

GCE A LEVEL – COMPUTER SCIENCE UNIT 3 QUESTION PACK

1500U30-1 · 2015 spec Unit 3 Topic 5 · A2 unit, first sat 2017, 100 marks, 2h paper

REVISE.wales**COMPUTER SCIENCE – UNIT 3 · Systems Analysis, HCI & Professional Practice**

Topic 3.5 – Software development methodologies, evaluation criteria, HCI, validation and codes of conduct

Comparing Waterfall and Agile, identifying tasks in a design review, evaluating systems against usability/performance/scalability/security criteria, describing natural and immersive human-computer interfaces, validation vs verification, data recovery, and the role of codes of conduct in promoting professional behaviour throughout the development lifecycle.

2015 specification · current

Estimated time for entire question pack: ~3 h 10 min

Derived from the Unit 3 pace of ~1.5 min/mark, padded for written-prose answers (127 marks over 16 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 3.5 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.

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Q	Source	Max	Mark
1	S17 Q1	6	
2	S17 Q10	3	
3	S17 Q13	10	
4	S18 Q2	8	
5	S18 Q7	6	
6	S18 Q12	10	
7	S19 Q4	7	
8	S22 Q6	12	

Q	Source	Max	Mark
9	S22 Q9	4	
10	S22 Q12	4	
11	S22 Q13	12	
12	S23 Q6	4	
13	S23 Q13	13	
14	S24 Q2	8	
15	S24 Q6	8	
16	S24 Q13	12	
Total		127	

Systems Analysis, HCI & Professional Practice – what the spec asks

WJEC GCE A Level Computer Science (from 2015) · Unit 3: Programming & System Development · Topic 3.5.

Waterfall lifecycle

- Sequential phases: feasibility, requirements, design, implementation, testing, maintenance.
- Each phase completes before next begins; heavy documentation.
- Good for stable, well-understood requirements; predictable cost / schedule.
- Bad at handling changing requirements once design is locked.

Agile development

- Iterative cycles (sprints) delivering working software every 2-4 weeks.
- Embraces change; close collaboration with customer.
- Light documentation; emphasis on working code and test automation.
- Methodologies: Scrum, Kanban, XP.

Evaluation criteria

- Functionality: does it meet the specified requirements?
- Performance: speed, throughput, memory and resource usage.
- Usability: easy for the target user to learn and operate.
- Scalability: copes as users / data grow.
- Security: protects data, resists misuse, controls access.

Human-computer interaction (HCI)

- Natural language: speak/write to the computer (Siri, Alexa).
- Touch: capacitive screens on phones, tablets, kiosks.
- Immersive: VR / AR headsets putting the user inside the interface.
- Experiential: gesture, gaze, biometric inputs.

Validation & verification

- Validation: are we building the right product? Checks meet user requirements.
- Verification: are we building it right? Checks meet specification (tests, reviews).
- Validation methods: presence, format, range, type, length checks at input.
- Verification methods: double entry, visual check, code review, unit testing.

Codes of conduct & documentation

- Professional bodies (BCS, IEEE) publish codes covering competence, integrity, confidentiality.
- Promote ethical behaviour, public interest, accountability, continued learning.
- Analysis documentation: feasibility report, requirements spec, DFDs.
- Maintenance documentation: design notes, test plans, change logs, user manual.

Systems Analysis, HCI & Professional Practice in one page

Quick-reference notes – revisit before each question.

Waterfall

Feasibility → Requirements → Design → Implementation → Testing → Maintenance.
Sequential, heavy docs.
Best when requirements are stable.

Agile

Short sprints, working software each iteration.
Embraces change.
Customer involved throughout.
Light docs, automated tests, daily stand-ups.

Evaluation criteria

Usability: clear, easy, accessible.
Performance: fast, responsive.
Scalability: handles growth.
Security: confidentiality, integrity, availability.
Functionality: meets requirements.

HCI types

Natural: voice / NL chat.
Touch / multi-touch.
Immersive: VR / AR.
Experiential: gesture, gaze, biometric.
Design for the target user, context and accessibility.

Validation vs verification

Validation = right product (meets user needs).
Verification = product right (meets spec).
Validation: range, type, length, presence, format.
Verification: review, test, double-entry.

Code of conduct themes

Public interest.
Professional competence (keep skills current).
Integrity (no fraud, no plagiarism).
Confidentiality.
Compliance with laws and standards.

Answer all questions.

1. Two human computer interfaces (HCI) are voice input and touch screen.
- (a) Give **two** benefits of using a touch screen interface on a mobile device. [2]
- (b) Describe the difficulties in creating a natural language interface for voice input. [4]

2. Explain the terms object, class and method in object-oriented programming. [3]

3. (a) Draw a truth table to show the value of **P** for all possible values of **A**, **B** and **C** for the following Boolean expression:

$$P = \bar{A} \cdot B + C \quad [4]$$

- (b) Using the data in the 8 bit register below, design a mask and use it to demonstrate how a logical operation can be used to extract the least significant 4 bits. [3]

Bit number	7	6	5	4	3	2	1	0
Register contents	1	1	1	0	0	0	1	1

4. (a) Describe the processes carried out during the lexical, syntax and semantic analyses stages of compilation. [6]
- (b) Describe **one** advantage of using a programming language that requires compiling compared with a programming language that requires interpreting. [2]
- (c) Describe **two** advantages of using a programming language that requires interpreting compared with a programming language that requires compiling. [4]
- (d) State the purpose of an assembler. Describe the difference between the source code of an assembler and the source code of a compiler. [4]

10. A software company carries out a design review as part of its quality control procedures.

Identify **three** tasks that would be carried out during a design review. [3]

11. A linked list can be ordered or unordered.

(a) Explain the difference between searching for an item in an ordered list compared with searching an unordered list. [2]

(b) The table below includes an unordered list of names.

Index	Data	Next Pointer (1)	Next Pointer (2)	Next Pointer (3)
0	Smith			
1	Jones			
2	Ahmed			
3	Lewis			
4	Thomas			
5	Brown			
6				
7				
8				
9				

(i) Copy the table and complete the **Next Pointer (1)** column to link the list in ascending alphabetical order. [3]

(ii) Add Murphy and Collins to the linked list and complete the **Next Pointer (2)** column. [4]

(iii) Complete the **Next Pointer (3)** column to delete Smith. [2]

(c) Draw a representation of a binary tree using the data items from question 11(b) as key values. [3]

12. A debugging tool of an Integrated Development Environment (IDE) enables stepping, break points and variable watches.

Describe the use of stepping, break points and variable watches in the debugging of programs. [6]

13. Compare the Waterfall and Agile approaches to systems analysis and discuss suitable programming paradigms for each approach. [10]

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END OF PAPER

Answer all questions.

1. A binary tree structure is designed to contain strings and uses the following rules:
- The left pointer indicates the condition “earlier or at the same position in the alphabet”
 - The right pointer indicates the condition “later in the alphabet”
- (a) Construct a binary tree using these rules and the data entered in the following order:
Goat, Duck, Fox, Bear, Ant, Cat, Leopard, Owl, Mayfly, Insect, Jaguar, Emu.
You may use the initial letters if you wish. [2]
- (b) Carry out a pre-order traversal of the tree and give **one** use of pre-order traversals. [2]
- (c) Carry out an in-order traversal of the tree and give **one** use of in-order traversals. [2]
- (d) Carry out a post-order traversal of the tree and give **one** use of post-order traversals. [2]
2. The evaluation of a computer based solution should consider system functionality and system performance.
- (a) Identify a criterion for the evaluation of the functionality of a system and a criterion for the evaluation of the performance of a system. [2]
- (b) Developments in human-computer interaction include natural, immersive and experiential interfaces.
Describe, giving examples, the main characteristics of natural and immersive human computer interfaces. [6]
3. Use a truth table to prove De Morgan's Law $\overline{A + B} = \bar{A} \cdot \bar{B}$. [3]
4. (a) Simplify the following using De Morgan's Law's and Boolean identities.
Identify which law or identity you are using: [3]
- $$\overline{A \cdot B} + A$$
- (b) Simplify the following expression using Boolean identities and rules: [5]
- $$A \cdot B \cdot (\bar{B} + C) + B \cdot C + B$$

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]

10. (a) Describe the purpose of data validation. [2]
- (b) Write an algorithm to validate a date in dd/mm/yyyy format. [11]
11. (a) Describe what is meant by Object-Oriented Programming (OOP). [4]
- (b) Explain the relationship between classes and instances. [3]
- (c) Explain what is meant by a method. [3]
12. Explain the need for standardisation of computer languages and discuss the advantages arising from the use of algorithms and programming languages that have been standardised.
- You should draw on your knowledge, skills and understanding from a number of areas across your Computer Science course when answering this question. [10]

END OF PAPER

Answer all questions.

1. (a) Explain the differences between stack and queue data structures. [4]

- (b) This is a diagram of a linked list in alphabetical order.



- (i) Redraw the linked list after the data item 'E' has been added. [2]
- (ii) Redraw the amended linked list after the data item 'C' has been deleted. [2]

2. Clearly showing each step, simplify the following Boolean expressions using Boolean algebra, identities and De Morgan's Law.

(a) $A\bar{A} + A.B + A\bar{B} + B\bar{B}$ [5]

(b) $(\bar{A}.B) + A.C + B$ [5]

3. This is an eight-bit number:

01101001_2

Include this number in a worked example to demonstrate how masking can be used to determine the state of the most significant bit. [3]

4. (a) Describe the term natural language interface. [2]

(b) Using an example, describe a potential use for natural language interfaces. [2]

(c) Describe the potential problems that can be associated with natural language interfaces. [3]

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:
- $$B \text{ AND NOT } (A \text{ NOR } B) = B \quad [4]$$

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- (i) Waterfall [4]
 - (ii) Agile [4]
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10. Draw a truth table to prove the following:
- $$B \text{ AND NOT } (A \text{ NOR } B) = B \quad [4]$$

11. This algorithm duplicates a three-dimensional array of length n . You can assume the array (myArray) has already been populated with data.

```
1  declare i,j,k,n as integer
2  declare myArray[n,n,n]
3  declare myArrayCopy[n,n,n]
4
5  set i = 0
6  set j = 0
7  set k = 0
8
9  for i = 0 to n - 1
10
11      for j = 0 to n - 1
12
13          for k = 0 to n - 1
14
15              set myArrayCopy[i,j,k] = myArray[i,j,k]
16
17          next k
18
19      next j
20
21  next i
```

- (a) Evaluate the efficiency of the algorithm and using Big O notation, determine the growth rate for time performance. [5]
- (b) Determine the growth rate of memory space during a single run of the algorithm. [2]
- (c) Identify the type of time complexity and draw a graph of the algorithm to illustrate the order of time performance. Graph paper is not required. [2]
12. Describe how data may be recovered if lost. [4]
13. Discuss the importance of codes of conduct in promoting professional behaviour throughout the software development stages.

You should draw on your knowledge, skills and understanding from a number of areas across your computer science course when answering this question. [12]

END OF PAPER

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1  declare i,j,k,n as integer
2  declare myArray[n,n,n]
3  declare myArrayCopy[n,n,n]
4
5  set i = 0
6  set j = 0
7  set k = 0
8
9  for i = 0 to n - 1
10
11      for j = 0 to n - 1
12
13          for k = 0 to n - 1
14
15              set myArrayCopy[i,j,k] = myArray[i,j,k]
16
17          next k
18
19      next j
20
21  next i
```

- (a) Evaluate the efficiency of the algorithm and using Big O notation, determine the growth rate for time performance. [5]
- (b) Determine the growth rate of memory space during a single run of the algorithm. [2]
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13. Discuss the importance of codes of conduct in promoting professional behaviour throughout the software development stages.
- You should draw on your knowledge, skills and understanding from a number of areas across your computer science course when answering this question. [12]

END OF PAPER

4. Clearly showing each step, simplify the following Boolean expressions using Boolean algebra, identities and De Morgan's Law where appropriate.

(a) $A.(1+C) + \bar{B}.(A+B)$ [5]

(b) $X.(\overline{Y+Z}) + \bar{Z}.X$ [5]

5. Write a quicksort algorithm, to sort an array of integers into ascending order. [8]

6. State the purpose of validation and verification, giving a suitable method for each. [4]

7. An online grocery store uses binary trees. These binary trees can be traversed using a variety of methods.

- (a) Describe the following methods of traversal and give an example of why each method would be used in the grocery store.

(i) In-order traversal [3]

(ii) Post-order traversal [3]

(iii) Pre-order traversal [3]

- (b) Draw an example of a balanced binary tree for grocery items. [1]

8. Giving suitable examples, describe the types of software tool that have been designed to assist in the following:

(a) Analysis and planning [3]

(b) Software development [3]

(c) Version management [3]

12. This is an algorithm which searches for consecutive data items in three separate one dimensional arrays all of size n . You can assume all the arrays have already been populated with data.

```
Algorithm Search

declare i as integer
declare myArray1[n] as integer[]
declare myArray2[n] as integer[]
declare myArray3[n] as integer[]
declare found as string

set i = 0
set found = ""
do

    if myArray1[i] = myArray1[i+1] then
        set found = found + myArray1[i] + " "
    end if

    if myArray2[i] = myArray2[i+1] then
        set found = found + myArray2[i] + " "
    end if

    if myArray3[i] = myArray3[i+1] then
        set found = found + myArray3[i] + " "
    end if

    set i = i + 1

while (i < n)
output "Consecutive data items found: " , found
```

- (a) Evaluate the efficiency of the algorithm and using Big O notation, determine the growth rate for time performance. [5]
- (b) Draw a graph of the algorithm to illustrate and identify its order of time performance. Graph paper is not required. [4]
13. Discuss contemporary approaches to human-computer interaction.

You should draw on your knowledge, skills and understanding from a number of areas across your computer science course when answering this question. [13]

END OF PAPER

2. Computer languages such as HTML and CSS are standardised.
- (a) Describe the need for the standardisation of computer languages. [4]
- (b) Explain, giving a suitable example, the potential difficulties involved in agreeing and implementing standards. [4]
3. Clearly showing each step, simplify the following Boolean expressions using Boolean algebra, identities and De Morgan's Law where appropriate.
- (a) $(1.X + \overline{Y.Y}).\overline{X} + X.Z$ [6]
- (b) $(\overline{A}.A + A.A).1 + B.C.0$ [6]
4. Write an algorithm to search an unsorted one-dimensional array of strings and replace any duplicate values with the string "X" and then output the array. [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]

10. This is a signed 8-bit integer:

00001111₂

Include this integer in a worked example to demonstrate how masking can be used to determine the sign of the integer.

[3]

11. This algorithm merges two one-dimensional arrays of length n . Assume the arrays (`myArray1` and `myArray2`) have already been populated with data.

`num(array)` returns the number of elements currently in the array.

```
1  declare i,j as integer
2  declare myArray1[n]
3  declare myArray2[n]
4  declare myArray3[]
5
6  set i = 0
7  set j = 0
8
9  for i = 0 to len(myArray1) - 1
10     set myArray3[num(myArray3)] = myArray1[i]
11 next i
12
13 for j = 0 to len(myArray2) - 1
14     set myArray3[num(myArray3)] = myArray2[j]
15 next j
16
17 output myArray3
```

- (a) Evaluate the efficiency of the algorithm and, using Big O notation, determine the growth rate for time performance. [5]
- (b) Determine the growth rate of memory space during a single run of the algorithm. [2]
- (c) Identify the type of time complexity and draw a graph of the algorithm to illustrate the order of time performance. Graph paper is not required. [2]
12. Explain, giving a suitable example, the shortest path algorithm. [4]
13. Discuss the potential use of natural language interfaces in human-computer communication to address the problem of communicating with computers.

You should draw on your knowledge, skills and understanding from a number of areas across your computer science course when answering this question. [12]

END OF PAPER

END OF QUESTION PACK

16 questions · 127 marks · ~3 h 10 min

Source: WJEC A2 Computer Science Unit 3 (1500U30-1), Summer 2017–2024, COVID gap
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