OXFORD AQA
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OxfordAQA International AS/A-Level

Computer Science (9645)

CS04
Example responses (Additional specimen)

For teaching from September 2024 onwards

For International GCSE exams in May/June 2025 onwards

Contents

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Introduction

This guide includes example responses to questions from CS04 of the second set of Specimen Assessment Materials for International A-Level Computer Science (9645).

The non-multiple choice questions are presented with example responses and commentary from a senior examiner.

Assessment Objectives

The exams will measure how students have achieved the following assessment objectives:

- AO1: Demonstrate knowledge and understanding of the key concepts and principles of computer science.
- AO2: Apply knowledge and understanding of key concepts and principles of computer science.
- AO3: Analyse problems in computational terms in order to develop and test programmed solutions and demonstrate an understanding of programming concepts.

Example Responses

Question 1 part 1.1

Question 1.1 tests Assessment Objective AO1 and requires students to recall why the Halting problem cannot be solved.

Mark Scheme

0 1 . 1 Explain why it is not possible to create a Turing machine that solves the Halting problem.

[2 marks]

Question	Part	Marking guidance	Total marks
01	1	The Halting problem is non-computable / undecideable // there is no algorithm that solves the Halting problem; Inspection alone cannot always determine whether any given algorithm will halt for its given inputs // a program cannot be written that can determine whether any given algorithm will halt for its given inputs;	2 AO1 = 2

Response A

The Halting problem is an unsolvable problem.

Commentary

This response received **0 marks.** Although this is true, the question is focusing more on *why* it is unsolvable (which then leads to discussing how no algorithm exists for it).

Response B

You cannot write a program which could decide whether any algorithm would halt with its inputs.

Commentary

This response received **1 mark.** The student has made it clear that the program must work for every possible algorithm/input (which it cannot).

Question 1 part 1.2

Question 1.2 tests Assessment Objective AO1 and requires students to recall three components of a Turing machine.

0 1 . 2 A Turing machine can be viewed as a computer with a single fixed program.

State **three** other components of a Turing machine.

[3 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
01	2	• Finite set of states (in a state transition diagram); • A finite alphabet of symbols • An infinite tape (with marked-off squares) • A (sensing) read-write head (that can move along the tape one square at a time); • Start state; • (Set of) accepting / halting states; • State register // current state;	3 AO1 = 3

Response A

A single fixed program and a read-write head.

Commentary

This response received **1 mark**. Although they are both components of a Turing Machine, the student had given a component already provided in the question.

Response B

An initial state to start at and a set of halting states.

Commentary

This response received **2 marks**. The student had identified two components (explanation of transition rules, and the start state).

Question 1 part 1.3

Question 1.3 tests Assessment Objective AO1 and requires students to recall why a Universal Turing Machine is more powerful than a physical computer.

0 1 . 3 State why a Universal Turing Machine (UTM) can be considered more powerful than any computer that you can purchase.

[1 mark]

Mark Scheme

Question	Part	Marking guidance	Total marks
01	3	Because it has an infinite amount of memory / tape;	1 AO1 = 1

Response A

No computer that you buy can have an infinite amount of memory.

Commentary

This response received **1 mark**. The student had answered from the perspective of the computer but had given the same point as the mark scheme.

Response B

A computer does not have states, tape, and a read-write head.

Commentary

This response received **0 marks.** The student had not identified the key difference and possibly did not know that a Turing machine is the theoretical model for computers.

Question 2 part 2.2

Question 2.2 tests Assessment Objective AO2 and requires students to write BNF production rules for an example number system.

0 2 . 2

In the same language:

A digit is defined as any single numeric symbol from this list: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9.

A whole number is defined as a sequence of one or more digits.

An integer is defined as a whole number, or a + or – symbol followed by a whole number.

Write Backus-Naur Form (BNF) production rules for digit, whole number and integer.

[3 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
02	2	**Solution:** <digit> ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 <whole-number> ::= <digit> | <digit> <whole-number> <integer> ::= <whole-number> | + <whole-number> |- <whole-number> *1 mark for each correct rule* Alternative for integer (1 mark, accept in either order): <symbol> ::= + | - <integer> ::= <whole-number> | <symbol> <whole-number> **A** <whole-number> defined with recursion other way around, i.e. <whole-number> ::= <digit> | <whole-number> <digit> **A** non-terminal names e.g. digit not enclosed in <> signs	**3** **AO2 = 3**

Response A

<digit> ::= 0|1|2|3|4|5|6|7|8|9

<whole number> ::= <whole number><digit> | <digit>

<integer> ::= <sign> <whole number> | <whole number>

<sign> ::= +|-

Commentary

This response received **3 marks**. The student had correctly written the rules for all three, and had used an additional rule to represent the sign which may go before the integer. This was accepted as an alternative answer. The student had also put the recursive statement of *<whole number>* before the call of *<digit>*, this was accepted as it did not affect the answer in this example.

Response B

<digit> ::= 0|1|2|3|4|5|6|7|8|9

<whole number> ::= <digit> | <digit><digit> | <digit><digit><digit> | …

<integer> ::= + <whole number> | - <whole number>

Commentary

This response received **1 mark**. The student had identified the rule for *<digit>*, however they did not use recursion for the *<whole number>* rule and had instead created an infinite rule which would not be possible in BNF. They were also missing one scenario from the *<integer>* rule.

Question 3 part 3.1

Question 3.1 tests Assessment Objective AO2 and requires students to interpret the finite state machine.

0 3 Postcodes are used to aid the sorting of mail and help to ensure that mail being sent arrives at the correct destination as quickly as possible.

The format of a UK postcode (ignoring any spaces) is shown in **Figure 2**.

Figure 2

- 1 or 2 letters
- followed by:
  - 1 numeric digit or
  - 2 numeric digits or
  - 1 numeric digit then 1 letter
- followed by 1 numeric digit
- followed by 2 letters

When a post box is emptied in the town of Ipswich, the mail in the post box is taken to a central sorting office. Each item is looked at and placed in one of three vans depending upon the postcode written on the envelope.

Postcodes that begin with IP1, IP2, IP3 or IP4 followed by one numeric digit and two letters, e.g., IP2 8QY, are for mail being sent to an address in the town of Ipswich and go in Van A.

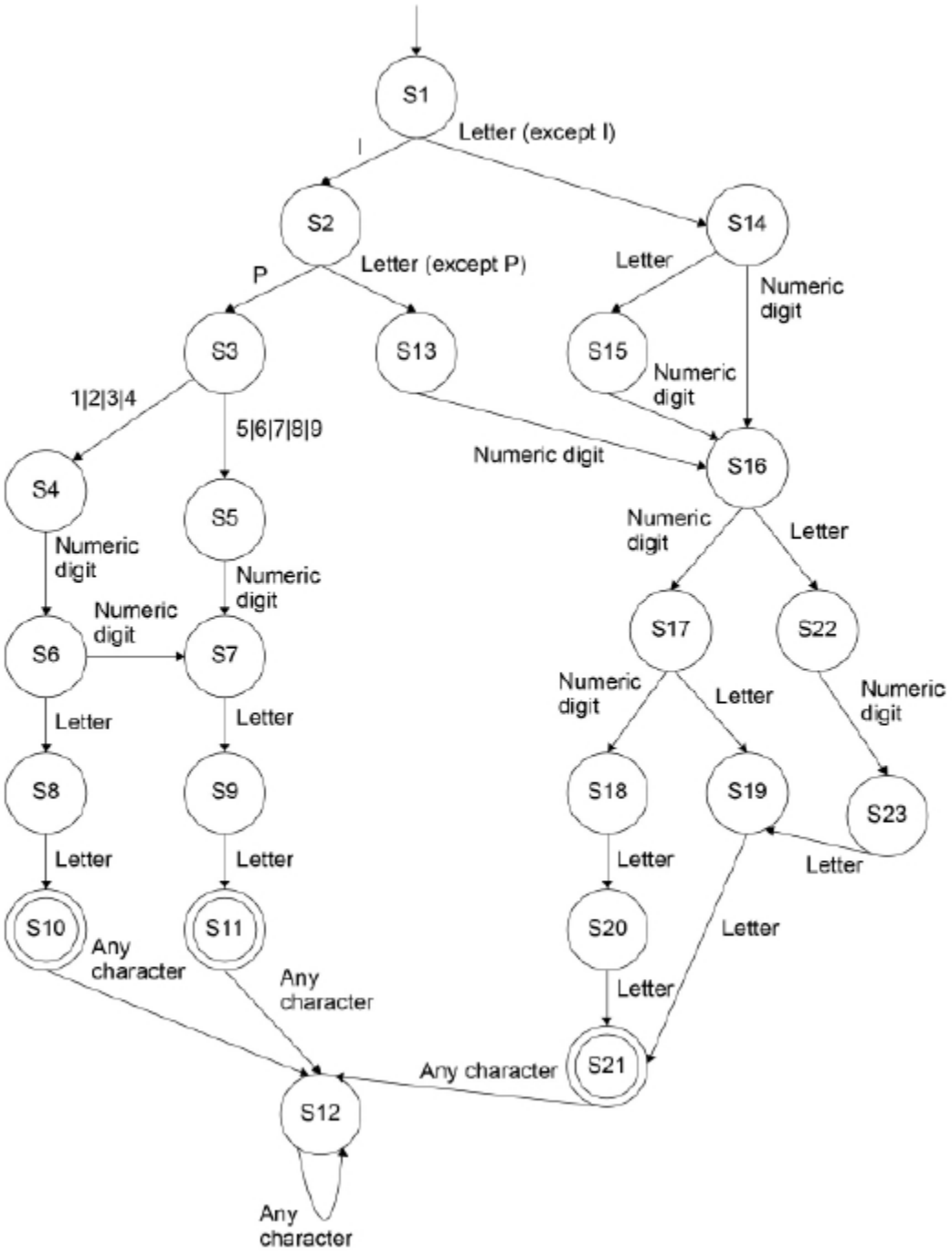
Other postcodes that begin with IP, e.g., IP5 3QW, are for areas not in the town but near to Ipswich and go in Van B.

Postcodes that start with anything other than IP, e.g., CO3 5FN, are not for the Ipswich area and go in Van C. IP postcodes do not use the full range of formats available for UK postcodes.

A Finite State Machine (FSM) could be used to sort mail using postcodes. **Figure 3** on the next page shows a state transition diagram for an FSM used at the Ipswich sorting office.

In **Figure 3**, if a transition is not defined from a state for a particular input symbol then the FSM will stop processing the input and it will be rejected.

Figure 3



0 3 . 1 If the FSM in **Figure 3** finishes at state S12, what does it mean?

[1 mark]

Mark Scheme

Question	Part	Marking guidance	Total marks
03	1	Input string is a (valid) postcode followed by additional characters // the input string is not a valid (UK) postcode // the mail will not be put in any of the three vans; **NE**. The input string is not a valid IP postcode **A**. Postcode has additional characters at the end **A**. Postcode is too long	**1** **AO2 = 1**

Response A

S12 is a trash node and will reject all inputs.

Commentary

This response received **0 marks.** The student had identified that the state was designed to reject all inputs which reach it but had not given a reason why an input may reach this state.

Response B

That the postcode had too many characters after it.

Commentary

This response received **1 mark.** The student had identified that the input was a postcode and had additional characters at the end.

Question 3 part 3.2

Question 3.2 tests Assessment Objective AO2 and requires students to identify the purpose of another state from the diagram.

0 3 . 2 If the FSM in **Figure 3** finishes at state S11, what does it mean?

[1 mark]

Mark Scheme

Question	Part	Marking guidance	Total marks
03	2	(The string represents) an IP postcode that is not for a location in the town of Ipswich // (The string represents) an IP postcode that is for a location near Ipswich // (The string represents) a postcode for a letter that needs to go in Van B; **NE**. valid postcode	**1** **AO2 = 1**

Response A

The letter needs to go in Van B and not Van A.

Commentary

This response received **1 mark.** The student had identified why an input would go to state S11 and not state S10. Although they haven't mentioned it is a postcode, they had explained using the context of the question (that they are delivering letters) and this was accepted.

Response B

That a correct postcode has been entered and the input is accepted.

Commentary

This response received **0 marks.** Although they were technically correct, it was not enough to determine the purpose of state S11 when other accepted states also exist in **Figure 2**.

Question 3 part 3.3

Question 3.3 tests Assessment Objective AO2 and requires students to identify differences between two example postcodes given in the question.

0 3 . 3 Assuming that the FSM in **Figure 3** can be used to recognise any valid IP postcode, state **one** format used for UK postcodes that IP postcodes do **not** use.

[1 mark]

Mark Scheme

Question	Part	Marking guidance	Total marks

03	3	(IP / two letters) followed by number, letter, (number, letter, letter) //
		(IP / two letters) followed by number between 5 and 9, number, (number, letter, letter) //
		IP followed by 0;
		
		A. postcodes that only have one letter at the start
			1
			
			AO2 = 1

Response A

Postcodes that start with two letters and then have one number, followed by one letter

Commentary

This response received **1 mark**. The student had identified the key difference in both formats.

Response B

Postcodes with one letter at the beginning

Commentary

This response received **1 mark**. The student had correctly identified a difference using the rules from **Figure 1**.

Question 3 part 3.4

Question 3.4 tests Assessment Objective AO2 and requires students to write a regular expression for UK postcodes described in **Figure 2**.

0 3 . 4 The language recognised by an FSM can also be represented by a regular expression. When writing regular expressions `\d` is used to represent any numeric digit and `\a` is used to represent any alphabetic character.

For example, the regular expression `\d \d \a \d` describes the language of all strings that contain two numeric digits followed by one letter and then one numeric digit.

Write a regular expression that represents a valid UK postcode as described in **Figure 2**. This is shown again here.

Figure 2

- 1 or 2 letters
- followed by:
  - 1 numeric digit or
  - 2 numeric digits or
  - 1 numeric digit then 1 letter
- followed by 1 numeric digit
- followed by 2 letters

In your answer you should only use the `|` metacharacter once.

[4 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks

03	4	`\a?\a;\d;(\a|\d)?;\d\a\a; //`
		`\a\a?;\d;(\a|\d)?;\d\a\a; //`
		`\a?\a;\d;(\d|\a)?;\d\a\a; //`
		`\a\a?;\d;(\d|\a)?;\d\a\a;`
		
		Mark as follows:
		
		1 mark:
		1. regular expression can start with either one or two letters R. if more than two letters allowed
		
		1 mark:
		2. regular expression has a numeric digit after the initial letters A. if more than the correct number of letters allowed
		//
		regular expression has a numeric digit before it allows a single, optional letter or numeric digit
		
		1 mark:
		3. regular expression allows a single, optional letter or numeric digit after the first numeric digit in the expression
		//
		regular expression allows a single, optional letter or numeric digit before the numeric digit followed by exactly two letters at the end of the expression
		
		1 mark:
		4. regular expression ends with a numeric digit followed by exactly two letters
		
		MAX 3 if final answer is not correct
		
		R. any mark points after 2nd use of | metacharacter
		A. suitable alternatives to `\a` and `\d` e.g. use of `[A-Z]`, `[a-z]` or `[A-Za-z]` instead of `\a` and `[0-9]` instead of `\d`
		
		DPT. / instead of \
			4
			
			AO2 = 4

Response A

\a\a\d\a\a

Commentary

This response received **1 mark.** The student had given the rules for postcodes for Van A from **Figure 2** and had not identified that it should be for all rules in **Figure 1**. They received one mark because the rule does end with \d\a\a

Response B

\a\a?\d\d\a\a

Commentary

This response received **3 marks** (MP1, MP2, MP4). The student had missed out the rule that allowed for an extra digit or extra letter after the first digit (MP3).

Question 4 part 4.2

Question 4.2 tests Assessment Objective AO1 and requires students to state two advantages to using a digital signature.

0 4 . 2 The security of the communication could be improved by the addition of a digital signature.

State **two** benefits of including a digital signature.

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
04	2	**1 mark:** Detect (unauthorised) changes to message; **1 mark:** Authenticate sender's identity / / confirm who sent it;	2 AO1 = 2

Response A

It can confirm if the original message has been tampered with, and it also confirms that the sending device was who sent the message.

Commentary

This response received **2 marks.** The word “tampered” was inferred as edited/changed and so this was given as a benefit of the doubt. The second point was covered with the correct terminology.

Response B

It makes sure that only the receiving device can read the message and that the sending device was the one that sent it.

Commentary

This response received **1 mark.** The student has described a benefit of asymmetric encryption but this benefit is not covered by the digital signature. They do, however, make the point about confirming the authenticity of the sender and so have gained credit for this.

Question 5 part 5.2

Question 5.2 tests Assessment Objective AO1 and requires students to recall two advantages of serial transmission instead of parallel transmission.

0 5 . 2 Data can be transmitted using either serial or parallel data transmission.

State **two** advantages of serial data transmission instead of parallel data transmission.

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
05	2	Can be used over longer distances; Fewer wires/cables/lines required; Only one pathway required; Cheaper to use; Less interference/crosstalk; Easier to synchronise;	2 AO1 = 2

Response A

It can be more reliable over longer distances and also uses fewer wires.

Commentary

This response received **2 marks.** The student had identified that it can be used over long distances compared to parallel and that is uses less wires.

Response B

It would be cheaper to install one cable over a long distance, instead of multiple cables over the same distance.

Commentary

This response received **1 mark.** The student had identified the reason why serial data transmission was cheaper overall, however, both points made are related to cost.

Question 5 part 5.4

Question 5.4 tests Assessment Objective AO1 and requires students recall what is meant by the term latency.

0 5 . 4 When data is transmitted over long distances such as satellites, latency can become a problem.

Describe what latency is.

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
05	4	Delay between sending a request and receiving a response; Caused by the time it takes for data to travel over a distance;	2 AO1 = 2

Response A

Latency is the delay between data being sent and the data being received. Over long distances, such as satellite communication, this delay increases because the signal has to travel a very large distance.

Commentary

This response received **2 marks**. The student had correctly stated what latency is and then follows this up with what causes it over long distances.

Response B

Latency is the amount of data that can be sent through a network at one time, measured by how wide the connection is. High latency means the network can carry more data quickly, which improves performance over long distances such as satellites.

Commentary

This response received **0 marks**. The student has confused latency and bandwidth and therefore not answered the question given.

Question 6

Question 6 tests Assessment Objective AO1 and requires students to describe Big Data and explain the challenges it brings as well as possible solutions.

0 6 Big Data is an important application area for modern computer science.

Discuss the use of Big Data, including:

- What Big Data is, using examples to illustrate your description.
- Some of the challenges that Big Data brings with it and the approaches that can be taken to overcome these, in relation to programming and hardware.

[6 marks]

Mark Scheme

<table>
<tr><th>Question</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>06</td><td>
<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>3</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response. The response covers all three areas indicated in the guidance below and in at least two of these areas there is sufficient detail to show that the student has a good level of understanding. To reach the top of this mark range, a good level of understanding must be shown of all three areas.</td><td>5-6</td></tr>
<tr><td>2</td><td>A line of reasoning has been followed to produce a coherent, relevant, substantiated and logically structured response which shows a good level of understanding of two areas indicated in the guidance below or a good level of understanding of one area and a reasonable level of understanding of the other two areas. To reach the top of this mark range, a good level of understanding must be shown of two areas.</td><td>3-4</td></tr>
<tr><td>1</td><td>A limited attempt has been made to follow a line of reasoning and the response has a mostly logical structure. A good level of understanding has been shown of at least one area or some understanding has been shown of all three areas.</td><td>1-2</td></tr>
</table>
<u>Guidance – Indicative</u>
‘Big Data’ is a catch-all term for data that cannot be stored or processed using traditional methods.
<table>
<tr><th>Characteristic</th><th>Expansions / Examples</th></tr>
<tr><td>Variety of different forms of information // data may lack structure</td><td>Cannot be represented in a table // by a relational database.
May include:
Email messages
Videos
Images
Web site contents
Facial recognition</td></tr>
<tr><td>There is a lot / high volume of data (to process as one dataset) // data will not fit on one server</td><td>Hundreds of terabytes
Large medical datasets for diagnosis
Gene sequencing
Predicting disease outbreaks Results of large-scale scientific experiments</td></tr>
</table>
</td><td>6</td></tr>
</table>

The data is generated / received / must be processed at high velocity / very quickly	Thousands of items to process per second. Data must be processed as it is received– it cannot be batched and processed later Card payment fraud detection Recommendations systems	

Challenges:

- Data cannot be stored on one server / computer.
- Not possible to process data quickly enough with one computer.
- Data cannot be represented in a table // by a relational database.
- Some forms of data / unstructured data are difficult to analyse.

How to overcome:

- Distributed database systems // distributed file systems // blocks of individual files distributed across multiple servers.
- Use of functional programming.
- (Massively) parallelising the execution of programs.
- MapReduce // input split into parts then mapper executed on each part then all results combined by reducer(s) // function-to-data model.
- Functional programming makes it easier to write distributable code // determine which parts of code can be run independently.
- Functional programming makes it easier to write correct code // example features of functional programming that facilitate writing correct code.
- Use of many thousands of commodity servers.
- Use of servers with multiple CPUs / cores / drives.
- Machine learning can identify patterns / the value in the data // use of predictive data models.
- Use of languages such as XML or JSON to describe semi-structured data.
- Use of fact-based model can manage bigger data sets better than relational model.

Response A

Big Data is the idea that dealing with massive amount of storage on a day-to-day basis is challenging. There are three main areas of Big Data: Volume; Velocity; and Variety.

Volume is the idea that there are huge amounts of data that is too big to fit on just one server. This means that companies usually buy lots and lots of storage across multiple servers to meet the demands of the storage.

Velocity is the idea that there is lots of requests/data that needs to be processed/responded too in a very short amount of time. If some requests are not dealt with quick enough, then the data might become useless causing more problems in the future. Companies may set priorities on data so that data with a higher priority is processed before data with a lower priority, but where would all of this data be stored while waiting in the queue? What size should the queue be? You can also hire servers temporarily for a day or two if you have a lot of data to process in a particularly busy time but this will cost the company money in the short-term.

Variety is the idea that data could be stored in multiple formats and you want them in one consistent format. It takes a lot of processing time to convert data into a correct format which could be avoided. Companies may demand that data be submitted in a specific format through a website/app so that less processing time is wasted converting data.

Storing so much data can lead to various issues. One issue is the purpose of the data, is it being used for the right reasons e.g. to help people or is it being used for the wrong reasons e.g. targeting advertisements based on what you buy without your consent. What If this data was hacked, and millions of people had their data leaked from one server? If this happened on a rented server who would take the blame? Also, how long should the data be kept for until it is not needed?

Commentary

This response received **5 marks**.

This was a nearly complete response to the question. The student demonstrated a good understanding of two out of three areas (the meaning of Big Data and some of the challenges). They covered the characteristics of Big Data and provided accurate descriptions of volume, velocity, and variety.

The student also attempted to address the challenges, describing how Big Data can lead to privacy issues and concerns about the security of storing it. However, other areas such as discussing the physical challenges of storing Big Data could have been given.

While these areas were covered well, the student did not attempt to discuss the approaches that could be taken to overcome the problems. However, overall, there is enough evidence to place this response at the bottom of Level 3 and award 5 marks.

Response B

Big Data is about data too big to store in one place. This is challenging because sometimes you want to store thousands of rows of data but you do not have enough storage for it. If you cannot store all of your data then this is going to have a negative effect.

To solve this problem, you can install more hard-drives onto your computer. This will provide much more storage as hard-drives can be 1 Terabyte each. It would also be worth having a back-up device with high amounts of storage in case your data is lost or hacked.

If you are storing data about people you need to be careful. What if it contains personal data which could reveal secrets if someone hacked it? You also need to think about which country you are storing this data as different countries have different rules on data. Also, you have to be aware of laws and make sure that data is stored securely, and you have permission to store it. You also need to think about what level of access everyone has to it, e.g. customers can only see their own data but managers can read all of the data and admins can have read/write access to everything.

Commentary

This response received **3 marks**.

This was a part response to the question. The student demonstrated some understanding of Big Data, particularly its meaning and the challenges of storing large amounts of data. They also mentioned relevant considerations such as personal data, legal requirements, and access levels, showing awareness of privacy and security issues.

However, the response did not cover the characteristics of Big Data (volume, velocity, and variety) or provide detailed examples of how Big Data is managed in practice. The discussion of solutions was limited and somewhat simplistic, focusing mainly on adding storage rather than more comprehensive approaches. Overall, there is enough evidence to place this response at the bottom of Level 2.

Question 7 part 7.2

Question 7.2 tests Assessment Objective AO1 and requires students to recall why IPv6 was introduced.

0 7 . 2 There are currently two standards for IP addresses known as V4 and V6.

Explain why V6 was introduced.

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
07	02	IPv4 addresses were running out due to the growing number of devices; IPv6 provides a much larger address space; IPv6 supports improved security and efficiency in data transmission; IPv6 allows for better handling of modern internet traffic/IoT devices.	2 AO1 = 2

Response A

V6 was introduced because there were not enough V4 addresses for all devices. It also provides a much larger address space so more devices can have unique IP addresses.

Commentary

This response received **2 marks**. The student correctly states that V6 was introduced because the number of addresses available with V4 is insufficient. It also correctly recognises that V6 provides a much larger address space, allowing more devices to have unique IP addresses.

Response B

V6 was made because V4 was old and needed to be updated as it didn't have enough addresses for devices.

Commentary

This response received **1 mark.** The student shows some awareness that IPv6 was introduced after IPv4 and hints at the address shortage, but the explanation is vague

Question 7 part 7.4

Question 7.4 tests Assessment Objective AO1 and requires students to recall the purpose of DHCP.

0 7 . 4 State the purpose of the Dynamic Host Configuration Protocol (DHCP).

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
07	04	Automatically assigns IP addresses to devices on a network; Reduces the need for manual IP configuration; Ensures devices receive correct network settings; Helps manage and reuse IP addresses efficiently.	2 AO1 = 2

Response A

DHCP automatically gives devices an IP address when they join a network. It also helps to make sure devices receive the correct network settings such as the subnet mask, default gateway, and DNS server.

Commentary

This response received **2 marks**. The student correctly states the main purpose of DHCP (assigning IP addresses) and also recognises that it provides other essential network settings, showing a clear and accurate understanding.

Response B

DHCP gives devices an IP address on a network and makes sure they are always connected to the Internet.

Commentary

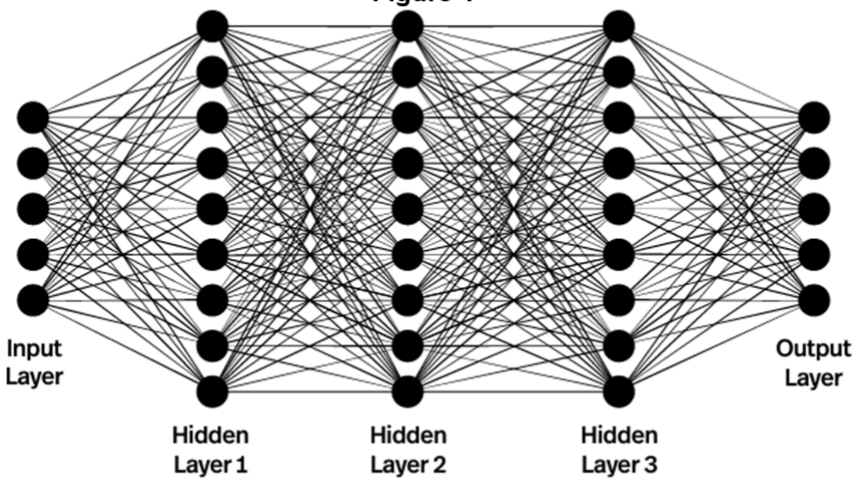
This response received **1 mark.** The student shows some understanding that DHCP assigns IP addresses, but the claim about ensuring Internet connectivity is inaccurate.

Question number part 8.1

Question 8.1 tests Assessment Objective AO1 and requires students to give a reason for having multiple hidden layers in a neural network.

0 8 The diagram shown in **Figure 4** represents an artificial neural network.

Figure 4



0 8 . 1 Explain the reason for having several hidden layers in an artificial neural network.

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
08	1	Enables deep learning to take place; To produce output; Allows for more complex problems to be solved; To enable the neural network to learn and make decisions on its own; To improve the accuracy;	2 AO1 = 2

Response A

Hidden layers allow the neural network to learn more complex patterns in the data. Having several layers helps the network make more accurate predictions.

Commentary

This response received **2 marks**. The student clearly explains the purpose of hidden layers in an artificial neural network, showing that they allow the network to learn complex patterns and improve prediction accuracy.

Response B

The problem it is trying to solve might be more complex and need more layers.

Commentary

This response received **1 mark**. The student had identified that multiple hidden layers are needed for more complex problems.

Question 8 part 8.2

Question 8.2 tests Assessment Objective AO1 and requires students to explain how neural networks allow for machine learning.

0 8 . 2 Explain how artificial neural networks enable machine learning.

[3 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
08	2	Artificial neural networks are intended to replicate the way human brains work; Weights / values are assigned for each connection between nodes; The data are input at the input layer and are passed into the system; They are analysed at each subsequent (hidden) layer where characteristics are extracted / outputs are calculated; The process of training / learning is repeated many times to achieve optimum outputs // reinforcement learning takes place; Decisions can be made without being specifically programmed; The deep learning net will have created complex feature detectors; The output layer provides the results;	3 AO1 = 3

Response A

A neural network enables machine learning by creating a set of nodes with connections between them. For each connection in between, weights are assigned. Data is passed in through the input layer and will work its way through the nodes, applying the weights to the data as it travels through the layers. The output layer then calculates the answer and will result in a decision being made that wasn't programmed by the programmer.

Commentary

This response received **3 marks.** The student had described the weights assigned between nodes and the fact that data is input at the first layer and passed into the system. They also described that the output layer produces a result; and explained that a decision is made that wasn't provided by the programmer. Four correct points have been made, however, a maximum of 3 marks can be awarded.

Response B

Neural networks are made to copy how the human brain works. Data is input and this data is used to determine a result as it passes through layer by layer. These layers are updated if any errors occur so next time it can be more accurate. This is called back propagation.

Commentary

This response received **2 marks**. The student described that neural networks are supposed to replicate the way the human brain works. They also mentioned that back propagation is used to correct errors. They described that data is input and it travels layer by layer but did not specify an input layer and there was no detail on the layer system, so the third mark was not awarded.

Question 8 part 8.3

Question 8.3 tests Assessment Objective AO1 and requires students to explain how artificially intelligent systems can develop bias

0 8 . 3 Describe how artificially intelligent systems may develop bias.

[2 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks
08	3	Bias in training data can be learned by the AI; Human biases in data collection or labelling can be transferred to the AI; Insufficient diversity in the training dataset can lead to biased results; If data reflects historical bias, AI may reinforce those patterns; AI may learn from skewed data affecting its fairness;	2 AO1 = 2

Response A

AI can develop bias if it is trained on data that is not fair. For example, if an AI is trained using data where one group of people is underrepresented, it might make unfair decisions for that group.

Commentary

This response received **2 marks.** The student clearly explains how bias can occur in AI, identifying the impact of an unbalanced training dataset. They provide a relevant example that shows understanding of how bias affects AI decisions.

Response B

AI can be biased because it uses data from people. It might also pick favourites or make mistakes on purpose.

Commentary

This response received **1 mark**. The student shows some awareness that AI can learn from human data, but the explanation is vague. The second sentence is inaccurate because AI does not “pick favourites” or make mistakes intentionally.

Question 9 part 9.3

Question 9.3 tests Assessment Objective AO1 and requires students to explain the term higher-order function.

0 9 . 3 `map` is an example of a higher-order function.

State what a higher-order function is.

[1 mark]

Mark Scheme

Question	Part	Marking guidance	Total marks
09	3	A function that takes a function as an argument // returns a function as a result // takes a function as an argument and returns a function as a result; **A**. "Parameter", "Input" for "Argument" **NE**. A function that uses another function **R**. Explanations that are specifically of the map function	1 AO1 = 1

Response A

A higher-order function could take functions as parameters and could return a function as a result.

Commentary

This response received **1 mark.** This was a full response to the question. The student has used the word parameter instead of argument but this was accepted.

Response B

A function that will use other functions to find results

Commentary

This response received **0 marks**. The student identified that other functions are part of the function, but it was not enough explanation as simply calling other functions would be included in this. There needed to be a mention of arguments as functions / returning functions to be awarded the mark.

Question 10

1 0 A parcel delivery company uses a relational database to store information about the deliveries that it makes. These details include information about each customer who sends a parcel, the individual parcels being delivered and pricing details.

The company offers three different service speeds, which are "Express", "Standard" and "Economy". The price that is charged for delivering a parcel depends upon the service speed selected and the weight of the parcel to the nearest gram.

For each service speed, parcel prices are split into bands for a range of weights. For example, for the "Express" service, the price bands are shown in **Table 4**.

Table 4

Minimum Weight (g)	Maximum Weight (g)	Price
0	249	£1.99
250	499	£2.99
500	999	£3.99
1000	4999	£4.99
5000	19999	£9.99

Similar price bands, but with different prices, exist for the "Standard" and "Economy" services.

The details are stored using the three relations shown in **Figure 5**.

Figure 5

Customer(CustomerID, Title, Forename, Surname)

PriceBand(ServiceSpeed, MinWeight, MaxWeight, Price)

Parcel(ParcelID, ServiceSpeed, Weight, DateSent, CustomerID, RecipientName, HouseNumber, Street, Town, County, Postcode)

Question 10 part 10.2

Question 10.2 tests Assessment Objective AO2 and requires students to create an SQL statement for updating records.

10.2 The price that is charged for an "Express" delivery, weighing between 1000 and 4999 grams is to be increased to £5.99.

Complete these SQL statements to make this update.

[4 marks]

```
UPDATE
_____

_____
SET
_____

_____
WHERE
_____

_____
```

Mark Scheme

Question	Part	Marking guidance	Total marks

10	2	`UPDATE PriceBand`
		`SET Price = 5.99`
		`WHERE ServiceSpeed = "Express"`
		`AND MinWeight = 1000 AND`
		`MaxWeight = 4999`
		
		1 mark for `UPDATE PriceBand`
		
		1 mark for `SET Price = 5.99`
		
		1 mark* for `ServiceSpeed = "Express"`
		
		1 mark* for either `MinWeight = 1000` or `MaxWeight = 4999` (or both joined by `AND`). **A.** use of >= and <= instead of = if conditions given for both `MinWeight` and `MaxWeight`.
		
		To award both marks indicated by * symbol, the conditions must be joined by `AND`s.
		A. Double or single quotes around `Express`
		A. `Express` written in any case
		A. £ symbol before `5.99`
		A. Table names before fieldnames
		
		DPT for fieldname before table name.
		DPT for unnecessary punctuation e.g. quotes where they should not appear. Allow one semicolon at the very end of the statement, but not at the end of each clause.
		DPT use of incorrect equality operator e.g. ==
			4
			
			AO2 = 4

Response A

```
UPDATE PriceBand

SET Price = “5.99”

WHERE ServiceSpeed = "Express" AND MinWeight = 1000 AND MaxWeight = 4999
```

Commentary

This response received **3 marks**. The student correctly identified PriceBand after the UPDATE command. MP2 was not awarded because quotations are around *5.99* which is a data type mismatch (as it is a float value). The student has correctly written the condition ServiceSpeed = "Express" and the combined MinWeight = 1000 AND MaxWeight = 4999, which correctly uses AND to join the weight conditions.

Response B

```
UPDATE PriceBand

SET Price

WHERE ServiceSpeed = "Express" AND Valid MinWeight AND MaxWeight
```

Commentary

This response received **2 marks**. The student identified that PriceBand should go after the UPDATE command. MP2 was not awarded because the SET clause is incomplete; the new value for Price is missing. Another mark was awarded because the ServiceSpeed = "Express" condition is correctly written. However, the conditions for MinWeight and MaxWeight are incorrectly written as “Valid MinWeight AND MaxWeight” is not valid SQL syntax.

Question 10 part 10.3

10.3 Write an SQL statement that will list all of the parcels sent by the customer whose **CustomerID** is 109.

For each parcel, the list should include the **DateSent**, the **Postcode** that the parcel was sent to, the **ServiceSpeed** that was used and the **Price** charged, and no other details.

The list should be presented in order, with the parcel sent the longest time ago at the top of the list and the parcel sent most recently at the bottom.

[6 marks]

Mark Scheme

Question	Part	Marking guidance	Total marks

10	3	**Solution 1**
		`SELECT DateSent, Postcode, ServiceSpeed, Price`
		`FROM Parcel, PriceBand`
		`WHERE CustomerID = 109`
		`AND Parcel.ServiceSpeed = PriceBand.ServiceSpeed`
		`AND Parcel.Weight >= PriceBand.MinWeight`
		`AND Parcel.Weight <= PriceBand.MaxWeight`
		`ORDER BY DateSent`
		
		Solution 2
		`SELECT DateSent, Postcode, ServiceSpeed, Price`
		`FROM Parcel INNER JOIN PriceBand ON`
		`Parcel.ServiceSpeed = PriceBand.ServiceSpeed`
		`AND Parcel.Weight >= PriceBand.MinWeight`
		`AND Parcel.Weight <= PriceBand.MaxWeight`
		`WHERE CustomerID = 109`
		`ORDER BY DateSent`
		
		1 mark for `SELECT` clause with correct four fields
		1 mark for `FROM` clause with correct two tables
		1 mark for `CustomerID = 109`
		1 mark for `Parcel.ServiceSpeed=PriceBand.ServiceSpeed`
		1 mark for `Parcel.Weight >= PriceBand.MinWeight AND Parcel.Weight <= PriceBand.MaxWeight`
		1 mark for `ORDER BY DateSent`
		MAX 2 of the 3 marks for conditions if not joined by `ANDs`
		
		Conditions linking the two tables can be present in either the `FROM` or `WHERE` clause or a mixture of both, as long as they are syntactically and logically correct.
		
		Marks for correct files/tables in `SELECT` and `FROM` statements should not be awarded if additional fields/tables included, except allow the inclusion of the `CUSTOMER` table in the `FROM` statement so long as it has been correctly linked to the `PARCEL` table.
		
		Marks can be awarded for the conditions in the `WHERE` statement even if the required tables are not present in the `FROM`.
		A. Table names before fieldnames.
		A. Use of `Alias/AS` command e.g. `FROM Parcel AS P` then use of `P` as table name (note some dialects of SQL do not require `AS` e.g. FROM `Parcel P`).
		A. Insertion of spaces into fieldnames.
		A. `109` with no delimiters or delimited using " or '.
		A. Use of `BETWEEN` command for weight range e.g. `Parcel.Weight BETWEEN PriceBand.MinWeight AND PriceBand.MaxWeight`
		A. `ORDER BY` written as one word `ORDERBY`.
		A. `ASC` at the end of `ORDER BY`.
		I. Unnecessary brackets.
		
		DPT for unnecessary punctuation – allow one semicolon at the very end of the statement, but not at the end of each clause.
		DPT for fieldname before table name.
			6
			
			AO2 = 6

		DPT use of incorrect equality operator e.g. == **Refer responses using nested SQL queries to team leaders.**	

Response A

SELECT DateSent, Postcode, ServiceSpeed,Price

FROM Parcel, PriceBand

WHERE CustomerID = 109 AND Parcel.ServiceSpeed = PriceBand.ServiceSpeed AND Parcel.Weight >= PriceBand.MinWeight AND Parcel.Weight <= PriceBand.MaxWeight

Commentary

This response received **5 marks.**

This was an almost complete solution to the question. The student correctly identified all the fields for the SELECT command. They also stated the two correct table names after the FROM command. The correct conditions for the CustomerID, ServiceSpeed and Weight are correctly placed after the WHERE command. However, the student did not use the ORDER BY command to order the results by DateSent.

Response B

SELECT DateSent, Postcode, ServiceSpeed, Price

FROM Parcel

WHERE CustomerID = 109

ORDER Date

Commentary

This response received **2 marks.** The student correctly identified the fields for the SELECT command and included the condition CustomerID = 109 in the WHERE clause. However, the second table, PriceBand, is missing from the FROM clause, which is required to access the Price field, and the necessary join and weight conditions are not included. In addition, the ORDER BY syntax is incorrect; it should be ORDER BY DateSent rather than ORDER Date.