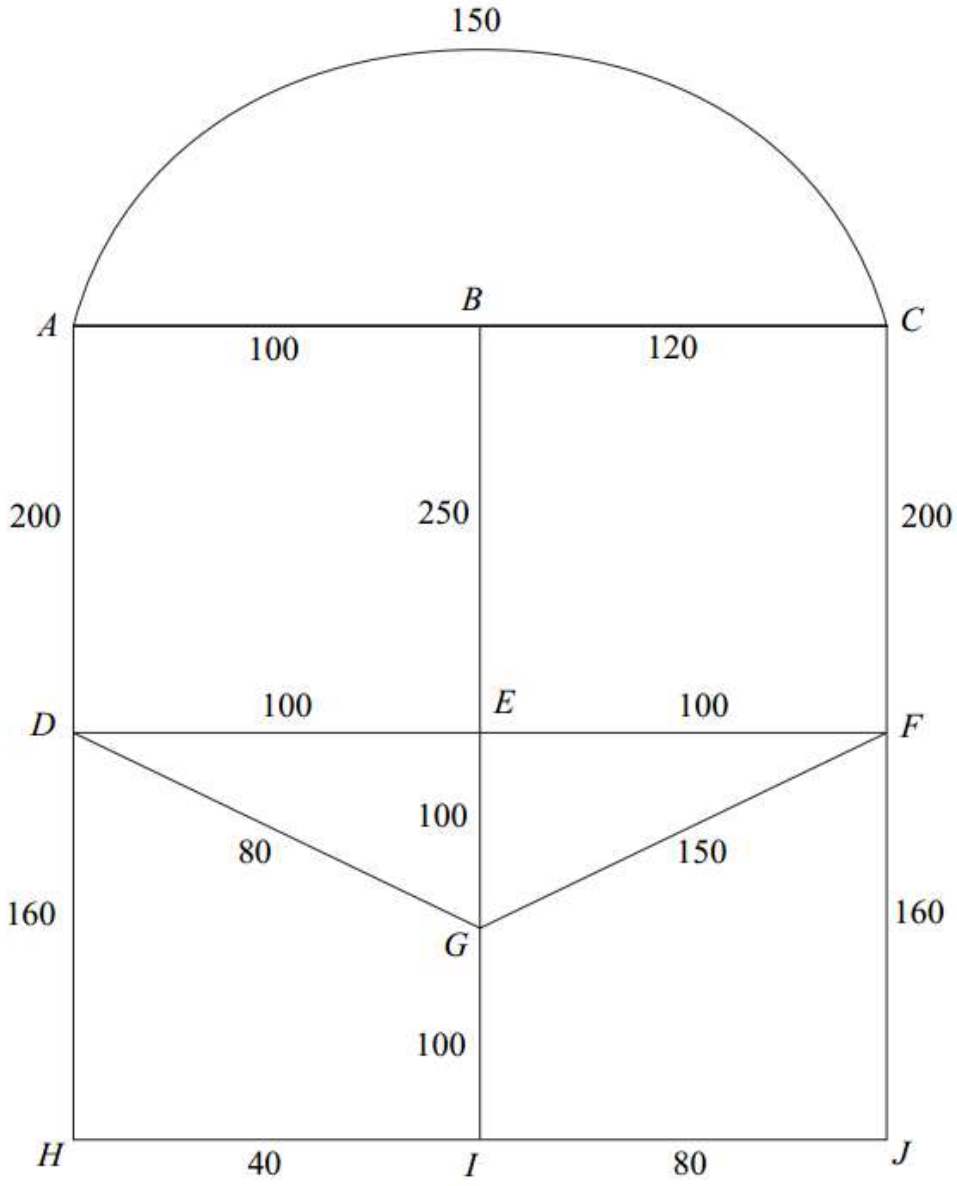
Decision 1: Chinese Postman

Past Paper Questions
2006 - 2013

Name:

7 Stella is visiting Tijuana on a day trip. The diagram shows the lengths, in metres, of the roads near the bus station.



Total = 2090

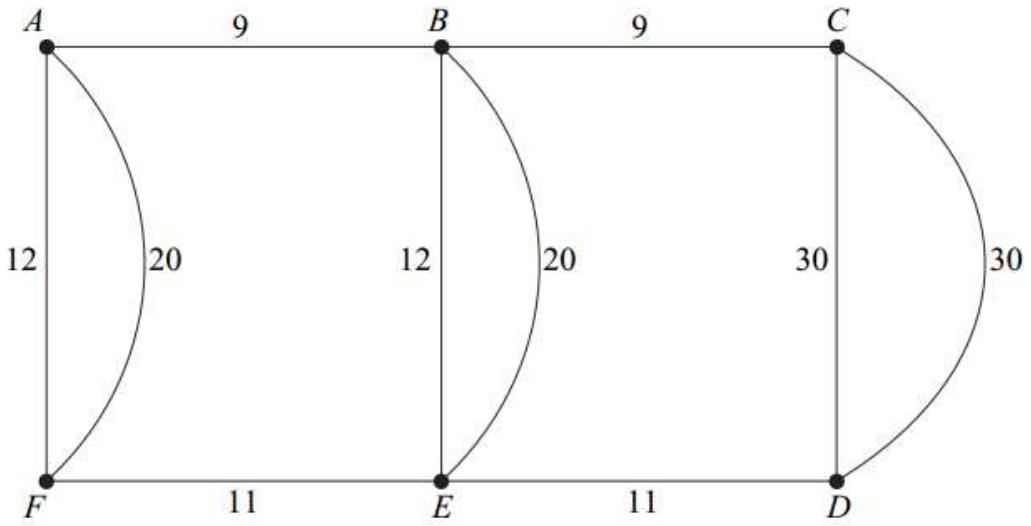
Stella leaves the bus station at A. She decides to walk along all of the roads at least once before returning to A.

(a) Explain why it is not possible to start from A, travel along each road only once and return to A. *(1 mark)*

(b) Find the length of an optimal 'Chinese postman' route around the network, starting and finishing at A. *(5 marks)*

(c) At each of the 9 places B, C, . . ., J, there is a statue. Find the number of times that Stella will pass a statue if she follows her optimal route. *(2 marks)*

4 The diagram shows a network of roads connecting 6 villages. The number on each edge is the length, in miles, of the road.



Total length of the roads = 164 miles

(a) A police patrol car based at village A has to travel along each road at least once before returning to A. Find the length of an optimal 'Chinese postman' route for the police patrol car. *(6 marks)*

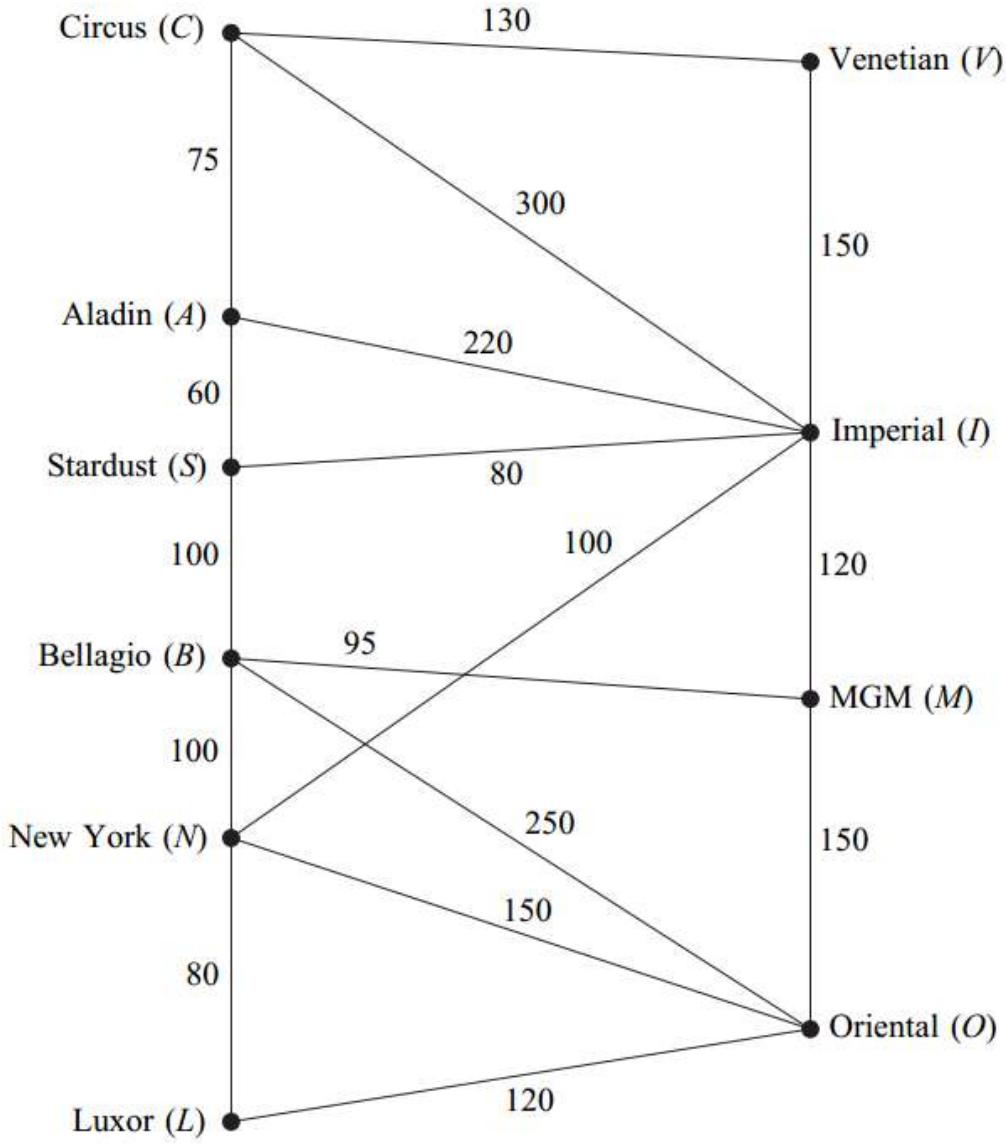
(b) A council worker starts from A and travels along each road at least once before finishing at C. Find the length of an optimal route for the council worker. *(2 marks)*

(c) A politician is to travel along all the roads at least once. He can start his journey at any village and can finish his journey at any village.

(i) Find the length of an optimal route for the politician. *(2 marks)*

(ii) State the vertices from which the politician could start in order to achieve this optimal route. *(1 mark)*

7 The network shows the times, in seconds, taken by Craig to walk along walkways connecting ten hotels in Las Vegas.



The total of all the times in the diagram is 2280 seconds.

(a) (i) Craig is staying at the Circus (C) and has to visit the Oriental (O).

Use Dijkstra's algorithm on **Figure 2** to find the minimum time to walk from C to O. *(6 marks)*

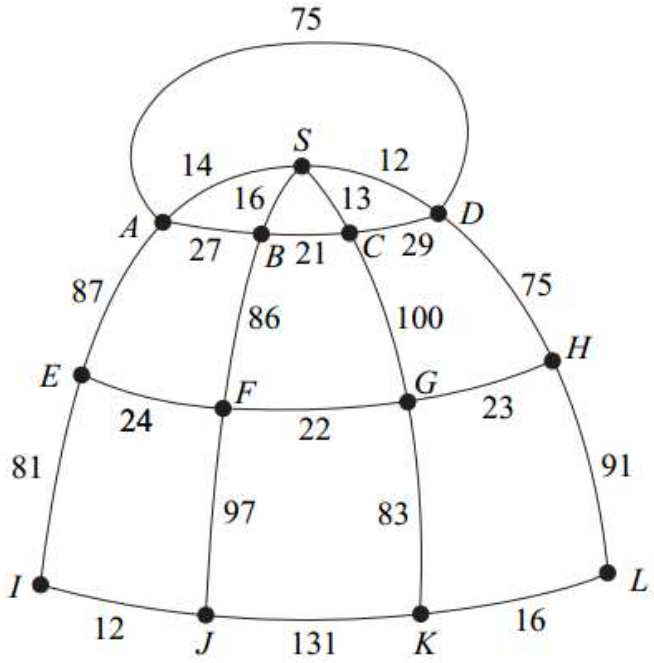
(ii) Write down the corresponding route. *(1 mark)*

(b) (i) Find, by inspection, the shortest time to walk from A to M. *(1 mark)*

(ii) Craig intends to walk along all the walkways. Find the minimum time for Craig to walk along every walkway and return to his starting point. *(6 marks)*

4 The diagram shows the various ski-runs at a ski resort. There is a shop at S. The manager of the ski resort intends to install a floodlighting system by placing a floodlight at each of the 12 points A, B,..., L and at the shop at S.

The number on each edge represents the distance, in metres, between two points.

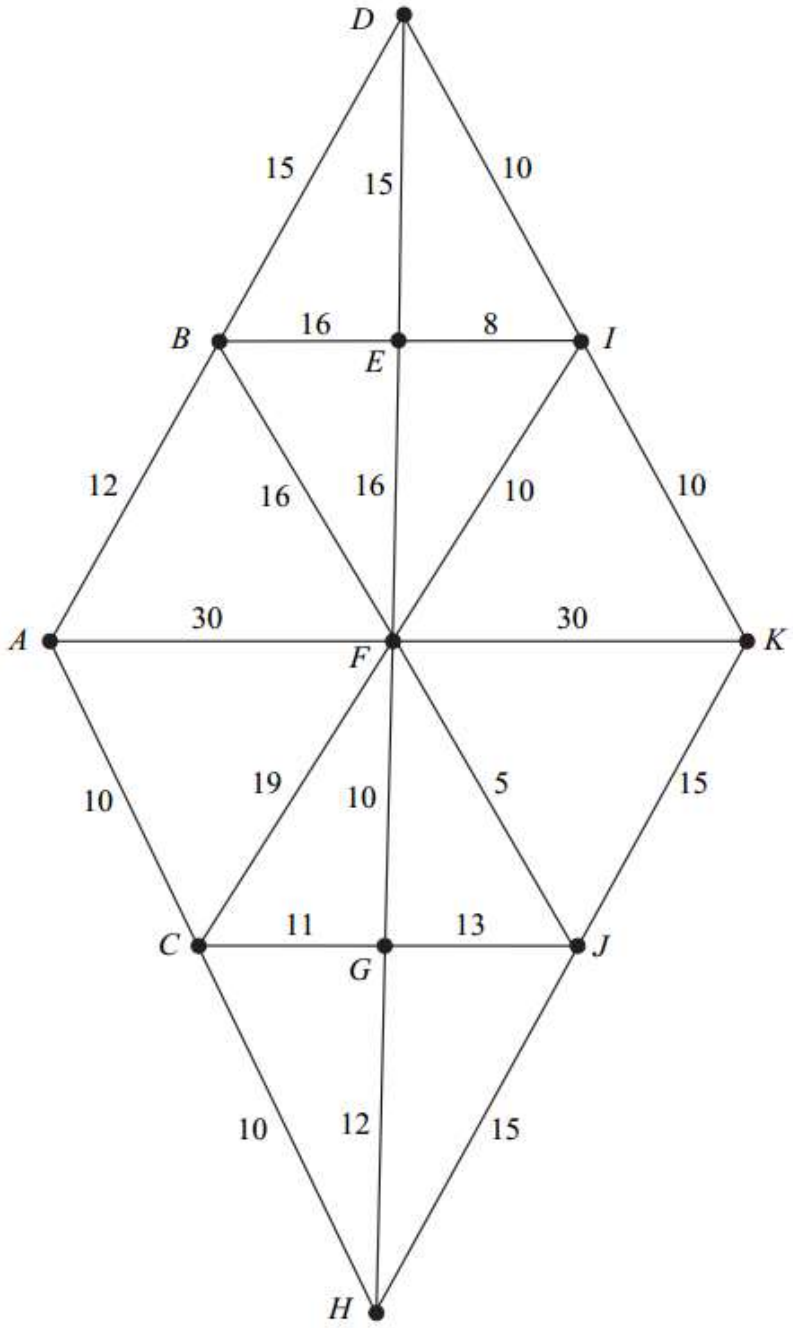


Total of all edges = 1135

(b) At the end of each day a snow plough has to drive at least once along each edge shown in the diagram in preparation for the following day's skiing. The snow plough must start and finish at the point L.

Use the Chinese Postman algorithm to find the minimum distance that the snow plough must travel. *(6 marks)*

4 The network shows 11 towns. The times, in minutes, to travel between pairs of towns are indicated on the edges.



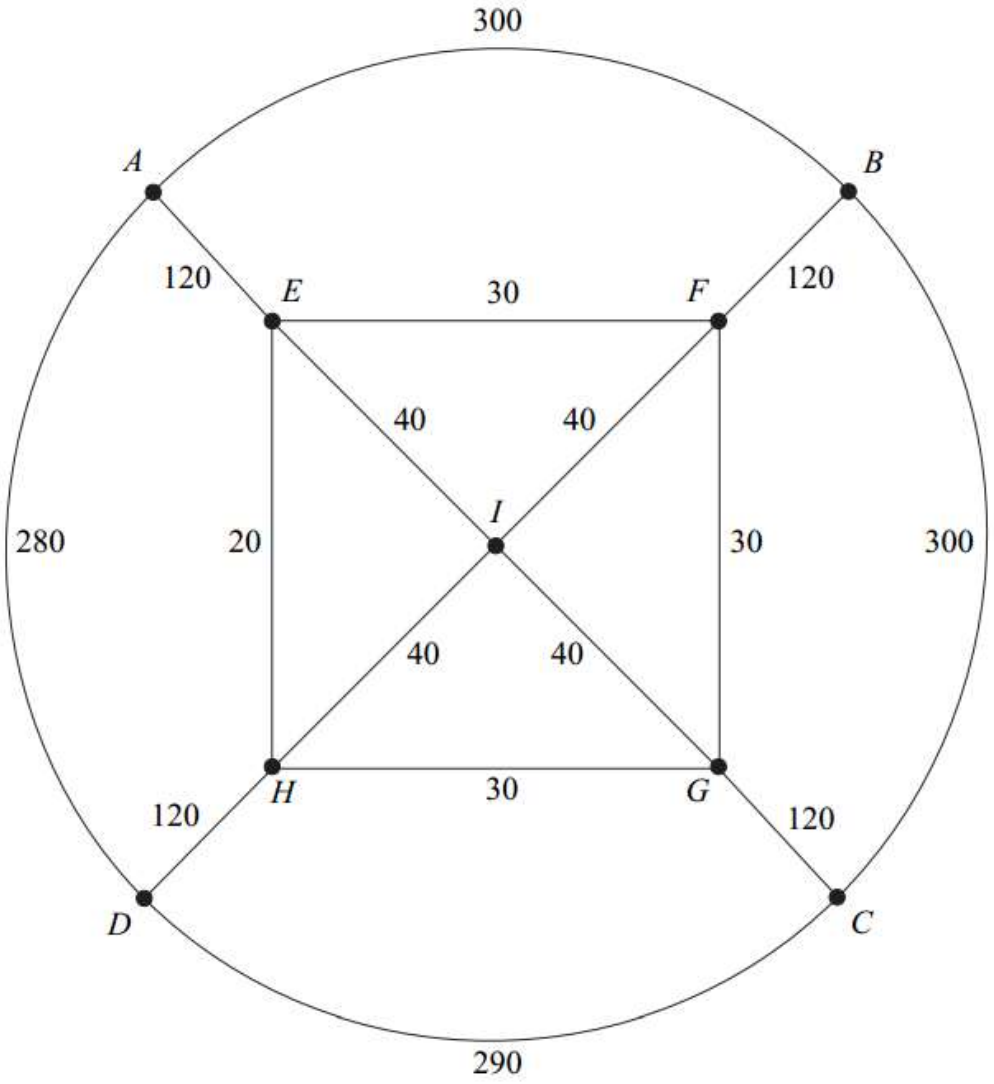
The total of all of the times is 308 minutes.

(a) (i) Use Dijkstra's algorithm on **Figure 2** to find the minimum time to travel from A to K. *(6 marks)*

(ii) State the corresponding route. *(1 mark)*

(b) Find the length of an optimum Chinese postman route around the network, starting and finishing at A. (The minimum time to travel from D to H is 40 minutes.) *(5 marks)*

5 The diagram shows a network of sixteen roads on a housing estate. The number on each edge is the length, in metres, of the road. The total length of the sixteen roads is 1920 metres.



Total Length = 1920 metres

(a) Chris, an ice-cream salesman, travels along each road at least once, starting and finishing at the point *A*. Find the length of an optimal 'Chinese postman' route for Chris. *(6 marks)*

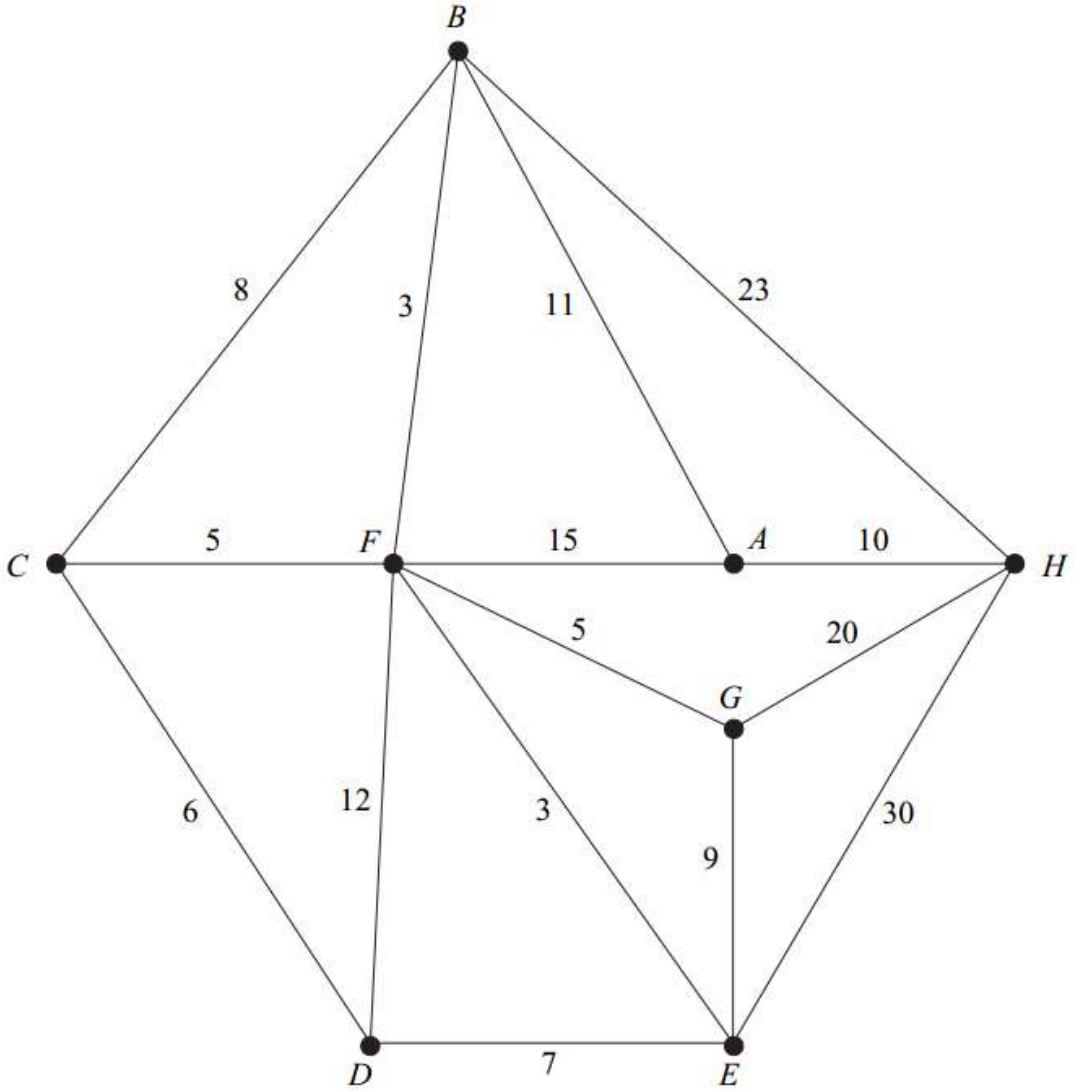
(b) Pascal, a paperboy, starts at *A* and walks along each road at least once before finishing at *D*. Find the length of an optimal route for Pascal. *(2 marks)*

(c) Millie is to walk along all the roads at least once delivering leaflets. She can start her journey at any point and she can finish her journey at any point.

(i) Find the length of an optimal route for Millie. *(2 marks)*

(ii) State the points from which Millie could start in order to achieve this optimal route. *(1 mark)*

3 The diagram shows roads connecting some places of interest in Berlin. The numbers represent the times taken, in minutes, to walk along the roads.



The total of all walking times is 167 minutes.

(a) Mia is staying at D and is to visit H.

(i) Use Dijkstra's algorithm on **Figure 1** to find the minimum time to walk from D to H. *(6 marks)*

(ii) Write down the corresponding route. *(1 mark)*

(b) Each day, Leon has to deliver leaflets along all of the roads. He must start and finish at A.

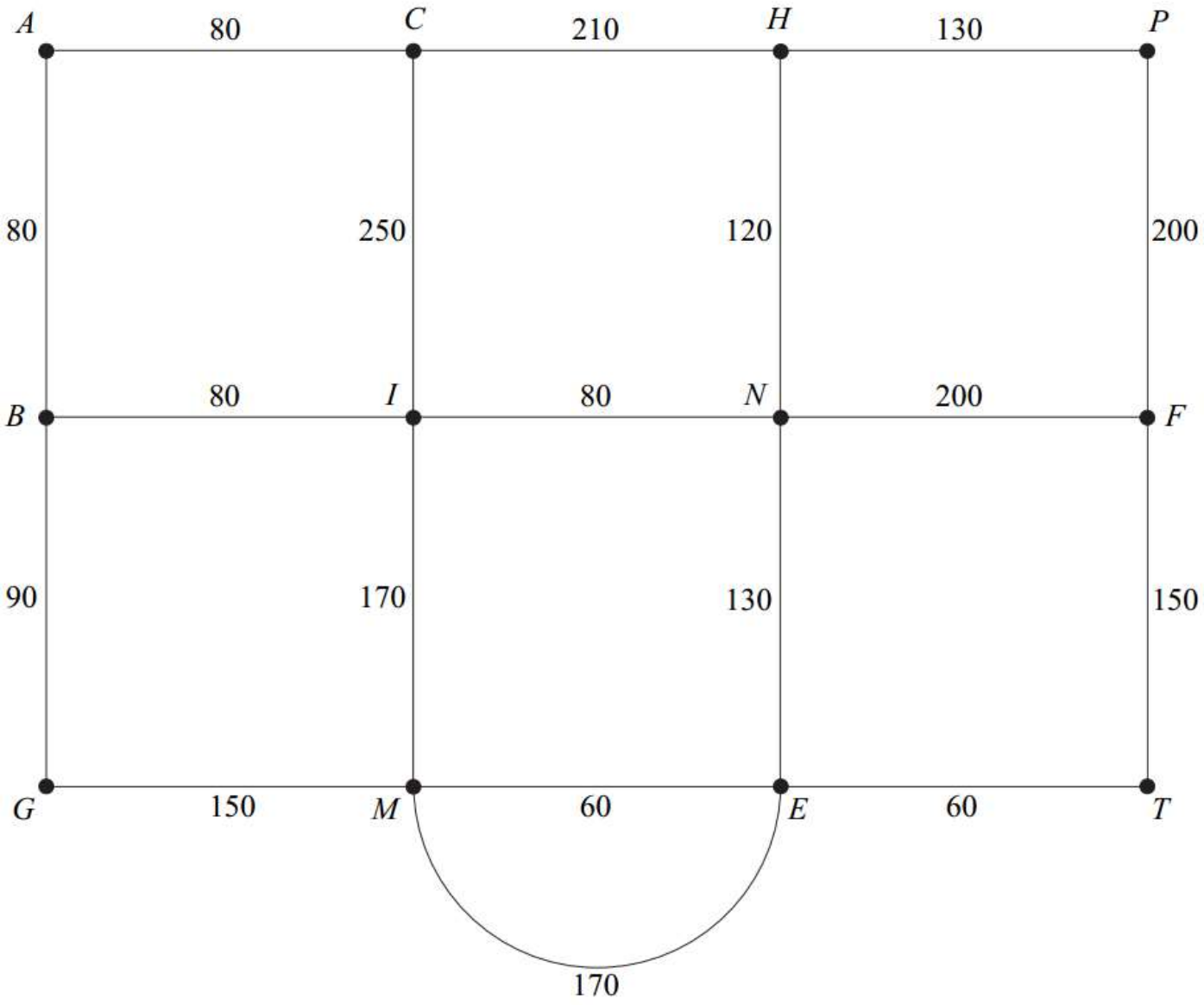
(i) Use your answer to part (a) to write down the shortest walking time from D to A. *(1 mark)*

(ii) Find the walking time of an optimum Chinese Postman route for Leon. *(6 marks)*

4 The diagram opposite shows a network of roads on a housing estate. The number on each edge is the length, in metres, of the road.

Joe is starting a kitchen-fitting business.

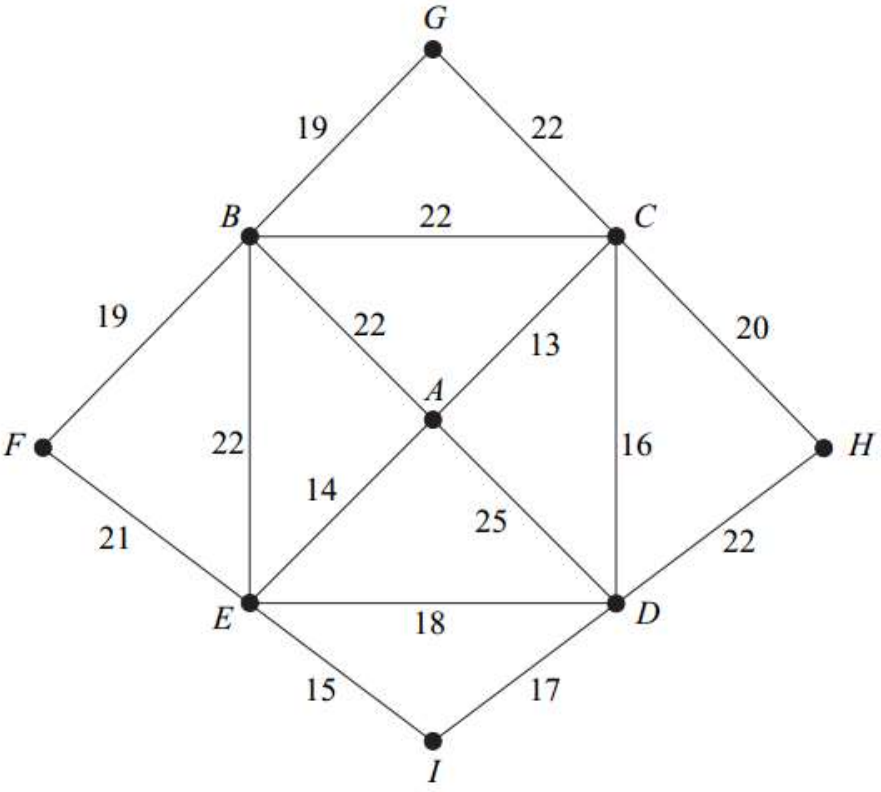
(a) Joe delivers leaflets advertising his business. He walks along all of the roads at least once, starting and finishing at C. Find the length of an optimal Chinese postman route for Joe. *(6 marks)*



Total length of roads = 2410 metres

4 In Paris, there is a park where there are statues of famous people; there are many visitors each day to this park. Lighting is to be installed at nine places, A, B, …, I, in the park. The places have to be connected either directly or indirectly by cabling, to be laid alongside the paths, as shown in the diagram.

The diagram shows the length of each path, in metres, connecting adjacent places.



Total length of paths = 307 metres

(b) A security guard walks along all the paths before returning to his starting place. Find the length of an optimal Chinese postman route for the guard. *(6 marks)*

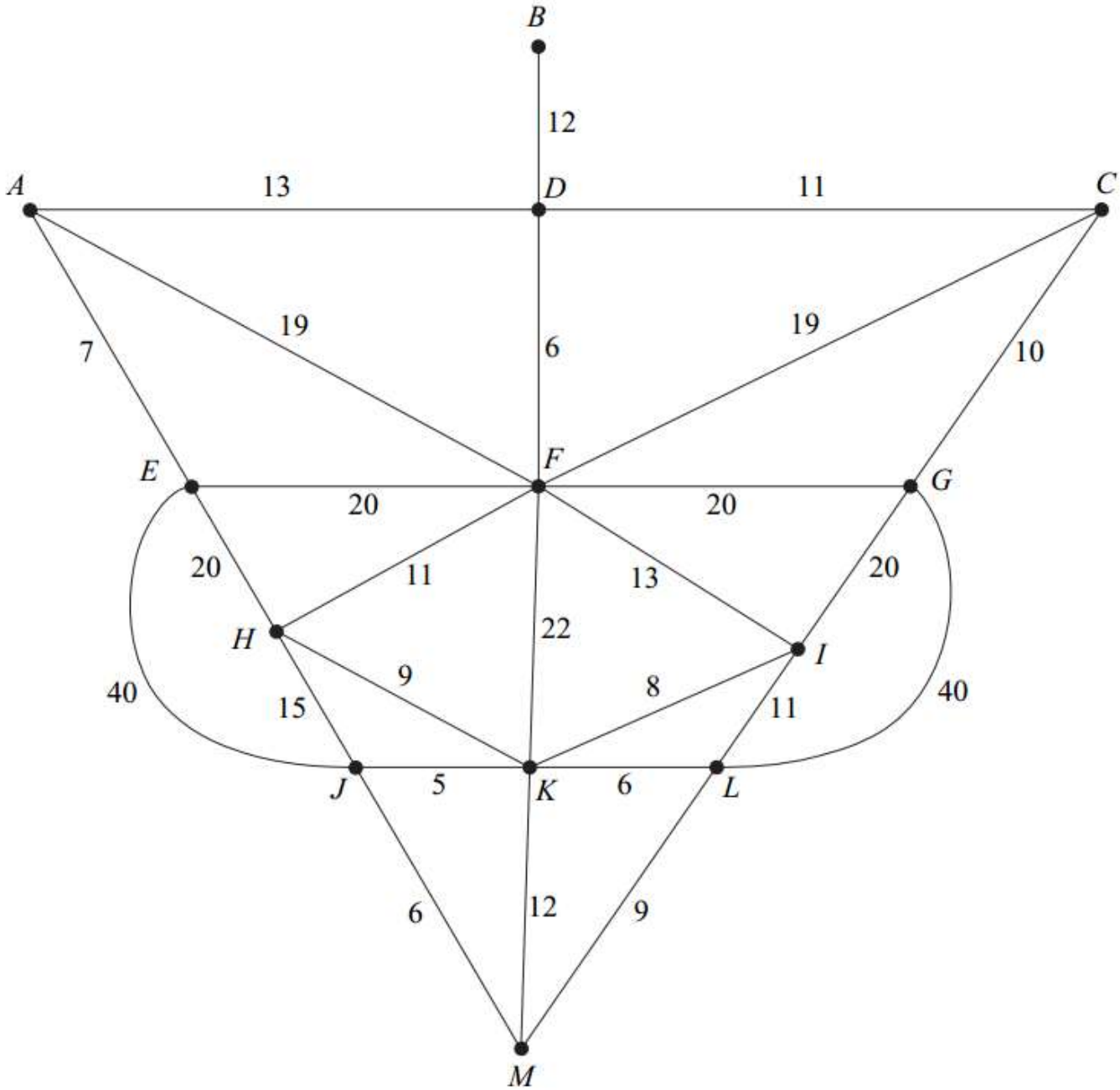
4 The network below shows 13 towns. The times, in minutes, to travel between pairs of towns are indicated on the edges.

The total of all the times is 384 minutes.

(a) Use Dijkstra's algorithm on the network below, starting from M, to find the minimum time to travel from M to each of the other towns. *(7 marks)*

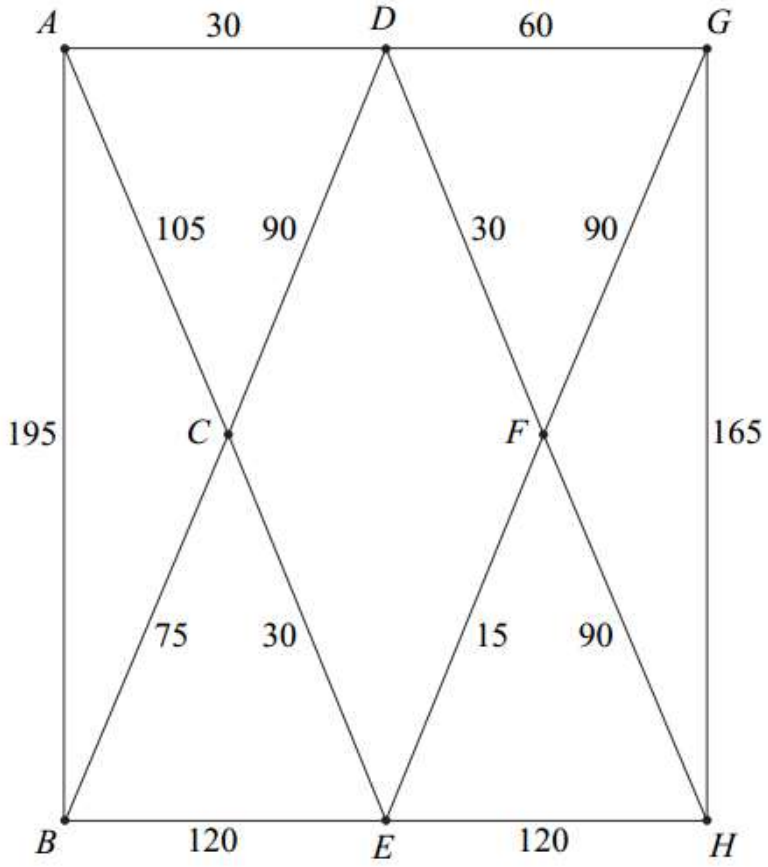
(b) (i) Find the travelling time of an optimum Chinese postman route around the network, starting and finishing at M. *(6 marks)*

(ii) State the number of times that the vertex F would appear in a corresponding route. *(1 mark)*



5 Norris delivers newspapers to houses on an estate. The network shows the streets on the estate. The number on each edge shows the length of the street, in metres.

Norris starts from the newsagents located at vertex A, and he must walk along all the streets at least once before returning to the newsagents.



The total length of the streets is 1215 metres.

(a) Give a reason why it is not possible to start at A, walk along each street once only, and return to A. *(1 mark)*

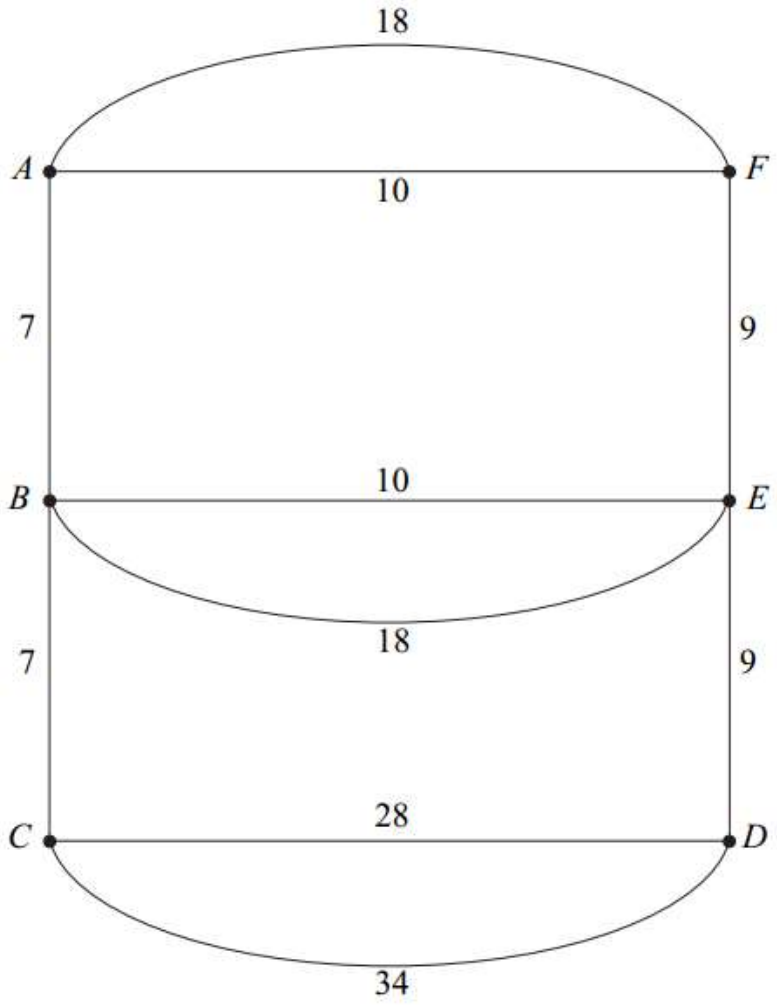
(b) Find the length of an optimal Chinese postman route around the estate, starting and finishing at A. *(5 marks)*

(c) For an optimal Chinese postman route, state:

(i) the number of times that the vertex F would occur; *(1 mark)*

(ii) the number of times that the vertex H would occur. *(1 mark)*

5 A council is responsible for gritting main roads in a district. The network shows the main roads in the district. The number on each edge shows the length of the road, in kilometres. The gritter starts from the depot located at point A, and must drive along all the roads at least once before returning to the depot.



Total = 150 km

(a) Find the length of an optimal Chinese postman route around the main roads in the district, starting and finishing at A. *(5 marks)*

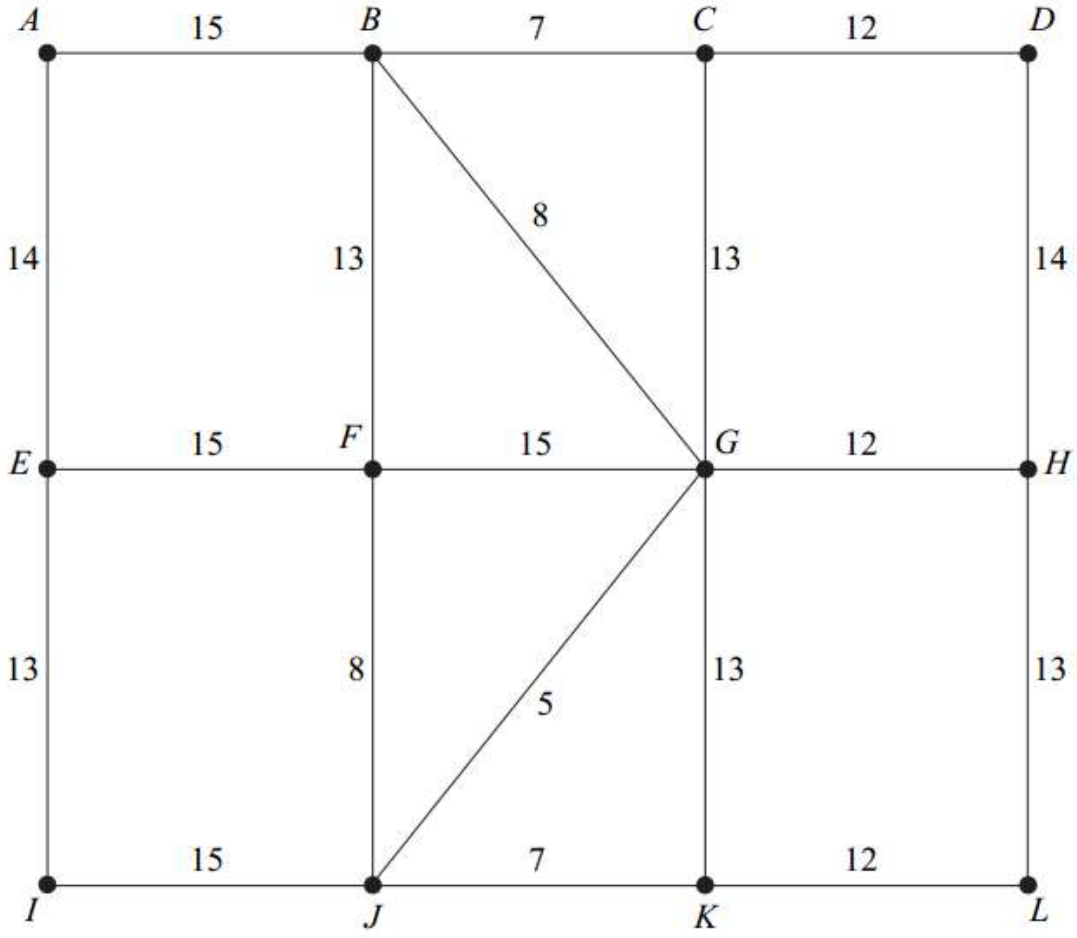
(b) Zac, a supervisor, wishes to inspect all the roads. He leaves the depot, located at point A, and drives along all the roads at least once before finishing at his home, located at point C. Find the length of an optimal route for Zac. *(2 marks)*

(c) Liz, a reporter, intends to drive along all the roads at least once in order to report on driving conditions. She can start her journey at any point and can finish her journey at any point.

(i) Find the length of an optimal route for Liz. *(2 marks)*

(ii) State the points from which Liz could start in order to achieve this optimal route. *(1 mark)*

4 The following network shows the times, in minutes, taken by a policeman to walk along roads connecting 12 places, A, B, ..., L, on his beat. Each day, the policeman has to walk along each road at least once, starting and finishing at A.



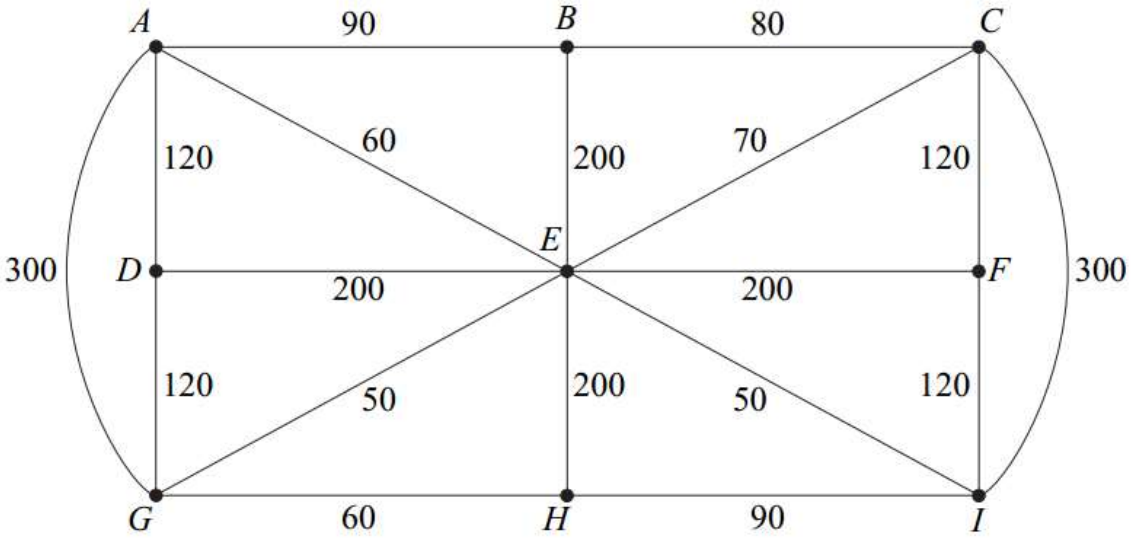
The total of all the times in the network is 224 minutes.

(a) Find the length of an optimal Chinese postman route for the policeman. *(5 marks)*

(b) State the number of times that the vertex J would appear in a route corresponding to the length found in part **(a)**. *(1 mark)*

5 The network below shows some streets in a town. The number on each edge shows the length of that street, in metres.

Leaflets are to be distributed by a restaurant owner, Tony, from his restaurant located at vertex B. Tony must start from his restaurant, walk along all the streets at least once, before returning to his restaurant.



The total length of the streets is 2430 metres.

(a) Find the length of an optimal Chinese postman route for Tony. *(5 marks)*

(b) Colin also wishes to distribute some leaflets. He starts from his house at H, walks along all the streets at least once, before finishing at the restaurant at B.

Colin wishes to walk the minimum distance. Find the length of an optimal route for Colin. *(1 mark)*

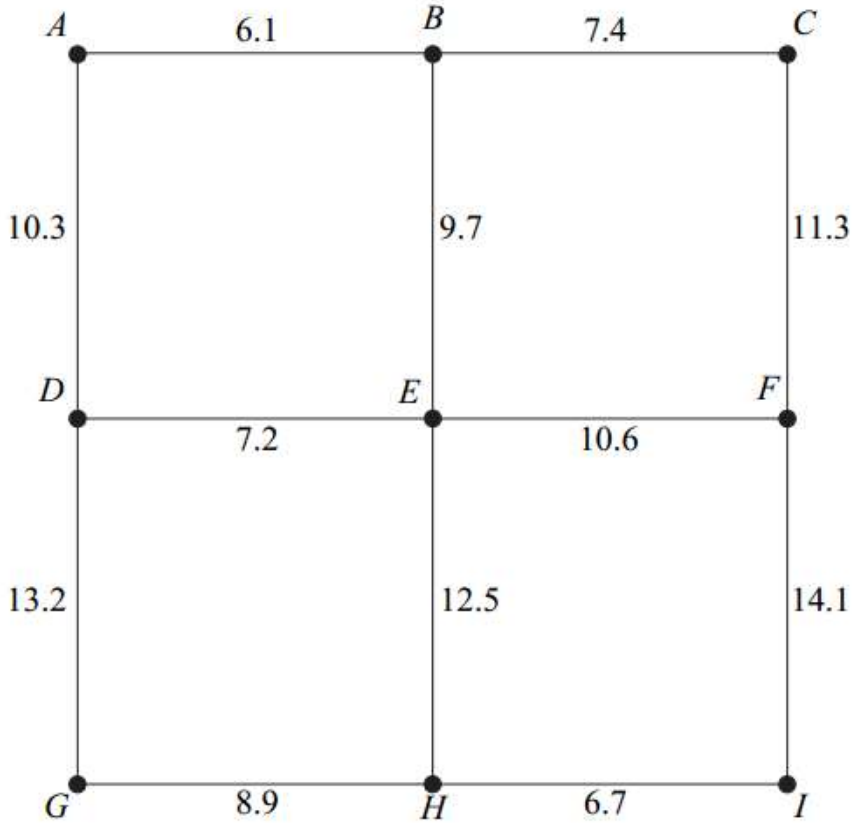
(c) David also walks along all the streets at least once. He can start at any vertex and finish at any vertex. David also wishes to walk the minimum distance.

(i) Find the length of an optimal route for David. *(1 mark)*

(ii) State the vertices from which David could start in order to achieve this optimal route. *(1 mark)*

3 The following network shows the lengths, in miles, of roads connecting nine villages, A, B, …, I.

A delivery man lives in village A and is to drive along all the roads at least once before returning to A.



Total length of all the roads is 118 miles

(a) Find the length of an optimal Chinese postman route around the nine villages, starting and finishing at A. *(5 marks)*

(b) For an optimal Chinese postman route corresponding to your answer in part **(a)**, state:

(i) the number of times village E would be visited;

(ii) the number of times village I would be visited. *(2 marks)*

5 The network on the page opposite shows the times, in minutes, taken by police cars to drive along roads connecting 12 places, A, B, …, L.

On a particular day, there are three police cars in the area at A, E and J. There is an emergency at G and all three police cars drive to G.

(a) (i) Use Dijkstra's algorithm on the network, **starting from *G***, to find the minimum driving time for each of the police cars to arrive at G. *(7 marks)*

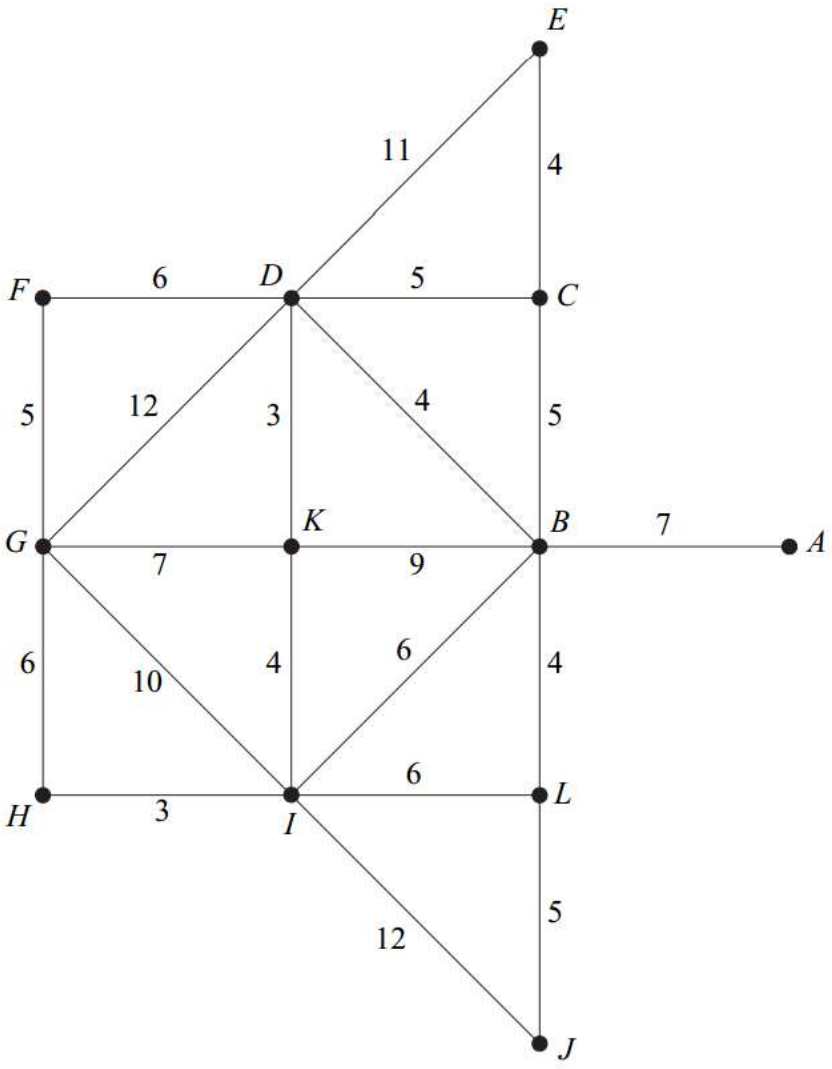
(ii) For each of the police cars, write down the route corresponding to the minimum driving time in your answer to part **(a)(i)**. *(3 marks)*

(b) Each day, a police car has to drive along each road at least once, starting and finishing at A.

For an optimal Chinese postman route:

(i) find the driving time for the police car; *(6 marks)*

(ii) state the number of times that the vertex B would appear. *(1 mark)*



Total of all times = 134 minutes