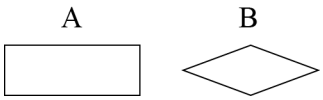
1 **a** Define the term *algorithm*. **(1 mark)**

b Give an example of an algorithm used in everyday life. **(1 mark)**

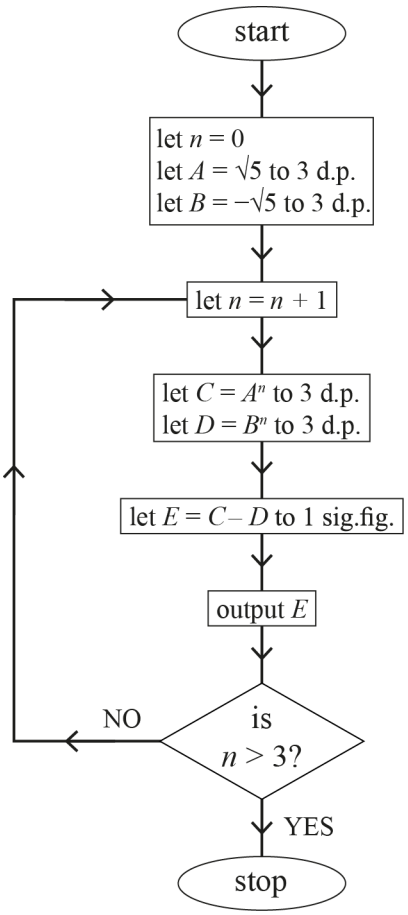
c Explain the meaning of shapes A and B in Figure 1, when used in a flow chart. **(2 marks)**

Figure 1



2 An algorithm is described by the flow chart in Figure 2.

Figure 2



a Complete the table, recording the results of each step as the algorithm is applied.

You may not need all of the rows.

Give the values of A, B, C and D to 3 decimal places and the values of E to 1 significant figure. **(3 marks)**

A	B	n	C	D	E	is $n > 3$?

b If the restriction of $n > 3$ is changed to $n > 100$, state the value of E when $n = 100$. **(1 mark)**

3 The algorithm below finds the approximate square root of a number.

1 Input a number, N

2 Calculate $S = \frac{N}{2}$

3 Calculate $T = \frac{\frac{N}{S} + S}{2}$

4 If $S = T$ when rounded to 2 decimal places, go to 7

5 Replace S with the value of T

6 Go to 3

7 Output S to 2 decimal places

a Apply the algorithm with $N = 7$.

Complete the table, recording the values of S and T each time they change. **(3 marks)**

S	T	$S = T$ to 2 dp?

b Show that the algorithm fails when $N = -4$.

Give a reason for this failure. **(3 marks)**

4 The list of numbers below is to be sorted into **descending** order.

7 5 4 6 8

a Perform the first pass of a bubble sort, showing each comparison. **(2 marks)**

b Write the number of comparisons and the number of swaps used in this first pass. **(1 mark)**

c State which numbers, if any, are guaranteed to be in their correct final position after the first pass. **(1 mark)**

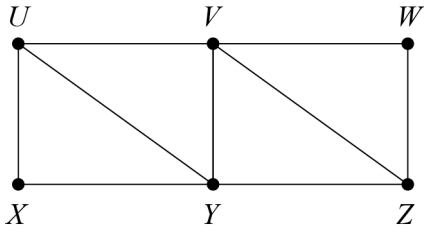
5 Use a quick sort to arrange the numbers below into **ascending** order**.**

65 43 24 64 46 13 71 23 16 45

(4 marks)

6 Look at Figure 3.

Figure 3



a Explain why *UXYZWVYU* is not a cycle of the graph in Figure 3. **(1 mark)**

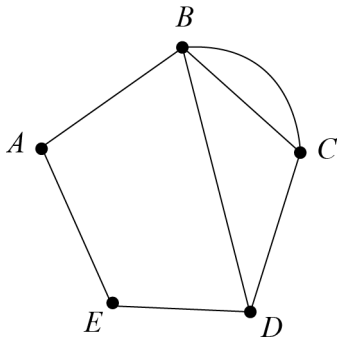
b Explain why there would be 5 arcs in a spanning tree of the graph in Figure 3. **(1 mark)**

c Show that the sum of the valencies of the vertices of the graph in Figure 3 is equal to twice the number of edges. **(2 marks)**

d Determine whether the network *UXYZWVYU* is Eulerian. **(1 mark)**

7 Look at Figure 4.

Figure 4



Show that the graph in Figure 4 is,

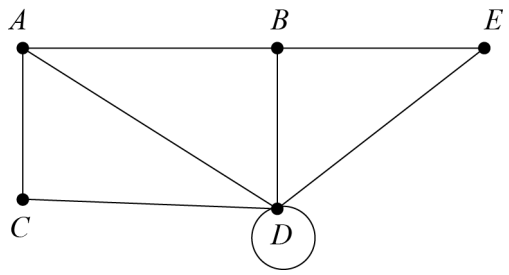
a connected **(1 mark)**

b not simple. **(1 mark)**

8 Draw the graph of K_5. **(1 mark)**

9 Look at Figure 5.

Figure 5



a Use an adjacency matrix to represent the graph in Figure 5. **(2 marks)**

A network is defined by the distance matrix below.

	A	***B***	***C***	***D***	***E***
A	–	6	–	7	–
B	6	–	4	–	12
C	–	4	–	5	–
D	–	–	5	–	–
E	–	10	–	–	–

b Draw the network. **(2 marks)**

10 Below are the lengths of seven pieces of wood to be cut from 1.25 m strips.

All lengths are given in cm.

40 55 65 40 40 45 40 45 70 40 45

a Use the first-fit decreasing algorithm to calculate how many 1.25 m strips are required and how much wood will be wasted. **(4 marks)**

b **i** Use the full-bin algorithm to calculate how many 1.25 m strips are required. **(2 marks)**

ii State if your solution for part **bi** is optimal. Justify your answer. **(2 marks)**

11 **a** A computer uses an algorithm of quadratic order to sort numbers into ascending order.

It takes 1.2 seconds to sort 500 numbers.

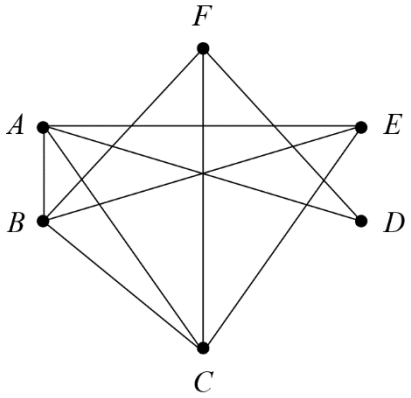
Find how long it will take to sort 5000 numbers. **(2 marks)**

b An algorithm requires $2n^3 + 6n$ steps to complete a problem of size n.

State the order of this algorithm. **(1 mark)**

12 Look at Figure 6.

Figure 6



a Complete a Hamiltonian cycle starting *ADF* for the graph in Figure 6. **(1 mark)**

b Use the planarity algorithm to determine whether the graph shown in Figure 6 is planar.

Draw a diagram to justify your answer. **(3 marks)**

Arcs *ED* and *CD* are now added to the graph.

c Explain why the new graph is not planar. **(1 mark)**