International Advanced Subsidiary in Computer Science

Unit 1: Principles of Computer Science

Mark Scheme

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed-out work should be marked UNLESS the candidate has replaced it with an alternative response.

Specific marking guidance

- For explanations, justification points that are not linked to a correct identification should not be rewarded.

This mark scheme includes colour coded text. Centres must ensure that all hard copies are printed in full colour so that assessment guidance is accurately conveyed.

Question number	Answer	Additional Guidance	Mark
1	**The two correct answers are C (1) and D (1)** A is not correct because it applies to IPv6 addresses B is not correct because IPv4 addresses are logical addresses E is not correct because it applies to MAC addresses	The correct answers are: **C** They are written as four groups of numbers separated in dotted-decimal format. **D** They uniquely identify the host interface.	2

Question number	Answer	Additional Guidance	Mark
2	Award **one** mark for: • milliseconds (1)	Accept: ms s/seconds	1

Question number	Answer	Additional Guidance	Mark
3	Award up to **two** marks for a linked definition that makes reference to: • Uses two keys / key pair / public and private key (1) one key for encryption and a different key for decryption (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
4	Award **one** mark for each of the following up to a maximum of **two** marks: • Any three letters correct (1) • Remaining three letters correct (1) E | G | M | W | Q | Y	Ignore case	2

Question number	Answer	Additional Guidance	Mark
5	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • Frequency analysis can reveal patterns in the ciphertext (1) because each plaintext letter is always encrypted to the same ciphertext letter (1) • An exhaustive search will decrypt the message (1) because the number of possible keys is limited/26 factorial (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
6	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • The key is genuinely random (1) so that patterns will not emerge in the ciphertext (1) • The key is only used once (1) so that multiple messages cannot be compared to reveal information about the key (1) • The key is at least as long as the plaintext/message (1) since repeating the key (to match the length of the plaintext/message) would introduce patterns into the ciphertext (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
7	Award **one** mark for each of the following up to a maximum of **two** marks: • Array (1) • Tuple (1) Accept any other appropriate response.		2

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>8</td><td>Award one mark for each of the following up to a maximum of three marks:

• Berlin element deleted (1)
• Existing London value amended to 12 (must not be as an additional element) (1)
• Additional element added with key of Shanghai and value of 6 (1)

Maximum two marks if any other changes are seen.

Exemplar completed table:

<table><tr><td>London</td><td>12</td></tr><tr><td>Singapore</td><td>6</td></tr><tr><td>Delhi</td><td>10</td></tr><tr><td>Shanghai</td><td>6</td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table></td><td>Rows can be listed in any order as long as the values are paired with correct keys.

Ignore minor spelling errors in city names and ignore empty rows.</td><td>3</td></tr>
</table>

Question number	Answer	Additional Guidance	Mark
9	Award **one** mark for each appropriate point given in the correct order, up to a maximum of **two** marks: • The key will be hashed (to find the position/index) (1) and the key-value paid at the position/index will be deleted (1). Accept any other appropriate phrasing.		2

Question number	Answer	Additional Guidance	Mark
10	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks. • Each table must have a unique primary key (1) so that any foreign key in a related table matches an existing primary key (1) • Deleting a record from the parent table should trigger deletions from child tables (1) so that orphaned records cannot occur (1) • Updates in the parent table should be cascaded to child tables (1) so that inconsistent data is prevented (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
11	Award **two** marks for a fully correct conversion to hexadecimal: • 7B (2) OR Award **one** mark for either of the following in the correct position: • 7 (1) • B (1)	Ignore case and blank spaces.	2

Question number	Answer	Additional Guidance	Mark
12	Award **one** mark for any of the following, up to a maximum of **two** marks: • It can represent many different writing systems/emojis/symbols (1) • It uses a variable-width encoding system / It uses between 1 and 4 bytes per character (1) • It enables backward compatibility with ASCII (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
13	Award **one** mark for each appropriate point given in the correct order, up to a maximum of **two** marks: • A numerical calculation/binary shift is performed by the ALU/processor (1) and the result is too small to be (accurately) represented/stored (in the bits available) (1) • A number of small magnitude is divided by a number of large magnitude (1) resulting in a number too small to be (accurately) represented (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
14	Award **two** marks for a fully correct conversion to denary: • 22 5/8 / 22 $\frac{5}{8}$ / 22.625 (2) OR Award **one** mark for either of the following: • 22 (1) • 5/8 / $\frac{5}{8}$ / .625 (1)	If answering in fractions, answers must clearly show 22 5/8 not 225/8	2

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>15</td><td>Award one mark for each of the following, up to a maximum of six marks:

• Convert -44 to signed binary 1010100 (1)
• Pad the result for -44 with 1(s) on the left up to 8 bits (1)
• Convert -11 to signed binary 10101 (1)
• Pad the result for -11 with 1(s) on the left up to 8 bits (1)
• Evidence of adding in binary with carries (1)
• Fully correct answer (1)

Exemplar full method:

Convert both values to signed binary and pad:
$-44_{10} = (1)1010100_2$
$-11_{10} = (111)10101_2$

Add values together:

Working like this may be seen (with carry bits recorded below or above)
<table><tr><td>-44</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>-11</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>Answer</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>Carry</td><td>1</td><td>1</td><td>1</td><td></td><td>1</td><td></td><td></td><td></td></tr></table></td><td>If more than 8-bits given in the answer, do not award mp6.

Allow other equivalent approaches for working.</td><td>6</td></tr>
</table>

Question number	Answer	Additional Guidance	Mark
16	Award **one** mark for any of the following, up to a maximum of **two** marks: • Variety (1) • Velocity (1) • Veracity (1) • Volume (1) • Value (1)		2

Question number	Answer	Additional Guidance	Mark
17	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • The training data must be diverse/representative / must be designed to actively include under-represented groups (1) because the LLM cannot produce representative output without having learnt from diverse sources (1) • The training data must be filtered/pre-processed to remove explicitly biased material (1) so that the LLM does not reproduce it (1) • The training data must include the context of the model (1) so that the model does not make judgements based on inaccurate norms for the scenario/time period/location (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
18	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • The model may be able to identify clusters/associations (1) because it identifies naturally occurring patterns in data sets (1) • Training can begin more quickly (1) because it does not need training data that is already labelled/categorised (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
19	**The correct answer is D** A is not correct because the output Q would be 0001 for AND B is not correct because the output Q would be 1110 for NAND C is not correct because the output Q would be 1000 for NOR	The correct answer is **D** XOR	1

Question number	Answer	Additional Guidance	Mark
20	Award **one** mark for a definition that makes reference to: • It is a finite sequence of instructions/rules/steps to solve a problem/complete a task (1) Accept any other appropriate response.		1

Question number	Answer	Additional Guidance	Mark
21	Award **one** mark for: • Linear search (1) Accept any other appropriate response.		1

Question number	Answer	Additional Guidance	Mark
22	**The correct answer is B** A is not correct because the procedural programming paradigm uses a high level of abstraction C is not correct because the procedural programming paradigm does not use logical schemas. D is not correct because the procedural programming paradigm does use flow control.	The correct answer is **B** It uses imperative commands.	1

Question number	Answer	Additional Guidance	Mark
23	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • It reduces complexity (1) because the programmer says what they want to happen rather than how it happens (1) • It improves readability/maintainability (1) because there are fewer instructions overall (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
24	Award **one** mark for: • Recursion (1)	Do **not** accept function.	1

Question number	Answer	Additional Guidance	Mark
25	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • A logic error occurs (1) because not all the items in the list will be searched / only the first 8 items will be searched / the loop condition is hard-coded (1) Accept any other appropriate response.	Do **not** accept generic explanation of a logic error.	2

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>26</td>
<td>Award one mark for each of the following up to a maximum of four marks:

• First row correct (1)
• First iteration correct (1)
• Remaining iterations correct (1)
• found set to True on last row and output “3.7 was found at position 7” (1)

Exemplar completed table:
<table>
<tr><th>lower</th><th>upper</th><th>mid</th><th>distances[mid]</th><th>found</th><th>target</th></tr>
<tr><td>0</td><td>10</td><td>0</td><td></td><td>False</td><td>3.7</td></tr>
<tr><td></td><td></td><td>5</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>3.47</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>8</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>3.93</td><td></td><td></td></tr>
<tr><td></td><td>7</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>6</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>3.61</td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td>7</td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td>3.7</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>True</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Program output</td><td colspan="4">3.7 was found at position 7</td></tr>
</table>
Students may choose to write one iteration on each row – accept so long as the same values are present.</td>
<td>Ignore minor spelling errors in the output.
Ignore 1.2 in distances [mid] column in the first row.

Mark points in the table are colour coded:

BP1
BP2
BP3
BP4</td>
<td>4

4</td>
</tr>
</table>

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>26
(continued)</td><td>
Alternative exemplar table:
<table>
<tr><th>lower</th><th>upper</th><th>mid</th><th>distances[mid]</th><th>found</th><th>target</th></tr>
<tr><td>0</td><td>10</td><td>0</td><td></td><td>False</td><td>3.7</td></tr>
<tr><td></td><td></td><td>5</td><td>3.47</td><td></td><td></td></tr>
<tr><td>6</td><td></td><td>8</td><td>3.93</td><td></td><td></td></tr>
<tr><td></td><td>7</td><td>6</td><td>3.61</td><td></td><td></td></tr>
<tr><td>7</td><td></td><td>7</td><td>3.7</td><td>True</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Program output</td><td colspan="3">3.7 was found at position 7</td></tr>
</table>
Students may insert values in every cell by repeating unchanging variables – accept.

Alternative exemplar table:
<table>
<tr><th>lower</th><th>upper</th><th>mid</th><th>distances[mid]</th><th>found</th><th>target</th></tr>
<tr><td>0</td><td>10</td><td>0</td><td></td><td>False</td><td>3.7</td></tr>
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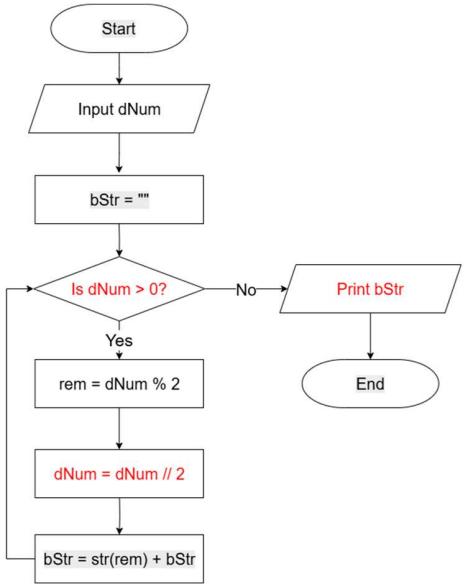
<tr><td colspan="3">Program output</td><td colspan="3">3.7 was found at position 7</td></tr>
</table>
</td><td></td><td></td></tr>
</table>

Question number	Answer	Additional Guidance	Mark
27	Award **four** marks for a fully correct expression: • $Q = \bar{A}.B + \bar{C}.D$ (4) OR Award **one** mark for any of the following up to maximum of **three** marks: • + between two expressions (1) • $\bar{A}.B$ (1) • $\bar{C}.D$ (1)		4

Question number	Answer	Additional Guidance	Mark
28	Award **one** mark for each correct operation in the correct box, up to a maximum of **three** marks: • dNum > 0 (1) • dNum = dNum // 2 (1) • Output bStr (1) Exemplar answer:  Accept any other appropriate response.	Accept dNum = 0 Accept dNum = dNum div 2 Accept alternative syntax e.g. dNum <>0 / print(bStr)	3

Question number	Answer	Additional Guidance	Mark
29	Award **one** mark for each of the following, up to a maximum of **two** marks: • Allows computers to execute different programs/tasks easily (without the need to reconfigure hardware) (1) • The computer can modify its own data or program (1) • Fast execution (as both programs and data are in the same memory) (1) Accept any other appropriate response.		2

Question number	Answer	Additional Guidance	Mark
30	Award **one** mark for each of the following, up to a maximum of **two** marks: • Peripheral/device management (1) • User interface (1) • User management (1) • Process management (1) Accept any other appropriate response.	**Do not** accept multitasking and memory management.	2

<table>
<tr><th>Question number</th><th>Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>31</td><td>Award one mark for each of the following up to a maximum of two marks:

• CPU registers and main memory/RAM in the correct positions (1)
• L1 and L3 cache in the correct position (1)

Exemplar answer:

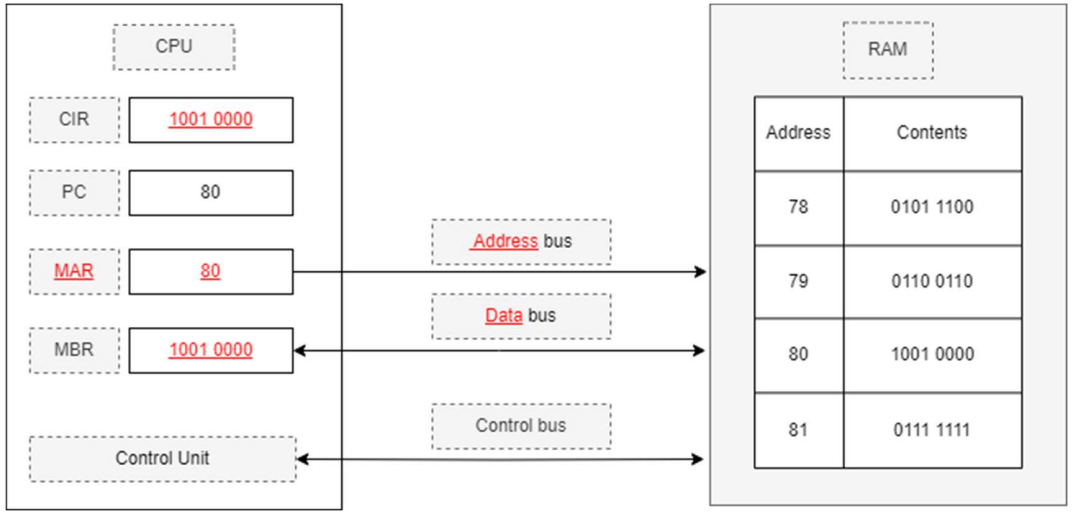
<table><tr><td>Label</td><td>Type of Memory</td></tr><tr><td>A</td><td>CPU registers</td></tr><tr><td>B</td><td>L1 cache</td></tr><tr><td>C</td><td>L3 cache</td></tr><tr><td>D</td><td>Main Memory/RAM</td></tr></table></td><td></td><td>2</td></tr>
</table>

Question number	Answer	Additional Guidance	Mark
32	Award up to **two** marks for completed boxes: 1. Suspends the currently executing process 2. Status is saved in a stack frame (1) 3. Services the interrupt 4. Status is popped from the stack frame (1) 5. Resumes executing the suspended process Accept alternative wording for the steps.		2

Question number	Answer	Additional Guidance	Mark
33	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • Bits from the same word can get out of step with each other (1) because they are transmitted along multiple wires at the same time (1) Accept any other appropriate response.	Accept explanation of why skew cannot affect serial transmission	2

Question number	Answer	Additional Guidance	Mark
34	Award **one** mark for each appropriate point in a linked response up to a maximum of **two** marks: • (Logical) memory is split into variable-sized blocks/partitions/segments (1), which are loaded into physical memory (for execution) (1) • (Logical) memory is split into variable-sized blocks/partitions/segments (1). The segment table maps the segment to physical memory locations (1) Accept any other appropriate response.	Do **not** accept segments on its own. Answer must refer to variable size.	2

Question number	Answer	Additional Guidance	Mark
35	Award **one** mark for an identification point and **one** mark for an appropriate linked justification, up to a maximum of **two** marks: • It makes up for the difference in speed between the CPU and RAM (1) by providing a temporary data store (1) • It enables the CPU to handle more instructions per second (1) because it frees up the data bus to be used again for another fetch (1) • It acts as a buffer between the different speeds of the CPU and the RAM (1) because it stores data until the data bus is ready (1) Accept any other appropriate response.	Accept MDR	2

Question number	Answer	Additional Guidance	Mark
36	Award **one** mark for each of the following up to a maximum of **six** marks: • Address bus (1) • Data bus (1) • MAR (1) • 80 (1) • 1001 0000 in MBR (1) • 1001 0000 in CIR (1) Exemplar answer: 		6