FOR OFFICIAL USE

National Qualifications 2024

Mark

X816/76/01 Computing Science

MONDAY, 20 MAY
1:00 PM – 3:00 PM

X8167601

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth
Day Month Year

Scottish candidate number

Total marks — 80

SECTION 1 — Software design and development, and Computer systems — 55 marks
Attempt ALL questions.

Attempt either Section 2 OR Section 3

SECTION 2 — Database design and development — 25 marks

SECTION 3 — Web design and development — 25 marks

You may use a calculator.
Show all workings.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

X8167601

SECTION 1 — SOFTWARE DESIGN AND DEVELOPMENT, AND COMPUTER SYSTEMS — 55 marks

Attempt ALL questions

1. (a) Convert the following denary number to an 8-bit two's complement number.

Comp Sys

−25 **1**

(b) State the largest positive integer that can be represented using 8-bit two's complement. **1**

2. Describe how evaluation differs when developing software using an agile methodology compared to an iterative methodology. **2**

3. (a) Convert the binary number below into floating-point representation.

Comp Sys

−0.111

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

Space for working

sign	mantissa	exponent

(b) State the effect on the representation of floating-point numbers of increasing the number of bits used to represent the exponent. **1**

[Turn over

4. An array `surnames` contains a list of surnames.

Using a design technique of your choice, design an algorithm to find the number of characters in the longest surname. **4**

5. Computer performance is improved by the inclusion of cache memory on the same computer chip as the processor.

Comp Sys

Describe how cache memory improves performance. **2**

6. A prime number is only divisible by one and itself. The first five prime numbers are shown below:

2, 3, 5, 7, 11, . . .

The code below checks if a number is prime.

```
Line 1    FUNCTION checkPrime(INTEGER n) RETURNS BOOLEAN
Line 2        DECLARE validPrime INITIALLY TRUE
Line 3        IF n < 2 THEN
Line 4           SET validPrime TO FALSE
Line 5        ELSE
Line 6           FOR divisor FROM 2 TO (n-1) DO
Line 7              IF <the remainder of n divided by divisor is
                       equal to 0> THEN
Line 8                 SET validPrime TO FALSE
Line 9              END IF
Line 10          END FOR
Line 11       RETURN validPrime
Line 12   END FUNCTION
...
Line 42   DECLARE inputNum AS INTEGER INITIALLY FROM KEYBOARD
Line 43   <set isPrime by calling the function checkPrime to
          identify if inputNum is prime or not>
Line 44   IF isPrime = TRUE THEN
Line 45       SEND inputNum & " is prime." TO DISPLAY
Line 46   ELSE
Line 47       SEND inputNum & " is not prime." TO DISPLAY
Line 48   END IF
```

(a) Using a programming language of your choice, write the code for line 7. **2**

(b) Using a programming language of your choice, write the code for line 43. **2**

7. Recipe Finder is an app which allows users to search a list of stored recipes and displays the matching recipes.

The app stores the following details about each recipe:

- recipe title
- main ingredient
- cooking time (in minutes)
- cost per portion
- average rating (out of 5).

The app uses the record data structure shown below for the recipe data.

```
RECORD Recipe IS {STRING title, STRING ingredient,
                  INTEGER minutes, REAL cost, REAL avgRating}
```

(a) Using a programming language of your choice, declare a variable that can store the data for 750 recipes.

Your answer should include the record data structure defined above. **2**

7. (continued)

(b) Users want to search for recipes by entering the main ingredient and the maximum cooking time (in minutes). The titles and cooking times of any matching recipes should be displayed. For example:

Inputs:

Main ingredient: Pasta

Maximum cooking time: 60

Output:

Lasagne requiring 45 minutes.

Macaroni Cheese requiring 25 minutes.

…

If no recipes match the criteria the following message is displayed.

'No matches found.'

Using a programming language of your choice, write the code to display this information. Your answer should use the record data structure provided. **6**

8. A program should generate a list of unique random integers between a lower and upper limit as chosen by the user.

MARKS DO NOT WRITE IN THIS MARGIN

Enter the number of values	7
Enter the minimum value	0
Enter the maximum value	20
The values are	1,5,7,9,13,15,19

(a) Identify two boundaries of this problem. **2**

The function `validNum` is used to check if a number is already present in the array or not.

When the code is tested an error is found.

```
...
Line 34   FUNCTION validNum(INTEGER randomNum,
                        ARRAY OF INTEGER values) RETURNS BOOLEAN
Line 35      DECLARE valid INITIALLY FALSE
Line 36      FOR index FROM 0 TO length(values) - 1 DO
Line 37         IF values[index] = randomNum THEN
Line 38            SET valid TO FALSE
Line 39         END IF
Line 40      END FOR
Line 41      RETURN valid
Line 42   END FUNCTION
...
Line 63   DECLARE randomList as ARRAY OF INTEGER
          INITIALLY [0] * <size of array>
Line 64   FOR index FROM 0 TO length(randomList) - 1 DO
Line 65      randomVal = <random number between minimum value
                        and maximum value>
Line 66      WHILE validNum(randomVal,randomList) = FALSE
Line 67         randomVal = <random number between minimum value
                          and maximum value>
Line 68      END WHILE
Line 69      SET randomList[index] TO randomVal
Line 70   END FOR
...
```

8. (continued)

(b) The error is found to be in the function `validNum` shown in lines 34 to 42.

(i) Identify the error in the function. **1**

(ii) Describe the effect of this error when lines 63 to 70 are executed. **2**

(c) The error has been corrected and the code now executes as expected.

Describe how the `validNum` function could be made more efficient. **2**

(d) Formal and actual parameters are used in the code.

Identify a formal parameter for the `validNum` function and its associated actual parameter. **2**

Formal parameter _____

Actual parameter _____

[Turn over

9. An insurance company requires that a black box is installed in an insured car to store data about each journey. **MARKS** DO NOT WRITE IN THIS MARGIN

The black box records data for each journey including:

- date of travel
- distance travelled in miles
- time spent driving in hours (for example 1 hour 15 minutes is stored as 1.25).

A sample of the data is shown below.

09/03/2024, 40.25, 1.25
04/04/2024, 5.12, 0.17
04/04/2024, 5.12, 0.21
…

A program is written to analyse this data.

The top-level design for the program is shown below.

1. Read the data from a text file into parallel 1D arrays.
2. Calculate the average speed for each individual journey by dividing the distance for that journey by the time taken for that journey.
3. Calculate the average distance travelled for journeys longer than one hour.
4. Write the average speed of all journeys that have a greater distance than the average distance to a file.

(a) Complete the table below to show the missing data flow for steps 2, 3 and 4. **4**

Step	IN/OUT	Data flow
1	IN	
	OUT	date[], distance[], drivingTime[]
2	IN	
	OUT	
3	IN	
	OUT	avgDistance
4	IN	
	OUT	

9. (continued)

(b) Explain how the data flow identified at the design stage would assist the programmer when implementing the code for the program. **1**

(c) Step 3 calculates the average distance for journeys longer than one hour.

Using a design technique of your choice, design an algorithm for step 3. **4**

9. (continued)

(d) The company has been the target of a Denial of Service (DOS) attack involving resource starvation. Comp Sys

(i) Describe what is meant by a resource starvation DOS attack. **1**

(ii) State one cost to the company as a result of a DOS attack. **1**

[Turn over for next question

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10. Lewis uses a smart watch to track the distance he walks each day for a week. His target is to walk 5 kilometres or more each day.

The program will find the highest the number of consecutive days Lewis meets this target.

For example, if the data was 5.2, 4.2, 4.0, 4.8, 5.8, 5.2, 6.4

The expected output should be 3.

The following code has been developed to find the highest number of consecutive days Lewis has met his target but there is an error.

```
...
Line 09   FUNCTION consecutiveDays (ARRAY OF REAL values)
          RETURNS INTEGER
Line 10     DECLARE counter INITIALLY 0
Line 11     DECLARE longestStreak INITIALLY - 1
Line 12     FOR index FROM 0 TO LENGTH(values) - 1 DO
Line 13       SET counter TO 0
Line 14       IF values[index] >= 5.0 THEN
Line 15          SET counter TO counter + 1
Line 16       ELSE
Line 17          IF counter > longestStreak THEN
Line 18             SET longestStreak TO counter
Line 19          END IF
Line 20          SET counter TO 0
Line 21       END IF
Line 22     END FOR
Line 23     IF counter > longestStreak THEN
Line 24          SET longestStreak TO counter
Line 25     END IF
Line 26     RETURN longestStreak
Line 27   END FUNCTION
...
Line 46   SET distances TO [5.2, 4.2, 4.0, 4.8, 5.8, 5.2, 6.4]
Line 47   SET daysMet TO consecutiveDays(distances)
...
```

10. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(a) Complete the trace table for the first two iterations of the loop.

The trace table should indicate the line number where a variable changes value and the new value of that variable. **3**

Line number	counter	index	longestStreak
10	0		
11			−1
12		0	
13	0		
15			
12			
13			
18			
20			

(b) State the line number of the code that should be removed to correct the algorithm. **1**

(c) Name and describe a debugging technique that could be used during execution of the code. **2**

(d) Explain why the scope of the variable `counter` is local. **1**

10. (continued)

(e) Describe how modular programming increases the efficiency and maintainability of the code. **2**

Efficiency _____

_____

_____

Maintainability _____

_____

_____

[END OF SECTION 1]

SECTION 2 — DATABASE DESIGN AND DEVELOPMENT — 25 marks

Attempt ALL questions

11. A gym would like to make use of a relational database.

(a) Some of the end-user requirements described by the gym staff are to find and display the:

- number of classes run by each instructor
- name of the member who attends the most classes
- name and address of any member who attends more than five classes per week
- total cost of all the classes attended by a member.

(i) Using the end-user requirements above, identify one functional requirement of the relational database. **1**

(ii) State an aggregate function that would be needed when implementing the functional requirement identified in part (i) above. **1**

[Turn over

11. (continued)

(b) The following sample data shows:

- instructors and the classes that they run
- members and the classes that they attend.

Instructor	Class
Ins1	Class1
Ins2	Class4
Ins3	Class2
Ins3	Class3

Member	Class
Mem1	Class2
Mem2	Class2
Mem3	Class1
Mem1	Class3
Mem2	Class4

Using this sample data, complete an entity-occurrence diagram. Your diagram should include the:

- name of the entities
- instances for each entity
- association between these instances. **2**

12. An e-sports club runs weekly tournaments. The club uses three linked tables in a relational database to store details of players, tournaments and scores as shown below.

Player	Tournament	Score
playerID	tournamentID	playerID*
forename	title	tournamentID*
surname	date	score
email		

The following SQL statement has been written to add a new score to the `Score` table.

```
INSERT INTO Score(playerID,score)
VALUES("P1815", 550);
```

The `tournamentID` field is missing from the SQL statement.

Explain why this causes the SQL statement to fail. **2**

DO NOT WRITE IN THIS MARGIN

13. A relational database is used to store details of items for sale in a fruit and vegetable shop and of the shop's suppliers in linked tables.

Sample data from two tables is shown below.

Item						
itemID	**itemName**	**type**	**buyingPrice**	**sellingPrice**	**quantity**	**supplierRef**
145	Gala apples	Fruit	0.40	0.44	60	F96
146	Iceberg lettuce	Veg	0.52	0.60	45	F216
147	Satsuma	Fruit	0.30	0.37	52	W125P
148	Red pepper	Veg	0.48	0.50	76	F216
149	Organic banana	Fruit	0.17	0.23	104	W984
150	Cauliflower	Veg	0.93	0.95	34	F216
151	Orange	Fruit	0.85	0.89	23	W87
…	…	…	…	…	…	…

Supplier		
supplierRef	**supplierName**	**address**
W87	FV Wholesale	136 Main Street
F216	Sunnybank	Sunnybank Road
P1982	J Barrow	96 Hillview Street
W984	Fruit Direct	26 Glasgow Road
F1982	Appletree Farm	Appletree Way
F96	Smyth's Farm	Drovers Brae
W125P	M White	42 Nevis Crescent
…	…	…

13. (continued)

(a) The number of oranges in stock has increased by 20.

Write the SQL statement for a single query which would correctly change the quantity of oranges. **2**

(b) Previously, the shop sold items supplied by private sellers. The shop has now decided to only sell items supplied by local farmers or wholesalers.

The `supplierRef` of private sellers start with the letter P.

Write an SQL statement to remove the details of all private sellers from the database. **2**

[Turn over

13. (continued)

(c) The profit that an item makes is calculated by subtracting the price the item is bought for from the price that the item sells for.

The shop would like to know the largest profit for fruits and vegetables. The largest profit should be listed first. The expected output is shown below.

type	Profit
Veg	0.08
Fruit	0.07

Design the SQL statement to produce this output. **4**

Field(s) and calculation(s)	
Table(s)	
Search criteria	
Grouping	
Sort order	

14. A driving school uses a relational database to store details of driving instructors, pupils and bookings in three linked tables.

The relational database uses the following three tables.

Instructor	Pupil	Booking
instructorID	pupilRef	bookingNo
name	name	instructorID*
dayOff	address	pupilRef*
hourlyRate	town	date
		time
		duration

(a) The driving school would like a list of the names of all the instructors who have an hourly rate of more than £35 and the names of all their pupils.

Complete the SQL statement below to produce this list. **3**

```
SELECT Instructor.name AS [Instructor], Pupil.name AS
[Pupil]
```

[Turn over

MARKS

DO NOT WRITE IN THIS MARGIN

(b) Sample data from the pupil table is shown below.

Pupil			
pupilRef	**name**	**address**	**town**
PU1	P Clifford	21 Clark Street	Kilmarnock
PU2	N Price	76 Burnside Ave	Greenock
PU3	M Flood	41 Sinclair Street	Greenock
PU4	A Singh	92 Rugby Road	Kilmarnock
PU5	J Wilson	8 Stadium Way	Falkirk
PU6	M Ali	56 Lime Road	Falkirk
PU7	S McGuire	18 Craigneuk Ave	Airdrie
PU8	D McGregor	120 Wallace Place	Greenock
...	...	...	...

The driving school use the following SQL statement to display the number of pupils in each town.

```
SELECT town, COUNT(*) AS [Number Per Town]
FROM Pupil
GROUP BY town
ORDER BY COUNT(*) DESC, town ASC
```

(i) Using the sample data provided, write the expected output from the SQL statement above. **2**

town	Number Per Town

(ii) The SQL statement above makes use of the `GROUP BY` command.

Explain why the `GROUP BY` command is required in the SQL statement above to produce the expected output. **1**

_____

_____

_____

14. (continued)

(c) The data from the instructor table is shown below.

Instructor			
instructorID	**name**	**dayOff**	**hourlyRate**
001	C Robertson	Saturday	35
002	L MacLean	Sunday	40
003	T Jack	Wednesday	35
004	B Avidal	Saturday	36
005	F Shabnam	Tuesday	36

The output below shows the average hourly rate of instructors who have their day off at the weekend.

Average Hourly Rate
37

Write the SQL statement that would produce the output above. **3**

14. (continued)

(d) The driving school would like to know the `pupilRef` of all the pupils who have lessons with the instructor who offers lessons at the cheapest hourly rate.

```
SELECT pupilRef
FROM Booking,Instructor
WHERE Booking.instructorID = Instructor.instructorID
AND hourlyRate = MIN(hourlyRate);
```

When tested the SQL statement did not execute because an aggregate function cannot be included in a `WHERE` clause in this way.

Describe one solution to this problem. **2**

[END OF SECTION 2]

SECTION 3 — WEB DESIGN AND DEVELOPMENT — 25 marks

Attempt ALL questions

15. A section of the CSS code for styling a website is shown below:

```
main {background-color: red;}
section {background-color: red; padding: 5px;}
p {padding: 5px;}
h1 {color: white; font-size: 22px; padding: 5px;}
h2 {padding: 5px;}
```

Use grouping selectors to re-write the code to make it more efficient. **3**

16. Usability testing is carried out on a low fidelity prototype of a holiday website login page.

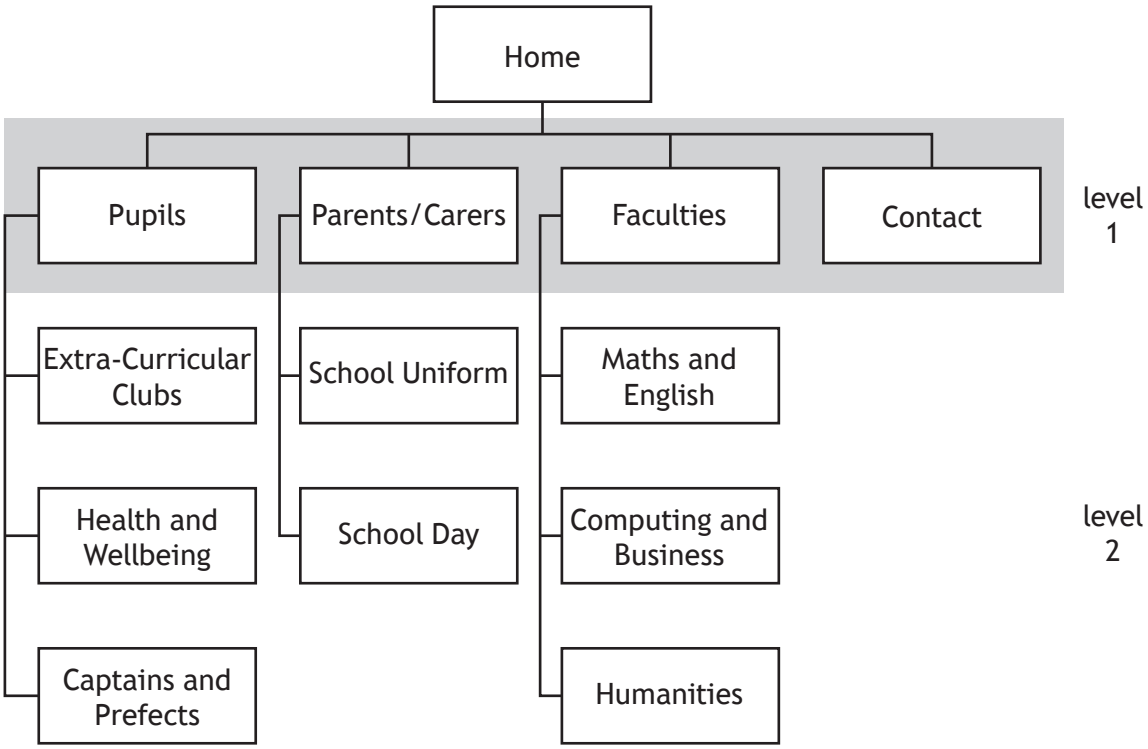
In order to register a user must enter their forename, surname, email address and a password.

Usability testing is carried out using personas, test cases and scenarios.

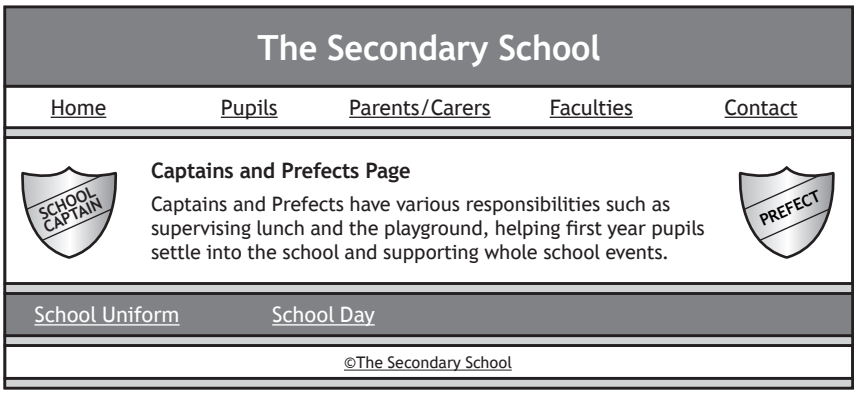
(a) Describe what is meant by 'personas'. **1**

(b) Describe two scenarios that can be used to carry out usability testing for this form. **2**

17. The following diagram shows the navigational structure of a secondary school website.



(a) (i) The 'Captains and Prefects' web page has been created and is shown below. It does not match the navigational structure shown above.



Describe the difference between the navigational structure and the actual web page. **1**

17. (a) (continued)

(ii) Complete the CSS code to style the horizontal navigational bar so that:

- no bullet points are shown
- each list item is placed horizontally
- when the cursor is placed over an anchor element, the background colour is white and the text colour is black. **3**

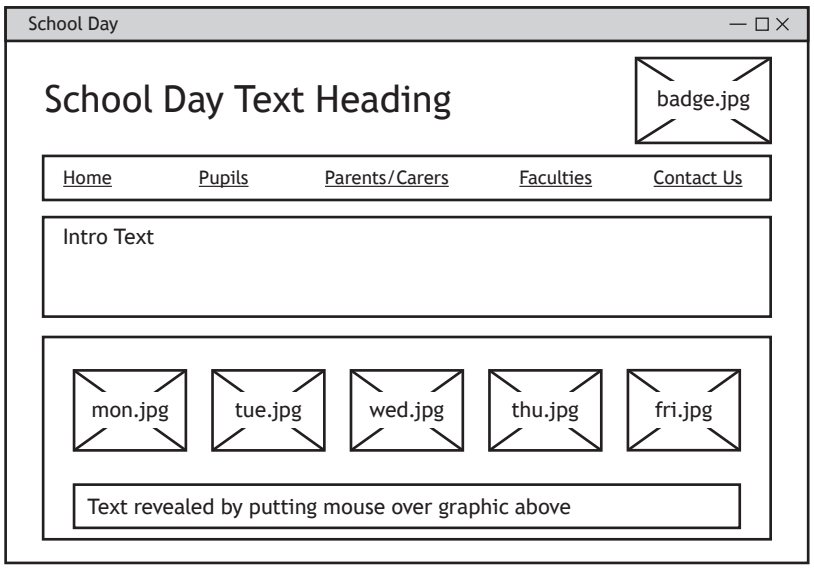
```
nav ul {_____:none;}

nav ul li {_____;width:180px;}

nav ul li a {display:block;padding:6px;}

nav ul li _____ {background-color: white;
                 color: black;}
```

(b) The wireframe for the 'School Day' web page is shown below.



17. (b) (continued)

When the mouse is moved over the `mon.jpg` graphic, the Monday text should appear with information about Monday's school day. The `displayMon` JavaScript event executes this feature.

Part of the HTML code used for this web page is shown below.

```
…
<img src="mon.jpg">
…
<section id="monText" style="display:none">
   <h2>Monday</h2>
   <p>8.55am – 3.45pm</p>
</section>
…
```

(i) The HTML code shown above is not fit for purpose.

Re-write the line of code to correct the error. **1**

(ii) The function `displayMon` calls another JavaScript function named `hideAllDays` which hides the text for all of the days currently displayed, ensuring only the text for Monday is displayed.

```
<script>

function hideAllDays()  {
  document.getElementById("monText").style.display="none";
 …
 }

function displayMon()  {
_____A_____
  document.getElementById("monText").style.display="__B__";
 }
</script>
```

Complete the missing JavaScript code for the function `displayMon`. **2**

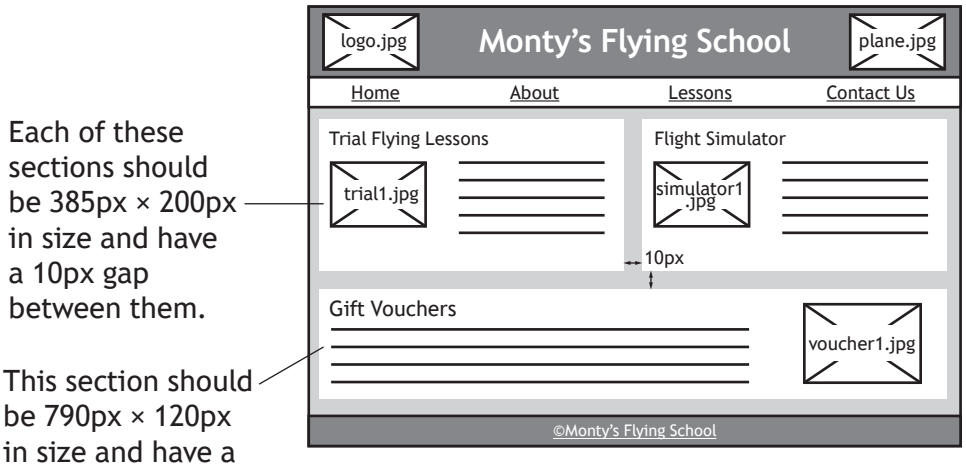
A _____

B _____

18. Monty's Flying School has a website to advertise their business.

(a) The wireframe for one of the web pages is shown below.

The 'Trial Flying Lessons' and the 'Flight Simulator' sections should be displayed side by side and the 'Gift Vouchers' section displayed underneath.



Complete the CSS code to allow all three sections to be displayed as shown in the wireframe. **3**

```
#trialFlyingLessons, #flightSimulator {width : 385px ;
height : 200px; float:left;}

#flightSimulator {









}
#giftVouchers{









}
```

18. (continued)

(b) (i) The 'Gift Vouchers' section includes a link to open a new web page which will allow users to enquire about gift vouchers for flying lessons.

The user must enter their name, contact telephone number, email, preferred location (Glasgow, Edinburgh or Prestwick airport) and a preferred date for the lesson.

Draw a wireframe for a form that would allow users to provide the information for a gift voucher. **3**

[Turn over

18. (b) (continued)

(ii) The HTML code used to create the input box to allow the user to enter their email is shown below.

```
Email*<input type="text" name="email" size="50">
```

State the attributes that would need to be added to ensure that an email address of at least six characters must be entered. **2**

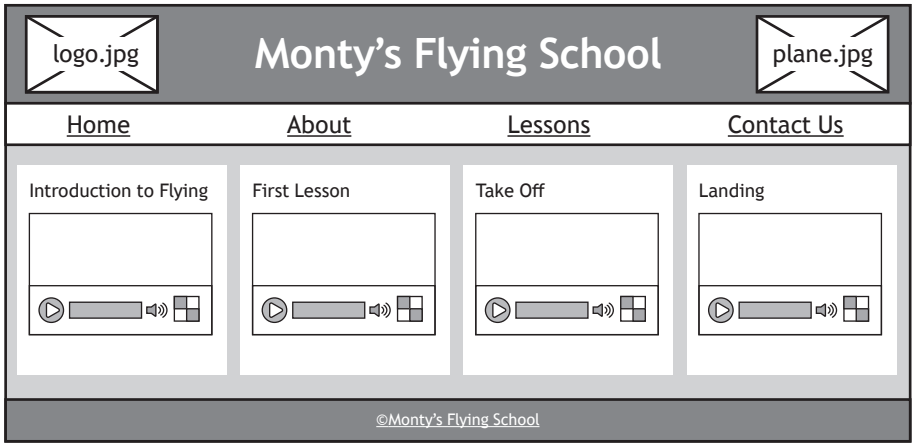
(c) The CSS rule below is contained in an external stylesheet.

```
footer p {font-size: 10px; }
```

State the type of selector used in the code above and explain its effect. **2**

18. (continued)

(d) Another web page is to be created that will display video clips as shown in the wireframe below.



Describe two different compatibility tests that should be carried out on this web page. **2**

[END OF SECTION 3]

[END OF QUESTION PAPER]

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