Grade 8 – 9 Resource Pack: All Exam Boards

This resource is aimed at students who are already working at a grade 7 and who are looking to move to a grade 8 or grade 9 in Computer Science.

There are many general revision resources and textbooks for this course, so this pack focuses on specific grade 8/9 content and skills, including:

- Extended answers, such as “explain” questions and essays
- More complex topics, such as the TCP/IP model, processor architecture and system security
- Writing algorithms for unseen problems

There are some general revision strategies for achieving the top grades, plus specific grade 8/9 practice on the main topic areas.

There is a significant amount of content that is common to all exam boards, this pack therefore aims to be appropriate for any student regardless of the exam board they are using. However, there is some content that will inevitably be more appropriate for one board rather than another. Therefore, please be aware of the specification you are undergoing and whether each individual aspect of this resource is suitable for your students.

Contents

Top Grade Revision Strategies

Getting the top grade is about showing understanding of the whole specification and being able to apply that to new problems or situations. You are aiming for close to 100% on the paper.

Imaging briefly sitting a year 7 maths test now. Would you get 100%?

I would hope that the answer is yes!

Even if you didn't get 100% in tests in year 7, you may be able to get 100% if you took the test now, and the paper would seem easier than it did in year 7. Why? Because your knowledge, understanding and skills in maths have moved on far enough, and you have used the knowledge often enough, that the year 7 work now seems easy.

You can do the same thing for your GCSEs. If you are aiming for the top grades you need to know the material well enough and have gone far enough beyond it that the GCSE exam becomes easy, so that you can achieve close to 100%.

Part of getting close to 100% is using strategies to make sure that you maximise your marks on each question, including:

- Getting top band on essays
- Getting full marks on 3-4 mark "explain" questions
- Avoiding "silly" mistakes

These are examples of *performance goals*, which focus on reaching measureable standards, such as top band in an essay, rather than *outcome goals* which are out of your control. Although getting a grade 9 sounds like a performance goal, it depends on the examiner, so you are not in full control of the outcome. However, you can make sure that you write in a style that maximises your chance of getting full marks on an essay, and this is within your control.

The Learning Checklist that follows, includes both performance goals and *process goals.* Process goals focus on the actions you need to take *during the exam* to meet your performance goals. For example, to meet a performance goal of "get top band in an essay", you might focus on the processes of "using technical terms" and "using the PEE structure".

If you want to achieve the top band, you need to think and write in a manner that shows you understand the subject. Focus on the actions and behaviours that help you to achieve this and show it to the examiner.

Types of exam question

In the specification, there will be a list of topics, key points and examples that you will need to know. The questions could ask you to state, describe or explain any specific example, or use several examples in an extended answer.

Knowledge

Your knowledge of the key terms will be tested using short (1-2 mark) questions. These require you to either state one or two of the examples from the specification or define a particular term.

Tips

- Make sure you know all the points on the specification because you don't know which ones will come up
- Remember that you cannot use the words in the term in your definition
- Use examples to help your definitions – even for one or two marks, you can write a little more to guarantee the marks

Practice

- Can you recall **all** the bullet points for each topic?
- Use mind maps, flash cards and mnemonics to practise recalling all the key examples – these will form the mark scheme in the exam

Understanding

Your understanding of the key points will be tested using longer questions (3-4 marks), with command words like "describe" or "explain".

Getting a top grade means getting full marks on the long answers. To do this you need to be able to describe and explain each of the points in the specification using clear examples. You may be able to choose your examples – in which case use examples listed in the specification. You may be asked to describe specific examples, so make sure that you know all of them.

If the example is one you don't know, can't remember or have never seen before, try to relate it to one of the examples in the specification:

- What are its features? Is it similar to an example you know?
- Which examples is it different to? How? Does this help you to understand it?
- Are there any general principles you can apply?

The following prompts may help you to develop any point into a 3-4 mark answer.

BT-FEST
Because – Therefore – For Example – So That

(This is the old PEE structure in disguise, with some key connectives to help writing style)

As you are writing a sentence, try saying each connective with a slight rising inflection
For example
One way to improve CPU performance is to increase the cache
...because…
this reduces the number of times the RAM is accessed
...therefore…
the execution time is quicker
...because…
the processor is not waiting for instructions to be fetched from the RAM

Now you may not quite write it like this, but checking for

because… therefore… for example… and so that...

will prompt you to think about adding examples and reasons to your answer.

Another way to think of this is answering the questions
What… How… Why… What If..

You can use the connective "such as..." in the same way as "for example..."
Use whatever connectives suit you best: **one connective = one extra mark**

Essays

To get full marks on the essays you need to

- Cover all the points given in the question
- Write in a clear, well-structured way
- Discuss both/several points of view. You don't need to agree with both sides, rather you need to know both sides so you can agree with one and disprove the other!
- Reach a reasoned conclusion, based on the arguments you have given

As a basic structure, write one paragraph per point in the question, plus a conclusion.

Use connectives to make your answer flow. Use the BT-FEST idea from above.

You might want to use the following paragraph structure
1) Make your point
    Explain your point clearly with examples
2) Make a counter point from another point of view
    Think about how someone would try to argue against your point
3) Reinforce your original point by arguing against the counter argument

In this way, you are arguing for your point of view by both making your view clear and by defeating any counter arguments.

Building up notes and 4 mark answers

You need to make sure that your notes and revision allow you to get 3-4 marks on any point on the specification

For example, pick a point such as “character sets”

For 1-2 marks, you need to be able to define a character set clearly

Character sets

- A character set defines how a set of readable characters
- are converted into binary numbers
- to be processed by a computer

Notice how the points are split up to make each key point clear.
This could be expanded with an example
Character sets

- A character set defines how a set of readable characters
    - Such as the English alphabet on a keyboard
- are converted into binary numbers
- to be processed by a computer

This could now be up to 3 marks for the description, which should be plenty.

We also know from the specification that we need to know ASCII and Unicode, so let’s expand the notes further:

- The more bits per character
- the more characters can be represented
    - For example, in ASCII only 7 bits are used per character
        - giving 128 different characters
    - whereas in Unicode up to 32 bits are used per character
        - giving 2^32 different characters
            - enough for all the alphabets in the world

Notice how we keep adding layers of technical detail, giving examples and explaining what we mean to keep adding marks.

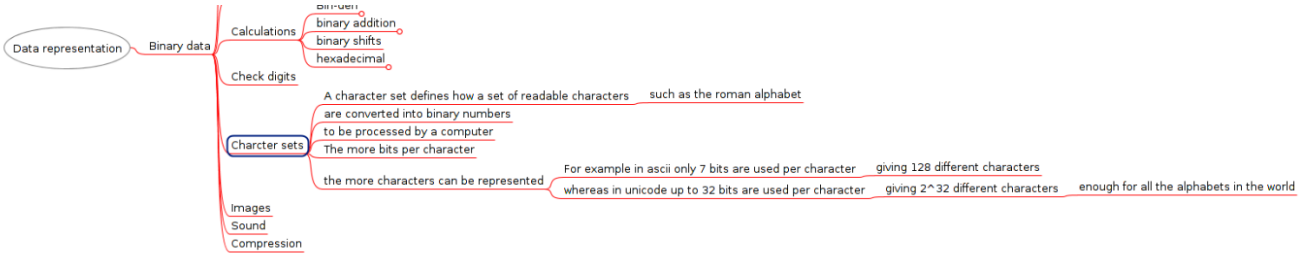
It is a good exercise to go through the specification and develop each point to 3-4 marks.
You can do this in lots of different ways

- Using bullet points
    - Which could become flash cards
- Using mind maps
    - Which could be made interactive

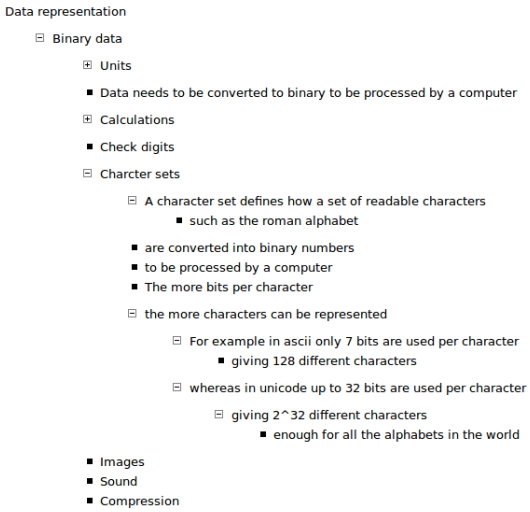
Doing it yourself is important to check that you know the whole specification

Examples

As a mind map



As an interactive applet[1]



In the interactive version, you can click to show/hide the points, which might help you to practice them.

The notes for this pack are in the interactive form.

As a flash card (to be printed)

Character Set	• defines how a set of readable characters
	  ○ Such as the English alphabet on a keyboard
	• are converted into binary numbers
	• to be processed by a computer
	• The more bits per character
	• the more characters can be represented
	  ○ compare ASCII/Unicode

You may also want to turn the notes into labelled diagrams, as images may be easier to remember. Make sure that you can recall/recreate the 3-4 mark details when you need them.

[1] Both the mind map and interactive applet were made using the free software Freeplane

Personal Learning Checklist

Knowledge, Understanding and Skills	Process Goal	Performance Goal
Component 1 – Theory		
Systems Architecture	Refer to the fetch-execute cycle when talking about components and performance Link the components together when describing how the processor works	Be able to explain clearly the function of all the components of the processor Be able to explain the fetch-execute cycle Be able to explain how to improve processor performance
Memory and Storage	Use the standard list of features when comparing memory and storage technologies	Be able to recommend a storage device for a given situation
Network Technologies	Use the TCP/IP model when describing network technologies	Be able to explain how data is transmitted across a network
System Security	Use the standard list of security threats and solutions Link each threat to the correct solution(s) and combine security solution Start with people as the weak point in a system	Achieve top band in each essay answer Achieve full marks on explain questions
Ethical, Legal, Cultural and Environmental Concerns	Refer to all the points given in the question Write using a top-band structure Discuss issues from more than one point of view	Achieve top band in each essay answer
Component 2 – Programming		
Writing Algorithms	Break hard problems into smaller steps Know and use the standard patterns to solve problems	Be able to write an algorithm in pseudocode for an unseen problem
Robust Programming	Use your experience of coding to recall good coding practice Consider normal, boundary and erroneous test data	Be able to analyse an unseen piece of code

Topic Revision

Systems Architecture

Diagnosis

Explain two ways to improve the performance of a computer system [6]

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Describe how the CPU processes instructions [6]

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Diagnosis example answers

Explain two ways to improve the performance of a computer system [6]

- One way to improve the performance of a computer system is to increase the size of the cache memory on the processor.
- The cache is used to store commonly used instructions, which reduces the number of fetch operations to fetch instructions from the RAM.
- Fetching data from the RAM is slow, so reduces the number of fetch operations speeds up the execution of a program.

- Another way to improve computer system performance is to add a graphics card.
- The graphics card contains specialised processors that are optimised to process graphics, for example by parallel processing.
- This improves the run time of graphics programs as the graphics routines are executed more quickly.
- Furthermore, graphics processing is handled by the graphics card, so the main CPU can process other instructions, allowing the system to process more data in the same timeframe as a system without a dedicated graphics processor.

There are several ways given in the specification to improve system performance. I have picked two – you may have picked others. The full list is given in the revision notes.

You get 3 marks *per method* of improving performance:
1 mark for stating how to improve it, e.g. increase cache size
2 marks for explaining how the change improves performance

Notice how the full mark answer develops each point.

- The points are linked in a logical order.
- The answer shows coverage of the key points in the specification.
- You can add detail by
    - Explaining what the component does or how it works
    - Referring to the fetch-execute cycle (using technical language and linking topics)
    - Explaining where the increase in performance comes from

Describe how the CPU processes instructions [6]

- The CPU fetches the next instruction to be processed from the RAM.
- The address of the next instruction is stored in the program counter.
- The address is passed to the memory address register
    - and the data is fetched from the RAM into the memory data register.
- The instruction is decoded by the processor
    - which executes the instruction.
- The control unit controls the fetch execute cycle
    - by sending control signals to all the components connected to the processor.

(Up to 6 marks for valid steps)

You need to know this list of steps for the F-E cycle.
Make sure that you refer to the components of the CPU and link them to the F-E cycle

Practice questions

Use the same mark scheme as the diagnosis questions and check your points against the notes.

Describe how the CPU processes data, referring to the following in your answer: [6]
* The fetch-execute cycle
* RAM
* registers in the CPU

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Explain how each of the following will improve computer system performance [3 marks each]

- Increasing the number of cores
- Increasing the cache size
- Increasing the clock speed
- Increasing the amount of RAM
- Adding a graphics card

Note that this is too big for a normal exam question. However, you might as well practice all of them for revision. In a real exam question you might only be asked about two or three specific ways, or you may be able to choose your own examples.

Number of cores [3]

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Cache size [3]

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Clock speed [3]

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RAM [3]

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Graphics card [3]

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Memory and Storage

The table below shows the standard ways to compare storage technologies. You will need to apply these criteria to different scenarios.

Technology	Example devices	Capacity	Read/Write Speed	Portability	Durability	Reliability	Cost	Common uses
Optical	CD, DVD, Blu-ray(TM)	Low	Slow	Reasonable. Small and light.	Immune to magnetic fields, but easily scratched.	Reasonable. Data cannot be overwritten. However, fewer devices now have DVD players.	Low	Sending SW, backing up files e.g. photos
Magnetic	Hard Disk (Built in and portable)	High	Medium – faster than optical, but slower than solid state	Poor. Many moving parts, so needs to be still when in use. Much larger than other media.	Not great, Susceptible to damage from movement and from magnetic fields.	Very good. Hard disk can be overwritten many times.	Low per GB, but quite expensive	Secondary storage in PC or network. Portable HDD are also popular for backing up files
Solid State	Solid State Hard Disk, SD card, Flash drive/memory stick	Medium	Fast	Very portable. Can be made into tiny memory cards. No moving parts, so can be used on the move	Very durable.	Very good. Most devices have USB connections for memory sticks. However, SD cards require special readers. Also, solid state drives can be written to fewer times than magnetic media.	High per GB	Moving devices, e.g. cameras, phones, drones. High-performance PCs, Laptops

Diagnosis

Alice is going on holiday at the end of year 11 and is taking her digital camera and laptop to record her journey. She wants to be able to store photos and videos of her trip. She will transfer the files to her laptop each day so that she has enough space on her camera for more images. She also wants to keep a backup copy of her photos and videos in case her laptop is damaged or stolen.

The camera uses solid state memory.
Explain two reasons why this is the most appropriate storage technology for this device. [6]

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Alice is considering two ways to back up her files
* On a memory stick
* On a portable hard drive

Discuss which solution would be the most appropriate. * Your quality of written communication will be assessed in this answer [8]

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Diagnosis mark scheme and notes

The camera uses solid state memory.
Explain why this is the most appropriate storage technology for this device.

- Solid state memory has no moving parts
    - and therefore, it is not affected by movement.
        - This is important in a camera because the camera may be in motion when data is being written to the SD card
            - especially if she is filming a tracking shot

- Solid state memory has very fast write times
    - which means that the camera can store more data per second
        - This means that the camera can store more frames per second
            - so it can record in slow motion
            - or it can take pictures faster

You could have used any two of the features from the table – why not try the question again and use two different criteria

To get 3 marks for a reason you need
1 mark for identifying a correct feature of the technology *from the standard list in the table*
1 mark for describing the benefit of this feature
1 mark for linking this back to the context

Don't just go for the first one you think of, e.g. small; you need to pick something you can write about in detail.

Notice again how the extra marks are gained by adding clear technical details taken from the table. Also notice how the notes in the table are linked back to the context, for example linking the read/write time to the frame rate of the camera.

If you are not sure about the context/detail, consider using "maybe" in the sentence or giving a range of examples such as in the second answer.

Alice is considering two ways to back up her files
* On a memory stick
* On a portable hard drive

Discuss which solution would be the most appropriate.

Example answer:
A memory stick may be appropriate because it is **very small** and **is therefore portable**. Also, memory sticks are now **relatively cheap for their capacity**. However, depending on how long she is travelling, a memory stick **might not have enough capacity for her videos**, which **may be very large files**. Furthermore, **a small memory stick might also be easy to lose** while she is travelling.

An alternative option would be a portable hard drive. This may be **larger than a memory stick,** however modern portable drives are **not much bigger**. Furthermore, portable hard drives can have a **very large capacity, potentially up to a terabyte**, so she should be **able to store all her videos** and photos. Portable hard drives **are sensitive to movement** when they are being accessed, but Alice can back up her files when appropriate, so this should not be a factor. Also, **rugged cases for hard drives are cheap** and this would help her to protect her data.

Overall**, I think that the best choice would be** a portable hard drive **because** the increased capacity and reduced risk of losing the drive make it more useful for backing up large files while travelling.

This should get a top band because:
- Both points given in the question are discussed
- It considers a range of technological features from the table
- It uses clear paragraphs and connectives to have a top-band style
- Each point is discussed with pros and cons related to the context give
- There is a clear conclusion based on the arguments already made

Practice

Software companies often sell software on DVD.
Explain why this is a suitable medium to distribute software [4]

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Alice is going on holiday at the end of year 11 and is taking her digital camera and laptop to record her journey. She wants to be able to store photos and videos of her trip. She will transfer the files to her laptop each day so that she has enough space on her camera for more images. She also wants to keep a backup copy of her photos and videos in case her laptop is damaged or stolen.

Alice is considering backing up her photos to the cloud.
Discuss whether this is a suitable choice* Your quality of written communication will be assessed in this answer. [8]

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A manufacturer is making a high-quality slow motion digital video camera for students to record science experiments. Discuss which form of storage would be most appropriate for this device* [8]

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Software companies often sell software on DVD.
Explain why this is a suitable medium to distribute software [4]

Points may include:

- Small, light and flat,
  - so easy to package and easy to post
- Very cheap for capacity,
  - so easy to mass produce
- Capacity is appropriate for modern installers
  - which are relatively small
  - because extra content can be downloaded via the internet once the SW is installed

1 mark for a valid point
1 mark for explanation of point related to the context

Alice is considering backing up her photos to the cloud. Discuss whether this is a good choice. [8]

Points for

- Many devices have automatic uploads
  - so she doesn't need to remember to back up the files
  - so she is less likely to lose them
- Cloud storage is free on some services/she may already have cloud storage through school or work
  - so there is no additional cost for the backup
- Cloud storage capacity is very large
  - possibly unlimited
  - and she can buy extra space easily if she needs it

Points against

- Backing up to cloud storage requires an internet connection
  - which she may not have if she is abroad
  - or may cost more
    - particularly if she needs to use a mobile connection
    - or pay for internet access in a hotel/internet cafe
- Automatic backups could be expensive
  - if she inadvertently incurs data roaming charges

Conclusion
If she is expecting to have reliable internet connection then cloud storage is a good idea. However, if she is somewhere without internet then she will need another solution, such as a portable hard drive.

Full marks if

- You several points for and against (at least two of each)
- You made clear technical points from the table
- Your points were linked back to the context of travelling
- You made a valid conclusion based on your points

A manufacturer is making a high-quality slow motion digital video camera for students to record science experiments. Discuss which form of storage would be most appropriate for this device. [8]

Possible points

SD Card

Points for

* Fast read-write times
    which are good for slow-motion

* Very small
    keeping camera small/light
        and therefore easier to students to use

* Very robust
    useful if the camera may be used by students

* can be removed/replaced
    so students can keep their own videos/other groups of students can use the camera

* Good capacity
    May be sufficient for videos – often used in cameras

Points against

* is the read/write time fast enough, or is a solid-state drive needed?
* is there a risk of the cards being lost?
* is the capacity large enough for the quality of video?

Solid state hard drive

Points for

* Very large capacity
    for storing large amounts of high-quality slow motion video

* Very fast read-write times
    for storing high frame rate

Points against

* Very expensive
    Is the device too expensive?

*very bulky/heavy
    not ideal in a portable camera

Students may also discuss DVD as a possible storage method

Full marks if

- You considered two or more solutions
- You made clear technical points about each one
- and linked these to the context pf a camera for students
- and you drew a valid conclusion based on your arguments

Networks

Diagnosis

I have written an email on my mail client on my phone. When I press send, the email is sent to my mail server using the address mail.school.co.uk
Explain how the email is sent to my mail server. [6]

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Diagnosis mark scheme and notes

1 mark per valid point to max 6
For 6 marks, the answer must reference

- The sending device
- Routers
- The receiving device

- First the sending device will look up the IP address of the mail server on a DNS server.
    - This is a database that matches IP address with domain names.
- Next the data is split into packets.
    - Each packet is given the source and destination IP address
    - and also a sequence number.
- The packets are sent onto the internet.
    - Routers use the destination IP addresses to send the data to the mail server by the most efficient route.
    - Each packet may take a different route.
- The mail server receives the packets and uses the sequence numbers to reassemble them into the right order.
    - If any packets are missing the mail server can send a request that the packet is resent.

Notice that this is just an explain question, not an essay, so there are no marks for the quality of written communication.

- This means that you can list the key points in clear sentences.
- Make sure that you cover all the key devices – they weren't given in the question, but it still helps to talk about senders, receivers and routers.
- Remember to talk about devices not people!

Networks is a big topic
There is a lot to remember – it may help to turn the notes into a large, labelled diagram.
It helps if you can remember the basic principles in the TCP/IP model – this will help you to fill in any gaps.

Remember that networks are designed using the same principles as the phone system or the post office. If you think about making a phone call, or sending a letter, then you already know the main steps and principles!

Practice

Explain how the following devices are used when a computer connects to a website

Router [2]

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DNS Server [2]

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Ethernet card [2]

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Explain the importance of protocols in network communications, giving an example of a common protocol [4]

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Practice answers

Explain how the following devices are used when a computer connects to a website

Router

- Uses the destination IP address
- in a packet
- to route the packet to the destination by the quickest route
- Routers can route packets around network congestion

DNS Server

- A DNS server converts a Domain Name
    - such as google.com
- into an IP address

Ethernet card

- An Ethernet card allows a computer to connect to a network
- by converting data into the correct format to be sent on the network
- such as via an Ethernet cable

Explain the importance of protocols in network communications, giving an example of a common protocol

- Protocols are a standard for communication
    - which means that any device or software using the protocols can connect to any other device or service using the same protocols
        - **For example**, a webserver will be set up to send and receive traffic using the **http protocol**
            - which can be read and displayed by any web browser

You must have an example of a protocol for full marks.

Security

There are two ways to think about security

- know the risks and think about solutions
- know security strategies and think about the problems they solve

While there is a solution to each risk, in many cases you will need to consider either multiple solutions to one risk or multiple benefits of one strategy. The problems and solutions overlap in many ways. Use this to help you remember the points or develop an answer – if you can remember one point, the links may help you to remember more.

When analysing a scenario, you may want to consider the following principles:

- Most data loss is accidental, either by employee error or employees losing laptops, memory sticks etc.
- Most malicious damage is done by employees not hackers
    - either for money
    - or for revenge

The people are the biggest risk

- Training staff
- Control access to systems
- Have software in place to monitor systems
- Reduce external data, e.g. Internet access, USB memory sticks etc.
- Don't allow staff to use their own devices, or take sensitive data off site

Any automated systems, security check etc. need to be

- Up to date, to deal with the latest threats
- Repeated at regular intervals

Some specific risks and strategies are summarised in the notes. Check your specification carefully, as the required examples are slightly different for each exam board.

Diagnosis

A school has developed a revision app for students. Students can sign up and then log in to complete tasks and receive feedback. The app stores data about the students, such as target grades and SEN needs to help tailor the questions to their needs.

Explain two security risks to the system and how they may be reduced. [6]

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Diagnosis mark scheme

A school has developed a revision app for students. Students can sign up and then log in to complete tasks and receive feedback. The app stores data about the students, such as target grades and SEN needs to help tailor the questions to their needs.

Explain two security risks to the system and how they may be reduced. [6]

Example answer

- One risk is theft of sensitive data about the students.
    - This could be through hackers accessing the data stored by the app.
- One way hackers could do this is by a brute force attack to find a user's password.
    - To reduce this risk the system should indicate to students how strong their password is and only allow passwords that meet secure conditions,
        - such as being longer that 8 characters.
    - Furthermore, the system should lock after three wrong password attempts
        - to stop hackers using software to automatically try large numbers of passwords.
- The system could also use Captcha's or similar tools to prevent automated attacks by bots.
- To further reduce the risks from theft, the data stored by the system should be encrypted so that stolen data cannot be read by thieves.

- Another risk is SQL injection.
- A hacker could access the app data by typing SQL commands into input forms on the site.
    - This risk can be reduced by ensuring that all inputs in forms are validated,
    - and any command characters are removed before the input is processed.
    - Many web authoring packages include SQL injection protection as standard.

The answer here is more than is needed for 6 marks, to show you how each answer can be extended.

For three marks, you need

- A valid risk from the table
- A description of what the risk is
- One suggestion of how to reduce the risk

You need to explain two risks and you get three marks per risk explained

You can redo this question several times, picking a different two risks each time.
You can also flip the question and ask, "Explain two ways the data in the app can be protected from theft."

There are many variations on this question.
Make sure you can get three marks for each risk and solution listed in your specification.

Practice

A school stores a large amount of student data on its network, including medical details for trips.

Explain three risks to the school network, and steps the school can take to reduce these risks. [9]

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Ethical, Legal, Social, Cultural and Environmental issues

This is a very broad topic and is likely to be an essay.

Good practice is to read regularly the technology sections of national newspapers or websites to consider the big topics in computing.

You will need to be able to discuss the scenario given from several points of view – there may be prompts for this given in the question.

It may be easiest to approach the scenario with a series of questions that you can then discuss. Some possible starting points for discussion are given below.

Use the writing structures given at the start of the booklet particularly
point-counter point-reinforce original point

Issue	**Prompt Questions**
Ethical issues	What is morally right? What is socially right? Who benefits? Who loses out? Do users understand what they are doing? Do users have choices? Can they opt in and/or opt out? Does the digital divide get bigger?
Legal issues	Is there any data to protect?
Cultural issues	Does everyone have access? Is there any discrimination?
Environmental issues	How is the tech made? How is old tech disposed of?
Privacy issues	Is user data kept secure? Is the data protection act followed?
Stakeholders	Who will use this? Who needs it? How are businesses affected? How are consumers affected?
Technology	What new technology is needed?

Diagnosis

A tech business is considering developing a new fitness watch. Discuss the issues they will need to consider when developing their device including:

- Stakeholders
- Technology
- Ethical issues
- Environmental issues
- Legal issues

Your quality of written communication will be assessed in this answer.

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Example essay

The tech business will need to consider the needs of the owners or shareholders in the business, who will be keen that the device is profitable for the company. This means that the device must be manufactured cheaply enough to turn a profit, while maintaining quality to keep the consumers happy. There is an ethical issue here as the company should not use exploitative manufacturing methods and should consider using renewable resources.

Consumers will be keen that the watch is compatible with a range of smart phones and devices, so that they can use the watch with their existing devices. The company can achieve this by using existing standards for connectivity, such as Bluetooth and USB. This will also help to ensure that their device sells into a larger market. The company must also ensure that the device doesn't adversely affect any existing devices with which it is used.

The company should consider making the watch robust enough to last for several years, both in terms of the reliability of its hardware and in terms of its software. The device should be able to be updated as other technology and apps develop. To achieve this the developer could use a standard operating system with the ability to receive automatic updates. The developer could consider using an open-source OS to allow other developers and users to develop or maintain the device in the future. It is more environmentally friendly if devices last longer as there is less waste, however consumers may still want a new device anyway.

The fitness watch may collect data about the user, such as their location, and the company needs to ensure the security of the user's data. For example, the device could include a password to unlock it. Any data sent to the company should be encrypted before it is transmitted, so that it cannot be read if it is intercepted. Furthermore, if any data is stored by the company, they must store it securely, in line with the data protection act. The company must be clear with the user what data will be collected and how it shall be used.

The watch may also include sensors such as a microphone for voice control. While this is a useful feature for the user, there is a security risk if the device is hacked; the microphone could be used to monitor users without their knowledge. Therefore, the company must make sure that the watch includes appropriate security measures, for example, meeting industry standards and using well established security protocols. The company should carry out sufficient testing to ensure that the device and any security measures are robust, including penetration testing on their own network.

Notice the following for a top band

- All the prompts in the question have been addressed
- The answers draw in technical content from across the specification
- Each point is quite brief, but the points are well linked so they give a wide range of issues related to the context.
- Everything is related back to the context, including a min-conclusion for each paragraph giving the impact on the company or the actions they must take to address the issue

Practice

Discuss the issues relating to the introduction of driverless cars, including:

- Legal issues
- Ethical issues
- Environmental issues

Your quality of written communication will be assessed in this answer

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Practice essay
Suggested points

Legal issues

- Who is culpable in a crash? The driver? The manufacturer?
- Who has responsibility for testing the car? The programmer? The manufacturer? The retailer?
- What data is collect by the vehicle? How is it stored in line with the data protection act? Does it meet the RIPA? (I.e. can the manufacturer spy on your movements?)
- Who sets the standards for controlling communication between cars?

Note that data could improve legal cases if it can be used to prove responsibility in a crash

Ethical issues

- Can AI make decisions in life-threatening situations?
- Who is responsible for safety?
- What data is gathered? Is it used ethically and with full knowledge of the drivers?

- Driverless cars can improve mobility, particularly for the elderly/sick
- Driverless cars may be safer, if set up correctly
- May be some early risks that pay off later, like air travel – are we willing to take that risk?

Environmental issues

- may improve air quality if AI drives more economically
- may reduce fuel use
- may result in scrappage of old cars – could be both good or bad
- If cars can run more closely, would traffic increase?

Note that these are not marking points per se. Rather they are prompts for points that you may have considered. To get the top band you don't need to make these specific points, rather you need to:

- Make a range of technical points
- Consider all the prompts in the question
- Consider different points of view
- Back up your points with evidence and examples

Some of the points are open-ended and there is no single right/wrong answer.

If you are not sure if you would get the top band, then your work is probably not clear enough yet.

More essay practice

Discuss the ethical and legal issues for an ISP monitoring customer Internet use

Discuss the impact of increasing use of mobile technology on young people

Discuss the benefits and risks of a large business allowing staff to use their mobile devices on the company Wi-Fi

“All major operating systems should be open source”.
Discuss how far you agree with this statement.

A tech firm is considering developing smart implants for people who have lost limbs in accidents.
Discuss the ethical, legal and environmental issues they need to consider.

Component 2 – Algorithms and Programming

Writing code

Diagnosis

Write a function to convert a 2-digit hexadecimal number into denary. The hexadecimal number is passed as a parameter to the function. The subroutine hex_digit(x) converts a single hex digit from 0 to F into the equivalent denary number and you may use this function in your solution if you wish. [5]

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Here are the names and test marks for several students on different topics, stored in a 2D array called scores.
scores[0,0] is “Alex”, scores[0,1] is 80 and scores[1,0] is “Bob”
Write an algorithm to find the range of the marks [8]

Alex	80	85	83	79	92
Bob	87	88	90	84	87
Charlie	95	95	100	95	95
Danni	92	93	92	96	98

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Explain the benefits of defensive programming [4]

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Explain two features of an IDE that help developers write robust code [6]

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Diagnosis mark scheme

Writing code for an unseen problem is one of the hardest skills in computer science.
Luckily, the whole subject is designed to give you a method to use to solve an unseen problem!
Hopefully you already have plenty of experience writing your own code and solving problems.

Before we analyse the diagnostic questions, here are some standard algorithms and coding patterns you should be able to recognise, write and use.

Standard algorithms and techniques

Switch-case statement

Used for: Choosing one of a list of possible options
Example

```
function calculate(x, y, operator)
   switch operator:
         case +:
               return  x + y
         case -:
               return x – y
         case *:
               return x*y
         case /:
               return x/y
         case default:
               return “unknown operator”
```

If-else statement

Used for: deciding if something has happened

```
if mark > 40 then
   return pass

if mark > 40 then
   return pass
else
   return fail
```

Nested if are similar to a switch-case statement

```
if mark > 80 then
   return top band
else
   if mark > 40 then
      return pass
   else
      return fail
```

For loop

Used for: looping through a list of items OR looping a fixed number of times
Example
Make sure you can loop through the items in a list or 1D array, using the indexes

```
prices = [10, 12, 30, 5, 7]
for i = 0 to 4
   print(prices[i])
next i
```

You can use two for loops to go through a 2D array

```
board =        [[0, 0, 0],
               [1, 0, 0],
               [0, 0, 0]]

for i = 0 to 2
   for j = 0 to 2
      print(board[i,j])
   next j
next i
```

You can combine a loop with a flag variable and an if statement to check if something occurs in the list

```
flag = False
prices = [10, 12, 30, 5, 7]
for i = 0 to 4
   if prices[i] > 10 then
      flag  = True
   end if
next i
if flag then
   print("There are items over £10")
end if
```

Conditional loop

Used for: looping an unknown number of times
Examples

```
password = ""
while len(password) < 8 do
   INPUT password
end while
```

Some standard list patterns

Finding a total

Using the “in” pattern

```
total = 0
for value in list
   total = total + value
print total
```

Using a while loop and an index

```
total = 0
i = 0
while i < len(list)
   total = total + list[i]
   i = i + 1
print total
```

Using a for loop and the index (we will use this pattern)

```
total = 0
for i = 0 to len(list) – 1
   total = total + list[i]
next i
print total
```

Finding minimum value

```
min = list[0]
for i = 1 to len(list) – 1
   if list[i] < min then
      min = list[i]
   end if
next i
print min
```

Counting something in a list

```
count = 0
for i = 0 to len(list) – 1
   if list[i] == value_to_find then
      count = count + 1
   end if
next i
print count
```

Combining ideas – finding the average of all the items over £100

```
total = 0
count = 0
for i = 0 to len(list) – 1
   if list[i] > 100 then
      total = total + list[i]
      count = count + 1
   end if
next i
average = total / count
print average
```

Find the student with the highest average grade across the five tests and print their name and average score.
Scores is a 2D array as before

	Test1	Test2	Test3	Test4	Test5
Alex	80	85	83	79	92
Bob	87	88	90	84	87
Charlie	95	95	100	95	95
Danni	92	93	92	96	98

```
max_value = 0
max_name = “”
for i = 0 to 4
   total = 0
   for j = 1 to 5
      total = total + scores[i,j]
   next j
   average = total/5
   if average > max_value then
      max_value = average
      max_name = scores[i,0]
   end if
next i
print max_name, max_value
```

Here's how to build up the last answer in stages:

1) Loop through all the scores for all the students

```
for i = 0 to 4
   for j = 1 to 5

   next j
next i
```

2)
Calculate the average for one student

```
for i = 0 to 4
   total = 0
   for j = 1 to 5
      total = total + scores[i,j]
   next j
   average = total/5
next i
```

3)
Check if the average is a maximum

```
max_value = 0
max_name = ""
for i = 0 to 4
   total = 0
   for j = 1 to 5
      total = total + scores[i,j]
   next j
   average = total/5
   if average > max_value then
      max_value = average
      max_name = scores[i,0]
   end if
next i
```

4)
Print the results

```
max_value = 0
max_name = ""
for i = 0 to 4
   total = 0
   for j = 1 to 5
      total = total + scores[i,j]
   next j
   average = total/5
   if average > max_value then
      max_value = average
      max_name = scores[i,0]
   end if
next i
print max_name, max_value
```

Armed with these standard patterms, you can now use some or all of the following problem solving strategy...

Problem solving strategy

1) List the main steps of the problem
2) Break these down into sub steps
    You may need to re-order or add steps
3) Spot any standard patterns, e.g. is this a 2D array, i.e. two for loops?
4) Identify any decisions – these are your if statements
5) Identify any calculations
6) Identify any loops – does anything need repeating?
7) Idenifty any variables
    these will be the nouns in your bullet points
    Do you need any variables for your calculations? Any temporary results? Any counters etc. for your loops?
8) Start writing your code
    Define you function
        What is its name? What are the parameters? What is the return value?
    Initialise any variables, e.g. set total to 0
    Start coding your bullet points
        Can you code the main calculation?
    Check your loops
    Check the code produces the right answer (hand trace)

Here are the diagnostic questions again:

Write a function to convert a 2 digit hexadecimal number into denary. The hexadecimal number is passed as a parameter to the function. The subroutine hex_digit(x) converts a single hex digit from 0 to F into the equivalent denary number and you may use this function in your solution if you wish

Solution:

```
function hex_to_den(hex)
   digit0 = hex[0]
   den0 = hex_digit(digit0)
   digit1 = hex[1]
   den1 = hex_digit(digit1)
   denary = 16*den0 + den1
   return denary
```

You'll get a mark for

- the function definition – you can always give the name of your function and any define any parameters
- the correct return value
- using the subroutine provided – check what is given to you in the question. Remember to only write the function requested, for example don't start worrying about uer input if that is handled by a subroutine.
- the correct calculation
- using the indexes correctly

Here are the test marks for several students on different topics.
Write an algorithm to find the range of the marks

Alex	80	85	83	79	92
Bob	87	88	90	84	87
Charlie	95	95	100	95	95
Danni	92	93	92	96	98

Step 1
This is a 2D array, so probably two for loops

```
for i = 0 to 3
   for j = 1 to 5
   next j
next i
```

Step 2
We need to identify the key calculation and what data is needed
In this case we need the range, so we need the largest and smallest values in the array
These are standard patterns from earlier

```
max = scores[0,1] #set to first value in array to give something to compare to
min = scores[0,1]
for i = 0 to 3
   for j = 1 to 5
   next j
next i
```

```
max = scores[0,1] #set to first value in array to give something to compare to
min = scores[0,1]
for i = 0 to 3
   for j = 1 to 5
      if scores[i,j] > max then
         max = scores[i,j]
      end if
      if scores[i,j] < min then #this could be an elseif
         min = scores[i,j]
      end if
   next j
next i
```

Step 3
complete the calculation and return the answer

```
max = scores[0,1] #set to first value in array to give something to compare to
min = scores[0,1]
for i = 0 to 3
   for j = 1 to 5
      if scores[i,j] > max then
         max = scores[i,j]
      end if
      if scores[i,j] < min then #this could be an elseif
         min = scores[i,j]
      end if
   next j
next i
range = max – min #could return max-min directly
return range
```

Notice how we built this up by combining known patterns.
It doesn't really matter what is in the array. We just loop through it and pick out the required values for the calculation.

Explain the benefits of defensive programming

2 marks for valid points
2 marks for valid examples or explanations of points

e.g.

- Input validation prevents the program from crashing
- By ensuring that input are of the correct data types
- Such as integers for calculations

- Input sanitisation avoids security issues
- Such as SQL injection
- By removing command characters from input boxes

Explain two features of an IDE that help developers write robust code

1 mark for named feature
2 marks for valid explanation

Example
One feature of an IDE that aids development of robust code is a run-time environment that allows the developer to test code without having to compile it and install it on the target device. For example, an android developer could use a run-time environment to test that a program works on many different phones without owning them

Another feature of an IDE is code completion and syntax highlighting, which may help the developer to use a good coding style by automatically indenting code correctly and by enforcing the use of sensible variable names.

In this case no context was given, so you can give your own examples
However, you may need to relate you points to a scenario

Practice

1. Write an algorithm to find the total price of this order

The order is stored in an array called order like this:

85	102	76	130	26

Items over £100 get a 10% discount
VAT must be added at the end at 20%

2. Write an algorithm to
   - Ask the user to input a sequence of test scores
   - Calculate the average of the scores
   - The program should ask for inputs until the user inputs -1
     - this value is not included in the average

3. Using the scores array from before

   a) Write an algorithm to find the student with the lowest range in their scores

   b) Write an algorithm to store any students with an average score below 90 in an array

4. Ask the user for a password and check that it contains
   - at least 8 characters
   - at least one number
   - at least one uppercase and one lowercase character

Output “valid” if it meets all three conditions or a suitable error message if not

Note that ord(c) returns the ASCII code for a character
(You can check in the text book the ASCII ranges for uppercase, lowercase and numbers)

5. Find the name of the first item that costs more than £200

The names and prices are stored in two 1D arrays like this

names

T-shirt	Trousers	Boots	Jacket	Hat	Rucksack	Tent

prices

10.0	36.99	99.99	129.99	12	104.99	230.0

Notice how you can come up with lots of variants easily for more practice, for example
- Change the calculation
- Add layers of complexity, such as discounts

6. This algorithm is supposed to find the median of list of numbers, stored in a 1D array called "numbers"
Correct the code

```
n = numbers.length #alternative way to get the length of a list or array
mid = numbers / 2
median = numbers[mid]
OUTPUT median
```

7. Here is an algorithm to count the number of prices greater than or equal to £100 in a list called *prices*

```
x = 0
for i = 1 to len(prices) – 1
if list[i] > 100 then
x = x + 1
end if
next i
print x
```

Fix an error in the algorithm
Explain how the developer could have improved the code to make it easier to maintain

Sample answers

1.

```
total = 0
for i = 0 to len(order)-1
   if order[i] > 100 then
      total = total + order[i]*0.9
   else
      total =  total + order[i]
  end if
total = total*1.2
print total
```

2.

```
score = 0
total = 0
count = 0
while score <> -1
   OUTPUT “Please enter a score”
   INPUT score
   if score <> -1 then
      total = total + score
      count = count + 1
   end if
end while
OUTPUT total/count
```

3. See earlier example – can you adapt it?

4.

```
valid = False
while not valid
   len = False
   lower = False
   upper  = False
   num = False
   OUPUT “Please choose a password”
   INPUT password
   for i = 0 to password.length – 1
      code = ord(password[i])
      if 48 <= code <= 57 then
         num = True
      else if 65 <= code <= 90 then
         upper  = True
     else if 97 <= code <= 122 then
        lower = True
      end if
   if password.length  >= 8 and upper and lower and num then
      OUTPUT “Valid”
      valid = True
   end if
end while
```

5. See earlier array patterns

6.

```
n = numbers.length #alternative way to get the length of a list or array
numbers.sort #sort the list before finding the median
if n MOD 2 == 1 then #i.e. if n is an odd number
  mid = n-1 / 2 #-1 as the indexes start at 0
  median = numbers[mid]
else
   mid = n/2
   median = (numbers[mid] + numbers[mid-1]) / 2 #average of the two middle numbers
end if
OUTPUT median
```

7.

```
count = 0 #use meaningful variable names
for i = 0 to len(prices) – 1 #index from 0
   if prices[i] >= 100 then #check name and >=
      count = count + 1    #use indentation to improve readability
   end if
next i
print count
```

If you want extra practice coding beyond GCSE try these:

Think Python: a very good book (and free!) explaining thinking strategies for problem solving and how these link to code. Chapters 1-14 are sufficient for GCSE.
http://openbookproject.net/thinkcs/python/english3e/

BIO: the British Informatics Olympiad. Lots of hard coding problems. Like the maths challenge… only for programming!
http://www.olympiad.org.uk/

Final thoughts

Getting a top grade is about practicing the knowledge, understanding and skills required to get full marks in such a way as to produce your best on the day. This includes having an A* mind-set.

- Be confident in your ability to answer questions.
- Start with a simple point… and then build on it
- Practice all the points in the specification to 3 mark depth
- Use connectives to improve your writing style
- Use technical language in context
- Read the question and refer to the context
- Check your answers carefully
- Read around the subject

You chose to study this and you are working at the top grades – enjoy it and show off!

Good luck!