

- McCANN
- SMITH
- QUAGLIA
- CONGDON
- EVES
- PATEL
- BUSH
- FOX
- OSBORNE

- (a) Use a quick sort to produce a list of these names in alphabetical order. You must make your pivots clear. (4)
- (b) Use the binary search algorithm on your list to locate the name PATEL. State the number of iterations you use. (3)

The binary search algorithm is to be used to search for a name in an alphabetical list of 641 names.

- (c) Find the maximum number of iterations needed, justifying your answer. (2)

2) M S Q C E P B F O Total 9 marks

C B E M S Q P F O

B C E M F O P S Q

B C E F M O P Q S

B C E F M O P Q S

B C E F M O P Q S

1 B X $\frac{1+9}{2} = 5^{th} = M$ reject 1-5

2 C X $\frac{6+9}{2} = 7.5^{th} \rightarrow 8^{th} = Q$ reject 8-9

3 E X

4 F X

5 M X

6 O $\frac{6+7}{2} = 6.5 \rightarrow 7^{th} = Patel$

7 P

8 Q X

9 S X

\therefore Patel is 7th in the list

c) 9, each iteration reduces it by half or half + 1

2. (a) (i) Define the term complete matching.

- (ii) Explain the difference between a complete matching and a maximal matching. (3)

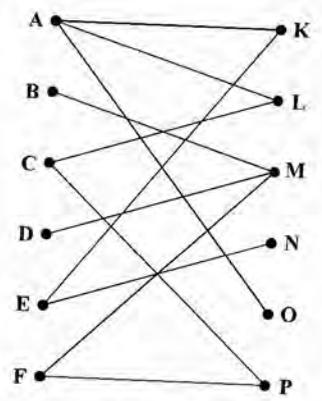


Figure 1

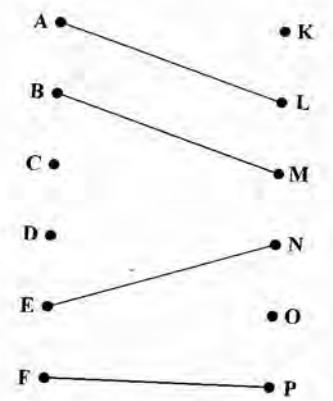


Figure 2

Figure 1 shows the possible allocations of dancing partners for the Truly Come Ballroom dancing competition. Six women, Annie (A), Bella (B), Chloe (C), Danika (D), Ella (E) and Faith (F), are to be paired with six men, Kieran (K), Lucas (L), Michael (M), Nasir (N), Oliver (O) and Paul (P).

Figure 2 shows an initial matching.

- (b) Use the maximum matching algorithm **once** to find an improved matching. You must state the alternating path you use and list your improved matching. (3)

After dance practice, it is decided that Bella could also be paired with Kieran, and Danika could also be paired with Nasir.

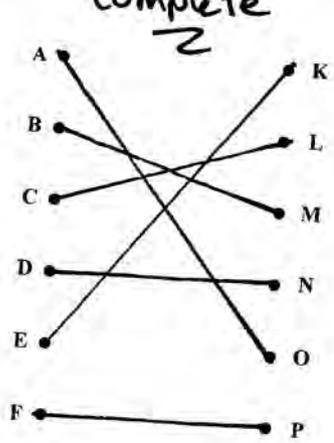
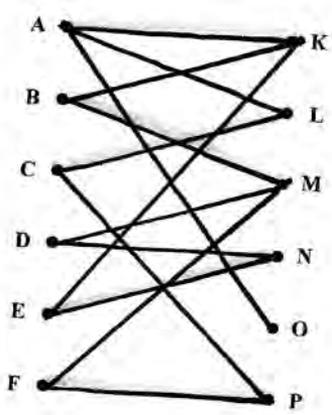
- (c) Starting with your improved matching from part (b), use the maximum matching algorithm to obtain a complete matching. You must state the alternating path you use and list your final matching. (3)

(Total 9 marks)

2. (a)

All the elements of set X are matched to all the elements of set Y in a 1-1 manner.

C-L = A-K cs C=L - A=K
 A=K B=M C=L E=N F=P



$$D-N = E-K = A-O \text{ as } D=N-E=K-A=0$$

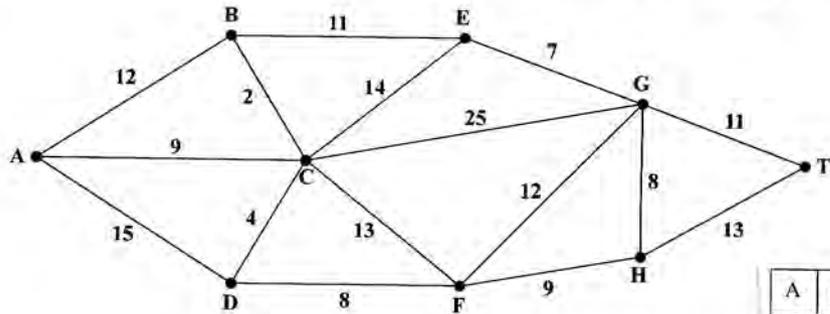


Figure 3

Figure 3 shows a network representing the time taken, in minutes, to travel by train between nine towns, A, B, C, D, E, F, G, H and T.

A train is to travel from A to T without stopping.

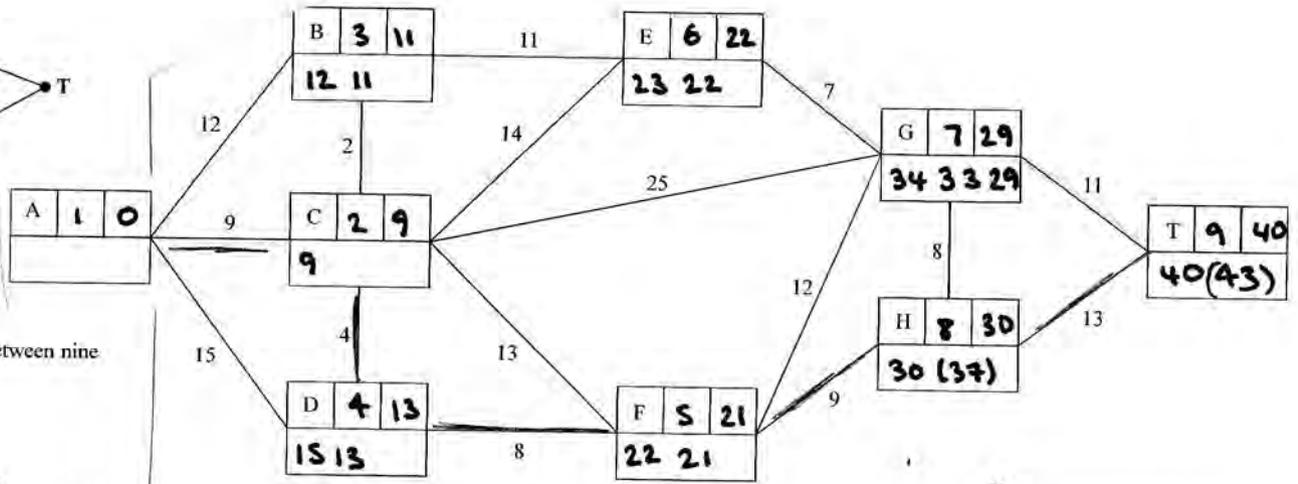
(a) Use Dijkstra's algorithm to find the quickest route from A to T and the time taken. (6)

At present, the train travels from A to T via F without stopping.

(b) Use your answer to (a) to find the quickest route from A to T via F and the time taken. (2)

A train is to travel from A to T, stopping for 2 minutes at each town it passes through on its route.

(c) Explain how you would adapt the network so that you could use Dijkstra's algorithm to find the quickest route for this train. You do not need to find this route. (2)



Key:

Vertex	Order of labelling	Final value
Working values		

a) ACBEGT (40)
 b) ACFHT (43)
 c) +2 to every arc except for GT and HT.

4. (a) State three differences between Prim's algorithm and Kruskal's algorithm for finding a minimum spanning tree.

(3)

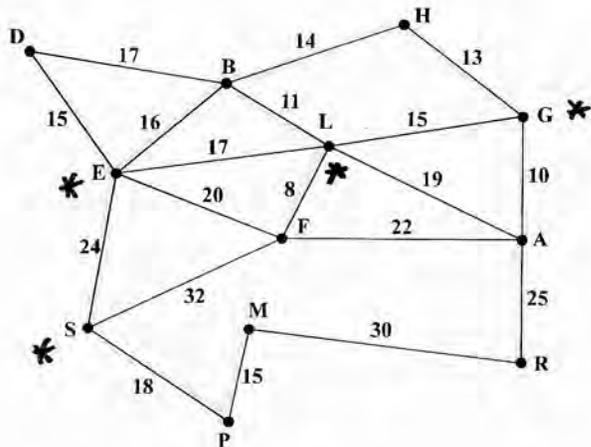


Figure 4

[The total weight of the network is 341]

- (b) Use Prim's algorithm, starting at D, to find a minimum spanning tree for the network shown in Figure 4. You must list the arcs in the order in which you select them.

(3)

Figure 4 models a network of school corridors. The number on each arc represents the length, in metres, of that corridor. The school caretaker needs to inspect each corridor in the school to check that the fire alarms are working correctly. He wants to find a route of minimum length that traverses each corridor at least once and starts and finishes at his office, D.

- (c) Use the route inspection algorithm to find the corridors that will need to be traversed twice. You must make your method and working clear.

(4)

The caretaker now decides to start his inspection at G. His route must still traverse each corridor at least once but he does not need to finish at G.

- (d) Determine the finishing point so that the length of his route is minimised. You must give reasons for your answer and state the length of his route.

(3)

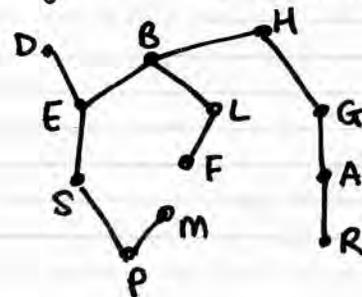
(Total 13 marks)

- a) Prim's can be applied to a matrix

no cycles/rejections with Prim's
(no need to check!)

Prim's grows a connected tree,
Kruskal's grows a disconnected tree.

- b) DE
EB
BL
LF
BH
HG
GA
ES
SP
PM
AR



$$= 169$$

c) ES 24 LG 15 \Rightarrow 39

EL 17 SG 55 \Rightarrow 72

EG 32 SL 40 \Rightarrow 72

repeat ES, LG + 39 = $\frac{380}{2}$

- d) repeat EL, finish at S

+17 = 358

EL is shortest pairing not inc G.
G cannot be paired as it must remain 'odd' on the starting node.

Michael and his team are making toys to give to children at a summer fair. They make two types of toy, a soft toy and a craft set.

Let x be the number of soft toys they make and y be the number of craft sets they make.

Each soft toy costs £3 to make and each craft set costs £5 to make.

Michael and his team have a budget of £1000 to spend on making the toys for the summer fair.

(a) Write down an inequality, in terms of x and y , to model this constraint.

(1)

Two further constraints are:

$$y \leq 2x$$

$$4y - x \geq 210$$

(b) Add lines and shading to Diagram 1 in the answer book to represent all of these constraints. Hence determine the feasible region and label it R.

(4)

Michael's objective is to make as many toys as possible.

(c) State the objective function.

(1)

(d) Determine the exact coordinates of each of the vertices of the feasible region, and hence use the vertex method to find the optimal number of soft toys and craft sets Michael and his team should make. You should make your method clear.

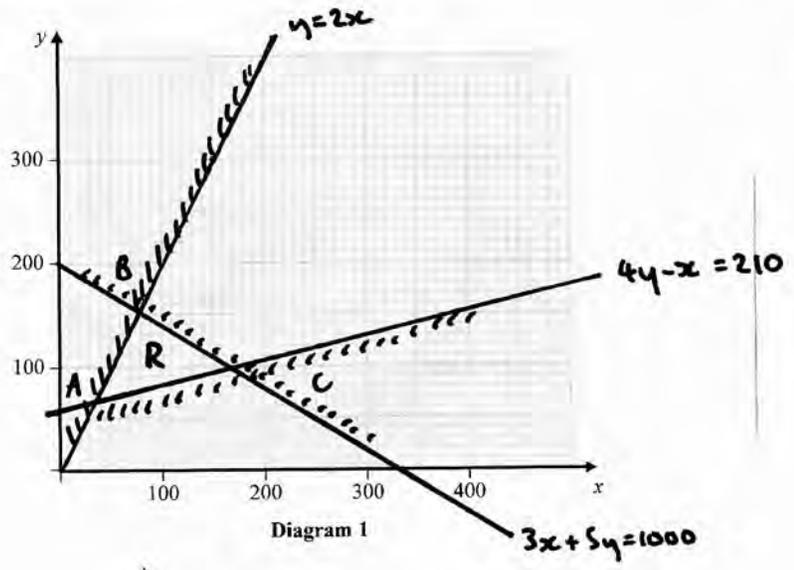
(7)

5. (a)

$$3x + 5y \leq 1000$$

(Total 13 marks)

(b)



$$z = 170, y = 100$$

$$x = 390, y = 150$$

c) $\max x+y$

d) (A) $y = 2x, 4y - x = 210, 7x = 210 \therefore x = 30, y = 60$

(B) $y = 2x, 3x + 5y = 1000, 13x = 1000, x = \frac{1000}{13}, y = \frac{2000}{13}$

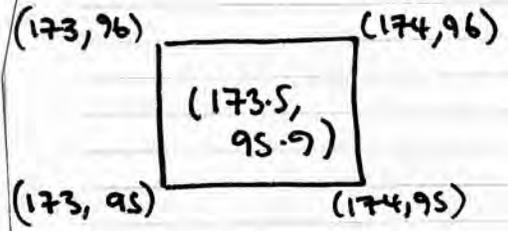
(C) $x = 4y - 210 \Rightarrow 12y - 630 + 5y = 1000, 17y = 1630, y = \frac{1630}{17}, x = \frac{2950}{17}$

A(30,60)
 B($\frac{1000}{13}, \frac{2000}{13}$) C($\frac{2950}{17}, \frac{1630}{17}$)

(A) $x+y = 90$

(B) $x+y = 230.8$

(C) $x+y = 269.4 \therefore C! = \max \text{ toys}$



	$3x+5y \leq 1000$	$4y-x \geq 210$	$T=x+y$
(174, 96)	1002 X		
(173, 96)	999 ✓	211 ✓	<u>269</u>
(174, 95)	997 ✓	206 X	
(173, 95)	994 ✓	207 X	

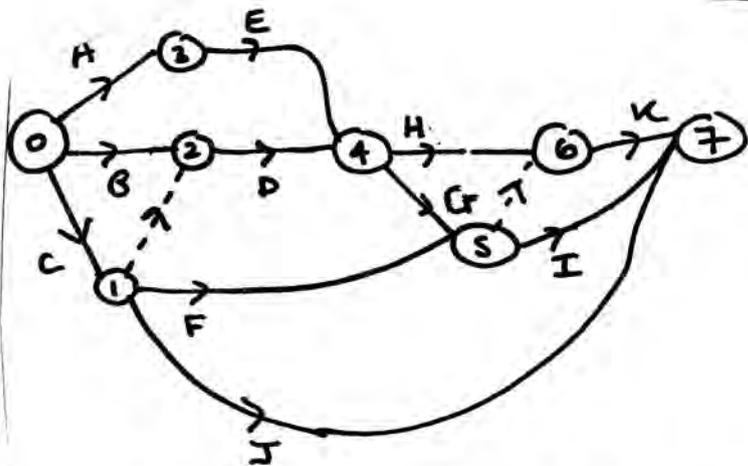
173 soft toys
 96 craft sets
 = 269 toys made

6. (a) Draw the activity network described in this precedence table, using activity on arc and dummies only where necessary. (5)

Activity	Immediately preceding activities
A	-
B	-
C	-
D	B, C
E	A
F	C
G	D, E
H	D, E
I	F, G
J	C
K	G, H

- (b) Explain the possible reasons dummies may be needed in activity networks. (2)

(Total 7 marks)



①② D depends on B and C but F depends on C only

⑤⑥ No two activities may share the same start and end event

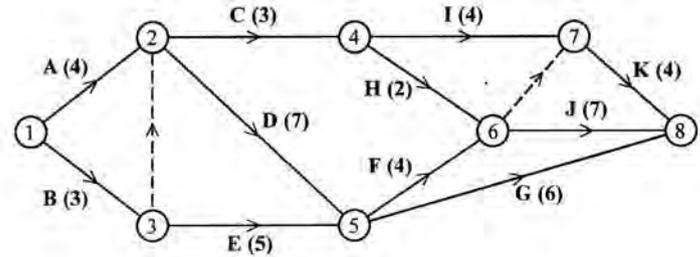


Figure 5

A company models a project by the activity network shown in Figure 5. The activities are represented by the arcs. The number in brackets on each arc gives the time, in days, to complete the activity. Each activity requires exactly one worker. The project is to be completed in the shortest possible time.

- (a) Add early and late event times to Diagram 1 in the answer book. (3)
- (b) State the critical path and its length. (2)
- (c) On Diagram 2 in the answer book, construct a cascade (Gantt) chart. (4)
- (d) By using your cascade chart, state which activities **must** be happening at:

- (i) time 7.5
(ii) time 16.5

(2)

It is decided that the company may use up to 25 days to complete the project.

- (e) On Diagram 3 in the answer book, construct a scheduling diagram to show how this project can be completed within 25 days using as few workers as possible. (3)

(Total 14 marks)

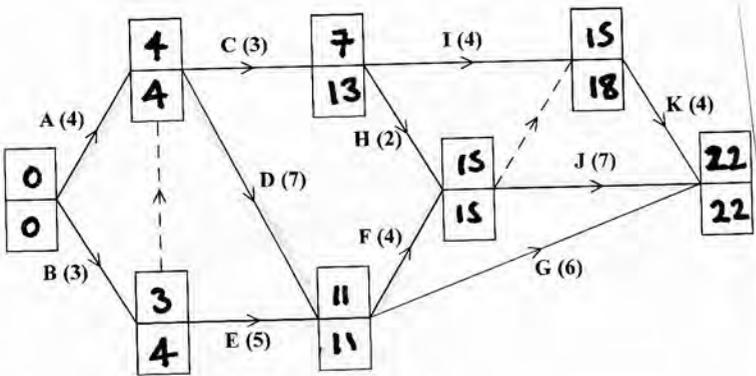


Diagram 1

(b) Critical Path **ADFJ**
 Length **22**

(c) ANSWER THIS ON DIAGRAM 2 (LARGE GRID) ON OPPOSITE PAGE.

(d) Time 7.5 **D, E**
 Time 16.5 **J,**

(e) ANSWER THIS ON DIAGRAM 3 (SMALL GRID) ON OPPOSITE PAGE.

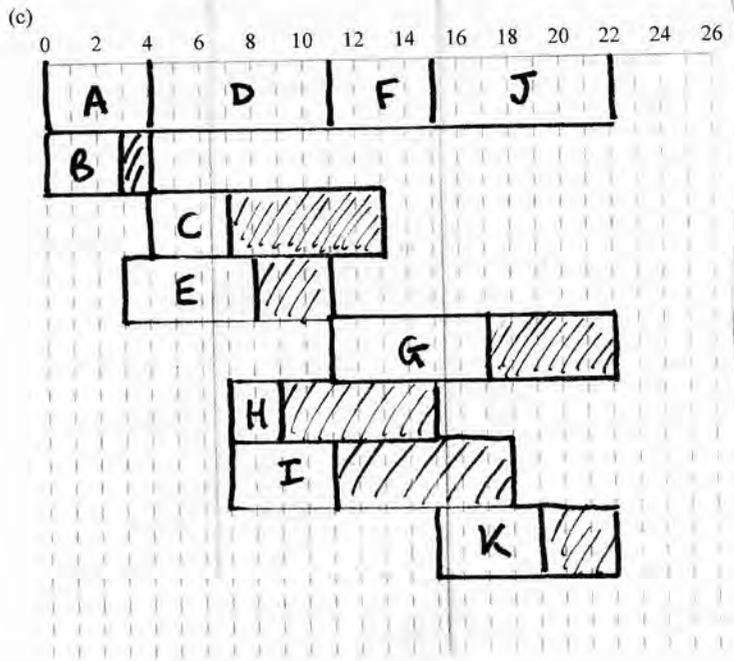


Diagram 2

