AQA

A-level
COMPUTER SCIENCE
7517/2

Paper 2

Mark scheme

June 2021

Version: Final 1.1

216A7517/2/MS

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Level of response marking instructions

Level of response mark schemes are broken down into levels, each of which has a descriptor. The descriptor for the level shows the average performance for the level. There are marks in each level.

Before you apply the mark scheme to a student's answer read through the answer and annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1 Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level. The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer and not look to pick holes in small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level and then use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 3 with a small amount of level 4 material it would be placed in level 3 but be awarded a mark near the top of the level because of the level 4 content.

Step 2 Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do not have to cover all of the points mentioned in the Indicative content to reach the highest level of the mark scheme.

An answer which contains nothing of relevance to the question must be awarded no marks.

A-level Computer Science

Paper 2

June 2021

To Examiners:

- **When to award '0' (zero) when inputting marks on CMI+**
  A mark of 0 should be awarded where a candidate has attempted a question but failed to write anything credit worthy.

  Insert a hyphen when a candidate has not attempted a question, so that eventually the Principal Examiner will be able to distinguish between the two (not attempted / nothing credit worthy) in any statistics.

- This mark scheme contains the correct responses which we believe that candidates are most likely to give. Other valid responses are possible to some questions and should be credited. Examiners should refer responses that are not covered by the mark scheme, but which they deem creditworthy, to a Team Leader.

The following annotation is used in the mark scheme:

; - means a single mark
// - means alternative response
/ - means an alternative word or sub-phrase
A. - means acceptable creditworthy answer
R. - means reject answer as not creditworthy
NE. - means not enough
I. - means ignore
DPT. - in some questions a specific error made by a candidate, if repeated, could result in the loss of more than one mark. The **DPT** label indicates that this mistake should only result in a candidate losing one mark on the first occasion that the error is made. Provided that the answer remains understandable, subsequent marks should be awarded as if the error was not being repeated.

Examiners are required to assign each of the candidates' responses to the most appropriate level according to **its overall quality**, then allocate a single mark within the level. When deciding upon a mark in a level examiners should bear in mind the relative weightings of the assessment objectives.

eg

In the following questions, the marks available are as follows:

Question 02 (max 3 marks)
AO1 (knowledge) – 1 mark
AO1 (understanding) – 2 marks

Question 05.4 (max 7 marks)
AO2 (analyse) – 5 marks
AO3 (programming) – 2 marks

Question 11.5 (max 6 marks)
AO1 (knowledge) – 2 marks
AO1 (understanding) – 4 marks

Question 14.3 (max 4 marks)
AO1 (knowledge) – 2 marks
AO1 (understanding) – 2 marks

Qu	Pt	Marking guidance	Total marks
01	1	**All marks AO2 (apply)** Award **3 marks** if correct final answer is shown: 16 // 2^4 If final answer is not given then award **3 marks** if correct calculation is shown: $2^{\left(\frac{400 \times 1000}{1000 \times 800} \times 8\right)}$ If final answer is not correct or overall calculation is not clear then award **up to 2 marks for working**, one for each of the points listed below: • multiplying 400 by 1000 // 400 000 shown in working; • dividing 3 200 000 or 400 000 or 8000 or 3200 or 400 or 8 by a number; • multiplying 1000 by 800 // 800 000 shown in working; • multiplying by 8 to convert from bytes to bits; • colour depth calculated as 4; • showing 2^x as the last stage of the working, where x is the value calculated so far;	**3**

Qu	Pt	Marking guidance	Total marks
01	2	**All marks AO1 (understanding)** Bitmap images store the colour of each pixel // vector graphics do not need to store the colour of each pixel; **A.** data about pixel instead of colour, but **R.** just storing pixels The image contains 800 000 pixels // images can contain lots of pixels; Vector graphics store information about / properties of the objects that an image is composed of; **A.** "shapes" for "object" **R.** "equations" for "object" **R.** "instructions" for "object" unless clear that instructions are descriptions of objects **A.** examples of properties/information instead of the actual words, if there are at least two valid examples **NE.** vector graphics are composed of objects without reference to properties/information It takes only a small amount of memory to store the properties of an object; (Large) images can be composed of relatively few objects // there will be fewer objects than there would be pixels // a single object might be equivalent to many pixels; **Max 3**	**3**

Qu	Pt	Marking guidance	Total marks
01	3	**All marks AO1 (understanding)** Individual objects / components / parts of the image can be manipulated / edited / duplicated / copied independently; **NE.** images are easy to edit The image / individual objects / components / parts of the image can be enlarged / scaled without loss of quality / without becoming pixelated // vector graphics are resolution independent; **A.** zoomed in" for enlarged **NE.** easy to scale If an object / component is deleted, the software knows what is behind it // no "hole" is left in the image; **R.** faster transmission times (as a direct consequence of fewer bytes, given in question) **Max 2**	**2**

Qu	Pt	Marking guidance	Total marks
02		**1 mark AO1 (knowledge) and 2 marks AO1 (understanding)** **What it is (1 mark):** Processing is carried out // applications/programs are executed on an application server (**A.** server); **NE**. Resources are stored on the server **Why selected (Max 2 marks):** Clients are cheaper to purchase // clients can have lower hardware specification; **NE.** cheaper without further explanation Less configuration of clients is necessary // easier to configure/add a new client // easier to replace a client; Simpler installation/updating of software (as only done on server); **R.** if implication that software is on client Impossible to install unauthorised software on workstations // more secure as fewer settings can be changed; Workstations consume less electricity/power; Licensing can be cheaper (as licence per active user not per client); Longer MTBF for workstations // workstations do not fail/break as often // workstations need less maintenance; **Max 3**	**3**

Qu	Pt	Marking guidance	Total marks
03	1	**Mark is AO2 (analyse)** Bit rate is double / twice baud rate // baud rate is half bit rate; **A.** "It" is double **A.** 2:1	**1**

Qu	Pt	Marking guidance	Total marks
03	2	**Mark is AO1 (understanding)** They are (directly) proportional // the greater the bandwidth, the higher the bit rate; **A.** as bit rate increases so does bandwidth as BOD **NE.** bandwidth constrains bit rate	**1**

Qu	Pt	Marking guidance	Total marks
03	3	**All marks AO1 (understanding)** Serial sends one bit at a time / after each other whereas parallel sends multiple bits simultaneously/at same time; **R.** bytes, values, packets, data for bits Serial uses a single wire / cable / path / line whereas parallel uses several / multiple wires / cables / paths / lines; **NE.** answers that refer to multiple channels **Both sides of point must be made to award a mark.**	**2**

Qu	Pt	Marking guidance	Total marks
04	1	**Mark is AO2 (apply)** $Q1=\overline{X2}.\overline{X1}.X0$; **A.** a logically equivalent expression	1

Qu	Pt	Marking guidance	Total marks
04	2	**All marks AO2 (apply)** **1 mark:** 1 row completed correctly **OR** **2 marks:** 4 rows completed correctly **OR** **3 marks:** 8 rows completed correctly	3

INPUTS			OUTPUTS							
X2	X1	X0	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Qu	Pt	Marking guidance	Total marks
04	3	**All marks AO2 (analyse)** **2 marks:** Output **Qn** is 1 / on / activated when the binary pattern input is the value **n** **A. n** for **Qn** **A.** relationship between **n** and output **Qn** described by example eg if the value of the inputs is 0 then output 0 is on, if the value of the inputs is 1 output 1 is on, and so on. **A.** it is a (3-bit) binary decoder **OR** **1 mark:** One / a different output is 1 / on / activated for each different input pattern // it converts a binary input to a decimal output	2

Qu	Pt	Marking guidance	Total marks
04	4	**Mark is AO2 (analyse)** **Q0;** **NE.** 0	**1**

Qu	Pt	Marking guidance	Total marks
05	1	**Mark is AO2 (analyse)** **B**; (FacilityID, BookingDate, EndTime) **R.** if more than one lozenge shaded	**1**

Qu	Pt	Marking guidance	Total marks
05	2	**All marks AO2 (analyse)** The design is not normalised // there is (unnecessary) data duplication // there is data redundancy // inconsistent data could occur // (one of the) attributes are determined by attributes that are not (part of) the primary key; If a customer made more than one booking then their details would need to be entered more than once / each time // there would be redundancy in relation to the customer data // customer data could be stored multiple times; If customer details were entered more than once they could be inconsistent // there could be inconsistency in the customer data // updates may need to be made to multiple records if a customer's details changed; **A.** updates to customer details would be harder to perform as **BOD** Deleting all of the bookings that a customer made would also delete the data about the customer; It would not be possible to store details about a customer before they had made a booking; It would be harder to identify all the bookings for one customer (as they did not have a unique identifier) // it may be impossible (**A.** difficult) to distinguish between two customers with the same name (if they did not have an email address); **Notes:** • For all mark points (other than the first) it must be stated that it is the customer data that is the issue to award the mark. • Accept points stated the other way around, ie as advantages of the new design instead of reasons to reject the original design. **Max 2**	**2**

Qu	Pt	Marking guidance	Total marks

05	3	**All marks AO3 (programming)**
		
		`FacilityID INT PRIMARY KEY,`
		//
		`FacilityID INT,`
		`PRIMARY KEY(FacilityID),`
		
		`Description VARCHAR(100),`
		`MaxPeople INT,`
		`PricePerHour SMALLMONEY`
		
		1 mark: `FacilityID`, with sensible data type and identified as primary key.
		
		1 mark: two fields other than the primary key have sensible data types and lengths (if given).
		
		1 mark: fully correct definition, with syntactically correct SQL including commas separating each line of code.
		
		A. any sensible types. Lengths do not need to be specified.
		I. brackets at the start / end of the code
		
		Valid alternative SQL types are:
		
		• Alternative types for `FacilityID` and `MaxPeople`: tinyint, smallint, mediumint, integer, number, byte.
		• Alternative types for `Description`: char, nchar, nvarchar, ntext, longvarchar, varchar2, nvarchar2, text, tinytext, mediumtext, longtext, string.
		• Alternative types for `PricePerHour`: money, float, real, decimal, double, numeric, currency. **R.** integer only types.
			3

Qu	Pt	Marking guidance	Total marks

05	4	**5 marks for AO2 (analyse) and 2 marks for AO3 (programming)**
		
		Mark Scheme
		
		AO2 (analyse) – 5 marks:
		
		1 mark for correctly analysing the data model and identifying the tables that data needs to be extracted from (`FacilityForSport, Booking`) and the fields that need to be extracted (`FacilityID, StartTime, EndTime`), and including these and no other tables or fields in the query
		
		1 mark for correctly identifying the condition to select facilities suitable for the correct sport: `Sport = "Basketball"` or correctly identifying the condition to select bookings on the required date: `BookingDate = "15/06/2021"`
		
		1 mark for correctly identifying the condition to link the two tables: `Booking.FacilityID = FacilityForSport.FacilityID`
		
		1 mark for at least one condition that would identify some overlapping bookings and no bookings that don't overlap, or **2 marks** for conditions that would identify all overlapping bookings and no bookings that don't overlap. Example conditions (not the only ones) that would identify all overlapping bookings:
		
		Example set of conditions 1
		
		`StartTime <= "14:15" AND EndTime >= "16:15"`
		(existing booking starts before and ends after new booking)
		`StartTime >= "14:15" AND StartTime <= "16:15"`
		(existing booking starts during new booking)
		`EndTime >= "14:15" AND EndTime <= "16:15"`
		(existing booking ends during new booking)
		
		Example set of conditions 2
		
		`StartTime <= "16:15" AND EndTime >= "14:15"`
		(existing booking starts before or at the same time as the end of new booking and ends after or at the same time as the start of new booking)
		
		Note: Award a **maximum of 2 of the 3 marks** for the correct conditions if they are not joined by the correct logical operators.
		
		Note: The AO2 marks for analysing the data model should be awarded regardless of whether correct SQL syntax is used or not as they are for data modelling, not syntactically correct SQL programming
		
		A. mark(s) can be awarded for the correct logical conditions even if the required tables are not identified as being used by the query
		A. > instead of >= and < instead of <=
			7

AO3 (programming) – 2 marks:

1 mark for fully correct SQL in two of the three clauses (SELECT, FROM, WHERE)

OR

2 marks for fully correct SQL in all three clauses (SELECT, FROM, WHERE)

Notes:

- For the SELECT clause to count as correct SQL it must have the correct field names in it and no others.
- For the FROM clause to count as correct SQL it must have the correct table names in it. Other, unnecessary tables can also be included so long as they are correctly linked into the query by conditions so would not break it.
- For the WHERE clause to count as correct SQL it must include at least one valid condition, but does not have to include them all.

A. instead of `FacilityForSport.FacilityID` accept `Booking.FacilityID` or just `FacilityID` in the SELECT clause for non-nested queries. For a nested query accept `X.FacilityID` where `X` is the alias of the relation produced by the nested query eg `BookingsAtTime` in example 3.
A. table names before fieldnames separated by a full stop.
A. use of `Alias`/`AS` command eg `FROM Booking AS B` then use of `B` as the table name and note that command `AS` is not required eg `FROM Booking B`.
A. `INNER JOIN` written as one word ie `INNERJOIN`.
A. insertion of spaces into fieldnames.
I. unnecessary brackets so long as they would not stop the query working.
A. use of any type of quotation marks, hashes or no delimiters around dates and times.
A. month in date as `6` instead of `06`
A. > instead of >= and < instead of <=
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.

Overall Max 6 if solution does not work fully

Example Solutions

Example 1 – All conditions in WHERE clause

```
SELECT FacilityForSport.FacilityID, StartTime, EndTime
FROM FacilityForSport, Booking
WHERE Sport = "Basketball"
  AND Booking.FacilityID = FacilityForSport.FacilityID
  AND BookingDate = "15/06/2021"
  AND
  ( StartTime <= "14:15" AND EndTime >= "16:15"
    OR StartTime >= "14:15" AND StartTime <= "16:15"
    OR EndTime >= "14:15" AND EndTime <= "16:15" )
```

Example 2 – Use of INNER JOIN

```
SELECT FacilityForSport.FacilityID, StartTime, EndTime
FROM FacilityForSport INNER JOIN Booking ON
  Booking.FacilityID = FacilityForSport.FacilityID
WHERE Sport = "Basketball"
  AND BookingDate = "15/06/2021"
  AND
  ( StartTime <= "14:15" AND EndTime >= "16:15"
    OR StartTime >= "14:15" AND StartTime <= "16:15"
    OR EndTime >= "14:15" AND EndTime <= "16:15" )
```

Example 3 – A Nested Solution

```
SELECT FacilityForSport.FacilityID, StartTime, EndTime
FROM ( SELECT FacilityID, StartTime, EndTime
       FROM Booking
       WHERE BookingDate = "15/06/2021"
         AND
         ( StartTime <= "14:15" AND EndTime >= "16:15"
           OR StartTime >= "14:15" AND StartTime <= "16:15"
           OR EndTime >= "14:15" AND EndTime <= "16:15" )
     ) AS BookingsAtTime INNER JOIN FacilityForSport
       ON BookingsAtTime.FacilityID =
         FacilityForSport.FacilityID
WHERE Sport = "Basketball"
```

Refer nested solutions to team leaders for marking

Qu	Pt	Marking guidance	Total marks
06	1	**All marks AO2 (apply)**	6

R0	R1	R2	R3	R4
	100010 (34)	110 (6)		
0 (0)			1 (1) *1*	
		1100 (12)	10 (2) *2*	
		11000 (24)	100 (4)	
		110000 (48)	1000 (8)	
		11000 (24)	100 (4) *3*	
100 (4)	1010 (10) *4*			0 (0) *5*
		1100 (12)	10 (2)	0 (0)
		110 (6)	1 (1)	
101 (5)	100 (4) *6*			1 (1)
			0 (0)	

1 mark: Correct initial values loaded into `R0` and `R3` – Area 1
1 mark: Logical shifting left of register values in loop – Area 2
1 mark: Exiting loop and shifting right – Area 3
1 mark: First addition and subtraction on `R0` and `R3` – Area 4
1 mark: Addition and subtraction loop – Area 5
1 mark: Correct final values in registers `R0` and `R1` – Area 6

Award marks for the correct values in the indicated areas. The values do not need to be in the exact cells shown for marks to be awarded, but must be in the correct sequence in the column they are in.

Award marks for values written in either decimal or binary. If a binary and decimal value are written in one cell and one is correct but the other incorrect then treat the cell as being correct

Max 5 if any incorrect values in table.

Qu	Pt	Marking guidance	Total marks
06	2	**All marks AO2 (analyse)** Performs (integer) division // outputs the quotient after performing a division // outputs how many times one number (`R2`) goes into another (`R1`) // `R0` is the quotient; Outputs the remainder / what is left over after performing (integer) division // `R1` is the remainder;	2

Qu	Pt	Marking guidance	Total marks
07	1	**All marks AO1 (understanding)** **Why laser is suitable (Max 2):** Low cost per printed page // toner is cheaper (per page) than ink; Prints many pages per minute // high speed; Options to install a (greater) variety of paper trays // (greater) variety of paper handling options; Toner will not dry out; **A.** toner does not expire as quickly as ink; High resolution output; **Why having a wireless adapter is suitable (Max 2):** Easy to share printer between many devices; Can connect / print directly from computers / laptops with WiFi // no need to install a network / cabling / wireless router to facilitate wireless / network / remote printing; Printer can be managed remotely; WiFi should be fast enough for likely number of users / documents (as small office); WiFi should have sufficient range for devices to connect (as small office);	**3**

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>07</td><td>2</td><td>
All marks AO1 (understanding)
<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>3</td><td>A comprehensive description of how a laser printer works, which shows an excellent level of understanding, covering almost all of the indicative content below.</td><td>5–6</td></tr>
<tr><td>2</td><td>A sound description of how a laser printer works, which shows a good level of understanding. The key parts of the indicative content are covered but there are gaps in the description.</td><td>3–4</td></tr>
<tr><td>1</td><td>Some relevant points are made, but overall the description conveys only a limited understanding, either because only a very small number of points are made or the points made are not drawn together to form an accurate description.</td><td>1–2</td></tr>
</table>
<u>Guidance – Indicative Content</u>

Bitmap of image built in memory from page description.
(Negative) charge applied to (photosensitive) drum.
Laser beam directed at drum.
R. laser directed at paper.
Mirror is used to direct laser beam.
Where laser strikes drum charge is neutralised / reversed / cancelled / discharged.
(Negative) charge applied to toner.
Toner sticks to drum based on charge // where the laser struck.
Paper passed over drum and toner transfers to it.
Positively charged transfer roller assists transfer of toner from drum to paper.
A. charge applied to paper assists with transfer.
Heater fuses toner onto paper.
For colour printing four different colour toners // four drums are required.

</td><td>6</td></tr>
</table>

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>08</td><td></td><td>
All marks AO2 (apply)

1 mark: Both 18 and -72 represented correctly in two’s complement:

18: 00010010
-72: 10111000

1 mark: Correct answer in binary: 11001010
</td><td>2</td></tr>
</table>

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>09</td><td></td><td>

All marks AO1 (understanding)

<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>4</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>10–12</td></tr>
<tr><td>3</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>7–9</td></tr>
<tr><td>2</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>4–6</td></tr>
<tr><td>1</td><td>A few relevant points have been made but there is no evidence that a line of reasoning has been followed. The points may only relate to one or two of the areas from the guidance. There is insufficient evidence of a good understanding of any of the three areas.</td><td>1–3</td></tr>
</table>

<u>Guidance – Indicative Content</u>

Area 1: What Big Data is

Overarching description: Data that can’t be processed or analysed using traditional processes or tools.

<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

Email messages
Videos
Images
Web site contents
Facial recognition</td></tr>
</table>

</td><td>12</td></tr>
</table>

There is a lot / high volume of data (to process as one dataset) // data will not fit on one server	Hundreds of terabytes Large medical datasets for diagnosis Gene sequencing Predicting disease outbreaks Results of large-scale scientific experiments
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

Good level of understanding = Either all three characteristics covered or two characteristics and the overarching description. Some examples or expansions covered.

Area 2: Challenges and How Overcome

Challenges:

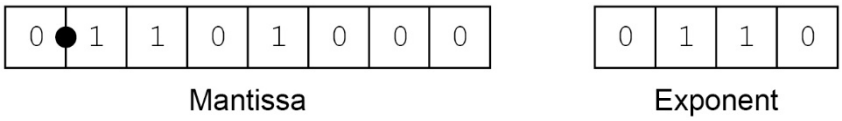
- Data cannot be stored on one server / computer.
- Not possible to process data quickly enough with one computer.
- Data cannot be represented in a table // by a relational database.
- Some forms of data / unstructured data are difficult to analyse.

How 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. *Good level of understanding = A range of challenges and how to overcome them are discussed.* **Area 3: Ethical and Legal Issues** • How can data be kept securely? • Who should have access to what data? • Will people know what data is being stored about them? • Where should / will the data be stored // concerns relating to data being stored in other countries. • What rights do people have in relation to data stored about them? • Example laws (allow two examples): Computer Misuse Act, General Data Protection Regulations / GDPR / Data Protection Act, Regulation of Investigatory Powers Act / RIPA. • Who owns data about individuals? *Good level of understanding = A range of issues described*	

Qu	Pt	Marking guidance	Total marks
10	1	**All marks AO2 (analyse)** **1 mark** per correct letter on a row. If a letter is used more than once then a mark should only be awarded (if merited) the first time the letter is used. Subsequent reuse of the same letter should not be credited even if the second/third use of the letter is in the correct position. **Value description** / **Correct letter (A-D)** A negative value that is valid in the representation. — A; The largest positive value that can be represented in the system. — D; A value that is not valid in the representation because it is not normalised. — C;	**3**

Qu	Pt	Marking guidance	Total marks
10	2	**All marks AO2 (apply)**  Award **2 marks** for correct answer: 52 If answer is incorrect then award **1 method mark** for either: • showing correct value of both mantissa and exponent in decimal (Mantissa = 0.8125 // 13/16 Exponent = 6) • showing binary point shifted 6 places to right in binary number • indicating that final answer has been calculated using answer = mantissa x $2^{exponent}$ and used either the correct mantissa, the correct exponent, or both in this calculation.	**2**

Qu	Pt	Marking guidance	Total marks
10	3	**Mark is AO2 (apply)** 0.3 // 105 - 104.7 // | 104.7 - 105 |; **A.** award BOD mark if correct method has been shown ie 105 - 104.7 but candidate has then made an error performing the subtraction operation **R.** -0.3 unless the accept point above also applies	**1**

Qu	Pt	Marking guidance	Total marks
10	4	**Mark is AO2 (apply)** 0.29(%); **A.** 0.0029 // 0.3 ÷ 104.7 **A.** follow-through of incorrect answer to question part 10.3 **A.** award BOD mark if correct method has been shown but candidate has then made an error performing the division operation	**1**

Qu	Pt	Marking guidance	Total marks
10	5	**Mark is AO1 (understanding)** The effect / impact of an error depends on its size relative to the number that is / should be represented // a particular (absolute) error is more significant the smaller the number that is / should be represented // a particular (absolute) error is less significant the bigger the number that is / should be represented; **NE.** relative error shows the significance/importance of error	**1**

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>11</td><td>1</td><td>All marks AO2 (analyse)

1 mark per valid IP address

<table>
<tr><td>The Router 1 port labelled A</td><td>192.168.x.y
where:
• x is in range 192 to 207
• y is in range 0 to 255
R. 192.168.192.0
R. 192.168.207.255</td></tr>
<tr><td>The Router 1 port labelled B</td><td>192.168.x.y
where:
• x is in range 64 to 79
• y is in range 0 to 255
R. 192.168.64.0
R. 192.168.79.255</td></tr>
<tr><td>The computer labelled C</td><td>192.168.x.y
where:
• x is in range 64 to 79
• y is in range 0 to 255
R. 192.168.64.0
R. 192.168.79.255
R. same response as for part B</td></tr>
</table></td><td>3</td></tr>
</table>

Qu	Pt	Marking guidance	Total marks
11	2	**Mark is AO2 (analyse)** **C**; (255.255.240.0) **R.** more than one lozenge shaded	**1**

Qu	Pt	Marking guidance	Total marks
11	3	**Mark is AO1 (understanding)** There are not enough (unique) addresses in IPv4 // IPv4 addresses are running out // to provide more addresses; Eliminate need for NAT / network address translation // facilitates true end-to-end connectivity; Simplified / more efficient routing is possible; Improved facilities for multicasting; Automatic configuration possible without DHCP; Allows bigger packet sizes; Devices can move / roam between location and keep the same IP address; Improved support for prioritising traffic by type; **Max 1**	**1**

Qu	Pt	Marking guidance	Total marks
11	4	**Mark is AO1 (understanding)** Star; **A.** physical star, star topology, star network	**1**

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>11</td><td>5</td><td>

2 marks for AO1 (knowledge) and 4 marks for AO1 (understanding)

<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>3</td><td>A detailed, coherent, description of CSMA/CA that includes the use of RTS / CTS and that conveys good understanding of how the protocol works. Whilst there may be some omissions from the description it contains no misunderstandings.</td><td>5–6</td></tr>
<tr><td>2</td><td>An adequate description of CSMA/CA, including at least three points from the list below. The description is logically organised so that it makes sense when read as a whole and therefore demonstrates a reasonable understanding of how the protocol works. The description may or may not include the use of RTS / CTS.</td><td>3–4</td></tr>
<tr><td>1</td><td>A small number of points relevant to of CSMA/CA have been recalled (in this case award one mark per point, up to a maximum of two from lists below). However, the structure of the response, or lack of it, demonstrates only a very limited understanding, if any, of the protocol used.</td><td>1–2</td></tr>
</table>

Indicative Content

- Computer with data to send monitors / listens for (data signal).
- If (data) signal present / another transmission in progress then continue to wait.
- When no (data) signal present computer sends a Request to Send / RTS. **A.** if no valid points made about RTS / CTS in response then accept ‘when no data signal is present computer starts to transmit data’, but since no marks awarded for RTS / CTS then marks are limited to max Level 2.
- Two computers could start transmitting simultaneously <u>if they both detect there is no data signal.</u>
- <u>Receiver / WAP</u> responds (to RTS) with a Clear to Send / CTS signal.
  A. router
- RTS / CTS signal blocks any other transmissions from nodes in range (for a specified time).
- If / when CTS received then start to transmit. **A.** by implication as **BOD** if the student states that the computer will begin to transmit after the receiver sends the CTS.
- If CTS not received continue to wait (until transmission ends).
- Receiver sends acknowledgement / ACK <u>after (all) data received</u>
- After transmitting (the transmitter) waits to receive acknowledgement packet (to confirm data received and not corrupted).
- If no acknowledgement / ACK received (within reasonable time period) then:
  - wait a time period.
  - then listen again / retransmit.
- The acknowledgement / ACK also notifies other computers that they can transmit again // after the time specified in the CTS passes, other nodes can transmit.
- Waiting periods are (often) random. **A.** an example waiting period that is random.
- Collisions cannot be detected by transmitter.

</td><td>6</td></tr>
</table>

Qu	Pt	Marking guidance	Total marks
12		**All marks AO1 (knowledge)** Music represented as sequence of MIDI (event) messages; **A.** music represented as sequence of instructions **A.** "events" for "event messages" **R.** music represented as sequence of notes **Max 1 mark for an example** of data that might be contained in a message: • Channel; • Note on / note off; • Pitch / frequency / note number; • Volume / loudness; • Velocity; • Key pressure / aftertouch; • Duration / length; • Timbre; • Instrument; • Pedal effects; • Pitch bend; • Note envelope; MIDI messages are usually two or three bytes long; First byte of each MIDI message is a status byte (others are data bytes); Bit rate is 31,250 bits per second; MSB value of 1 indicates status byte, 0 indicates data bytes; Status bytes are divided into a command and a channel number (4 bits for each); Sixteen channels are supported; **Max 2**	**2**

Qu	Pt	Marking guidance	Total marks
13	1	**All marks AO1 (knowledge)** **Application Software:** Performs user-oriented tasks // performs tasks that a user would still want to perform if they did not have a computer; **NE.** examples of tasks **System Software:** Software used in the management of a computer system; **A.** software that is used to run a computer Layer(s) of software that abstract the user from how the computer works; **A.** software that hides complexity of hardware from user **A.** software that provides a virtual machine	**2**

Qu	Pt	Marking guidance	Total marks
13	2	**All marks AO1 (knowledge)** **Description (1 mark):** (Software that) performs a non-core / ancillary / specific management function for a computer; **A.** (software that) performs a task that helps manage / configure / maintain a computer **A.** (software that) manages a computer system but is not essential **NE.** (software that) manages a computer **Example (1 mark):** Award a mark for a statement of any reasonable example, such as virus checker, disk defragmenter, backup, compression, encryption software etc; **R.** examples that relate to core functions of the operating system **R.** examples that are application software or if the response includes multiple examples, one of which is application software	**2**

Qu	Pt	Marking guidance	Total marks
14	1	**Mark is AO1 (understanding)** **B**; (The computer can only be used with one program) **R.** more than one lozenge shaded	**1**

Qu	Pt	Marking guidance	Total marks
14	2	**All marks AO1 (knowledge)** To marshal / control operation of fetch-execute cycle; Controls fetching / loading / storing operations; **NE.** fetches instructions Determines the type of an instruction; **A.** decodes instructions To execute (some) instructions; To synchronise operation of processor; To send control signals / commands to other components; To control the transfer of data between registers; To handle interrupts; **Max 3**	**3**

Qu	Pt	Marking guidance	Total marks
14	3	**2 marks AO1 (knowledge) and 2 marks AO1 (understanding)** **1 mark (AO1 knowledge): What cache memory is (Max 1):** * Memory that can be accessed very quickly; Memory located on (**A.** close to) the processor; **1 mark (AO1 knowledge): What cache memory is used for:** To store most frequently used // most recently used // pre-fetched instructions/data // to store instructions in the locality of the instruction currently being executed; **2 marks (AO1 understanding): How more cache memory improves performance (Max 2):** More instructions/data can be stored in the cache; #Instructions/data stored in cache can be accessed more quickly than instructions/data in main memory // if an instruction is accessed a second time, it can be retrieved more quickly; This increases the probability that a particular data item/instruction is in the cache when fetched // this increases the probability of a cache hit // fewer fetches from main memory will be required; **Note:** Only award the point marked # if the point marked * has not already been awarded	**4**