OXFORD AQA
INTERNATIONAL QUALIFICATIONS

INTERNATIONAL A-LEVEL
COMPUTER SCIENCE
CS04

Unit 4 Advanced concepts and principles of computer science

Mark scheme

Specimen

Version: 1.0 Final

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 oxfordaqaexams.org.uk

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How to mark

Aims

When you are marking your allocation of scripts your main aims should be to:

- recognise and identify the achievements of students
- where relevant, place students in the appropriate mark band and in the appropriate part of that mark band (high, low, middle) for **each** assessment objective
- record your judgements with brief notes, annotations and comments that are relevant to the mark scheme and make it clear to other associates how you have arrived at the numerical mark awarded for each assessment objective
- ensure comparability of assessment for all students, regardless of question or examiner.

Approach

It is important to be **open minded** and **positive** when marking scripts.

The specification recognises the variety of experiences and knowledge that students will have. It encourages them to study computer science in a way that is relevant to them. The questions have been designed to give them opportunities to discuss what they have found out about computer science. It is important to assess the quality of **what the student offers**.

Do not mark scripts based on the answer **you** would have written. The mark schemes have been composed to assess **quality of response** and not to identify expected items of knowledge.

Assessment Objectives

This component requires students to:

AO1: Demonstrate knowledge and understand 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.

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 student, if repeated, could result in the student failing to achieve multiple marks. The **DPT** label indicates that this mistake should result in a student not achieving only 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.

Question	Part	Marking guidance	Total marks
01	1	Multiple bits transmitted simultaneously / at same time; **NE.** data, values etc for bits Each (simultaneously transmitted) bit is sent down a different wire / cable / path / line; **A.** multiple wires / cables / paths / lines used for transmission	**2** **AO1 = 2**

Question	Part	Marking guidance	Total marks
01	2	The hardware / wiring required for serial data transmission is cheaper; **NE.** cheaper without reference to hardware or wiring Serial transmission does not suffer from crosstalk // (two) bits cannot interfere with each other because they are not sent simultaneously; Serial transmission does not suffer from data skewing // bits transmitted are guaranteed to arrive in the order they were sent; **NE.** more reliable, lower probability of interference / corruption Serial transmission can be used over longer distances; **Max 1**	**1** **AO1 = 1**

Question	Part	Marking guidance	Total marks
01	3	**B** Latency is the rate at which signals on a wire or line can change; **R.** if more than one lozenge shaded	**1** **AO1 = 1**

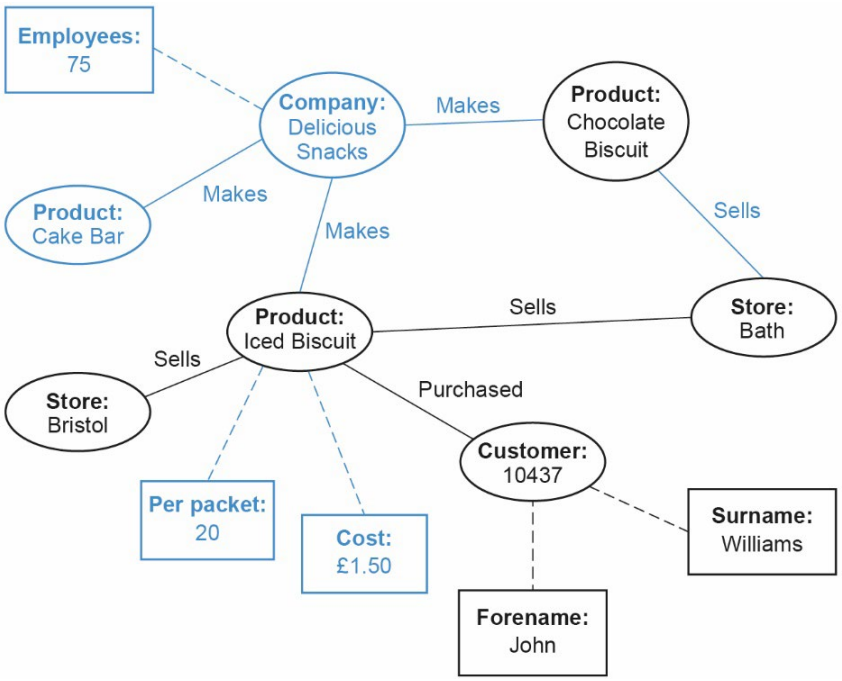
Question	Part	Marking guidance	Total marks
01	4	Start the receiver clock ticking; **A.** to wake up the receiver Synchronise the clock in the receiver to the transmitter clock // bring the clock in the receiver into phase with the clock in the transmitter; **A.** to synchronise the receiver and transmitter clocks **A.** synchronise the clocks in the devices	**1** **AO1 = 1**

		NE. synchronise the (two) clocks **R.** indicates start of transmission **Max 1**	

Question	Part	Marking guidance	Total marks
01	**5**	Allows the (next) start bit to be recognised; Provides time for the receiver to process / transfer the received data; **NE.** indicates that the received data can be processed **R.** indicates end of transmission **R.** indicates clocks no longer need to be synchronised **Max 1**	**1** **AO1 = 1**

Question	Part	Marking guidance	Total marks
02	**1**	The data is generated/received/must be processed/responded to at high velocity/<u>very</u> 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** **AO1 = 1**

Question	Part	Marking guidance	Total marks
02	**2**	**1 mark** for representing "The Bath store sells chocolate biscuits" with a <u>solid line</u> 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 <u>rectangular boxes</u> containing this data, connected to the Iced Biscuits with <u>dashed lines</u>. **R.** Both pieces of data in in one box	**3** **AO2 = 3**

		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 An example fully correct diagram is shown below: 	

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>03</td><td>1</td><td>
Award 1 mark for each pair of measure and how it is effective.

Do not award marks for both rows 1 and 2.

<table>
<tr><th></th><th>Measure</th><th>How Makes Effective</th></tr>
<tr><td>1</td><td>Use WPA (WiFi Protected Access)/WPA2 (A. WEP)
NE. use of password</td><td>To encrypt transmission // so that if intercepted transmissions cannot be understood/read by someone who does not have the key / by an unauthorised person</td></tr>
<tr><td>2</td><td>Encrypt transmissions</td><td>So that if intercepted cannot be understood/read by someone who does not have the key / by an unauthorised person</td></tr>
<tr><td>3</td><td>Disable broadcast of SSID (Service Set Identifier)</td><td>So that the network is harder to discover // so that you must know the SSID to connect</td></tr>
<tr><td>4</td><td>Use a MAC address white list A. “Hardware” for “MAC”
NE. whitelist without reference to MAC addresses</td><td>So that only devices with a known address // address on the list can connect</td></tr>
</table>

Max 2
</td><td>2

AO1 = 2</td></tr>
</table>

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>03</td><td>2</td><td>
<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>
• WAP responds (to RTS) with a Clear to Send / CTS signal. A. router, receiver for “WAP”
• 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>
</td><td>6

AO1 = 6</td></tr>
</table>

		• 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.
		• Collisions cannot be detected by transmitter.	

Question	Part	Marking guidance	Total marks
04	1	The problem can be solved // algorithm exists for problem (that will run); In polynomial time (or better);	2 AO1 = 2

Question	Part	Marking guidance	Total marks
04	2	Use of heuristic // use an algorithm that makes a guess/estimate based on experience; That provides a close-to-optimal solution/approximation // that only works in some cases; **A.** non-optimal Example of heuristic method e.g. hill-climbing/stochastic/local improvement/greedy algorithms/simulated annealing/trial and error/any reasonable example; Relax some of the constraints on the solution; **A.** solve simpler version of problem **A.** limit size of input **Max 2**	2 AO1 = 2

Question	Part	Marking guidance	Total marks
04	3	**A** The Halting problem; **R.** if more than one lozenge shaded	1 AO1 = 1

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>05</td><td>1</td><td>
1 mark for two or three correct responses OR
2 marks for four correct responses

<table>
<tr><th>Construct</th><th>Example</th><th>Valid?</th></tr>
<tr><td>identifier</td><td><code>Player2name</code></td><td>No;</td></tr>
<tr><td>parameter</td><td><code>x,y:bool</code></td><td>Yes;</td></tr>
<tr><td>procedure-def</td><td><code>procedure square(s:real)</code></td><td>No;</td></tr>
<tr><td>procedure-def</td><td><code>procedure rect(w:int,h:int)</code></td><td>No;</td></tr>
</table>

A. alternative clear indicators of Yes/No such as Y/N, True/False and Tick/Cross.
</td><td>2

AO2 = 2</td></tr>
</table>

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>05</td><td>2</td><td>
The <code><type></code> rule has an extra type <code>char</code>;
The <code><procedure-def></code> rule does not allow a procedure without parameters // cannot be just an identifier;

Accept answers comparing the figures the other way around, ie:

• the type rule does not allow a char
• a procedure does not have to have parameters / can be just an identifier.
</td><td>2

AO2 = 2</td></tr>
</table>

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>05</td><td>3</td><td>
Required as there can be a list of parameters // required as there can be more than one parameter;

BNF does not support iteration // BNF can only achieve iteration through recursion // would need infinite number of rules otherwise // recursion allows for more than one parameter;

Max 1

A. Input for parameter
NE. Rule needs to loop
</td><td>1

AO1 = 1</td></tr>
</table>

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>06</td><td>1</td><td>1 mark for two or three keys correctly named.
2 marks for all four keys correctly named.

<table><tr><th>Label</th><th>Key Name</th></tr><tr><td>❶</td><td>A's Private Key</td></tr><tr><td>❷</td><td>B's Public Key</td></tr><tr><td>❸</td><td>B's Private Key</td></tr><tr><td>❹</td><td>A's Public Key</td></tr></table>
A. “Sender” for “A” and “Recipient” for “B” (or similar role descriptions)
Allow use of same key name more than once and mark correct in the position it is correct (if any).</td><td>2

AO1 = 2</td></tr>
</table>

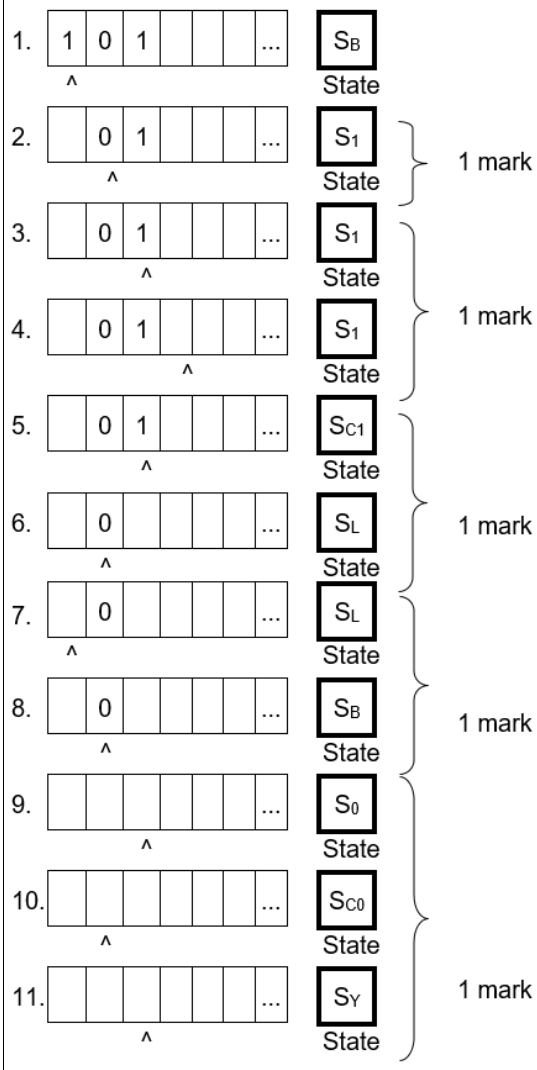
<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>06</td><td>2</td><td>Two (message) digests are compared // received and recalculated digests compared;
A. “They” for the two message digests
A. “Hash” for “digest”
R. Two messages are compared</td><td>1

AO1 = 1</td></tr>
</table>

<table>
<tr><th>Question</th><th>Part</th><th>Marking guidance</th><th>Total marks</th></tr>
<tr><td>06</td><td>3</td><td>To authenticate/confirm identity of sender // to confirm that message was sent by A;
A. Ensures person is who they say they are
NE. Identify the sender (must be clear that the signature confirms this identity), know who the sender is

To detect if message has been tampered with/changed;
NE. Prevent the message being tampered with</td><td>2

AO1 = 2</td></tr>
</table>

Question	Part	Marking guidance	Total marks
07	1	One mark per bracketed section.  **Must have correct tape contents and state for each mark** **A.** blank symbols instead of empty cells **DPT** If the read/write head is not drawn on some rows, this should result in the loss of the mark on the first occasion that it is missing only. Marks should be awarded for subsequent rows, even if the read/write head is not drawn.	**5** **AO2 = 5**

Question	Part	Marking guidance	Total marks
07	2	(After a 0 has been read,) the rules keep moving the read/write head to the right (preserving the contents of the tape); Until a blank symbol is encountered / the end of the number is reached, then the state is changed to S_{C0} (and the head is moved left/direction reversed); **Note:** To achieve the first mark, it must be clear that the head moves right regardless of whether a 0 or 1 is read and also that this is a repeated process ie not just moving one place right. **Note:** If it is stated that the process of moving continues until the end of the number is reached, then it can be inferred that the head was moving right for the first mark, if this was not explicitly stated. **Note:** Marks should not be awarded for just explaining what the rules do individually.	**2** **AO2 = 2**

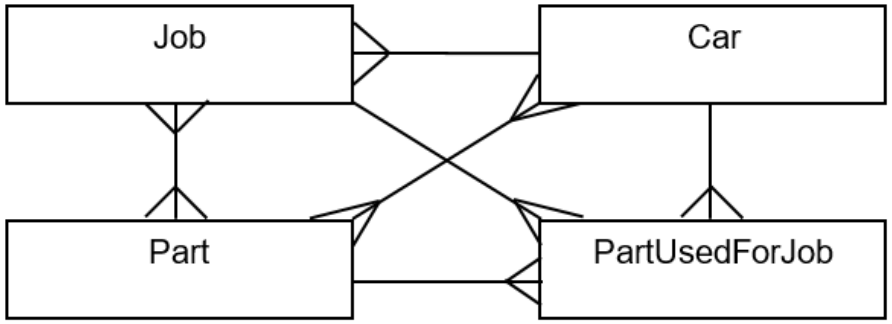
Question	Part	Marking guidance	Total marks
07	3	It reads instructions one at a time // reads instructions in sequence // deals with instructions line by line; And executes these instructions; Instructions are / transition function is stored on the tape; **A.** "rules" for "instructions" **Max 2**	**2** **AO1 = 2**

Question	Part	Marking guidance	Total marks
08		**Purpose (1 mark):** To automate the configuration of hosts connecting to a (TCP/IP) network // to allocate IP addresses/subnet mask/default gateway to hosts; **A.** “computer” or suitable alternative term for “host” **Why used (1 mark):** Reduces the need for expert knowledge when configuring a host // reduces the time required to configure hosts // facilitates efficient use of a limited pool of IP addresses // avoids errors with a relevant example such as duplicating IP addresses or programming incorrect subnet mask; **A.** enables reuse of IP addresses **NE.** “avoiding errors” without an example **Contents of communication (max 2 marks):** 1. Host sends request to discover a (DHCP) server; **A.** host sends request for configuration	**4** **AO1 = 4**

		2. (DHCP) server(s) offer configuration to host; **NE.** server gives IP address to host 3. Host accepts offer of configuration from (a DHCP) server (by echoing the accepted configuration back to the server); 4. (DHCP) server confirms that configuration has been allocated to host; **A.** "IP Address" for "configuration" but **N.E.** "subnet mask", "default gateway" for this mark point **Award one mark for any one correct point OR two marks for any two correct points, made in the correct order.**	

Question	Part	Marking guidance	Total marks
09	**1**	CarRegNo and JobDate; **A.** Just both these attribute names written with no further explanation **R.** "CarRegNo or JobDate"	**1** **AO2 = 1**

Question	Part	Marking guidance	Total marks
09	**2**	**AO2 – 1 mark:** A person may own more than one car // a person may bring different cars to the garage; It might be desired to store details of an owner when the car they own is not yet known; **A.** A car might be owned by more than one person (at different times) **A.** Easier to transfer car from one owner to another **AO1 – 1 mark:** Avoid storing owner details once for each car they own / multiple times; Avoid having to input owner details once for each car they own; To transfer car between owners would only have to change one attribute in the car relation; Minimise data duplication // no unnecessary repeated data; **A.** reduce for minimise Eliminate data redundancy; **A.** Reduce/minimise for eliminate Eliminate data inconsistency // improve consistency // avoid inconsistency problems; Eliminate update anomalies; **A.** Example in context Eliminate insertion anomalies; **A.** Example in context **NE.** Fewer errors when updating/inserting/deleting without concrete example or good explanation **NE.** Saving space/memory **NE.** Easier to query	**2** **AO1 = 1** **AO2 = 1**

Question	Part	Marking guidance	Total marks
09	3	**1 mark** for any one correctly drawn relationship **OR** **2 marks** for three relationships drawn correctly **Max 1** if more than three relationships drawn and any are incorrect  	**2** **AO2 = 2**

Question	Part	Marking guidance	Total marks

09	4	**1 mark:** Correct `UPDATE` clause
		1 mark: Correct `SET` clause
		1 mark: Correct `WHERE` clause
		
		Max 2 if SQL not fully working
		
		A. Any type of quotation marks or hashes for delimiters for `JobDuration` or no delimiters
		A. The value `206` if it is delimited by any type of quotation mark
		A. Any sensible format for the time data eg `"01.30"`, `"1:30"`, `"1:30.00"` etc.
		A. Time given as a decimal ie 1.5
		A. Table name given before fieldname
		I. Quotation marks around fieldnames
		I. Any attempt to also change value of `InGarage`
		
		<u>Example Solution</u>
		
		`UPDATE Job`
		`SET JobDuration = "01:30"`
		`WHERE JobID = 206`
			3
			
			AO3 = 3

Question	Part	Marking guidance	Total marks
09	5	**1 mark:** Correct `INSERT INTO` clause **1 mark:** Correct `VALUES` clause **Max 1** if SQL not fully working	**2** **AO3 = 2**

		A. List of fields in any order for method 2, but to get the VALUES mark in method 2, order of fields list in `INSERT INTO` must match order of values in `VALUES`
		A. The value(s) `206` and `12` if they are delimited by any type of quotation mark
		
		Example Solutions
		
		Method 1:
		
		`INSERT INTO PartUsedForJob`
		`VALUES (206, 12, 2)`
		
		Method 2:
		
		`INSERT INTO PartUsedForJob (JobID, PartID, QuantityUsed)`
		`VALUES (206, 12, 2)`	

Question	Part	Marking guidance	Total marks

09	6	**1 mark:** Correct `SELECT` clause
		1 mark: Correct `FROM` clause
		1 mark: Correct `WHERE` clause including correct condition to identify job
		1 mark: Correct `ORDER BY` clause
		1 mark: Tables correctly linked in `FROM` or `WHERE` clause
		
		Max 4 if SQL not fully working
		
		Accept table names before fieldnames separated by a full stop.
		Accept use of `Alias`/`AS` command eg `FROM Part AS P` then use of `P` as the table name but note that command `Alias`/`AS` is not required eg `FROM Part P`.
		Accept `INNER JOIN` written as one word ie `INNERJOIN` or just as `JOIN`
		Accept `ORDER BY` written as one word ie `ORDERBY`.
		Accept `ASC` at end of `ORDER BY` clause.
		Accept insertion of spaces into fieldnames.
		Accept use of `"` or `'` as delimiters around number 93.
		Ignore 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.
		
		Example Solutions
		
		Example 1
		
		`SELECT Part.PartID, Description, Price, QuantityUsed`
		`FROM Part, PartUsedForJob`
			5
			
			AO3 = 5

		`WHERE JobID = 93`
		`AND PartUsedForJob.PartID = Part.PartID`
		`ORDER BY Part.PartID`
		
		Example 2
		
		`SELECT Part.PartID, Description, Price, QuantityUsed`
		`FROM Part INNER JOIN PartUsedForJob ON PartUsedForJob.PartID = Part.PartID`
		`WHERE JobID = 93`
		`ORDER BY Part.PartID`
		
		Refer responses using nested SQL queries to team leaders.	

Question	Part	Marking guidance	Total marks
09	7	**1 mark:** Create a new relation to identify which make/model(s) of car each part can be fitted to; **A.** Use of a relation name given that clearly identifies the purpose eg `PartToFitMakeModel` instead of an explanation **A.** If it is just stated that a new relation is created if the attributes in the relation make its purpose clear **NE.** A relation to link the `Part` and `Car` relations **2 marks from:** Store the attributes `PartID`, `Make` and `Model` in the new relation; **I.** Inclusion of additional attributes Make the `PartID`, `Make` and `Model` / all the attributes the entity identifier; **A.** The creation of a new field as an entity identifier for this relation if it is explained that a constraint would also need to be added to ensure that it is not possible to record twice in the relation that a particular part could be fitted to a particular make and model of car Accept answers by example, such as: `PartToFitMakeModel(PartID, Make, Model)` **Alternative Response** **1 mark:** Create two new relations, one to associate an entity identifier with each make and model of car (eg `MakeModelID`) and one to link the parts to this new relation. **A.** If it is just stated that new relations will be created if the attributes in the relations make its purpose clear	**3** **AO2 = 3**

		2 marks from: Store the attributes `Make` and `Model` with a new entity identifier (eg `MakeModelID`) in one of the new relations; Store the `PartID` in the other new relation together with the entity identifier from the first new relation (eg `MakeModelID`); Make the `PartID` and `MakeModelID` the entity identified in the second new relation; **A.** The creation of a new field as an entity identifier for this relation if it is explained that a constraint would also need to be added to ensure that it is not possible to record twice in the relation that a particular part could be fitted to a particular make and model of car Accept answers by example, such as: `UniqueMakeModel(MakeModelID, Make, Model)` and `PartToFitMakeModel(PartID, MakeModelID)` **A.** Table or entity for relation. **A.** Field for attribute. **A.** Primary key for Entity Identifier.	

Question	Part	Marking guidance	Total marks
10	**1**	2; **R.** If more than one lozenge shaded	**1** **AO3 = 1**

Question	Part	Marking guidance	Total marks
10	**2**	**One mark** per correct row in the **Result** column: **Function Call** / **Result** `fw [4,3]` / `12;` `fx sales` / `[20, 50, 32];` **A.** alternative styles of bracket **R.** no brackets **R.** each element in a separate list `fz sales` / `102;` **A.** sum of elements in list in second row if list on second row incorrect	**3** **AO3 = 3**

Question	Part	Marking guidance	Total marks
10	3	Total/one day's sales value/income/revenue (for all products); **A.** total/one day's profit as BOD **NE.** sales, total sales	1 AO2 = 1

Question	Part	Marking guidance	Total marks
11	1	❶ node / neuron; ❷ hidden / processing (layer);	2 AO1 = 2

Question	Part	Marking guidance	Total marks
11	2	More than one/multiple/several hidden/processing layers;	1 AO1 = 1

Question	Part	Marking guidance	Total marks
11	3	Improved / more consistent decision making; Very large data sets can be analysed quickly; Continuous availability; Lower cost of operation; Can be available to more people / in areas that human expertise is not readily available // highly scalable; Accept specific examples of benefits, for example for mark point 1, that medical diagnosis could be more accurate. **Max 3**	3 AO1 = 3