AQA

A-level
COMPUTER SCIENCE
7517/2

Paper 2

Mark scheme

June 2023

Version: 1.0 Final

236A7517/2/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 2023

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 creditworthy.

  Insert a hyphen when a candidate has not attempted a question, so that eventually the Lead Examiner will be able to distinguish between the two (not attempted / nothing creditworthy) 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 question, the marks available are as follows:

Question 05.3 (max 2 marks)
AO1 (understanding) – 1 mark
AO2 (analysis) – 1 mark

Question 07.3 (max 10 marks)
AO2 (analysis) – 4 marks
AO3 (programming) – 6 marks

Question 11.3 (max 4 marks)
AO1 (knowledge) – 2 marks
AO1 (understanding) – 2 marks

Question 11.4 (max 2 marks)
AO1 (knowledge) – 1 mark
AO1 (understanding) – 1 mark

Qu	Pt	Marking guidance	Total marks
01	1	**All marks AO2 (apply)** Award **2 marks** for correct answer: 16.48 **A.** responses written correctly to more decimal places (16.4794921875) or as a fraction 16 491/1024 **A.** 48000 × 16 × 3 × 60 / 8 / 1024 / 1024 Award **1 mark** for an answer written to 0 or 1 decimal places (16 or 16.5) or if truncated to 16.47 If answer is incorrect then award **1 method mark** for doing at least **three** of: • multiplying by 48000 • multiplying by 16 • multiplying by 3 • multiplying by 60 • dividing by 8 • dividing by 1024 / 2^{10} • dividing by 1024 / 2^{10} a second time The following method points are equivalent to performing two of the method points in the list above: • multiplying by 180 • dividing by 2 • dividing by 1048576 / 2^{20} **Max 1** if answer is not correct and written to at least 2 decimal places	2

Qu	Pt	Marking guidance	Total marks
01	2	**Mark is AO2 (apply)** Award **1 mark** for correct answer: 30000 **A.** 15000 × 2, double 15000	1

Qu	Pt	Marking guidance	Total marks
01	3	**Mark is AO1 (knowledge)** Digital to Analogue Converter **A.** DAC **NE.** Digital to Analogue **R.** Initialism and full name both given but do not match eg Digital to Analogue Converter (ADC) **R.** If two components named	1

Qu	Pt	Marking guidance	Total marks
02	1	**All marks AO1 (knowledge)** Port number(s); **A.** destination port number and source port number as separate marks **A.** "port" as **BOD** Sequence number; **A.** packet number Time to live; **A.** TTL, maximum hop count Packet size/length; **A.** size Type of service; **A.** priority Protocol identifier; **A.** "protocol" as **BOD** Packet identifier/ID number; IP version; Options/Padding; Flags; Window size value; Fragment offset // header length; **A.** Total number of packets in message **NE.** Total number of packets **A.** Acknowledgement number **Only mark first two responses** **Max 2**	**2**

Qu	Pt	Marking guidance	Total marks
02	2	**All marks AO1 (understanding)** **Explain what the checksum is used for:** To check if the contents of the packet/data have been corrupted/changed (during transmission) // to check if the received data is/is not the same as the transmitted data; **A.** "tampered" for "corrupted/changed" **A.** To check if an error has occurred during transmission **A.** To check if the data has been sent/transmitted correctly **NE.** To check if received/transmitted data is correct **NE.** To correct (some) errors in the received data **NE.** Error checking **Outline how the checksum's value will be determined:** Calculated from the payload/data/contents (of the packet); **A.** Hash/apply a function to the payload/data/contents of the packet **A.** Explanation of a reasonable calculation that could be done **NE.** Explanation of a calculation that could not reasonably be performed to produce a useful checksum **NE.** "apply an algorithm to data" unless clear that this is mathematical, or produces a single value as an output **I.** Responses that go on to talk about a comparison being made using the checksum to check if the data is received correctly.	**2**

Qu	Pt	Marking guidance	Total marks
02	3	**All marks AO1 (understanding)** Connects two networks together; **NE.** Connects a network to the Internet **Note:** Must be explicitly stated to award mark, not implied from other points Router determines which outgoing link to send packet along // determines which router/host/node to send packet to next; **NE.** Router determines where to send packet next **NE.** Router determines next hop **R.** Responses which suggest a router always sends the packet to the final destination Router uses most efficient/shortest/cheapest/best path to the destination; Router (monitors the network and) updates routes/routing table to reflect congestion/failure/network changes; **A.** Congestion management as **BOD** Router modifies the (MAC/hardware) addresses for the next hop // router modifies the (MAC/hardware) addresses to get to the next router; **R.** IP addresses **A.** To remove packets that have no time to live // have reached the maximum hop count **Max 2**	**2**

Qu	Pt	Marking guidance	Total marks
03	1	**Mark is AO2 (apply)** WIGYVMXC; **I.** case	**1**

Qu	Pt	Marking guidance	Total marks
03	2	**Mark is AO1 (understanding)** Each letter/character is always encrypted to the same letter/character; The letters/characters in the ciphertext will have the same frequency as their corresponding letters/characters in the plaintext (allowing the correspondence to be worked out given enough ciphertext); **A.** The ciphertext is susceptible to frequency analysis **NE**. Patterns in the text can be identified The ciphertext will retain structural properties of the plaintext message; **A.** Examples of structural properties, eg some letters frequently occur next to each other, some letters rarely appear next to each other, position of spaces can identify word lengths, common short words can be identified **R.** Susceptible to brute-force cracking techniques **Max 1**	1

Qu	Pt	Marking guidance	Total marks
03	3	**Mark is AO2 (analysis)** There are more (possible) keys; It is not possible to work out how other letters/characters have been encrypted directly from the knowledge of how one letter/character has been encrypted; There is no pattern to the letter replacements; **A.** Letter replacements are not in alphabetical order **A.** Letter replacements in the cipher are random **A.** It is not the case that every letter has the same shift **A.** (Some) letters are shifted by different (**A.** random) amounts **NE.** Letters are encrypted randomly **R.** Each letter has a random key **Note:** “Random” must clearly relate to the letter replacement to award a mark **Max 1**	1

Qu	Pt	Marking guidance	Total marks
03	4	**All marks AO1 (understanding)** The key must be (at least) as long as the data to be encrypted/plaintext; The key must not be reused // key must only be used once; **NE.** one time pad The key must be (truly) random; The key must be kept securely/not revealed/only known by user(s); **A.** The key must be destroyed after use as an alternative to the second or fourth mark points **Max 2**	**2**

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>04</td><td>1</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 both areas indicated in the guidance below and, in each area, there is sufficient detail to show that the student has a good level of understanding.</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 at least one area indicated in the guidance below and some understanding of the other area.</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 one area or some understanding of both 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. There is insufficient evidence of a good level of understanding of either of the two areas.</td><td>1–3</td></tr>
</table>

<u>Guidance – Indicative Content</u>

Area 1: Fetch-Execute Cycle

<u>F-E Stage 1 Fetch:</u>
Contents of Program Counter/PC transferred to Memory Address Register/MAR
R. If implied the instruction is stored in the PC
Address bus used to transfer this address to main memory
Read signal sent along control bus
Transfer of main memory content uses the data bus
Contents of addressed memory location loaded into the Memory Buffer Register/ MBR
Increment (contents of) Program Counter/PC **A**. At any part of fetch process after transferring PC to MAR
Increment Program Counter/PC and fetch instruction simultaneously
Contents of MBR copied to CIR

<u>F-E Stage 2 Decode:</u>
Instruction to decode held by the (Current) Instruction Register/(C)IR
The control unit decodes the instruction
Instruction split into opcode and operand(s)

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

		F-E Stage 3 Execute: If necessary, data is fetched/stored The opcode identifies the type of operation/instruction to be performed (by the processor) The operation (identified by the opcode) is performed by the control unit. ALU used for calculation/comparisons Result (may be) stored in register/main memory **A.** accumulator Status register updated If jump/branch required Program Counter/PC is updated Control bus will transfer signals to other components to initiate/sequence actions *A good level of understanding would be demonstrated by a response that effectively covered all three stages of the cycle and did not focus excessively on one particular stage. There may be omissions, but these would not be of any key points. Any errors made would be minor.* **Area 2: Improving Hardware** Replace the processor with one which has more cores **A.** Increase number of cores Replace the processor with one which has more cache memory // increase the amount of cache memory // add cache memory Increase clock speed of processor // replace the processor with one which runs at a faster clock speed **NE.** faster processor Use a parallel processor architecture // use more processors which can work in parallel Use a processor with a bigger word size Use a processor that makes (better) use of pipelining Install more RAM // main memory // primary memory Use RAM // main memory // primary memory with a faster access time Replace the motherboard with one which has buses which run at a faster clock speed **A.** increase bus clock speed Replace the motherboard with one which has more lines in data bus **A.** increase number of lines in data bus **A.** Replace HDDs with SSDs // replace HDDS with HDDs that can read data at a faster rate // replace SSDS with SSDs that can read data at a faster rate **A.** Use the Harvard architecture instead of the von Neumann architecture *A good level of understanding would be demonstrated by a response that covered a range of hardware improvements that could be made (eg to the processor, buses, main memory) and did not focus excessively on only one component. Explanations of how a change would improve performance could be taken into account when considering how good the understanding is.*	

Qu	Pt	Marking guidance	Total marks
04	2	**1 mark AO1 (knowledge) and one mark AO1 (understanding)** **1 mark (knowledge):** A signal/request sent to the processor (from a hardware device or program); **Max 1 mark (understanding) from:** So that a device/source that needs the (immediate) attention of the processor can be serviced/dealt with // so that an urgent error condition can be serviced/dealt with; **A.** Examples of error conditions that would be likely to generate an interrupt **NE.** To deal with an error, unless stated or clear from example that must be dealt with immediately **NE.** So that a task of higher priority can be carried out So that the currently executing process/task/program can be suspended; **A.** "stopped" as **BOD** **R.** Suspend/stop the fetch-execute cycle/processor **R.** "instruction" for "process"	2

Qu	Pt	Marking guidance	Total marks
05	1	**All marks AO2 (analysis)** Customer(CustomerID, FirstName, LastName, TelephoneNumber) Booking(BookingID, ShowingID, CustomerID) AssignedSeat(BookingID, SeatNumber) **1 mark:** Customer relation created and contains the correct attributes and no others. **1 mark:** Booking relation created and contains the correct attributes and no others (but see accept point below). **A.** Inclusion of NumberOfPeople or NumberOfSeats attribute – must be clear from attribute name that this is a count/quantity **I.** BookingID not included (as ShowingID and CustomerID could be composite entity identifier) **1 mark:** AssignedSeat relation created and contains the entity identifier from the Booking relation, the SeatNumber and optionally AssignedSeatID. **A.** Entity identifier from Booking relation not identified in Booking relation **1 mark** for correct entity identifiers in one or two relations or **2 marks** for correct entity identifiers in all three relations. The correct entity identifiers are: • Customer: CustomerID **R.** composite entity identifier of FirstName and LastName, identifier based on TelephoneNumber • Booking: BookingID // composite entity identifier of ShowingID and CustomerID • AssignedSeat: Composite entity identifier of entity identifier from Booking relation and SeatNumber (**A.** including AssignedSeatID) // AssignedSeatID // ShowingID and SeatNumber **For all mark points** **A.** Spaces in relation and attribute names. **A.** Alternative names for relations and attributes created by candidate, as long as meaning is clear. **R.** Use of incorrect attribute names for attributes already used in relations defined on the question paper. **I.** Any representation for foreign keys. **Accept responses written in SQL – ignore syntactical errors and data type errors in such responses.**	5

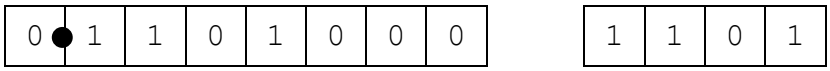
Qu	Pt	Marking guidance	Total marks
05	2	**All marks AO2 (analysis)** The `Film` table should not be included // only the `Showing` table should be included; The date is missing quotation marks/hashes/delimiters; **A.** An asterisk / list of attributes is missing after `DELETE` **NE.** Not specified what to delete **Max 2**	2

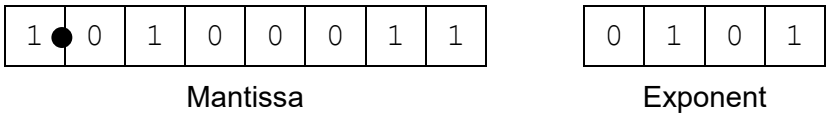
Qu	Pt	Marking guidance	Total marks
05	3	**1 mark AO2 (analysis) and 1 mark AO1 (understanding)** **1 mark AO2 (analysis):** There might already be bookings for (a showing/showing on) this date; **A.** "There might already be bookings for these showings" without date reference **R.** "There might already be bookings for a/the showing" without date reference **1 mark AO1 (understanding):** The database would prevent the query from running as there would be records in the bookings table that referenced showings that no longer existed // if executed the query could leave records/bookings (in the bookings table) that referenced showings that no longer existed // there will be ShowingIDs that reference showings that do not exist; **A.** The foreign key rules might be violated **A.** Referential integrity rules might be violated **A.** Any bookings for the showings would also need to be deleted **Award both marks if stated that all bookings for the 29th March would also need to be deleted**	2

Qu	Pt	Marking guidance	Total marks
05	4	**Mark is AO1 (understanding)** Each resource is represented by a URL; Entering a URL causes the server to (use CRUD to) retrieve (the relevant) data; **A.** Used to carry out a search **A.** To access a database/resource/dataset URLs are sent between the client and the server using HTTP; **Max 1**	1

Qu	Pt	Marking guidance	Total marks
05	5	**Mark is AO1 (knowledge)** **B**; (GET→SELECT, POST→INSERT, DELETE→DELETE, PUT→UPDATE) **R.** If more than one lozenge shaded	1

Qu	Pt	Marking guidance	Total marks
05	6	**All marks AO1 (understanding)** More compact; **A.** facilitates faster transmission, smaller file size, uses less memory Quicker (**A.** easier) to parse; Structure understood directly in some languages (eg JavaScript); (Native) support for arrays; Easier <u>for humans</u> to read/write/understand; **Max 2**	2

Qu	Pt	Marking guidance	Total marks
06	1	**All marks AO2 (apply)**  Mantissa Exponent Award **2 marks** for correct answer: 0.1015625 // 13/128 **A.** Rounded to at least 4 dp (eg 0.1016) 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 = –3) • showing binary point shifted 3 places to left in binary number • indicating that final answer has been calculated using answer = mantissa × $2^{exponent}$ and used either the correct mantissa, the correct exponent, or both in this calculation.	2

Qu	Pt	Marking guidance	Total marks
06	2	**All marks AO2 (apply)** Award **3 marks** for correct answer:  If answer is incorrect then award **up to 2 method marks**, one for each point from this list: • correct (unsigned) fixed point representation of 23.25 in binary: 10111.01; **A.** leading 0s and trailing 0s • correct fixed point representation of –23.25 in binary: 101000.11; **A.** leading 1s and trailing 0s • showing the correct value of the exponent in decimal (5) or binary (101) in the working space or in binary in the final answer box // showing the binary point being shifted 5 places left; • showing the correct value of the mantissa in binary in the working space or final answer box.	3

Qu	Pt	Marking guidance	Total marks
06	3	**All marks AO1 (knowledge)** **1 mark** for two types of error correctly identified or **2 marks** for all three types of error correctly identified. **Situation** / **Type of error** A calculation is performed and the result of the calculation is so close to zero that the number that is stored is zero. / Underflow A calculation is performed and the result of the calculation is too large to fit in the available number of bits. / Overflow **R.** stack overflow A decimal value is converted to floating point but it cannot be represented exactly in the available number of bits. / Rounding **A.** truncation	2

Qu	Pt	Marking guidance	Total marks
06	4	**Mark is AO1 (understanding)** Move a/some bit(s) from the exponent to the mantissa; **A.** Increase number of bits in mantissa and reduce number of bits in exponent **A.** Examples in which mantissa has more than 8 bits and total number of bits in mantissa and exponent sums to 12 **NE.** Add more bits to the mantissa **NE.** Make the mantissa larger and the exponent smaller Use an implicit bit in the mantissa // do not store one of the bits on either side of the binary point as the value of the bit on one side of it can be inferred from // is the opposite of the value of the bit on the other side of it; **R.** use fixed point **Max 1**	1

Qu	Pt	Marking guidance	Total marks
07	1	**Mark is AO2 (apply)** Award **1 mark** for correct value in `R0`: `R1` 0 1 0 0 0 1 1 0 `15` 0 0 0 0 1 1 1 1 `R0` 0 0 0 0 0 1 1 0 **R.** Any cells of `R0` left empty	1

Qu	Pt	Marking guidance	Total marks
07	2	**Mark is AO2 (apply)** Award **1 mark** for correct value in `R0`: `R1` 0 0 0 0 0 1 1 0 `48` 0 0 1 1 0 0 0 0 `R0` 0 0 1 1 0 1 1 0 **R.** Any cells of `R0` left empty	1

Qu	Pt	Marking guidance	Total marks
07	3	**4 marks AO2 (analysis) and 6 marks AO3 (programming)** **6 marks AO3 (programming syntax must be correct):** *MP1:* Value in memory location 100 is loaded into a register; *MP2:* After some manipulation has been carried out (whether correct or not) values are stored into memory locations 101 and 102 (do not award if it is the same value stored twice); *MP3:* Binary pattern of one digit correctly isolated from the input value (for leftmost digit must also be shifted so bits in correct place); *MP4:* Binary pattern of one digit correctly translated into ASCII for one of numeric digits **or** letter digits (ignore if the pattern is later changed again to be incorrect); *MP5:* Binary pattern of one digit correctly translated into ASCII for both numeric digits **and** letter digits (ignore if the pattern is later changed again to be incorrect); *MP6:* Conversion process fully working for the both digits (ASCII codes must be correct when program terminates); **Note:** If MP3 not awarded MP4, MP5, MP6 cannot be awarded **A.** Any understandable method for identifying labels **DPT.** Use of invalid register names eg R27, Rn **DPT.** Use of binary for immediate operand values **DPT.** Omission of # to indicate immediate operand values **DPT.** R before memory address eg R100 **DPT.** Use of MOV instead of LDR or STR, or vice-versa **DPT**. Repeated use of incorrect delimiters eg ; < > . “ ‘ (occasional errors can be ignored) **4 marks AO2 (concept must be understood, syntax need not be correct):** *MP7:* Attempt to use masking **and/or** shifting to identify one digit; *MP8:* Attempt to use masking **and/or** shifting a second time to identify the second digit; *MP9:* Attempt to use comparison and branching to make program treat numeric digits and letter digits differently for at least one of the two digits (whether threshold values correct or not); *MP10:* Use of addition or masking to attempt to convert a digit to an ASCII code (whether correct ASCII codes produced or not); **Note:** If MP3 not awarded MP10 cannot be awarded **Max 9 if solution not fully working**	**10**

Example Solution 1

```
        LDR R0, 100             MP1
        AND R2, R0, #15         MP7, MP3
        CMP R2, #10
        BLT isnumber            MP9
        ADD R2, R2, #55         MP10, MP4
        B doleftdigit
isnumber:
        ADD R2, R2, #48         MP5
doleftdigit:
        AND R1, R0, #240        MP8
        LSR R1, R1, #4
        CMP R1, #10
        BLT isnumber2
        ADD R1, R1, #55
        B storetomemory
isnumber2:
        ADD R1, R1, #48         MP6
storetomemory:
        STR R1, 101
        STR R2, 102             MP2
```

Example Solution 2

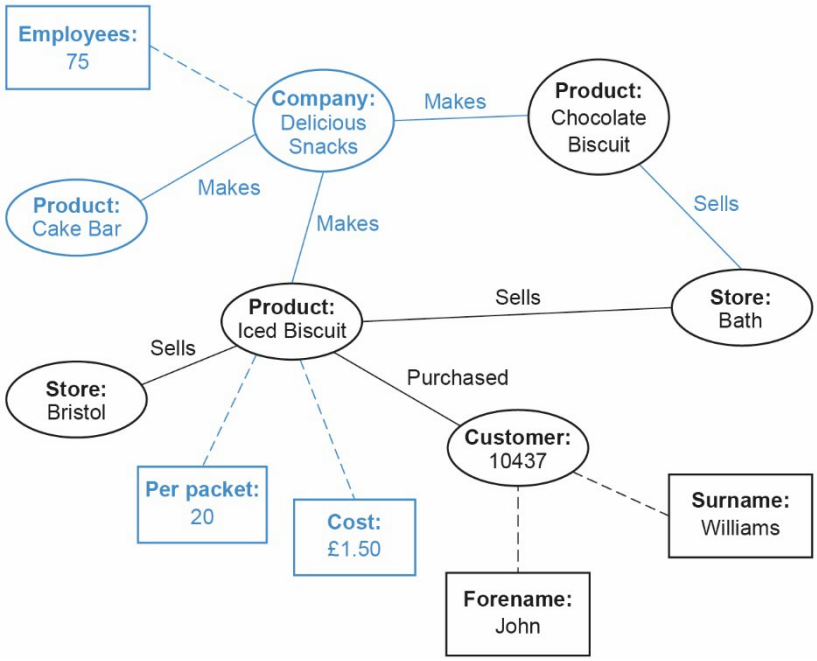
```
        LDR R0, 100             MP1
        AND R0, R0, #15         MP7, MP3
        CMP R0, #9
        BGT isletter            MP9
        ORR R0, R0, #48         MP10, MP4
        B doleftdigit
isletter:
        SUB R0, R0, #9
        ORR R0, R0, #64         MP5
doleftdigit:
        STR R0, 102
        LDR R0, 100
        LSR R0, R0, #4          MP8
        AND R0, R0, #15
        CMP R0, #9
        BGT isletter2
        ORR R0, R0, #48
        B finish
isletter2:
        SUB R0, R0, #9
        ORR R0, R0, #64         MP6
finish:
        STR R0, 101             MP2
```

Example Solution 3

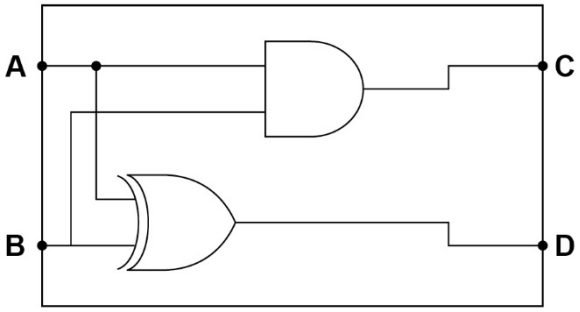
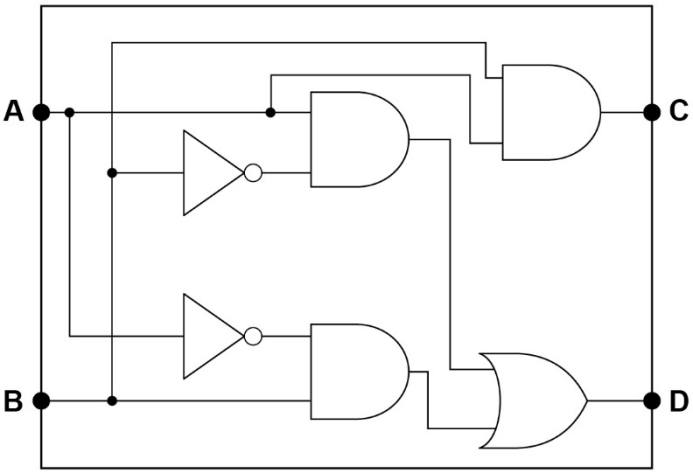
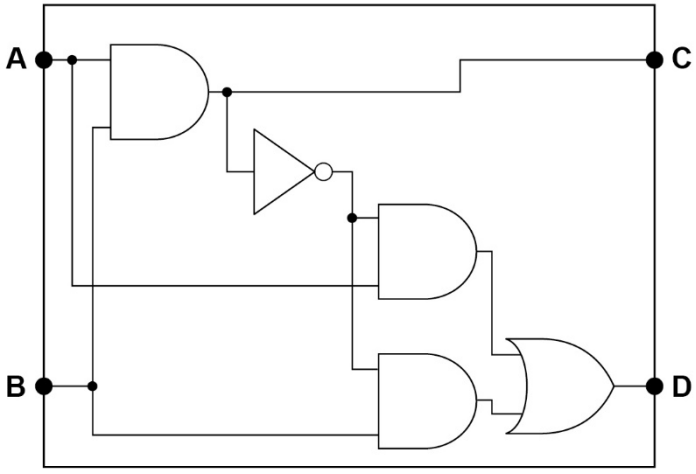
```
        LDR R1, 100             MP1
        LSR R2, R1, #4          MP7, MP3
        LSL R1, R1, #4
        LSR R2, R1, #4          MP8
        CMP R2, #10
        BLT number              MP9
        ADD R2, R2, #7          MP10
number:
        ADD R2, R2, #48         MP4, MP5
        STR R2, 101
        CMP R2, #10
        BLT number2
        ADD R2, R2, #7
number2:
        ADD R2, R2, #48         MP6
        STR R2, 102             MP2
```

Qu	Pt	Marking guidance	Total marks
08	1	**Mark is AO1 (knowledge)** The data is generated/received/must be processed/responded to at high velocity/very quickly; **NE.** "velocity" on its own. **NE.** High velocity of data **NE.** Speed data transmitted/sent at **A.** "changed", "modified" or similar instead of "processed" but **NE.** accessed **A.** An example of what very quickly would be eg milliseconds, but not a long time period eg seconds **A.** Instantly/immediately for very quickly as **BOD**	1

Qu	Pt	Marking guidance	Total marks
08	2	**All marks AO2 (analysis)** **1 mark** for representing "The Bath store sells chocolate biscuits" with a solid line joining the store and product labelled "Sells". **A.** Alternative labels which clearly have the same meaning eg "Stocks" **A.** Use of directed arrow **1 mark** for representing "There are 20 individual biscuits in a packet of iced biscuits and each packet costs £1.50" by drawing rectangular boxes containing this data, connected to the Iced Biscuits with dashed lines. **R.** Both pieces of data in in one box **1 mark** for representing "Both chocolate biscuits and iced biscuits are made by the company Delicious Snacks. The company has 75 employees and also makes cake bars." by: • adding an oval for the company Delicious Snacks • connecting a rectangle to the company oval by dashed lines indicating the number of employees • adding an oval for the new product Cake Bar • linking the oval for the company to all three products using solid lines and giving these an appropriate label eg "makes". **A.** Alternative labels which clearly have the same meaning eg "Manufactures" **A.** Use of directed arrows **I.** Incorrect spelling as long as meaning is clear. **DPT.** Use of incorrect line styles (solid/dashed) **DPT.** Wrong shapes used for rectangles and ovals **DPT.** Missing labels on lines **DPT.** Labels on dashed lines	3

		An example fully correct diagram is shown below:  	

Qu	Pt	Marking guidance	Total marks
08	3	**All marks AO1 (understanding)** Immutable data structures // the state of a data structure cannot be changed (after creation); Statelessness // functions do not have side-effects // all functions are pure; Functions can be distributed to servers and executed on data sets then the results can be combined // map-reduce; Higher-order functions can compose the results of processing on multiple processors/cores // functions are first-class objects; The order of execution can be determined at run-time // the order of execution can be determined by the translator/compiler/interpreter (**A.** language) // the order of execution is not defined by the program code // programs are not a sequence of instructions that must be followed in a specific order; **NE.** Suitable for parallel processing **Max 2**	**2**

Qu	Pt	Marking guidance	Total marks
09	1	**All marks AO2 (apply)** **1 mark:** Output C is correct for all inputs **1 mark:** Output D is correct for all inputs **1 mark:** Circuit is fully correct and uses exactly two gates **Example Circuits** **3 mark solution:**  **2 mark solution:**  **2 mark solution: b**  	3

Qu	Pt	Marking guidance	Total marks
09	2	**Mark is AO2 (analysis)** It adds two bits (**A.** numbers) together // it is a half adder; **A**. it is an adder as BOD, it performs addition **R.** it is a full adder	1

Qu	Pt	Marking guidance	Total marks
09	3	**All marks AO2 (apply)** **Marking guidance for examiners** • Award marks for working out until an incorrect step has been made. • Ignore missing steps from the example solutions, as long as the jumps between steps are logically correct. • If, in any one step, a candidate is simplifying different parts of an expression simultaneously and makes an error, award marks for the correctly simplified part(s) and then stop marking. **1 mark** for final answer: A **3 marks** for working. Award up to **three marks** for applying each one of the three techniques (**one mark** per application, multiple marks can be awarded for using the same technique more than once): • a successful application of De Morgan's Law (and any associated cancellation of NOTs) that produces a simpler expression – award 2 marks if De Morgan's Law applied twice simultaneously • applying an identity other than cancelling NOTs that produces a simpler expression • successfully expanding brackets // factorising. **Note:** A simpler expression is one that is logically equivalent to the original expression but uses fewer logical operators. **Max 2** for working if there is no successful application of De Morgan. **Max 3** overall if any incorrect working **Example Solution 1** $\mathrm{A} \cdot \overline{\mathrm{B}} + \mathrm{B} \cdot (\overline{\overline{\mathrm{A}} + (\overline{\mathrm{B}} \cdot \mathrm{C})})$ $\mathrm{A} \cdot \overline{\mathrm{B}} + \mathrm{B} \cdot \mathrm{A} \cdot \overline{\overline{\mathrm{B}} \cdot \mathrm{C}}$ Application of De Morgan $\mathrm{A} \cdot (\overline{\mathrm{B}} + \mathrm{B} \cdot \overline{\overline{\mathrm{B}} \cdot \mathrm{C}})$ Factorising $\mathrm{A} \cdot (\overline{\mathrm{B}} + \mathrm{B} \cdot (\mathrm{B} + \overline{\mathrm{C}}))$ Application of De Morgan $\mathrm{A} \cdot (\overline{\mathrm{B}} + \mathrm{B} \cdot \mathrm{B} + \mathrm{B} \cdot \overline{\mathrm{C}})$ Expand brackets $\mathrm{A} \cdot (\overline{\mathrm{B}} + \mathrm{B} + \mathrm{B} \cdot \overline{\mathrm{C}})$ By $X \cdot X = X$ $\mathrm{A} \cdot (1 + \mathrm{B} \cdot \overline{\mathrm{C}})$ By $X + \overline{X} = 1$ $\mathrm{A} \cdot 1$ By $X + 1 = 1$ A By $X \cdot 1 = X$	4

Example Solution 2

$A \cdot \overline{B} + B \cdot (\overline{\overline{A} + (\overline{B} \cdot C)})$	
$A \cdot \overline{B} + B \cdot (\overline{\overline{A} + \overline{(\overline{B} + \overline{C})}})$	Application of De Morgan
$A \cdot \overline{B} + B \cdot A \cdot (B + \overline{C})$	Application of De Morgan
$A \cdot \overline{B} + B \cdot A \cdot B + B \cdot A \cdot \overline{C}$	Expand brackets
$A \cdot \overline{B} + A \cdot B + B \cdot A \cdot \overline{C}$	By $X \cdot X = X$
$A \cdot (\overline{B} + B) + B \cdot A \cdot \overline{C}$	Factorising partially
$A \cdot 1 + B \cdot A \cdot \overline{C}$	By $X + \overline{X} = 1$
$A + B \cdot A \cdot \overline{C}$	By $X \cdot 1 = X$
A	By $X + (X \cdot Y) = X$

Example Solution 3

$A \cdot \overline{B} + B \cdot (\overline{\overline{A} + (\overline{B} \cdot C)})$	
$A \cdot \overline{B} + B \cdot (\overline{\overline{A} + \overline{(\overline{B} + \overline{C})}})$	Application of De Morgan
$A \cdot \overline{B} + B \cdot A \cdot (B + \overline{C})$	Application of De Morgan
$A \cdot (\overline{B} + B \cdot (B + \overline{C}))$	Factorising
$A \cdot (\overline{B} + B \cdot B + B \cdot \overline{C})$	Expanding brackets
$A \cdot (\overline{B} + B + B \cdot \overline{C})$	By $X \cdot X = X$
$A \cdot (1 + B \cdot \overline{C})$	By $X + \overline{X} = 1$
$A \cdot 1$	By $X + 1 = 1$
A	By $X \cdot 1 = X$

Example Solution 4

$A \cdot \overline{B} + B \cdot (\overline{\overline{A} + (\overline{B} \cdot C)})$	
$A \cdot \overline{B} + B \cdot (\overline{\overline{A} + \overline{(\overline{B} + \overline{C})}})$	Application of De Morgan
$A \cdot \overline{B} + B \cdot A \cdot (B + \overline{C})$	Application of De Morgan
$A \cdot \overline{B} + B \cdot A \cdot B + B \cdot A \cdot \overline{C}$	Expand brackets
$A \cdot \overline{B} + B \cdot A + B \cdot A \cdot \overline{C}$	By $X \cdot X = X$
$A \cdot \overline{B} + B \cdot A$	By $X + (X \cdot Y) = X$
$A \cdot (\overline{B} + B)$	Factorising
$A \cdot 1$	By $X + \overline{X} = 1$
A	By $X \cdot 1 = X$

Qu	Pt	Marking guidance	Total marks
10	1	**Mark is AO2 (analysis)** 2; **A.** Number not stated but identified that 4 and 5 are the valid patterns **I.** Incorrect patterns stated if correct answer 2 given	1

Qu	Pt	Marking guidance	Total marks
10	2	**Mark is AO1 (understanding)** Receiver and transmitter (continuously) synchronised by a common clock // timing information transmitted within/alongside the data // receiver and transmitter clocks are (continuously) synchronised; **A.** Both devices synchronised by same clock **NE.** Receiver and transmitter are synchronised **NE.** Transmission synchronised to a clock signal	1

Qu	Pt	Marking guidance	Total marks
10	3	**Mark is AO1 (understanding)** Errors that change an even number of bits (**A.** two bits) cannot be detected; **R.** multi-bit errors cannot be identified (Errors can be detected but) errors cannot be corrected; **A.** Position of errors cannot be identified **Max 1**	1

Qu	Pt	Marking guidance	Total marks
10	4	**Mark is AO1 (knowledge)** **A**; (Line A) **R.** If more than one lozenge shaded	1

Qu	Pt	Marking guidance	Total marks

11	1	**All marks AO1 (understanding)**
		
		Establish an end-to-end connection (between email servers);
		A. end-to-end path
		NE. virtual path, virtual circuit
		
		Perform error detection // correction // request that corrupted segments (**A.** packets, data) are resent // add error detection/correction information to the data // sending acknowledgement packets // ensuring packets are delivered;
		A. Add checksum/CRC to data
		
		(Use the port number to) pass the data on to the correct // email server application software in the application layer (when it is received) // add port number (to segment to identify the application to associate with the data);
		A. socket for port number as BOD
		
		Split data up into segments (and adds header information) // assembles segments in correct order to rebuild message // adds segment numbers;
		A. "packets", "frames", "datagrams" for segments
		
		Perform flow control // matches speed of sender and receiver;
		
		Manage congestion;
		
		Max 3
			3

Qu	Pt	Marking guidance	Total marks
11	2	**Mark is AO1 (understanding)** Protocol conversion;	1

<table>
<tr><th>Qu</th><th>Pt</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>11</td><td>3</td><td>
2 marks AO1 (knowledge) and 2 marks AO1 (understanding)

Award 1 mark for each correctly named protocol, up to a maximum of 2 marks and 1 mark for each correct explanation of what a protocol will be used for, if linked to the correct protocol.

<table>
<tr><th>Protocol (knowledge)for</th><th>Purpose (understanding)</th></tr>
<tr><td>SMTP // Simple Mail Transfer Protocol</td><td>To send/transmit/receive email (to/from another email server/client).</td></tr>
<tr><td>POP(3) // Post Office Protocol (3)</td><td>(So that clients can) retrieve emails on the server.
R. Sending emails
A. Receiving emails as BOD but R. Receiving emails if answer suggests that this is done as the email is sent.</td></tr>
<tr><td>IMAP // Internet Message Access Protocol</td><td>(So that clients can) retrieve/manage emails on the server.
R. Sending emails
A. Receiving emails as BOD but R. Receiving emails if answer suggests that this is done as the email is sent.</td></tr>
<tr><td>HTTP/HTTPS</td><td>So users can access email via the web/a web browser.</td></tr>
</table>

A. If correct initialism used but then the full term is incorrect eg “SMTP – Special Mail Transfer Protocol” as BOD
A. Other protocols that achieve the same purposes as those listed above
R. Non-application layer protocols eg TCP, IP

Note: Marks can be awarded for both IMAP and POP(3) protocol names, but to award the mark for purpose, two marks can only be given for the purpose of IMAP and POP(3) if the purposes given are different.
</td><td>4</td></tr>
</table>

Qu	Pt	Marking guidance	Total marks
11	4	**1 mark AO1 (knowledge) and 1 mark AO1 (understanding)** **What is (knowledge):** A (reserved) port (number) that has a specific purpose // a port that has a reserved number // a port assigned by the Internet Assigned Numbers Authority (IANA); **Why used (understanding):** The communication is initiated by the sender/client (therefore the port number must be the same for all initial email communications);	2

<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>

All marks AO1 (understanding)

<table>
<tr><th>Level</th><th>Description</th><th>Mark Range</th></tr>
<tr><td>3</td><td>The description is comprehensive and covers both transmission and reception. At least three of the keys to use for particular processes have been correctly identified. Whilst there may be some omissions, any errors are minor.</td><td>5–6</td></tr>
<tr><td>2</td><td>A significant amount of the process has been described but there may be some misunderstandings and/or omissions. At least two of the keys to use for particular processes have been correctly identified. The description might cover only transmission or reception.</td><td>3–4</td></tr>
<tr><td>1</td><td>A few relevant points have been made but the description contains significant omissions or misunderstandings.</td><td>1–2</td></tr>
</table>

<u>Guidance – Indicative Content</u>

Transmission

- A message digest/(hash) value is calculated from the message contents.
- The message digest/(hash) value is encrypted using A’s private key.
- The encrypted message digest/(hash) value is known as the digital signature.
- The digital signature (**A.** hash) is appended to the message.
- The message (and signature) are encrypted using B’s public key.

Note: Signature can be appended to message before or after encryption with B’s public key takes place.

Reception

- B’s private key is used to decrypt the message (and signature).
- The message is rehashed // a new message digest/hash is calculated from the message.
- A’s public key is used to decrypt the digital signature (to produce the received message digest).
- If received message digest and recalculated message digest match/if both hashes match then the sender can be authenticated/then B knows that A sent the message.
  A. If recalculated hash matches digital signature then B knows A sent message, if third point not awarded.
  NE. If hashes match then B knows message has not been tampered with

A. “data” for message
A. “checksum”, “hash”, “digest” as synonyms
A. “encrypted hash” or “encrypted digest” for signature
R. More than one key referenced for any process that involves just one key

</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>12</td><td>1</td><td>All marks AO2 (analysis)

<table>
<tr><th>Call number</th><th>Argument</th><th>Value returned</th></tr>
<tr><td>1</td><td>[4, 2, 5, 3]</td><td>52</td></tr>
<tr><td>2</td><td>[2, 5, 3]</td><td>24</td></tr>
<tr><td>3</td><td>[5, 3]</td><td>11</td></tr>
<tr><td>4</td><td>[3]</td><td>3</td></tr>
<tr><td>5</td><td>[]</td><td>0</td></tr>
</table>

1 mark: Argument column contains the following three values in order:
• [2, 5, 3]
• [5, 3]
• [3]
A. Destructuring argument to 2:[5, 3], 5:[3], 3:[]
R. Missing brackets

1 mark: Bottom row of table has Argument as [ ] and Value returned as 0
A. Argument column empty as BOD

1 mark: Value returned column contains 52, 24, 11, 3 in order
I. Working shown in column</td><td>3</td></tr>
</table>

Qu	Pt	Marking guidance	Total marks
12	2	**Mark is AO2 (analysis)** **A**; (The set of integers) **R.** if more than one lozenge shaded	1