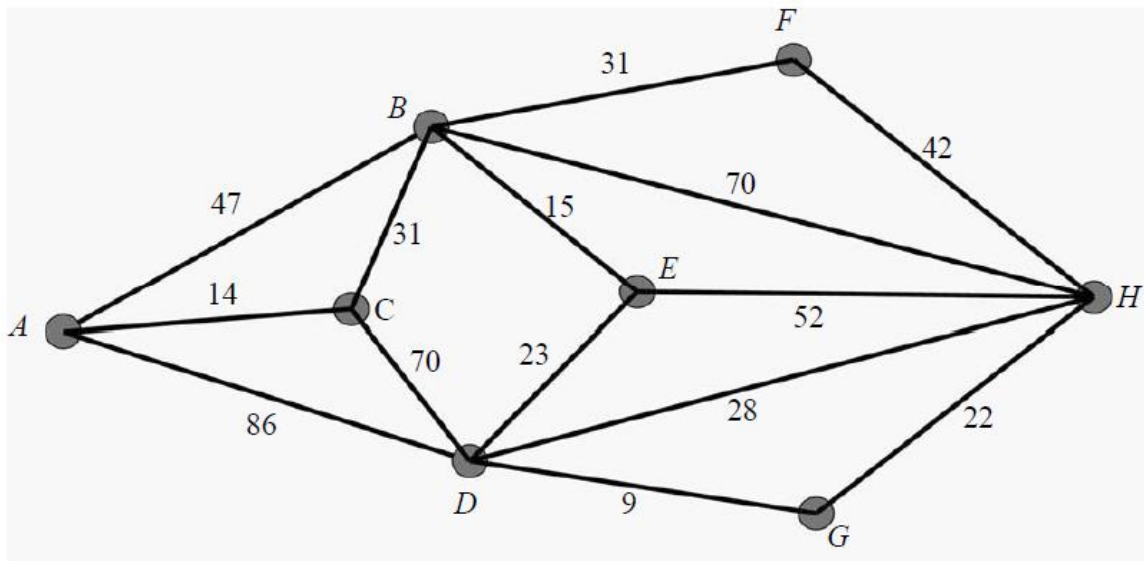




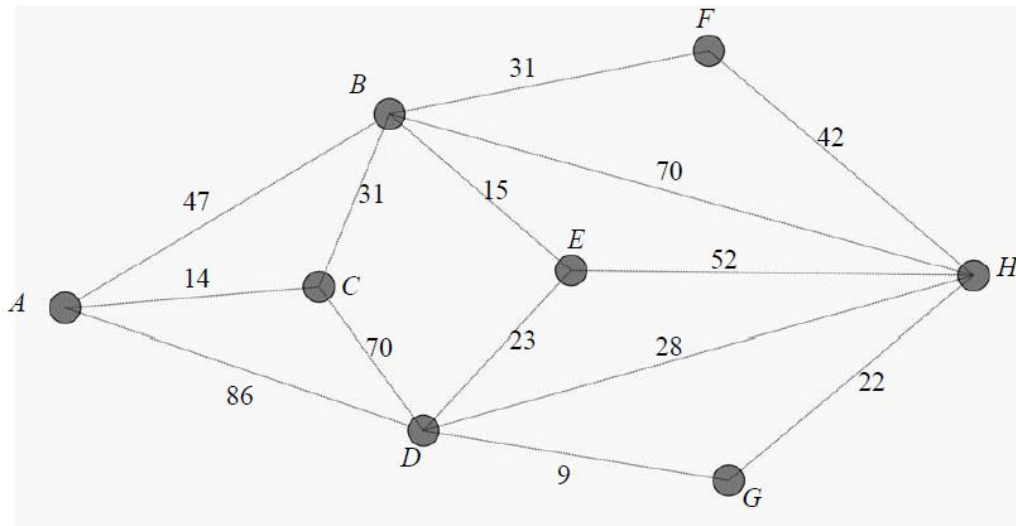
**Question 1**

The diagram below represents a draft plan for recycled water plumbing at part of the Caveman Creek Development. Most houses are expected to have one recycled water outlet. The vertices (*A* to *H*) represent outlets (taps) for recycled water. The distances between the outlets are shown as weighted edges. Some, but not all of the edges in the final plan will represent pipes. All distances are in metres and the diagram is NOT to scale.



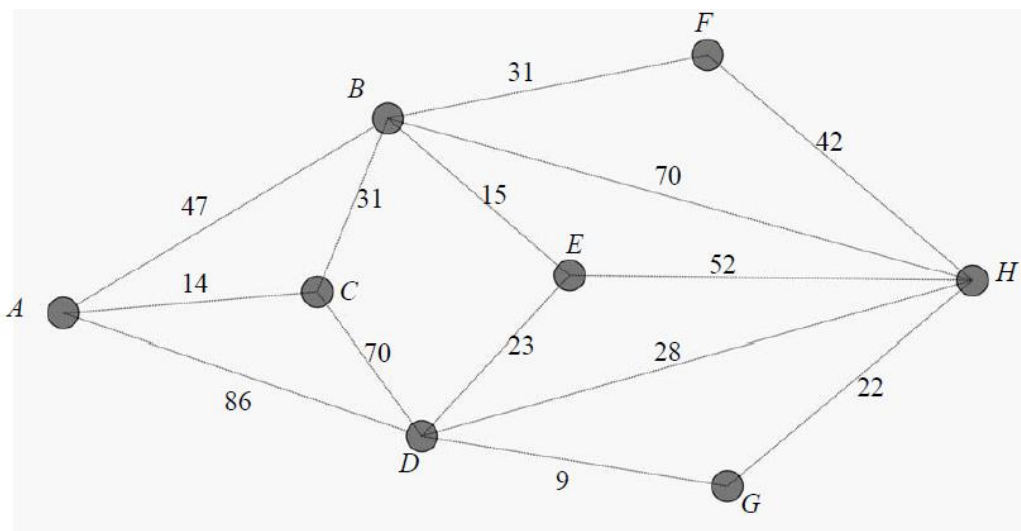
- a. Use Dijkstra's algorithm to determine the shortest distance from *A* to *G* and state the path taken?

- b. The architect's final plan will only show pipes that allow the minimum length of pipe to be used that still allows all outlets to be connected to the network. Draw the architect's final plan on the diagram below.



- c. What is the mathematical term used to describe the network drawn in part b?

- d. Construction workers have encountered underground rock that prevents them from laying water pipes between vertices  $D$  and  $G$ , vertices  $A$  and  $C$  and vertices  $B$  and  $F$ . What is the minimum length of pipe they will now need to use so that all outlets have water? The diagram below may be used for working.



(3 + 2 + 1 + 1 = 7marks)

## Question 2

One of the Caveman Creek football coaches has introduced a fitness program that involves a 6 km run, a 1km hurdle race, a 10 km cycle race and a 1 km race carrying a medicine ball.

The times that each of four players complete each of these races correct to the nearest minute is given in the table below:

	Player			
	Andrew (A)	Bruce (B)	Charles (C)	David (D)
Run (6 km) (R)	35	39	38	42
Hurdles (1 km) (H)	8	6	9	8
Cycle (10 km) (Y)	17	18	20	20
Medicine Ball (1 km) (M)	12	11	16	15

A competition is held in teams to complete each of these events one after the other. The team containing Andrew, Bruce, Charles and David needs to determine which part of the race should be completed by each player to minimize the time.

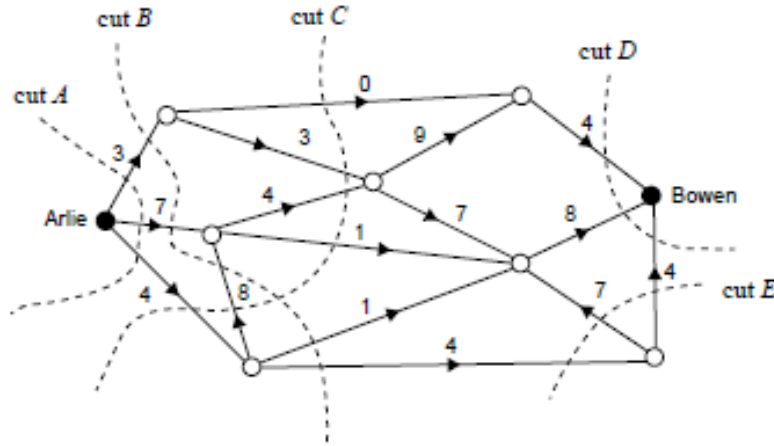
Use the Hungarian Algorithm to determine which players should do each event. Be sure to show the final allocation(s) and the total time it should take for all the events to be completed by the team.

(4 marks)

**Question 3**

A train journey consists of a connected sequence of stages formed by edges on the following network from Arlie to Bowen. The number of available seats for each stage is indicated beside the corresponding edge, as shown on the diagram below.

The five cuts, *A*, *B*, *C*, *D*, *E*, shown on the network, are attempts to find the maximum number of available seats that can be booked for a journey from Arlie to Bowen.



a. Write down the capacity of cut *A*, cut *B* and cut *C*.

cut *A* = \_\_\_\_\_ cut *B* = \_\_\_\_\_ cut *C* = \_\_\_\_\_

b. Cut *E* is not a valid cut when trying to find the maximum flow between Arlie and Bowen. Explain why this is the case.

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c. Determine the maximum number of available seats on a journey between Arlie and Bowen.

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(3 + 1 + 1 = 5 marks)

#### Question 4

A section of the showgrounds has flooded due to a broken water pipe. The table below shows the activities that need to be completed in order to repair the water pipe. Also shown are some of the durations, Earliest Start Times (EST) and the immediate predecessors for the activities.

Activity	Activity description	Duration (hours)	EST	Immediate predecessor(s)
A	Erect barriers to isolate the flooded area	1	0	–
B	Turn off the water to the showgrounds		0	–
C	Pump water from the flooded area	1	2	A, B
D	Dig a hole to find the broken water pipe	1		C
E	Replace the broken water pipe	2	4	D
F	Fill in the hole	1	6	E
G	Clean up the entire affected area	4	6	E
H	Turn on the water to the showgrounds	1	6	E
I	Take down the barriers	1	10	F, G, H

a. Draw an activity network (directed digraph) to illustrate this repair.

b. What is the duration of activity B?

c. What is the Earliest Start Time (EST) for activity D?

d. Once the water has been turned off (Activity B), which of the activities C to I could be delayed without affecting the shortest time to complete all activities?

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(2+1 + 1 + 1 = 5 marks)