Student Name _____

Eastern Goldfields College
Mathematics Applications U3&4 2017

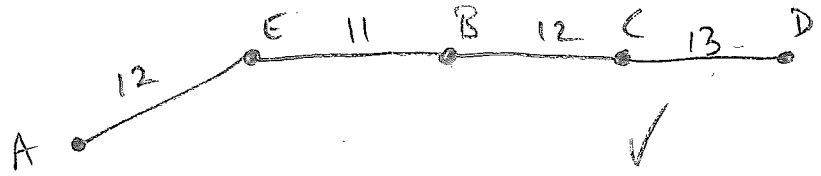
Test 6 – Calculator Free Section

Working Time: 20 minutes | **Total Marks: 21 marks**

Question 1 [3 marks]

The arc lengths between the five vertices A, B, C, D and E of a network are shown in the table below. Determine the length of the minimum spanning tree for this network.

	A	B	C	D	E
A	~~0~~	~~13~~	~~15~~	~~14~~	~~12~~
B	~~13~~	~~0~~	~~12~~	~~14~~	11
C	~~15~~	12	~~0~~	~~13~~	~~13~~
D	~~14~~	~~14~~	13	~~0~~	~~14~~
E	12	~~11~~	~~13~~	~~14~~	~~0~~

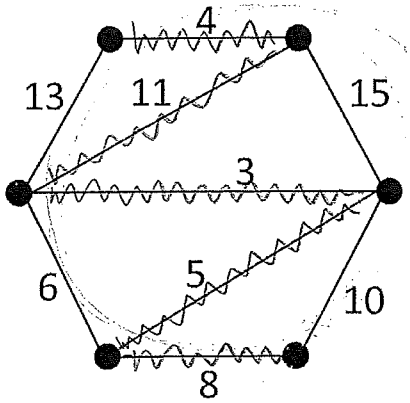


12 + 11 + 12 + 13.

= 48

Question 2 [2 marks]

Show the minimum spanning tree on the following network.



4 + 11 + 3 + 5 + 8 = 31

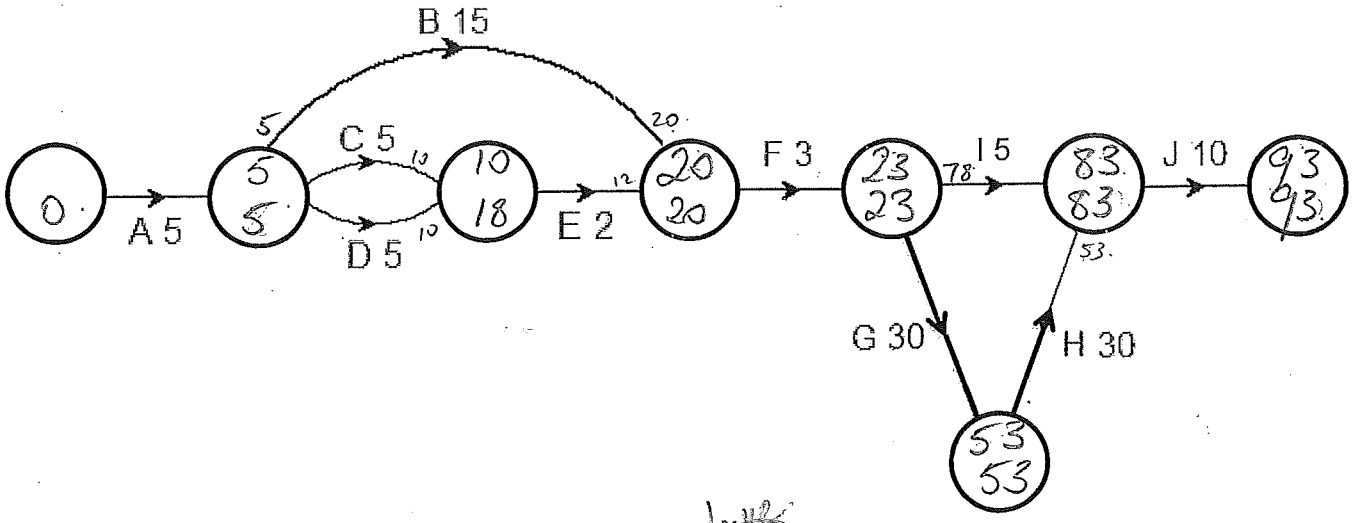
✓✓ correct + on network Not needed

✓x correct but not on network

OR ✓x 4 out of 5 correct.

Question 3 **[7 marks: 2, 2, 1, 2]**

Consider the following project network for baking a cake. All times are in minutes.



a) State the minimum amount of time required to back a cake?

93 minutes or 1hr 33 min.

b) State the critical path?

A5 → B15 → F3 → G30 → H30 → J10

ABFGHJ

c) Task I is icing making. What is the maximum amount of time icing making can be delayed before there is a change to the critical path?

78 − 23 = 55 or 83 − 28 = 55

55 minutes. 60 − 5 = 55

d) If Julie begins the project at 1:42 pm and uses all the float time allowed for making the icing and finishes this activity, she will finish at exactly 3:05 pm. Explain how this has been calculated.

93 min = 1 hr 53.

1:42 pm

+1 hr

2:42

33 +

95 min.

1:15

3:15

OR

1:42 pm +

83 min.

3:05 pm.

42 + 83 = 125

2:05

Finishes project @ 3:15

− 10 min for Task

= 3:05 pm.

Question 4 [9 marks: 1, 4, 2, 2]

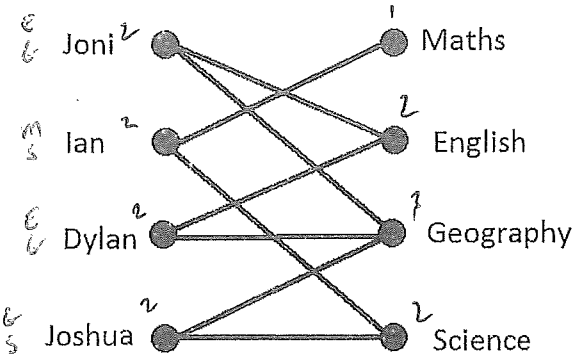
Joni, Ian, Dylan and Joshua are teachers in a school. The school has a Maths class, an English class, a Geography class and a Science class that need a teacher. Each teacher can be allocated one class only.

Joni can teach English or Geography. Ian can teach Maths or Science. Dylan can teach English or Geography. Joshua can teach Geography or Science.

a) What type of graph would be best to display this information?

Bipartite ✓

b) Construct a graph of the information above and use it to decide on the assignment of each teacher to a subject.



✓ Nodes / labels

✓ Edges / Allocations

Ian – Maths ✓ Ian + Joshua (only option avail)

Joshua – Science

Joni – English ✓ Joni & Dylan (can be other way)

Dylan - Geography

c) Explain why Joshua must take the Science class.

✓ ← must have to get 2nd ✓

Ian is the only teacher who can take maths, which means he cannot take science. Joshua is the only other teacher who can take science.

Or Joni + Dylan can only teach both english + Geography. So these 2 teachers must teach these 2 subjects ✓

d) Is there another possible assignment solution of teacher to subject? If so, write the alternative allocation, if not, explain why.

✓ leaving Joshua to be only able to teach Science

Yes ✓

Ian – Maths

Joshua – Science

Joni – Geography

Dylan - English ✓ Swap (b) for Joni & Dylan around

Student Name _____

Eastern Goldfields College
Mathematics Applications U3&4 2017
Test 5 – Calculator Assumed Section

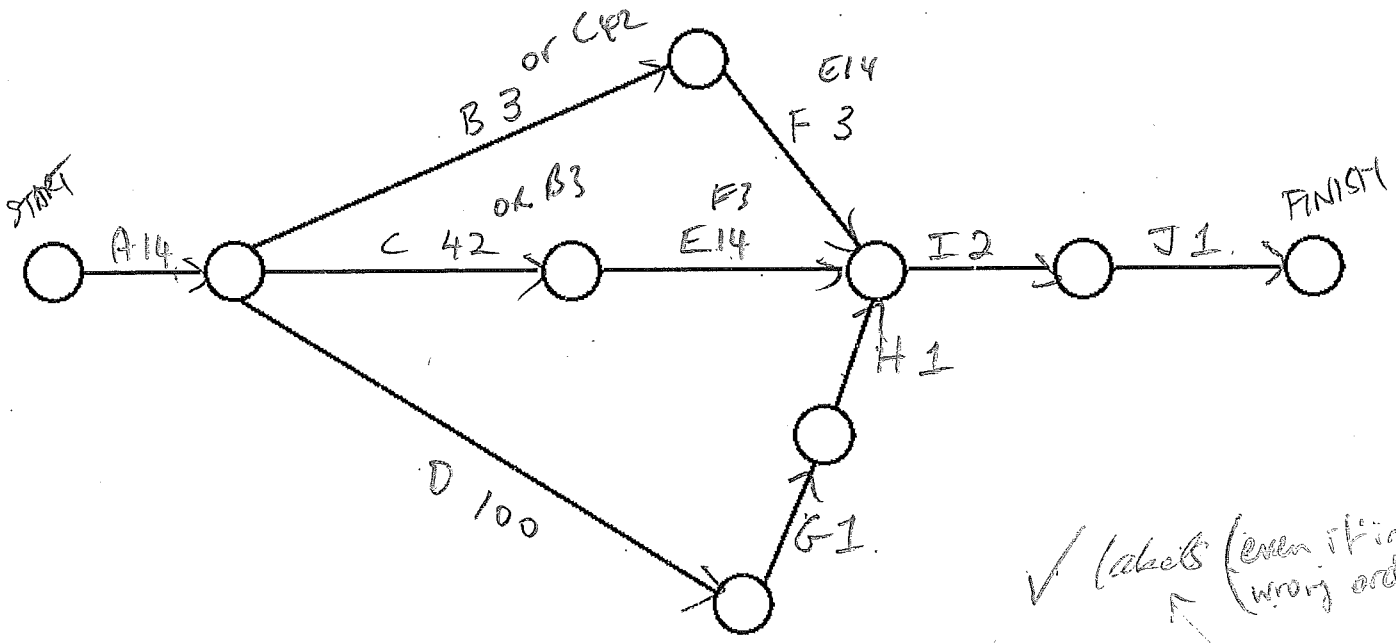
Working Time: 35 minutes | **Total Marks: 32 marks**

Question 1 [3 marks]

The tasks involved in a project, their immediate predecessors and duration, are shown below.

Task	A	B	C	D	E	F	G	H	I	J
Immediate predecessor	-	A	A	A	C	B	D	G	F, E, H	I
Duration (days)	14	3	42	100	14	3	1	1	2	1

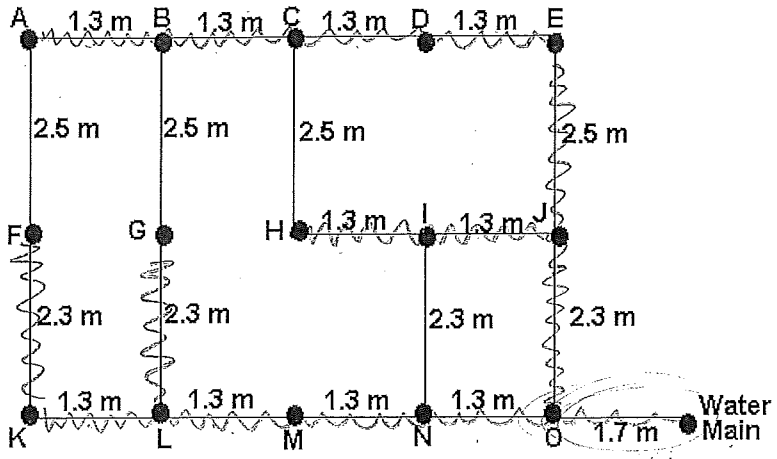
Add the information from the table to the project network below.
[Note: The diagram below is not drawn to scale]



✓ labels (even if in wrong order)
✓✓ rest.
-1 no direction.
-1 / error (max -3) can still receive

Question 2 [7 marks: 3, 2, 2]

The network below shows the existing pipes in a garden reticulation scheme. The letters A to O represent the watering stations and the network must be connected to the main as shown. The owner wishes to replace the old rusty pipes with new pipes so that the water may flow more efficiently.



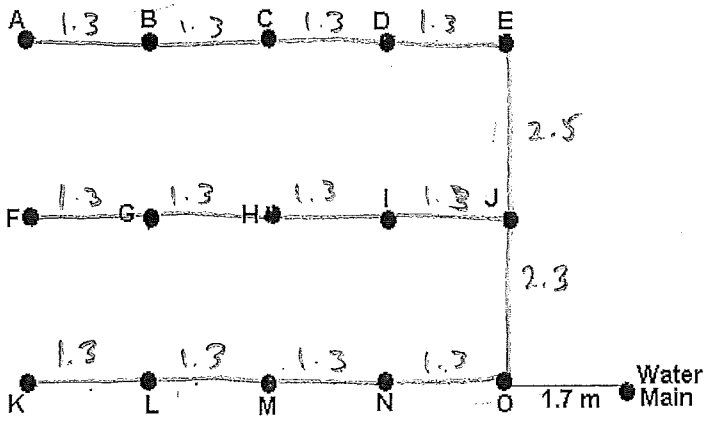
other trees possible

✓✓ p/w or ✓x if missed 1 pipe

a) What is the minimum amount of pipe that needs to be replaced so that each of the stations ***(A to O)*** is connected by new pipe to the water main. *(ie. Find the minimum spanning tree of the network).*

$1.7 + (1.3 \times 10) + (2.3 \times 3) + 2.5 = 24.1\text{ m}$ ✓F.T

b) The current layout has obvious inefficiencies. Using the measurements from above design a completely new layout that would allow the least amount of pipe to be used in the network. Show this on the network below.



other trees possible

✓✓ p/w.

c) Given that the new pipe cost $25 per metre to install, how much money would have been saved using your solution to part (b) instead of part (a).

$(1.3 \times 12) + 2.5 + 2.3 + 1.7 = 22.1\text{ m}$.

OR. $2 \times 25 = \$50$

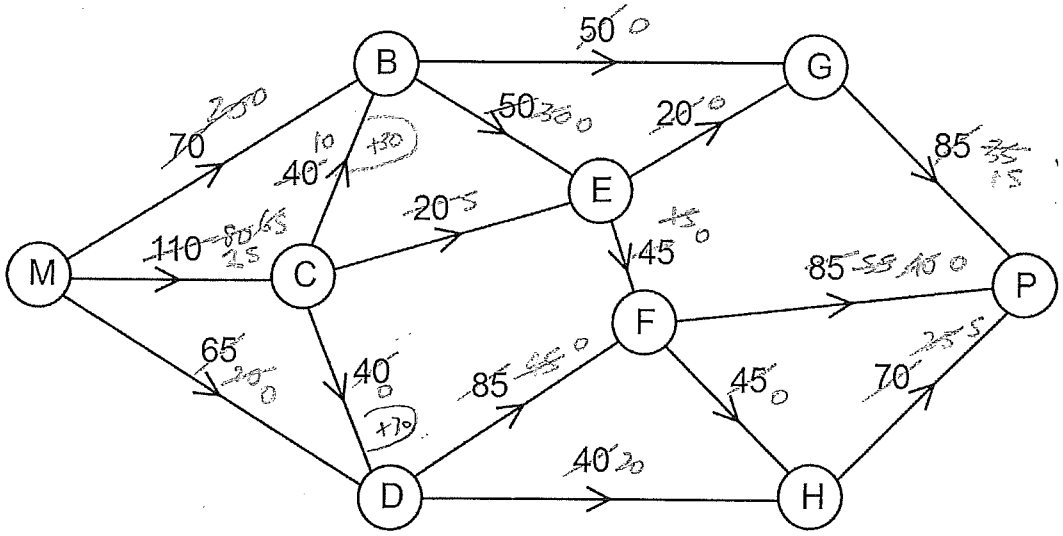
$24.1 \times 25 = \$602.50$

$22.1 \times 25 = \$552.50$

$\$50$ saving ✓ ✓F.T (a)(b)

Question 3 [10 marks: 5, 2, 3]

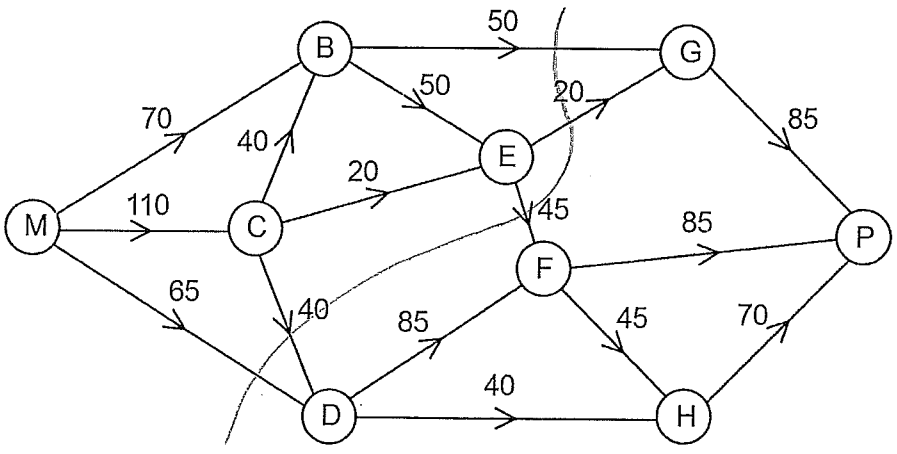
The network below shows the available paths to transport raw product from mine M to port P. The number on each arc is the maximum weight of raw product that can be moved along it, in hundreds of tonnes per hour.



(a) Determine the maximum weight of raw product that can be transported in one hour from the mine M to the port P. Show systematic working.

MBGP = 50
MBEGP = 20
MBEFP = 30
MCEFP = 15
MCDFP = 40
MDFHP = 15
MDHP = 20
Total = 220
∴ 22000 tonnes/hr.

(b) Show maximum flow equals minimum cut



(c) The mine transport manager has funds to increase the capacity of arc CB or arc CD by up to 3 000 tonnes per hour. Determine which, if either, would be the best to choose and calculate the new maximum weight of raw product that can be transported in one hour from the mine M to the port P. Justify your answer.

CD is better ✓ Will allow MCDHP an extra 500 tonnes (5×100) ✓ explanation

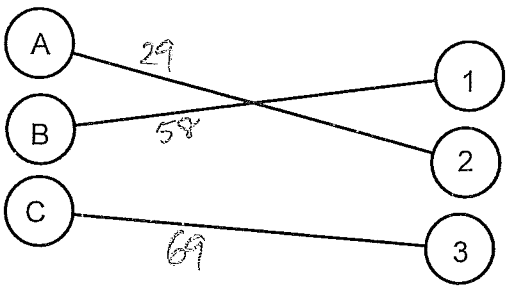
∴ new max flow 22500 ✓

Question 4 [12 marks: 1, 3, 8]

Four people needing a kidney transplant and four willing donors are ranked according to the potential for a successful transplant. 0 being not a successful match and 100 being a perfect match. The following table shows a summary of the results.

	Donor 1	Donor 2	Donor 3
Recipient A	26	29	30
Recipient B	58	55	56
Recipient C	75	78	69

a) If a computer randomly allocated recipients to donors and the allocation is shown below, calculate the potential success rate out of 300.



$\frac{156}{300} = 52\%$

$\frac{29+58+69}{300}$

b) Is there a better allocation of recipients to donors in order to maximise the chance of success? Justify your answer.

Yes D1 to B
D2 to C
D3 to A

$\frac{58+78+30}{300} = \frac{166}{300}$

55.3%

c) If another recipient and another donor are included in the process show how the Hungarian algorithm can be used to identify the maximum chances of success by matching the recipients to the donors. (There are blank tables on next page to assist you.)

	Donor 1	Donor 2	Donor 3	Donor 4
Recipient A	26	29	30	25
Recipient B	58	55	56	60
Recipient C	75	70	69	70
Recipient D	66	68	68	65

A – 3
B – 4
C – 1
D – 2

$\frac{233}{400} = 58\%$

-2 Not maximised. FT 2

	Donor 1	Donor 2	Donor 3	Donor 4	
Recipient A	~~26~~ 1 0	~~29~~ 4	~~30~~ 5	~~25~~ 0	-25
Recipient B	~~58~~ 5 2	~~55~~ 0	~~56~~ 1	~~60~~ 5	-55
Recipient C	~~75~~ 5 5	~~70~~ 1	~~69~~ 0	~~70~~ 1	-69
Recipient D	~~66~~ 1 0	~~68~~ 3	~~68~~ 3	~~65~~ 0	-65
	-1	-0	-0	-0	

	Donor 1	Donor 2	Donor 3	Donor 4
Recipient A	0	4	5	0
Recipient B	2	0	1	5
Recipient C	5		0	1
Recipient D	0	3	3	0

A 1 26.
B 2 55
C 3 69
D 4 65

A 4 25
B 2 55
C 3 69.
D 1 66.

= 215/400

	Donor 1	Donor 2	Donor 3	Donor 4
Recipient A				
Recipient B				
Recipient C				
Recipient D				

END OF TEST