Computer Science (H046, H446)

Year 13 Enterance
Ravinder Singh

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:
Additional resources may be supplied with this paper.

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **240**.
- The total number of marks may take into account some 'either/or' question choices.

1 RestaurantReview is a website that allows users to leave reviews and ratings for different restaurants.

The website uses a database with the following structure.

The database management system ensures referential integrity is maintained.

Whenever a review is added to the system, the restaurant's average rating is updated. This transaction is ACID.

The A in ACID refers to Atomic.

State what the letters CID refer to in ACID.

C ----------

I ----------

D ----------

[3]

2 A small manufacturing business uses networked computers with closed source application software installed.

All computers owned by the business are connected together into a Local Area Network (LAN). Various network protocols are used in this network.

i. Give **three** advantages to the business of connecting computers together in a LAN.

1 ----------

---

2 ----------

---

3 ----------

---

[3]

ii. Explain what is meant by a network protocol.

[2]

iii. Give the names of **two** protocols that may be used in a LAN.

1

2

[2]

iv. Explain why protocol layering is used.

[3]

3 A company wants more customers to be able to find their website on the internet.

The company would like to start selling their products on their website. They will use both client side and server side processing to do this.

Tick (✓) **one** box on each row to identify whether each task would be best performed on the client side or the server side.

Task	Client Side	Server Side
Loading the website HTML code		
Applying CSS styles to a website		
Running JavaScript code to check that the customer surname has been entered on the order form		
Running queries on the database to check if an item is available in stock		

[4]

4(a) A hotel uses a computer system to keep track of room bookings. The hotel staff are able to query a database to discover which rooms are booked or which rooms are free.

The hotel's computer network uses a client-server model.

i. Describe what is meant by the term 'client-server' in this context.

[3]

ii. Give **two** advantages of client-server compared to peer-to-peer.

1

2

[2]

(b) The hotel's network uses multiple switches.

Explain the purpose of a network switch.

[3]

(c) * The hotel is concerned about the security of its computer network.

Discuss the threats which potentially exist to the hotel's computer network and how these threats could be eliminated or reduced.

[9]

(d) The hotel stores data about rooms, customers and bookings in a database. Each customer can book multiple rooms and each room can be booked multiple times.

i. Draw an Entity Relationship Diagram for this database.

[4]

ii. Define what is meant by the term 'foreign key', giving **one** example of where a foreign key would be used in the hotel booking database.

Definition _____

_____

_____

_____

Example _____

_____

_____

_____

[3]

iii. Describe **two** different ways that hashing could be used in this database.

1 _____

_____

_____

_____

_____

_____

_____

2 _____

_____

_____

_____

_____

_____

_____

[4]

(e) The hotel booking database enforces referential integrity.

Explain what is meant by the term ‘referential integrity’ and how this could potentially be broken.

---

[2]

---

5 An architect firm specialises in designing skyscrapers.

The computers in the architect firm's office are connected to a LAN which is connected to the Internet.

i. The LAN is set up in a client-server network.

Give **one** advantage and **one** disadvantage to the architects' firm of a client-server set up rather than a peer to peer setup.

Advantage ----------

Disadvantage ----------

---------- [2]

ii. The LAN is connected to the Internet via a firewall. Describe the term 'firewall'.

---------- [1]

iii. State why the architects' firm would use a firewall.

---------- [1]

6(a) A team of programmers create a robot that will be used in a factory. The robot will be able to do the work of multiple humans.

The programmers discuss whether to write the instructions for the robot in assembly language or a high-level language.

The robot provides a web-based interface for users. The home screen webpage for this interface is shown in **Fig. 4**.

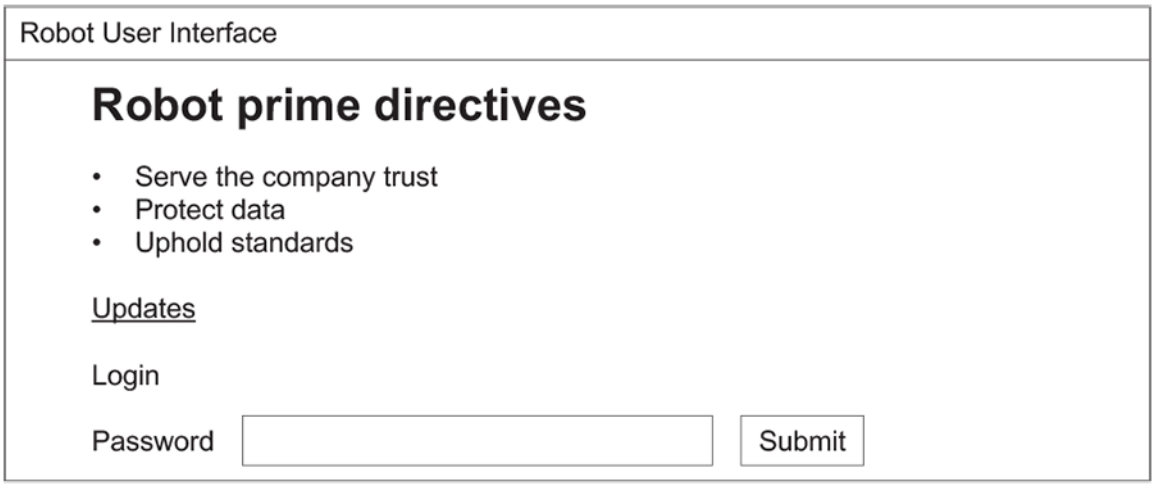


Fig. 4

i. Complete this HTML code that will display the webpage shown in **Fig. 4**.

```
<html>
    <head>
        <title>Robot User Interface</title>
    </head>
    <body>
        <h1>Robot prime directives</h1>
        ……
            <li>Serve the company trust</li>
            <li>Protect data</li>
            <li>Uphold standards</li>
        ……
    <a …… = "updates.html">Updates</a>
    <p>……</p>
    <form action="dologin.php">
        Password
        <input type = "……" name="pw">
        <input type = "……">
    </form>
    </body>
```

```
</html>
```

[5]

ii. Write CSS code that could be used in an external stylesheet to format all text using the <h1> tag as white with a red background.

---

[3]

(b) The robot's web interface uses images that show the robot in action. These photographs have been taken using a digital camera.

The programmers do not want other people to download and use these images.

i. State the name of **one** relevant piece of legislation and describe how this would protect these images.

Legislation _____

_____

Description _____

_____

_____

_____ **[3]**

ii. For other areas of the web interface, the programmers need to use images that they have not created themselves.

Give **two** ways that they could make sure these images are used legally.

1 _____

_____

2 _____

_____ **[2]**

7 A website sells tickets for sporting events. The website uses HTML, CSS and JavaScript.

Describe the purpose of HTML and CSS within the code of the website.

HTML _____

_____

_____

_____

CSS _____

_____

_____

_____

[4]

8 A company wants more customers to be able to find their website on the internet.

Discuss why search engine indexing and page ranking will be important in achieving this.

You should include the following in your answer:

- what search engine indexing means and what information is collected
- what PageRank means and possible factors that can affect a PageRank score of a website
- possible ways for the company to improve the PageRank score of pages on its website.

[12]

9(a) A website charges a booking fee of £2.99 on each ticket sold. In addition, if the tickets are purchased from outside of the UK, £4.99 is added to the booking fee. The booking fee is calculated using a JavaScript function named `bookingfee()`.

Complete the definition of the `bookingfee()` function below.

```
function bookingfee(numtickets, country) {

    var nonUKprice = 4.99;

    var perTicketPrice = ……;

    var total = 0;

    if (country!="UK") {

         total = total + ……;

    }

    total = total + (…… * perTicketPrice);

     …… total;

}
```

[4]

(b) The JavaScript function above is used to show users the booking fee. When users click to buy the tickets, the booking fee is calculated again on the server.

i. Explain why server side processing is used to recalculate the booking fee.

---

[3]

ii. Explain **one** advantage of client side processing to either the customer buying the tickets, or to company who own the website.

---

[2]

10

i. Convert the hexadecimal value **B7E** to a binary number.

---

[1]

ii. 110010101 is a binary number that is represented using sign and magnitude.

Convert this binary number to a denary number.

---

[1]

iii. Complete this binary subtraction. Both numbers are 8-bit integer values represented using two's complement.

Show the result in the same format and show your working.

0110 1101 –

0011 0100

---

[3]

11

i. Convert the denary number –119 to an 8-bit binary number with two's complement representation.

[1]

ii. Convert the unsigned binary number 1101101 to hexadecimal.

[1]

iii. Convert the denary number 171 to hexadecimal.

[1]

iv. Convert the hexadecimal number A6 to binary.

[2]

12(a) The floating point binary number 010011 011 consists of a 6-bit mantissa and 3-bit exponent, both represented in two's complement. Convert the number to denary, showing your working.

[3]

(b) Show the denary number –5.25 in floating point binary form representing the mantissa and exponent in two's complement, using as few bits as possible. Show your working.

[4]

13 Negative binary values can be represented using either sign and magnitude or two's complement.

i. Convert the denary number **-107** to an 8-bit binary number using sign and magnitude.

---

[1]

ii. Convert the denary number **-107** to an 8-bit binary number using two's complement.

---

[1]

iii. Give **one** advantage of storing values using two's complement instead of sign and magnitude.

---

[1]

14 A programmer creates another function to count and return how many capital letters are in a string that is passed into the function as a parameter.

The `asc()` function takes in a character and returns its ASCII value. For example `asc("A")` returns 65. Capital letters have ASCII values between 65 and 90 inclusive.

i. Complete the function below.

```
function countCapitals(text)
    // initialise counter to 0
    capCount = 0
    // loop through each character in the string passed in
    for x = 0 to text.length-1
        c = text.subString(x, 1)
        // check if character is a capital
        if asc(c) >= 65 ……
            // if so, increment counter
            ……
        endif
    next x
    ……
endfunction
```

[3]

ii. Give **one** similarity between ASCII and Unicode.

---

[1]

iii. Give **two** differences between ASCII and Unicode.

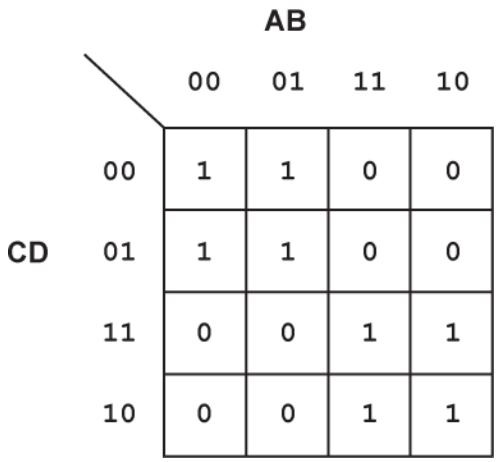
Difference 1 ---

Difference 2 ---

---

[2]

15 Draw the logic gates represented by the Karnaugh Map below. Show your working.



CD \ AB	00	01	11	10
00	1	1	0	0
01	1	1	0	0
11	0	0	1	1
10	0	0	1	1

[4]

16

CD \ AB	00	01	11	10
00	1	1	0	1
01	0	0	0	0
11	0	0	1	0
10	1	1	1	0

Fig. 9.1

State the Boolean expression represented by the Karnaugh map in Fig. 9.1, in its smallest form.

[4]

17

i. Simplify the Boolean expression ¬A v ¬B using De Morgan's First Law.

[1]

ii. Simplify the Boolean expression ¬(¬B) using double negation.

[1]

iii. Simplify the Boolean expression (A v B) ∧ (A v C) using distribution.

[2]

18(a)

A computer scientist has created the following logic circuit shown in **Fig. 6**.

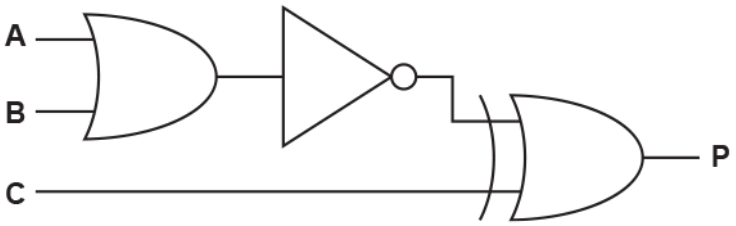


Fig. 6

i. Give the Boolean expression that represents the logic circuit shown in **Fig. 6**. Do not attempt to simplify the expression.

---

[2]

ii. Complete the truth table for the logic circuit shown in **Fig. 6.**

A	B	C	P
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

[3]

(b) The following Karnaugh map represents another logic circuit.

CD \ AB	00	01	11	10
00	1	1	1	1
01	1	1	0	0
11	0	0	0	0
10	0	0	1	1

Use this Karnaugh map to find the simplified expression for this circuit.

You should highlight the map as appropriate and write the expression here.

---

[4]

19 Ben installs burglar alarms. The alarm is made up of a door sensor and a motion sensor. When the alarm is set, the siren will sound if either the door sensor or the motion sensor detect movement.

The alarm also has a test mode setting. When the test mode setting is enabled, an engineer can check the sensors are working without the siren going off.

The inputs to the alarm are as follows.

Input	System
A	Door sensor
B	Motion sensor
C	Alarm has been set
D	Test mode enabled

Draw a logic circuit to show the logic that is used in the burglar alarm to determine if the siren goes off.

[4]

20 A Boolean expression for a logic system is shown below:

$Q \equiv \neg (\neg A \wedge \neg B)$

i. Simplify this Boolean expression so that it does not include any negation. You must explain which Boolean algebra rule(s) you are using at each step.

---

[2]

21 A company releases an in-home virtual assistant called ‘Bertie Butler’.

The device, when placed in a room, listens out for the phrase “Hey Bertie”. When someone says that phrase it then listens to the question that follows and tries to give a relevant answer.

Bertie Butler has a number of built-in input and output devices.

Bertie Butler’s circuitry is designed to only listen out for “Hey Bertie” under certain circumstances, which are:

The privacy button (**P**) must be off and the microphone must generate a signal (**S**) to say a sound has been heard.

i. Complete the truth table for whether the device is listening (**L**).

P	S	L
False	False	
False	True	
True	False	
True	True	

[2]

ii. Draw logic gates to represent the circuitry needed.

[3]

22(a) A computer game stores tasks that the player has requested. Each task has:

- an identification (ID) number e.g. **Task A**
- a real number to be processed e.g. **123456.789**
- an integer number to represent the order the tasks should be accessed e.g. **1**.

The task that needs to be processed the earliest is given the order number 1.

Two or more tasks can have the same order number. For example, two tasks can have an order number 1.

The data about each task needs to be stored. This will store the ID number, data value and order number for a task.

Explain why a record data structure is suitable for this data.

---

[2]

(b) The tasks will be stored in a binary search tree before they are processed. They are stored in ascending order by their order number.

i. Give **two** characteristics of a binary search tree.

1 ---

---

2 ---

---

[2]

ii. Give an advantage of storing the tasks in a binary search tree instead of a 1-dimensional array.

---

[1]

iii. Tick (✓) **one** column in each row to identify whether each statement applies to a depth-first (post-order) tree traversal, a breadth-first tree traversal, or neither of these two traversals, when performed on a binary search tree.

Statement	Depth-first (post-	Breadth-first	Neither of these two

	order)		traversals
All nodes at the current depth are visited before moving to the next depth			
The algorithm traverses to the end of one branch before moving to another branch			
The algorithm will make use of backtracking			
The traversal can be used to output the contents of the tree in ascending order			
The algorithm will output the root node last			

[5]

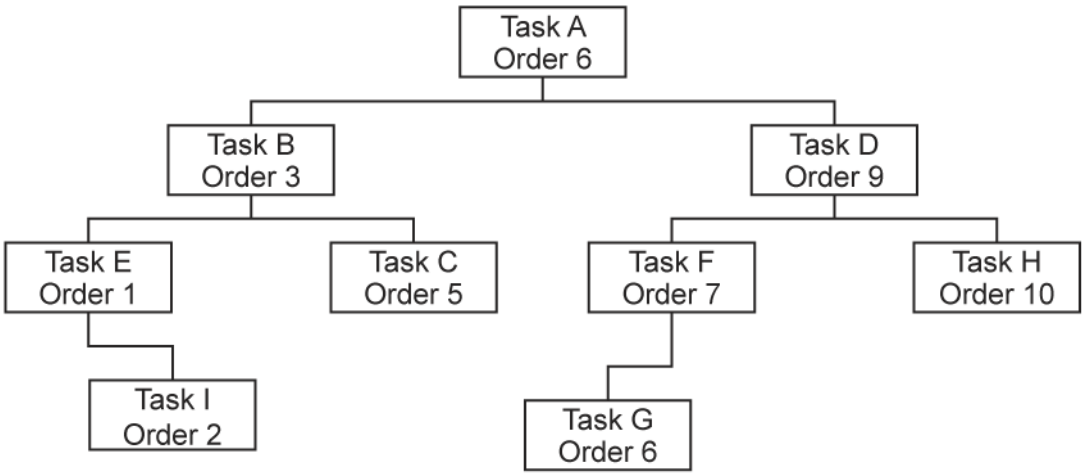
iv. The tasks currently stored in the binary search tree are shown here.

When a new task is inserted with the same order number as a pre-existing task, it is classed as having a higher order number.

For example, task G has the same order number as task A. Since task G was inserted after task A it is classed as a higher number.

Change the diagram to show the contents of the binary search tree after the following tasks are inserted in the order given:

- Task X with order number 12
- Task Y with order number 7
- Task Z with order number 11



[3]

23(a) The following strings are stored in an array.

“rainbow”	“moon”	“sun”	“stars”	“clouds”	“tornado”

Explain how a linear search would search the array for the index that stores “clouds”.

[3]

(b) State why a binary search cannot be used in this example.

[1]

24 A graph is a type of data structure.

An example graph is shown in **Fig. 1**.

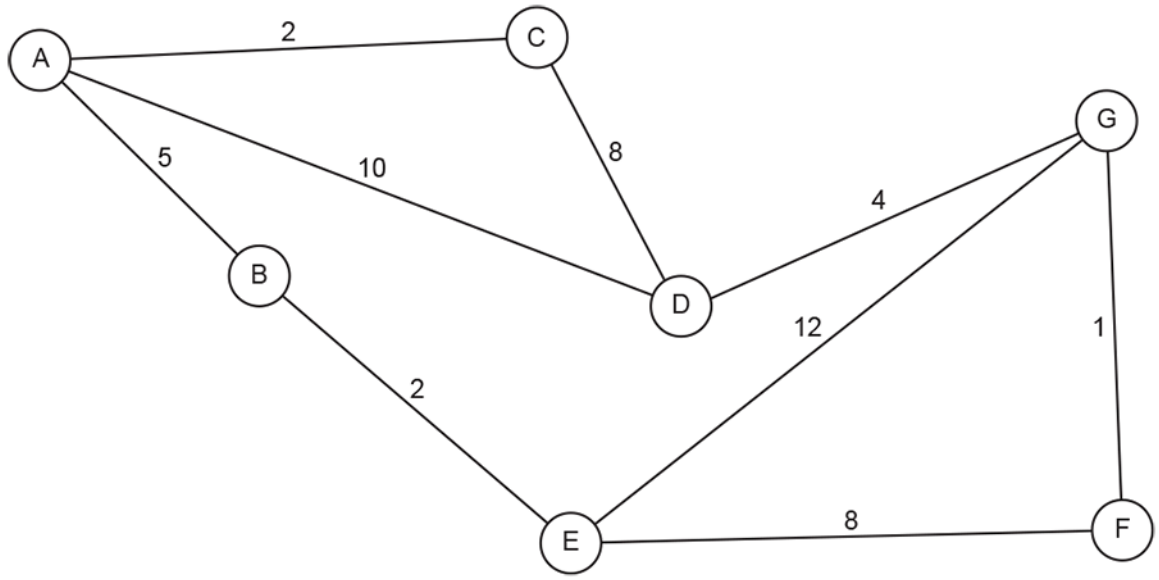


Fig. 1

Show how Dijkstra's algorithm can be used on the graph shown in **Fig. 1** to find the shortest path from start node A to end node G.

You must state the nodes on the final path and the distance of this path. Show your working.

You may use the table below to give your answer.

Node	Distance travelled	Previous node

Final path: .....

Distance: .....

[6]

25

i. Describe how a merge sort differs from a bubble sort.

[4]

ii. Name **two** sorting algorithms, other than a bubble sort and merge sort.

1

2

[2]

26

i. The array `numbers` contains 356 numbers to be sorted by the bubble sort algorithm.

State the maximum number of passes a bubble sort would need to complete to sort 356 numbers into order.

[1]

ii. State the name of **one** other sorting algorithm.

[1]

27 A program is amended to include the use of several queue data structures.

i. Describe how an array can be used to implement a queue data structure.

[3]

ii. * Discuss the use of object-oriented programming and procedural programming to create and manipulate the queue data structures.

You should include the following in your answer:

- the features of object-oriented programming
- the features of procedural programming
- the benefits of using object-oriented instead of procedural programming when creating several queue structures.

[9]

28 The temperatures of an ocean are input into a computer system. They are recorded, and will be accessed, in the order in which they arrive. The data for one week is shown:

5, 5.5, 5, 6, 7, 6.5, 6

The data is to be stored in a data structure. The programmer stores the data in a queue.

Explain why a queue is used instead of a stack.

[2]

29 Dexter is leading a programming team who are creating a computer program that will simulate an accident and emergency room to train hospital staff.

Two of Dexter's programmers have developed different solutions to one part of the problem. Table 3.1 shows the Big O time complexity for each solution, where *n* = the number of data items.

	Solution A	Solution B
Time	O(n)	O(n)
Space	$O(k^n)$ (where k > 1)	O(log n)

Table 3.1

i. The Big O time complexity for time of each solution is O(n).

Explain what is meant by time complexity, with reference to the solutions' Big O time complexity.

[3]

ii. Name the space complexity for each solution:

Solution A _____

Solution B _____

[2]

iii. Explain, with reference to the Big O complexities of each solution, which solution you would suggest Dexter chooses.

[4]

30 A game developer is storing the number of pets a player has in a 1-dimensional array. At each timer interval, the array is searched, using a linear search, to check if any pets' hunger or bored values are greater than 90%. If they are, an alert is displayed to the user.

i. State the complexity of searching the pets in Big-O notation.

---

[1]

ii. A given computer takes 4 milliseconds (ms) to search an array of 20 pets. Calculate an estimate of how long the computer will take to search an array of 100 pets.

Show your working.

---

[2]

31(a) Stacks and queues are both data structures.

A stack is shown in Fig. 4.1 before a set of operations are carried out on it.

Draw what the stack shown in Fig. 4.1 would look like after the following operations:

```
push("A"), push("B"), pop(), push("C"), pop(), push("D")
```

Fig. 4.1

[2]

(b) Fig. 4.2 shows a stack in two states: State One and State Two.

Fig. 4.2

List the operations needed to get the stack from State One to State Two.

---

[3]

32(a) The component below is a D-Type, positive edge triggered, flip-flop.

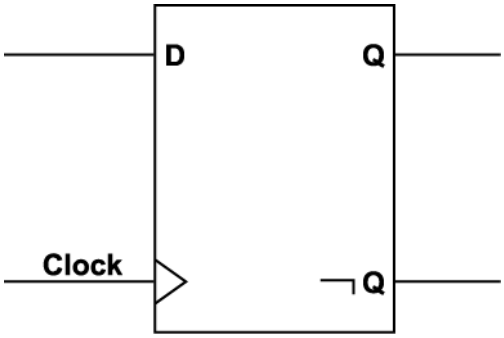


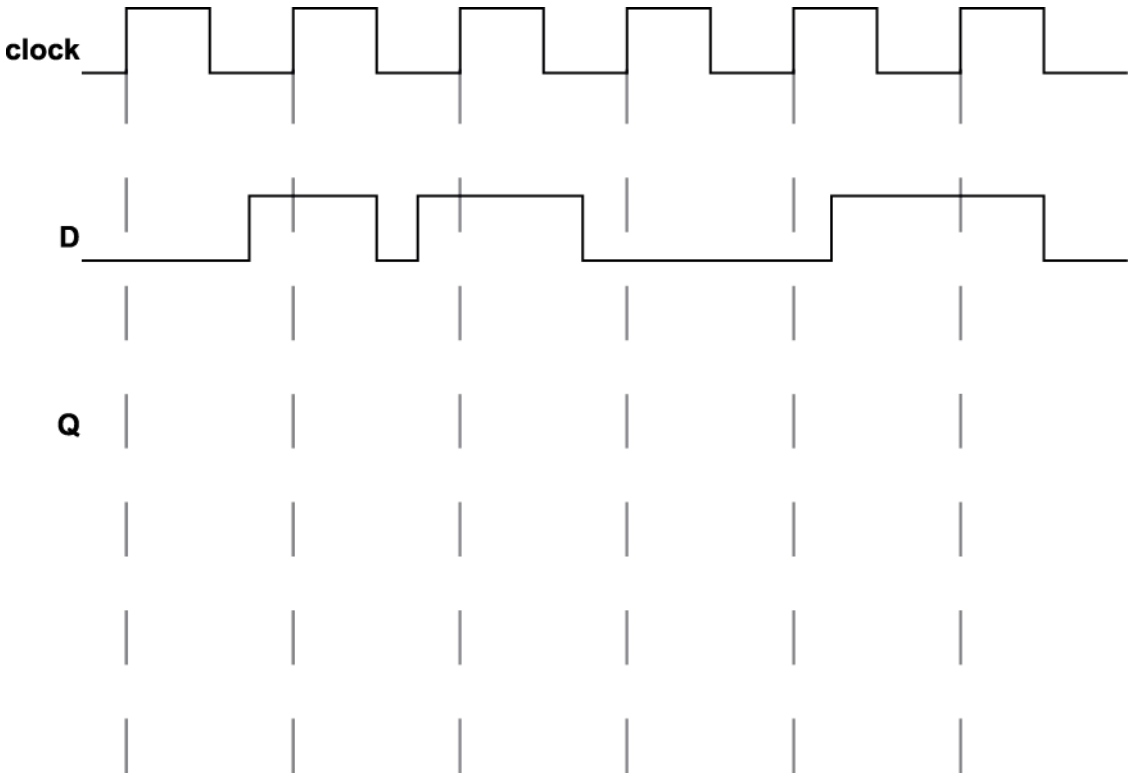
Fig. 10.2

State the purpose of a flip-flop.

---

[1]

(b) Draw the output of the flip-flop from Fig. 10.2 on the diagram below.



[3]

33 * Discuss the positive and negative impacts computers are having on the environment.

[9]

34 *"It's like the Wild West, the Internet. There are no rules." – Steven Wright.*

The quote above suggests that the Internet is a lawless place.

Discuss the extent to which you agree with this statement and how important you feel that the regulation of the internet is.

[9]

35 * *"The Computer Misuse Act means that computer users are criminalised for simply trying to learn how systems work."*

Discuss whether or not you agree with this statement.

[9]

END OF QUESTION PAPER

Question			Answer/Indicative content	Marks	Guidance
1			– Consistency – Isolation – Durability (1 mark per -, max 3)	3 AO1.1	Examiner's Comments Well attempted by most candidates. In general, candidates either scored three or zero marks.
			Total	3	
2		i	e.g. • Share hardware (e.g. printers) • Share files • Share Internet connection • Centralised security • Log on / access files from any machine on the LAN • Central maintenance • Central backup / storage • Central installation / update of programs • Can monitor user activity • Can control access levels // Centralised useradmin • Access an intranet	3	Mark first answer in each answer space Examiner's Comments This question challenged many candidates who were unable to give three advantages to the business and instead gave 3 benefits of a LAN over a WAN which was not what the question required. The candidates who did manage to gain full marks were able to give clear advantages to a business of having their machines networked in a LAN. OCR support Link to a resource for features of a computer network can be found in this document on TeachCambridgehttps://teachcambridge.org/item/01e01b94–6f2e-4afa-a765-c11b94aca292
		ii	• A set of rules // an agreement • Used to ensure the (proper / successful) **transfer of data** between devices // used to govern the **transmission / communication** between devices • May specify format of data / error checking / etc	2	Allow suitable example of contents of a protocol for MP3 Do not award a rule - must be plural Examiner's Comments This was generally well answered and many candidates were able to gain both marks

Question			Answer/Indicative content	Marks	Guidance
		iii	1 mark per protocol listed e.g. • HTTP // Hypertext Transfer Protocol • HTTPS // Hypertext Transfer Protocol Secure • TCP // Transmission Control Protocol • IP // Internet Protocol • UDP // User Datagram Protocol • FTP // File Transfer Protocol • Ethernet • WPA // Wi-Fi Protected Access • DHCP // Dynamic Host Configuration Protocol • SMTP // Simple Mail Transfer Protocol • POP // Post Office Protocol • IMAP // Internet Message Access Protocol • RDP // Remote Desktop Protocol • VoIP // Voice over Internet Protocol	2	Mark first answer in each answer space If mentioned one protocol with 2 versions e.g. IPv4 & IPv6 - only 1 mark If they've written the protocol in full but got any word wrong, no mark awarded <u>Examiner's Comments</u> Generally well answered and it was interesting to see the different protocols candidates were able to name. Some candidates named two of the layers in TCP/IP instead of protocols which gained them no marks.
		iv	• To apply protocols in order / one after the other • To provide independence of layers // Layers can be modified without affecting other layers // Layers are self-contained • Hides details from previous or next layer(s) // is an abstraction • Each layer is well defined / does a specific job • Breaks **tasks** down into manageable units // Groups similar protocols together • Improved troubleshooting (easier identification of the layer that causes the issue) • Each layer only communicates with adjacent layers// simplifies interfacing • Hardware/software can be manufactured to fit into one specific layer • Allows for standards for individual tasks/layers to be developed // for compatibility	3	<u>Examiner's Comments</u> Protocol layering has appeared in questions in previous papers, but many candidates were not able to explain why they are layered. Some candidates gave a description of the layers in TCP/IP without saying why it was layered.
			Total	10	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td></td><td></td><td>1 mark for each correct row.

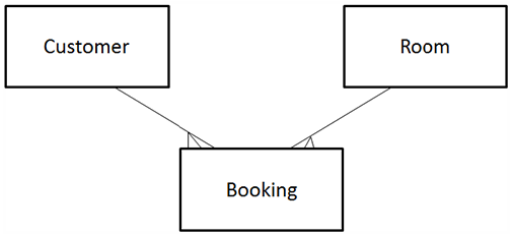
<table><tr><th>Task</th><th>Client Side</th><th>Server Side</th></tr><tr><td>Loading the website HTML code</td><td>✓</td><td></td></tr><tr><td>Applying CSS styles to a website</td><td>✓</td><td></td></tr><tr><td>Running JavaScript code to check that the customer surname has been entered on the order form</td><td>✓</td><td></td></tr><tr><td>Running queries on the database to check if an item is available in stock</td><td></td><td>✓</td></tr></table></td><td>4</td><td>Accept alternatives to ticks in the boxes so long as it is clear which side is marked.

<u>Examiner's Comments</u>

Most candidates were able to gain 2 or 3 marks on this question with many gaining all 4 marks. The most common error was ticking server side for Running JavaScript to check the surname.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>4</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
4	a	i	• Client computers connect to server • Server provides access to a resource/service • In this case hotel staff use client computers to connect to database on server (or other sensible example).	3 AO1.2	
		ii	e.g. • only one point of failure • easier to manage users/access • Easier to backup • Easier to keep data secure. • Technicians can more easily remotely install / monitor.	2 AO1.1	
	b		• Joins computers/devices together on a LAN • Receives packets/data • Recipient's address is given in packet header/it uses the mac address • Send packets/data • Out the correct port /to the specific computer device	3 AO1.1	

Question	Answer/Indicative content	Marks	Guidance
c	**Mark Band 3–High Level (7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of network security. The material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation. The candidate provides a thorough discussion which is well balanced. Evaluative comments are consistently relevant and well-considered. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. **Mark Band 2-Mid Level (4-6 marks)** The candidate demonstrates reasonable knowledge and understanding of network security; the material is generally accurate but at times underdeveloped. The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence/examples are for the most part implicitly relevant to the explanation. The candidate provides a sound discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. **Mark Band 1-Low Level (1-3 marks)** The candidate demonstrates a basic knowledge of network security; the material is basic and contains some inaccuracies. The candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides a limited	9 AO1.1 (2) AO1.2 (2) AO2.1 (2) AO3.3 (3)	AO1 Malware and viruses are software that can have a negative impact on computer systems Spyware and keyloggers can record information entered and send back to a third party Phishing attacks attempt to steal data by fraudulently appearing as legitimate emails asking for secure information Denial of Service Attacks can overload a computer system with traffic and effectively disable access for legitimate users AO2 Hotel's systems could be disrupted by DDOS attacks so no external bookings able to be made. Phishing and spyware attacks may compromise visitor security and result in financial loss Malware, viruses could destroy hotel data Theft of customer data would be an issue under Data Protection Act / GDPR for which the hotel could be prosecuted AO3 Education for staff and customers is important to deal with recognising and dealing with threats Up to date software, limitations of use of devices such as USB sticks and restricted access to wireless networks can all limit risks. Use of Firewall to restrict traffic entering and leaving the network. Should be balanced against customer experience; will customers return if they have no access to It facilities?

Question			Answer/Indicative content	Marks	Guidance
			discussion which is narrow in focus. Judgments if made are weak and unsubstantiated. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. **0 marks** No attempt to answer the question or response is not worthy of credit.		
	d	i	-Customer, Room and Booking entities, must be singular -Customer joined to Booking and Room joined to booking and no other links -Customer to Booking relationship indicated as one-many -Room to Booking relationship indicated as one-many	4 AO2.2	
		ii	• A field that links to a (primary) key in a second table • Example : Customer ID // RoomID… • … in Booking table	3 AO1.1 (1) AO2.1 (2)	
		iii	• Hashing for security • …e.g. hash <u>passwords</u> in database • …to make sure they cannot be read if they are stolen • Hashing for direct access • …e.g. Customer/Room/Booking records can be quickly accessed • …by using hash of index as address	4 AO1.2 (2) AO2.2 (2)	
	e		• Database/relationships are consistent // each foreign key links to an existing/valid primary key • Suitable example of being broken (e.g. if primary key is deleted/updated, foreign keys are no longer valid / changes should be cascaded)	2 AO1.1 (1) AO1.2 (1)	Accept example that is not related to the database given (as this is an AO1 question)
			Total	**30**	

Question			Answer/Indicative content	Marks	Guidance
5		i	Advantage: – Centrally administered in one location. (1) – One location to back up. (1) Disadvantage: – Central point of failure. (1) – Can be expensive to maintain / set up (e.g. cabling costs, specialist staff.) (1) (Max 1 Advantage, 1 Disadvantage)	2 (AO1.2)	Accept for MP1 better security Do not credit quick access as an advantage **Examiner's Comments** Many candidates offered advantages and disadvantages of networks in general as opposed to those of a client-server over a peer to peer setup.
		ii	A hardware device / piece of software that monitors (and filters / blocks) traffic / packets going to and from a network. (1) (Max 1)	1 (AO1.1)	Accept 'content' for 'traffic / packages' **Examiner's Comments** To achieve this mark, candidates were required to show an understanding that firewalls monitor traffic going to and from a network, many only discussed one-way traffic.
		iii	Prevent unauthorised access to a network. (1) To restrict applications that are used internally that have internet access. (1) To restrict websites that can be accessed from within the company. (1) To protect the company's data / intellectual property. (1) (Max 1)	1 (AO 1.2)	Accept for MP1 malicious attacks / traffic **Examiner's Comments** Most candidates gave 'to stop malicious attacks' which was awarded as an interpretation of 'to protect company data'.
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
6	a	i	• and • href • Login • text/password • submit	5	<html> <head> <title>Robot User Interface</title> </head> <body> Robot directives - Serve the company trust - Protect data - Uphold standards Updates Login <form action="dologin.php"> Password <input type = "text" name="pw"> <input type = "submit"> </form> </body> </html> HTML tags are not case sensitive Correct answer only <u>Examiner's Comments</u> Generally well answered and many candidates gained full marks with most being able to gain at least two.

		ii	• h1 and other code contained in { }
			• color :white;
			• background-color : red;
			//background: red;
				3	Ignore presence or lack of <style> tags.
					Ignore lack of semicolons
					
					Penalise misspelling of "color" once and then FT
					
					h1 {
					color:white;
					background-color: red;
					}
					
					White can be #FFFFFF or #FFF
					Red can be #FF0000 or #F00
					
					<u>Examiner's Comments</u>
					
					Many candidates were able to gain full marks. The most common reasons candidates lost marks was through the use of quotes around the colour equals instead of colons and for misspelling colour

Question			Answer/Indicative content	Marks	Guidance
	b	i	• Copyright Designs and Patents Act Any two from: • Gives the author (the programmers)ownership/copyright of the photographs • …no need to apply // this is automatic • Others cannot use/distribute // can beprosecuted/fined for using/distributing… • …without permission • Permission can be granted / bought / licenced	3	Must be full name of Act for MP1 FT for versions of Copyright or nothing for MP2-6 Examiner's Comments Many candidates were able to gain 2 marks but many did not give the full name of the legislation.
		ii	• Ask permission of **author / photographer /owner** • Use images marked as copyright free (e.g.Creative Commons Licence) • Purchase (licence to use) image	2	Do not accept just "ask permission" Examiner's Comments Many candidates were able to gain 2 marks. It was surprising to see how many believed that you could use copyright images for your business just by crediting the artist. Candidates should be made aware that although crediting the artist may help avoid plagiarism it does not allow you free use of a copyright image.
			Total	13	
7			• HTML defines the structure of a web page • HTML defines the content of a web page • Using tags (enclosed in <>) • CSS defines the style / appearance • Using selectors such as classes / IDs / etc • Can be placed within HTML or externally in a file • Multiple pieces of CSS can be combined (the more local instances overriding)	4 AO1.1	Do not accept layout/format for HTML as this is too vague and can be used to describe CSS
			Total	4	

Question			Answer/Indicative content	Marks	Guidance

8			**Mark Band 3-High Level (9-12 marks)**
			The candidate demonstrates a thorough knowledge and understanding of search indexing and page rank. The material is generally accurate and detailed.
			
			The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation.
			
			The candidate is able to assess the extent to which page rank and search engine optimization is important to online visibility.
			
			There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.
			
			A mark band 3 answer will explain in detail how search indexing happens and the factors affecting PageRank scores. There will be clear evaluative points that identify how to improve PageRank score.
			
			Mark Band 2-Mid Level (5-8 marks) The candidate demonstrates reasonable knowledge and understanding of search indexing and page rank; the material is generally accurate but at times underdeveloped.
			
			The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed.
			
			Evidence/examples are for the most part implicitly relevant to the explanation.
			
			The candidate makes a reasonable attempt to come to a conclusion as to why page rank and search engine optimisation are important to online visibility.
			
			There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence.
			
			A mark band 2 answer will cover both search indexing and page ranking and will expand the points, explaining what
				12	Points may include but aren't limited to:
					
					AO1 Knowledge and Understanding
					Search engine indexing:
					
					• Search engine indexing is where a database of key words is kept with links to relevant pages stored with the keyword
					• Words are stored along with their position on a page
					• Bots (spider/crawlers) will "crawl" the web finding web pages and looking for key words on them
					• The will navigate from page to page following hyperlinks
					• They are then sent back to the search engine's database
					• When you search for a website, you are not searching on the web, you are searching in the search providers database
					
					PageRank:
					
					• Used to find and rank website pages and then list the results in a search engine. If a website has a higher score, it will appear higher in the list of search results.
					• More links from more important pages, ranks a page higher
					• Stored as a weighted, directed graph
					  ◦ Pages are nodes
					  ◦ Hyperlinks are edges in one direction
					  ◦ Weightings are calculated by page rank
					
					AO2 Application
					To get more of presence they will need to...
					
					• Make effective use of meta tags that effectively describe the contents of the website.
					• Make effective use of H1 tags using suitable headings that describes the content of the website
					• Increase the number of quality of incoming links from other websites, ideally those with a high PageRank score themselves
					• Increase the number of outgoing links
					• Key words can be stored in meta tags,

Question			Answer/Indicative content	Marks	Guidance
			information is collected during indexing and factors that affect PageRank scores although these may not be balanced. There should be some attempt to identify how to improve PageRank score. Mark Band 1-Low Level (1-4 marks) The candidate demonstrates a basic knowledge of search indexing or page rank; the material is basic and contains some inaccuracies. The candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides nothing more than an unsupported assertion. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. *A mark band 1 answer will contain some basic, relevant facts about what search indexing is and/or what PageRank means. They may not discuss how the company can improve PageRank.* 0 mark No attempt to answer the question or response is not worthy of credit.		title tags or header tags (h1, h2 etc) • Damping factor is used to quash a PageRank based on the idea that a user will only click through a certain number of links AO3 Evaluation • PageRank algorithm is only one algorithm that is used to Rank websites. • To get a better presence on the internet, the company will need to consider who links to their page, the more popular the better • They could potentially work with other companies who have established websites and get incoming links from those sites • It's important that a company ensures their site is malware free/secure as this can impact on their PageRank score <u>Examiner's Comments</u> Many candidates were able to discuss some factors that affect PageRank and how the website could improve it. Far less were able to discuss search engine indexing correctly. Some were able to apply their knowledge to the scenario. More successful candidates were able to give a good description of both search engine indexing and PageRank as well as relevant suggestions for how the website could improve their PageRank.
			Total	12	

Question			Answer/Indicative content	Marks	Guidance
9	a		• 2.99 • nonUKprice • numtickets • return	4 AO3.2	Correct answer only. Penalise spelling if incorrect. Do not accept £ sign in first bullet point.
	b	i	• processing done away from the user's control/Client side processing could be altered • Browser may not support client-side language/ scripting could be turned off • Booking fee calculation needs to be correct for all locations	3 AO2.1	
		ii	To the customer any 2x1: • No need to submit to server and wait for response • Website will work more quickly for user To the company any 2x1: • Reduces load on the server • Will need to spend less on processing power/bandwidth	2 AO1.2	
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
10		i	• 1011 0111 1110	1	CAO
		ii	• -149	1	CAO
		iii	0011 1001 • One mark for correct left hand nibble (CAO) • One mark for correct right hand nibble (CAO) • One mark for working clearly shown	3	Working could include showing "borrowing" values from other columns or making the second number negative and adding. Answer must be 8 bits to achieve full marks (stated in question). No marks if only working is denary <u>Examiner's Comments</u> Most candidates were able to gain some marks, with many gaining full marks. A popular method was to do two's complement addition. Candidates should be encouraged to show their working in binary and not do the subtraction in denary and then just give the answer in binary. The question asks them to complete a binary subtraction.
			Total	**5**	
11		i	1000 1001	1 AO1.2	Correct answer only
		ii	6D	1 AO1.2	Correct answer only
		iii	AB	1 AO1.2	Correct answer only
		iv	1010 0110 1 mark per nibble	2 AO1.2	Correct answer only
			Total	**5**	

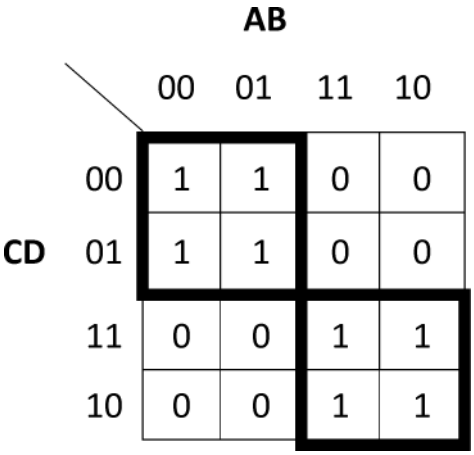
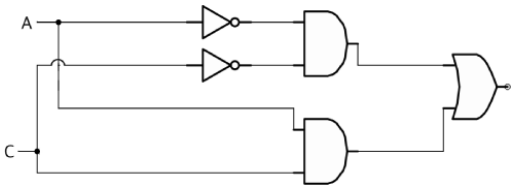
Question			Answer/Indicative content	Marks	Guidance
12	a		– Exponent is 3 – Mantissa becomes 0100.11 – Which is 4.75. (accept 4¾) (1 per -, max 3)	3 AO1.2	Examiner's Comments This question was better attempted than similar questions in previous series. Most candidates clearly demonstrated the 'floating' of the point the correct number of places.
	b		– In fixed point is 1010.11 – Mantissa becomes 1.01011 – Exponent of 3 / 11 – Giving answer of 101011 011 (1 per -, max 4)	4 AO1.2	For MP3 any number of leading 0s is valid (including none) Examiner's Comments Many candidates did not convert the original denary number to the correct fixed-point binary representation. Others who did convert to fixed point correctly did not go on to represent their floating-point solution in as few bits as possible.
			Total	7	

Question			Answer/Indicative content	Marks	Guidance
13		i	• 1110 1011	1	Correct answer only Examiner's Comments Binary and hexadecimal questions were generally well answered with many candidates being able to gain full marks across the question parts.
		ii	• 1001 0101	1	Correct answer only Examiner's Comments Binary and hexadecimal questions were generally well answered with many candidates being able to gain full marks across the question parts.
		iii	• Calculations are more easily performed on two's complement • Two's complement allows for a (negligible) larger range of numbers to be stored // by example • No additional hardware is required in two's complement // Addition and subtraction are carried out using only an adder • Two's complement has only one representation for 0	1	Accept the reverse of the MP Examiner's Comments Binary and hexadecimal questions were generally well answered with many candidates being able to gain full marks across the question parts.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance

14		i	`function countCapitals(text)`
			`    // initialise counter to 0`
			`    capCount = 0`
			`    // loop through each character in the string passed in`
			`    for x = 0 to text.length-1`
			`        c = text.subString(x, 1)`
			`        // check if character is a capital`
			`        if asc(c) >= 65 **and asc(c) <= 90**`
			`// if so, increment counter`
			`            **capCount = capCount + 1**`
			`        endif`
			`    next x`
			`    **return capCount**`
			`endfunction`
				3	Accept alternative answers in high-level languages (e.g. `capCount ++` or `capCount +=1 / &&` for and for BP1)
					
					Accept `countCapitals = capCount` for BP3 (Returning via assigning to function identifier is used in VB / Pascal)
					
					Accept **and asc(c) < 91** instead of **<=90**
					
					Allow FT for returning the value they increment as a counter if it isn't capCount

		ii	• Both (use binary) to represent characters // are character sets • The first 7/8 bits of Unicode is the same as ASCII (overlaps)	1	
		iii	• ASCII has fewer characters (128/256) // Unicode has more characters • ASCII is 7/8 bits whereas Unicode can be larger 16/32 / can have variable sized characters • ASCII limited to Latin / English / European characters whereas Unicode can represent other symbols (e.g. Chinese/Cyrillic/Emojis)	2	Only mark the 1st answer for each difference For BP2&3, must have both sides to get the mark <u>Examiner's Comments</u> Candidates should be encouraged to give a complete answer. Just saying 'Unicode uses more bits than ASCII' is not enough to be given a mark at this level.
			Total	6	

Question			Answer/Indicative content	Marks	Guidance
15			– Correctly identified groups on Karnaugh map / Correct boolean statement.(1) – NOT A AND NOT C Gates (1) – A AND C gates (1) – Both sets of gates joined by OR gate (with no other gates used). (1)	4 (AO2.2)	 (¬A ∧ ¬C) ∨ (A∧C) Or equivalent.  Or equivalent. **Examiner's Comments** Most candidates scored well on these questions demonstrating their understanding of logic gate circuits. Some candidates simplified the circuit in part b) which achieved full marks provided the resultant circuit gave the same output.
			Total	**4**	
16			(¬A ∧¬D) ∨(A ∧B ∧C) ∨(¬B ∧¬C ∧¬D) One mark for each bracketed section. One mark for them being joined with ORs	4	
			Total	**4**	

Question			Answer/Indicative content	Marks	Guidance
17		i	¬ (A ∧ B)	1	Accept NOT (A AND B) / other correct notations e.g. $\overline{A.B}$ ¬ must be the correct way round Examiner's Comments Many candidates gained full marks with the most common error being ¬(A v B)
		ii	B	1	Examiner's Comments Almost all candidates were able to gain a mark on this question.
		iii	• 1 mark for A • 1 mark for v (B ∧ C) A v (B ∧ C)	2	Doesn't need brackets Allow other correct notation e.g. A+B.C Allow either order e.g. (B∧C) v A Allow Av(BC) / AvBC Examiner's Comments The majority of candidates recognised that distribution meant that there was only one A following simplification but the most common error for the second mark was again to use OR instead of AND for B AND C
			Total	4	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>18</td><td>a</td><td>i</td><td>• ¬ (A ∨ B) // NOT (A OR B)
• ⩒ C // XOR C</td><td>2</td><td>First MP requires brackets, NOT A or B is incorrect.

Can be written in different order (e.g. C XOR NOT (B OR A) as long as logically correct.

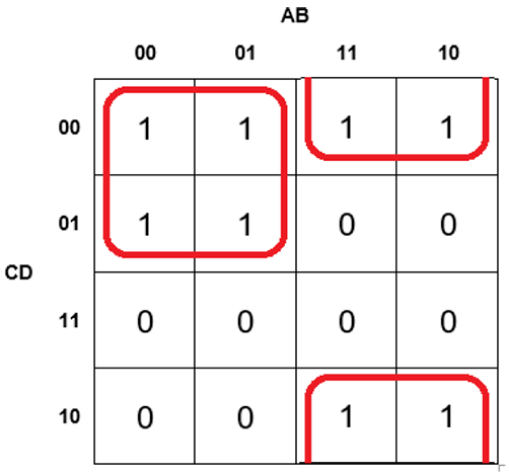
Accept $\overline{(A + B)} \oplus C$

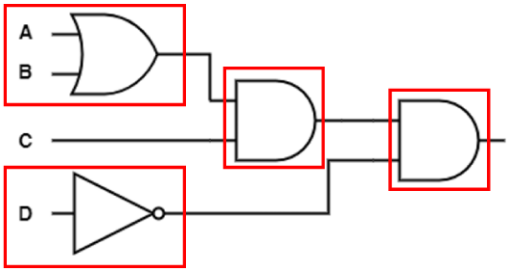
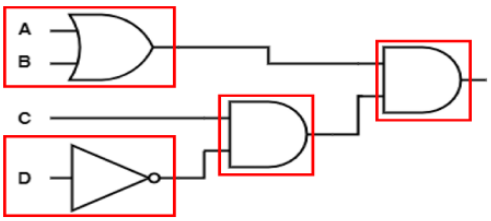
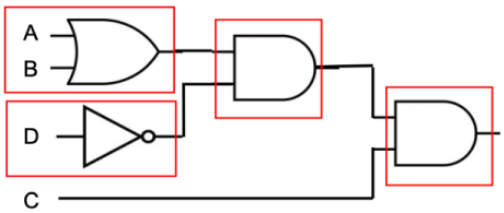
<u>Examiner's Comments</u>

This question was generally well answered, although some candidates confused AND and OR</td></tr>
<tr><td></td><td></td><td>ii</td><td>• 1 mark for first two rows (1,0)
• 1 mark for next two rows (0,1)
• 1 mark for next four rows (0,1,0,1)

<table>
<tr><th>A</th><th>B</th><th>C</th><th>P</th><th>Marking Guidance</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td rowspan="2">1 Mark</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><td rowspan="2">1 Mark</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td rowspan="4">1 Mark</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td></tr>
</table>
</td><td>3</td><td><u>Examiner's Comments</u>

This question was generally well answered.</td></tr>
</table>

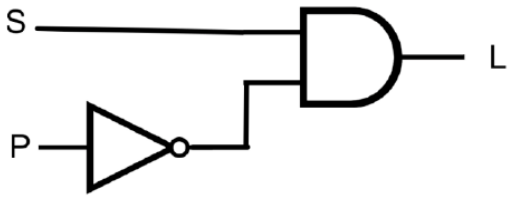
Question			Answer/Indicative content	Marks	Guidance
	b		• Correct highlighting on K map as shown • ¬A ∧ ¬C // $\bar{A}.\bar{C}$ // NOT A AND NOT C… • A ∧ ¬D // $A.\bar{D}$ D // A AND NOT D… • …∨ // + // OR joining the 2 correct expressions together	4	 Do not penalise candidates who attempt to simplify even further (e.g. NOT A AND NOT C = NOT (A OR C) using De Morgan's). MP1 - correct answer only MP4 is dependent on MP2 & 3 Examiner's Comments There were many candidates who were able to gain full marks on this question. Those who did not showed a lack of understanding of grouping on a Karnaugh map, either grouping to include zeros or missing the wrapping group and adding another group in for the top row.
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
19			1 mark for each correct area **including labelled inputs**  **Alternatives (1 mark per area):**   	4	Max 3 if any additional gates. NOT gate must have only one input, AND/OR gates must have two inputs NOT gate must have circle Ignore any names on gates <u>Examiner's Comments</u> There were a range of marks on this question. More successful candidates gave all four gates accurately, but most candidates were able to gain at least one or two marks. Some candidates were unaware of what a logic circuit was and instead produced a range of different diagrams including flow charts.
			Total	**4**	
20			• Identification of De Morgan's and/or double negation rule • Correct final answer to give A v B	2 AO2.2	
			Total	**2**	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>21</td><td></td><td>i</td><td>
<table>
<tr><th>P</th><th>S</th><th>L</th></tr>
<tr><td>False</td><td>False</td><td>False</td></tr>
<tr><td>False</td><td>True</td><td>True</td></tr>
<tr><td>True</td><td>False</td><td>False</td></tr>
<tr><td>True</td><td>True</td><td>False</td></tr>
</table>
1 Mark for first 2 rows, 1 Mark for second 2 rows.
</td><td>2
AO1.2</td><td>Accept any sensible representation of True or False

<u>Examiner's Comments</u>

Well answered by most candidates with some opting for a different representation of True / False in their response. These responses, where correct, were condoned but centres would best advise candidates to use the representations given in the context in future series.</td></tr>
<tr><td></td><td></td><td>ii</td><td>-P going into NOT Gate
-S going into AND gate…
-…NOT P going into AND gate, L coming out of it and no additional gates or connections.
(1 per -, max 3)</td><td>3

AO3.1</td><td> 

<u>Examiner's Comments</u>

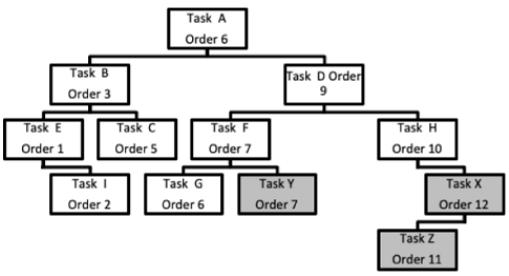
Generally, candidates responded well to this question, but some candidates used incorrect logic gate representations. Centres should remind candidates of the acceptable boolean algebra logic gate representations see specification appendix 5d.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>5</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
22	a		1 mark each to max 2 for justification e.g. • Can store multiple items of data under **one identifier** // so all the data about a task can be accessed using the same identifier • Can store data of **different data types** and this task has string, real and integers	2	Examiner's Comments Record structures were poorly understood, and it was clear that many candidates had very limited experience of using records / structures within a programming language. Many candidates gave responses related to database records rather than record data structures.
	b	i	1 mark each e.g. • Each node can have 0, 1 or 2 child nodes // a maximum of 2 child nodes • Nodes are ordered (with left nodes less than the parent and right nodes greater) • The location to which a node is added depends on its order.	2	Examiner's Comments Some candidates gave generic properties of trees such as 'root' instead of specific characteristics of a binary search tree as required by the question. There was then some lack of precision when describing the number of child nodes each parent node could have (maximum two, not always two), or lack of clarity in defining 'ordered' without qualifying what this meant.
		ii	1 mark for advantage e.g. • Searching is faster (O(log n)) • Inserting new tasks is faster • Do not need to sort the structure (each time a new task is inserted)	1	Examiner's Comments A number of candidates erroneously talked about binary tree traversal to traverse a 1D list. However, there were many clear and correct responses. Some unqualified 'easier' / 'quicker' type responses gained no credit. Candidates had to identify that it was quicker to search/insert into the tree.

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>iii</td><td>1 mark for each row

<table>
<tr><th>Statement</th><th>Depth-first (post-order)</th><th>Breadth-first</th><th>Neither of these two traversals</th></tr>
<tr><td>All nodes at the current depth are visited before moving to the next depth</td><td></td><td>✓</td><td></td></tr>
<tr><td>The algorithm traverses to the end of one branch before moving to another branch</td><td>✓</td><td></td><td></td></tr>
<tr><td>The algorithm will make use of backtracking</td><td>✓</td><td></td><td></td></tr>
<tr><td>The traversal can be used to output the contents of the tree in ascending order</td><td></td><td></td><td>✓</td></tr>
<tr><td>The algorithm will output the root node last</td><td>✓</td><td></td><td></td></tr>
</table></td><td>5</td><td><u>Examiner's Comments</u>

Many candidates achieved at least partial credit if not full credit.</td></tr>
<tr><td></td><td></td><td>iv</td><td>1 mark for Task Y to right of Task F
1 mark for Task X to right of Task H …
… 1 mark for Task Z to left of Task X

 
</td><td>3</td><td>The direction of left/right child nodes must be clear and cannot just be a downward vertical line.

<u>Examiner's Comments</u>

The binary search tree diagram generally was answered well with the majority of candidates gaining full marks.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>13</td><td></td></tr>
</table>

Question			Answer/Indicative content	Marks	Guidance
23	a		1 mark each • Compare the first element (rainbow) to search item / clouds • If it is equal to the search item return index / found • If it is not equal move to the next element • Repeat until either search item / clouds is equal // or the end of the list has been reached	3	Allow answers by example from the given dataset Examiner's Comments Most candidates scored the majority of the marks available and demonstrated a clear understanding of a linear search. Many candidates answered by example with values from the given list.
	b		1 mark for: the data is not in order/sorted	1	Examiner's Comments Most candidates correctly identified the requirement for data to be sorted/ordered for a binary search to work. 'Organised' was too vague and was not accepted.
			Total	4	

<table>
<tr><th colspan="3">Question</th><th>Answer/Indicative content</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>24</td><td></td><td></td><td>1 mark for final path A, D, G
1 mark for final distance 14
1 mark for each SECTION or equivalent working shown.

<table>
<tr><th>Node</th><th>Distance travelled</th><th>Previous node</th><th>Marking Guidance</th></tr>
<tr><td>A</td><td>0</td><td>- / N/A / blank / None</td><td rowspan="2">1 Mark</td></tr>
<tr><td>B</td><td>5</td><td>A</td></tr>
<tr><td>C</td><td>2</td><td>A</td><td rowspan="2">1 Mark</td></tr>
<tr><td>D</td><td>10</td><td>A</td></tr>
<tr><td>E</td><td>7</td><td>B</td><td rowspan="2">1 Mark</td></tr>
<tr><td>F</td><td>15</td><td>E</td></tr>
<tr><td>G</td><td><s>19</s>
14</td><td><s>E</s> D</td><td>1 Mark</td></tr>
</table>
</td><td>6</td><td>Nodes should appear in the alphabetical order given if candidates add them as the algorithm progresses but allow other orderings of the nodes.

For the last mark in the table there must be a clear indication that G 19 from E is overwritten by G 14 from D.

Allow equivalent discrete maths approach or textual description.

Check diagram for annotations / solution.

<u>Examiner’s Comments</u>

Candidates answering ‘by inspection’ could gain 2 marks for the final path and distance, and many less successful responses thus scored 1 or 2 marks by doing so, demonstrating little real understanding of how Dijkstra’s algorithm operates. A common error was the incorrect solution ACDG that showed ignorance of not continuing the search from the node with the least distance travelled that has not already been marked as visited. For full marks there had to be an indication that the first path to G (19 from E) was overwritten by G (14 from D) for the last mark in the table. Relatively few candidates demonstrated this.</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6</td><td></td></tr>
</table>

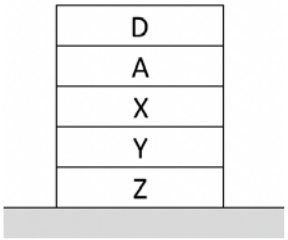
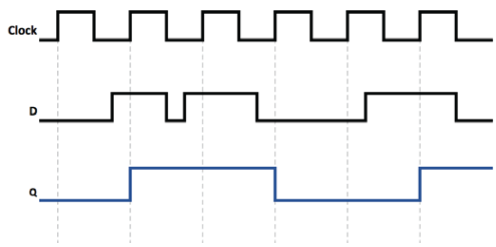
Question			Answer/Indicative content	Marks	Guidance
25		i	1 mark per bullet to max 4 • Merge sort splits the data • Merge sorts the split data as it is put back together • Bubble moves through the data in a linear way • Bubble moves through the data repeatedly • Merge is more efficient with larger volumes of data to sort • Merge may require more memory space	4	Allow points by demonstration/example
		ii	1 mark per example e.g. • Insertion • Quick	2	
			Total	6	
26		i	355	1	<u>Examiner's Comments</u> Many candidates did not appreciate that a bubble sort will require a maximum of n -1 passes in the worst case since the first item in the list will be in position after that number of passes and so would not require an additional pass. The most common incorrect responses were 356, and 3562 which confused the worst case time complexity $O(n^2)$ with the number of passes.
		ii	Insertion sort	1	Accept any valid sorting algorithm e.g. Merge sort, Quick sort <u>Examiner's Comments</u> Nearly all candidates could identify an additional sorting algorithm with the most common response being 'Insertion sort'.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
27		i	1 mark per bullet to max • Queue has head pointer and tail pointer • When an item is enqueued the tail pointer increments • When an item is dequeued the head pointer increments	3	Max 1 mark for Enqueue/Dequeue operations if description of effect on tail/head pointers not given <u>Examiner's Comments</u> Many candidates identified the need to have a head/tail pointer but struggled to gain more than 1 mark by expanding on how enqueue and dequeue operations would be implemented. Some candidates continued to talk about push/pop operations for a queue rather than enqueue/dequeue and often gave properties of a queue in general such as First In First Out rather than answering the question.
		ii	**Mark Band 3 – High level** **(7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of object-oriented and procedural programming; the material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated*. **Mark Band 2 – Mid level** **(4-6 marks)** The candidate demonstrates reasonable knowledge and understanding of object-oriented and procedural programming; the material is generally accurate but at times underdeveloped. The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence/examples are for the most part implicitly relevant to the explanation. The candidate provides a reasonable discussion, the majority of which is focused. Evaluative comments are, for the most part appropriate, although one or two opportunities for development are missed. *There is a line of reasoning presented with*	9 AO1.1 (2) AO1.2 (2) AO2.1 (2) AO3.3 (3)	**AO1: Knowledge and Understanding** **Indicative content** • OOP defines an object as an independent entity • OOP defines the attributes of the object and the methods that can be applied to it • attributes could be private to restrict accidental changes • Procedural the statements are executed in the order they are written **AO2: Application** • OOP allows for an object to be created from the queue • Many instances of this queue can then be declared in the main program. • Procedural will need each queue to be declared individually • Procedural will need to make use of subroutines where the queue will need to be sent and returned each time. **AO3: Evaluation** • OOP you can create multiple instances of the queue as required by the program without having to re-write all of the declarations etc. In procedural you would have to write separate code for each new stack • OOP reduces amount of code needed therefore fewer errors are likely as code is written once and then used

Question			Answer/Indicative content	Marks	Guidance
			some structure. The information presented is in the most part relevant and supported by some evidence. Mark Band 1 – Low Level (1-3 marks) The candidate demonstrates a basic knowledge of object-oriented and procedural programming with limited understanding shown; the material is basic and contains some inaccuracies. The candidates makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides a limited discussion which is narrow in focus. Judgements if made are weak and unsubstantiated. *The information is basic and comunicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear*. 0 marks No attempt to answer the question or response is not worthy of credit.		• multiple times • OOP can reduce mistakes because the subroutines are self-contained in procedural it would need to make sure the correct values are passed and returned, or global variables may be required which uses excess memory. <u>Examiner's Comments</u> Many candidates were able to identify some elements of OOP and Procedural programming to achieve a Level 1 response or were able to describe features in detail for a Level 2 response. Far fewer were able to apply this to the specific context to achieve a Level 3 response. Those with good knowledge of OOP stood out in terms of giving clear evaluations of multiple queues generated from instance of the class, encapsulation to reduce side effects and possibilities for inheritance for different types of queues. Many did not describe the necessary creation of enqueue and dequeue subroutines in procedural programming for each separate queue or the need to pass queues to or returning queues from subroutines. Misconception There was a lot of confusion between inheritance and instantiation, e.g. "when creating several queues you can use inheritance, so all queues inherit attributes and methods". Candidates need to be clear that each instance of a class is assigned the attributes of the class and has access to all associated methods.
			Total	12	

Question			Answer/Indicative content	Marks	Guidance
28			1 mark per bullet • Queue outputs data in a First In First Out fashion • It will retrieve the temperature values in the order they were recorded or • Stack outputs the data in a Last In First Out fashion • It will retrieve the temperature values in the reverse of the order they were recorded	2 AO1.2 (1) AO2.2 (1)	Mark Point 1 is the definition Mark Point 2 is for context of the temperature values <u>Examiner's Comments</u> The majority of candidates were able to define a queue as a FIFO structure. Most of those who did so were able to successfully go on to relate this to the context of the question, which was to be able to retrieve the temperature values in the same order as they had originally been recorded. A number of candidates answered equally well by explaining why a stack would not have been appropriate.
			Total	2	

Question			Answer/Indicative content	Marks	Guidance
29		i	1 mark per bullet • How the times scales as data size increases • O(n) = linear complexity • Increases at the same rate as the number of data items increases	3	
		ii	1 mark each A = exponential B = logarithmic	2	
		iii	1 mark for recommendation, max 3 for explanation • Recommend: Solution B Justification • A's space does not scale well when increased in number of items • B's space scales well / does not increase significantly with number of items • As n increases at some point a will require significantly more space than B • Both have same time complexity so need to look at space	4	
			Total	9	
30		i	O(n)	1 AO1.1 (1)	Examiner's Comment: Most candidates scored well for this section.
		ii	1 mark per bullet to max 2 • 20(ms) • … showing working	2 AO1.2 (1) AO2.1 (1)	Examiner's Comment: Most candidates scored well for this section.
			Total	3	

Question			Answer/Indicative content	Marks	Guidance
31	a		– D at top of stack with A directly below it – X,Y,Z directly below A (with no other entries)  (1 per - , max 2)	2 (AO2.2)	Allow new drawing or amendment of original. Examiner's Comments This part question was generally well answered.
	b		– `pop()` – `pop()` – `push("A")` (1 per - , max 3)	3 (AO3.1)	Examiner's Comments In most cases candidates used the operations given in the stem of the question correctly. Some candidates did not achieve full marks for incorrect use of the pop () operation. They incorrectly passed a parameter to specify the item to pop. Candidates should be reminded that a stack data structure can only pop items from the top therefore no parameter is required.
			Total	5	
32	a		To store the state of a bit	1	
	b		 One mark for each two correct clock cycles.	3	
			Total	4	

Question	Answer/Indicative content	Marks	Guidance
33	**Mark Band 3–High Level (7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of the effect of computers on the environment. The material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence / examples will be explicitly relevant to the explanation. The candidate provides a thorough discussion which is well balanced. Evaluative comments are consistently relevant and well-considered. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. **Mark Band 2-Mid Level (4-6 marks)** The candidate demonstrates reasonable knowledge and understanding of the effect of computers on the environment; the material is generally accurate but at times underdeveloped. The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence / examples are for the most part implicitly relevant to the explanation. The candidate provides a sound discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. **Mark Band 1-Low Level (1-3 marks)** The candidate demonstrates a basic knowledge of the effect of computers on the environment; the material is basic and contains some inaccuracies. The	9 AO1.1(2) AO1.2(2) AO2.1(2) AO3.3(3)	The materials and fuel used in producing and transporting computers has an environmental impact. Digital devices have short life spans and are quickly disposed of… They often end up in landfill or are sent to less economically developed countries to be dismantled due to the value of some of the materials inside them. These devices are often made up of toxic materials (such as mercury) These can harm people disposing of the waste and damage / pollute the area in which they are buried / burned. People have many digital devices. These all need powering / charging. This means there is an increase in demand for electricity. Which means an increase in fossil fuel being burned. Computers are being used to automate the use of things like central heating. This can reduce electricity consumption Computers have encouraged a paperless approach… ..both in the workplace and in terms of companies sending bills to homes This has the potential to reduce the use of paper and as such destruction of trees. Developments in digital storage has reduced the need for physical media to be produced (e.g. CD, DVDs etc) This reduces the need for using plastics. Computers have allowed people to work from home / communicate from afar… This means they don't have to commute / travel, reducing traffic and pollution. Computers can analyse data which can be used in improve efficiency – data mining (appropriate example). <u>Examiner's Comments</u> Candidates were assessed on the quality of their extended response in this question. The negative impacts of computers on the environment were

Question			Answer/Indicative content	Marks	Guidance
			candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides a limited discussion which is narrow in focus. Judgments if made are weak and unsubstantiated. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. 0 marks No attempt to answer the question or response is not worthy of credit.		generally well addressed by most candidates with fewer citing a balanced range of positive impacts. The level of discussion therefore varied with most candidate responses being given Level 2.
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
34			Mark Band 3–High Level (7-9 marks) The candidate demonstrates a thorough knowledge and understanding of the regulation of the Internet; the material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation. The candidate provides a thorough discussion which is well-balanced. Evaluative comments are consistently relevant and well-considered. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. Candidate has used appropriate technical terminology throughout. There are few if any spelling errors or errors of grammar. Mark Band 2 –Mid Level (4-6 marks) The candidate demonstrates reasonable knowledge and understanding of the regulation of the Internet; the material is generally accurate but at times underdeveloped. The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence/examples are for the most part implicitly relevant to the explanation The candidate provides a reasonable discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. There may be spelling errors or errors of grammar in the response but they are not obtrusive. Mark Band 1-Low Level (1-3 marks) The candidate demonstrates a basic knowledge of the regulation of the Internet; the material is basic and contains some inaccuracies. The candidate makes a limited attempt to apply acquired knowledge and understanding to the context provided. The candidate provides a limited discussion which is narrow in focus.	9 AO1.1 (2) AO1.2 (2) AO2.1 (2) AO3.3 (3)	Anyone can put content onto the Internet. It can be hard to track down who put information up. People can make untrue claims or present biased information. There are certain crimes that have originated because of the internet (e.g. phishing and pharming) Other crimes have found new avenues through the internet (e.g. drugs, obscene materials etc.) Laws have been written to take into account the internet (e.g. RIPA in the UK). Traditional laws still apply to the Internet. Governments can apply laws in their jurisdictions… ..but may not be able to enforce them if content is from outside their country. It can be hard to track people down if they actively try to hide their identity. Regulation whilst difficult on the internet may be to some extent desirable. Education is important – teaching people about the risks of using the internet. Content is available to people of all ages and vulnerabilities. <u>Examiner's Comments</u> Candidates were assessed on the quality of their extended response in this question. Most candidates offered a reasonably well supported discussion citing appropriate legislation which can be applied to the internet. Many continued the discussion offering valid reasons why the application of such legislation may not be successful. Many candidates were given L2 or L3.

Question			Answer/Indicative content	Marks	Guidance
			Judgments if made are weak and unsubstantiated. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. There are likely to be spelling errors and/or errors of grammar, which will disrupt the flow of the response. 0 marks No attempt to answer the question or response is not worthy of credit.		
			Total	9	

Question			Answer/Indicative content	Marks	Guidance
35			**Mark Band 3–High Level (7-9 marks)** The candidate demonstrates a thorough knowledge and understanding of legislation including the Computer Misuse Act. The material is generally accurate and detailed. The candidate is able to apply their knowledge and understanding directly and consistently to the context provided. Evidence/examples will be explicitly relevant to the explanation. The candidate provides a thorough discussion which is well balanced. Evaluative comments are consistently relevant and well-considered. There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated. **Mark Band 2-Mid Level (4-6 marks)** The candidate demonstrates reasonable knowledge and understanding legislation including the Computer Misuse Act; the material is generally accurate but at times underdeveloped. The candidate is able to apply their knowledge and understanding directly to the context provided although one or two opportunities are missed. Evidence/examples are for the most part implicitly relevant to the explanation. The candidate provides a sound discussion, the majority of which is focused. Evaluative comments are for the most part appropriate, although one or two opportunities for development are missed. There is a line of reasoning presented with some structure. The information presented is in the most part relevant and supported by some evidence. **Mark Band 1-Low Level (1-3 marks)** The candidate demonstrates a basic knowledge of legislation including the Computer Misuse Act; the material is basic and contains some inaccuracies. The candidate makes a limited attempt to apply acquired knowledge and understanding to	9 AO1.1 (2), AO1.2 (2), AO2.1 (2), AO3.3. (3)	AO1 Computer Misuse Act is legislation aimed at criminalising unauthorised access to a computer system Three stages: Unauthorised access to a computer system Unauthorised access with intent to commit further offences Unauthorised modification of computer material Punishable by up to twelve months in prison and an unlimited fine. AO2 Computer users who investigate how systems work require authorisation in order to not break the Act. Examples such as changing a social media post on a friend's mobile phone potentially breaks all three sections of the Act. Investigation of systems can break the Act without intent, e.g. by changing server logs because of their actions. Users must be aware of the Act (as with any other law) in order to be responsible. AO3 Material available online (e.g. self study videos) that explain how systems work and teach without the need to investigate using unauthorised access. Investigating systems that you own yourself or have authorisation to access does not break the law. Systems are offered to users with strict conditions attached and investigation is not a legitimate excuse for breaking the law. Ethical / white hat hackers will not break this law because they have authorisation. Grey and black hat hackers will break Computer Misuse Act.

Question			Answer/Indicative content	Marks	Guidance
			the context provided. The candidate provides a limited discussion which is narrow in focus. Judgments if made are weak and unsubstantiated. The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear. 0 marks No attempt to answer the question or response is not worthy of credit.		
			Total	9	