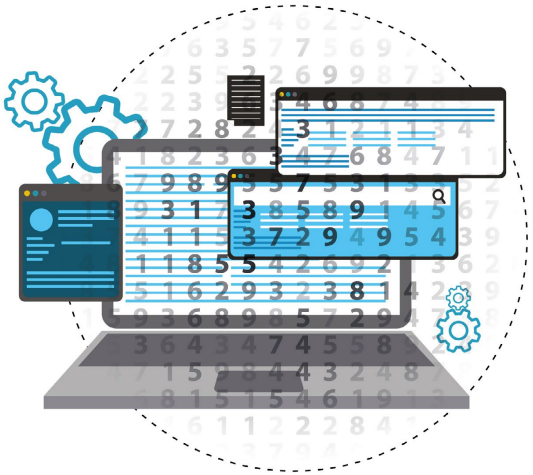
Cambridge Assessment International Education

Example Responses – Paper 3

Cambridge International AS & A Level

Computer Science 9618

For examination from 2024



Cambridge Pathway

Contents

Introduction

The main aim of this booklet is to exemplify standards for those teaching Cambridge International AS & A Level Computer Science.

This booklet contains responses to all questions from June 2024 Paper 32, which have been written by a Cambridge examiner. Responses are accompanied by a brief commentary highlighting common errors and misconceptions where they are relevant.

The question papers and mark schemes are available to download from the School Support Hub

9618 June 2024 Question Paper 32

9618 June 2024 Mark Scheme 32

Past exam resources and other teaching and learning resources are available from the School Support Hub

Question 1

1 **(a)** Describe the effect of changing the allocation of bits used for the mantissa and for the exponent in a floating-point number with a fixed total number of bits.

If the number of bits in the mantissa is increased the precision of the mantissa increases, and vice versa. If the number of bits in the exponent increases the range of numbers that can be represented increases, and vice versa. [2]

Examiner comment

- Candidates generally answered this question well and understood that if the number of bits in the mantissa increased, the number of bits in the exponent would decrease due to the fixed total number of bits in the register.
- Some candidates who said that when the number of bits in the mantissa increases, the number of bits in the exponents decreases without linking that to the effect it would have on the floating-point number. Some candidates gave the opposite response such as 'when the number of bits in the exponent increases, the range decreases'.

(b) Real numbers are stored in a computer, using floating-point representation with:

- 12 bits for the mantissa
- 4 bits for the exponent
- two's complement form for both the mantissa and exponent.

Calculate the normalised floating-point representation of +54.8125 in this system.

Show your working.

Mantissa												Exponent			
0	1	1	0	1	1	0	1	1	0	1	0	0	1	1	0

Working *54.8125 = 00110110.1101*

move the binary point 6 places to the left to give 0.1101101101 X 2^6

giving an exponent of 6 (0110)

[3]

Examiner comment

- Many candidates were awarded high marks for this question.
- Candidates who gave the wrong final answer were awarded marks for working if it was clear that they had used a valid method to convert a denary number to a binary number, and that they had found or applied the correct exponent, which is 6.
- Some candidates made errors when completing the mantissa, even though they had converted the binary number correctly. Some examples of this are:

1	1	0	1	1	0	1	1	0	1	0	0

- In this example the most significant bit should be 0 as it is a positive number, with the rest completed using the sequence that has been correctly calculated:

0	0	1	1	0	1	1	0	1	1	0	1

- In this example, the candidate incorrectly began with their least significant bit being placed in the first available place on the right of the mantissa with the rest of the sequence being correct, but with two leading zeros.
- Other candidates simply made incorrect calculations to give incorrect mantissas and / or exponents.

Question 2

2 **(a)** Outline why protocols are essential for communication between computers.

Protocols provide a standard set of rules to enable successful data transfer between devices. They also allow communication between devices on different platforms.

..... [2]

Examiner comment

- Very few candidates were awarded both marks for this question. The most likely mark point achieved by candidates who were awarded a mark was a reference to enabling communication between devices on different platforms.
- Many candidates included a simple statement about a protocol being a set of rules, or a protocol enables communication. These were considered to be answers that may be given for a similar question at AS Level, so would not be awarded the mark at A Level.

(b) State the names of **two** different protocols associated with the sending and receiving of emails between computers.

Sending *SMTP*

Receiving *POP3 or IMAP*

[2]

Examiner comment

- These were the only allowable protocols for this question. Some candidates wrote the names out in full which was acceptable, but not necessary.
- Most candidates were awarded at least 1 mark here, with many awarded both marks. One common error was candidates thinking that IMAP was a sending protocol.

(c) Explain the meaning of the phrase:

BitTorrent protocol provides peer-to-peer file sharing.

BitTorrent allows the sharing of files between thousands of users who are connected together over the internet. Users share files directly with each other, so no web server or central device is used. [3]

Examiner comment

- Many candidates incorrectly gave an answer that described in detail how BitTorrent works from a user's point of view. However, this question asked for the meaning of the phrase 'BitTorrent protocol provides peer-to-peer file sharing', so an answer explaining BitTorrent from the point of view of peer-to-peer file sharing was required.
- Many candidates were awarded at least 1 mark because they showed an understanding of the fact that no central file server is used or that all users are of equal status. Full-mark answers were rare.

Question 3

3 **(a)** Explain what is meant by the term **non-composite data type** and give an example of a non-composite data type.

A non-composite data type is defined without referencing another data type. It can be a primitive data type or it can be user-defined.

Example *an enumerated data type*

[3]

Examiner comment

- This question was generally answered well with many candidates awarded 1 mark for the explanation, and another mark for a correct example. The first point about not referencing another data type was the most common correct answer seen. For the second point, candidates had to include both parts; that it could be primitive or user-defined. Many candidates only gave one or the other, so didn't say enough for the mark.
- A few candidates incorrectly described composite data types or gave an example of a composite data type.

(b) Write **pseudocode** statements to declare the set data type `EvenNumbers` to hold this set of even numbers between 2 and 12:

2, 4, 6, 8, 10, 12

```
TYPE Numbers = SET OF INTEGER
DEFINE EvenNumbers (2, 4, 6, 8, 10, 12) : Numbers
```

..... [4]

Examiner comment

- Most candidates were awarded 1 or 2 marks out of 4 for this question, and it was found to be quite difficult. Questions in this topic area usually cover record data types, so it was unusual; however, it is a topic on the syllabus that needed to be covered. The A Level Pseudocode Guide for Teachers gives advice on this topic and other user defined data types and how they should be represented.
- In the given example, the identifier `EvenNumbers` and the list of numbers 2, 4, 6, 8, 10, 12 would all have to feature in a fully correct solution, because these are all given in the question. In addition, it is a composite data type, so more than one line of pseudocode would be expected. In this case, `TYPE` and any reasonable identifier, in this case `Numbers`, are used in the first line to declare the set data type `Numbers` as a `SET OF INTEGER`. The second line defines the given numbers under the required identifier `EvenNumbers` as type `Numbers`.

Question 4

4 Sheila has a customer called Fred. Fred wants to send Sheila a confidential document as part of a transaction.

Explain how Fred uses asymmetric encryption to send his document securely.

Sheila uses an algorithm to generate a matching pair of public and private encryption keys. Fred acquires Sheila's public key, which he uses to encrypt his message. He then sends this cipher text to Sheila. Sheila uses her private key to decrypt the cipher text.

..... [4]

Examiner comment

- Many candidates were awarded high marks for this question, but relatively few of these were awarded all 4 marks.
- Candidates were generally aware that the sender, in this case Fred, would need the receiver's (in this case Sheila's) public key and to encrypt the message. Candidates who were careful to ensure that they were clear that the encrypted message or cipher text was then sent to Sheila, were awarded another mark. Finally, most candidates were generally aware that the receiver (Sheila) would decrypt the message with their own private key.
- The marking points that were generally unclear in many responses, so were awarded the fewest marks, were the fact that the keys had to be generated as a matching pair and that the public key of the receiver (Sheila) had to be shared with the sender (Fred).

Question 5

5 **(a)** Write this infix expression in Reverse Polish Notation (RPN):

`(7 – 2 + 8) / (9 – 5)`

7 2 – 8 + 9 5 – /

..... [2]

Examiner comment

- Most candidates were awarded at least 1 mark for this question. This could be if their answer was correct up to and including the + sign, or the answer after the + sign was correct. Candidates with a fully correct answer were awarded both marks.
- This question was generally answered well, but some candidates wrote the first group of digits where candidates slightly out of order as 7 2 8 - +.

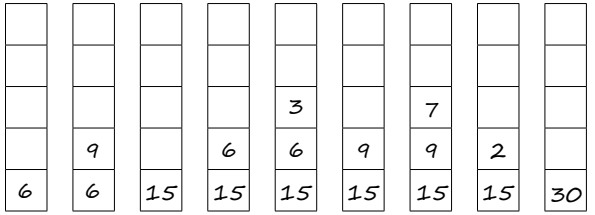
(b) Evaluate this RPN expression:

`a d + a b + c – *`

when

`a = 6, b = 3, c = 7` and `d = 9`

Show the changing contents of the stack as the RPN expression is evaluated.



[4]

Examiner comment

- Candidates who demonstrated that the changing contents of a stack as a Reverse Polish Notation (RPN) expression is calculated in full, as shown above, were awarded all 4 marks. However, candidates were awarded marks for the different stages so most candidates were awarded some marks and many were awarded high marks.
- Candidates who correctly completed the first three columns were awarded 1 mark. Those who correctly completed the second three columns were awarded the second mark, the third mark was awarded for columns seven and eight, and the fourth mark was awarded for the final column.
- Common errors included:
  - mathematical operators in the stack: this would not happen because during the evaluation process when an operator is seen the most recent two values are popped from the stack, then evaluated, and the solution of this operation is pushed onto the stack.
  - missing steps in the solution: sometimes candidates omitted the solution of an operation and carried on by pushing the next value onto the stack.

(c) Write this RPN expression in infix form:

```
b a c - + d b + * c /
```

(((a – c) + b) * (d + b))/c

[3]

Examiner comment

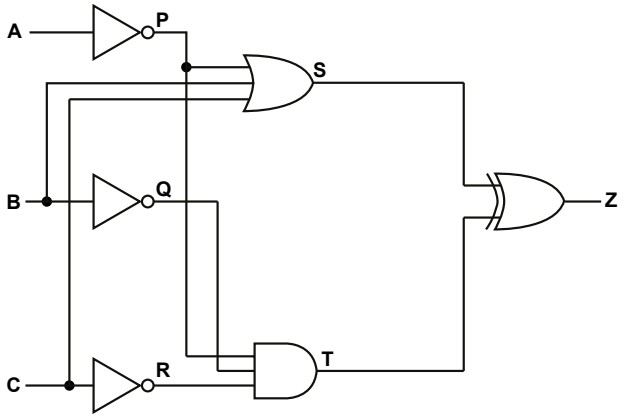
- This question was generally well answered with the full range of marks awarded. The answer shown is the ideal answer to illustrate how a computer may see the conversion of a given RPN expression to infix. There were 3 marks available for this question, and candidates who gave the example response or an answer with all the letters and operators in the same order as shown in the example response with at least the minimum required brackets, as shown below were awarded full marks:

  `(a - c + b) * (d + b)/c`

- Some candidates placed some of the letters or operators in the wrong order.

Question 6

6 The diagram shows a logic circuit.



(a) Complete the truth table for the given logic circuit.
Show your working.

			Working space					
A	**B**	**C**	**P**	**Q**	**R**	**S**	**T**	**Z**
0	0	0	1	1	1	1	1	0
0	0	1	1	1	0	1	0	1
0	1	0	1	0	1	1	0	1
0	1	1	1	0	0	1	0	1
1	0	0	0	1	1	0	0	0
1	0	1	0	1	0	1	0	0
1	1	0	0	0	1	1	0	0
1	1	1	0	0	0	1	0	0

[3]

Examiner comment

The areas highlighted grey were given in the question and candidates had to complete the rest of the truth table. This question was generally well answered with most candidates awarded at least 1 mark. However, the full range of marks was seen, so not everyone was awarded full marks.

(b) Write the Boolean expression that corresponds to the logic circuit as a sum-of-products.

Z = $\overline{A}.\overline{B}.C + \overline{A}.B.\overline{C} + \overline{A}.B.C + A.\overline{B}.C + A.B.\overline{C} + A.B.C$

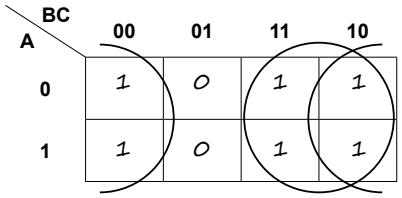
[2]

Examiner comment

Answers were accepted with or without the dots representing the logical AND. Most candidates were awarded 1 mark, with many awarded both marks.

(c) (i) Complete the Karnaugh map (K-map) for this Boolean expression:

$\overline{A}.\overline{B}.\overline{C} + \overline{A}.B.\overline{C} + \overline{A}.B.C + A.\overline{B}.\overline{C} + A.B.\overline{C} + A.B.C$

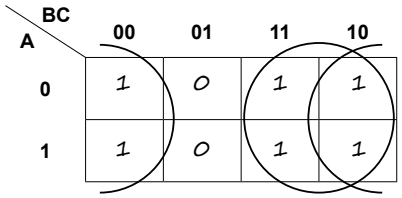


[2]

Examiner comment

- Most candidates were awarded at least 1 mark for this question. Some candidates placed a 1 or a 0 in the boxes and others left boxes blank.
- Some candidates placed the 1s, but not the 0s. A fully correct answer required both 1s and 0s.

(ii) Draw loop(s) around appropriate group(s) in the K-map to produce an optimal sum-of-products. [2]



[2]

Examiner comment

- Most candidates who drew loops on their diagram were awarded at least 1 mark.
- Some candidates didn't draw any loops, and some missed off the wraparound 4 x 1 loop. Some candidates drew an incorrect 2 x 1 loop in the left-hand column of the Karnaugh map.

(iii) Write the Boolean expression from your answer to part **c(ii)** as a simplified sum-of-products.

$B + \overline{C}$

[1]

Examiner comment

Most candidates who drew appropriate loops in **(c)(ii)** gave a correct Boolean algebra expression in this question.

Question 7

7 **(a)** Outline what is meant by **direct access** as a method of file access.

Direct access allows a record to be found in a file without other records being read. Records are located using the key field of the target record.

..... [2]

Examiner comment

- Some candidates were awarded 1 mark, but very few candidates were awarded both marks.
- Many candidates not applied the correct terminology to the response, for example, stating that a 'file may be found without looking through other files'. The term 'data' was also sometimes inaccurately used in a similar context.
- Candidates are advised to learn the differences between fields, records and files and use the correct term when answering similar questions. In this case, a record is being found in a file without looking through the other records in the file.

(b) Explain how direct access is used to locate a specific record in sequential files and random files.

(i) Sequential files *In sequential files, an index of all key fields is kept. The index is searched to find the address of the file location where the target record is stored.*

..... [2]

Examiner comment

- The key elements of this question were the key field and the index of key fields that were used to locate a particular record.
- Only a few candidates were awarded the marks for this question. Some candidates searched for files instead of records, as with **(a)** and many candidates often described sequential access to sequential files rather than the required direct access to sequential files.

(ii) Random files *A hashing algorithm is used on the key field of the record to calculate the address of the memory location where the target record is expected to be stored.*

..... [2]

Examiner comment

- This question was answered a little better than the other parts of **Question 7**.
- Many candidates were able to describe the hashing algorithm used on the key field or the fact that the hashing algorithm was used to calculate the target record's location, so were awarded 1 mark. Some candidates were also awarded a mark for describing an appropriate collision resolution technique, such as linear probing.
- Some candidates used incorrect terminology, for example, stating that the hashing algorithm was applied to the file. Some answers did not give enough detail, so if 'a hashing algorithm is used to find the address' was written, this did not say to what the hashing algorithm was applied, nor did it say what the address was.

Question 8

8 **(a)** Complete the pseudocode to find an item in a 1D array `Widgets` of type `STRING`, using a **linear** search.

```
DECLARE Widgets : ARRAY[1:50000] OF STRING
DECLARE TopOfList : INTEGER
DECLARE EndOfList : INTEGER
DECLARE Count : INTEGER
DECLARE ToFind : STRING
DECLARE Found : BOOLEAN
DECLARE NotInList : BOOLEAN
TopOfList ← 1
EndOfList ← 50000
OUTPUT "Enter the name of the item you wish to find "
INPUT ToFind

Found ← FALSE
NotInList ← FALSE
Count ← TopOfList

WHILE Found = FALSE AND NotInList = FALSE//Count <= EndOfList
   IF ToFind = Widgets[Count] // Widgets[Count] = ToFind THEN
      Found ← TRUE
   ENDIF
   Count ← Count + 1

   IF Found = FALSE AND Count > EndOfList THEN
      NotInList ← TRUE
   ENDIF
ENDWHILE
IF Found = TRUE THEN
   OUTPUT "Item found at position ", Count - 1, " in array"
ELSE
   OUTPUT "Item not in array"
ENDIF
```

[4]

Examiner comment

Candidates had to fill in the blanks of a partially complete linear search algorithm written in pseudocode. The question was quite well answered with most candidates awarded at least 1 mark, with many candidates awarded high marks. However, full-mark responses were rare, with the last mark being the one that was most often not achieved. This line required candidates to insert two conditions connected with a logical `AND`, in a similar style to the second answer; although in this case, candidates were not told there was an `AND`, so had to work it out for themselves. Some candidates were awarded this mark and others realised that two conditions were required, but unfortunately, rather than writing the two correct conditions, they wrote two versions of one of the correct conditions, for example, `IF Count > EndOfList AND Count > 50000 THEN`.

(b) Compare the methods used by the linear and binary search algorithms to find an item in an array. Refer to Big O notation in your answer.

A linear search sequentially checks each element of the array until the matching element is found, or the end of the array is reached. A binary search finds the mid-point of an array and determines which side contains the item to be found.

Big O notation is used to indicate the time complexity of an algorithm.

[4]

Examiner comment

- A suitable alternative answer could be: 'The binary search requires the array elements to be sorted, which the linear search does not. The binary search starts in the middle of the array but the linear search starts at the beginning. A binary search has a Big O notation of $O(\text{Log}_2\ n)$ and for the linear search it is O(n).'
- Candidates could also have given other acceptable answers. They had to demonstrate that they understood the differences between the linear and binary search methods, and their understanding of Big O as it related to these algorithms.
- Many successful responses were seen with most candidates awarded marks for this question. Candidates are advised when writing the Big O notation for an algorithm that they write it using the standard format as $O(\text{Log}_2\ n)$.

Question 9

9 **(a)** Outline **two** benefits and **two** limitations of a virtual machine.

Benefit 1 *Applications that aren't compatible with the host computer can be run on the virtual machine.*

Benefit 2 *Virtual machines are useful for testing software as it will not crash the host computer if something goes wrong.*

Limitation 1 *The performance of the guest operating system will not be as good on a virtual machine as it would be on its own compatible hardware because of the extra code that is running.*

Limitation 2 *Building an in-house virtual machine can be expensive, time consuming and complex to maintain.*

[4]

Examiner comment

- The answers shown are examples as there are many possible answers that could have been given.
- For this question, possible answers were grouped into different concepts, so that if candidates gave two examples that could be considered as the same concept, they would only be awarded a mark for one of them, with the second answer marked as a repeat. For example, an answer such as 'easier to recover if software causes a system to crash as virtual machine software protects the host system' would be considered to cover the same concept as Benefit 2, above.
- This question was generally answered well with most candidates awarded some marks. The full range of marks was seen with a many candidates awarded high or full marks. However, candidates are advised when answering benefit and limitation questions that all of their benefits and limitations cover separate distinct points to ensure their mark is maximised.

(b) Explain the roles of the host operating system and the guest operating system as used in a computer system running a virtual machine.

The host operating system is the normal operating system for the host computer. It runs the virtual machine software. The guest operating system runs within the virtual machine, under the control of the host operating system.

[3]

Examiner comment

- Candidates found this question more difficult to be awarded all the marks, although some successful responses were seen. Candidates were required to explain the roles of the host and guest operating systems as used in a computer system running a virtual machine.
- Suitable alternative answers could have been awarded the marks, however, the answer given in the example response would be awarded 3 marks. If the question were longer then more detail would be required.

Question 10

10 A **declarative** programming language is used to allow clients to choose daily activities at the beach.

```
01 activity(paddleboarding).
02 activity(sailing).
03 activity(rowing).
04 activity(kayaking).
05 activity(jetskiing).
06 client(stevie).
07 client(antonio).
08 client(henry).
09 client(eliza).
10 client(rebeka).
11 client(danny).
12 client(erik).
13 client(simone).
14 client(petra).
15 client(frankie).
16 choice(petra, rowing).
17 choice(frankie, sailing).
18 choice(erik, sailing).
19 choice(eliza, rowing).
20 choice(stevie, jetskiing).
21 choice(henry, sailing).
22 done(henry, jetskiing).
23 done(rebeka, jetskiing).
24 done(antonio, kayaking).
```

These clauses have the meanings:

Clause	Meaning
01	Paddle boarding is an activity.
06	Stevie is a client.
16	Petra has chosen rowing.
22	Henry has already done jet skiing.

(a) Jane is a client who would like to choose the activity surfing and she has already done sailing.

Write additional clauses to represent this information.

25 (25) client(jane).

26 (26) activity(surfing).

27 (27) choice(jane, surfing).

28 (28) done(jane, sailing).

[4]

Examiner comment

- Candidates generally knew how to answer this question. However, it is important that candidates remember the simple rules that apply to declarative programming languages when they write their responses, such as:
  - unless you are writing a variable, there must be no capital letters
  - all facts, clauses and rules end with a full stop.
- Candidates who followed these rules and at the same time wrote their clauses in a sensible order as shown above, with the `client` and `activity` being defined before the choice and done clauses, were awarded the marks.

(b) Using the variable `List`, the goal:

```
choice(List, rowing)
```

returns

```
List = petra, eliza
```

Write the result returned by the goal:

```
choice(List, sailing)
```

List = (List =) frankie, erik, henry [1]

Examiner comment

In a similar fashion to **10(a)**, the only capital that is allowed is at the start of the variable. In this case, List. However, as this is showing what would be returned by a given goal, there will be no full stop at the end of the returned list of names.

(c) `C` is a client who would like to choose `A` if `A` is an activity and `C` has **not** already done `A`.

Write this as a rule:

```
may_choose_activity(C, A)
```

IF client(C) AND activity(A) AND NOT done(C, A).

[4]

Examiner comment

- This question part was more difficult than the previous two parts, but most candidates were awarded at least 1 mark and many were awarded high or full marks.
- Candidates needed to write a rule. It was acceptable to use alternative syntax, such as a comma in place of the logical AND.
- Similar issues were noted with responses to this question part as with the others. The names of the clauses could not have capital letters, but the contents of the brackets in every case were single letter variables so should all have been capitals. All the logical operators if written in full must also be in capitals. In addition, the whole rule would be finished with a final full stop.

Question 11

11 Explain what is meant by **Reinforcement Learning** in relation to Artificial Intelligence.

Reinforcement Learning is a machine learning technique based on rewards and punishment. An agent learns to behave in an environment by performing the actions and seeing the results of the actions. For each good action, the agent receives positive feedback as a reward, and vice versa. It learns automatically using feedback without any labelled data or specific instructions. [3]

Examiner comment

- For this question, candidates were required to explain what is meant by Reinforcement Learning in relation to Artificial Intelligence. The example response given is a coherent response that could have been written in the time and space available and would cover sufficient material to be awarded all 3 marks.
- One issue noted in many responses was candidates including many concepts related to Artificial Intelligence, such as ideas related to Deep Learning, or Back Propagation of Errors, rather than restricting their responses to Reinforcement Learning, as required by the question.
- Most candidates answered the question and were awarded at least 1 mark, demonstrating that they knew what Reinforcement Learning meant. It is possible that many of these candidates might have achieved more marks had they expanded on the point they made, rather than trying to introduce other Artificial Intelligence topics.

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