Coimisiún na Scrúduithe Stáit
State Examinations Commission

Leaving Certificate 2022

Marking Scheme

Computer Science

Higher Level

Note to teachers and students on the use of published marking schemes

Marking schemes published by the State Examinations Commission are not intended to be standalone documents. They are an essential resource for examiners who receive training in the correct interpretation and application of the scheme. This training involves, among other things, marking samples of student work and discussing the marks awarded, so as to clarify the correct application of the scheme. The work of examiners is subsequently monitored by Advising Examiners to ensure consistent and accurate application of the marking scheme. This process is overseen by the Chief Examiner, usually assisted by a Chief Advising Examiner. The Chief Examiner is the final authority regarding whether or not the marking scheme has been correctly applied to any piece of candidate work.

Marking schemes are working documents. While a draft marking scheme is prepared in advance of the examination, the scheme is not finalised until examiners have applied it to candidates' work and the feedback from all examiners has been collated and considered in light of the full range of responses of candidates, the overall level of difficulty of the examination and the need to maintain consistency in standards from year to year. This published document contains the finalised scheme, as it was applied to all candidates' work.

In the case of marking schemes that include model solutions or answers, it should be noted that these are not intended to be exhaustive. Variations and alternatives may also be acceptable. Examiners must consider all answers on their merits, and will have consulted with their Advising Examiners when in doubt.

Future Marking Schemes

Assumptions about future marking schemes on the basis of past schemes should be avoided. While the underlying assessment principles remain the same, the details of the marking of a particular type of question may change in the context of the contribution of that question to the overall examination in a given year. The Chief Examiner in any given year has the responsibility to determine how best to ensure the fair and accurate assessment of candidates' work and to ensure consistency in the standard of the assessment from year to year. Accordingly, aspects of the structure, detail and application of the marking scheme for a particular examination are subject to change from one year to the next without notice.

Section A — Short Answer Questions — 30 marks

Answer any six questions.

Question 1 **5 marks**

Output
5 6 15 5 6

Each correct response in the correct order 1 mark

Question 2 **3 + 2(1,1) marks**

(a)

- **A type of memory used to store data/programs when the computer is switched on/running.**
- **Called volatile because entire contents are cleared when the computer is switched off.**

Very good description - clear understanding demonstrated	3 marks
Fair description - limited understanding	1 mark

(b)

- **Physical location. Registers are located inside (part of) the CPU – RAM is not physically as close to the CPU.**
- **Access time/speeds. Contents of registers can be accessed much faster by CPU than contents of RAM.**
- **Cost. Registers are more expensive than RAM (per byte).**
- **Capacity. Registers hold less than RAM (because of cost).**
- **Material. Made from different materials.**
- **Any other valid difference.**

1 marks for each difference clearly described

Question 3 **4(2,2) +1 marks**

(a)

Transistor

- **A transistor is type of electronic switch.**
- **A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit.**
- **A transistor is the fundamental building block of gates, logic circuits (adders, multiplexors etc.), integrated circuits and microprocessors.**
- **Transistors are used to represent binary 1's and 0's.**

Integrated Circuit

- **An integrated circuit (chip) is an electronic component that contains multiple discrete components combined together into logic circuits on a single silicon board.**

For each term:

Very good explanation - clear understanding demonstrated	2 marks
Fair explanation - limited understanding	1 mark

(b)

- **There is a physical limitation to the number of transistors that can fit on a single chip.**

Full correct response	1 mark

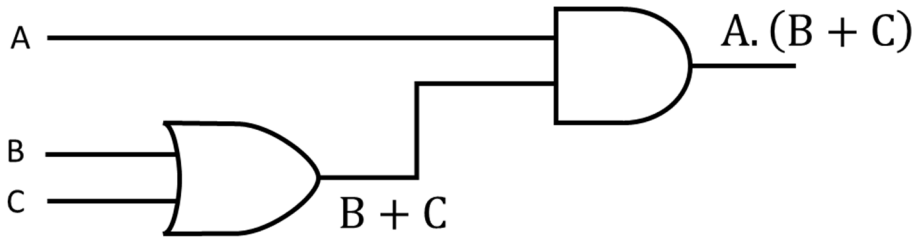
Question 4 **2+3 marks**

(a)

A	B	C	A AND (B OR C)
0	0	0	0
0	0	1	0
0	1	0	**0**
0	1	1	**0**
1	0	0	**0**
1	0	1	**1**
1	1	0	**1**
1	1	1	**1**

Every value correct	2 marks
3 (or more) correct values	1 mark

(b)



Gates combined correctly as above	3 marks
Use of AND and OR gates with either input correctly labelled	2 marks
Use of AND or OR gates with either inputs correctly labelled	1 mark

Question 5 **5 marks**

Letter	Missing Text
A	pH < 7
B	FALSE
C	TRUE
D	OUTPUT "Base"
E	OUTPUT "Neutral"

Each correct response 1 mark

Question 6 **5 marks**

- **A web client sends a browser request to a web server. This browser request is then processed by the web server which responds by sending the result back to the client in the form of a server response.**

Very good explanation - clear understanding demonstrated	5 marks
Good explanation - clear information, lacking demonstration of full understanding	3 marks
Fair explanation - limited understanding	1 mark

Question 7 **3+2 marks**

(a)

- **Ransomware is a type of malicious software (malware) that threatens to publish or blocks access to data or a computer system, usually by encrypting it, until the victim pays a ransom fee to the attacker. In many cases, the ransom demand comes with a deadline. If the victim doesn't pay in time, the data is gone forever or the ransom increases.**

Very good description - clear understanding demonstrated 3 marks
Fair description - limited understanding 1 mark

(b)

- **Company policy and procedures (people controls).**
- **Password policies.**
- **Anti-virus software.**
- **Security systems (e.g. firewall, VPN).**
- **Encryption.**
- **Cloud (security services may be better than local organisations).**
- **Any acceptable measure.**

Each correct response 1 mark

Question 8 **5 marks**

<u>Cost (advantage)</u>

- **No need to for one-off up-front capital costs.**
- **No need for upgrading/replacements costs.**

<u>Cost (disadvantage)</u>

- **Costs are ongoing (pay-as-you-go) which could work out more expensive in the long run.**
- **Ongoing costs to cloud service provider to keep software and hardware up-to-date**

<u>Environment (advantage)</u>

- **Economy of scale meaning that cloud providers can offer shared services more efficiently thereby reducing carbon footprint.**
- **Many cloud companies generate their own energy (and supply to grid)**
- **Less paper.**

<u>Environment (disadvantage)</u>

- **Owing to its success there is a greater demand for cloud services – thus increasing the energy demand and greater carbon footprint.**

Award 3 marks for better of cost or environment as follows:
2 marks for better of advantage/disadvantage as follows:
Very good description - clear understanding demonstrated 2 marks
Fair description - limited understanding 1 mark

1 mark for other advantage/disadvantage (within the same heading)
Very good description - clear understanding demonstrated 1 mark

Award 2 marks for other heading (i.e. cost/environment) as follows:
1 mark for advantage
Very good description - clear understanding demonstrated 1 mark
1 mark for disadvantage
Very good description - clear understanding demonstrated 1 mark

Question 9 **2+3 marks**

(a)

- **Self-driving vehicles – safety/more accessible.**
- **Healthcare – early detection of chronic illnesses, modelling disease spread etc.**
- **Entertainment – music/concert/movie/book recommender systems etc.**
- **Online shopping – product recommender systems, ads etc.**
- **Facial recognition in home/business security systems.**
- **Environmental protection.**
- **Fairer justice systems.**
- **Arts – music/literature.**
- **Education.**
- **Any valid example of how machine learning can be used to benefit society.**

Each correct response 1 mark

(b)

- **If the data on which the algorithm makes its decision contains bias, the algorithm's output will also be biased.**

Very good description - clear understanding demonstrated 3 marks
Fair description - limited understanding 1 mark

Question 10 **3+2 marks**

(a)

- **The minimum number of weighings to find the fake coin is 2 as follows:**
  Place a group of 3 coins on each pan (weighing 1). If they weigh the same the fake is among the other 2 (so the fake can be found by placing each of the other 2 on the pans – weighing 2). If they don't weigh the same choose 2 of the coins from the 3 on the heavier side of the pan. Weigh these two coins (weighing 2). If they are both the same the 3rd coin is the fake. If they don't weigh the same the heavier coin will be evident from the pan.

Valid solution (2 weighings) 3 marks
Valid solution (3 or more weighings) 2 marks
Reasonable attempt 1 mark

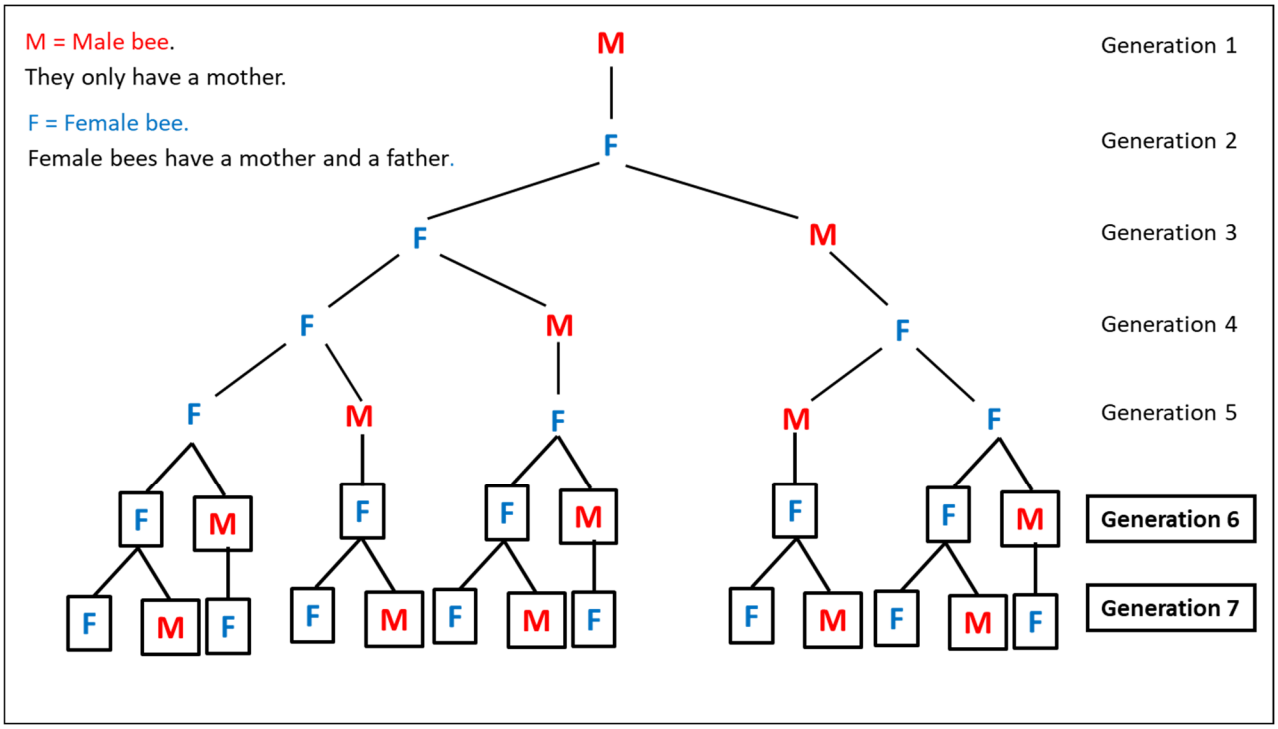
(b)

- **By ignoring irrelevant details such as coin colour, size and value**

Very good description - clear understanding demonstrated 2 marks

Question 11 **3+2 marks**

(a)



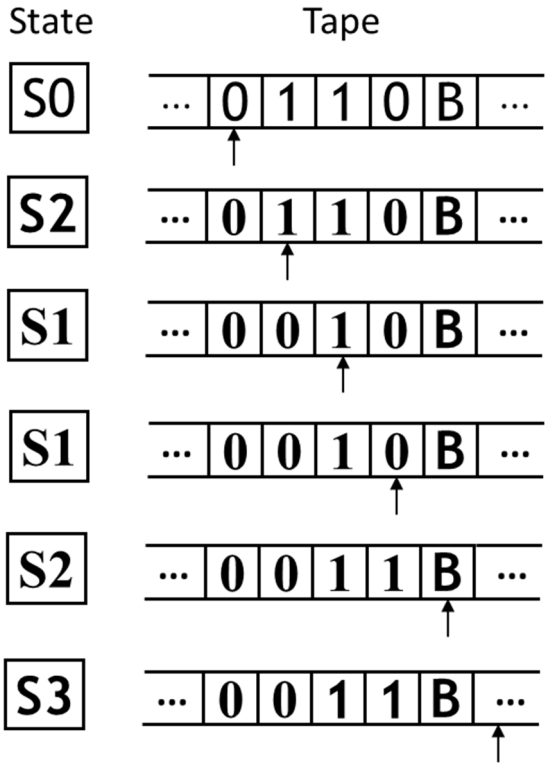
Full correct response	3 marks
One fully correct generation	2 marks
Two or more branches from generation 7 fully complete	2 marks
Any correct value	1 mark

(b)

- **Number of bees at each generation is the sum of the number of bees at the previous two generations (Fibonacci sequence).**

Very good description - clear understanding demonstrated	2 marks
Fair description - limited understanding	1 mark

Question 12 **5 marks**



Full correct response	5 marks
Three or more correct tapes	3 marks
Two correct tapes	2 marks
One correct tape	1 mark

Section B — Long Questions — 30 marks

Question 13 — **30 (19, 11) marks**

(a) — **19 (2,2,6,2,4,3) marks**

(i) — **2 marks**

An information system (IS) is the software used to help organise and analyse business data and streamline the day to day (transactional) operation of a business.

Very good description - clear understanding demonstrated	2 marks
Fair description - limited understanding	1 mark

(ii) — **2 marks**

- **Improve operational efficiencies – an IS could be used to handle bookings and payments automatically, database could be used to organise and manage information about relevant entities such as dogs, customers or staff.**
- **Information could be used to improve decision making and strategic planning.**
- **Improve customer service – as system should be available 24/7. An IS would make it easier for customers to learn more about K-9 kennels.**
- **Cost reductions (increase in profits).**
- **Any valid example of a benefit for K-9 kennels.**

For each unique valid/correct example	1 mark

(iii) — **6 marks**

Stakeholder	Role
Dog owners / general public / customers	**end-users**
K9-Kennels / John and Mary and their employees	**client / project sponsor** **Users of the system**
Software company including any relevant job title e.g. project manager / analyst / designer / programmer / tester etc.	**Any relevant description**

For each correctly identified stakeholder	1 mark
For each stakeholder role:	
Very good description - clear understanding demonstrated	2 marks
Fair description – limited understanding	1 mark

(iv) **2 marks**

- **K-9's existing business services and the systems (hardware, software etc.) in place to support them.**
- **Customer requirements.**
- **Project feasibility (cost-benefit analysis).**
- **Contract / Memorandum Of Understanding (MOU).**
- **Project plan (e.g. deliverables, key milestones, schedule etc.).**
- **Any relevant topic.**

For each topic:
Good description - clear understanding demonstrated 1 marks

(v) **4 marks**

<u>Reasons for choosing Web App</u>

- **Accessibility.**
- **Ease of updates.**
- **Better discovery on search engines. (SEO).**
- **Cost-effective development.**
- **Faster speed to market.**
- **Any valid reason.**

<u>Reasons for choosing Mobile App</u>

- **Speed and performance.**
- **Ability to send push notifications.**
- **Improved user experience.**
- **Offline access.**
- **Any valid reason.**

For each reason:
Very good description - clear understanding demonstrated 2 marks
Fair description - limited understanding 1 mark

(vi) **3 marks**

The choice of software development process/methodology (e.g. waterfall, agile etc.) is important as it enables a project to provide better estimates, deliver stable systems, keep the customer informed, create a clear understanding of the task ahead, and identify pitfalls earlier, allowing for ample time to make adjustments.

Very good explanation - clear understanding demonstrated 3 marks
Fair explanation - limited understanding 1 mark

(b) **11 (4, 2, 2, 3) marks**

(i) **4 marks**

Image and description of item	1 mark
Add to cart button	1 mark
Link to checkout page	1 mark
Overall aesthetic	1 mark

(ii) **2 marks**

User-centred design features – involving the user throughout the design process

- **Consistent page layout e.g. navigation at top/side of every page, footer content the same on every page.**
- **Good balance of content and white space.**
- **Good contrast between text and background.**
- **Use of consistent font – size, colour, formatting.**
- **Visited links change in appearance.**
- **Good use of basic design principles - repetition, contrast, proximity, alignment.**
- **Responsive design – works on different device sizes and in different browsers.**
- **Any valid feature.**

For each user-centred design feature:
Good description - clear understanding demonstrated 1 marks

(iii) **2 marks**

<u>Wireframe</u>

- **A wireframe is a sketch of diagram of a webpage that shows the overall structure of the page (i.e. elements such as navigation menu, headings, images, content area and footer).**
- **Wireframes are drawn during the design stage of the design process.**
- **Wireframes are low-fidelity visual representations of some aspect of a system.**
- **Wireframes do not contain real content (when the content is added they may need to change).**
- **Wireframes are relatively quick to develop and change.**
- **Wireframes are relatively cheap.**

<u>Prototype</u>

- **A prototype is a 'trimmed down' working version of the system (or some aspect of the system) used for demonstration and evaluation purposes.**
- **Prototypes are developed in the implementation (create) stage of the design process**
- **A prototype is software whereas wireframes are sketches (digital or hand-drawn) – they are relatively costly to develop.**
- **Prototypes provide a mid to high fidelity visual representation of the system 'look and feel'. They take colours, content and branding into account and also allow users to engage/experience the system (button clicks etc.).**

For each difference 1 mark

(iv) **3 marks**

String

- **Customer name, address, contact details, product details**

Integer

- **Quantity ordered, credit card number, CCV, phone number**

Boolean

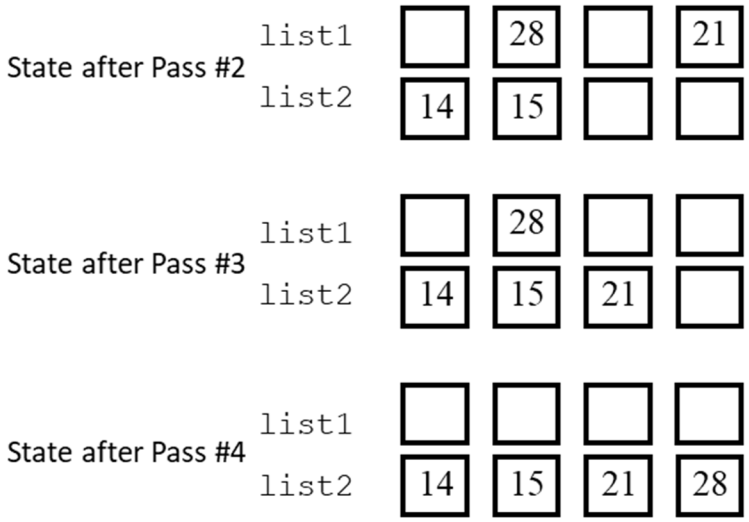
- **Delivery address same as customer address?**
- **Receive product promotions, updates, mailing list etc.**
- **Accept terms and conditions?**

For each valid/correct example 1 mark

Question 14 **30 (13, 17) marks**

(a) **13 (3, 2, 3, 2, 3) marks**

(i) **3 marks**



Each correct pass 1 mark

(ii) **2 marks**

- **Select the largest (instead of the smallest) element from list 1 and move it to list2**
- **Any valid response.**

Good description - clear understanding demonstrated 2 marks

(iii) **3 marks**

- **Initialise the minimum to be the first element in the list. Then, working/walk across the list compare each element to the minimum element so far. If the current element is less than the minimum element so far then let it be the new minimum. Continue in this manner until the end of the list is reached.**
- **Pseudocode / flowchart / code are also acceptable**

Very good description - clear understanding demonstrated 3 marks
Fair description - limited understanding/use of built in functions 1 mark

(iv) **2 marks**

- **The same element would always be copied.**
- **list1 will remain unchanged.**
- **This would result in an infinite loop.**

Very good explanation - clear understanding demonstrated 2 marks

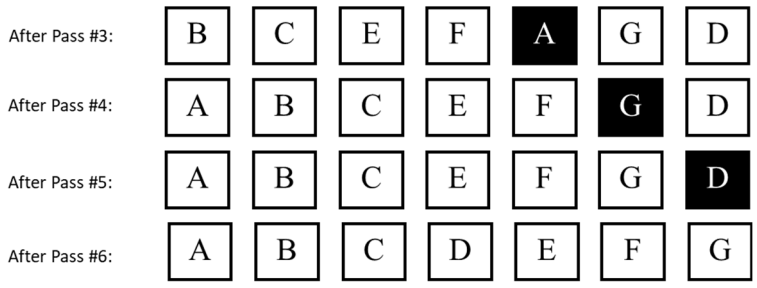
(v) **3 marks**

- **The selection sort algorithm works by passing across every element in the list to sort (from left to right). The element being passed over is called the current element. For each current element the algorithm looks for the minimum (smallest) element to its right. This minimum element is selected and swapped with the current element. The algorithm then moves on to the next element.**
- **Pseudocode / flowchart / code are also acceptable.**

Very good description - clear understanding demonstrated 3 marks
Fair description - limited understanding 1 mark

(b) **17 (4, 4, 4, 5) marks**

(i) **4 marks**



Each correct pass 1 mark

(ii) **4 marks**

- **The insertion sort works by passing across each element in the list starting from the second element. At the start, the first element is considered sorted and all elements to its right are considered unsorted. On each pass the first element in the unsorted list is inserted into the sorted list at its correct position.**
- **Pseudocode / flowchart / code are also acceptable.**

Very good explanation - clear understanding demonstrated	4 marks
Good explanation - clear information, lacking demonstration of full understanding	2 marks
Fair explanation - limited understanding	1 mark

(iii) **4 marks**

- **A list that is already sorted.**
- **A list where all the values are the same.**
- **A list with only two distinct values.**
- **A list where all the values are different.**
- **A list with just one element – list size 1.**
- **An empty list – list size zero.**
- **Any valid test case.**

For each unique test case:

Very good description - clear understanding demonstrated	2 marks

(iv) **5 marks**

- **Worst case is $O(n^2)$ – list in reverse order. For each of the n elements there are n comparisons required to make the insertion at the correct positon.**

AND

- **Average case is also $O(n^2)$ / best case is O(n) – list is already sorted so no there is need to execute inner loop.**

Very good discussion - clear understanding demonstrated	5 marks
Good discussion - clear information, lacking demonstration of full understanding	3 marks
Fair discussion - limited understanding	1 mark

Question 15 **30 (3, 11, 16) marks**

(a) **3 marks**

Step 1. **1x10=10**
0x9=0
2x8=16
0x7=0
0x6=0
4x5=20
1x4=4
1x3=3
0x2=0
2x1=2

Step 2. **10+16+20+4+3+2=55**

Step 3. **55/11=5 remainder 0**

Step 4. **Remainder = 0 => ISBN is valid**

Full correct response	3 marks
Two or three correct steps	2 marks
Any correct step	1 mark

(b) **11 (2, 4, 3, 2) marks**

(i) **2 marks**

- **Make code more readable / understandable for self / others.**
- **To enable programmer to isolate a part of the code for testing.**
- **Comments when used as doc strings can become part of the system documentation.**
- **Comments can contain information about the author, date, version log etc.**
- **Any reasonable use for comments should be accepted.**

Each unique correct response	1 mark

(ii) **4 marks**

Variable.

- **A variable is a placeholder for data that can change as a program runs.**
- **A named entity that has a value.**
- **A reference to a memory/storage location.**
- **A parameter is a special kind of variable.**

Examples from code: isbn, total, i, check_digit

Datatype

- **A category of data that can be held in a variable.**
- **A restriction on the values that can be stored in a variable.**

Examples from code: isbn is a string, total, i and check_digit are all integers

For each term:	
Good description - clear understanding demonstrated	1 mark
Valid example	1 mark

(iii) **3 marks**

- **`int` converts (casts) the string representation of each character of the `isbn` to an integer. This happens on each iteration of the loop. This is done so that the digit can be multiplied (integer multiplication) by its position.**

Very good description - clear understanding demonstrated	3 marks
Fair description - limited understanding	1 mark

(iv) **2 marks**

- **As a loop counter / iterating variable**
- **As an index into the list, isbn (to retrieve the next digit) / As a means of scanning the digits from left to right**
- **As the digit position**

Very good description - clear understanding demonstrated	2 marks
Fair description - limited understanding	1 mark

(c) **16 (5, 3, 2, 4, 2) marks**

(i) **5 marks**

i	digit	total	isbn
		0	102004110
2	0	0	10200411
3	1	3	1020041
4	1	7	102004
5	4	27	10200
6	0	27	1020
7	**0**	**27**	**102**
8	**2**	**43**	**10**
9	**0**	**43**	**1**
10	**1**	**53**	**0**

Full correct answer	5 marks
Two or more correct rows/cols	3 marks
Any one correct row/col	1 mark

(ii) **3 marks**

- **`isbn1` is used to store the original `isbn` as the value of `isbn` is changed**

Very good description - clear understanding demonstrated 3 marks
Fair description - limited understanding 1 mark

(iii) **2 marks**

- **% is the modulus/remainder operator. It returns the remainder when one number is divided by another e.g. 9%4 -> 1**
- **// is the floor division operator. It returns the result of a division rounded down to the next smallest whole number e.g. 9//4 -> 2**

For each operator:
Good description - clear understanding demonstrated 1 mark

(iv) **4 marks**

- **Use of string in program 1 and int in program 2 (to store the ISBN)**
- **Program 1 traverses string left to right – program 2 takes digits from right to left**
- **Program 1 uses range to count from 10 down to 2 (or 10 down to but not including 1) whereas program 2 uses range to count from 2 up to 10 (or 2 up to but not including 11)**
- **Program 1 does not modify the original isbn number – program 2 does. Program 2 needs to use isbn1 to keep track (remember) the original isbn.**

For each difference:
Very good description - clear understanding demonstrated 2 marks

(v) **2 marks**

- **letter/digit errors, such as l → 1 or O → 0**
- **single digit errors, such as 1 → 2**
- **transposition errors, such as 12 → 21**
- **twin errors, such as 11 → 22**
- **jump transpositions errors, such as 132 → 231**
- **jump twin errors, such as 131 → 232**

Very good description - clear understanding demonstrated 2 marks
Fair description - limited understanding 1 mark