Write your name here

Surname	Other names

Pearson Edexcel GCE

Centre Number	Candidate Number

AS and A level Further Mathematics
Decision Mathematics 1

Practice Paper
Route inspection problems

You must have:
Mathematical Formulae and Statistical Tables (Pink)

Total Marks

Instructions

- Use black ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer all the questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – there may be more space than you need.
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Inexact answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 9 questions in this question paper. The total mark for this paper is 100.
- The marks for each question are shown in brackets – use this as a guide as to how much time to spend on each question.
- Calculators must not be used for questions marked with a * sign.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

1.

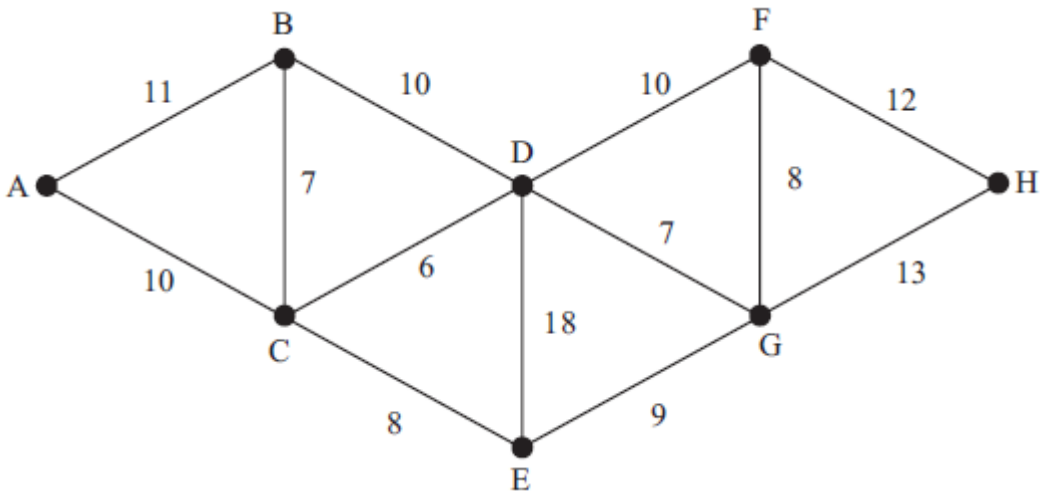

Figure 1

[*The weight of the network is 129 miles*.]

Figure 1 models a network of canals. The number on each arc gives the length, in miles, of that canal.

Brett needs to travel along each canal to check that it is in good repair. He wishes to minimise the length of his route.

(*a*) Use the route inspection algorithm to find the length of his route. State the arcs that should be repeated. You should make your method and working clear.

(6)

A canal between B and F, of length 12 miles, is to be opened and needs to be included in Brett's inspection route.

(*b*) Determine if the addition of this canal will increase or decrease the length of Brett's minimum route. You must make your reasoning clear.

(2)

(Total 8 marks)

2.

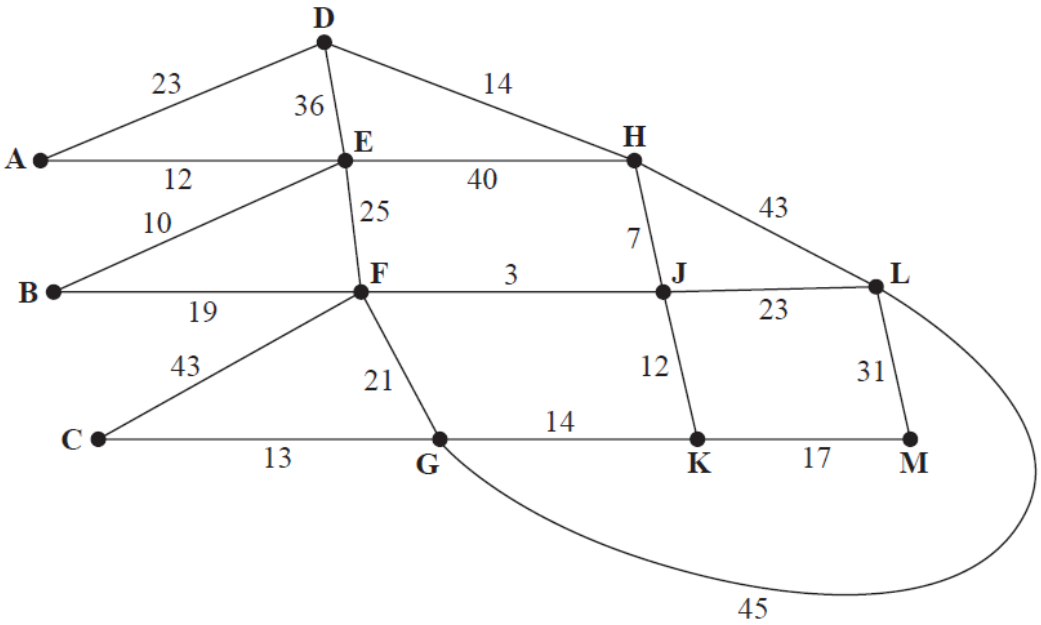

Figure 2

[The total weight of the network is 451]

Figure 2 models a network of tracks in a forest that need to be inspected by a park ranger. The number on each arc is the length, in km, of that section of the forest track.

Each track must be traversed at least once and the length of the inspection route must be minimised. The inspection route taken by the ranger must start and end at vertex A.

(*a*) Use the route inspection algorithm to find the length of a shortest inspection route. State the arcs that should be repeated. You should make your method and working clear.

(5)

(*b*) State the number of times that vertex J would appear in the inspection route.

(1)

The landowner decides to build two huts, one hut at vertex K and the other hut at a different vertex. In future, the ranger will be able to start his inspection route at one hut and finish at the other. The inspection route must still traverse each track at least once.

(*c*) Determine where the other hut should be built so that the length of the route is minimised. You must give reasons for your answer and state a possible route and its length.

(4)

(Total 10 marks)

3.

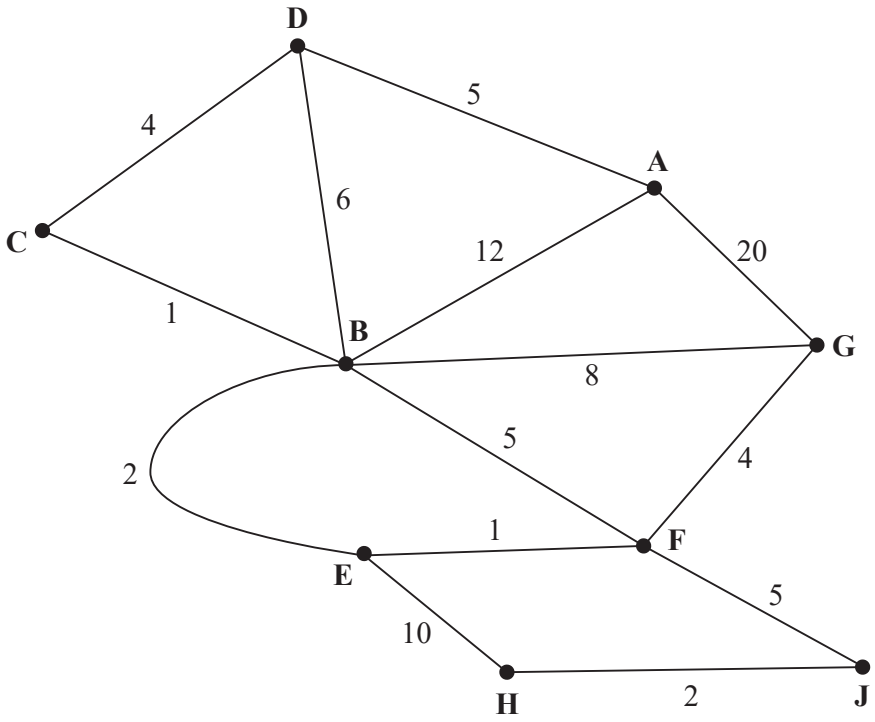

Figure 3

[*The total weight of the network is 85*]

Figure 3 represents a network of roads. The number on each edge represents the length, in miles, of the corresponding road. Robyn wishes to travel from A to H. She wishes to minimise the distance she travels.

(*a*) Use Dijkstra's algorithm to find the shortest path from A to H. State the shortest path and its length.

(6)

On a particular day, Robyn needs to check each road. She must travel along each road at least once. Robyn must start and finish at vertex A.

(*b*) Use the route inspection algorithm to find the length of the shortest inspection route. State the edges that should be repeated. You should make your method and working clear.

(5)

The roads BD and BE become damaged and cannot be used. Robyn needs to travel along all the remaining roads to check that there is no damage to any of them. The inspection route must still start and finish at vertex A.

(*c*) (i) State the edges that should be repeated.

(ii) State a possible route and calculate its length. You must make your method and working clear.

(4)

(Total 15 marks)

4.

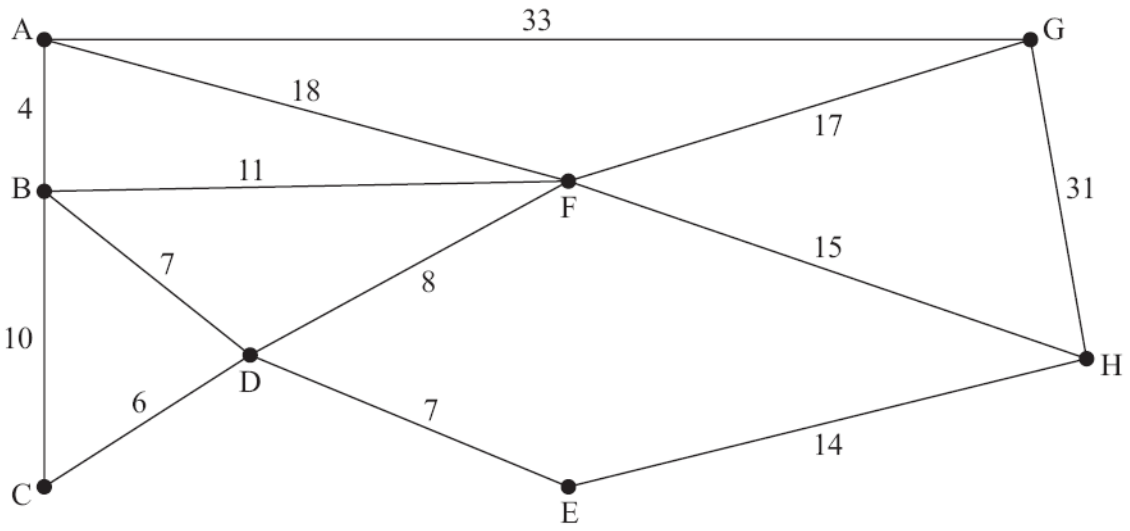

Figure 4

[*The total weight of the network is 181 miles*]

Figure 4 represents a network of power cables that have to be inspected. The number on each arc represents the length, in km, of that cable.

A route of minimum length that traverses each cable at least once and starts and finishes at A needs to be found.

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

(5)

(*b*) Write down a possible shortest inspection route, giving its length.

(2)

It is now decided to start and finish the inspection route at two distinct vertices. The route must still traverse each cable at least once.

(*c*) Determine possible starting and finishing points so that the length of the route is minimised. You must give reasons for your answer.

(3)

(Total 10 marks)

5.

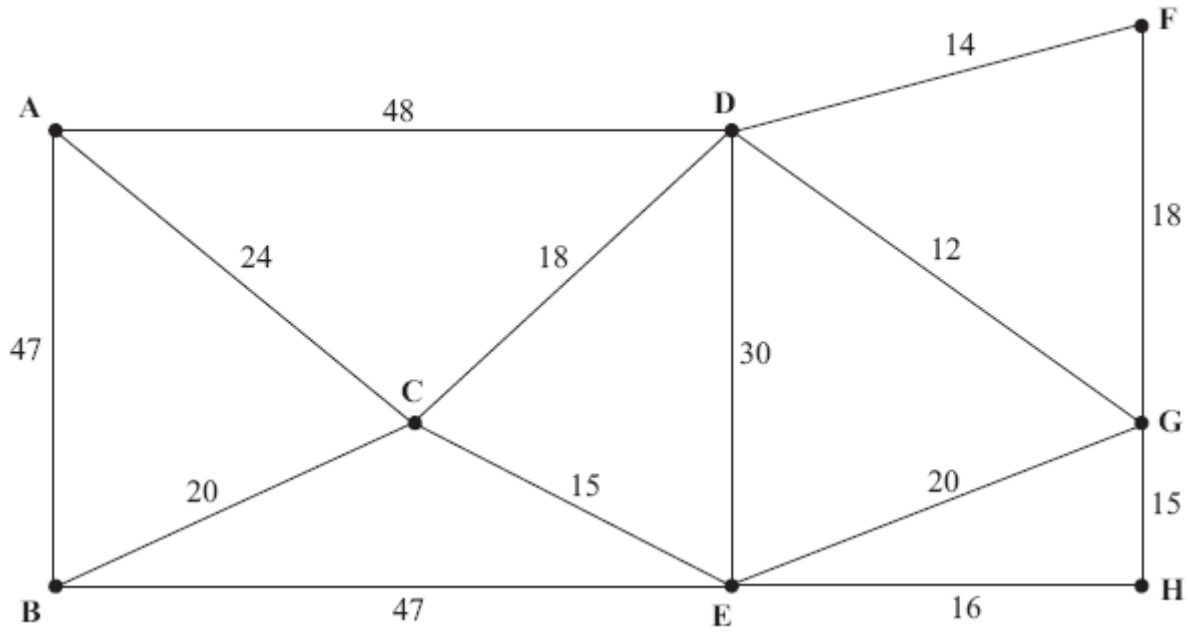

Figure 5

[*The total weight of the network is 344 miles*]

Figure 5 represents a railway network. The number on each arc represents the length, in miles, of that section of the railway.

Sophie needs to travel along each section to check that it is in good condition.

She must travel along each arc of the network at least once, and wants to find a route of minimum length. She will start and finish at **A**.

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

(5)

(*b*) Write down a possible shortest inspection route, giving its length.

(2)

Sophie now decides to start the inspection route at **E**. The route must still traverse each arc at least once but may finish at any vertex.

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

(3)

(Total 10 marks)

6.

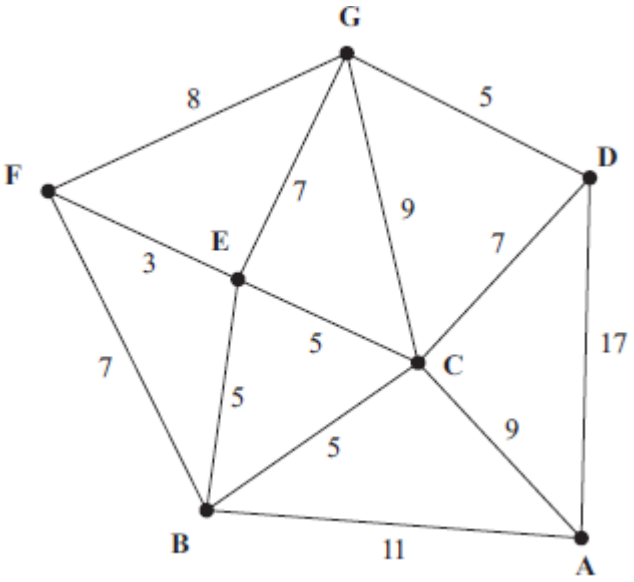

Figure 6

[*The total weight of the network is 98 km*.]

Figure 6 models a network of gas pipes that have to be inspected. The number on each arc represents the length, in km, of that pipe.

A route of minimum length that traverses each pipe at least once and starts and finishes at **A** needs to be found.

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

(5)

(*b*) Write down a possible shortest inspection route, giving its length.

(2)

It is now decided to start the inspection route at **D**. The route must still traverse each pipe at least once but may finish at any node.

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

(3)

(Total 10 marks)

7.

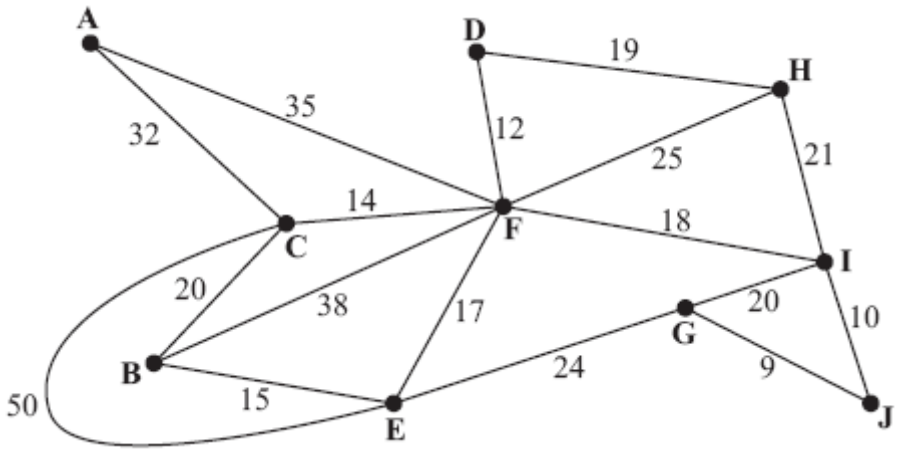

Figure 7

[The weight of the network is 379]

Figure 7 represents the roads in a highland wildlife conservation park. The vertices represent warden stations. The number on each arc gives the length, in km, of the corresponding road.

During the winter months the park is closed. It is only necessary to ensure road access to the warden stations.

(*a*) Use Prim's algorithm, starting at **A**, to find a minimum connector for the network in Figure 5. You must state the **order** in which you include the **arcs**.

(3)

(*b*) Given that it costs £80 per km to keep the selected roads open in winter, calculate the minimum cost of ensuring road access to all the warden stations.

(2)

At the end of winter, Ben inspects all the roads before the park re-opens. He needs to travel along each road at least once. He will start and finish at **A**, and wishes to minimise the length of his route.

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

(6)

(*d*) Find the length of the shortest inspection route.

(1)

If Ben starts and finishes his inspection route at different warden stations, a shorter inspection route is possible.

(*e*) Determine the two warden stations Ben should choose as his starting and finishing points in order that his route has minimum length. Give a reason for your answer and state the length of the route.

(3)

(Total 15 marks)

8.

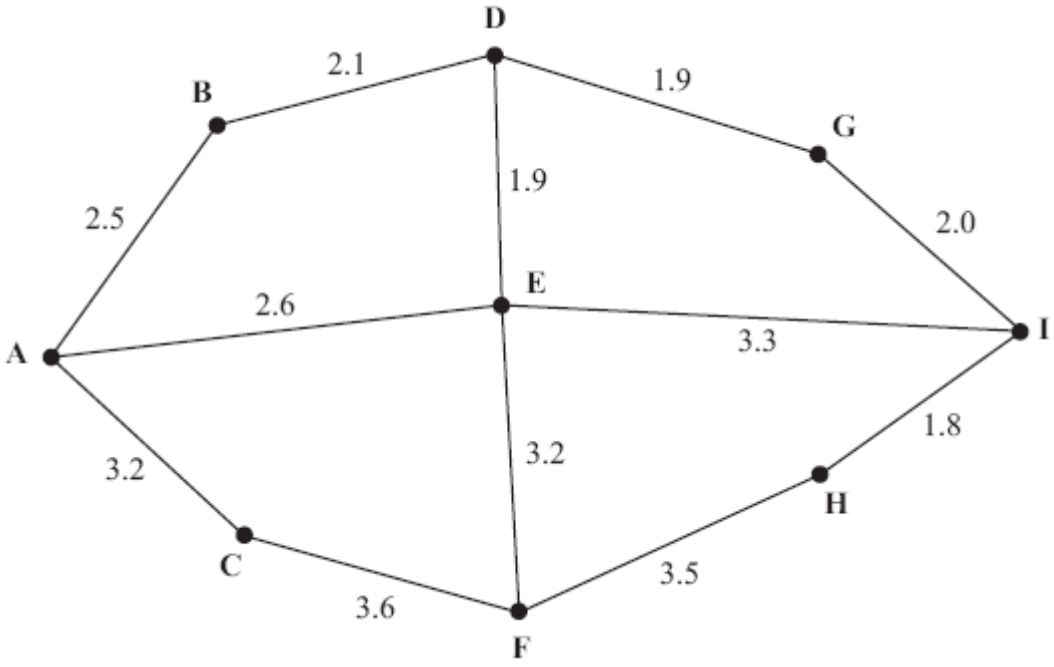

Figure 8

[*The total weight of the network is* 31.6 *km*]

Figure 8 models a network of roads. The road markings on these roads are to be renewed. The number on each arc represents the length, in km, of that road. In order to renew the road markings, each road must be traversed at least once.

(*a*) Use the route inspection algorithm, starting and finishing at **A**, to find a suitable route, which should be stated. You must make your method and working clear.

(5)

(*b*) State the roads that must be traversed twice and the length of the route.

(3)

The machine that will be used to renew the road markings can only be delivered to **D**. It will start at **D**, but it may finish at any vertex.

Each road must still be traversed at least once.

(*c*) Given that the route is to be minimised, determine where the machine should finish. Give reasons to justify your answer.

(3)

(Total 11 marks)

9.

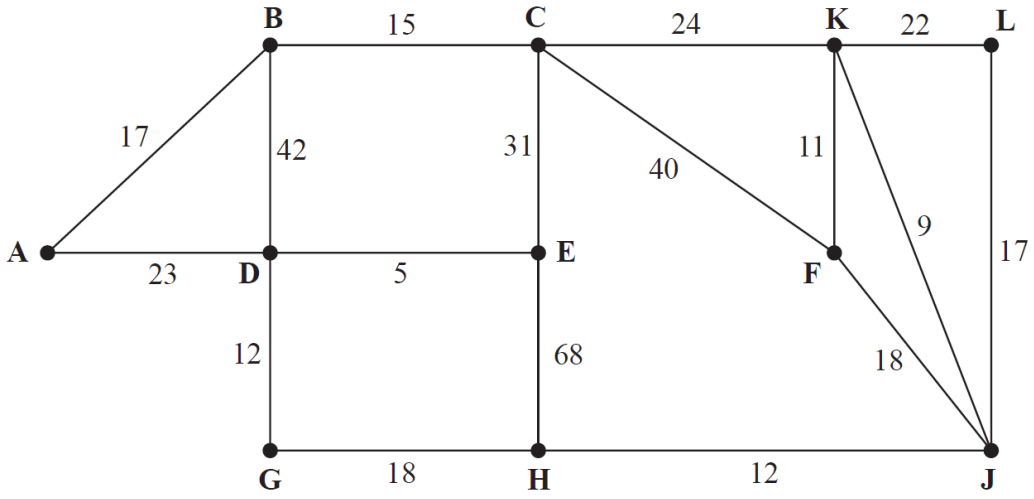

Figure 9

[*The total weight of the network is 384*]

Figure 9 models a network of corridors in an office complex that need to be inspected by a security guard. The number on each arc is the length, in metres, of the corresponding section of corridor.

Each corridor must be traversed at least once and the length of the inspection route must be minimised. The guard must start and finish at vertex **A**.

(*a*) Use the route inspection algorithm to find the length of the shortest inspection route. State the arcs that should be repeated. You should make your method and working clear.

(5)

It is now possible for the guard to start at one vertex and finish at a different vertex. An inspection route that traverses each corridor at least once is still required.

(*b*) Explain why the inspection route should start at a vertex with odd degree.

(2)

The guard decides to start the inspection route at **F** and the length of the inspection route must still be minimised.

(*c*) Determine where the guard should finish. You must give reasons for your answer.

(2)

(*d*) State a possible route and its length.

(2)

(Total 11 marks)

TOTAL FOR PAPER: 100 MARKS