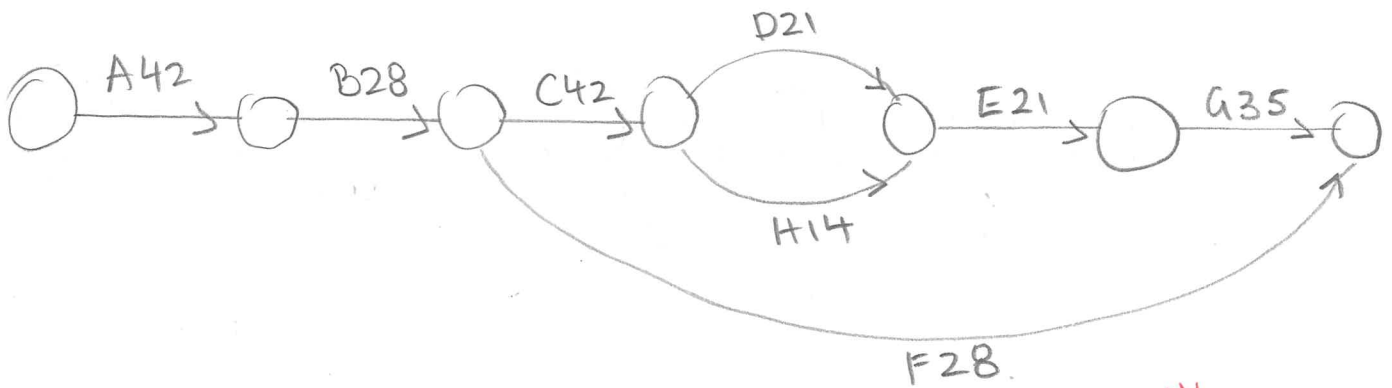
6. (4 marks)

The table below shows the tasks required for the building of a new cafe in the city and the time required in days. The project was started on 1<sup>st</sup> September 2022.

Task	Activity	Duration	Immediate Predecessor
A	Clear land	42	-
B	Lay the slab	28	A
C	Build the walls	42	B
D	Install electrics	21	C
E	Plaster the walls	21	D, H
F	Landscaping	28	B
G	Interior design	35	E
H	Roof	14	C

(a) Draw a project network to represent the above information.

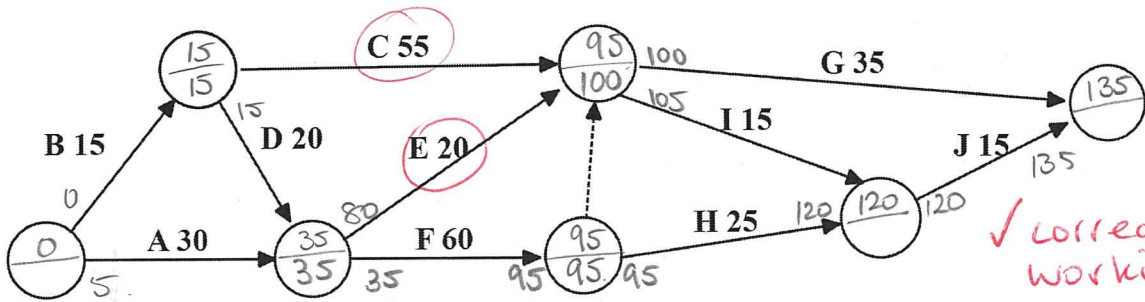
[4]



✓ with one error  
✓ all correct.  
✓ labelled  
✓ arrows.

7. (7 marks)

The diagram below shows the project network for the completion of tasks A, B, C, D, E, F, G and H with times to complete the task given in hours.



- (a) Determine the minimum completion time and the state the critical path. [3]  
 Critical path = B, D, F, H, J ✓ correct C.P.  
 MCT = 135 hrs. ✓ correct MCT.
- (b) The network shows a dummy activity. What is the purpose of the dummy activity? [1]  
 Shows that CEF must be completed before G + I can begin. ✓ reasonable purpose.
- (c) How long can Task E be delayed without affecting the critical path? [1]  
 $80 - 35 = 45 \text{ min.}$  ✓ correct 45 mins.
- (d) If the time taken for Task C increased by 15 hours what affect does this have on the minimum completion time and the critical path. [2]  
 $C = 70$  ✓ states no affect.  
 It will not affect the critical path or minimum completion time.  
 $B15 \rightarrow C70 = 85 < 95.$  ✓ reason.