NAME DATE STARTED TARGET END DATE

GCE A LEVEL — COMPUTER SCIENCE UNIT 3 QUESTION PACK

1500U30-1 · 2015 spec Unit 3 Topic 6 · A2 unit, first sat 2017, 100 marks, 2h paper

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COMPUTER SCIENCE — UNIT 3 · Software Design — BNF & Syntax Diagrams

Topic 3.6 — Defining the syntax of languages and data formats using Backus-Naur Form and syntax diagrams

Building BNF definitions for constants, postal addresses, ISBNs, WiFi QR strings and website URLs, using terminal and non-terminal symbols, alternation, repetition and concatenation; and drawing syntax diagrams as an alternative visual notation.

2015 specification · current

Estimated time for entire question pack: ~54 min

Derived from the Unit 3 pace of ~1.5 min/mark, padded for written-prose answers (36 marks over 5 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive topic question pack**, not a single mock paper. It contains every question from the WJEC A2 Unit 3 papers (Summer 2017 – Summer 2024, COVID gap) that maps onto Topic 3.6 of the 2015 specification.

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working. A calculator is allowed where useful.

For Examiner's use only

Q	Source	Max	Mark
1	S17 Q7	8	
2	S18 Q8	11	
3	S22 Q7	6	

Q	Source	Max	Mark
4	S23 Q9	5	
5	S24 Q7	6	
Total		**36**	

Software Design — BNF & Syntax Diagrams — what the spec asks

WJEC GCE A Level Computer Science (from 2015) · Unit 3: Programming & System Development · Topic 3.6.

Backus-Naur Form (BNF) basics

- Meta-language for describing the syntax of another language.
- Rule format: `<rule_name> ::= alternative1 | alternative2`.
- Non-terminals in <angle brackets>; terminals appear literally (often quoted).
- Recursion expresses repetition (e.g. one-or-more digits).

Building blocks for BNF

- Single character classes: `<digit> ::= 0|1|2|3|4|5|6|7|8|9`.
- Lowercase / uppercase letter rules cover alphabets cleanly.
- Compose more complex rules from simpler ones.
- Always cover every allowed form; ensure rule terminates.

Expressing repetition

- One-or-more: `<digits> ::= <digit> | <digit> <digits>`.
- Optional: define two rules, one with and one without the optional part.
- Fixed count: list it out, e.g. `<three_digits> ::= <digit><digit><digit>`.
- Use indirection to keep rules short and readable.

Common patterns

- Postal address = street + town + postcode, separated by spaces or commas.
- ISBN = prefix + group + publisher + title + check, separated by hyphens or spaces.
- URL = protocol + “://” + domain + optional path.
- Always inspect the worked example to identify separators and field boundaries.

Syntax diagrams

- Visual alternative to BNF using boxes (terminals), ovals (non-terminals), and arrows.
- Follow any path from entry to exit to generate a valid string.
- Loops show repetition; branches show alternatives.
- Often clearer for short rules; BNF wins for very long grammars.

Marking-scheme tips

- Define every terminal class needed (digits, letters, special chars).
- Use clear, consistently named non-terminals.
- Match the worked example exactly — substitute back to check.
- Include the top-level rule that joins all the parts.

Crib sheet »

Software Design — BNF & Syntax Diagrams in one page

Quick-reference notes — revisit before each question.

BNF format

<rule> ::= alternative1 | alternative2
Non-terminals in <>.
Terminals are literal characters (often quoted).
Compose complex rules from simpler ones.

Character classes

<digit> ::= 0|1|2|3|4|5|6|7|8|9
<lower> ::= a|b|...|z
<upper> ::= A|B|...|Z
<alnum> ::= <digit>|<lower>|<upper>

Repetition

One-or-more digits: <digits> ::= <digit> | <digit><digits>
Two digits exactly: <digit><digit>
Two or three: <digit><digit> | <digit> <digit><digit>

Optional parts

Use alternation with two rules: one including the optional element, one without.
Example: <url> ::= <proto>://<domain> | <proto>://<domain><path>

Worked example check

Take the example string in the question.
Substitute it back through your rules.
Every choice must resolve to a defined non-terminal.
If it doesn't fit, add the missing case.

Syntax diagrams

Visual flowchart of grammar.
Boxes for terminals, ovals for non-terminals.
Branch points = alternatives; loops = repetition.
Often clearer than BNF for short rules.

5. *(a)* Using the laws of Boolean algebra and De Morgan's theorem simplify the following Boolean expression:

$$A \cdot (\overline{A \cdot B})$$ [4]

(b) Simplify the following Boolean expression:

$$A \cdot B + A \cdot (B + C) + B \cdot (B + C)$$ [4]

6. Write a bubble sort algorithm, using pseudo-code, to sort an array of integers into ascending order. [9]

7. The name of a constant in a certain computer language must either be a single uppercase letter, or a single uppercase letter followed by one or more uppercase letters or digits.

(a) Produce an appropriate syntax diagram to define a constant in this language. [4]

(b) Produce an appropriate Backus-Naur Form (BNF) definition for a constant in this language. [4]

8. Below is part of an algorithm that initialises a two dimensional array named GRID of size N x N with zeros.

```
for i = 0 to N - 1
          for j =  0 to N - 1
                GRID(i,j) = 0
          next j
    next i
```

Evaluate the efficiency of the algorithm and, using Big O notation, determine the growth rate for the time performance. [4]

9. *(a)* Define the term algorithm. Other than pseudo-code, state **one** method of expressing an algorithm. [2]

(b) Describe the main characteristics of a recursive algorithm. [2]

(c) Describe **two** disadvantages of using a recursive algorithm. [2]

7. An Institute for ICT technicians in schools and colleges operates a code of conduct.

(a) Describe the purpose of the code of conduct. [2]

(b) Identify **two** standards that should be included in the code for professional competence. [2]

(c) Identify **two** standards that should be included in the code for professional integrity. [2]

8. An online retailer offers a large range of stock items. They use a hash table to store details of the stock items in their computer based stock control system. Each stock item has a key value.

(a) Explain the operation of a hash table and why the time taken to perform search and insertion operations is not affected by the number of stock items stored. [3]

(b) The retailer needs to store customers' delivery details, including their postal address. In this system a postal address is made up of the street, town and postcode.

Street can be a house number or name followed by the name of the street.
All towns begin with an uppercase letter followed by lowercase letters.
All letters in a postcode will be uppercase.
Postcodes can include two or three digits.

Produce an appropriate Backus-Naur Form (BNF) definition for this postal address. [8]

9. The two sections of code below carry out the same task. One section of code uses iteration and the other recursion.

```
Declare subFactorial
fact = 1
input n
for i = 1 to n
     fact = fact * i
next i
print "factorial of", n "is", fact
end sub
```

```
function factorial(n) is integer
if n <= 1 then
     return 1
else
     return factorial = n * factorial(n-1)
end if
end function
```

(a) Describe iteration. [2]

(b) Describe recursion. [2]

(c) Describe **two** advantages of using an iterative function compared with a recursive function to solve a given problem. [4]

6. (a) Describe the approach to analysis and design in the following software development methodologies:

(i) Waterfall [4]

(ii) Agile [4]

(b) (i) Describe **one** piece of documentation that should be produced during the analysis stage of software development. [2]

(ii) Describe **one** piece of documentation that should be used during the maintenance stage of software development [2]

7. Every book contains a unique 13-digit International Standard Book Number (ISBN). An ISBN comprises five parts: a GS1 assigned prefix, registration group, publisher, title and a check digit. Each individual part is separated with a space or hyphen.

- The GS1 assigned prefix must be 978 or 979.
- The registration group must be a number between 01 and 99
- The publisher must be a number between 00001 and 99999.
- The title must be a number between 01 and 99.
- The check digit must be a single digit.
- A separator of each part which can be either a space (' ') or hyphen ('-').

Example: 978-11-08412-72-8
Produce a Backus-Naur Form (BNF) definition for a 13-digit ISBN. [6]

8. Functional programming and logic programming are both declarative programming paradigms. Explain these two paradigms, giving an example language in each case:

(a) Functional programming [3]

(b) Logic programming [3]

9. All computer languages should follow the same standards.

(a) Explain the need for standardisation of computer languages. [2]

(b) Describe two potential difficulties involved in agreeing these standards. [2]

10. Draw a truth table to prove the following:

B AND NOT (A NOR B) = B [4]

9. A QR code generator uses a string to produce a WiFi access QR code. The string comprises the QR code type, encryption type, network name (SSID) and password. The string is separated using colons.

- The QR code type is WIFI.
- Colon (:)
- Encryption can be either WEP or WPA.
- The network name can contain only lowercase letters, uppercase letters and digits.
- The password can contain lowercase letters, uppercase letters, special characters and digits.

Example: WIFI:WEP:WJECWiFiPublic:Pa$$w0rd1

Produce a Backus-Naur Form (BNF) definition for the string. [5]

10. Giving suitable examples, describe the differences between translation and execution errors. [4]

11. Describe the difference between compilers and interpreters. Give one example of a language which is compiled and one example of a language which is interpreted. [8]

6. When evaluating computer-based solutions, there are several criteria that can be considered.

Describe the following criteria when evaluating computer-based solutions and give suitable examples:

(a) Usability [2]

(b) Performance [2]

(c) Scalability [2]

(d) Security [2]

7. A website URL is made up of a protocol, a domain name, and an optional file path.

- The protocol can only be “http” or “https”.
- The domain name can only consist of alphanumeric characters, hyphens and full stops.
- The protocol and domain name must be separated by a colon and two forward slashes.
- The optional file path must start with a forward slash and can only contain alphanumeric characters and forward slashes.

Example: https://www.wjec.co.uk/home/

Produce a Backus-Naur form (BNF) definition for a valid website URL. [6]

8. Explain program version management. [6]

9. Explain, using suitable examples, recursive and non-recursive sorting algorithms. [8]

END OF QUESTION PACK

5 questions · 36 marks · ~54 min
Source: WJEC A2 Computer Science Unit 3 (1500U30-1), Summer 2017–2024, COVID gap
Curated for WJEC Computer Science 2015 spec A2 Unit 3 — Topic 6 (3.6)