AIC, MATHEMATICS LEARNING AREA
YEAR 12 MATHEMATICS APPLICATIONS – UNIT 4
Assessment Type: Response - 7%
TASK 9 - TEST 6 –Term 3, Week 7
CALCULATOR-ALLOWED

Syllabus Content: **4.2** Networks and Decision Mathematics

Student Name: Answer Key

ID: _____ Date: _____

TIME ALLOWED: 1 period under test conditions

MATERIAL REQUIRED / RECOMMENDED FOR THIS PAPER:

TO BE PROVIDED BY THE SUPERVISOR

Question/answer booklet.

TO BE PROVIDED BY THE CANDIDATE

Standard Items: pens, pencils, pencil sharpener, highlighter, eraser, ruler, calculator.

IMPORTANT NOTE TO CANDIDATES

No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be attempted	Suggested working time (minutes)	Marks available
Calculator Assumed	**5**	**5**	**50 minutes**	**42**
			Marks available:	**/42**
			Task Weighting	7%

Instructions to candidates

- The rules for the conduct of this examination are detailed in the booklet *WACE Examinations Handbook*. Sitting this examination implies that you agree to abide by these rules.
- Answer the questions in the spaces provided.
- Spare answer pages can be used. If you need to use them, indicate in the original answer space where the answer is continued.

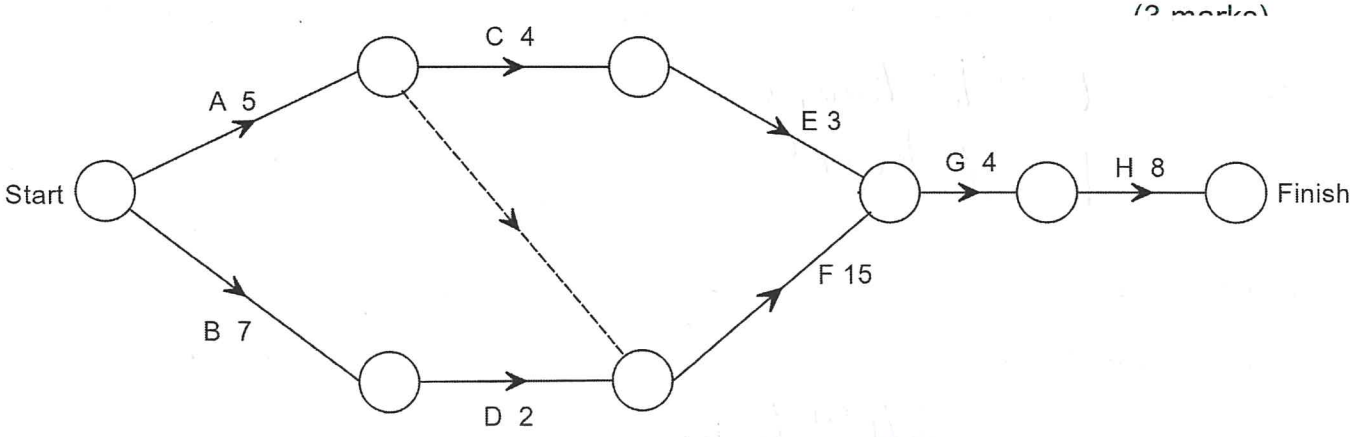
Question 1 **(12 marks)**

A farm project consists of eight activities. The activities, their duration times (in hours) and the immediate predecessors for each activity are shown in the table.

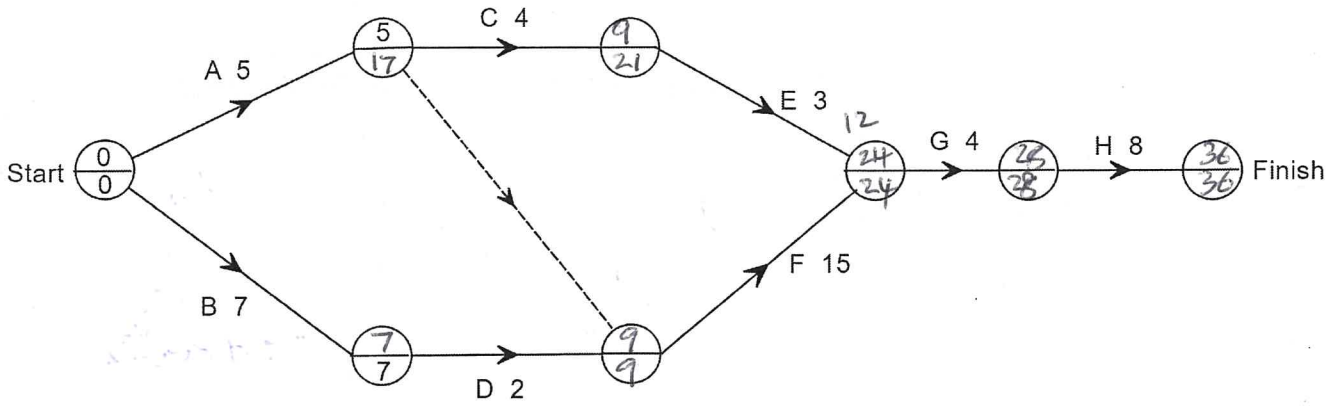
Activity	Completion Time	Immediate Predecessors
A	5	None
B	7	None
C	4	A
D	2	B
E	3	C
F	15	A, D ✓
G	4	E, F ✓
H	8	G ✓

(a) By referring to the diagram below, complete the table above by filling in the 3 missing values in the last column.

(3 marks)



(b) Complete the network below showing the earliest possible starting time (EST) and the latest starting time (LST), where these are the top and bottom numbers respectively in each node. (2 marks)



(c) Determine the minimum completion time and the critical path. (2 marks)

BDFGH, 36 hours

(d) Calculate the float (slack) time for activities E and F. (2 marks)

E = 12 hours
F = 0 hours

(e) Calculate:

(i) the earliest possible starting time for activity G. (1 mark)

24th hour

(ii) the latest possible starting time for activity A. (1 mark)

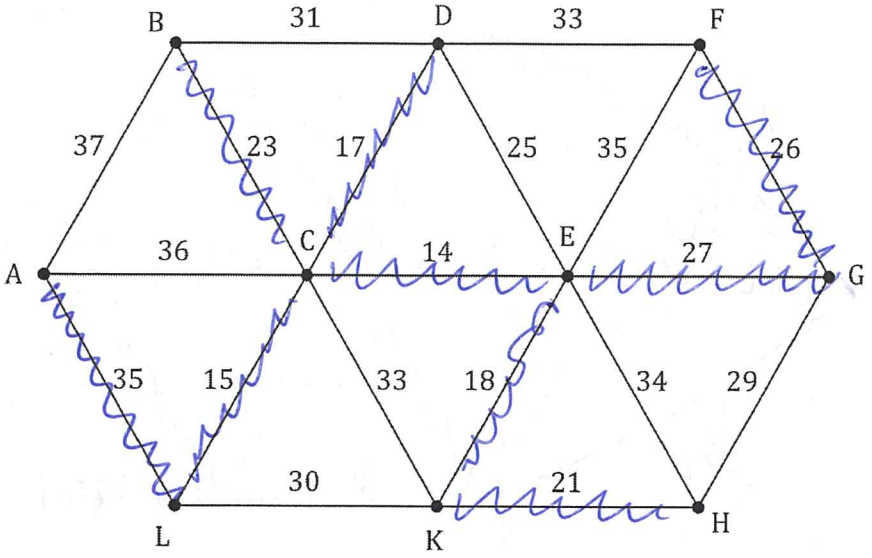
12th hour

(f) If activity A is delayed by five hours, what effect, if any, will it have on the completion time of the project? (1 mark)

No effect

Question 2 **(8 marks)**

Ten mains-powered smoke alarms (represented by the letters in the graph below) must be installed in a building. The edge weights on the graph represent the length of the cable, in metres, required between adjacent alarms.



(a) Clearly identify (highlight) the minimum spanning tree on the graph above.(3 marks)

Any tree ✓ All correct ✓
Partially correct ✓

(b) Determine the cost of installing the cabling between the alarms using the minimum spanning tree, given that each metre of cabling will cost $21.50. (2 marks)

$35+15+23+17+14+18+21+27+26$

$= 196\text{m}$ ✓

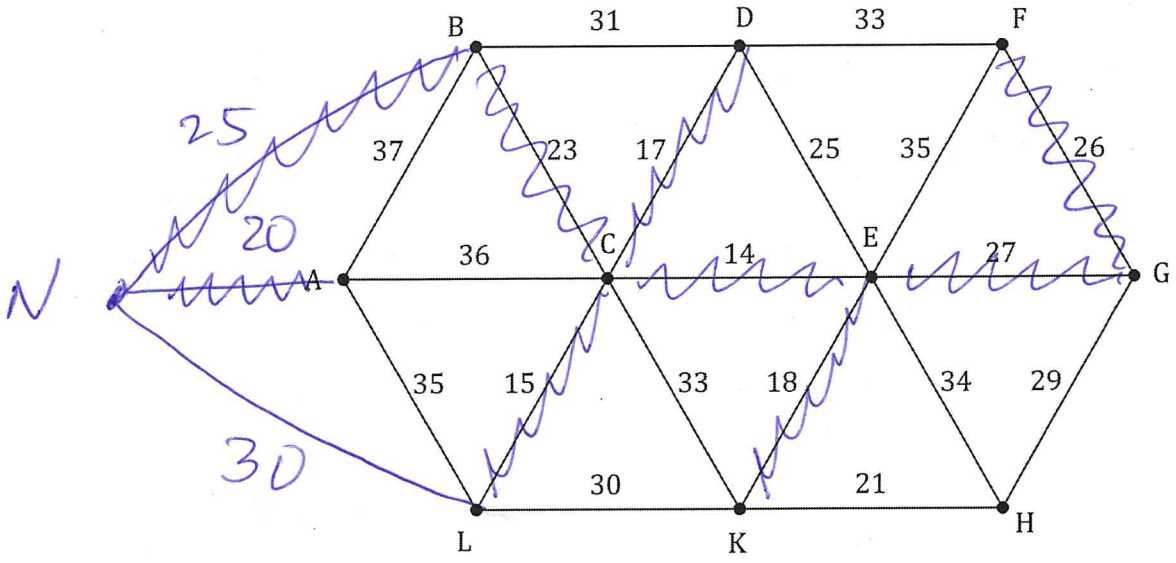
Total cost 196×21.50

$= \$4214$

(c) Explain how your answer to part (b) will change if smoke alarm N is added to the system with cable lengths of $20, 25$ and 30 metres to alarms A, B and L respectively.

(A copy of the graph from the previous page is shown below if you wish to use it.)

(3 marks)



Minimum Spanning Tree changes

AL no longer used

AN included, BN included ✓

(Any one point above)

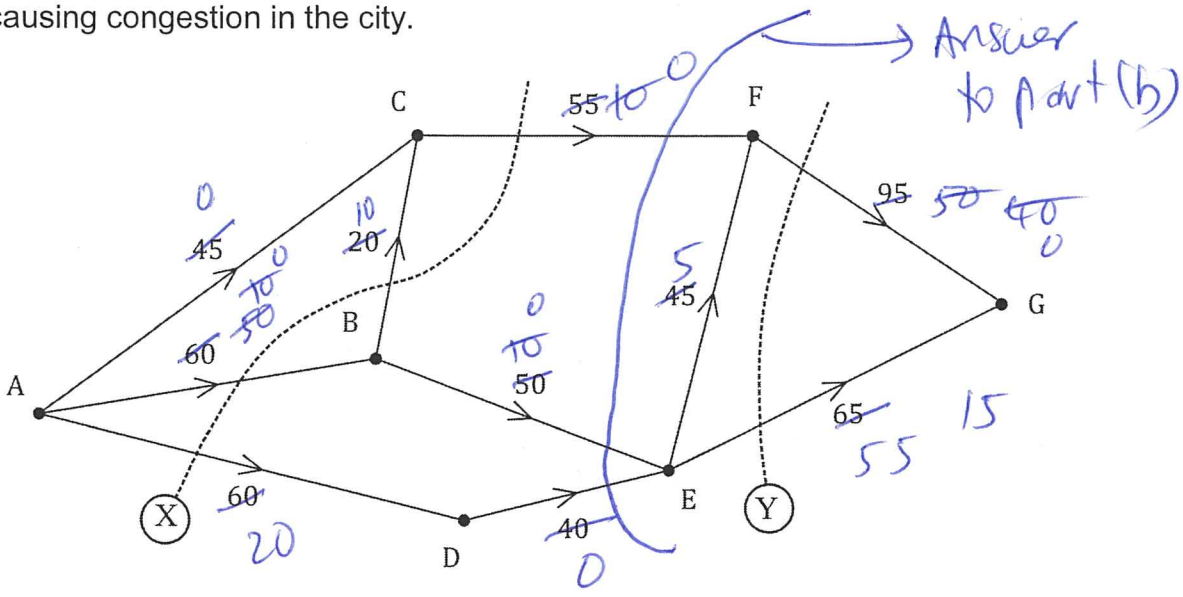
MST is now 206m

Total cost is $4429

or increased by $215

Question 3 **(7 marks)**

When a city bypass is closed, traffic that would normally use it is forced to flow through main roads in the city. The edge weights on the directed graph below show the maximum number of vehicles per minute that can travel between junctions (represented by vertices) without causing congestion in the city.



(a) Determine the value of cut X and the value of cut Y. (2 marks)

$X = 60+60+0+55 = 175$ vpm ✓

$Y = 95+65 = 160$ vpm ✓

(b) Determine the maximum flow of vehicles per hour from A to G. (3 marks)

ACFG = 45 ✓

ABCFG = 10

ABEFG = 40

ABEG = 10

ADEG = 40

= 145 vpm ✓

× 60

= 8700 vehicles per hour ✓

(c) City engineers recommend taking steps to improve traffic flow between junctions D and E. Determine, with reasoning, the maximum increase in the hourly flow of vehicles from A to G that their plan could achieve. (2 marks)

Spare capacity along ADEG = 20+0+15 ✓

increase by 15

Max possible increase

15 × 60

= 900 vph ✓

OR Cut Y (not using DE)

160 − 145 = 15

Question 4 **(10 marks)**

A telemarketing company has three workers: Awis, Geme and Haikal.

These three workers are to be assigned to one of four contracts (A, B, C or D). The number of successful sign-ups is shown in the table below.

	Contract A	Contract B	Contract C	Contract D
Awis	16	12	8	18
Geme	20	15	8	16
Haikal	18	11	17	15

Each worker must be assigned to just one company, and no contract can have more than one worker. The company wishes to **maximise** the number of successful sign-ups.

(a) Before starting the Hungarian algorithm, two steps must be taken to re-draw the above table. Mention the two steps that need to be taken. (2 marks)

→ Identify maximum number in matrix ✓ and subtract all other entries from this number

→ Add a dummy row ✓

(b) Fill in the table with values after the above two steps have been taken (2 marks)

4	8	12	2
0	5	12	4
2	9	3	5
0	0	0	0

✓ ✓

(c) Begin the process of the Hungarian algorithm to determine which contract must be given to which worker: (4 marks)

2	6	10	0
0	5	12	4
0	7	1	3
0	0	0	0

✓

Column minimum unchanged

3	6	10	0
0	4	11	3
0	6	0	2
1	0	0	0

✓ ✓

			✓
✓			
		✓	

✓

(d) Complete the table below indicating which contract is assigned to which worker. (1 mark)

	Awis	Geme	Haikal
Contract	D	A	C

✓

(e) State the maximum number of sign-ups after the contracts have been awarded. (1 mark)

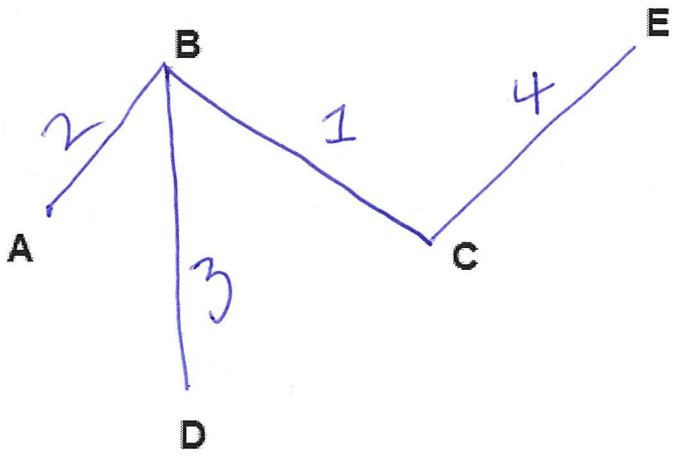
18 + 20 + 17 = 55 sign ups

Q5 : (2, 3 = 5 marks)

(a) Use Prims Algorithm to determine the minimum spanning distance.

	A	B	C	D	E
A	-	2	3	7	6
B	2	-	1	3	-
C	3	1	-	4	4
D	7	3	4	-	5
E	6	-	4	5	-

(b) Draw the *weighted* minimum spanning tree from your findings in (a) (i) by clearly joining the edges.



End of Test: EXTRA WORKING PAGE