

H

National Qualifications

Computing Science

Wednesday, 20 May

Instructions to Candidates

Candidates should enter their surname, forename(s), date of birth, Scottish candidate number and the name and level of the subject at the top of their first answer sheet.

Total marks – 80 marks

Only Section 1 and Section 2 have been provided.

SECTION 1 — Software design and development, and Computer systems — 55 marks

Attempt ALL questions

SECTION 2 — Database design and development — 25 marks

Attempt ALL questions

You may use a calculator.

Show all workings.

Questions marked with an asterisk differ in some respect from those in the printed paper.

You must clearly identify the question number you are attempting on your answer sheet.

An owl in the margin indicates a new question.

[Braille page 2] Marks are shown in square brackets at the end of each question or part question.

Do not remove any exam materials. You must leave this booklet on your desk; if you do not, you could lose all the marks for this paper.

[Braille page 3] SECTION 1

SOFTWARE DESIGN AND

DEVELOPMENT, AND COMPUTER

SYSTEMS — 55 marks

Attempt ALL questions

Now 1. (a) Convert the 8-bit two's complement number 1010 1010 into denary. [1 mark]

(b) State how many bits would be required to represent the number -273 using two's complement notation. [1 mark]

Now * 2. (a) Convert the binary number below into floating-point representation:

1.11

There are 16 bits for the mantissa (including the sign bit) and 8 bits for the exponent. [3 marks]

Complete the table using the format as shown:

In the table below, sign is followed by: mantissa; exponent.

____: _____; _____.

(b) Describe how the 24 bits allocated in part (a) can be changed to increase the precision of floating-point numbers that can be represented. Your answer should refer to both the mantissa and **[Braille page 4]** exponent. (4 print lines) [1 mark]

ow 3. Formal and actual parameters are used in the code below.

```
Line 1  FUNCTION discount (REAL price, REAL percentage)
        RETURNS REAL
Line 2      DECLARE discountAmount AS REAL INITIALLY 0.0
Line 3      SET discountAmount TO price * (percentage/100)
Line 4      SET price TO price – discountAmount
Line 5      RETURN price
Line 6  END FUNCTION
...      ...
Line 66  SET newPrice TO discount(originalPrice, discountRate)
```

Identify one formal parameter and its associated actual parameter. [2 marks]

Formal parameter (1 print line)

Actual parameter (1 print line)

[Braille page 5] ow 4. Explain why a processor with a smaller amount of cache memory would underperform when compared with an identical processor with a larger amount of cache memory. (4 print lines) [2 marks]

ow 5. A company wants to extract the domain name from e-mail addresses. The domain name is the part after the '@' in the e-mail address.

For example, 'qas.co.uk' would be extracted from 'robertsmith@qas.co.uk'.

Using a design technique of your choice, design an algorithm to extract the domain name from any e-mail address stored in the variable email and assign it to the variable domainName. [3 marks]

ow * 6. A motorway service station has a tyre inflation machine controlled by a program.

The image has been replaced with a description.

On the control panel there are 3 small separate screens for:

'Maximum Pressure', currently showing 100.00, below this is the screen for;

'Current Pressure', currently showing 32.50 and to the right of these screens is the screen for;

[Braille page 6] 'Required pressure', showing a blank screen.

Below the 'Required pressure' screen is a keypad with numbered buttons for 0 to 9, and buttons for a decimal point, 'clear' and 'enter'.

There are also 4 instructions:

'1. Connect hose to tyre'

'2. Enter required pressure using keypad and press enter'

'3. Air will be increased or decreased as required'

'4. When unit beeps, disconnect hose'

The machine measures the current tyre pressure. The machine then asks the user to enter their required tyre pressure and the program determines if the machine should inflate or deflate the tyre accordingly.

(a) During the analysis stage boundaries are identified.

State one boundary for this program. (3 print lines) [1 mark]

(b) The owners have a website which shows the location of the service station.

They discover that the website's digital certificate has expired.

Other than the expiry date, state one other piece of information contained within a digital certificate. (2 print **[Braille page 7]** lines) [1 mark]

(c) The owners send an e-mail to a supplier.

Explain why both a digital certificate and a digital signature are needed. [2 marks]

Digital certificate (3 print lines)

Digital signature (3 print lines)

(d) Describe how intelligent traffic control systems can reduce the environmental impact of a motorway. (4 print lines) [1 mark]

ow 7. Staff at an event use an app to record the number of times they serve tea, coffee and water. The details of the drinks served are collected and stored in parallel arrays named `drinkTypes` and `numOrders` as shown below.

<code>drinkTypes</code>	<code>numOrders</code>
.....	
Tea	1
Coffee	3
Tea	2
Water	6
Coffee	1
Water	4
Tea	2

[Braille page 8] The app will count and store the number of times each type of drink has been served in an array called `totals`.

For example, using the data above there are 5 teas, 4 coffees and 10 waters.

The expected values in the `totals` array would be `[5, 4, 10]`.

The code below is used to implement this. When the code was tested an error was found.

[Braille page 9]

```
Line 1  FUNCTION checkItems (ARRAY OF STRING drinkTypes,  
        ARRAY OF INTEGER numOrders) RETURNS ARRAY OF INTEGER  
  
Line 2    DECLARE currentItem INITIALLY  
  
Line 3    DECLARE drinks INITIALLY AS [Tea,Coffee, Water]  
  
Line 4    DECLARE currentTotal INITIALLY 0  
  
Line 5    FOR index FROM 0 TO length(numOrders)-1 DO  
  
Line 6        DECLARE totals INITIALLY [0] * 3  
  
Line 7        SET currentDrink TO drinks[index]  
  
Line 8        SET currentDrinkTotal TO  
            countItems (drinkTypes,numOrders,currentDrink)  
  
Line 9        SET totals [index] TO currentDrinkTotal  
  
Line 10    END FOR
```

[Braille page 10]

```
Line 11    RETURN totals  
  
Line 12 END FUNCTION  
  
...  
  
Line 20 FUNCTION countItems (ARRAY OF STRING drinkTypes,  
        ARRAY OF INTEGER numOrders, STRING currentDrink)  
        RETURNS INTEGER  
  
Line 21    DECLARE total INITIALLY 0  
  
Line 22    FOR counter FROM 0 TO length (drinkTypes)-1 DO  
  
Line 23        IF drinkTypes [counter] = currentItem THEN  
  
Line 24            SET total TO total + numOrders [counter]  
  
Line 25        END IF  
  
Line 26    END FOR  
  
Line 27    RETURN total  
  
Line 28 END FUNCTION
```

[Braille page 11] (a) The contents of the drinkTypes and numOrders arrays are shown below.

drinkTypes	numOrders
.....	
Tea	1
Coffee	3
Tea	2
Water	6
Coffee	1
Water	4
Tea	2

Using the data above, complete the trace table below by identifying the missing values for A to E below. [4 marks]

In the table below, Line number is followed by index; totals; currentDrink; currentDrinkTotal.

[Braille page 12] 5: 0; _; _; _.

6: _; [0, 0, 0]; _; _.

7: _; _; A; _.

8: _; _; _; 5.

9: _; [5, 0, 0]; _; _.

5: 1; _; _; _.

6: _; B; _; _.

7: _; _; C; _.

8: _; _; _; D.

9: _; E; _; _.

(b) Identify the line number causing the error and describe the change required to make the code fit for purpose. [2 marks]

Line number (1 print line)

Change (4 print lines)

(c) Describe how a watchpoint could be used to test code. (4 print lines) [2 marks]

ow 8. A Harshad number is an integer that is exactly divisible by the sum of its digits.

For example:

132 is a Harshad number.

The digits of 132 are 1, 3 and 2 and the sum of these digits is 6.

132 is exactly divisible by 6 ($132 \div 6 = 22$).

[Braille page 13] 251 is not a Harshad number.

The digits of 251 are 2, 5 and 1 and the sum of these digits is 8.

251 is not exactly divisible by 8 ($251 \div 8 = 31.375$).

The algorithm below is used to check if a number is a Harshad number or not.

[Braille page 14]

```
Line 1  FUNCTION checkHarshad (INTEGER number) RETURNS INTEGER
Line 2    DECLARE numberString AS STRING INITIALLY ""
Line 3    SET numberString TO <parameter number converted to a
           string of digits>
Line 4    DECLARE total AS INTEGER INITIALLY 0
Line 5    FOR index FROM 0 TO length (numberString) DO
Line 6        SET digitChar TO numberString [index]
Line 7        SET digit TO <digitChar converted to an integer>
Line 8        SET total TO total + digit
Line 9    END FOR
Line 10   <Divide number by total and store the remainder in
           the variable named result>
Line 11   RETURN result
```

[Braille page 15]

```
Line 12  END FUNCTION
...
Line 40  RECEIVE checkNo FROM INTEGER KEYBOARD
Line 41  _____
Line 42  IF finalResult = 0 THEN
Line 43    SEND checkNo & "is a Harshad number" TO DISPLAY
Line 44  ELSE
Line 45    SEND checkNo & "is not a Harshad number" TO DISPLAY
Line 46  END IF
```

(a) Using a programming language of your choice, write the code for line 10. [2 marks]

(b) The function checkHarshad is used to assign a value to the variable finalResult.

Using a programming language of your choice, write the missing code at Line 41 to call the function. [2 marks]

(c) The program makes use of local variables.

[Braille page 16] (i) Explain why the scope of the variable total is local. (3 print lines) [1 mark]

(ii) Explain why the use of local variables makes programs more efficient. (3 print lines) [1 mark]

ow 9. An online streaming service that offers TV shows, movies and documentaries, uses a program to manage its media library.

The program stores data in four parallel 1D arrays called: title, type, genre, releaseYear.

A sample of the data is shown below.

Grace, TV Show, Thriller, 2024

Beneath the Blue Sky, Movie, Drama, 2023

Life in the City, TV Show, Drama, 2020

Echoes of Yesterday, Movie, Thriller, 2022

West Street, Movie, Action, 2018

Marine Life, Documentary, Nature, 2024

(a) The procedure below is used to display the position of all 'Thriller' titles in the genre array.

[Braille page 17]

Line 1 PROCEDURE search (ARRAY OF STRING genre)

Line 2 DECLARE position INITIALLY 0

Line 3 FOR index FROM 0 TO length (genre) -1 DO

Line 4 IF genre [index] = "Thriller" THEN

Line 5 SET position TO index

Line 6 END IF

Line 7 END FOR

Line 8 SEND position TO DISPLAY

Line 9 END PROCEDURE

(i) Using the sample data provided, state the output from this procedure. (1 print line) [1 mark]

(ii) Explain why this procedure is not fit for purpose. (3 print lines) [1 mark]

(iii) Describe the changes needed to make this procedure fit for purpose. (3 print lines) [1 mark]

(b) The streaming service wants to analyse the number of TV dramas in their **[Braille page 18]** full library.

Using a design technique of your choice, design an algorithm to calculate the number of TV dramas and write this number to an external file called 'tvDramas.txt'. [5 marks]

(c) The software developer has used Unicode to represent the text in the program instead of extended ASCII.

Describe one advantage of using Unicode instead of extended ASCII to represent text. (3 print lines) [1 mark]

(d) The streaming service uses tracking cookies.

Describe how tracking cookies can impact users' privacy. (3 print lines) [1 mark]

ow 10. A book shop has a collection of 2000 books. The title, author, publication year and price of each book is stored in a text file.

(a) A program is required to store and process the book data.

A sample of the data stored is shown below.

In the table below, Title is followed by: Author; Publication Year; Price.

[Braille page 19] The Diary: Ann Laird; 1917; 15.98.

Animal Park: George Smith; 1995; 9.99.

Animal Park: George Smith; 1945; 9.51.

Animal Park: George Smith; 1937; 12.99.

Coding 101: Aisha Khan; 2005; 12.34.

Coding 101: Joe Brand; 2013; 14.99.

Pride: Julia Workman; 2001; 11.45.

Pride: Julia Workman; 2015; 15.29.

....;;

(i) Using a programming language of your choice, define a suitable record data structure to store a book's data. [2 marks]

(ii) Using a programming language of your choice, declare a variable that could be used to store data for 2000 books.

Your answer should make use of the record data structure defined in part (i). [2 marks]

(b) An author can publish a book under the same title in different years.

[Braille page 20] One feature of the program is to display the earliest publication year of a book when the user enters a title and author.

The top-level design for this feature is shown below.

1. Read the data from a text file into an array of records.
2. Ask user to enter the title and author to search for.
3. Find the position in the array of records of the earliest publication year of the book with the title and author entered in step 2.
4. Display the earliest publication year of the book with the title and author entered in step 2. If no match is found, display a message indicating this.

Refer to the table below to identify the missing data flow for steps 1, 3 and 4. [3 marks]

Step	IN	OUT
.....	...	
1	—	—
2	—	searchTitle, searchAuthor
3	—	foundPosition
4	—	—

[Braille page 21] Write your answers in the form:

Step _ : Flow _ : Data _

(c) Using a programming language of your choice, write the code for step 3.

Your answer should use the record data structure and variable declared in part (a).
[6 marks]

[END OF SECTION 1]

[Braille page 22] SECTION 2

DATABASE DESIGN AND

DEVELOPMENT — 25 marks

Attempt ALL questions

ow 11. A car repair business uses a database to manage details of all the work carried out in their garage. The entities and attributes for the database are shown below.

In the table below, Vehicle is followed by: Customer; Job; Mechanic.

regNo: customerID; jobID; mechanicID.

type: forename; regNo*; forename.

make: surname; mechanicID*; surname.

model: address; date; hoursWorked.

customerID*: telephone; workRequested; _.

_: email; _; _.

Describe an entity-relationship diagram to show the relationships that exist in this database.

Your answer should only show the entity names and cardinality. [3 marks]

[Braille page 23] ow 12. The database table below contains some sample data on various walking tours around Scotland.

Tour

In the table below, tourID is followed by: tourName; season; location; miles; guided.

E2: Spooktacular; Autumn; Edinburgh; 5; False.

E5: Tay Forest Walk; Summer; Pitlochry; 7; False.

W1: Cobbler's Way; Spring; Arrochar; 7; True.

E4: Tentsmuir Trek; Summer; St Andrews; 9; True.

N7: Rocks and Shoals; Spring; Thurso; 4; True.

S3: Hen's Farm; Spring; Galashiels; 3; False.

W4: Loch Ryan Tour; Summer; Stranraer; 14; False.

N8: Deeside Walk; Winter; Aberdeen; 1; False.

N2: Ski Country; Winter; Aviemore; 10; False.

C6: Castle Tour; Autumn; Stirling; 7; False.

C1: Lornty Nature Trail; Summer; Blairgowrie; 8; True.

[Braille page 24] W3: Storr's View; Autumn; Skye; 9; True.

W2: Festive Lights; Winter; Glasgow; 6; False.

....;;;;

The following SQL statement is used to display the shortest guided tour for each season.

```
SELECT season, MIN (miles) AS [Shortest route]
FROM Tour
WHERE guided = True
GROUP BY season
ORDER BY MIN (miles) DESC;
```

Using the sample data provided, write the expected output from the SQL statement above. Answer in the format: season _ - Shortest route_ [2 marks]

ow 13. A decorating company uses a database to keep track of the work they carry out. Sample data from the database is shown below.

[Braille page 25] Job

In the table below, jobID is followed by: jobDescription; billedCost; expenses.

AT44: Exterior walls painted; 800.00; 600.00.
PD27: Chandelier polished and rehung; 400.00; 175.00.
BC99: Lounge wallpapered; 350.00; 180.00.
BF89: 3 bedrooms wallpapered; 750.00; 475.00.
BH49: 2 exterior doors painted; 320.00; 100.00.
NF77: Exterior woodwork varnished; 470.00; 300.00.
AB73: Windowsill repainting; 80.00; 42.00.
BD14: Kitchen ceiling painted; 250.00; 150.00.
SC45: Repaint hallway ceiling; 250.00; 136.00.
HL19: Painting of stairway banister; 400.00; 250.00.
WE99: 3 ceilings plastered and painted; 550.00; 375.00.
HT83: Install and paint balcony banister; 700.00; 100.00.
KL65: Dining room painted; **[Braille page 26]** 375.00; 180.00.
NV22: Varnish dining room floor; 350.00; 100.00.
GH99: Wallpaper entrance hallway; 1000.00; 650.00.
...: ...; ...;

The company wants to know the total profit from all jobs involving paint. Profit is calculated by subtracting the expenses from the billed cost.

Write the SQL statement to calculate the total profit and display it as shown below. [3 marks]

Total profit

1792.00

ow 14. An archery club runs an annual tournament. The entries and scores for the tournament are held in three database tables named 'Event', 'Archer' and 'Result'.

Sample data from each table is shown below.

[Braille page 27] Event

In the table below, eventID is followed by: eventName; type; extraMarshals.

Ev1: 10 m Shot; Lawn; False.

Ev2: 20 m Shot; Lawn; False.

Ev3: Target Shoot; Forest; True.

Ev4: Mountain Range; Hills; True.

....:;;

Archer

In the table below, archerID is followed by: forename; surname; style.

A1: Euan; Dilloway; Right-handed.

A2: Pandora; Audley; Right-handed.

A3: Kelsie; Buckthorpe; Left-handed.

A4: Locke; Turfus; Left-handed.

....:;;

[Braille page 28] Result

eventID	archerID	points
.....		
Ev1	A1	50
Ev1	A2	45
Ev1	A3	45
Ev1	A4	40
Ev2	A1	20
Ev2	A2	30
Ev2	A3	35
Ev2	A4	40
Ev3	A1	67
Ev3	A2	55
Ev3	A3	60
Ev3	A4	40
Ev4	A1	40
Ev4	A2	57
Ev4	A3	58
Ev4	A4	65
...	...	...

(a) Identify the primary key used in the Result table. [1 mark]

(b) A query was created to display the average number of points from the whole tournament. This query was saved as 'OverallAverage' and the output is shown below.

[Braille page 29] AveragePoints

46.69

Using the query 'OverallAverage', complete the SQL statement below to display the archers' names and the events where they scored more than the average points. [3 marks]

The expected output is shown below.

In the table below, forename is followed by: surname; eventName; points.

Euan: Dilloway; 10 m Shot; 50.

Euan: Dilloway; Target Shoot; 67.

Pandora: Audley; Target Shoot; 55.

Kelsie: Buckthorpe; Target Shoot; 60.

Pandora: Audley; Mountain Range; 57.

Kelsie: Buckthorpe; Mountain Range; 58.

Locke: Turfus; Mountain Range; 65.

SELECT forename, surname, eventName, points

(c) The organisers want to know the number of times a left-handed archer competed **[Braille page 30]** in a lawn event.

The expected output from the query is shown below.

Left-handed lawn archers

4

Design a query to display the output above. [3 marks]

Field(s) and calculation(s) _

Table(s) _

Search criteria _

Grouping _

Sort order _

ow 15. Caledonia Boating has a number of small boats that customers can book to take them on trips around Loch Lomond. They would like to make use of a relational database to manage their bookings.

(a) Some of the end-user requirements used to create the system were to find and display the:

- name of the customer who has booked the most expensive trip
- name of the captain of the boat with most bookings
- total number of boat trips on a specific date.

Using the end-user requirements above, create two functional requirements of the relational database. [2 marks]

[Braille page 31] Functional requirement 1 (4 print lines)

Functional requirement 2 (4 print lines)

Sample data from the implemented database tables is shown below.

Boat

In the table below, boatID is followed by: boatName; capacity; captain.

B022: Flying Fish; 7; Helen Anderson.

B060: The Aurora; 6; Malcolm Smith.

B102: Maid of the Myth; 10; Jabari Mensah.

B117: Big Blue; 20; Jimmy McMenemy.

B123: Pride of Scotland; 8; Lucy McWilliam.

....;;;

Customer

In the table below, custID is followed by: forename; surname; address; telNo.

[Braille page 32] 19: Jason; Summers; 4 Warden Drive; 01332 825671.

20: Sue; Robertson; 12 North Street; 01332 321546.

21: Fred; Cooper; 121 Windmill Road; 01332 772859.

22: Mateusz; Popescu; 86 View Road; 01332 828451.

....;;;

Booking

In the table below, bookRef is followed by: custID; tripDate; partySize; timeOut; timeIn; price.

R27: 22; 16/06/2026; 6; 09:00; 12:00; 130.00.

R28: 19; 20/06/2026; 12; 12:00; 14:00; 260.00.

R29: 21; 22/06/2026; 24; 10:00; 15:00; 440.00.

R30: 20; 25/06/2026; 23; 12:00; 16:00; 495.00.

...; ...; ...; ...; ...; ...

[Braille page 33] BoatBooking

bookRef	boatID	passengers
.....		
R27	B060	6
R28	B123	8
R28	B022	4
R29	B117	19
R29	B060	5
R30	B102	10
R30	B123	8
R30	B022	5
...;	...;	

(b) Caledonia Boating decide to lower the price by £15.00 for any booking where the party size is less than 10 and the trip starts before 12:00.

Write the SQL statement for a single query that would change the price for these bookings. [2 marks]

(c) Caledonia Boating want to calculate and display the average number of passengers that are booked for a trip on each boat.

The expected output is shown below.

[Braille page 34]

boatName	Average passengers
.....	
Big Blue	19
Flying Fish	4.5
Maid of the Myth	10
Pride of Scotland	8
The Aurora	5.5

Write an SQL statement to produce this output. [3 marks]

(d) A query is produced to show the lowest number of passengers on any boat with a capacity of less than 10 and where the price is greater than £200.

The expected output is shown below.

boatName	Least passengers
.....	
Pride of Scotland	8
The Aurora	5
Flying Fish	4

The following SQL statement is executed.

[Braille page 35]

```
SELECT boatName, passengers AS [Least passengers]
FROM Boat, Booking, BoatBooking
WHERE Boat.boatID = BoatBooking.boatID
AND capacity < 10
AND price > 200
GROUP BY boatName;
```

When tested, the actual output did not match the expected output.

Describe the three errors in the above SQL statement. [3 marks]

Error 1 (2 print lines)

Error 2 (2 print lines)

Error 3 (2 print lines)

[END OF SECTION 2]

[END OF QUESTION PAPER]