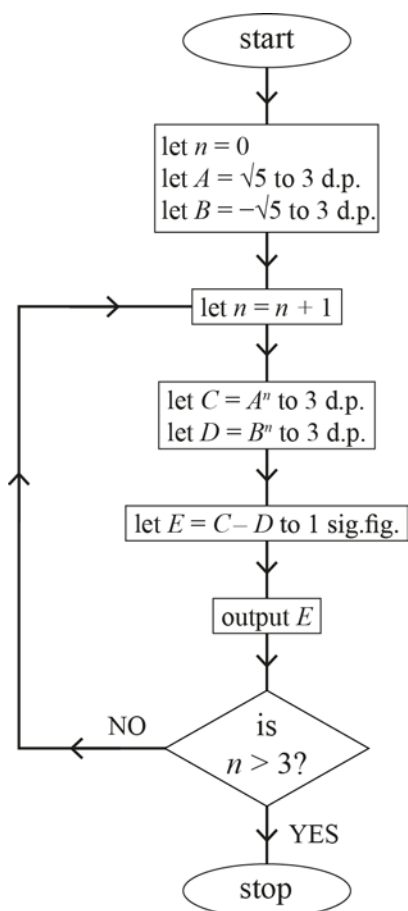**1 a** Define the term *algorithm*. **(1 mark)**

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

A   B

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

Figure 2

start

let $n = 0$
let $A = \sqrt{5}$ to 3 d.p.
let $B = -\sqrt{5}$ to 3 d.p.

let $n = n + 1$

let $C = A^n$ to 3 d.p.
let $D = B^n$ to 3 d.p.

let $E = C - D$ to 1 sig.fig.

output E

NO   is
$n > 3$?

YES

stop

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 $S = \dfrac{N}{2}$

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

      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.

$$7 \quad 5 \quad 4 \quad 6 \quad 8$$

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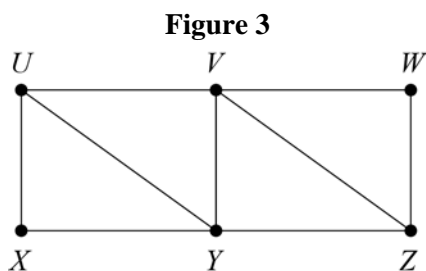
c State which numbers, if any, are guaranteed to be in their correct final position after the first pass. **(1 mark)**

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

$$65 \quad 43 \quad 24 \quad 64 \quad 46 \quad 13 \quad 71 \quad 23 \quad 16 \quad 45$$

(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 5.
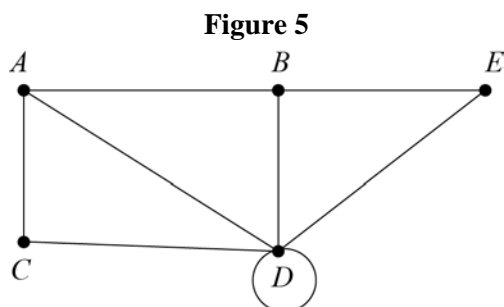
Figure 5

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)**

8 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)**