

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Wednesday 11 June 2025 – Morning

A Level Computer Science

H446/01 Computer systems

**Time allowed: 2 hours 30 minutes
plus your additional time allowance**

YOU CAN USE:

**a ruler (cm/mm)
an HB pencil**

DO NOT USE:

a calculator

Please write clearly in black ink.

Centre number

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Candidate number

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First name(s)

Last name

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS

Use black ink. You can use an HB pencil, but only for graphs and diagrams.

Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.

Answer ALL the questions.

INFORMATION

The total mark for this paper is 140.

The marks for each question are shown in brackets [].

Quality of extended response will be assessed in questions marked with an asterisk (*).

ADVICE

Read each question carefully before you start your answer.

- 1 Charlie is about to study a computer games design course at university. He needs to purchase a computer to allow him to design and edit the graphics in his games, including video files.
- (a) Charlie's computer contains a data bus, an address bus and a control bus.

State the purpose of each of these three buses.

Data bus _____

Address bus _____

Control bus _____

[3]

- (b) Charlie will need to use input AND output devices when designing and editing his computer games.
- (i) State ONE input device AND ONE output device that Charlie could use AND give an example use of each.

INPUT DEVICE

Device name _____

Example use _____

OUTPUT DEVICE

Device name _____

Example use _____

[4]

- (ii) Charlie will need to store a large collection of files containing high definition images and high definition videos that he will use during his course.

State a type of secondary storage device that Charlie could use and give a reason why.

Type of storage _____

Reason _____

[2]

(c) In addition to the Central Processing Unit (CPU), Charlie will purchase a Graphical Processing Unit (GPU) that will be used to process and display the graphics in his games.

(i) Tick (✓) ONE box on each row to indicate if each statement is referring to a CPU OR a GPU. [2]

STATEMENT	CPU	GPU
Suited to performing simple operations in parallel on larger data sets		
Suited to performing complex operations on smaller data sets		

(ii) State TWO benefits of using a GPU to process and display the graphics in computer games.

Benefit 1 _____

Benefit 2 _____

[2]

- (d) Charlie will require an operating system that will allow him to have several applications open at the same time.
- (i) State which type of operating system Charlie will need to install.

[1]

- (ii) An operating system that Charlie is thinking about installing uses a multi-level feedback queue.

Describe how a multi-level feedback queue works.

[3]

- (iii) An operating system manages and installs device drivers.

Explain why hardware devices require a device driver.

[2]

- (e) Once Charlie has installed an operating system he will need to install utility software.

State TWO utilities that Charlie could install and state the purpose of each.

Utility 1 _____

Purpose _____

Utility 2 _____

Purpose _____

[4]

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2 OCR Consultants is designing a computer for a large company.

(a) OCR Consultants is designing the architecture of the CPU.

(i) Compare TWO differences between the Von Neumann architecture and the Harvard architecture.

Difference 1 _____

Difference 2 _____

[4]

(ii) OCR Consultants is considering using pipelining.

State TWO benefits of using pipelining.

Benefit 1 _____

Benefit 2 _____

[2]

(iii) OCR Consultants can base the CPU around a RISC architecture or a CISC architecture.

Compare TWO differences between a RISC architecture and a CISC architecture.

Difference 1 _____

Difference 2 _____

[4]

(iv) Describe a benefit of making the CPU a multicore CPU.

_____ **[2]**

(b)* The employees of the large company work remotely from home and use large databases that store a lot of sensitive data. They need to be able to use the databases to search and sort data quickly.

OCR Consultants is considering two approaches:

THIN CLIENT APPROACH – this is where the database is stored virtually on a remote server. All of the data processing is also completed on a remote server on virtual machines. The employees' computers are only used to capture the data input and display the results from the virtual machines

THICK CLIENT APPROACH – this is where most of the processing is done on the employees' computer using specialised software to access the remote database.

Discuss the benefits and drawbacks of each of these approaches.

You should include the following in your answer:

**what is meant by virtual machines and virtual storage
the benefits and drawbacks of a thin client and thick client approach described in the question
a conclusion justifying which approach would be most suitable for this scenario. [9]**

[illegible]

3

(a)

(i) Convert the denary number 189 into an 8-bit binary number.

[1]

(ii) Convert the denary number 189 into a hexadecimal value.

[1]

(iii) Convert the hexadecimal value E4 into a denary number.

[1]

- (b) Explain the effect that a right shift of **THREE** places will have on a positive binary number.

[2]

- (c) Show the subtraction of these **TWO** floating point binary numbers.

Both numbers are stored in a normalised floating point format, using 6 bits for the mantissa and 4 for exponent.

You should show your result in the same format.

Show your working out.

011010 0011 – 010010 0010

Working space

Final 6-bit MANTISSA _____

Final 4-bit EXPONENT _____ **[6]**

(d)

- (i) Show the result of applying a bitwise AND mask of 1010 1110 to the byte 1010 0011. [2]

Byte	1010 0011
AND Mask	1010 1110
Result	<u> </u>

- (ii) State the purpose of the bitwise AND mask.

[1]

BLANK PAGE

- 4 Kofi is a software engineer and has been asked to write some code using the Little Man Computer (LMC) instruction set.
- (a) State the LMC command that would be used for each description given in the table. [3]

DESCRIPTION	LMC COMMAND
Load the value stored in the memory address into the accumulator	
Branch without checking the value in the accumulator	
Store the value from the accumulator into a memory address	
Branch if zero is in the accumulator	
Branch if zero or a positive number is in the accumulator	

- Write the code for this program using the LMC instruction set.**

You can assume that the two numbers will always be different.

[4]

(c)* Kofi is working on a number of projects. These include:

PROJECT 1 – Writing a mobile phone app to look at the news

PROJECT 2 – Writing software to send temperature readings from an embedded heat sensor to other devices

PROJECT 3 – Writing an image editing application for a desktop computer

PROJECT 4 – Writing software to calculate the results of a physics experiment that produces terabytes of data

PROJECT 5 – Writing a new device driver for a new piece of hardware.

Discuss which of these projects should be written in a high level programming language and which should be written in a low level language.

You should include the following in your answer:

what is meant by high level programming language and low level language

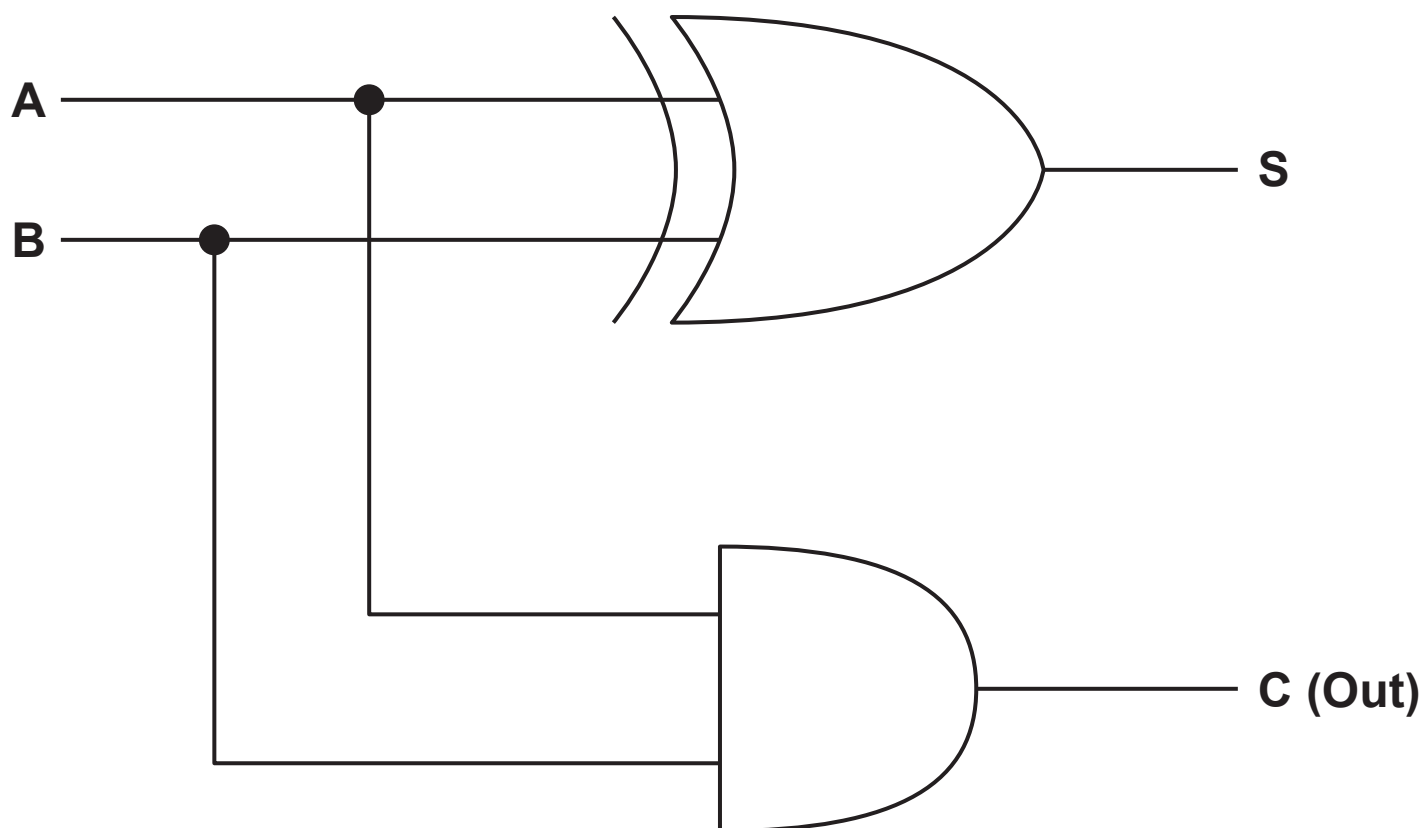
which projects are suitable for high level and which are suitable for low level languages

a conclusion that justifies why these different languages are needed. [12]

[illegible]

[illegible]

5 This diagram shows the logic circuit for a HALF adder.



(a) Complete the truth table for this half adder circuit. [4]

A	B	S	C (Out)
0	0		
0	1		
1	0		
1	1		

- (b) Describe the difference between a half adder circuit and a full adder circuit.**

[2]

- (c) The diagram opposite shows a partially completed logic circuit for a FULL adder.**

The full adder circuit contains THREE inputs:

A – represents the first input

B – represents the second input

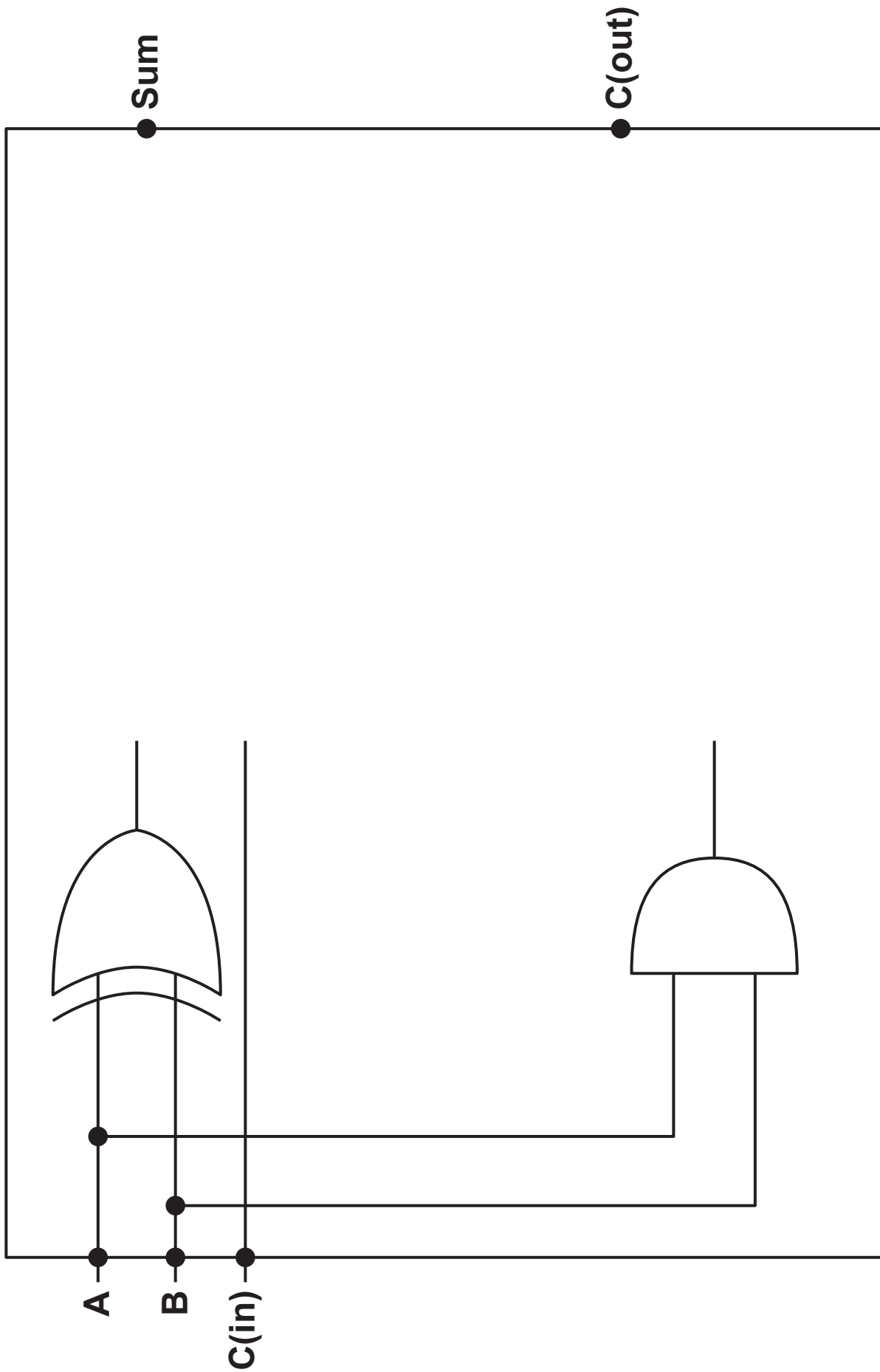
C(in) – represents the carry bit from the previous stage of the addition.

The full adder circuit contains TWO outputs:

Sum – represents the result of adding the three inputs A, B and C(in)

C(out) – represents the carry that is passed to the next stage of the addition.

Complete the logic circuit to represent a full adder. [4]



(d) This Karnaugh map represents a different logic circuit.

		AB			
		00	01	11	10
CD	00	0	1	1	1
	01	0	1	1	0
	11	0	0	0	0
	10	0	0	1	1

Use this Karnaugh map to find the simplified expression for this circuit.

You should annotate the Karnaugh map to show the groups that you have used to find the simplified expression.

Write your simplified expression here.

[4]

6 DCC Software is a company that creates a wide range of software products for home computers. Its products include image, video and sound editing software.

(a) DCC Software makes significant use of software libraries.

Explain the benefits of using software libraries to create software.

[4]

- (b) Once DCC Software has written a piece of software, they use translators to translate the programming code.
- (i) The table shows different stages of code compilation labelled A, B, C and D.

A	Lexical analysis
B	Syntax analysis
C	Code generation
D	Code optimisation

In each box write the letter of the stage that matches each description. [4]

Converts the high level code into low level instructions

Examines the code and improves the efficiency of it without affecting the functionality

Removes comments and whitespace and then converts the high level code into tokens

Identifies syntax errors and creates an abstract syntax tree

- (ii) DCC Software is considering the benefits of both an interpreter and a compiler.

State TWO benefits of using an interpreter.

Benefit 1 _____

Benefit 2 _____

[2]

- (iii) State TWO benefits of using a compiler.

Benefit 1 _____

Benefit 2 _____

[2]

- (c) DCC software uses a database table called **TblSoftware** to store details about all of their products.

ProductID	Name	Type	Price
DCC01	DCCPhotos	Image	£129.99
DCC02	DCCDraw	Image	£119.99
DCC03	DCCAnimate	Image	£99.99
DCC04	DCCMovie	Video	£189.99
DCC05	DCCEffects	Video	£99.99
DCC06	DCCAudio	Sound	£119.99

TblSoftware

- (i) Write an SQL statement to insert this new product into **TblSoftware**:

ProductID:	DCC07
Name:	DCCCast
Type:	Sound
Price:	£89.99

[3]

- (ii) Write an SQL statement to return the Name of products that have a Price that is less than the Price of the product with the Name "DCCDraw".

You should use a nested SELECT statement in your answer.

[5]

7*

- (a) OCR Photo is a free website designed to use Artificial Intelligence (AI) to generate unique photographs from a text description given by the user.**

The AI learns by searching the internet randomly for millions of photographs and then matching these to a textual description of the photograph. The photographs include people, property, landscapes and objects.

Discuss the legal and moral implications of this approach and what OCR Photo should consider.

You should include the following in your answer:

**what is meant by AI
the legal and moral implications of the learning
approach described in the question
a conclusion justifying if OCR Photo should use this
approach or not. [9]**

[illegible]

- (b) OCR Photo uses run length encoding to compress the generated photographs.

A black and white photograph is encoded using **B** for the colour black and **w** for the colour white. The encoded sequence is:

W4B1W4

W3B3W3

W2B5W2

W1B7W1

Use the grid to show the result of using run length encoding to decompress this sequence. [4]

- 8 Orla is developing a program that will allow candidates to complete quizzes for a range of subjects. Each quiz has THREE questions and each one is multiple choice with THREE possible answers.**
- (a) Orla is considering using a flat file database to store data about candidates, and the subjects and quizzes they sit.**

Explain the limitations of using flat file databases.

[4]

- (b) Due to the limitations of flat file databases, Orla decides to create a relational database containing these FOUR tables:

TblCandidate – Stores data about the candidates

TblSubject – Stores data about the subject

TblQuiz – Stores the questions for each individual quiz and the answers

TblResponse – Stores the candidate's responses for a given quiz.

The fields in each table are shown opposite. PK indicates the primary keys and FK indicates the foreign keys that are used.

Complete an Entity Relationship Diagram (ERD) to show the relationships between these FOUR tables. [3]

TblCandidate

TblSubject

TblResponse

TblQuiz

TblCandidate
CandidateID (PK)
CandidateName
eMail
PhoneNumber

TblSubject
SubjectID (PK)
SubjectName
Description

TblQuiz
QuizID (PK)
Q1Text
Q1Answer
Q2Text
Q2Answer
Q3Text
Q3Answer
SubjectID (FK)

TblResponse
ResponseID (PK)
Date
Q1Response
Q2Response
Q3Response
Score
QuizID (FK)
CandidateID (FK)

(c) In order to determine what tables were required, Orla used database normalisation.

(i) State TWO requirements for a database to be in Second Normal Form (2NF).

1 _____

2 _____

[2]

(ii) State TWO requirements for a database to be in Third Normal Form (3NF).

1 _____

2 _____

[2]

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- (d) Orla wants a web based version of the quiz. She develops a function called `checkAnswers` to calculate the score of each quiz on the client side using JavaScript.

Next to each candidate answer is an empty HTML element. When the user presses submit, the function, `checkAnswers`, will check if each answer is correct. If so, it will add the word "Correct" into the empty HTML element.

The function, `checkAnswers` takes THREE parameters:

`responses` – an array of the IDs of the HTML elements that contains the user's responses.

`feedbacks` – an array of the IDs of the HTML elements that the text "Correct" is to be written to if the candidate gets the question right. The array will be the same length as `responses`.

`answers` – an array of the correct answer for each of the questions. The array will be the same length as `responses`.

The function returns the final score out of three for the quiz. It loops through each question to calculate if the candidate got it correct and processes it appropriately if they did.

Complete the function `checkAnswers`, using pseudocode or program code. [5]

```

function checkAnswers(responses, feedbacks, _____)
{
    var _____ = 0;
    for(var qCount = 0; qCount < responses.length; qCount++)
    {
        response = document.getElementById(responses[qCount]).innerHTML;
        answer = answers[_____];
        feedbackElement = document.getElementById(feedbacks[qCount]);
        if (response == answer)
        {
            score = _____
            feedbackElement.innerHTML = "Correct";
        }
    }
    _____ score;
}

```

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]



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