A-Level Computer Science

Course at a Glance

Advances in computing are transforming the way we work and our new Computer Science specifications are changing with the times. We've worked closely with teachers to develop our popular qualifications, refreshing the content where needed but retaining the most popular and effective aspects of the previous specifications.

This evolutionary approach has built on strong foundations to deliver flexible, accessible and rigorous qualifications, backed by top quality support, resources and professional development. Without the need for huge changes we're delighted to present up-to-date specifications that focus on the knowledge, understanding and skills students need to progress to higher education or thrive in the workplace.

Subject Content

1 Fundamentals of programming

2 Fundamentals of data structures

3 Fundamentals of algorithms

4 Theory of computation

5 Fundamentals of data representation

6 Fundamentals of computer systems

7 Fundamentals of computer organisation and architecture

8 Consequences of uses of computing

9 Fundamentals of communication and networking

10 Fundamentals of databases

11 Big Data

12 Fundamentals of functional programming

13 Systematic approach to problem solving

14 Non-exam assessment - the computing practical project

Assessments

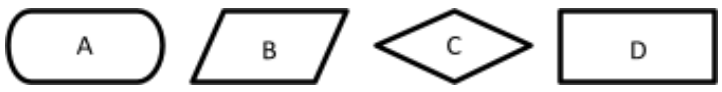
Paper 1
What's assessed: this paper tests a student's ability to program, as well as their theoretical knowledge of Computer Science from subject content 1-4 above and the skills required from section 13 above.
Assessed • On-screen exam: 2 hours 30 minutes • 40% of A-level
Questions Students answer a series of short questions and write/adapt/extend programs in an Electronic Answer Document provided by us. We will issue Preliminary Material, a Skeleton Program (available in each of the Programming Languages) and, where appropriate, test data, for use in the exam.

Paper 2
What's assessed: this paper tests a student's ability to answer questions from subject content 5-12 above.
Assessed • Written exam: 2 hours 30 minutes • 40% of A-level
Questions Compulsory short-answer and extended-answer questions.

Non-exam assessment
What's assessed: the non-exam assessment assesses a student's ability to use the knowledge and skills gained through the course to solve or investigate a practical problem. Students will be expected to follow a systematic approach to problem solving, as shown in section 13 above.
Assessed • 75 marks • 20% of A-level

Bridging Work

3.1 Fundamentals of Algorithms

<table>
<tr><th colspan="10">3.1.1 Representing algorithms</th></tr>
<tr><td>What is an algorithm?</td><td colspan="9"></td></tr>
<tr><td>Explain what the term ‘decomposition’ means when trying to solve a problem.</td><td colspan="9"></td></tr>
<tr><td>What is the term for removing information that is not necessary in order to solve a problem?</td><td colspan="9"></td></tr>
<tr><td rowspan="2">Name and describe two different ways in which an algorithm can be represented.</td><td>1.</td><td colspan="8"></td></tr>
<tr><td>2.</td><td colspan="8"></td></tr>
<tr><td>Identify the following symbols:
 
</td><td>A</td><td></td><td>B</td><td></td><td>C</td><td></td><td>D</td><td></td></tr>
<tr><td>What will be the result of following this algorithm and entering the number 15?


```
number ← USERINPUT
IF number > 20 THEN
    result number*2
ELSE
    IF number < 20 THEN
        result ← number*3
    ELSE
        IF result >100 THEN
            result ← result/2
        ENDIF
    ENDIF
ENDIF
OUTPUT result
```

</td><td colspan="9"></td></tr>
</table>

3.1.1 Representing algorithms (cont.)

Draw a flow chart that will:

- ask the user to enter a five-character code
- check that the code has five characters; if not, display the message 'Incorrect entry'
- ask the user to enter the code again
- check that the two codes match
  - if they do not match, display the message 'Do not match' and go back to the start
  - if they do match, display the message 'Code accepted'

What is the name of the paper method that can be used to test an algorithm to check whether there are any logic errors?

3.1.1 Representing algorithms (cont.)

Complete the grid to test the logic of this simple algorithm.

```
1  x ← 5
2  y ← 3
3  FOR INDEX ← 1 to 3
4      x ← x+y
5  ENDFOR
```

	3	***5***

A school is trying to calculate when the busiest times in the new canteen will be during lunch to ensure that enough food is available at the right times.

The canteen has a maximum capacity of 200.

Using the code provided, complete the grid to test the logic of this algorithm.

(Note that not all rows may be needed).

```
 1  students ← [175,-50,85,-90,-65,55]
 2  overspill ← 0
 3  total ← 0
 4  full ← 200
 5  index ← 1
 6
 7  WHILE index ≤ LEN(students)
 8     total ← total +students[index]
 9     IF total > full THEN
10         overspill ← total-full
11         OUTPUT 'Overspill of '+overspill +' at point'+index
12         total ← full
13     ENDIF
14     index ← index + 1
15  ENDWHILE
```

175	***200***	***0***	***1***

3.1.1 Representing algorithms (cont.)	
Give a real-world example of an abstraction. Explain how your example is an abstraction.	
Decompose the problem of 'pouring a glass of water' into a small set of tasks that each describes one action.	
Draw a flow chart for an algorithm to represent the following situation: ● A boy leaves his house in the morning to travel to school. ● He checks the time on his watch when he sets off. If the time is before 8am, he decides to walk to school. ● However, if the time is 8am or later, he decides to take the bus. ● He always follows this rule, and either way he will reach school on time. Ensure that you use the correct symbols for each stage of the algorithm.	

3.1.1 Representing algorithms (cont.)	
Write an equivalent algorithm in pseudocode for the same process.	
What is meant by 'tracing' an algorithm?	

Trace the following algorithm using inputs A = 5 and B = 7.
 	
`01  PRINT A, B`
`02  A ← B - A`
`03  B ← B - A`
`04  A ← A + B`
`05  PRINT A, B`	

Determine the purpose of the function shown above.	

3.1.1 Representing algorithms (cont.)	

Trace the following algorithm using inputs
A = 6 and B = 4.
 	
`01 WHILE B ≠ 0`
`02  T ← A`
`03  A ← B`
`04  B ← T MOD A`
`05  PRINT A`	

Trace the algorithm again, instead using A = 6 and B = 3	
Determine the purpose of the function above.	

3.1.2 Efficiency of algorithms

If you have two algorithms which both solve the same problem, how do you choose which algorithm to use?

What are the two main methods of measuring the efficiency of an algorithm?

1.

2.

Name the technique used to guess a password by trying all the possible combinations of numbers, letters and symbols.

These two algorithms perform the same task.

Explain which is the best, and why.

```
arr ← ['Jonny','Debra','Adam','Simon','Emily','Kate']
FUNCTION searchStudent1(arr)
    n ← 'Simon'
    found ← false
    index ← 0
    WHILE index < LEN(arr)
        index ← index +1
        IF arr[index]= n THEN
            found ← true
        ENDIF
    RETURN found
    ENDWHILE
ENDFUNCTION

FUNCTION searchStudent2(arr)
    n ← 'Simon'
    found ← false
    index ← 0
    WHILE index < LEN(arr)AND found = false
        index ← index +1
        IF arr[index]= n THEN
            found ← true
        ENDIF
    RETURN found
    ENDWHILE
ENDFUNCTION
```

Describe the algorithm below in terms of its inputs and outputs.

```
FUNCTION FindSmallest(arr)
    smallest ← arr[1]
    FOR i ← 2 TO LEN(arr)
        IF arr[i] > smallest THEN
            smallest ← arr[i]
        ENDIF
    ENDFOR
    RETURN smallest
ENDFUNCTION
```

3.1.3 Searching algorithms	
Explain how the linear search finds an item in an array.	
Explain how the binary search finds an item in an array.	
When is it better to use a linear search than a binary search?	
An array has 16 elements in it. In the worst case, how many comparisons need to be made in a linear search?	
A sorted array has 16 elements in it. In the worst case, how many comparisons need to be made in a binary search?	
Find the element '8' in the following array using a binary search. 1, 3, 5, 7, 8, 10, 12, 13, 15, 17, 18, 21, 22, 26, 27 State which elements you compare to the target in each step.	
What makes the above array usable in a binary search?	
You know that a binary search is more efficient than a linear search. Explain why you could choose to use either method in your program.	

3.1.4 Sorting algorithms	
Which of the two sorting methods uses the 'divide and conquer' approach?	
Perform a bubble sort on the array: 1, 5, 2, 8, 7, 3 Write down the state of the array after each pass of the algorithm.	
Which of the two sorting methods is more efficient? Explain why.	
Explain how the bubble sort will work to sort this simple array from: 19 | 3 | 14 | 8 | 20 | 1 To 1 | 3 | 8 | 14 | 19 | 20 The array will start at [1].	
Perform a merge sort on the following array to sort the data in ascending order: 19 | 23 | 3 | 14 | 8 | 20 | 5 | 1 The first stage of the sort has been completed for you; complete the second stage of the merge sort.	

3.2 Programming

<table>
<tr><th colspan="3">3.2.1 Data types</th></tr>
<tr><td rowspan="2">All programming languages will use data types. Give two reasons why data types are important.</td><td>1.</td><td></td></tr>
<tr><td>2.</td><td></td></tr>
<tr><td>Name two numerical data types and explain the difference between them.</td><td colspan="2"></td></tr>
<tr><td>Name two alphanumeric data types and explain the difference between them.</td><td colspan="2"></td></tr>
<tr><td>How many values can be represented using the Boolean data type?</td><td colspan="2"></td></tr>
<tr><td>Suggest an appropriate data type to store each of the following data items:</td><td colspan="2"><table>
<tr><td>The quick brown fox jumps over the lazy dog</td><td></td></tr>
<tr><td>A</td><td></td></tr>
<tr><td>872.15</td><td></td></tr>
<tr><td>54</td><td></td></tr>
<tr><td>TRUE</td><td></td></tr>
</table></td></tr>
</table>

3.2.1 Data types (cont.)		
What would happen if you tried to add the string “5” to 6? What should be done to “5” for the result to be correct?		
What would happen if you multiplied the string “5” by 6?		
Why does this occur?		
Describe, using an example, what data is stored by each of the following data types:	*Integer*	
	Real/float	
	Boolean	
	Character	
	String	

3.2.2 Programming concepts

Explain the output if this code is run using these values.

What is the term given to this type of programming structure?

```
x ← 1
WHILE x ≠ 3
    FOR i ← 1 TO 3
        OUTPUT x
    ENDFOR
    x ← x + 1
ENDWHILE
```

What is the name of the programming construct used in this function?

```
FUNCTION Compare(x,y)
    IF x > y THEN
        RETURN 1
    ELSE
        IF x < y THEN
            RETURN -1
        ELSE
            RETURN 0
        ENDIF
    ENDIF
ENDFUNCTION
```

What will be the outcome of the function if it is called using the following values?

a) `Compare(4,4)`
b) `Compare(7,4)`
c) `Compare(15,35)`

a)

b)

c)

Explain the difference between variables and constants.

Why is it a good idea to use named constants in your program code, instead of typing in the number every time that it needs to be used in your code?

3.2.2 Programming concepts (cont.)				
Explain the difference between declaration and assignment.				
Suggest two possible inputs for an ATM.	*1*		*2*	
Suggest two possible outputs for an ATM.	*1*		*2*	
What is meant by 'sequence' in programming?				
What is meant by 'selection'?				
What is meant by 'iteration'?				

Read the following pseudocode example. Identify an instance of sequence, selection and iteration.
`1 START program`
`2 INPUT A`
`3 INPUT B`
`4 FOR j ← 1 to 10`
`5 C ← (A +B)/2`
`6 IF A = B - 4`
`7 A ← 6`
`8 B ← 13`
`9 ENDIF`
`10 NEXT j`
`11 OUTPUT C`
`12 END program`
	Sequence			

	Selection			
	Iteration			

3.2.2 Programming concepts (cont.)

What is the difference between a procedure and a function?

Give two reasons why it is good programming practice to use subprograms in your code.

1

2

The pseudocode below shows two subprograms.
Which of the two subprograms is a function?

Program A

```
1 FUNCTION addNums(a,b)
2   c ← a + b
3   OUTPUT c
4 ENDFUNCTION
5
6 addNums(3,4)
```

Program B

```
1 FUNCTION addNums(a,b)
2   c ← a + b
3   RETURN c
4 ENDFUNCTION
5
6 answer ← addNums(3,4)
```

Explain which line gives you the answer to the question above and the key term used in the code.

What are the parameters used in both programs above?

What are the parameter values passed to both of the programs above?

The code below shows two types of iteration. Explain whether these are examples of definite or indefinite iteration, and why.

Example A

```
REPEAT
  OUTPUT 'Are we there yet?'
  reply  ←  USERINPUT
UNTIL reply = 'Yes'
OUTPUT 'At last!'
```

Example B

```
incorrectAnswer ← TRUE
WHILE incorrectAnswer
   OUTPUT 'Are we there yet?'
   reply  ←  USERINPUT
   IF reply = 'Yes' THEN
     incorrectAnswer ← FALSE
OUTPUT 'At last!'
ENDWHILE
```

Which of the two examples above checks the condition at the start of the iteration?

3.2.2 Programming concepts (cont.)	

A programmer has written this simple code to convert the temperature in Celsius to Fahrenheit:
 	
`1 FUNCTION  conC_F()`
`2  tc ←  USERINPUT`
`3  f ←(tc x 9/5)+32`
`4  OUTPUT f`
`5 ENDFUNCTION`
 	
Explain how this code could be improved to make it easier for other people to understand.	

3.2.3 Arithmetic operations in a programming language				
What operators are used for multiplication and division?	*Multiplication*		*Division*	
What is the difference between division and integer division?				
Answer the following short questions on arithmetic symbols:	*12 + 5*			
	12 – 5			
	*12 * 5*			
	12 / 5			
	12 MOD 5			
	12 DIV 5			

3.2.4 Relational operations in a programming language

Explain the meaning of each of the following relational operators:

=	
≠	
<	
>	
≤	
≥	

Name the relational operator used in the following program:

```
1 x ← 1
2 WHILE x ≠ 3
3   FOR i ← 1 TO 3
4     OUTPUT x
5   ENDFOR
6   x ← x + 1
7 ENDWHILE
```

Write the program code below in full by adding in the correct relational operators.

```
FUNCTION compareNums(x,y)
    IF x ___ y THEN
      OUTPUT 'x is larger'
    ELSE IF x ___ y THEN
      OUTPUT 'y is larger'
    ELSE
      OUTPUT 'x and y are equal'
ENDFUNCTION
```

Explain what will happen when the procedure is called with the parameter values shown.

a) `compareNums(15,24)`
b) `compareNums(56,14)`

a)	
b)	

3.2.5 Boolean operations in a programming language

State one use of including Boolean operators in our programs.

State whether the following statements are true or false:

4 <= 3	
11 > 10 AND 3 <= 3	
(NOT (3 = 5)) AND (4 < 5)	
NOT (3 = 4 OR 5 = 6)	

Explain how this simple program could be made more efficient through the use of a Boolean operator.

```
1  incorrectAnswer ← TRUE
2  WHILE incorrectAnswer
3    OUTPUT 'Are we there yet?'
4    USERINPUT ← reply
5    IF reply = 'Yes' THEN
6      incorrectAnswer ← FALSE
7      OUTPUT 'At last!'
8    ENDIF
9  ENDWHILE
```

3.2.6 Data structures		
What is an array used for?		

Consider the following array:
 	
`My_Array =`
`1  2  4  6`
`13  12  10  8`
`16  21  14  3`
`19  32  71  5`
 	
If `My_Array[1][2] = 21`, state the elements that would be returned in the following cases:
 	
a) `My_Array[0][2]`
b) `My_Array[2][0]`
c) `My_Array[4][4]`
	a)	

	b)	
	c)	
Suggest a possible use for a 1D array.		
Suggest a possible use for a 2D array.		
In what circumstances would you use a record rather than an array?		

3.2.7 Input/output and file handling	
Suggest one reason why you may wish to use an external file in your program.	
Write the pseudocode to ask for the user's name, and display a message saying 'Hello' concatenated with the name entered.	
Write some pseudocode that reads in a text file called "test.txt", and outputs each line.	
Write some pseudocode that asks a user for input, and writes it to a new file called "test2.txt".	
Why is it important to close a file after you have finished with it?	
When numeric input is given to the computer, why should you be careful before you start performing operations on it? What should you do to make sure no errors occur?	

3.2.8 String-handling operations in a programming language	
What do we call the operation of joining two strings together?	
Suppose a = “Hello”, b = “World” and c = “!!!”. What is the result of printing a + b + c?	
How can a string be converted into all upper case?	
What is the result of the following function calls? a) `POSITION("Hello world!","H")` b) `SUBSTRING(0,5,"Hello world!")` c) `SUBSTRING(3,6,"Hello world!")` d) `LEN("Hello world!")`	*a)* *b)* *c)* *d)*
If `CHAR_TO_CODE('C')` evaluates to 67, what do the following function calls evaluate to? a) `CHAR_TO_CODE('B')` b) `CHAR_TO_CODE('H')` c) `CHAR_TO_CODE('T')`	*a)* *b)* *c)*
Some programming languages do not allow you to print an integer to the screen. Explain why this is the case, and state how this can be fixed.	
Some shops have a ‘short code’ for their products. Write some pseudocode that creates a short code by combining the colour of the product, the first three letters of the item, and the size of the product. Use the variables `product_colour`, `product_name` and `product_size`.	
If `CODE_TO_CHAR(100)` evaluates to ‘d’, what do the following function calls evaluate to? a) `CODE_TO_CHAR(118)` b) `CODE_TO_CHAR(111)` c) `CODE_TO_CHAR(104)`	*a)* *b)* *c)*

Look at this simple program. What do you expect to happen if this code is executed as it is?
`Euro_rate ← USERINPUT`
`GB_Pounds ← USERINPUT`
`Holiday_money ← GB_POUNDS * Euro_rate`
`OUTPUT 'Your holiday money in Euros is '+Holiday_money`	

3.2.9 Random number generation in a programming language		
If RANDOM_INT(2, 4) will generate 2, 3 or 4, what do you expect the following functions calls to do? a) `RANDOM_INT(12, 16)` b) `RANDOM_INT(8, 9)` c) `RANDOM_INT(21, 28)` d) `RANDOM_INT(51, 57)`	*a)*	
	b)	
	c)	
	d)	
For your homework, you have been asked to write the code for a simple guessing game for homework. The program should ask the user for a number between 1 and 10, check whether the guess is the same as the random number, and display a success message. The user is allowed three attempts before the ‘Game over’ message is displayed. Write the pseudocode for this simple game.		

3.2.10 Subroutines (procedures and functions)

Subroutines refer to the use of procedures and functions. Give three reasons why a programmer would choose to use subroutines.

1.

2.

3.

Explain how the sample code below uses the parameters x and y to pass data into the function, using the values 15 and 12 as an example.

```
FUNCTION multiplyNums(x,y)
    total ← x * y
    RETURN total
ENDFUNCTION
```

Look at the two subroutines below. Both subroutines use the variable `x`. Explain the difference between the use of x in `multiplyNums()` and the use of x in `divideNums()`.

```
x ← 24

FUNCTION multiplyNums(y)
    total ← x * y
    RETURN total
ENDFUNCTION

FUNCTION divideNums(y)
    x ← 60
    result ← x/y
    RETURN result
ENDFUNCTION
```

What will be the result of the following function calls using the code above?

a) `total ← multiplyNums(2)`
b) `total ← multiplyNums(5)`
c) `result ← divideNums(6)`
d) `result ← divideNums(12)`

a)

b)

c)

d)

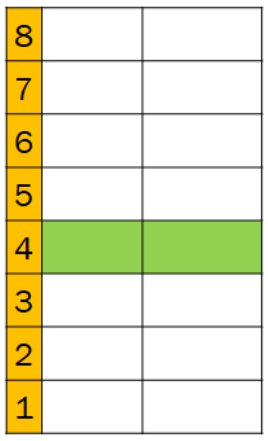
3.2.10 Subroutines (procedures and functions) (cont.)		
Explain why the variable `x` in the function `divideNums()` is known as a LOCAL variable.		
Give three reasons why it is better to use local variables rather than global variables in your code.	*1.*	
	2.	
	3.	

3.2.11 Structured programming

You have been set the task of creating a program for two players that will involve each player rolling a dice to determine the number of moves on a board shown here:

- Apart from Row 4, if a player's counter lands on the same row as that of their opponent, they return to the start.
- To win the game, a player must get both their counters to Row 8.

Explain how you would approach solving this problem.



State two methods you could use to plan out your solution before starting to write any code.

1.

2.

Explain why the structured approach to planning your solution is better than writing large sections of code straight away.

3.2.12 Robust and secure programming		
Name a consideration that should be made when writing software that allows users to input data.		
How should you design your program in accordance to this consideration?		
What is meant by a 'length check' on inputted data?		
Describe three other types of input validation.	*1.*	
	2.	
	3.	
Why is it important that programs are tested?		
What is a 'syntax error'?		
Give an example of a common cause of syntax error.		
What is a 'logic error'?		
Give an example of a common logic error.		

3.2.12 Robust and secure programming (cont.)	

Consider the following program:
 	
`x = 4`
`IF x = 4 THEN`
`  PRINT "x is equal to four"`
 	
Why does nothing get printed?	

The VAT price of an item is found by multiplying the price by 1.2. The program below finds the pre-VAT price from the price including VAT.
 	
`vat_price = 10.00`
`pre_vat_price = vat_price - vat_price/5`
`PRINT pre_vat_price`
 	
The program compiles but gives the wrong answer.
 	
What kind of error has occurred?
Can you fix the program so it works as intended?	

Explain the difference between extreme test data and erroneous test data.	
If working correctly, how should a program deal with erroneous test data?	
What name is given to test data which is out of range and should be rejected by the program, but is the correct type of input?	
What name is given to acceptable test data which is in the correct range?	

3.2.12 Robust and secure programming (cont.)

Consider a very simple program which outputs whether an inputted integer between -100 and 100 is positive, negative or zero.

For each of the different types of test data, give two examples of data which could be used to test this program, explaining your choice.

Normal			
Normal			
Extreme			
Erroneous			
Erroneous			

Using pseudocode, write a computer program which:

- Checks that the length of a password is greater than or equal to 8 characters
- Displays the message 'Valid' if it is
- Displays the message 'Invalid' if it is not.
- Returns the result of whether the password is valid or not.

The first two lines have been given for you:

```
FUNCTION lenCheck()
pwd ← USERINPUT
```

3.2.13 Classification of programming languages	
Place assembly code, machine code and program code in order from the least understandable to the most understandable by humans.	
What is machine code?	
What defines high-level languages?	
Give an example of a high-level language.	
What is assembly language? How did it evolve from machine code?	
State one characteristic of assembly code and machine code that is not shared with high-level code.	
What must happen in order for a computer to run a program written in a high-level language?	
Give one example of where assembly language would be preferred to a high-level language.	
Describe the function of translator software.	

3.2.13 Classification of programming languages (cont.)		
Describe each of the following translators:	*Assembler*	
	Interpreter	
	Compiler	
Which types of translator are used for high-level programming languages?		
When would using a low-level language be more suitable than a high-level language? Explain your answer.		
What are the benefits of using a programming language that is interpreted instead of compiled?	*1.*	
	2.	
State two benefits of using a programming language that is compiled instead of interpreted.	*1.*	
	2.	

3.3 Fundamentals of data representation

3.3.1 Number bases	
What name is given to the number system in base 10 that humans use?	
What name is given to the number system in base 2 that computers must use to store and process data?	
Why is hexadecimal number representation often used in computing?	
Why must all data be converted into this form before it can be processed by the computer?	

3.3.2 Converting between number bases		
Convert these binary numbers into denary:	*010 10101*	
	1110 0011	
Convert these denary numbers into binary:	*34*	
	53	
Convert these hexadecimal numbers into denary:	*37*	
	C4	
Convert these hexadecimal numbers into binary: *Hint: convert each hex digit into four binary digits and concatenate.*	*41*	
	5D	

3.3.3 Units of information

Complete the table with the correct quantities of bytes and their prefixes.

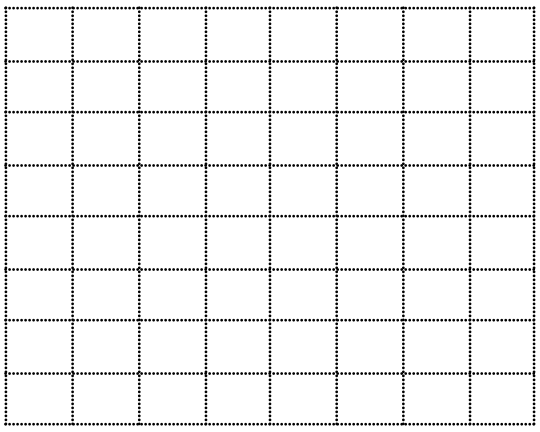
	b	*0 or 1*
Byte		
	1 KB	
		1,000 kilobytes
	1 GB	
terabyte		

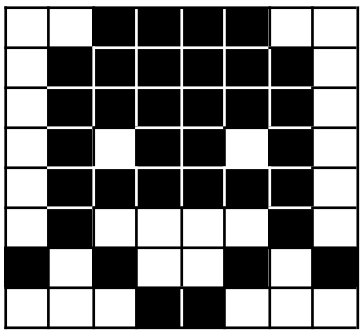
How many bits are there in a byte?	
How many bytes are there in a kilobyte?	
How many bits are there in a kilobyte?	
What name is given to the unit made up of a billion bytes?	

3.3.4 Binary arithmetic				
Add these two binary numbers together: 101 1101 + 001 1010				
Complete the addition of these sets of binary numbers.	*10110 + 11010 + 110*		*00100111 + 00011101 + 01110010*	
	00110010 + 001010 + 10111		*01000011 + 00111001 + 01000101*	
What is the result of performing a single left shift on a binary number?				
Complete the grid to show the result of a binary shift that has multiplied the original number by 8.				
Convert the original number and the result of your binary shift to decimal. Explain how the binary shift has worked in this example.				
What would be the result of applying a shift of two places to the right for the original number?				

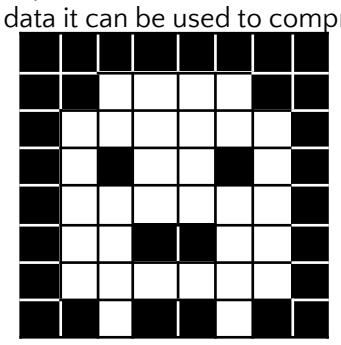
0	*0*	*0*	*1*	*1*	*1*	*0*	*1*

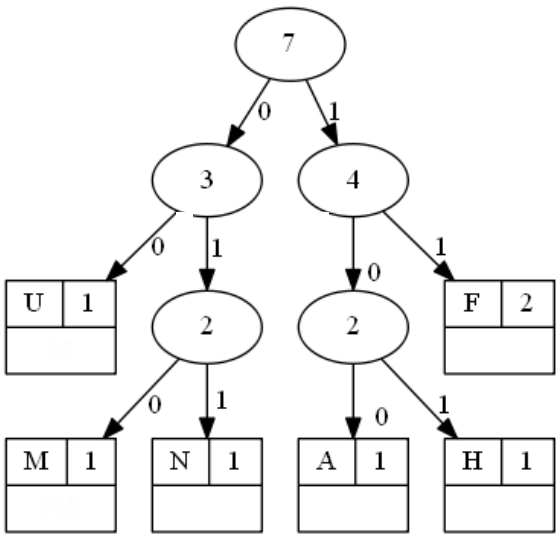
3.3.5 Character encoding	
How are individual characters represented by a computer?	
What is meant by the term ‘character set’?	
What does ASCII stand for?	
How many different characters can the ASCII set represent? How many bits does this use per character?	
Explain the limitations of using ASCII for global communication.	
Suggest a different character set that would be more useful for global communication.	
How many bits does this character set use per character?	
Explain one possible disadvantage of using this character set instead of ASCII. Do you think that this is a significant problem or not?	
Complete the code for this simple message in ASCII:	[redacted] 01100011 · [redacted] 99 · [redacted] c o d e

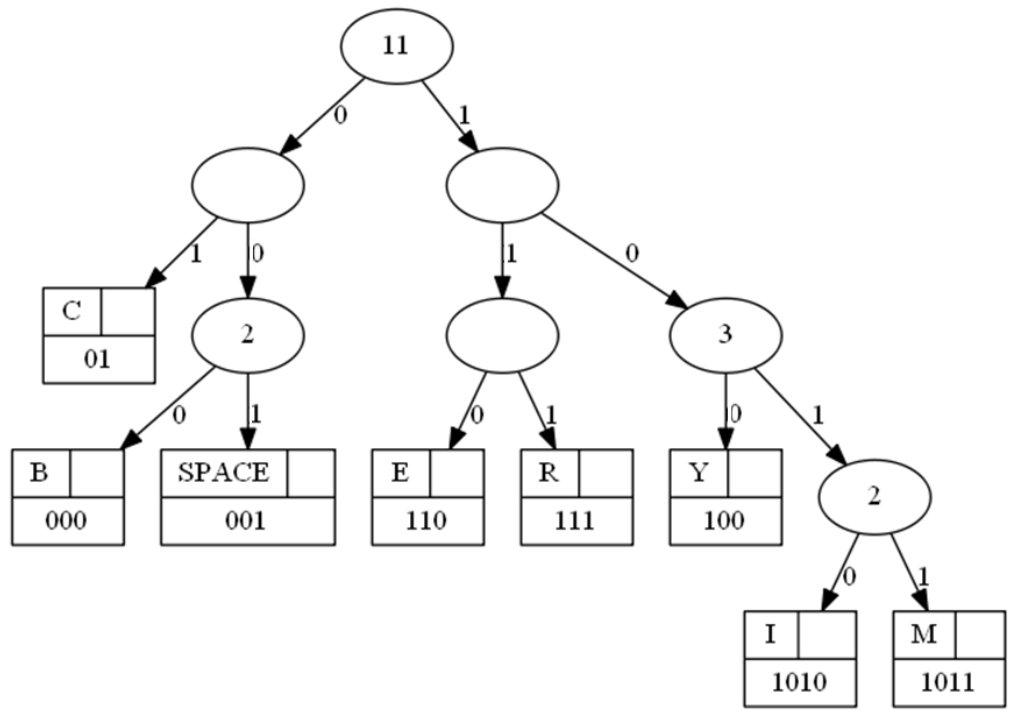
3.3.6 Representing images	
What is the term ‘pixel’ the shortened version of?	
What is a ‘pixel’?	
Describe how a simple black and white bitmap image can be stored by the computer.	
The binary numbers below represent a simple black and white bitmap image. On the 8 × 8 grid, fill in the appropriate spaces to create the image. A 1 represents white and a 0 represents black. Fill in each 8-bit string of digits in regular reading order. 0000 0000 0111 1110 0111 1110 0111 1110 0111 1110 0000 0000 1110 0111 1000 0001	
How is the storage of a colour image different from that of black and white images?	
What is ‘colour depth’?	
What is ‘metadata’?	
What information might typically be stored in image metadata?	

3.3.6 Representing images (cont.)	
What is meant by the term ‘resolution’?	
What are the effects of colour depth and resolution on the file size of the image?	
Write down the bit pattern used to create this black-and-white image. A 1 represents white and a 0 represents black. 	
What is the image resolution of the above image? Describe how this is calculated.	
Calculate the storage requirements for a colour image measuring 400 x 600 pixels. The image uses 32-bit for three RGB colours. Express your final answer in megabytes.	
Calculate the storage requirements for a colour image measuring 800 x 600 pixels using 8-bit indexed colour. Express your answer in kilobytes.	

3.3.7 Representing sound	
Explain the difference between analogue and digital signals.	
Describe the process of converting an analogue sound signal to digital.	
What is meant by the ‘sample rate’ of an audio recording?	
What is the sampling rate measured in?	
What effect does the sampling resolution have on the audio quality?	
What effect do the bit rate and sample rate have on the file size of the recording?	
Suppose a recording has been made with a sample rate of 1,000 Hz, and a sampling rate of 8 bits per sample. How much space would a 10-second recording take up?	

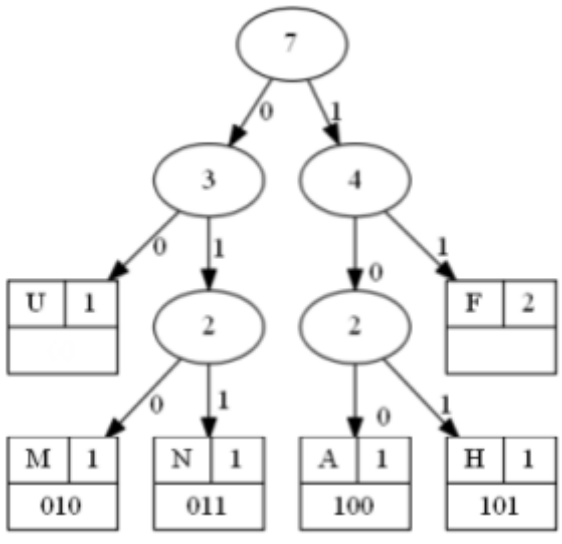
3.3.8 Data compression					
What is meant by the term ‘compression’?					
Why is it important when sending files over the Internet?					
Explain the difference between lossy and lossless compression.					
Give an example of a type of file for which lossy compression should not be used.					
Give an example of a file format that uses lossy compression and an example of a file format that uses lossless compression.	*Lossy*		*Lossless*		
Is run-length encoding (RLE) a lossy or lossless form of data compression?					
Explain how RLE works and what types of data it can be used to compress. 					

3.3.8 Data compression (cont.)	
Convert this code in RLE frequency and data pairs into the image it represents: Row1: `20 41 20` Row2: `10 11 40 11 10` Row3: `11 10 11 20 11 10 11` Row4: `11 60 11` Row5: `11 10 11 20 11 10 11` Row 6: `11 20 21 20 11` Row 7: `10 11 40 11 10` Row 8: `20 41 20`	
Specify the RLE frequency and data pairs for this simple black-and-white image.	
What is a binary tree?	
Complete the encoding values for each letter in this tree.	

3.3.8 Data compression (cont.)	
Using the tree shown in the previous question, decode this into text from the binary equivalent: `101001111010100011`	
Complete all the missing labels in the Huffman coding tree shown below for the text: `CYBER CRIME`	
Explain how data is compressed using a Huffman tree.	
Explain how you would calculate the number of bits required to store the string: HUFFMAN using 7-bit ASCII.	

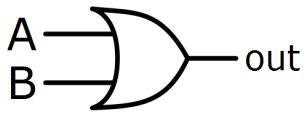
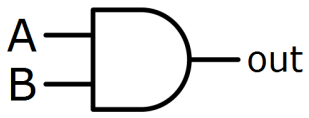
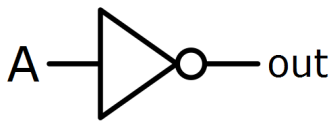
3.3.8 Data compression (cont.)

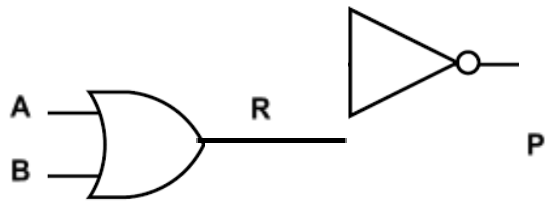
Using the Huffman tree shown here, describe how you would calculate the number of bits required to store the string "HUFFMAN" using Huffman coding.

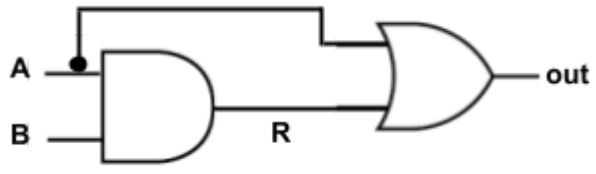


3.4 Computer systems

3.4.1 Hardware and software		
What is the difference between hardware and software?		
What is a ‘user interface’?		
Name three inputs and three outputs for a mobile phone.	*Inputs*	
	Outputs	
Which architecture was first described in 1945 that allows for the storage of data and programs in the same location?		
In what number system did John von Neumann propose to store the instructions used during the execution of programs?		
What is the purpose of the Central Processing Unit?		
Label the four elements that are required to form a basic computer system.	*A*	
	B	
	C	
	D	
What is the difference between main memory and secondary memory?		

3.4.2 Boolean logic	
What is a ‘logic gate’?	
Name three types of basic logic gate.	
What are truth tables used for?	
Which logic gate does this symbol represent? 	
Which logic gate does this symbol represent? 	
Which logic gate does this symbol represent? 	
Draw a logic diagram for the logic statement: `(A AND B) OR (NOT C)`	

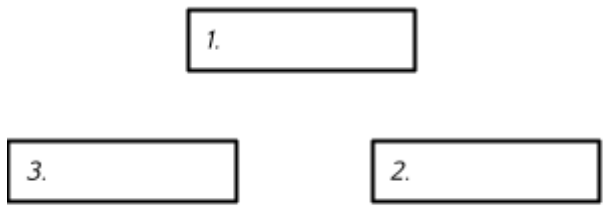
3.4.2 Boolean logic	
Draw a truth table for the OR gate.	
Draw a truth table for the NOT gate,	
Draw a truth table for the following circuit. 	

3.4.2 Boolean logic (cont.)	
Why is the set of possible inputs to a logic gate 0 and 1? How does this translate to the physical hardware of the computer?	
Draw a truth table for the following circuit. Can this circuit be simplified? *Hint: look at the truth table and see whether you can determine when it outputs true.*  	

3.4.3 Software classification				
What is the difference between application software and system software?				
Give two examples of system software.	*1.*		*2.*	
How would application software behave without system software?				
Give two examples of application software.	*1.*		*2.*	
Utility software is another example of system software. How does utility software differ from other types of system software?				
What is the purpose of an operating system?				
What is meant by ‘memory management’ and ‘peripheral management’?				
List some of the functions of operating systems.				

3.4.4 Systems architecture				
What are the two main components of the CPU?	*1.*		*2.*	
What cycle does the CPU carry out continuously to process instructions?				
Describe the role of a register in the CPU.				
Describe the role of a register in the CPU.				
What is the name of the register which keeps the address of the next instruction to be processed?				
Describe how the von Neumann computer system works.				
What is the name of the register which keeps the address of the next instruction to be processed?				
Which register in the CPU is used to store data that is fetched from main memory?				
Which register is used to tell the CPU where to locate this data?				
What is the name of the register that temporarily stores the results of logic operations and calculations during processing?				
State two functions of the control unit.	*1.*			
	2.			
Explain the function of the ALU and give some examples of the operations that it carries out.				

3.4.4 Systems architecture (cont.)	
Which bus is used to carry memory addresses from the CPU to main memory?	
What is meant by ‘an address’?	
What unit of measurement is used to describe the clock speed of a processor?	
Suppose a processor is capable of performing 1 billion operations per second. What is the clock speed of the processor?	
Why does increasing the cache size increase the performance of the processor?	
State one drawback of cache memory in comparison with main memory.	
What is the system bus?	
Typically, around how large is the cache memory located closest to the CPU?	
Does doubling the number of cores *exactly* double the performance of a processor? Explain your answer.	
What is ‘cache memory’? Why is it useful during program execution?	

3.4.4 Systems architecture (cont.)				
Add the missing labels to describe the fetch execute cycle.				
Order the three types of cache in order of proximity to the processor.				
Which register is used to keep track of which memory location to look at for the next instruction?				
Suppose data is fetched from main memory. Which register does it get stored in				
Suppose an instruction is fetched from main memory. Which register is does it get stored in?				
Which part of the CPU is used to translate instructions into a set of operations that can be performed directly by the CPU?				
Describe the first process that occurs in the fetch and execute cycle				
What is the purpose of RAM?				
Why do we use RAM instead of keeping everything in secondary storage?				
What data does the ROM store?				
Is RAM volatile or non-volatile? What about ROM?	*RAM*		*ROM*	
Which primary storage device is larger in memory capacity?				

3.4.4 Systems architecture (cont.)						
How could the addition of extra RAM speed up a computer? Why might this not always be effective?						
Can ROM be used as secondary storage?						
What is the name given to storage under the direct control of the CPU?						
Using an example of each, explain the difference between primary and secondary storage						
Why is secondary storage necessary?						
Name the three categories of secondary storage device.	*1.*		*2.*		*3.*	
State three common secondary storage devices and describe a purpose for which each might be used.	*1.*					
	2.					
	3.					

3.4.4 Systems architecture (cont.)		
State four reasons why solid-state memory is slowly becoming more popular than magnetic hard drives. Explain your reasoning.	*1.*	
	2.	
	3.	
	4.	
State one vulnerability of magnetic hard drives that is not found in DVDs.		
Briefly describe how data is physically written to a hard disk		
Briefly describe how data is physically written to a CD or DVD.		
Why would you use a Blu-ray disc instead of a DVD to store a modern video game for a home console?		
List the factors that should be considered when choosing an appropriate secondary storage device.		
What is 'flash memory'?		
What component is used in flash memory to store a single bit of data?		
Name another use for a Blu-ray disc, and give two reasons why Blu-ray is more suitable for the use that you have mentioned than other secondary storage methods.		

3.4.4 Systems architecture (cont.)		
Explain why solid-state storage has a faster access speed than a magnetic hard drive.		
Why can't RAM be used as a secondary storage device?		
What is meant by 'cloud storage'? Give one example of why it may be seen as useful.		
Can you think of an example of why you might not want to use cloud storage?		
Give two advantages using optical media to store data.	*1.*	
	2.	
	3.	
Give three disadvantages using optical media to store data.	*1.*	
	2.	
	3.	
Give two advantages using magnetic media to store data.	*1.*	
	2.	
	3.	
Give three disadvantages using magnetic media to store data.	*1.*	
	2.	
	3.	

3.4.4 Systems architecture (cont.)							
Give two advantages using solid-state media to store data.	*1.*						
	2.						
	3.						
Give three disadvantages using solid-state to store data.	*1.*						
	2.						
	3.						
What is meant by an 'embedded' system?							
Give an example of an embedded system that could be found in the human body.							
Give three examples of devices that you can find in your house that may contain an embedded system.	*1.*		*2.*		*3.*		
Cars are an example of an object with multiple embedded systems for performing different tasks. Suggest two uses for an embedded system in a car.	*1.*		*2.*				
Suggest two reasons why a manufacturer may use embedded systems instead of general purpose computers in their products.	*1.*		*2.*				
How do embedded systems and general-purpose computers differ?							

3.5 Fundamentals of computer networks

3.5 Fundamentals of computer networks						
What is a 'network'?						
What do the following acronyms stand for?	*PAN*		*LAN*		*WAN*	
Explain the main differences between a PAN, a LAN and a WAN.						
State three benefits of using a LAN in a small organisation	*1.*					
	2.					
	3.					
State two drawbacks of using a LAN in a small organisation.	*1.*					
	2.					

3.5 Fundamentals of computer networks (cont.)				
Give three advantages of using computer networks over standalone devices.	*1.*			
	2.			
	3.			
Give three disadvantages of using computer networks over standalone devices.	*1.*			
	2.			
	3.			
Describe the purpose of Wi-Fi.				
Describe the method by which information is transmitted in Wi-Fi.				
What is the service set identifier (SSID) of a wireless network?				
Which protocol allows for data to be sent over physical wires in a network?				
Describe two methods of protecting a Wi-Fi network.	*1.*		*2.*	

3.5 Fundamentals of computer networks (cont.)		
Why is it faster to send data over a fibre-optic cable instead of a coaxial cable?		
State three mediums for transmitting data over a network. For each medium, state one potential advantage and disadvantage of using that medium.	*Medium 1:*	
	Advantage	
	Disadvantage	
	Medium 2:	
	Advantage	
	Disadvantage	
	Medium 3:	
	Advantage	
	Disadvantage	

3.5 Fundamentals of computer networks (cont.)		
What hardware does the network need in order to connect to it wirelessly?		
Draw a simple diagram to represent the following network topologies:	*Star*	*Bus*
Describe two advantages of using a star network over a bus network.	*1.*	
	2.	
Sarah has started a business providing accountancy services for small businesses. She will be employing two other people to work in the business; each person will need their own computer. Explain which network you would recommend for Sarah, and give reasons why.		
What is meant by 'latency'?		
When can latency be a problem in the performance of networks?		
Other than latency, describe the other factor that affects the performance of networks.		

3.5 Fundamentals of computer networks (cont.)				
What is a ‘protocol’ in networking’?				
Name and describe three common network protocols.	*1.*			
	2.			
	3.			
What is the key difference between the HTTPs protocol and the HTTP protocol? When is it particularly important that a website uses HTTPs?				
What physical hardware is required for a computer to connect to the Internet?				
What is the purpose of a router?				
What is a ‘switch’?				
State two items of hardware that are required to connect to the Internet.	*1.*		*2.*	
What is meant by a MAC address?				
What is meant by an IP address?				

3.5 Fundamentals of computer networks (cont.)		
Explain how IP addresses can be static or dynamic.		
State how the TCP/IP protocol is structured.		
Describe what happens at each layer of the TCP/IP model.	*Application*	
	Transport	
	Internet	
	Link	
Name six protocols that are commonly used in the *Application* layer.	*1.*	
	2.	
	3.	
	4.	
	5.	
	6.	

3.5 Fundamentals of computer networks (cont.)				
Common protocols used in the transport layer are TCP and UDP. What do these acronyms stand for, and what is the difference between the two protocols?				
What is a data packet?				
Describe how the process of packet switching is used to carry data across a network.				
What are the names of the two main 'families' of protocols which control the transmission of data over wireless networks and wired networks?	*1.*		*2.*	
What protocol operates in the Internet layer of the TCP/IP model and what does it do?				
What is the purpose of a firewall?				

3.5 Fundamentals of computer networks (cont.)		
For each of the following vulnerability prevention techniques, explain how it helps to protect a network.	*Authentication*	
	Encryption	
	MAC address filtering	
Why is it important to have network security?		

3.6 Fundamentals of cyber security

3.6 Fundamentals of cyber security		
What is meant by the term ‘cybersecurity’?		
Describe two ways of preventing brute force attacks on user passwords?	*1.*	
	2.	

3.6.1 Cyber security threats		
How can vulnerabilities of a network be identified?		
Explain how penetration testing works.		
Explain the difference between white-box penetration testing and black-box penetration testing. Give one disadvantage of each system.		
Give two examples of a ‘poor’ network policy.	*1.*	
	2.	

3.6.1 Cyber Security Threats	
Why is it important to install updates for your computer system?	
Give an example of a network vulnerability that does not come in the form of malware.	

3.6.1.1 Social engineering		
Social engineering is the process of influencing people into giving away confidential information. Explain what each of the following methods of social engineering involves.	*Blagging*	
	Phishing	
	Pharming	
	Shouldering	

3.6.1.2 Malicious code						
Name three types of malware that could be found on a computer.	*1.*		*2.*		*3.*	
What is the purpose of adware?						
How does spyware operate?						
Explain how phishing is used to trick someone into installing malware / giving away personal information.						
Describe what is meant by 'malware'.						
How does most malware find its way onto computers?						

3.6.2 Detecting and preventing cybersecurity threats				
List four methods of protecting your personal data from cyberattacks.	*1.*			
	2.			
	3.			
	4.			
List four biometric measures that can be used instead of passwords for user authentication.	*1.*		*3.*	
	2.		*4.*	
You have signed up for online banking using your personal email address. Explain how email confirmation will be used to confirm your identity.				
You have set up an online file backup for your school work. As part of the security features you entered your mobile phone number as a two-step verification to ensure no one else can access your work. Explain how this feature works when you access your online file backup at college for the first time.				
What is meant by a 'brute force attack' when guessing a password?				
A company wants to ensure that it is well protected against potential cyberattacks. Suggest three ways the company can help to ensure that passwords are kept as secure as possible.	*1.*			
	2.			
	3.			

3.6.2 Detecting and preventing cyber security threats (cont.)	
Jenna has set up a blog using an open source website creation tool. When she visits the site to update her blog she is prompted to enter a CAPTCHA before she can log in. Explain what a CAPTCHA is and why it is used.	
Nathan enjoys playing games on his mobile phone, but he is irritated by constant reminders to update his browser software and wants a way to stop this from happening. What is your advice to him?	
What is a 'denial of service' attack?	
What is the process of reading information as it is getting sent from sender to receiver called?	
What is a 'zero day' attack?	
What is 'SQL injection'? How can it be used to attack a database?	
What is used to monitor and read the information that is sent over a network?	

3.7 Ethical, legal and environmental impacts of digital technology on wider society…

What is meant by the term ‘ethics’?		
How do ethics differ from legislation?		
Social media has greatly affected the way we communicate with one another. Can you give another example of how technology has had an impact on culture?		
How has the Internet affected peoples’ right to privacy?		
What is meant by a ‘throwaway technology’?		
What name is given to the crime in which software is downloaded illegally without a licence?		
Explain the difference between proprietary software and open-source software.		
Describe one advantage and one disadvantage of using open-source software.	*1.*	
	2.	

The Copyright Designs and Patents Act 1988 makes it illegal to share intellectual property. What is meant by the term ‘intellectual property’?		
Name two UK legal acts relating to computer use, and explain the purpose of each.	*1.*	
	2.	
Describe two of the impacts that our use of technology has on the environment.		
Modern smartphones include features such as the ability to monitor how far you walk and your heart rate after exercise. Suggest how a wearable device could help doctors monitor patient health in the future and what features it might include.		
Describe two ways in which the use and disposal of computer systems can have a negative effect on the environment.	*1.*	
	2	
State two methods we can employ in computer science to reduce the impact we have on the environment.	*1.*	*2.*
Companies have started sending hardware to be buried in landfill to LEDC countries in Africa. Is this practice ethical? Explain your answer.		

State two uses of technology that positively impact on the environment.	*1.*	
	2.	
How has technology affected society in terms of communication?		
How has technology affected society in terms of healthcare?		
How has technology affected society in terms of transport?		
How has technology affected society in terms of sport?		

What is the Freedom of Information Act (2000)? Can it be used to get, say, patient records from a hospital?	
What does it mean if a file is shared under the 'no derivative works' Creative Commons licence?	
Suppose you release your intellectual property on the Internet, and want to allow people to share, distribute and modify it in any way, but still credit your original work. Which licence should you release the file under?	
How has technology affected society in terms of the workplace?	
What is the 'digital divide'? How has this affected society?	
One of your friends really enjoys playing video games and has told you that he can get a copy of the latest game by using keygen software to create a product licensing key. What is this an example of and what risks does your friend expose himself to.	