TRINITY COLLEGE

Year 12 Mathematics Applications
Test 6 2017

Calculator Free

Project Networks and Assignment Problems

STUDENT'S NAME _____

DATE: Wednesday 30th August **TIME:** 50 minutes **MARKS**: 50

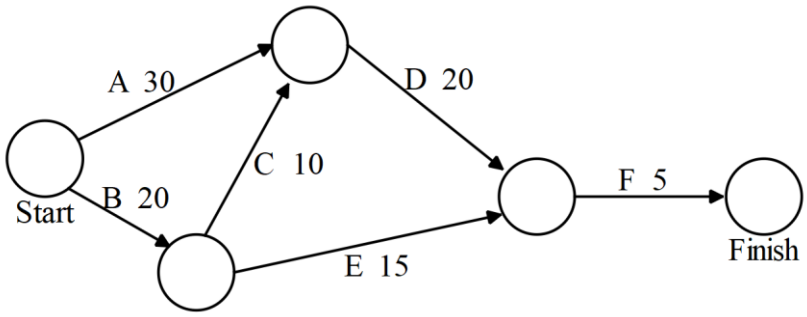
INSTRUCTIONS:
Standard Items: Pens, pencils, drawing templates, eraser

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

---

1. (5 marks)

In the following project network the times for activities A – F are given in minutes.



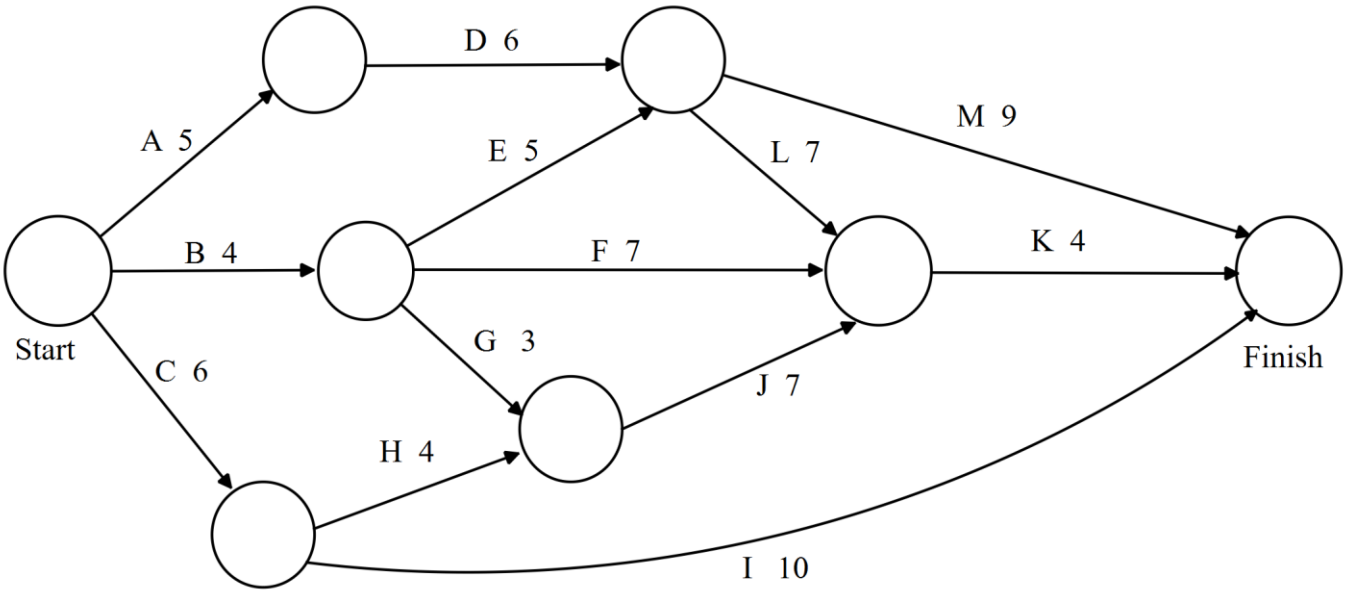
(a) State the minimum completion time and critical path(s) for the project. [2]

(b) Complete the precedent table below. [3]

Activity	Immediately Preceded by:
A	
B	
C	
D	
E	
F	

2. (11 marks)

A project consists of 13 activities, A to M. The project network representing the scheduling of these activities is shown below. The times are in hours.



(a) State the critical path and the minimum completion time for this project. [2]

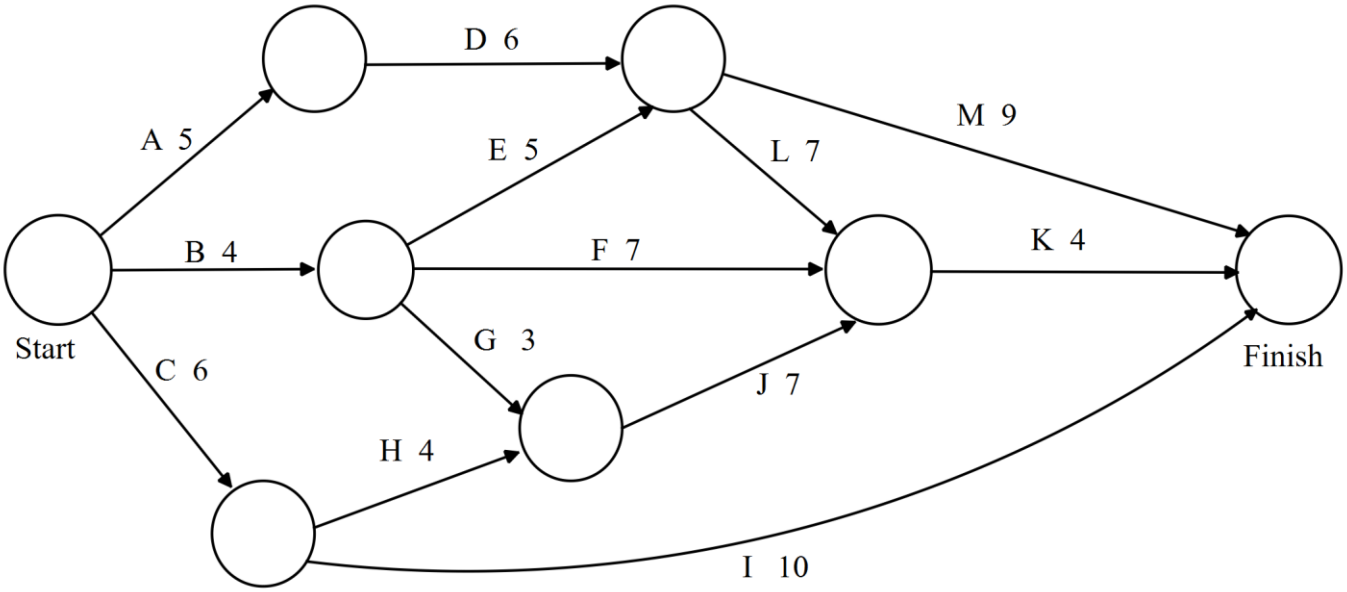
(b) Determine the:

(i) earliest starting time for activity F. [1]

(ii) latest start time for activity I. [1]

(iii) float time for activity H. [1]

A copy of the diagram is given below. It can be used to assist with parts (c) to (e).



(c) If activity C is delayed by 5 hours, what effect will this have on the critical path and the completion time? [2]

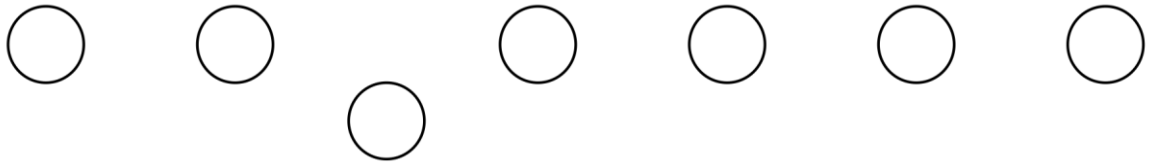
(d) If activity G is delayed by 3 hours, what is the maximum number of hours activity J can be delayed without effecting the minimum completion time? [2]

(e) A volunteer has offered three hours of their time to help reduce the time of one activity by 3 hours. Which task(s) could the organiser assign the volunteer to get the greatest reduction in the minimum completion time? [2]

3. (5 marks)

The table below describes the various activities involved in assembling a computer. Complete the project network for this table of activities.

Activity	Description of Activity	Immediate Predecessor	Time (min)
A	Install mother-board	-	4
B	Test hard drive	A	30
C	Install hard drive	B,E	4
D	Install I/O ports	A	5
E	Install GPU	D	5
F	Test GPU	B,E	8
G	Install operating system	C,F	15
H	Test assembled computer	G	12



4. (8 marks)

A company has four factories, F1, F2, F3 and F4, each of which can produce four products, A, B, C and D. The sales revenue and production cost, in thousands, of the factories differ from one plant to another and is given in the tables below.

	Sales Revenue in Factories			
Product	F1	F2	F3	F4
A	50	68	49	62
B	60	70	51	74
C	55	67	53	70
D	58	65	54	68

	Production Cost in Factories			
Product	F1	F2	F3	F4
A	49	60	45	61
B	55	63	45	49
C	52	62	49	68
D	55	64	48	66

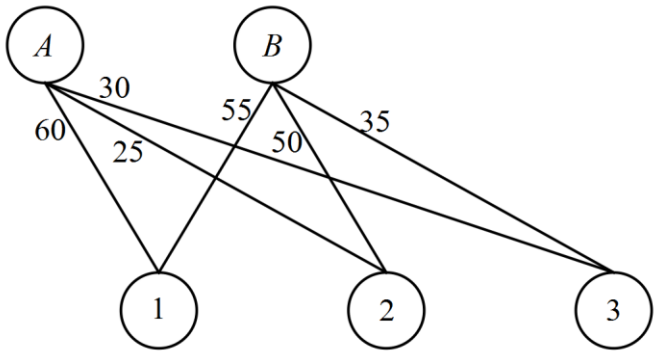
(a) Given that Profit = Revenue – Cost, fill in the missing values in the table below. [2]

	Profit in Factories			
Product	F1	F2	F3	F4
A	1			
B	5			
C	3	5	4	
D	3	1	6	

(b) By showing use of the Hungarian Algorithm, determine the optimal allocation of products to factories and the maximum profit associated. [6]

5. (11 marks)

Mr Smith is getting quotes to get some jobs done around his house. He needs the gutters cleaned (1), the windows washed (2) and his backyard weeded (3). He wants it all done on the same day so he will need to hire a different company to complete each job. The quotes (in dollars) for two companies, Aaron's A Team (A) and Bill's Bleachers (B) are shown in the bipartite graph below.



(a) If Mr Smith can complete one of the jobs himself to help minimise the cost, state:

(i) which of the three jobs he should do. [1]

(ii) the minimum cost and how he should allocate the remaining two jobs. [2]

Mr Smith is worried he won't have time to do any of the jobs himself so he decides to get two more companies to quote on the jobs. Their quotes are shown in the table below.

	Carl's Cleaners (C)	Damon's Dynamites (D)
Gutters Cleaned (1)	\$60	\$80
Windows Washed (2)	\$65	\$45
Backyard Weeded (3)	\$40	\$35

(b) Add the new information to the bipartite graph above. [2]

(c) By showing use of the Hungarian Algorithm, determine the optimal allocation of the three jobs to three different companies and the minimum cost associated. [6]

6. (10 marks)

Five jobs (1 to 5) are to be completed on five different machines (A to E). The associated costs are shown in the following table.

Job/Machine	**A**	**B**	**C**	**D**	**E**
1	9	3	1	13	1
2	1	17	13	20	5
3	0	14	8	11	4
4	19	3	0	5	5
5	12	8	1	6	2

The first few steps of the Hungarian Algorithm have been carried out to minimise the cost of completing the jobs. The resulting matrix below can be used to determine if an optimal solution has been found.

(a) Explain why the resulting matrix cannot be used to determine the optimal solution. [2]

$$\begin{bmatrix} 8 & 0 & 0 & 7 & 0 \\ 0 & 14 & 12 & 14 & 4 \\ 0 & 12 & 8 & 6 & 4 \\ 19 & 1 & 0 & 0 & 5 \\ 11 & 5 & 0 & 0 & 1 \end{bmatrix}$$

(b) Make any necessary adjustments needed to produce a matrix that can be used to determine an optimal solution. [3]

(c) State all optimal allocations and the minimum cost. [5]