



# Cambridge International AS & A Level

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## COMPUTER SCIENCE

9618/31

Paper 3 Advanced Theory

October/November 2024

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

### INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use an HB pencil for any diagrams, graphs or rough working.
- Calculators must **not** be used in this paper.

### INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].
- No marks will be awarded for using brand names of software packages or hardware.

This document has **16** pages. Any blank pages are indicated.



1 Numbers are stored in a computer using binary floating-point representation with:

- 10 bits for the mantissa
- 6 bits for the exponent
- two's complement form for both the mantissa and the exponent.

(a) Calculate the normalised binary floating-point representation of +201.125 in this system.

Show your working.

**Mantissa**

**Exponent**

|  |  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |  |
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Working .....

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[3]

(b) Calculate the denary value of the given normalised binary floating-point number.

Show your working.

**Mantissa**

**Exponent**

|   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |
|---|---|---|---|---|---|---|---|---|---|

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 1 | 0 | 1 |
|---|---|---|---|---|---|

Working .....

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Answer .....

[3]





2 Reduced Instruction Set Computers (RISC) is a type of processor.

Identify **four** features of a RISC processor.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....

[4]

3 (a) Describe circuit switching as a method of data transmission.

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.....

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.....

.....

..... [3]

(b) State **one** benefit and **one** drawback of circuit switching as a method of data transmission.

Benefit .....

.....

Drawback .....

.....

[2]





- 4 The TCP/IP protocol may be viewed as a stack that contains four layers: Application, Transport, Internet, Link.

Describe how the layers of the TCP/IP protocol stack interact with each other.

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..... [4]

- 5 (a) Explain what is meant by a hashing algorithm in the context of file access.

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..... [3]

- (b) The use of a hashing algorithm can result in the same storage location being identified for more than one record.

Outline **two** methods of overcoming this issue.

1 .....

.....

2 .....

.....

[2]





6 (a) Describe the user-defined data type **set**.

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.....

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..... [3]

(b) Write **pseudocode** statements to declare the set data type, `SymbolSet`, to hold the following set of mathematical operators, using the variable `Operators`.

+   -   \*   /   ^

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..... [4]





7 The truth table for a logic circuit is shown.

| INPUT |   |   |   | OUTPUT |
|-------|---|---|---|--------|
| A     | B | C | D | T      |
| 0     | 0 | 0 | 0 | 0      |
| 0     | 0 | 0 | 1 | 1      |
| 0     | 0 | 1 | 0 | 0      |
| 0     | 0 | 1 | 1 | 1      |
| 0     | 1 | 0 | 0 | 0      |
| 0     | 1 | 0 | 1 | 0      |
| 0     | 1 | 1 | 0 | 0      |
| 0     | 1 | 1 | 1 | 0      |
| 1     | 0 | 0 | 0 | 0      |
| 1     | 0 | 0 | 1 | 1      |
| 1     | 0 | 1 | 0 | 0      |
| 1     | 0 | 1 | 1 | 1      |
| 1     | 1 | 0 | 0 | 0      |
| 1     | 1 | 0 | 1 | 1      |
| 1     | 1 | 1 | 0 | 0      |
| 1     | 1 | 1 | 1 | 1      |

(a) Write the Boolean logic expression that corresponds to the given truth table as the sum-of-products.

T = .....  
 ..... [3]





(b) Complete the Karnaugh map (K-map) for the given truth table.

|    |    | AB |    |    |    |
|----|----|----|----|----|----|
|    |    | 00 | 01 | 11 | 10 |
| CD | 00 |    |    |    |    |
|    | 01 |    |    |    |    |
|    | 11 |    |    |    |    |
|    | 10 |    |    |    |    |

[2]

(c) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products.

[2]

(d) (i) Write the Boolean logic expression from your answer to part (c) as the simplified sum-of-products.

T = .....

..... [2]

(ii) Use Boolean algebra to write your answer to part (d)(i) in its simplest form.

T = ..... [1]





8 (a) Describe the process of **segmentation** for memory management.

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..... [4]

(b) Explain what is meant by **disk thrashing**.

.....

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.....

..... [3]







- 9 A veterinary surgery wants to create a class for individual pets. Some of the attributes required in the class are listed in the table.

| Attribute      | Data type | Description                                        |
|----------------|-----------|----------------------------------------------------|
| PetID          | STRING    | unique ID assigned at registration                 |
| PetType        | STRING    | type of pet assigned at registration               |
| OwnerTelephone | STRING    | telephone number of owner assigned at registration |
| DateRegistered | DATE      | date of registration                               |

- (a) State **one** reason why the attributes would be declared as `PRIVATE`.

.....  
 ..... [1]

- (b) Complete the class diagram for `Pet`, to include:

- an attribute and data type for the name of the pet
- an attribute and data type for the name of the owner
- a method to create a `Pet` object and set attributes at the time of registration
- a method to assign a pet ID
- a method to assign the date of registration
- a method to return the pet name
- a method to return the owner's telephone number.

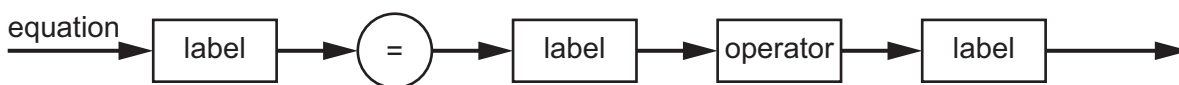
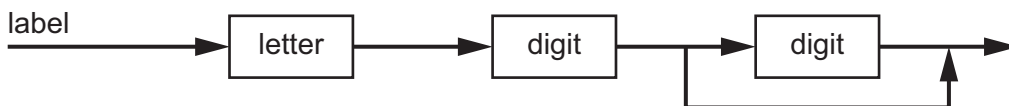
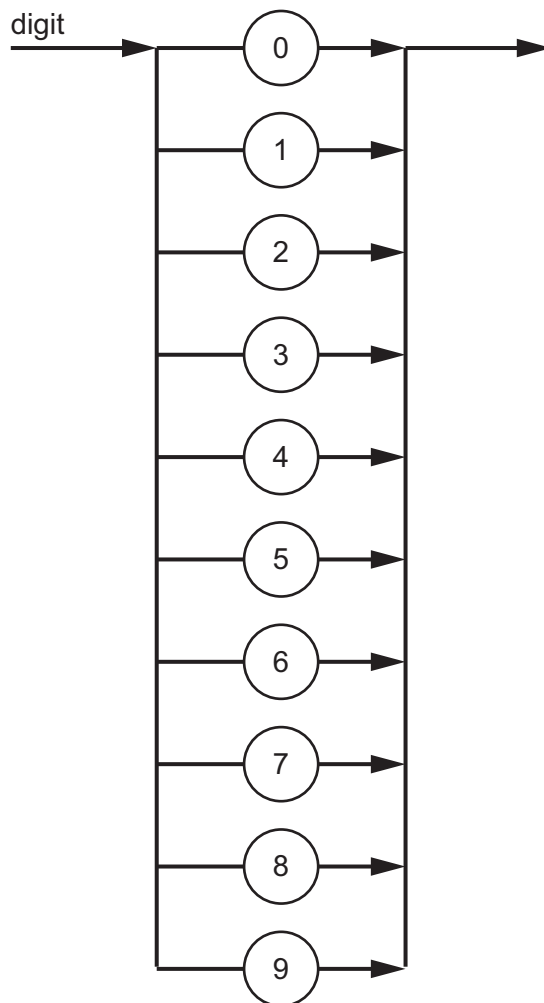
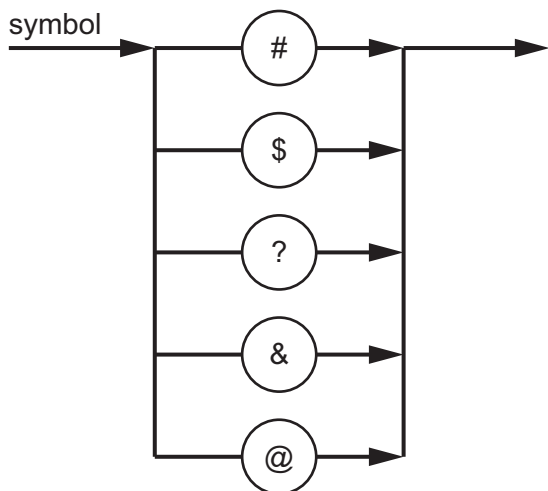
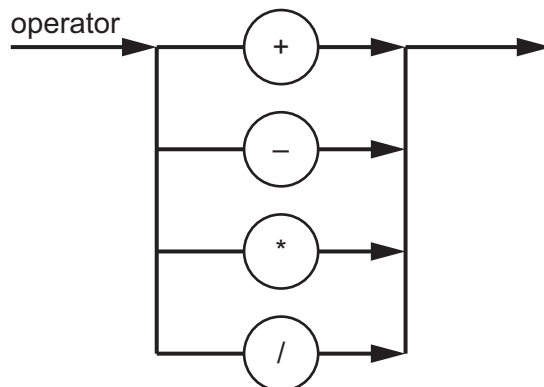
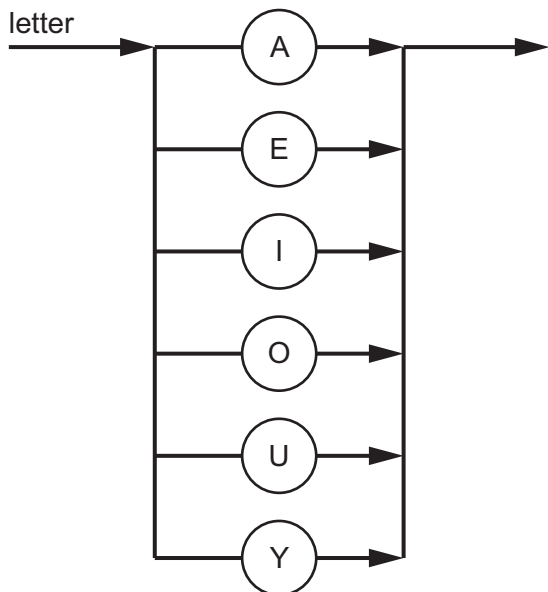
| <b>Pet</b>     |          |
|----------------|----------|
| PetID          | : STRING |
| PetType        | : STRING |
| OwnerTelephone | : STRING |
| DateRegistered | : DATE   |
| .....          | : .....  |
| .....          | : .....  |
| .....          |          |
| .....          |          |
| .....          |          |
| .....          |          |
| .....          |          |

[5]





10 Several syntax diagrams are shown.





(a) Complete the Backus-Naur Form (BNF) for the given syntax diagrams.

<operator> ::= .....

.....

<label> ::= .....

.....

<equation> ::= .....

.....

[4]

(b) A new syntax rule, **password**, is required. It must begin with a letter or a symbol, followed by a digit and end with one or two symbols.

(i) Draw a syntax diagram for **password**.

[3]

(ii) Write the BNF for **password**.

.....

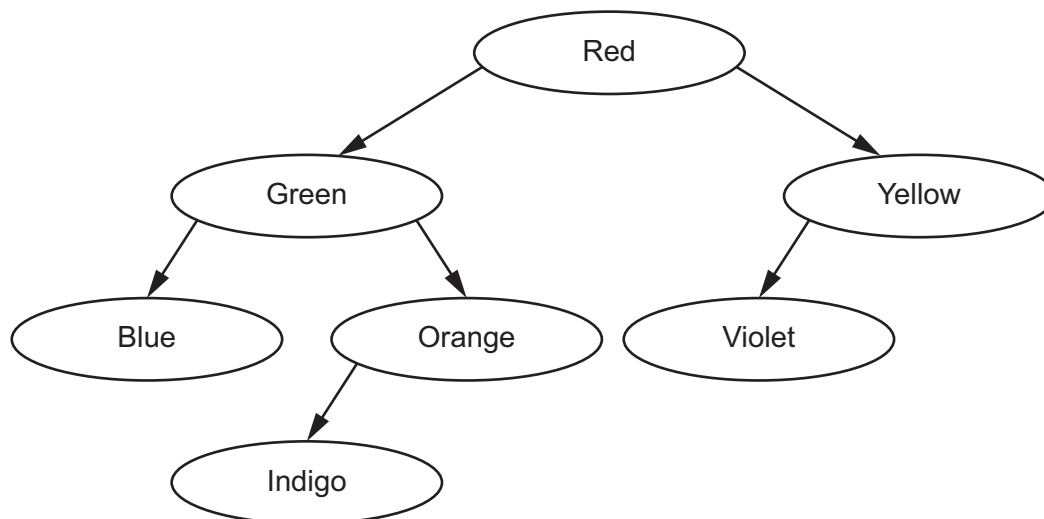
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..... [2]



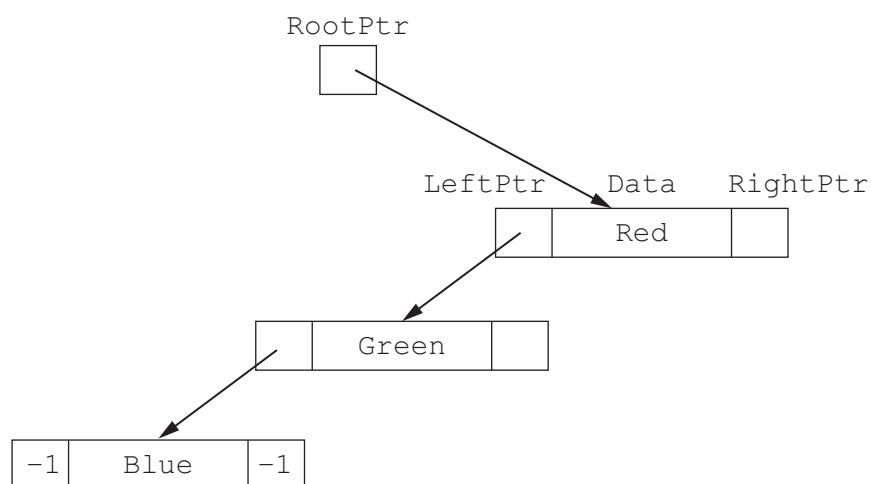
11 The following diagram shows an ordered binary tree.



- (a) A linked list of nodes is used to store the data. Each node consists of a left pointer, the data and a right pointer.

–1 is used to represent a null pointer.

Complete this linked list to represent the given binary tree.

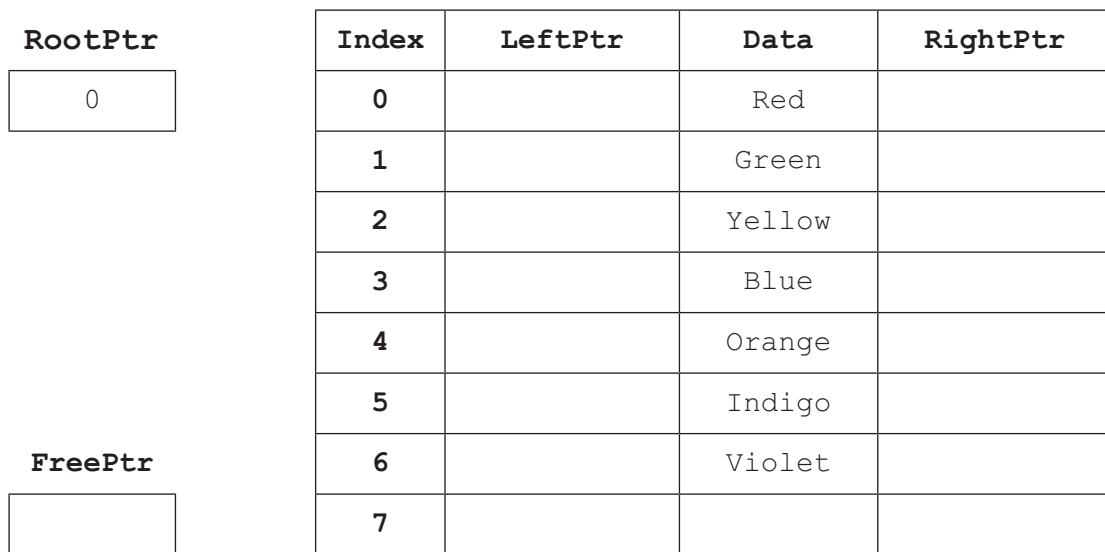


[4]



(b) A user-defined record structure is used to store the nodes of the linked list in part (a).

Complete the diagram, using your answer for part (a).



[4]

(c) The linked list in part (a) is implemented using a 1D array of records. Each record contains a left pointer, data and a right pointer.

The following pseudocode represents a function that searches for an element in the array of records `BinTree`. It returns the index of the record if the element is found, or it returns a null pointer if the element is **not** found.

Complete the pseudocode for the function.

```
FUNCTION SearchTree(Item : STRING) .....  
  
    NowPtr ← .....  
    WHILE NowPtr <> -1  
        IF ..... THEN  
            NowPtr ← BinTree[NowPtr].LeftPtr  
        ELSE  
            IF BinTree[NowPtr].Data < Item THEN  
                .....  
            ELSE  
                RETURN NowPtr  
            ENDIF  
        ENDIF  
    ENDWHILE  
    RETURN NowPtr  
ENDFUNCTION
```

[4]





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