
COMPUTER SCIENCE

9608/32

Paper 3 Written Paper

October/November 2018

MARK SCHEME

Maximum Mark: 75

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

Cambridge International is publishing the mark schemes for the October/November 2018 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **14** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

Question	Answer	Marks
1(a)(i)	1 mark per bullet point: <ul style="list-style-type: none"> • Correct value for exponent identified e.g. (0.010101×2^5) • Used to give correct value e.g. 1010.1 or $21/64 \times 32$ • Correct answer i.e. 10.5 // $10\frac{1}{2}$ 	3
1(a)(ii)	1 mark per bullet point: <ul style="list-style-type: none"> • Correct binary value i.e. 111.1 • Value for exponent identified e.g. (0.1111×2^3) • Correct answer i.e. 01111000 00000011 	3
1(a)(iii)	1 mark per bullet point: <ul style="list-style-type: none"> • Any working method for conversion • Applied accurately • Correct answer i.e. 10001000 00000011 	3
1(b)(i)	<u>Largest</u> (positive) number (in this format)	1
1(b)(ii)	Overflow // too large to represent // would become negative	1

Question	Answer	Marks
2(a)	1 mark per bullet point to max 3: <ul style="list-style-type: none"> • Must have a <u>central</u> device • Each node is connected to the central device • Each node has a dedicated connection • Each connection must be bidirectional • Nodes may operate under different protocols 	3
2(b)(i)	1 mark per bullet point to max 2: <ul style="list-style-type: none"> • dedicated circuit/channel/(physical) path • connection established before/at the start of the communication • which lasts for duration of connection // circuit released at end of the communication • all data is transmitted along the same route 	2

Question	Answer	Marks															
2(b)(ii)	1 mark for each row: <table border="1" data-bbox="607 284 1666 611" style="margin-left: 40px;"> <thead> <tr> <th data-bbox="607 284 1039 347">Statements</th> <th data-bbox="1039 284 1359 347">Circuit switching</th> <th data-bbox="1359 284 1666 347">Packet switching</th> </tr> </thead> <tbody> <tr> <td data-bbox="607 347 1039 411">Shares bandwidth</td> <td data-bbox="1039 347 1359 411"></td> <td data-bbox="1359 347 1666 411">✓</td> </tr> <tr> <td data-bbox="607 411 1039 475">Data may arrive out of order</td> <td data-bbox="1039 411 1359 475"></td> <td data-bbox="1359 411 1666 475">✓</td> </tr> <tr> <td data-bbox="607 475 1039 539">Data can be corrupted</td> <td data-bbox="1039 475 1359 539">✓</td> <td data-bbox="1359 475 1666 539">✓</td> </tr> <tr> <td data-bbox="607 539 1039 611">Data are less likely to get lost</td> <td data-bbox="1039 539 1359 611">either✓</td> <td data-bbox="1359 539 1666 611">or✓</td> </tr> </tbody> </table>	Statements	Circuit switching	Packet switching	Shares bandwidth		✓	Data may arrive out of order		✓	Data can be corrupted	✓	✓	Data are less likely to get lost	either✓	or✓	4
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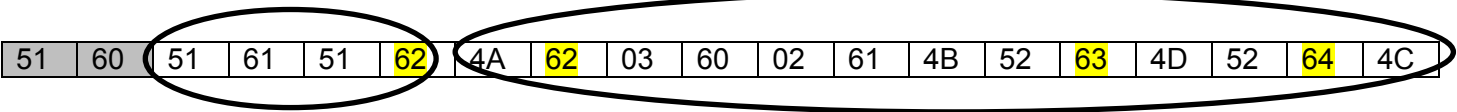
PUBLISHED

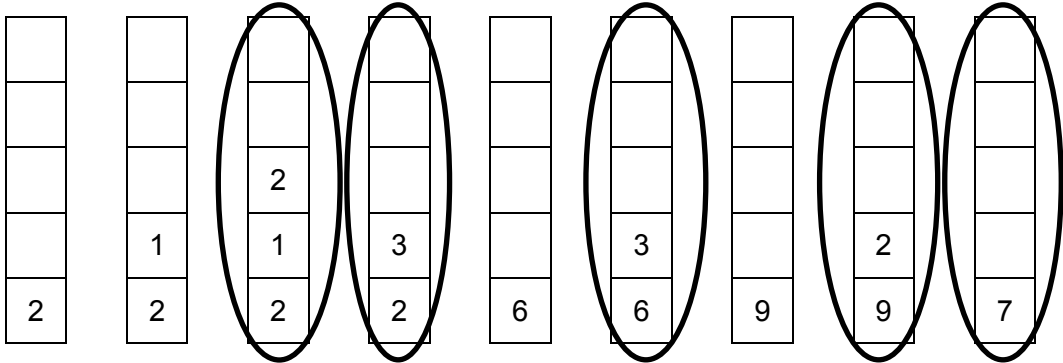
Question	Answer	Marks																						
3(a)	<p>1 mark per bullet point to max 3:</p> <ul style="list-style-type: none"> • Correct use of Idempotent law $Y = Y.Y$ $Y = Y + Y$ • Correct use of Complement law $0 = Y.\bar{Y}$ $1 = Y + \bar{Y}$ • Correct use of Distributive law $X(Y + Z) = X.Y + X.Z$ • Correct use of Redundancy law $X.\bar{Y} + Y = X + Y$ • Correct use of identity law $X.1 = X$ <p>1 mark for the correct answer</p> <p>For example:</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 60%;">$X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.C$</td> <td>Idempotent law</td> </tr> <tr> <td>$X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.\bar{C} + A.B.C$</td> <td>Distributive law</td> </tr> <tr> <td>$X = A.\bar{C}.\bar{B} + A.B.\bar{C} + A.B.C$</td> <td>Complement/Inverse law</td> </tr> <tr> <td>$X = A.\bar{C} + A.B$</td> <td></td> </tr> <tr> <td>$X = A.\bar{C} + B$</td> <td>Correct answer</td> </tr> <tr> <td> </td> <td></td> </tr> <tr> <td>$X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.C$</td> <td>Distributive law</td> </tr> <tr> <td>$X = A.\bar{C}.\bar{B} + A.B.C$</td> <td>Complement/Inverse law</td> </tr> <tr> <td>$X = A.\bar{C} + A.B.C$</td> <td></td> </tr> <tr> <td>$X = A.\bar{C} + B.C$</td> <td>Redundancy Law</td> </tr> <tr> <td>$X = A.\bar{C} + B$</td> <td>Correct answer</td> </tr> </table>	$X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.C$	Idempotent law	$X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.\bar{C} + A.B.C$	Distributive law	$X = A.\bar{C}.\bar{B} + A.B.\bar{C} + A.B.C$	Complement/Inverse law	$X = A.\bar{C} + A.B$		$X = A.\bar{C} + B$	Correct answer	 		$X = A.\bar{B}.\bar{C} + A.B.\bar{C} + A.B.C$	Distributive law	$X = A.\bar{C}.\bar{B} + A.B.C$	Complement/Inverse law	$X = A.\bar{C} + A.B.C$		$X = A.\bar{C} + B.C$	Redundancy Law	$X = A.\bar{C} + B$	Correct answer	4
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3(b)(i)	<p>1 mark for first four as 0, 1 mark for 1011</p> <table border="1" data-bbox="342 284 730 874"> <thead> <tr> <th>A</th> <th>B</th> <th>C</th> <th>X</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>0</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>0</td><td>1</td><td>0</td></tr> <tr><td>1</td><td>1</td><td>0</td><td>1</td></tr> <tr><td>1</td><td>1</td><td>1</td><td>1</td></tr> </tbody> </table> <p style="margin-left: 350px;">} 1 mark</p> <p style="margin-left: 350px;">} 1 mark</p>	A	B	C	X	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	1	1	0	1	0	1	1	0	1	1	1	1	1	2
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3(b)(ii)	<p>1 mark for correct K-map</p> <table border="1" data-bbox="371 957 875 1249"> <thead> <tr> <th colspan="2"></th> <th colspan="4" style="text-align: center;">AB</th> </tr> <tr> <th colspan="2"></th> <th>00</th> <th>01</th> <th>11</th> <th>10</th> </tr> </thead> <tbody> <tr> <th rowspan="2" style="vertical-align: middle;">C</th> <th>0</th> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <th>1</th> <td>0</td> <td>0</td> <td>1</td> <td>0</td> </tr> </tbody> </table>			AB						00	01	11	10	C	0	0	0	1	1	1	0	0	1	0	1													
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3(b)(iii)	<p>1 mark for each correct loop to max 2</p> <p style="text-align: center;">AB</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td></td> <td style="text-align: center;">00</td> <td style="text-align: center;">01</td> <td style="text-align: center;">11</td> <td style="text-align: center;">10</td> </tr> <tr> <td style="text-align: center;">C</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> </tr> <tr> <td></td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> </tr> </table>			00	01	11	10	C	0	0	0	1	1		1	0	0	1	0	2												
		00	01	11	10																											
C	0	0	0	1	1																											
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3(b)(iv)	<p>1 mark per bullet point:</p> <ul style="list-style-type: none"> • $A\bar{C}$ • $+ A.B$ <p>$X = A\bar{C} + A.B$</p>	2																														
3(c)(i)	<p>1 mark per bullet point to max 2:</p> <ul style="list-style-type: none"> • Correct column headings and row headings – values only • Correct column headings and row headings – order <p>1 mark for 2 correct rows or columns, 2 marks for 4 correct rows or columns (based on headings)</p> <p style="text-align: center;">AB</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td></td> <td style="text-align: center;">00</td> <td style="text-align: center;">01</td> <td style="text-align: center;">11</td> <td style="text-align: center;">10</td> </tr> <tr> <td style="text-align: center;">CD</td> <td style="text-align: center;">00</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> </tr> <tr> <td></td> <td style="text-align: center;">01</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> </tr> <tr> <td></td> <td style="text-align: center;">11</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> </tr> <tr> <td></td> <td style="text-align: center;">10</td> <td style="text-align: center;">0</td> <td style="text-align: center;">0</td> <td style="text-align: center;">1</td> <td style="text-align: center;">0</td> </tr> </table>			00	01	11	10	CD	00	0	1	1	0		01	0	0	1	0		11	0	0	1	0		10	0	0	1	0	4
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3(c)(ii)	<p>1 mark for each correct loop to max 2:</p> <div style="text-align: center; margin: 10px 0;"> <p>AB</p> <table border="1" style="margin: auto;"> <tr> <td></td> <td style="padding: 5px;">00</td> <td style="padding: 5px;">01</td> <td style="padding: 5px;">11</td> <td style="padding: 5px;">10</td> </tr> <tr> <td style="padding: 5px;">00</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">0</td> </tr> <tr> <td style="padding: 5px;">01</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">0</td> </tr> <tr> <td style="padding: 5px;">11</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">0</td> </tr> <tr> <td style="padding: 5px;">10</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">0</td> <td style="padding: 5px;">1</td> <td style="padding: 5px;">0</td> </tr> </table> </div>		00	01	11	10	00	0	1	1	0	01	0	0	1	0	11	0	0	1	0	10	0	0	1	0	2
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3(c)(iii)	<p>1 mark per bullet point:</p> <ul style="list-style-type: none"> • A.B • + B.C̄.D̄ <p>$X = A.B + B.C̄.D̄$</p>	2																									

Question	Answer	Marks																				
4(a)	1 mark per row <table border="1" data-bbox="342 284 1205 743"> <thead> <tr> <th data-bbox="342 284 622 347" rowspan="2">Symbol</th> <th colspan="2" data-bbox="622 284 1205 347">Token</th> </tr> <tr> <th data-bbox="622 347 909 411">Value</th> <th data-bbox="909 347 1205 411">Type</th> </tr> </thead> <tbody> <tr> <td data-bbox="342 411 622 480">Number1</td> <td data-bbox="622 411 909 480">60</td> <td data-bbox="909 411 1205 480">Variable</td> </tr> <tr> <td data-bbox="342 480 622 549">Number2</td> <td data-bbox="622 480 909 549">61</td> <td data-bbox="909 480 1205 549">Variable</td> </tr> <tr> <td data-bbox="342 549 622 617">Answer</td> <td data-bbox="622 549 909 617">62</td> <td data-bbox="909 549 1205 617">Variable</td> </tr> <tr> <td data-bbox="342 617 622 686">10</td> <td data-bbox="622 617 909 686">63</td> <td data-bbox="909 617 1205 686">Constant//Literal</td> </tr> <tr> <td data-bbox="342 686 622 743">0</td> <td data-bbox="622 686 909 743">64</td> <td data-bbox="909 686 1205 743">Constant//Literal</td> </tr> </tbody> </table>	Symbol	Token		Value	Type	Number1	60	Variable	Number2	61	Variable	Answer	62	Variable	10	63	Constant//Literal	0	64	Constant//Literal	3
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Answer	62	Variable																				
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0	64	Constant//Literal																				
4(b)	1 mark for each circled section 	2																				
4(c)(i)	(Code) Optimisation	1																				
4(c)(ii)	1 mark per bullet point: <ul style="list-style-type: none"> • LDD 236 • ADD 237 • ADD 238 • SUB 239 • STO 235 <p style="text-align: center;">Copy the instructions</p> <ul style="list-style-type: none"> • Remove line 4 STO 540 correct lines 3 and 6 in original code • Remove line 5 LDD 540 correct lines 3 and 6 in original code 	3																				

Question	Answer	Marks
4(c)(iii)	1 mark per bullet point: <ul style="list-style-type: none"> • Code has fewer instructions/occupies less space in memory • shortens execution time of program // time taken to execute whole program decreases 	2
4(d)	 <p style="text-align: center;">1 mark ← 1 mark → 1 mark</p> <p>1 mark no operators on the stack anywhere</p>	4

Question	Answer	Marks																																																																					
5(a)	1 mark per bullet point to max 4: <ul style="list-style-type: none"> • RISC has fewer instructions // CISC has more instructions • RISC has many registers // CISC has few registers • RISCs instructions are simpler // CISC’s instructions are more complex • RISC has a few instruction formats // CISC has many instruction formats • RISC usually uses single-cycle instructions // CISC uses multi-cycle instructions • RISC uses fixed-length instructions // CISC uses variable-length instructions • RISC has better pipelineability // CISC has poorer pipelineability • RISC requires less complex circuits // CISC requires more complex circuits • RISC has fewer addressing modes // CISC has more addressing modes • RISC makes more use of RAM // CISC makes more use of cache/less use of RAM • RISC has a hard-wired control unit // CISC has a programmable control unit • RISC only uses load and store instructions to address memory // CISC has many types of instructions to address memory 	4																																																																					
5(b)(i)	1 mark per bullet point: <ul style="list-style-type: none"> • Completing the As correctly • B in column 2, row 1 no other Bs in row 1 • Remainder correctly completed <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th data-bbox="367 922 887 1050" rowspan="2">Stage</th> <th colspan="9" data-bbox="887 922 1906 986">Time interval</th> </tr> <tr> <th data-bbox="887 986 999 1050">1</th> <th data-bbox="999 986 1111 1050">2</th> <th data-bbox="1111 986 1223 1050">3</th> <th data-bbox="1223 986 1335 1050">4</th> <th data-bbox="1335 986 1447 1050">5</th> <th data-bbox="1447 986 1559 1050">6</th> <th data-bbox="1559 986 1671 1050">7</th> <th data-bbox="1671 986 1783 1050">8</th> <th data-bbox="1783 986 1906 1050">9</th> </tr> </thead> <tbody> <tr> <td data-bbox="367 1050 887 1118">Fetch instruction</td> <td data-bbox="887 1050 999 1118">A</td> <td data-bbox="999 1050 1111 1118">B</td> <td data-bbox="1111 1050 1223 1118">C</td> <td data-bbox="1223 1050 1335 1118">D</td> <td data-bbox="1335 1050 1447 1118"></td> <td data-bbox="1447 1050 1559 1118"></td> <td data-bbox="1559 1050 1671 1118"></td> <td data-bbox="1671 1050 1783 1118"></td> <td data-bbox="1783 1050 1906 1118"></td> </tr> <tr> <td data-bbox="367 1118 887 1187">Decode instruction</td> <td data-bbox="887 1118 999 1187"></td> <td data-bbox="999 1118 1111 1187">A</td> <td data-bbox="1111 1118 1223 1187">B</td> <td data-bbox="1223 1118 1335 1187">C</td> <td data-bbox="1335 1118 1447 1187">D</td> <td data-bbox="1447 1118 1559 1187"></td> <td data-bbox="1559 1118 1671 1187"></td> <td data-bbox="1671 1118 1783 1187"></td> <td data-bbox="1783 1118 1906 1187"></td> </tr> <tr> <td data-bbox="367 1187 887 1256">Execute instruction</td> <td data-bbox="887 1187 999 1256"></td> <td data-bbox="999 1187 1111 1256"></td> <td data-bbox="1111 1187 1223 1256">A</td> <td data-bbox="1223 1187 1335 1256">B</td> <td data-bbox="1335 1187 1447 1256">C</td> <td data-bbox="1447 1187 1559 1256">D</td> <td data-bbox="1559 1187 1671 1256"></td> <td data-bbox="1671 1187 1783 1256"></td> <td data-bbox="1783 1187 1906 1256"></td> </tr> <tr> <td data-bbox="367 1256 887 1324">Access operand in memory</td> <td data-bbox="887 1256 999 1324"></td> <td data-bbox="999 1256 1111 1324"></td> <td data-bbox="1111 1256 1223 1324"></td> <td data-bbox="1223 1256 1335 1324">A</td> <td data-bbox="1335 1256 1447 1324">B</td> <td data-bbox="1447 1256 1559 1324">C</td> <td data-bbox="1559 1256 1671 1324">D</td> <td data-bbox="1671 1256 1783 1324"></td> <td data-bbox="1783 1256 1906 1324"></td> </tr> <tr> <td data-bbox="367 1324 887 1393">Write result to register</td> <td data-bbox="887 1324 999 1393"></td> <td data-bbox="999 1324 1111 1393"></td> <td data-bbox="1111 1324 1223 1393"></td> <td data-bbox="1223 1324 1335 1393"></td> <td data-bbox="1335 1324 1447 1393">A</td> <td data-bbox="1447 1324 1559 1393">B</td> <td data-bbox="1559 1324 1671 1393">C</td> <td data-bbox="1671 1324 1783 1393">D</td> <td data-bbox="1783 1324 1906 1393"></td> </tr> </tbody> </table>	Stage	Time interval									1	2	3	4	5	6	7	8	9	Fetch instruction	A	B	C	D						Decode instruction		A	B	C	D					Execute instruction			A	B	C	D				Access operand in memory				A	B	C	D			Write result to register					A	B	C	D		3
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5(b)(ii)	1 mark per bullet point: <ul style="list-style-type: none"> • Correct number of cycles for pipelining 8 • Correct number of cycles without pipelining $4 \times 5 = 20$ • No of cycles saved $20 - 8 = 12$ 	3																							
5(c)	1 mark for each row <table border="1" data-bbox="342 459 1424 959" style="margin-left: 20px;"> <thead> <tr> <th data-bbox="342 459 1081 595" rowspan="2">Statement</th> <th colspan="3" data-bbox="1081 459 1424 528">Architecture</th> </tr> <tr> <th data-bbox="1081 528 1196 595">SIMD</th> <th data-bbox="1196 528 1310 595">MIMD</th> <th data-bbox="1310 528 1424 595">SISD</th> </tr> </thead> <tbody> <tr> <td data-bbox="342 595 1081 671">Each processor executes a different instruction</td> <td data-bbox="1081 595 1196 671"></td> <td data-bbox="1196 595 1310 671" style="text-align: center;">✓</td> <td data-bbox="1310 595 1424 671"></td> </tr> <tr> <td data-bbox="342 671 1081 748">There is only one processor</td> <td data-bbox="1081 671 1196 748"></td> <td data-bbox="1196 671 1310 748"></td> <td data-bbox="1310 671 1424 748" style="text-align: center;">✓</td> </tr> <tr> <td data-bbox="342 748 1081 858">Each processor executes the same instruction input using data available in the dedicated memory</td> <td data-bbox="1081 748 1196 858" style="text-align: center;">✓</td> <td data-bbox="1196 748 1310 858"></td> <td data-bbox="1310 748 1424 858"></td> </tr> <tr> <td data-bbox="342 858 1081 959">Each processor typically has its own partition within a shared memory</td> <td data-bbox="1081 858 1196 959"></td> <td data-bbox="1196 858 1310 959" style="text-align: center;">✓</td> <td data-bbox="1310 858 1424 959"></td> </tr> </tbody> </table>	Statement	Architecture			SIMD	MIMD	SISD	Each processor executes a different instruction		✓		There is only one processor			✓	Each processor executes the same instruction input using data available in the dedicated memory	✓			Each processor typically has its own partition within a shared memory		✓		4
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