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Realising potential

# LEVEL 3 FOUNDATION TECHNICAL LEVEL IT: TECHNICAL SUPPORT

360 GLH (TVQ01014)

# LEVEL 3 TECHNICAL LEVEL IT: NETWORKING

720 GLH (TVQ01011)

**Specifications**
First registration September 2016 onwards

Version 5.1 November 2018

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# 1 About these qualifications

These qualifications are Advanced (Level 3) Technical qualifications, on a par with A-levels and have been built in close collaboration with employers and professional bodies ensuring that they have both recognition and value.

They are for learners over the age of 16 who wish to specialise or progress into a specific sector or specific occupational group, through advanced/higher apprenticeships, further study or employment.

Transferable skills (sometimes known as 'soft skills') have been contextualised explicitly within the content of each qualification. These transferable skills have been prioritised by employers and professional bodies in this sector and are a mandatory part of the qualification outcome. It is important to note that learners **must** demonstrate successful achievement of the identified transferable skill(s) appropriate to the qualification on at least **one** occasion to the required standard.

The Statements of purpose (pages 12 and 19) give more detail on the likely progression for learners with these qualifications.

Each qualification is one of the three components of the new Technical Baccalaureate (TechBacc).

The TechBacc is a performance table measure which recognises the highest level of technical training. It recognises the achievement of learners taking a Technical Level qualification, a Level 3 maths qualification and an Extended Project Qualification (EPQ).

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# 2 Qualifications at a glance – overview

## 2.1 Level 3 Foundation Technical Level IT: Technical Support

| | | | |
|---|---|---|---|
| **Ofqual qualification number** | 601/7126/1 | **AQA qualification number** | TVQ01014 |
| **First registration date** | 1 September 2016 | **Age range** | 16–18, 19+ |
| **Last registration date** | 31 August 2020 | **UCAS points** | Information on UCAS points can be obtained from ucas.com |
| **Last certification date** | 31 August 2023 | **Performance table points** | Information on performance measures can be found at education.gov.uk |
| **Total qualification time (TQT)** | 380 (GLH = 360) (See TQT section for more information) | **Eligibility for funding** | Yes |
| **Unit weighting**<br>**Externally assessed**<br>**Internally assessed** | 25% each unit (2 x units)<br>25% each unit (2 x units) | **Entry requirements** | There are no formal entry requirements for this qualification set by AQA. |

| | |
|---|---|
| **Mandatory units** | All units in this qualification are mandatory. |
| **Resits, resubmissions and retakes** | The learner is permitted one resit/retake in relation to each unit of the qualification.<br>Where a unit is examined/externally assessed, this means one resit. Where a unit is internally assessed and externally quality assured, this means one retake.<br>Resits, resubmissions and retakes are each permitted where learners have both failed the requirements of the unit and where the learner wishes to improve on a grade received.<br>Any resubmission of an assignment (ie a second attempt at an internally assessed unit task/assignment prior to external quality assurance) must be undertaken without further guidance from the tutor and must be completed within a defined and reasonable period of time following the learner receiving their initial result of the assessment. |

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| | | | |
|---|---|---|---|
| **Assessment model** | This qualification contains externally examined and internally assessed units. Internally assessed units are externally quality assured by AQA. | **Examination sessions** | January and June each year. |
| **Employer involvement during delivery** | It is a requirement that employers are engaged meaningfully in the delivery of this qualification. Further information on this can be found in the individual units (where relevant) and the Meaningful employer involvement section. | | |

| | |
|---|---|
| **Grading** | The units are graded Pass, Merit or Distinction<br><br>The overall qualification is graded as P, M, D, D* |

## Transferable skills contextualised within the units of this qualification

These are the skills deemed essential by the employers and professional bodies AQA has collaborated with on the development of this qualification. We have contextualised units around these 'soft' skills. There may be more than one opportunity for each transferable skill to be evidenced to the required standard across the units within the qualification. It is important to note that learners **must** demonstrate successful achievement of the identified transferable skill(s) appropriate to the qualification on **one** occasion to the required standard in the identified unit(s). Evidence produced for the transferable skills will be internally assessed and externally quality assured.

- Research
- Problem-solving

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## 2.2 Level 3 Technical Level IT: Networking

| | | | |
|---|---|---|---|
| **Ofqual qualification number** | 601/7128/5 | **AQA qualification number** | TVQ01011 |
| **First registration date** | 1 September 2016 | **Age range** | 16–18, 19+ |
| **Last registration date** | 31 August 2020 | **UCAS points** | Information on UCAS points can be obtained from ucas.com |
| **Last certification date** | 31 August 2023 | **Performance table points** | Information on performance measures can be found at education.gov.uk |
| **Total qualification time (TQT)** | 760 (GLH = 720) (See TQT section for more information) | **Eligibility for funding** | Yes |
| **Unit weighting**<br>**Externally assessed**<br>**Internally assessed** | 12.5% each unit (3 x units)<br>12.5% each unit (5 x units) | **Entry requirements** | There are no formal entry requirements for this qualification set by AQA. |

| | |
|---|---|
| **Mandatory units** | All units in this qualification are mandatory. |
| **Resits, resubmissions and retakes** | The learner is permitted one resit/retake in relation to each unit of the qualification.<br>Where a unit is examined/externally assessed, this means one resit. Where a unit is internally assessed and externally quality assured, this means one retake.<br>Resits, resubmissions and retakes are each permitted where learners have both failed the requirements of the unit and where the learner wishes to improve on a grade received.<br>Any resubmission of an assignment (ie a second attempt at an internally assessed unit task/assignment prior to external quality assurance) must be undertaken without further guidance from the tutor and must be completed within a defined and reasonable period of time following the learner receiving their initial result of the assessment. |

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| | | | |
|---|---|---|---|
| **Assessment model** | This qualification contains externally examined and internally assessed units. Internally assessed units are externally quality assured by AQA. | **Examination sessions** | January and June each year. |
| **Employer involvement during delivery** | It is a requirement that employers are engaged meaningfully in the delivery of this qualification. Further information on this can be found in the individual units (where relevant) and the Meaningful employer involvement section. | | |

| | |
|---|---|
| **Grading** | The units are graded Pass, Merit or Distinction<br><br>The overall qualification is graded as PP, MP, MM, DM, DD, D*D, D*D* |

## Transferable skills contextualised within the units of this qualification

These are the skills deemed essential by the employers and professional bodies AQA has collaborated with on the development of this qualification. We have contextualised units around these 'soft' skills. There may be more than one opportunity for each transferable skill to be evidenced to the required standard across the units within the qualification. It is important to note that learners **must** demonstrate successful achievement of the identified transferable skill(s) appropriate to the qualification on **one** occasion to the required standard in the identified unit(s). Evidence produced for the transferable skills will be internally assessed and externally quality assured.

- Teamwork
- Research
- Problem-solving
- Communication (written and oral)

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# 3 Level 3 Foundation Technical Level IT: Technical Support: Statement of purpose

## 3.1 Qualification objectives

The objectives of this qualification are:

- preparing learners to progress to a qualification in the same subject area but at a higher level or requiring more specific knowledge, skills and understanding
- meeting relevant programmes of learning
- preparing learners for employment
- giving learners personal growth and engagement in learning.

This qualification is linked to the following Standard Occupational Classification (SOC)[1] to prepare learners for work in this area:

AQA Level 3 Foundation Technical Level IT: Technical Support

- 313 – information technology technicians

## 3.2 Who is this qualification for?

This technical qualification is aimed at 16 to 18 year old learners who are seeking to develop skills and access a range of junior support job roles in a variety of sector settings, or as the first year of a two year programme where learners aspire to achieve the IT: Networking or IT: User Support qualifications.

It provides a progression pathway from a range of Level 2 qualifications and learning programmes as can be seen in the following document: gov.uk/government/publications/technical-and-vocational-qualifications-for-14-to-19-year-olds

There are no formal entry requirements for this qualification but to optimise their chances of success, learners will typically have five GCSE's at A* to C, preferably including English and maths.

This qualification could be studied alongside other Level 3 qualifications such as IT: Scripting and App Programming or the IT: Programming qualification for a multi-discipline technical role in a small or medium enterprise (SME).

It can form part of a study programme, Technical Baccalaureate and would benefit from being studied alongside an Applied General, A-level or an EPQ.

[1] SOC code is Standard Occupational Category – a common classification of jobs based on their skill content and level – assigned by The Office for National Statistics.

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## 3.3 What does this qualification cover?

All of the units in this qualification are mandatory and will provide a core knowledge and understanding of IT: technical support. Focusing on computer networks and supporting end users to solve computer and network related issues, all based on underpinning units in the fundamental principles of computing and communication technologies, this will prepare learners to work in this sector.

This qualification has been developed under the guidance of The Tech-Partnership and the British Computer Society (BCS) who are the sectors primary professional bodies.

The learner will cover topics such as:

- how devices communicate, focusing on both physical transmission methods and the media which they use
- designing and developing a simple computer network from a user specification and creating a maintenance plan
- fault investigation, diagnosis and resolution.

Transferable skills are those generic 'soft skills' that are valued by employers and higher education alike. The following transferable skills have been contextualised into the content of the qualification:

- research
- problem-solving.

Units which provide opportunities to achieve these skills are listed below:

| Unit code | Unit title | Transferable skill(s) |
|---|---|---|
| K/507/6427 | Developing and maintaining computer networks | Research |
| M/507/6428 | Supporting end users | Problem-solving |

Opportunities for each available transferable skill will be highlighted in the pass criteria for the unit where appropriate.

There may be more than one opportunity for each transferable skill to be evidenced to the required standard across the units within the qualification. It is important to note that learners **must** demonstrate successful achievement of the identified transferable skill(s) appropriate to the qualification on at least **one** occasion to the required standard.

The Transferable skills standards can be found in Appendix A.

## 3.4 What could this qualification lead to?

Learners who achieve this qualification will have a range of options.

Progression from this Level 3 Technical qualification is designed to be to work, as a junior IT support technician. Learners would have an opportunity for further study, topping up this qualification to a Level 3 Technical Level in IT: Networking or IT: User Support qualification. This qualification will also contribute to university entry and will provide opportunities to undertake a range of professional qualifications from vendors such as CISCO.

However, as it is studied at 16 to 19 as part of the study programme, learners will be studying additional qualifications such as an A-level, an EPQ, an AS and possibly re-sits for GCSE English and/or Maths, learners will potentially be able to access higher education – either HNCs and HNDs or degree programmes.

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Therefore, studying this qualification does not restrict future progression into one particular route.

The following are examples of job opportunities within this sector:

- IT technician, network technician, computer maintenance technician, helpdesk operator.

Companies that might employ someone with this qualification include:

- any company or internet service provider in this sector
- large commercial businesses
- the education sector
- charities.

## 3.5 Who supports this qualification?

This qualification has been developed in collaboration with employers, professional bodies and key stakeholders in the IT sector. Because of this, the knowledge, skills and competencies gained will provide the best possible opportunity for progression into employment, a higher or advanced apprenticeship or higher education.

This qualification is supported by the following organisations:

| | | |
|---|---|---|
| bcs The Chartered Institute for IT | British Computer Society (BCS) | bcs.org |
| TECH PARTNERSHIP | The Tech Partnership | thetechpartnership.com |
| UK Cyber Security Forum | UK Cyber Security Forum | ukcybersecurityforum.com |
| D-RISQ SOFTWARE SYSTEMS | D-RisQ | drisq.com |
| fasthosts Inspiring Better Business | Fasthosts | fasthosts.co.uk |
| TOSHIBA Leading Innovation | Toshiba UK | toshiba.co.uk |
| NETGEAR® | NETGEAR | netgear.co.uk |

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| | | |
|---|---|---|
| | Weheartdigital Limited | weheart.digital |
| | CompTIA | comptia.org |
| | Microsoft | microsoft.com |
| | AlfaPeople UK | alfapeople.com |
| | RSPCA | rspca.org.uk |
| | CCL Group Limited | cclgroupltd.com |
| | Cisco | cisco.com |
| | VMWare IT Academy | vmware.com |
| | Axelos | axelos.com |
| | City of Wolverhampton College | wolvcoll.ac.uk |
| | Burton and South Derbyshire College | bsdc.ac.uk |

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| | | |
|---|---|---|
| Solihull College & University Centre | Solihull College | solihull.ac.uk |
| SOUTH & CITY COLLEGE BIRMINGHAM | South and City College Birmingham | sccb.ac.uk |
| NULC Newcastle-under-Lyme College | Newcastle-under-Lyme College | nulc.ac.uk |
| Edge Hill University | Edge Hill University | edgehill.ac.uk |
| University of Bedfordshire | University of Bedfordshire | beds.ac.uk or<br>beds.ac.uk/howtoapply/departments/teacher-education/tt |
| STAFFORDSHIRE UNIVERSITY | Staffordshire University | staffs.ac.uk |

## 3.6 What are the benefits of this qualification?

### To learners

People often forget how much organisations and businesses in the United Kingdom, Europe and around the world in general, rely on IT technicians keeping computer systems and networks operational. Most businesses could not trade in the modern economy without technicians ensuring that computers and devices linked to them are working and are secure.

Studying this qualification will give you a variety of options. You could choose to use your achievements to contribute towards the larger IT: Networking and IT: User Support qualifications or you could use the qualification to contribute towards university entry. Even if you opt to go into an unrelated role in the workplace, this qualification will provide the basic underpinning technical learning to build and maintain a computer, build and maintain a network, and to help and support other users. This will mean that you have direct or additional skills to offer an employer.

You will study the course as part of a learning programme that could also include other subjects, but which will help you to develop the skills and knowledge that are needed in the fast-moving IT sector.

You will be working on industry focused assignments to help you to prepare for work which will help you to talk confidently about your knowledge and skills in an interview situation.

When you have successfully completed the course you will be able to look for a job, or if you prefer, along with your other studies you will be able to apply to university or college to continue your studies.

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Beginning with the fundamental principles of computing, you will study how computers and devices communicate, how networks are built and maintained, and you will understand how to support end users.

### To employers

This qualification has been developed in consultation with employers and professional bodies who have identified a range of technical and personal skills that are essential for a junior or entry role in this area.

All learners who have achieved this technical qualification will have learned and been assessed using the same content as there are no optional units in this programme and they will have demonstrated and achieved a range of transferable skills that are essential in this area such as the ability to research and skills in problem-solving, which are important sector skills.

Building on the fundamental principles of computing, learners will have studied how computers and devices communicate, how networks are built and maintained and they will understand how to support end users.

Employers can therefore be confident that learners have a solid grounding in technical IT and personal skills in research and problem-solving.

### To higher education institutions

Discussions with higher education institutions (HEIs) during the development of this IT: Technical Support qualification identified that to succeed in higher study learners would benefit from basic technical computing skills, particularly if the units studied also had embedded research and problem-solving skill development.

Learners will clearly benefit from being able to carry out basic checks on the technologies they use, whether this is connectivity, or resolving problems as they arise.

In this qualification learners will build on the fundamental principles of computing, they will study how computers and devices communicate, how networks are built and maintained and they will understand how to support other users.

HEIs can therefore be confident that this qualification will have developed both technical and personal skills necessary to study successfully at a higher level.

## 3.7 Links to professional body memberships

The British Computer Society (BCS) believes employers will recruit and train professionals with AQA Tech Level IT qualifications for roles that are likely to be at Registered IT Technician level (see Letter of Support).

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# 4 Level 3 Foundation Technical Level IT: Technical Support: Unit summary

This qualification is made up of four mandatory units. All units must be successfully completed to achieve the full qualification.

| | Unit title | Assessment type | Ofqual unit reference |
|---|---|---|---|
| 1 | Fundamental principles of computing | External examination | Y/507/6424 |
| 2 | Communication technologies | External examination | H/507/6426 |
| 3 | Developing and maintaining computer networks | Internally centre assessed | K/507/6427 |
| 4 | Supporting end users | Internally centre assessed | M/507/6428 |

## Links with other qualifications

The following units are shared across all qualifications in the IT sector:

Y/507/6424 1 Fundamental principles of computing

The following units are shared with IT: Networking, IT: User Support, IT: Cyber Security and IT: Cyber Security and Security Administration:

H/507/6426 2 Communication technologies
K/507/6427 3 Developing and maintaining computer networks

The following units are shared with IT: Networking and IT: User Support:

M/507/6428 4 Supporting end users

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# 5 Level 3 Technical Level IT: Networking: Statement of purpose

## 5.1 Qualification objectives

The objectives of this qualification are:

- preparing learners to progress to a qualification in the same subject area but at a higher level or requiring more specific knowledge, skills and understanding
- meeting relevant programmes of learning
- preparing learners for employment
- supporting a role in the workplace
- giving learners personal growth and engagement in learning.

This qualification is linked to the following Standard Occupational Classification (SOC)[2] to prepare learners for work in this area:

AQA Level 3 Foundation Technical Level IT: Networking

- 2133 – IT specialist managers
- 3131 – IT operations technicians

## 5.2 Who is this qualification for?

This technical qualification is aimed at 16 to 18 year old learners who are seeking to develop skills and access a range of networking job roles in a variety of sector settings, or a networking apprenticeship.

It provides a progression pathway from a range of Level 2 qualifications and learning programmes as can be seen in the following document: gov.uk/government/publications/technical-and-vocational-qualifications-for-14-to-19-year-olds

There are no formal entry requirements for this qualification but to optimise their chances of success, learners will typically have five GCSE's at A* to C, preferably including English and maths.

This qualification could be studied alongside other Level 3 qualifications such as Scripting and App Programming for a multi-discipline technical role in a small or medium enterprise (SME).

It can form part of a study programme, Technical Baccalaureate and would benefit from being studied alongside an Applied General, A-level or an EPQ.

[2] SOC code is Standard Occupational Category – a common classification of jobs based on their skill content and level – assigned by The Office for National Statistics.

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## 5.3 What does this qualification cover?

All of the units in this qualification are mandatory and will provide a core knowledge and understanding of IT networking. Focusing on computer networks, network security, maths for computing, internet technology, supporting end users to solve network related issues, all based on underpinning units in the fundamental principles of computing and communication technologies, this will prepare learners to work in this sector.

This qualification has been developed under the guidance of The Tech-Partnership and the British Computer Society (BCS) who are the sectors primary professional bodies.

The learner will cover topics such as:

- how devices communicate, focusing on both physical transmission methods and the media which they use
- designing and developing a simple computer network from a user specification and creating a maintenance plan
- fault investigation, diagnosis and resolution
- mathematical concepts contextualised for networking and computing including number systems, base conversion, logical operators and data interpretation and representation
- logic which is used every day by operating systems, networks and programmers alike
- the infrastructure of the internet
- the importance of caring about your personal digital footprint
- legal infringements and considerations around copyright, file sharing, intellectual property and plagiarism.

Transferable skills are those generic 'soft skills' that are valued by employers and higher education alike. The following transferable skills have been contextualised into the content of the qualification:

- communication (oral and written)
- research
- teamwork
- problem-solving.

Units which provide opportunities to achieve these skills are listed below:

| Unit code | Unit title | Transferable skill(s) |
|---|---|---|
| A/507/6464 | Industrial project | Teamwork |
| K/507/6427 | Developing and maintaining computer networks | Research |
| M/507/6428 | Supporting end users | Problem-solving |
| F/507/6496 | The internet | Research and communication (written and oral) |

Opportunities for each available transferable skill will be highlighted in the pass criteria for the unit where appropriate.

There may be more than one opportunity for each transferable skill to be evidenced to the required standard across the units within the qualification. It is important to note that learners **must** demonstrate successful achievement of the identified transferable skill(s) appropriate to the qualification on at least **one** occasion to the required standard.

The Transferable skills standards can be found in Appendix A.

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## 5.4 What could this qualification lead to?

Learners who achieve this qualification will have a range of options.

Progression from this Level 3 Technical qualification is designed to be to work, as a networking technician, network administrator or IT support technician. Learners would have an opportunity for further study either through university or through professional qualifications from vendors such as CISCO.

However, as it is studied at 16 to 19 as part of the study programme, learners will be studying additional qualifications such as an A-level, an EPQ, an AS and possibly re-sits for GCSE English and/or Maths, learners will potentially be able to access higher education – either HNCs and HNDs or degree programmes.

Therefore, studying this qualification does not restrict future progression into one particular route.

The following are examples of job opportunities within this sector:

- IT technician
- network technician
- network administrator
- systems technician
- systems administrator.

With experience this could also lead to:

- IT manager
- IT support manager
- network operations manager (computer services)
- service delivery manager.

Companies that might employ someone with this qualification are:

- any company or internet service provider in this sector
- large commercial businesses
- the education sector
- charities.

## 5.5 Who supports this qualification?

This qualification has been developed in collaboration with employers, professional bodies and key stakeholders in the IT sector. Because of this, the knowledge, skills and competencies gained will provide the best possible opportunity for progression into employment, a higher or advanced apprenticeship or higher education.

This qualification is supported by the following organisations:

| | | |
|---|---|---|
| bcs The Chartered Institute for IT | British Computer Society (BCS) | bcs.org |

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| | | |
|---|---|---|
| TECH PARTNERSHIP | The Tech Partnership | thetechpartnership.com |
| UK Cyber Security Forum | UK Cyber Security Forum | ukcybersecurityforum.com |
| D-RisQ SOFTWARE SYSTEMS | D-RisQ | drisq.com |
| fasthosts Inspiring Better Business | Fasthosts | fasthosts.co.uk |
| TOSHIBA Leading Innovation | Toshiba UK | toshiba.co.uk |
| NETGEAR | NETGEAR | netgear.co.uk |
| we digital | Weheartdigital Limited | weheart.digital |
| CompTIA | CompTIA | comptia.org |
| Microsoft | Microsoft | microsoft.com |
| AlfaPeople Creating opportunities | AlfaPeople UK | alfapeople.com |
| RSPCA | RSPCA | rspca.org.uk |
| CCL GROUP future thinking technology | CCL Group Limited | cclgroupltd.com |

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| | | |
|---|---|---|
| | Cisco | cisco.com |
| | VMWare IT Academy | vmware.com |
| | Axelos | axelos.com |
| | City of Wolverhampton College | wolvcoll.ac.uk |
| | Burton and South Derbyshire College | bsdc.ac.uk |
| | Solihull College | solihull.ac.uk |
| | South and City College Birmingham | sccb.ac.uk |
| | Newcastle-under-Lyme College | nulc.ac.uk |
| | Edge Hill University | edgehill.ac.uk |
| | University of Bedfordshire | beds.ac.uk or<br>beds.ac.uk/howtoapply/departments/teacher-education/tt |
| | Staffordshire University | staffs.ac.uk |

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# 5.6 What are the benefits of this qualification?

## To learners

Networking can be an interesting and rewarding career choice that will initially take you into work as a network technician, network administrator or IT support technician. You will study the course as part of a learning programme that could also include other subjects, but which will help you to develop the skills and knowledge that are needed in the fast-moving IT sector.

You will be working on industry focused assignments to help you to prepare for work which will help you to talk confidently about your knowledge and skills in an interview situation.

When you have successfully completed the course you will be able to look for a job, or if you prefer, along with your other studies you will be able to apply to university or college to continue your studies.

Beginning with the fundamental principles of computing, you will study how computers and devices communicate, how networks are built and maintained, you will understand network security and how to support end users.

With experience you will eventually be able to specialise in project management, cyber security or network operations in a more senior role.

## To employers

This qualification has been developed in consultation with employers and professional bodies who have identified a range of technical and personal skills that are essential for work in this area.

All learners who have achieved this technical qualification will have learned and been assessed using the same content as there are no optional units in this programme and they will have demonstrated and achieved a range of transferable skills that are essential in this area such as teamwork, the ability to research, skills in problem-solving and in both written and oral communication.

Building on the fundamental principles of computing, learners will have studied how computers and devices communicate, how networks are built and maintained, they will understand network security and how to support end users. In addition learners will have shown competence in maths that is important for understanding data communication and transmission and will be confident with statistics and data interpretation to support network installation and ongoing maintenance activities.

All learners will have been involved in a contextualised project which will have been industry driven and which will demonstrate the ability to contribute to team performance.

Employers can therefore be confident that learners have a comprehensive grounding in technical and personal skills.

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### To higher education institutions

Discussions with higher education institutions (HEIs) during the development of this networking qualification identified that to succeed in higher study in this area, learners would need to demonstrate competence in maths. Clearly this could have been studied as an additional A-level or AS, but there are aspects of this subject that are not necessarily relevant in the sector. For this reason a maths unit has been included as a mandatory part of this qualification providing opportunities for contextualised maths.

In addition, learners will have built on the fundamental principles of computing, learners will have studied how computers and devices communicate, how networks are built and maintained, they will understand network security and how to support end users.

All learners will have been involved in a contextualised project which will have been industry driven and which will demonstrate the ability to contribute to team performance.

HEIs can therefore be confident that learners will be ready to study at higher levels.

## 5.7 Links to trailblazers

This qualification has been developed to provide a comprehensive grounding in Networking with a view to offer learners the opportunity to progress to a Level 4 Trailblazer Apprenticeship as a Network Engineer: apprenticeships.org.uk/~/media/Apprenticeship-standards/DI%20-%20Network.ashx

## 5.8 Links to professional body memberships

The British Computer Society (BCS) believes employers will recruit and train professionals with AQA Tech Level IT qualifications for roles that are likely to be at Registered IT Technician level (see Letter of Support).

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# 6 Level 3 Technical Level IT: Networking: Unit summary

This qualification is made up of eight mandatory units. All units must be successfully completed to achieve the full qualification.

| | Unit title | Assessment type | Ofqual unit reference |
|---|---|---|---|
| 1 | Fundamental principles of computing | External examination | Y/507/6424 |
| 2 | Communication technologies | External examination | H/507/6426 |
| 3 | Developing and maintaining computer networks | Internally centre assessed | K/507/6427 |
| 4 | Supporting end users | Internally centre assessed | M/507/6428 |
| 5 | Maths for computing | Internally centre assessed | R/507/6437 |
| 6 | Network security management | External examination | A/507/6495 |
| 7 | The internet | Internally centre assessed | F/507/6496 |
| 8 | Industrial project | Internally centre assessed | A/507/6464 |

## Links with other qualifications

The following units are shared across the IT sector:

Y/507/6424 1 Fundamental principles of computing
A/507/6464 8 Industrial project

These also appear within:

AQA Level 3 Technical Level IT: User Support
AQA Level 3 Technical Level IT: Programming

The following units are shared with IT: Networking, IT: User Support, IT: Cyber Security and IT: Cyber Security and Security Administration:

H/507/6426 2 Communication technologies
K/507/6427 3 Developing and maintaining computer networks

The following units are shared with IT: Networking and IT: User Support:

M/507/6428 4 Supporting end users

The following unit is also shared with IT: Cyber Security and Security Administration:

R/507/6437 5 Maths for computing

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# 7 Meaningful employer involvement

## 7.1 Introduction

It is important that centres develop an approach to teaching and learning that supports the assessment of the technical focus of a Tech-level qualification. The specification contains a balance of practical skills and knowledge requirements and centres need to ensure that appropriate links are made between theory and practice in a way that is relevant to the occupational sector.

This will require the development of relevant and up-to-date training materials that allow learners to apply their learning to actual events and activity within the sector, and to generate appropriate evidence for their portfolio.

It is a requirement that employers are involved in the delivery and/or assessment of the Tech-level to provide a clear 'line of sight' to work, advanced/higher apprenticeships or higher education. Employer engagement enriches learning, raises the credibility of the qualification in the eyes of employers, parents and learners – as well as also furthering the critical collaboration between the learning and skills sector and industry.

**It is therefore a requirement that all learners undertake meaningful activity involving employers during their study and this activity will be scrutinised as part of our ongoing quality assurance activities with centres.**

Such is the importance of meaningful employer involvement (MEI) in the delivery of this qualification, should a centre be unable to evidence this, we will impose a sanction, together with an associated action plan. Further information on this process can be found in the AQA *Centre Administration Guide for Technical and Vocational Qualifications*.

AQA will not stipulate the minimum duration or contribution of employer involvement to the overall qualification grade as it is important that centres and employers are allowed flexibility in how best to work together to support learning and in which units – but this collaboration must be significant.

## 7.2 Definition of meaningful employer involvement

In order to meet our requirements, meaningful employer involvement must take at least one of the following forms:

- learners undertake structured work experience or work placements that develop skills and knowledge relevant to this qualification
- learners undertake project work, exercises and/or assessments set with input from industry practitioners – such as getting employers involved in developing real life case studies, or assignments
- learners take one or more units delivered or co-delivered by an industry practitioner – this could be in the form of master-classes or guest lectures
- industry practitioners operating as 'expert witnesses' that contribute to the assessment of a learner's work or practice, operating within a specified assessment framework. This may be for specific project work, exercises or examinations, or all assessments for a qualification.

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For the purpose of clarity, the following activities, whilst valuable, would **not** be considered as meaningful employer involvement:

- employers hosting visits, providing premises, facilities or equipment
- employers or industry practitioners providing talks or contributing to delivery on employability, general careers advice, CV writing, interview training
- learner attendance at career fairs, events or other networking opportunities
- simulated or centre-based working environments
- employers providing learners with job references.

More information on employer involvement in the delivery of technical level qualifications can be found at:

- gov.uk/government/uploads/system/uploads/attachment_data/file/306280/RR341_-_Employer_Involvement_in_Qualifications_Delivery_and_Assessment_Research_Report.pdf
- gov.uk/government/uploads/system/uploads/attachment_data/file/268624/document.pdf

## 7.3 Employer involvement in quality assurance

We need to make sure that the assessment remains relevant and valid, and that learning outcomes are what employers and higher education institutions are expecting of a learner who has achieved a Level 3 Tech-level qualification.

Each year a panel, including representatives from employers and HE, will be brought together to review outcomes from the units and we will ask for samples of learner work from your centre at each AQA external quality assurer (EQA) visit.

We are keen to work collaboratively with employers and HE to make sure that whatever the progression route chosen by the learner, this qualification will be recognised and valued.

If you have a local employer that would like to be involved in this review, we would be very pleased to consider them. Please email their contact details to techlevels@aqa.org.uk

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# 8 Synoptic delivery and assessment

The definition of synoptic assessment used by AQA is:

'A form of assessment which requires a learner to demonstrate that they can identify and use effectively, in an integrated way, an appropriate selection of skills, techniques, concepts, theories, and knowledge from across the whole qualification or unit, which are relevant to a key task'.

The design of this qualification allows learners to develop knowledge, understanding and skills from some units and then evidence this learning in the performance outcomes contained within other units.

The significant amount of synoptic content within the Tech-level supports synoptic learning and assessment by:

- showing teaching and learning links between the units across the specification
- giving guidance or amplification relating to the grading criteria for the internally assessed units, about where learners could apply the knowledge and understanding from other units
- providing a coherent learning programme of related units
- allowing holistic delivery and the application of prior or concurrent learning
- providing opportunities for the learning and assessment of multiple units combined together to promote holistic delivery
- developing and assessing learners' use of transferable skills in different contexts.

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Whilst we do not prescribe in which order the units should be delivered or assessed, it is important for centres to be aware of the links between the units so that the teaching, learning and assessment can be planned accordingly. This way, when being assessed, learners can apply their learning in ways which show they are able to make connections across the qualification.

**It is therefore a requirement that all learners undertake meaningful synoptic learning and assessment during their study. Plans for how this will be undertaken will be scrutinised as part of our centre approval process and its implementation monitored during our ongoing quality assurance activities with centres.**

Within each unit we provide references to where the unit content maps from or to other units within the qualification. This will help the learner understand where there are explicit opportunities for synoptic learning as well as synoptic assessment.

For example, learners will be able to see very clearly how they can apply the underpinning knowledge and theory from the core units into real life or work related tasks – such as projects and work experience – within the specialist units.

This approach will also enable learners to integrate transferable skills much valued by employers and HE into their assignments.

The following grid demonstrates the overall synoptic coverage in each unit of the qualification:

| Unit | Assessment outcomes/ pass criteria | Synoptic links to other units | % of synoptic assessment |
|---|---|---|---|
| Fundamental principles of computing | 5 | Underpinning knowledge for sector | 5/5 (100%) |
| Communication technologies | 5 | Underpinning knowledge for pathway | 5/5 (100%) |
| Developing and maintaining computer networks | 14 | Linked to Units 1, 2, 4, 5, 6, 7 and 8 | 13/14 (93%) |
| Supporting end users | 16 | Linked to Units 1, 3, 5 and 8 | 13/16 (82%) |
| Maths for computing | 15 | Linked to Units 1, 2, 4, 6, 7 and 8 | 12/15 (80%) |
| Network security management | 4 | Linked to Units 1, 2, 3, 4, 5, 7 and 8 | 5/5 (100%) |
| The internet | 15 | Linked to Units 1, 2, 3, 4, 5, 6 and 8 | 10/15 (67%) |
| Industrial project | All units contribute to the industrial project where learners will work together to create solutions for users or a client. | | |

This qualification contains 77.75% synopticity calculated over all eight units, or 88.9% synopticity calculated over seven units (excluding industrial project).

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# 9 Total qualification time

For any qualification which it makes available, Ofqual requires an awarding organisation to:

a assign a number of hours for total qualification time to that qualification, and

b assign a number of hours for guided learning to that qualification.

Total qualification time is the number of notional hours which represents an estimate of the total amount of time that could reasonably be expected to be required in order for a learner to achieve and demonstrate the achievement of the level of attainment necessary for the award of a qualification.

Total qualification time is comprised of the following two elements:

a the number of hours which an awarding organisation has assigned to a qualification for guided learning (GLH)

AQA has assigned GLH to the overall qualification and the individual units.

b an estimate of the number of hours a learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike guided learning, not under the immediate guidance or supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

AQA has assigned the following GLH and TQT values to its qualifications:

| Qualification | Guided learning hours (GLH) | Total qualification time (TQT) |
|---|---|---|
| IT: Technical Support (TVQ01014) | 360 | 380 |
| IT: Networking (TVQ01011) | 720 | 760 |

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# 10 Transferable skills

These valued 'employability' skills are an integral and explicit element within the design and structure of all AQA Level 3 Technical Level qualifications.

Discussions and collaboration with centres, employers and stakeholders (such as further education (FE) colleges, university technical colleges (UTCs), sector skills councils, professional/trade bodies and HE), made it clear that the inclusion of these skills is regarded as a priority, and that they should be included through contextualisation within the core subject content.

Employers and stakeholders prioritised the skills they required from employees in the sector as follows:

- teamworking
- communication
- problem-solving
- research.

Rather than force the inclusion of these skills across a random selection of units or across the qualification as a whole, specific units have been identified as being most appropriate and suitable for the inclusion of a transferable skill within the subject context. The skill becomes the driver for the assessment – rather than the subject content and this will be demonstrated by producing evidence to meet the required standard[3]. Not every unit within the qualification has a skill contextualised within the subject content.

| Unit code | Pathway | Unit title | Transferable skill(s) |
|---|---|---|---|
| A/507/6464 | Networking | Industrial project | Teamwork |
| K/507/6427 | Technical Support<br>Networking | Developing and maintaining computer networks | Research |
| M/507/6428 | Technical Support<br>Networking | Supporting end users | Problem-solving |
| F/507/6496 | Networking | The internet | Research and communication (written and oral) |

The skill is assessed as a performance outcome of the unit, at the Pass grade. It is assessed in the same way as any other assessment criteria within the unit.

The formal inclusion of a contextualised transferable skill does not preclude the inclusion of other 'soft' or 'employability' skills within the unit at the point of delivery, for example those which employers and HE will also value, such as critical thinking, project management, leadership, time management etc. However, these additional 'employability' skills will not be formally assessed as part of the unit performance outcomes.

[3] Please visit the specification homepage to access the transferable skills standards and associated guidance and recording documentation.

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# The AQA Skills statement

Upon the successful completion of a qualification, each learner will be issued with a Skills statement that will sit alongside their formal qualification certificate.

This Skills statement records the transferable skills that were contextualised within the units of the qualification and is an explicit way for learners to showcase the skills that have been formally assessed as part of the qualification. This Skills statement can then be used by a learner as evidence of this achievement within their CVs or HE applications.

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# 11 Support materials and guidance

The following delivery resources and support materials are available from AQA.

- A full Scheme of work (SOW) has been provided for each of the units in this programme. The SOW breaks down the unit content across a 30 teaching week academic year, although this is not mandated. Suggestions have been made for activities both for the tutor and the learner, and the document also contains links to external resources such as videos, task sheets, pdfs, PowerPoint presentations etc. Opportunities to develop English and maths skills have been identified and flagged, and SOWs include some mapping for stretch and challenge and equality and diversity, although tutors will benefit from making this much more class relevant. Assignment handouts have been identified and the assessment points for transferable skills have been highlighted in the final column.
- A sample Lesson plan has also been provided against the SOW, as a guide for good practice.
- A sample assignment has been provided for each of the internally assessed units. These are not mandated in the assessment of this qualification, but do provide a good starting point to help tutors who would benefit from assessment support. These assessments do not necessarily cover all of the criteria that need to be assessed within a unit and it is the tutor's responsibility to ensure that all criteria are assessed across the unit and qualification.
- Sample question papers and mark schemes for each of the examined units.

The schemes of work and lesson plans are available at: aqa.org.uk/subjects/ict-and-computer-science/tech-level/it-networking/teaching-resources

The sample assessment materials (question papers and mark schemes), plus the available sample assignments can be found at: aqa.org.uk/subjects/ict-and-computer-science/tech-level/it-networking/assessment-resources

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# 12 Qualification units

## 12.1 Unit 1: Fundamental principles of computing

| | |
|---|---|
| **Title** | Fundamental principles of computing |
| **Unit number** | Y/507/6424 |
| **Assessment** | Externally assessed |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | N/A |
| **Resources required for this unit** | Central processing unit (CPU); memory chips; motherboards; internal disk drives; expansion cards; computer cases; cables; power supplies; cooling devices; ports; external devices; operating systems; device drivers; applications software. |
| **Synoptic assessment within this unit** | This unit provides the underpinning knowledge for all units contained in either the IT: Technical Support pathway or the IT: Networking pathway. |

### Aim and purpose

This unit will provide the learner with the necessary knowledge to understand the different hardware and elements of a computer system and how these contribute to a fully functioning computer system. The learner will also develop a range of skills required to make changes to computer systems to ensure that they are fit for the particular requirements of the users.

### Unit introduction

The fundamental requirement of any information system is a responsive computer system. Anyone who works in the IT industry needs to be fully conversant with the hardware and software elements that work together to meet the needs of the user.

This unit will provide the learner with understanding of the fundamental building blocks of such systems and enable them to understand how the various components can be linked together and why different possible combinations of these elements can affect the potential of the system to perform to the required standard.

The ability to test or upgrade a system to identify any problems and ensure that it continues to provide the required level of performance is a fundamental skill required of a computer technician. This unit will also provide the opportunity for the learner to develop the relevant skills to enable them to carry out a range of basic tests and make the necessary adjustments to the system for a given scenario.

While small systems may be managed and maintained by a single individual, larger systems require teams of specialists to take responsibility for one or more components in areas such as security. Whether large or small, it is necessary for all testing and adjustments to the systems to be recorded and reported to the responsible manager. As a result, this unit will provide learners with opportunities to develop their skills in teamworking, written and oral communication and problem-solving.

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Computer systems use electricity and some components are heavy and/or difficult to handle, so the learner will be required to understand the correct methods for working safely with electrical equipment, and avoiding damage to components through static electricity. All computer systems use data, some (if not all) of which will be sensitive and the learners will need to understand their responsibilities in protecting the data and systems. Therefore, the learner will need to identify and apply the relevant laws and regulations governing working with electrical systems. It is essential that learners consider the safe disposal of equipment, manual lifting, data protection and computer misuse, and that they carry out risk assessments before undertaking any activities such as dismantling computers, moving computers, etc.

## Unit content

| Different types of computer | |
|---|---|
| Personal computers | • Micro-computers, tablets.<br>• Single user.<br>• Applications for personal use eg email, diary, spreadsheets, databases, word processors, web access. |
| Multi-user computers | • Mainframes.<br>• Supercomputers.<br>• Multi-user.<br>• Applications for governments and research eg storing and manipulating large volumes of data for online bookings and enquiries, payroll, weather prediction, simulators. |

| Hardware components of a computer system | |
|---|---|
| The internal components of a computer<br><br>CPU | • Arithmetic logic unit (ALU).<br>• Main memory.<br>• Cache.<br>• Control unit.<br>• Registers; accumulator etc.<br>• The steps of the Fetch-Execute Cycle.<br>• The effect of an interrupt on a Fetch-Execute Cycle.<br>• Pipelines.<br>• Multi-core processors. |

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| Hardware components of a computer system | |
|---|---|
| The internal components of a computer<br><br>Non-CPU components | • Power supply units (PSUs) which convert power from alternating current (AC) to direct current (DC).<br>• Cooling devices:<br>  • fans<br>  • heat sinks and thermal paste<br>  • water-based.<br>• Internal hard drives.<br>• Memory chips:<br>  • Random Access Memory (RAM) eg Static Random Access Memory (SRAM) and Dynamic Random Access Memory (DRAM)<br>  • Read Only Memory (ROM)<br>  • Programmable Read Only Memory (PROM)<br>  • Erasable Programmable Read Only Memory (EPROM)<br>  • Electrical Erasable Programmable Read Only Memory (EEPROM).<br>• Basic Input Output System (BIOS) and Extensible Firmware Interface (EFI):<br>  • independent of operating system<br>  • instructions eg booting, identification of devices, CPU, memory, power-on self-test (post).<br>• Cards or expansion cards such as sound, graphics, network cards etc.<br>• Input/output controllers. |
| Communication methods | • Computer ports such as Universal Serial Bus (USB), FireWire, Serial Advanced Technology Attachment (SATA), parallel.<br>• Internal and external computer buses eg systems bus, data bus, memory bus, parallel bus, serial bus. |
| External hardware | • Input devices eg mouse, scanner, keyboard, touch screen, web cam, microphone, barcode reader, sensors.<br>• Biometric readers eg fingerprint, iris.<br>• External output devices eg printers (2D, 3D), screens, speakers, slide projectors.<br>• Secondary/backing storage eg hard disk drives, USB drives, read/writeable DVDs, removable magnet disks, fixed magnetic disks, solid state drives.<br>• Specialist operator console. |

| Software requirements of a computer system | |
|---|---|
| Types of software | • Systems software.<br>• Applications software.<br>• Shareware.<br>• Freeware.<br>• Open source. |

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| Software requirements of a computer system | |
|---|---|
| System software | • Libraries eg routines which are used by multiple programs.<br>• Utility programs – such as systems backup, systems optimisers, disk formatters, disk defragging, text editor, graphic editor etc.<br>• Systems management software notifying actual or impending failures, capacity issues and other systems and network events eg monitoring, controlling and reporting on status of:<br>  • client devices (PC, laptop, other mobile devices)<br>  • printers<br>  • storage. |
| Operating systems | • A range of operating systems eg Microsoft Windows, Apple Mac OSX, Android, Linux, Unix.<br>• Types of operating systems eg single user, multi-user, multiprocessing, multitasking (cooperative and pre-emptive), multi-threading operating systems.<br>• Operating system functions eg input recognition, output device recognition, tracking files, tracking directories, managing peripheral devices, sharing resources between users, ensuring that users do not interfere with each other, managing security, access to devices, programs and data. |
| Device drivers | • Types of device driver.<br>• Role eg linking devices to computer system, translating commands received from operating system.<br>• Devices requiring drivers eg expansion cards (eg network, sound, video card), printers, monitors, scanners, mobile devices. |
| Applications software | • Types of application software:<br>  • off-the-shelf: generic programs which provide a recognised business or personal need eg word processors, databases, computer games, spreadsheets, email, internet software<br>  • bespoke designed for specific client needs<br>  • tailored – off-the-shelf adjusted for specific client needs. |
| Security software | • Firewalls.<br>• Antivirus.<br>• Anti-spyware.<br>• Authorisation.<br>• Authentication.<br>• Biometrics.<br>• Encryption. |
| Software inventory | • Software name.<br>• Software version.<br>• Date.<br>• Activity eg installation, test, update.<br>• Outcomes eg successful, failure, reasons for failure (if appropriate), remedial steps taken.<br>• Report of any other observations. |

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| How data is converted to information | |
|---|---|
| Data | • Elements which can be processed to produce useful information eg numbers (numeric), characters (alphanumeric), images, signals.<br>• Qualitative and quantitative data. |
| Information | • Organised data which delivers knowledge, clarification or proof eg reports, charts, graphs, telephone directories, text books.<br>• Information characteristics:<br>  • accuracy<br>  • validity<br>  • timeliness<br>  • authority<br>  • objectivity. |
| Data processing cycle | • Input data eg words, numbers, images, signals.<br>• Arithmetic operations eg +, -. *, /<br>• Logical eg 'and', 'or', 'not', 'nand', 'xor'<br>• Output information eg printed report, on-screen email, correction or operating signals to machinery. |

| How computers process user requirements | |
|---|---|
| Data storage units | • Bits, nibbles, bytes and words.<br>• Common multiples, eg:<br>  • kilobyte<br>  • megabyte<br>  • gigabyte<br>  • terabyte<br>  • petabyte.<br>• International system of quantities 'Kibibyte', etc and conflict with inaccurate international system of units (SI) definition of 'Kilo' etc. |
| Character encoding | • Character encoding eg American Standard Code for Information Interchange (ASCII), Extended ASCII, Unicode. |
| Programming languages | • Natural languages, eg English, French etc.<br>• Man readable vs computer readable languages (ie binary).<br>• Low level languages:<br>  • machine code<br>  • assembly language.<br>• High level languages which use commands and comments as well as characters which are easier for humans to understand eg JavaScript, C++, VB.net, Ada, Fortran, Delphi, PHP, Python.<br>• Fourth Generation languages (4GL) clear human commands eg Structured Query Language (SQL), OpenEdge Advanced Business Language, PROLOG. |
| Converting source code to machine code | • Assemblers, including cross-assemblers.<br>• Translators and their differences:<br>  • interpreters<br>  • compilers. |

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## Assessment outcomes

Learners will be able to:

| Assessment outcome 1: Understand the different types of computer | |
|---|---|
| a | The features of personal computers. |
| b | The features of applications for personal use and their uses. |
| c | The features of multi-user computers. |
| d | The features of applications for governments and research used for storing and manipulating large volumes of data. |

| Assessment outcome 2: Understand the hardware requirements of a computer system | |
|---|---|
| a | The internal components of a CPU including their purpose. |
| b | The steps of the Fetch-Execute Cycle. |
| c | The effect and purpose of an interrupt on a Fetch-Execute Cycle. |
| d | Maskable interrupts (IRQ) and non-maskable interrupts (NMI). |
| e | The internal components of a computer. |
| f | Internal and external power supply units (PSUs) which convert power from alternating current (AC) to direct current (DC). |
| g | Cooling devices and their purpose. |
| h | How internal hard drives work. |
| i | Types of memory chips. |
| j | Basic input output system (BIOS) and Extensible firmware interface (EFI) and their purpose. |
| k | Input/output controllers and expansion cards such as sound, graphics, network cards etc. and their purpose. |
| l | Computer ports and their purpose. |
| m | Internal and external computer buses. |
| n | Input devices eg mouse, scanner, keyboard, touch screen, web cam, microphone, barcode reader, sensors, biometric readers eg fingerprint, iris. |
| o | External output devices eg printers (2D, 3D), screens, speakers, slide projectors. |
| p | Secondary/backing storage eg hard disk drives, USB drives, read/writeable DVDs, removable magnetic disks, fixed magnetic disks, solid state drives (SSD). |
| q | The purpose of specialist operator consoles. |

| Assessment outcome 3: Understand the software requirements of a computer system | |
|---|---|
| a | Types of software. |
| b | Advantages and disadvantages of shareware, freeware and open source software. |
| c | The purpose of libraries eg routines which are used by multiple programs. |
| d | The features and purpose of utility programs. |
| e | The role of systems management software notifying actual or impending failures, capacity issues and other systems and network events eg monitoring, controlling and reporting on status. |
| f | The purpose of client devices. |
| g | Types of operating systems and their function. |
| h | The purpose of the operating systems. |

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| Assessment outcome 3: Understand the software requirements of a computer system | |
|---|---|
| i | The purpose of access to operating systems via a command line interface (CLI). |
| j | Types of file storage. |
| k | Justify the use of different types of file storage. |
| l | The purpose of device drivers. |
| m | The features of anti-malware and their purpose. |
| n | Security methods and their purpose. |
| o | The role of the software inventory including the following records. |

| Assessment outcome 4: Understand how data is converted to information | |
|---|---|
| a | The terms data and information with examples. |
| b | Methods of conveying information. |
| c | What can affect the quality or validity of information. |
| d | Qualitative and quantitative data. |
| e | The input, process, output cycle. |
| f | Arithmetic operations +, -, *, / |
| g | Logical operations. |
| h | Truth tables using up to three logical operations. |

| Assessment outcome 5: Demonstrate how computers process user requirements | |
|---|---|
| a | Bits, nibbles, bytes and words. |
| b | Use common multiples represented by decimal numbers or powers of 10. |
| c | The International System of Quantities ‘Kibibyte’, etc and the International System of Units (SI) definition of ‘Kilo’ etc. |
| d | The features and purpose of character encoding. |
| e | Types of language. |
| f | Describe Low level languages and their purpose. |
| g | The features and purpose of high level languages. |
| h | The features and purpose of Fourth Generation languages (4GL). |
| i | The purpose of assemblers, including cross-assemblers. |
| j | The features and purpose of translators. |

## Assessment

This unit is assessed by an external examination set and marked by AQA. The examination takes place under controlled examination conditions and the exam date will be published at the start of each academic year.

Learners are allowed to use a non-programmable scientific calculator in the examination.

The examination consists of a written paper with two sections, A and B. Learners have to complete both sections and there are no optional questions within either section.

The examination is 2 hours duration and the total number of marks available in the examination is 80.

Section A is worth 50 marks and consists of relatively short questions based on the whole of the specification for this unit. Learners are required to answer **all** of the questions in Section A.

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Section B is worth 30 marks and includes longer questions worth up to 15 marks each. The questions in Section B do not necessarily cover the whole of the specification for this unit at each assessment. Learners are required to answer **all** of the questions in Section B.

## Employer engagement guidance

The organisation, its staff and learners must have access to employers and expertise. The organisation will have computer/technical staff who will understand the practical activities identified in the assessment outcomes. Local employers could be invited to discuss the skills and knowledge they require to support their IT systems, to inform the structure and specific hardware and software identified in the unit.

Employers may also be able to provide opportunities to visit IT facilities or provide placement or shadowing opportunities for assessors and/or learners to provide updating of the former and learning opportunities for the latter.

Employers could be invited to an apprenticeship forum.

The British Computer Society (BCS) and the Association of Computing Machinery are two examples of professional bodies who engage with learners.

## Delivery guidance

Although, for the purposes of identifying specific assessment outcomes, areas such as hardware, software, networks etc, have been split into different elements of a computer system, it is not necessary or advisable to deliver the unit in this way.

Hardware and software could be taught together for example:

The CPU, for example, only understands '0's and '1's because at this level all instructions merely change the status of switches 'off' and 'on'. Early programmers and some of those at the forefront of microchip technology still need to understand how to change the status to produce specific results and thus they need to understand binary arithmetic and machine code. Others, work at the next level of instructions where individual codes have been assembled into simple human instructions eg 'load', 'execute', where the assembler then breaks the instructions down into machine code for the computer to understand. From here the learner can go on to consider need for devices such as input and output devices and the role of the operating system and device drivers in enabling the CPU to carryout instructions. Once these are in place then the introduction of applications software becomes a requirement for those individuals who wish to use the capabilities of the computer rather than program each instruction for themselves. Practical skills can be incorporated by the learners discussing the need for devices such as graphics cards, printers, iris scanners and then identifying and installing the appropriate range of hardware; selecting the correct drivers and testing the installation. Finally, the applications software could be selected to operate the hardware and installed and tested in its turn. This could all take place as part of a scenario for designing a new computer system.

### Assessment outcome 1

It is important that learners understand that computers are not limited to laptops or tablets but that they could be faced with larger and more complex machines.

The learner should have the opportunity to **research** the different computer types and **identify** the appropriate uses for each type.

This could include small group research and presentations of findings to the larger group, visits to local organisations with larger computer systems or presentations by individuals who work with the different computer types.

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As a result the learners should be able to **explain** the advantages and disadvantages of a particular computer type in a given situation ie research, data warehousing, data mining, administration.

## Assessment outcome 2

These are the physical components of the computer system and can be interpreted as anything that can be touched or felt. There have been many changes to computer hardware over time and new hardware and hardware modifications are appearing all of the time. Therefore, specific examples are intended only for guidance and should be adjusted to reflect the range of hardware available at the time of delivery and assessment of the unit. Learners should be able to **explore** the most up-to-date hardware available and **analyse** their strengths and weakness in order to **illustrate** their choice of hardware in a given scenario.

Where possible, learners should have the opportunity to identify components from computers using different CPU chips and operating systems and have access to either server-based systems or those who maintain such systems eg the organisation's network and server technicians, who can explain how the hardware supports organisational requirements. It would be advantageous for learners to have physical access through opportunities to look at the inside of a computer. It is not necessary for learners to actually dismantle the computer themselves, but seeing the hardware in place does assist understanding of how buses, for example, link the various items together and what the components look like when properly installed.

Some components are separate identifiable parts, such as the motherboard or ports, whereas others such as the central processing unit (CPU), which in the case of personal computers (PCs) and servers, for example, normally contain the arithmetic logic unit (ALU), the control unit (CU) and small, fast registers of read/write memory within a single unit or 'chip'. Learners should engage in class discussions or small group research activities to identify the individual components and their role in carrying out instructions and requests.

As the various parts are identified, a class or group discussion could take place as to the purpose, communication methods and location of each one. From this individuals or groups could create annotated diagrams of their findings, which could be discussed within the larger group or class.

For example, the learner would clearly benefit from being able to see and discuss as many of the following example devices as possible:

- input devices eg mouse, scanner, keyboard, touch screen, web cam, microphone, barcode reader, sensors
- external output devices eg printers (2D, 3D), screens, speakers, slide projectors
- secondary/backing storage eg hard disk drives, USB drives, read/writeable DVDs, removable magnetic disks, fixed magnetic disks, solid state drives (SSD).

## Assessment outcome 3

These are the components of the computer system and can be interpreted as anything that cannot be touched, but ensures that the computer carries out the required task quickly and accurately. There have been many changes to computer software over time and new software is always becoming available. Therefore, specific examples are intended only for guidance and should be adjusted to reflect the range of software available at the time of delivery and assessment of the unit.

Learners could be provided with a computer system for which they would need to identify the appropriate operating systems, drivers, applications software etc. They could carry this out as a group or individually feeding back to the group through presentation, video or report.

The learners could carry out a theoretical activity where they would identify the necessary software for a written computer specification.

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Presentations or sessions led by software or systems technicians would be beneficial to learners as the presenters could relate the software choices to actual events and possible issues which have arisen in the work place. This would assist learners in understanding the importance of software selection in the real world.

Learners should be able to explore the most up-to-date software available and analyse their strengths and weakness in order to illustrate their choice of hardware in a given scenario, through class discussion or small group research that could be fed back to the larger group.

Learners should consider different types of file storage and understand their purposes.

They could also work in pairs or small groups to investigate and provide feedback on specific types of security software such as antivirus, anti-spam and anti-malware, demonstrating a real understanding of the differences between these, and identifying examples of commonly used software to provide this functionality.

## Assessment outcome 4

Learners could carry out individual research and then have a class discussion on the difference between information and data or a research project by small groups, who could report back their findings to the larger group for discussion through presentations or poster presentations, for example. Learners could be presented with information that has been broken down in to its component data items – eg lists of dates, names, places, images – and be asked to consider how they could be organised to provide information.

The difference between qualitative and quantitative data could be discussed by the class reviewing examples of both, eg feelings, colours, preferences (qualitative) and election results, annual rainfall, age profiles (quantitative).

It is also important that learners recognise that information must be checked to see that it is accurate, valid, timely and objective. The learners could be given examples of good and poor information and instructed to consider whether they meet the criteria and provide their reasoning. Online tutorials are also available to assist understanding of the characteristics of information. Learners could produce leaflets, booklets or electronic resources after carrying out their own investigations in small groups or individually.

Learners could be given examples of data and consider the processing required to convert them into useful information. The steps that they take could be used as the basis of a class discussion of the data processing cycle. They could identify the input data and the range of operations (both arithmetic and logical) that they carried out on the data; the final output could then be drawn together as a set of instructions or diagrammatic representation of the cycle.

## Assessment outcome 5

Concepts such as character encoding and assembly language often involve numbers systems such as binary and hex, eg ASCII characters encoded in binary, performing arithmetic of hexadecimal values in assembly language etc. Learners should be able to accurately **manipulate** the various number systems eg addition, subtraction, conversions as well as understand the relationships between the machine code level and the complex higher level languages written from a human rather than a machine perspective. This will include the ability to **evaluate** different character encoding systems in terms of range of characters available, for example.

It is important that learners undertake practical exercises on number conversion, from one base to another, and practice arithmetic calculations; these must include denary, binary and hexadecimal bases and fractions. It may be possible to integrate this element of the assessment outcome with maths lessons or enable learners to develop presentations on number bases for other learners. The same discussions could include the reasons for binary and hexadecimal being essential to

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computer instructions, linking it to bits, bytes, nibbles and words. From this, the matching of binary or hexadecimal numbers to human understandable characters could be discussed and small group research conducted into the reasons for the development of different character codes such as ASCII, Unicode and Extended Binary Coded Decimal Interchange Code (EBCDIC) and how they differ from each other.

The learners could research the different types of programming language and produce a diagram of their position on a line from machine understandable to human understandable formats. The programs must include machine code, assemblers, high level and 4GLs. The outcomes could then be discussed in terms of the ways in which different programs can be translated in to machine code.

## Useful links and resources

### Books


- Hedly S and Aplin T, *Blackstone's statutes on IT and e-commerce,* 4th edition, ISBN-10 0199238219, ISBN-13 978-0199238217, Blackstone Press (2008).
- Reed C (ed.), *Computer law*, ISBN-10 0199696462, ISBN-13 978-0199696468, Oxford University Press (2012).
- Render B, Stair R and Hanna M, *Fundamentals of information systems*, 7th edition, ISBN-10 1133629628, ISBN-13: 978-1133629627, Mason, OH, South-Western College Publishing, 2013.
- Shelly GB and Cashman TJ, *Computer fundamentals for an information age*, ISBN 0-88236-125-2, Anaheim Publishing Company, Brea, CA, 2013.
- Burdett A, Bowen D, Butler D, Cumming A et al, *BCS glossary of computing and ICT*, ISBN-13 9781780171500 (2013).


### Websites

- e-booksdirectory.com (online books for download or reading, some free resources).

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## 12.2 Unit 2: Communication technologies

| | |
|---|---|
| **Title** | Communication technologies |
| **Unit number** | H/507/6426 |
| **Assessment** | Externally assessed |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | N/A |
| **Resources required for this unit** | Suitable Windows PC, Linux, Apple Macintosh OS X, Apple iOS or other suitable platforms, that offer basic terminal utilities for connecting to networking devices such as firewalls, routers and switches. Most terminal utilities are either intrinsic to the operating system (eg Linux) or free to download (eg PuTTY, an Open Source certificate program). Point-to-point communication between two computer systems can also be attempted using similar software. This will, of course, also require the possession of suitable serial, parallel and/or network cables. Other utilities such as protocol analysers (eg Wireshark) are also useful to demonstrate network traffic and its protocols and data.<br><br>Wired and wireless networks should also be demonstrated and investigated. This will require a different selection of hardware and software, eg wireless access points (WAP), wireless routers, wireless network cards etc.<br><br>Learners should also have access to suitable offline and online learning material, manuals, help sheets and coded examples in order to encourage self-sufficiency. |
| **Synoptic assessment within this unit** | IT: Technical Support linked to Units 1, 3.<br><br>IT: Networking linked to Units 1, 3, 5, 6 and 7.<br><br>This unit provides complementary coverage to the Fundamental Principles of Computing by moving the learner beyond a single 'standalone' computer system.<br><br>Learners will consider network types, transmission media and conceptual models which they will use to design, build and secure networks in later units.<br><br>Unit 5 provides learners with an understanding of different numbers systems, many of which have key uses in different communication technologies.<br><br>Extended guidance on synoptic assessment is provided later in this unit documentation. |

### Aim and purpose

This unit will provide the learner with the necessary knowledge to appreciate the fundamental aspects of data communication. It will enable a firm conceptual grasp of how data is transmitted at lightning speeds from one point to another, thereby enabling the modern technologies, devices and services we take for granted every single day.

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## Unit introduction

Communication technologies come in many shapes and sizes. In computing, the phrase is often used as an umbrella title to encapsulate a number of different technologies that we use each day, from the mobile telephone in our hand to the wireless network we have in our home or workplace.

In this unit, learners will gain an understanding of how devices communicate, focusing on both the physical transmission methods and the media that they use. An introduction to mobile technologies and networking is also provided, helping the learner to appreciate the range, variety and complexities of the hardware, software and services that are involved. By the unit's completion, learners will have honed their practical skills in order to create basic wired and wireless communications using a variety of devices, media and techniques.

## Unit content

| Fundamentals of data communication | |
|---|---|
| Types of signal | • Digital vs analogue signals; modulation.<br>• Representing data electronically (bits, bytes, protocol data units, etc). |
| Type of terminal equipment | • Data terminal equipment (DTE).<br>• Data circuit-terminating equipment (DCE). |
| Transmission types | • Synchronous transmission of data.<br>• Asynchronous transmission of data.<br>• Packet vs circuit switching. |
| Error detection and correction | • Cause of errors, eg signal disruption through channel noise (crosstalk, interference, impulse), coupled noise, (eg industrial, atmospheric).<br>• Error detection and correction techniques, eg:<br>  • repetition codes<br>  • parity bits (odd, even)<br>  • checksum<br>  • cyclic redundancy checks (crcs). |
| Bandwidth | • Bandwidth measurements, eg bit/s, kbit/s, Mbit/s, Gbit/s.<br>• Typical speeds, eg Ethernet 10 Mbit/s, Fast Ethernet 100 Mbit/s, Gigabit Ethernet 1 Gbit/s.<br>• Bandwidth limitation and noise.<br>• Bandwidth as consumption: throttling, capping and allocation. |

| Data communication methods | |
|---|---|
| Communication methods | • Point-to-point system, protocol and handshakes.<br>• Basic communication types:<br>  • simplex<br>  • half-duplex<br>  • duplex.<br>• Real world examples of the different communication types.<br>• Serial and parallel communication, speeds and typical uses. |

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| Data communication methods | |
|---|---|
| Transmission media | • Wired, eg coaxial, unshielded and shielded twisted pair (UTP/STP).<br>• Optical.<br>• Wireless eg:<br>  • infrared<br>  • radio<br>  • microwave<br>  • satellite. |
| Transmission media features | • Reliability.<br>• Flexibility.<br>• Susceptibility to signal noise.<br>• Ease of installation.<br>• Effective operational range.<br>• Security. |

| Basic mobile technology communication methods | |
|---|---|
| Fundamental concepts | • Mobile device; construction, components, etc.<br>• International mobile equipment identity (IMEI).<br>• Cells, base stations, roaming.<br>• Subscriber Identity Module (SIM), typical data stored in a SIM, eg International Mobile Subscriber Identity (IMSI), passwords, personal identification number (PIN), personal unblocking key (PUK).<br>• SIM form factors, eg mini-SIMs, micro-SIMs and nano-SIM. |
| Mobile standards | • Standards and key features of:<br>  • Global System for Mobile (GSM)/2G<br>  • General Packet Radio Service (GPRS)/2.5G<br>  • Third Generation/3G<br>  • Fourth Generation/4G.<br>• Licensed vs unlicensed technologies; frequencies, interference, strategies eg frequency hopping. |
| Mobile services | • Short Message Service (SMS).<br>• Over-the-air (OTA) programming.<br>• Global Positioning System (GPS).<br>• Mobile broadband and tethering. |

| The fundamentals of computer networks | |
|---|---|
| Network types | • Types and features of different types of computer network:<br>  • personal area network (PAN)<br>  • local area network (LAN)<br>  • wireless local area network (WLAN)<br>  • metropolitan area network (MAN)<br>  • wide area network (WAN)<br>  • storage area network (SAN). |

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| The fundamentals of computer networks | |
|---|---|
| Network topologies | • Different topologies, their key features, strengths and weaknesses:<br>  • bus<br>  • ring<br>  • star<br>  • tree<br>  • mesh. |
| Network rewards | • Typical arguments for networking:<br>  • sharing resources:<br>  • data<br>  • devices, eg printers<br>  • applications<br>  • internet and world wide web access<br>  • improved communication, eg:<br>  • email<br>  • instant message<br>  • video conferencing<br>  • intranet<br>  • improved data security, eg less risk of data loss, central management of user rights and privileges<br>  • enables remote working<br>  • reduced costs, efficiency saving<br>  • improved hardware and service monitoring. |
| Network risks | • Hacking and disruption.<br>• Loss of data.<br>• Loss of service.<br>• Loss of income.<br>• Compromise of data integrity.<br>• Loss of reputation; commercial damage. |

| Network conceptual models, protocols and devices | |
|---|---|
| The need for network models | • To abstract complex physical devices.<br>• To encourage interoperability between different equipment manufacturers.<br>• To standardise subject terminology. |
| Open systems interconnection (OSI) model | Seven Layer model:<br>• Layer 1 Physical hardware eg signalling, wiring.<br>• Layer 2 Data links eg frames, packets.<br>• Layer 3 Network.<br>• Layer 4 Transport eg streams, segments.<br>• Layer 5 Session eg authentication, encryption.<br>• Layer 6 Presentation.<br>• Layer 7 Application. |

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| Network conceptual models, protocols and devices | |
|---|---|
| TCP/IP – Transmission control protocol/internet protocol | • TCP/IP Layers:<br>  • network interface (link layer)<br>  • internet<br>  • transport<br>  • application. |
| Devices operating across the layers | • Generally:<br>  • web and application servers<br>  • network hosts<br>  • network management stations (NMSs).<br>• Specifically:<br>  • physical layer devices eg:<br>  • network interface cards (NICs)<br>  • repeaters<br>  • hubs<br>  • network layer protocols and devices eg:<br>  • internet protocols (IP) eg IPv6<br>  • routing information protocol (RIP)<br>  • open shortest path first (OSPF)<br>  • router<br>  • transport: layer protocols:<br>  • transport control protocol (TCP)<br>  • user datagram protocols (UDP)<br>  • data link layer protocols eg:<br>  • media access control (MAC)<br>  • IEEE 802 Standards eg<br>  • 802.4 Token passing bus<br>  • 802.5 Token passing ring<br>  • 802.7 Broadband LAN<br>  • 802.8 Fibre-optic LAN/MAN<br>  • 802.11 Wireless LAN. |

## Assessment outcomes

Learners will be able to:

| Assessment outcome 1: Understand the fundamentals of data communication | |
|---|---|
| a | Types of signal, modulation, transmission type and terminal equipment. |
| b | Methods of representing and measuring data electronically. |
| c | The principles of noise, error detection and correction techniques. |
| d | Bandwidth allocation, limitation and management. |

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| Assessment outcome 2: Analyse data communication methods | |
|---|---|
| a | Communication methods and speeds in real world situations. |
| b | The application of wired and wireless transmission media. |
| c | The physical and abstract features of transmission media. |

| Assessment outcome 3: Analyse basic mobile technology communication | |
|---|---|
| a | Mobile device components, including SIMs. |
| b | How mobile devices connect to, and are identified on, a local and international network. |
| c | The evolution of subscriber identification modules and mobile telecommunications technology. |
| d | Licensed and unlicensed technologies and strategies for dealing with interference. |
| e | Mobile services including SMS, OTA, GPS, mobile broadband and tethering. |

| Assessment outcome 4: Understand the fundamentals of computer networks | |
|---|---|
| a | Types and features of different area networks. |
| b | The arrangement of the various elements of a computer network. |
| c | The rewards of networking vs the practical, commercial and individual risks. |

| Assessment outcome 5: Understand network conceptual models, protocols and devices | |
|---|---|
| a | Network models and the need for standardisation. |
| b | The functions of, and the relationship between, the abstraction layers of the OSI conceptual models and internet protocol (IP) suite. |
| c | The functionality of devices operating across the layers and explain the protocols. |

## Assessment

This unit is assessed through an external examination set and marked by AQA. The examination takes place under controlled examination conditions and the exam date will be published at the start of each academic year.

Learners are allowed to use a non-programmable scientific calculator in the examination.

The examination consists of a written paper with two Sections, A and B. Learners have to complete both sections and there are no optional questions within either section.

The examination is 2 hours duration and the total number of marks available in the examination is 80.

Section A is worth 50 marks and consists of relatively short questions based on the whole of the specification for this unit. Learners are required to answer **all** of the questions in Section A.

Section B is worth 30 marks and includes longer questions worth up to 15 marks each. The questions in Section B do not necessarily cover the whole of the specification for this unit at each assessment. Learners are required to answer **all** of the questions in Section B.

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## Employer engagement guidance

The organisation, its staff and learners must have access to employers and expertise. The organisation will have computer/technical staff who will understand the practical activities identified in the assessment outcomes. Local employers could be invited to discuss the skills and knowledge they require to support their IT systems, to inform the structure and specific hardware and software identified in the unit.

Employers may also be able to provide opportunities to visit IT facilities or provide placement or shadowing opportunities for assessors and/or learners to provide updating of the former and learning opportunities for the latter.

Employers could be invited to an apprenticeship forum.

The British Computer Society (BCS) and the Association of Computing Machinery are two examples of professional bodies who engage with learners.

## Delivery guidance

It is recommended that this unit is taught as a precursor to Unit 3: Developing and maintaining computer networks, as many of its concepts are introduced in this unit.

Although it is suggested that the content is delivered to follow the order of the learning outcomes in this unit specification, it is not the only sequence that could be used. Tutors are encouraged to consider the holistic nature of the learner's programme and the scheme itself.

Learners must have access to the hardware and software facilities necessary for the opportunity to generate evidence of all of the grading criteria listed. In the case of mobile communications technology it is perfectly possible that a learner's device may be used if they accept the risks associated with connecting to potentially unsecured services and devices. As such, if centres cannot guarantee these resources, the unit should not be attempted.

### Assessment outcome 1

Learners will develop and demonstrate their knowledge and understanding of data communication fundamentals. They should explore the difference between encoding data as digital and analogue signals. This is best achieved using simple diagrams or animations, further supported by demonstrating practical skills in encoding sample data, comparing and contrasting the different causes of error that could disrupt the signal and finally including an error detection method to identify the problem.

Learners should be able to calculate data transfer times depending on available bandwidth. They must use the correct units and interpret the metrics correctly in order to calculate sensible answers. Comparisons can be made with many online 'broadband speed tests' that perform similar tasks in an automated fashion. Complications arise when bandwidth is constrained in some fashion and learners should understand these impacts, especially in terms of potential impact on speed and sustained connectivity.

### Assessment outcome 2

This focuses on the learner being able to demonstrate the range of their knowledge of different communication methods and media. These essentially involve the learner performing the necessary practical tasks and then documenting to a satisfactory standard to ensure that they have an embedded understanding of the concepts. As part of their development they could, for example, make data connections between two devices, potentially a DTE and a DCE or two DTEs using either a parallel or serial cable. They should be able to demonstrate an understanding of the different communication types and protocols that could be used in a point-to-point system. Exploring real world connectivity issues and being able to justify the communication type and protocol that would be most effective would be a way to show their understanding.

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Learners should be able to understand wired and wireless transmission media, and should practically complete both a suitable wired and wireless connection, then determine which method would be most suited to a selected real world situation or case study. This type of task can be completed through a combination of practical activity, maybe presenting their findings to the group.

### Assessment outcome 3

This outcome revolves around the use of mobile technology and learners have an opportunity to study their own resources. Learners should be able to demonstrate a working knowledge of the components of a mobile device: they should be able to provide technical descriptions rather than a superficial overview of the device. They should be able to explain the device in terms of its cellular infrastructure, explaining how data (eg voice, SMS text messages etc) is transferred from device to device. Learners should practice the evaluation of the features and functionality that specific services provide.

An investigation into the key features of mobile standards and the services offered through devices could be achieved through pair or group work; creating an information leaflet, presentation or booklet would help them to understand the differences.

### Assessment outcome 4

In this outcome, learners need to explore the basic concepts of different network types and their topologies. They should be able to identify the different types of network and topologies, linking this to real world examples. The centre's own network will provide an opportunity for exploration.

Learners should gain sufficient technical knowledge to enable them to create a rationale for the choice of particular technologies for installing a network and they should be able to articulate the risks that the business could face. The key to this outcome is that learners should be able to make reasoned judgements about the recommendations they make in context.

### Assessment outcome 5

This outcome focuses on the mapping of conceptual models to real life hardware and software that are used in a networked solution. Learners should be able to chart data travelling through the different layers of a conceptual model. This is most easily achieved pictorially, either through a static chart or diagram, or through a simple slideshow or animation. Learners could undertake pair or small group work against a variety of scenarios, being able to compare and contrast two different conceptual models.

To complete the unit learners should demonstrate their understanding by correctly using different networking devices (three would be recommended) at different conceptual levels and generating evidence to demonstrate the correct network protocols that might operate at different layers. This could be best achieved through the use of a protocol analyser.

## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other providing development on concepts and topics, reinforcing learning and skill development which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

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## AO1: Understand the fundamentals of data communication

This assessment outcome introduces the basic concepts of data communication including the types of signal, terminal, transmission types, error detection and bandwidth. Many units develop these concepts and provide practical examples of their use, features and functions.

**Unit 1 – AO5: Demonstrate how computers process user requirements**
This unit's assessment outcome, typically taught in parallel, supports the learners' understanding of bandwidth measurements by introducing the various units used in computing (eg Megabits, Gigabits etc). The learner should benefit from seeing these units in a practical context.

**Unit 3 – PO2: Identify the different types of network architectures and technology types**
Unit 3's second performance outcome enhances the learners' understanding of circuit and packet switching, LAN Technologies and WAN technologies.

**Unit 5 – PO1: Work with number systems**
Many concepts connected with low level data communication, eg digital signals, parity bits etc rely on the learners' appreciation of other number systems, particularly binary. This unit's first performance outcome provides a firm grounding of the various number systems used in computing.

## AO2: Analyse data communication methods

This assessment outcome examines the different methods used to communicate data, the media used and their attendant features.

**Unit 1 – AO2: Understand the hardware components of a computer system**
Learners may be able to analyse data communication methods more ably through their introduction to the recognisable serial and parallel communication methods studied in this unit.

**Unit 3 – PO2: Identify the different types of network architectures and technology types**
Transmission media and their features are explored in more detail through this performance outcome. Practical emphasis placed on LAN technologies, different transmission methods and media, eg wired (copper, optical) and wireless and their connectors should reinforce the learners' recognition factor.

## AO3: Analyse basic mobile technology communication

This assessment outcome focuses on mobile technologies; the hardware used, its organisation, current standards and available services.

**Unit 1 – AO1: Identify the different types of computer**
Learners access this type of communication technology through various mobile devices (eg tablets etc), many of which may be introduced as a type of personal computer in this assessment outcome. Learners should benefit from being able to connect the tangible hardware with the more conceptual ideas involved in mobile communication.

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## AO4: Understand the fundamentals of computer networks

This assessment outcome introduces the idea of a network by examining the different sizes available, their relevant topologies and the balance of risk and reward that a network may provide.

**Unit 3 – PO1: Identify communication activities facilitated by computer networks**
This performance outcome provides extended topic coverage for network rewards, eg personal communication business applications and e-business applications, that the learner may find helpful when attempting to explain the attractions of a network.

**Unit 3 – PO2: Identify the different types of network architectures and technology types LAN, WAN, WLAN etc**

**Unit 3 – PO3: Understand different types of local area networks (LANs) and wide area networks (WANs)**
These performance outcomes help the learner to explore the practical creation of LANs and WANs. In doing so, learners should have a better understanding of their similarities and differences.

**Unit 6 – AO1: Understand security issues for a network system**
This unit's coverage of common threats and vulnerabilities will help the learner to confidently identify and describe many types of network risk.

**Unit 6 – AO4: Analyse and develop a network security plan for an organisation**
This performance outcome should reinforce learners' appreciation of network risks and business impact while creating their networking security plan.

**Unit 7 – PO1: Understand the internet**
This unit's coverage of search engines, information services and business uses, eg web conferencing, voice-over-internet-protocol (VOIP), instant messaging, e-commerce etc will help the learner to confidently identify and describe many types of network reward.

## AO5: Evaluate network conceptual models, protocols and devices

This assessment outcome asks learners to evaluate the different models, protocols and devices that are used to describe network systems in a logical manner.

**Unit 1 – AO2: Understand the hardware components of a computer system**
This assessment outcome introduces the concept of expansion cards. One of these, the network interface cards (NICs) should provide the learner with a perfect example of a device operating at the physical layer.

**Unit 3 – PO2: Identify the different types of network architectures and technology types**
This unit's second performance outcome provides coverage of many data link layer protocols and standards, eg IEEE Institute of Electrical and Electronics Engineers (IEEE) 802 family for LAN, WLAN (Wireless LAN) etc.

**Unit 3 – PO5: Undertake end user network testing**
This performance outcome asks learners to perform diagnostics on various network physical layer devices, eg Network Interface Cards (NICs).

**Unit 7 – PO3: Understand the infrastructure**
This performance outcome, exploring network layers, internet technologies and protocols, is used to further develop concepts that the learners initially encounter in this assessment outcome.

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# Useful links and resources

## Books


- Dye M, McDonald R and Rufi A, *Network fundamentals*, ISBN 10 1-58713-208-7, Cisco Press, Indianapolis, IN (2008).
- Lammle T, *CompTIA Network+ study guide authorised courseware: exam N10-005*, ISBN 978 1 118 23886-8, John Wiley and Sons, Chichester (2012).
- Steinke S et al, *Network tutorial: a complete introduction to networks*, ISBN 1-57820-302-3, CRC Press, (2003).


## Websites

- Serial Communication: learn.sparkfun.com/tutorials/serial-communication/rules-of-serial
- Search Mobile Computing: searchmobilecomputing.techtarget.com
- Cisco: cisco.com
- The OSI Model's Seven Layers: support.microsoft.com/kb/103884
- Wireshark Protocol Analyser: wireshark.org/download.html
- PuTTY: chiark.greenend.org.uk/~sgtatham/putty/download.html

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# 12.3 Unit 3: Developing and maintaining computer networks

| | |
|---|---|
| **Title** | Developing and maintaining computer networks |
| **Unit number** | K/507/6427 |
| **Unit assessment type** | Centre assessed and externally quality assured |
| **Recommended assessment method** | Practical assignment<br><br>This is the preferred assessment method for this unit. A centre may choose an alternative method of assessment, but will be asked to justify as part of the quality assurance process. |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | Research[4] |
| **Resources required for this unit** | A live network environment.<br><br>Network hardware and software.<br><br>A range of tools including multimeters, screw drivers, pliers, wire cutters, rubber matting and anti-static wrist bands, lifting and moving equipment.<br><br>Professional documentation for designing and maintaining networks (may be available from own institution).<br><br>A range of wiring, conduits, connectors, etc. |
| **Synoptic assessment within this unit** | IT: Technical Support linked to Units 1, 2, 4.<br><br>IT: Networking Linked to Units 1, 2, 4, 5, 6, 7 and 8.<br><br>Draws on the underlying principles of Units 1 and 2, assessed practically in this unit, whilst also observing the health and safety aspects linked to the computer build and repair in Unit 4.<br><br>Many of the skills, tools and techniques which are common to both the IT technician and the network specialist are used in the assessment of this unit through common operational needs.<br><br>Investigations into network performance levels and faults may potentially provide fascinating data sets which can be used to exercise numeracy skills such as calculating probability, gathering and interpreting data – both core aspects of Unit 5.<br><br>Any networking design and planning will embrace security concepts drawn from Unit 6, particularly in terms of meeting ongoing maintenance challenges and protecting the network from emerging threats.<br><br>Any networking solution will ultimately feed into the larger internet and its uses and needs are reflected by connections found in Unit 7.<br><br>The IT project unit (Unit 8) can provide guidance when defining a networking project's goals, deliverables and scheduling. |

[4] Please visit the specification homepage to access the transferable skills standards and associated guidance and recording documentation.

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## Aim and purpose

This unit will provide learners with the underpinning knowledge and understanding of a range of computer networks and methodologies to enable them to develop a simple network from a specification and also the practical skills required to be able to develop and maintain networks for an organisation.

## Unit introduction

Computers, except those used for specific security sensitive purposes, are almost invariably linked to other computers through at least one network and often more than one. The development and maintenance of networks is therefore essential to modern business and everyday life.

Being online, linked to other machines, is essential for work, engaging with health, taxation, or other public bodies, and entertainment.

Even in small businesses or in the home, computers, mobile telephones and tablets are linked to each other, the television and one or more printers. Thus the ability to understand the types of network available, their strengths and weaknesses, the purpose of the components required and being able to build and maintain a network is valuable for anyone who works with computers.

Learners studying this unit would benefit from having initially studied Unit 2: Communication technologies.

This unit provides an opportunity to evidence achievement of the transferable skill of research.

## Unit content

| Communication activities facilitated by computer networks | |
|---|---|
| Types of personal communication using a computer | (eg)<br>• Blog.<br>• Instagram.<br>• Podcasts.<br>• Email.<br>• Wikis.<br>• Social networks. |
| Business applications | (eg)<br>• Project management.<br>• Diaries.<br>• Meeting planners.<br>• Spreadsheets.<br>• Databases.<br>• Documents. |
| E-Business applications | (eg)<br>• Banking.<br>• Retail.<br>• Marketing.<br>• Finance. |

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| Types of network architectures and technology types | |
|---|---|
| Network architectures | (eg)<br>• Peer-to-peer.<br>• Client/server.<br>• Virtual Local Area Network (VLAN).<br>• Virtual Private Networks (VPN). |
| Local area network (LAN) technologies and properties | • Types eg:<br>  • Ethernet; Institute of Electrical and Electronics Engineers (IEEE 802.3)<br>  • 10Base-T (IEEE 802.3i)<br>  • 100Base-TX (IEEE 802.3u)<br>  • 10GBase-T (IEEE 802.3an).<br>• Properties:<br>  • transmission media:<br>  • copper wire (twisted pair)<br>  • single mode optical fibre<br>  • multi-mode optical fibre<br>  • speed<br>  • duplex<br>  • distance<br>  • carrier sense multiple access with collision detection (CSMA/CD)<br>  • broadcast<br>  • collision. |
| Wireless local area networks (WLAN) technologies and properties | (eg)<br>• Types:<br>  • wi-fi 802.11<br>  • bluetooth<br>• Properties:<br>  • 802.11 IEEE standards, eg 802.11b, 802.11g, 802.11n<br>  • frequency, eg 2.4 ghz and 5 ghz<br>  • speed<br>  • distance<br>  • interference. |

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| Types of network architectures and technology types | |
|---|---|
| Wide area network (WAN) technologies and properties | Types eg:<br>• frame relay<br>• Asynchronous Transfer Mode (ATM)<br>• Integrated Services Digital Network (ISDN)<br>• wireless<br>• Very High Bit Rate Digital Subscriber Line (VDSL).<br>• Properties:<br>• speed<br>• distance<br>• transmission media<br>• circuit switch<br>• packet switch. |
| Wiring standards | (eg)<br>• Coaxial.<br>• Category 5 and 6 Unshielded Twisted Pair (UTP).<br>• Fibre optic. |
| Network hardware | (eg)<br>• File servers.<br>• Proxy servers.<br>• Connection devices.<br>• Wireless devices. |
| Connectors | • UTP:<br>• registered jack –RJ connectors eg:<br>• RJ-45<br>• RJ-11.<br>• Optical fibre connectors eg:<br>• straight tip (ST)<br>• subscriber connector (SC)<br>• mechanical transfer registered jack (MT-RJ)<br>• local connector (LC). |
| Media converters | (eg)<br>• Single mode fibre to Ethernet.<br>• Fibre to coaxial.<br>• Single mode to multimode. |
| Cables | (eg)<br>• Serial.<br>• RS 232.<br>• Universal Serial Hub. |
| Cabling standards | (eg)<br>• 565A.<br>• 565B. |

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| Types of network architectures and technology types | |
|---|---|
| Cable installation | (eg)<br>• Main distribute frame.<br>• 25 pair.<br>• 110 block.<br>• Broadband over power. |
| Network connecting devices | (eg)<br>• NIC.<br>• Hub.<br>• Switch.<br>• Basic bridge.<br>• Router. |
| Network wireless devices | (eg)<br>• Wireless access point (WAP).<br>• Wireless antennae:<br>  • point-to-point (PPP)<br>  • point-to-multi-point (PMP).<br>• Wireless ethernet bridge. |
| Basic network security | (eg)<br>• User accounts.<br>• User passwords.<br>• Access control lists (ACLs).<br>• Internet protocol (IP) address filtering.<br>• Media access control (MAC) filtering.<br>• Encryption methods, eg wired equivalent privacy (WEP), Wi-Fi protected access (WPA, WPA2) etc.<br>• Honeypots. |

| Types of local area networks (LANs) and wide area networks (WANs) | |
|---|---|
| Local area networks (LAN) | (eg)<br>• Personal area network (PAN).<br>• Enterprise area network (EAN).<br>• Campus area network (CAN). |
| Wide area network (WAN) | (eg)<br>• Joint academic network (JANET).<br>• Virtual private network (VPN). |
| Other network types | (eg)<br>• System area network.<br>• Storage area network. |

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| Designing and building a network from a specification | |
|---|---|
| Planning | • Create outline document:<br>  • goals<br>  • business requirements<br>  • constraints, eg physical environment, cost, time etc<br>  • minimum performance requirements.<br>  • regulatory and legislative requirements:<br>  • internal:<br>  • organisational policies and procedures<br>  • external:<br>  • laws and statutes<br>  • regulations eg ISO/IE 27002<br>  • standards.<br>• Wiring diagrams.<br>• Network diagrams:<br>  • physical<br>  • logical<br>  • software tools. |
| Build a network to meet the specification | • Select components eg wiring, connectors, hub, workstations.<br>• Select appropriate tools eg rubber mats, antistatic wrist bands, multimeters, correct range of screwdrivers, wire cutters, wire strippers, crimpers etc.<br>• Follow health and safety and other related requirements:<br>  • *Health and Safety at Work Act 1974*<br>  • *Health and Safety (Display Screen Equipment) Regulations 1992*<br>  • *Waste Electrical and Electronic Equipment recycling (WEEE) 2006*<br>  • *Manual Handling Operations Regulations 1992 (as amended)*<br>  • *Workplace (Health, Safety and Welfare) Regulations 1992. Approved Code of Practice and guidance*<br>  • *Electricity at work: Safe working practices (HSE).* |

| End user network testing | |
|---|---|
| Testing techniques | (eg)<br>• Simulation and replication.<br>• Substitution.<br>• Elimination.<br>• Upgrade, eg BIOS support (flashing), drivers.<br>• Reinstall software eg drivers or applications.<br>• Operating system support, updates and patches. |
| Benchmarking | Benchmark metrics eg response time, throughput, packet drop, streaming, etc.<br><br>Benchmarking software eg LAN/WAN speed tests, network stress tests, Quality of Service (QoS). |

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| End user network testing | |
|---|---|
| Diagnostic hardware tools | • Tools eg:<br>  • multimeter<br>  • network multimeter<br>  • network cable testers. |
| Firmware self-diagnostic routines | (eg)<br>• Power on Self-Test (POST).<br>• Network Interface Card (NIC) tests.<br>• Preboot Execution Environment (PXE) boot test. |
| Simple network management protocol (SNMP) | • Components:<br>  • managed device<br>  • agent<br>  • network management station (NMS).<br>• Devices that support SNMP:<br>  • routers<br>  • switches<br>  • servers<br>  • workstations<br>  • printers.<br>• Protocols.<br>• Proxy agents.<br>• Bilingual network-management systems. |
| Intrusion detection system (IDS) | • Network intrusion detection system (NIDS).<br>• Host intrusion detection system (HIDS). |
| Firewall | (eg)<br>• Hardware, software, rules, exceptions, Stateful Packet Inspection (SPI) and application layer. |
| Diagnostic software tools | (eg)<br>• Control panel (connections, adaptors).<br>• Ping.<br>• Traceroute.<br>• IPconfig/IFconfig.<br>• Netstat.<br>• Nbstat.<br>• Address resolution protocol (ARP). |
| Steps in trouble shooting | • Identify problem.<br>• Gather information.<br>• Question users.<br>• Look for changes.<br>• Identify possible issues. |
| Error logs | (eg)<br>• Operating system.<br>• Network service (eg HTTP, FTP) and application. |

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| End user network testing | |
|---|---|
| Error codes and messages | • Different formats (eg hexadecimal, binary etc) eg generated via hardware, BIOS, operating system, applications and utilities etc. |
| Documentation | • Recording outcomes and recommendations. |
| Test plan | • Features to be tested.<br>• Features not to be tested.<br>• Approach eg testing level, testing types, testing methods.<br>• Pass/fail criteria.<br>• Test deliverables eg test plan, test cases, test scripts, defect logs, test reports.<br>• Test environment:<br>  • hardware, software, network<br>  • testing tools.<br>• Estimate of costs.<br>• Schedule ie key milestones.<br>• Responsibilities.<br>• Test results.<br>• Remedial steps taken.<br>• Sign off performance. |

| Maintaining a network system | |
|---|---|
| Agree a service level agreement (SLA) | (eg)<br>• A description of the services to be provided and for whom.<br>• Roles, responsibilities of team members and contact details.<br>• Availability of the service.<br>• Service standards eg speed of reply to request.<br>• Customer responsibilities.<br>• Legal or other regulations that must be complied with.<br>• Qualitative and quantitative measures to monitor and evaluate service.<br>• Communication methods.<br>• Key performance indicators.<br>• How complaints will be dealt with.<br>• How the agreement will be reviewed and updated. |
| Complete network documentation | • Records of tests.<br>• Records of installations and upgrades.<br>• Records of issues.<br>• Records of details of resolution of issues. |
| Carry out preventive maintenance | • Test network for weaknesses eg reduced speeds, loss of connections.<br>• Installing upgrades and new hardware or software.<br>• Installing or upgrading security software.<br>• Monitoring traffic and bottlenecks. |

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## Performance outcomes

On successful completion of this unit learners will be able to:

| | |
|---|---|
| Performance outcome 1: | Identify communication activities facilitated by computer networks. |
| Performance outcome 2: | Identify the different types of network architectures and technology types. |
| Performance outcome 3: | Understand different types of local area networks (LANs) and wide area networks (WANs). |
| Performance outcome 4: | Design and build a network from a specification. |
| Performance outcome 5: | Undertake end user network testing. |
| Performance outcome 6: | Maintain a network system. |

## Grading criteria

| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO1: Identify communication activities facilitated by computer networks** | **P1** Describe **nine** activities which are supported by networks. | | |
| **PO2: Identify the different types of network architectures and technology types** | **P2** Describe **four** architectures. | **M1** Develop a network architecture for a defined user need. | **D1** Justify the choice of network architecture. |
| | **P3** Identify the network components for a defined user need. | **M2** Explain the choice of components. | |
| **PO3: Understand the different types of local area networks (LANs) and wide area networks (WANs)** | **P4** **Research** and map different types of network technologies. | | |
| | **P5** Using **research** describe the main characteristics and properties of **two** WAN and **two** LAN technologies. | | |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO4: Design and build a network from a specification** | **P6** Produce an outline planning document for defined user need. | **M3** Produce diagrammatic representations of the network. | |
| | **P7** Identify the components and the correct tools required to build the network defined. | | |
| | **P8** Build the network defined. | | |
| | **P9** Follow relevant health and safety regulations when building the network. | | |
| **PO5: Undertake end user network testing** | **P10** Describe **five** testing techniques. | **M4** Justify the importance of network benchmarking in system testing. | |
| | **P11** Identify at least **three** network faults on a selected system. | | |
| | **P12** Record fault information and create a test plan, identifying the appropriate tools and components required to carry out tests. | **M5** Justify the testing techniques to be used. | |
| | **P13** Carry out tests meeting all health and safety requirements and record the results. | **M6** Analyse the test results. | **D2** Evaluate the testing process. |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO6: Maintain a network system** | **P14** Provide evidence of following the requirements of an SLA. | **M7** Record and interpret information from complete network documentation. | **D3** Demonstrate preventive maintenance activities in meeting all requirements of the SLA. |

## Assessment amplification

**This section provides amplification of what is specifically required or exemplification of the responses learners are expected to provide.**

**In completing performance criteria P4 and P5, learners will be presented with an opportunity to demonstrate the transferable skill of research.**

Learners could use scenarios that cover a range of all of the performance outcomes. If the learners have the opportunity to have a work placement or a job in network support then they may be able to use evidence from these activities for some or all of the performance criteria.

For **P1** learners could produce a presentation or report on ways in which networks support at least nine different activities, clearly linking application to the value of having a network link.

For **M1** learners identify a preferred architecture and produce a design that would meet the needs of the scenario.

For **P3** learners could produce a table, an annotated list or report.

**P4** and **P5** are research-based and could be evidenced together as a presentation with detailed handouts or a report. Learners could make an educational video clip or animation that explores the context in which different types of LAN and WAN are used and then describe the main characteristics that differentiate them.

For **P6** learners will work on a scenario (preferably an employer brief) to produce an outline planning document for a network. This should include information about the user requirements, chosen architecture, components etc. The inclusion of diagrammatic representations to enhance the planning document and provide a visual overview of the system will provide evidence for **M3**.

For **P9** learners should be observed throughout as they will need to demonstrate that they can work safely.

For **P11** the evidence could be faults arising during the building of the network in PO4 or faults on another network. The evidence could be a fault log.

For **P14** evidence could be presented as a log of activities linked to an agreed SLA signed off by their manager or tutor confirming that the activities have taken place and the SLA has been met.

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## Employer engagement guidance

The institution could engage with local employers and their own network staff to provide staff to discussion networks with learners and provide work based opportunities or cases, scenarios and projects that learners could use for training and assessment purposes.

The British Computer Society (BCS) and the European arm of the Association for Computing Machinery, for example, may be willing to engage with learners in discussions on networking.

## Delivery guidance

### General comment

Learners studying this module would benefit from having studied Unit 2 Communication technologies.

The assessment criteria could be delivered holistically rather than as discrete elements through project work or work placement opportunities.

It would be very useful if learners could engage in work placement activities for this unit, if this is not possible then the learner must have access to a network development or training facility in order to carry out the design, building and testing activities that are essential elements of this unit.

### Performance outcome 1

The learners could carry out research in small groups, class discussions or visits to, or discussions with, network specialists within the organisation or with external institutions.

### Performance outcome 2

The learners could investigate a range of networks such as those within the institution, local organisation, or their own home networks and feed this back to the group in order to consolidate an agreed understanding of the topologies. From these discussions the learners could, as a group, identify the logical topology for each physical network they have identified.

The class could research the types of technology and their properties through further investigation into topologies and in discussion, if possible, with staff who support or manage the networks. However, if this is not possible then a class brain storming session could be used.

All of the unit content should be covered, but it is not expected that the learners would have encountered all of the elements in their investigations into specific topologies.

### Performance outcome 3

Either individually or in small groups, learners could carry out an investigation into different types of LANs and WANs. The investigations could take the form of online research, surveys of local organisations and discussions with network professionals. The results could then be presented to the wider group and a discussion take place as to reasons why organisations or individuals opt for a particular form.

### Performance outcome 4

Working in small groups, learners will need to be given projects with pre-prepared scenarios of network requirements that will allow them to identify outline document content as identified in the unit content. If at all possible, a local organisation (or even the learner's own organisation) that has a straightforward network learners could work on, with the outcome being judged by the organisation, would be an ideal scenario. It is important that the learner adheres to the requirements of the unit content, to ensure that they develop the skills required to be a network engineer or support technician.

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### Performance outcome 5

This outcome could be linked directly to the project work in Performance outcome 4. All networks will have issues eventually, but they are very likely to occur while they are being built. That is why testing always takes place during and at the end of a network build. When learners have completed the network in Performance outcome 5, the testing required to ensure the network is working correctly would meet the requirements of this performance outcome. However, should this not be possible, then learners should have access to a training or development network that can be altered to introduce errors, which the learners can then identify, test and correct.

Possibly in small groups, learners could identify a range of benchmarking standards and diagnostic tools for a range of different faults. The wider group could discuss the different choices and decide whether they were appropriate, and which approach would be the most efficient and effective.

Learners could discuss the importance of testing through class discussions or discussions with visiting technical speakers and also identify which would be the most appropriate tests for the installation of hardware and software required to build the computer system in Performance outcome 4. From this, there could be discussion of benchmarking standards and benchmarking software and the importance of benchmarking to identify the quality of the performance of the system. The learner should have the opportunity to discuss the range and role of diagnostic tools in identifying issues with a computer system. This may be the result of issues with the system they are building or machines that have been prepared to allow the learner to find and repair a range of hardware and software faults. If learners had a chance to work with technical staff, this opportunity may arise naturally.

Error codes and messages should also be investigated and learners should discuss how to interpret these, what they mean and where to seek clarification (as some error messages merely refer to error code ‘xxxxxxxxxx’ which gives no clue to the issue).

Learners could also research different testing documentation and their content, and as a group discuss in class why it is important to be able to identify failed as well as successful installations, repairs or upgrades. Learners should also discuss how they would identify when to report any problems to a senior colleague if the tests should fail or whether they can rectify the problem themselves.

### Performance outcome 6

Learners will need access to a real network in the work place, as part of a work placement or through a training or development lab network.

Learners should have the opportunity to carry out maintenance activities for the maintenance cycle and complete all necessary upgrades, updates, documentation, etc. This practical activity is important and thus a learner must take this responsibility over a period of time to ensure that they have the opportunity to engage with a range of maintenance activities.

## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other providing development on concepts and topics, reinforcing learning and skill development, which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

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## P1: Describe nine activities which are supported by networks

**Unit 1 – AO1: Understand the different types of computer**
In this unit learners identify the different types of computers and their common applications for personal and business use. Networking activities will often represent a large overlap with these, eg business application software, e-business and social networking, and may lead the learner to describe the nine needed.

**Unit 2 – AO4: Understand the fundamentals of computer networks**
This unit focuses on communication technologies and as such learners should begin to appreciate the rewards associated with networking. Network activities studied here dovetail neatly with this grading criterion, particularly shared resources and improved communication facilities.

**Unit 7 – PO1: Understand the internet**
The first performance outcome of this unit tasks the learner with understanding the basic facilities and uses of the internet. Among these are information services and varied business and education activities, all of which increase the scope of research and better reflect the types of network activity the learner could reference for this grading criterion.

## P2: Describe four architectures
## P3: Identify the network components for a defined user need

**Unit 1 – AO5: Demonstrate how computers process user requirements**
This assessment outcome provides background learning to the data sizes and metrics used by many of the different network architectures and technology types that this grading criterion is seeking. It should also exercise learners' numeracy skills.

**Unit 2 – AO1: Understand the fundamentals of data communication**
This grading criterion typically involves consideration of available network components and their bandwidths (as this has a direct impact on network use and performance). This assessment outcome specifically focuses on bandwidth metrics, speeds, limitations and management, all of which should provide rich additional coverage of the core concepts.

**Unit 2 – AO2: Analyse data communication methods**
This assessment outcome explores the different communication methods that underpin network communications. Transmission media and their features can be explored through this assessment outcome, which is particularly important for helping the learner to select appropriate cables, converters and connectors when identifying network components for a defined need.

**Unit 2 – AO4: Understand the fundamentals of computer networks**
This assessment outcome provides additional categorisations of network types, particularly in terms of different network topologies which are essential aspects of any network architecture and should support the learner completing this criterion.

**Unit 5 – PO1: Working with number systems**
Complementing the data sizes and metrics detailed in Unit 1, this unit's first performance outcome concentrates on working with different number systems, explaining how they work and how they are used in modern computing. Many of these applications include network-related concepts that will help the learner respond accurately and confidently when describing the attributes of each of the four architectures. It should also exercise learners' numeracy skills.

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**P4: Research and map different types of network technologies**
**P5: Using research describe the main characteristics and properties of two WAN and two LAN technologies**

**Unit 2 – AO4: Understand the fundamentals of computer networks**
Mapping different types of network technologies, particularly in terms of their physical and logical topologies, can be supported by this assessment outcome where various topologies are considered.

**P6: Produce an outline planning document for defined user need**
**P7: Identify the components and the correct tools required to build the network defined**
**P8: Build the network defined and P9 Follow relevant health and safety regulations when building the network**
**P9: Follow relevant health and safety regulations when building the network**

**Unit 8 – PO2: Plan a project with others to meet a specified outcome**
Creating planning documents, particularly in terms of setting goals and meeting business requirements, is at the heart of this performance outcome for the industrial project unit. Many links abound here, particularly when considering constraints, regulatory and legislative requirements and minimum performances requirements.

**Unit 4 – PO1: Build a computer system with hardware and software to meet specific requirements**
Designing a network involves the use of special tools. This performance outcome should provide the learner with knowledge of the tools most pertinent to this task, eg cable testers, wire cutters etc. This unit acts as both introduction and reinforcement of their correct (and safe) use when working with network components.

This performance outcome covers a range of system support tools that a typical IT technician may use. Inevitably there is a certain degree of cross-over with many tools (eg cable testers, wire cutters etc) that are also critical for building networked solutions; this unit acts as both introduction and reinforcement of their correct (and safe) use.

Health and Safety requirements also apply to building computer systems, and the safe practices and legislation that should be observed are reflected in this unit's first performance outcome. By connecting a 'safety first' approach across these units, the safety of both learners and equipment should be assured. In addition learners will have greater industry awareness of the standards expected when they successfully complete the programme and embark on their new IT career.

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**P10: Describe five testing techniques**
**P11: Identify at least three network faults on a selected system**
**P12: Record fault information and create a test plan, identifying the appropriate tools and components required to carry out tests**
**P13: Carry out tests meeting all health and safety requirements and record the results**

**Unit 1 – AO2: Understand the hardware requirements of a computer system**
This learning outcomes features coverage of the basic input output system (BIOS) in a typical computer system. The learner may find that the use of BIOS test functionality, eg checking an integrated LAN/Network Interface Card proves to be a viable technique.

**Unit 1 – AO3: Understand the software requirements of a computer system**
Testing a network often involves different software-based techniques. This assessment outcome focuses on software utilities used to diagnose and report network problems and could contribute to the learner's response.

**Unit 4 – PO3: Provide end users with advice and guidance**
This performance outcome provides learners with tools relating to sources of information and their relative validity. Identifying faults often requires the confident examination of complex manufacturer guides or third-party reference; having the skills to do this is invaluable.

Identifying network faults relies on knowing normal operating values and behaviours, usually from third party reference material. This performance outcome provides learners with tools relating to sources of information and their validity, both of which should assist the learner in determining, with confidence, which network aspects are not working correctly.

**Unit 4 – PO4: Using appropriate tools to troubleshoot end user problems safely**
This unit's performance outcome also focuses on variable diagnostic and monitoring tools that could be used by the learner to perform network benchmarking and testing of the hardware and software components which comprise the network.

**Unit 4 – PO6: Updating documentation**
This performance outcome focuses on different forms of documentation which an IT technician is likely to encounter (and complete) in their role. Many of these are also documents that a Networking specialist might use. Using the same documents in different IT scenarios reinforces their organisational (and sometimes legal) importance and correct usage.

**Unit 5 – PO3: Calculate with sequences, series, probability and recursion**
Substitution or elimination of faulty components are two of the core testing techniques that are being tested by this grading criterion. The use of probability (and related calculations) can provide empirical support to judgements made by the learner; these techniques are found in this unit. It should also exercise learners' numeracy skills.

**Unit 5 – PO4: Gather and interpret data in a meaningful manner**
Benchmarking is a core testing technique that can be used when networks are being examined for faults and performance. Data gathering, probability, eg from speed tests, benchmark metrics, packet drops and response time may be gathered and interpreted as quantitative data. It should also exercise learners' numeracy skills.

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## P14: Provide evidence of following the requirements of an SLA

**Unit 3 – PO2: Understand how to communicate effectively with end users**
This performance outcome is likely to be the learners' introduction to the concept of a service level agreement (SLA). It should provide additional depth and support to the learner when dealing with network SLA compliance.

**Unit 6 – PO4: Analyse and develop a network security plan for an organisation**
This performance outcome provides linked coverage of network SLAs by focusing on their relative advantages and disadvantages as part of a network security plan.

# Useful links and resources

## Journals

- *Computer networks* (Elsevier).
- *EURASIP journal on wireless communications and networking* (Springer).
- *International journal of networking and computing* (Elsevier).

## Books

- Dye M, McDonald R and Rufi A, *Network fundamentals*, ISBN 10 1-58713-208-7, Cisco Press, Indianapolis, IN, 2008.
- Lammle T, CompTIA *Network+ study guide authorised courseware: exam N10-005*, ISBN 978 1 118 23886-8, John Wiley and Sons, Chichester, 2012.
- Steinke S et al, *Network tutorial: a complete introduction to networks*, ISBN 1-57820-302-3, CRC Press, (2003).

## Standards

- *IEEE standard for software and system test, IEEE SA 829-2008*: standards.ieee.org/findstds/standard/829-2008.html

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## 12.4 Unit 4: Supporting end users

| | |
|---|---|
| **Title** | Supporting end users |
| **Unit number** | M/507/6428 |
| **Unit assessment type** | Centre assessed and externally quality assured |
| **Recommended assessment method** | Practical assignment<br><br>This is the preferred assessment method for this unit. A centre may choose an alternative method of assessment, but will be asked to justify as part of the quality assurance process. |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | Problem-solving [5] |
| **Resources required for this unit** | Learners will need access to helpdesk and remote connection software or the opportunity to work as an IT technician on a helpdesk to provide advice and guidance.<br><br>Support ticket services are available as commercial or open source packages eg Spiceworks, OS Ticket or commercial alternatives. Learners should have experience of communicating with users using a range of techniques, eg remote connections, face-to-face, phone conversations, email etc. Where this might contravene institutional policy Local Area Networks (LANs) or virtual machines could be used.<br><br>Learners will also need access to practical resources, eg faulty computers and suitable tools and technologies, eg multimeters, cable testers, diagnostic software, remote access software, as listed in the unit content, to troubleshoot problems. |
| **Synoptic assessment within this unit** | IT: Technical Support linked to Units 1 and 3.<br><br>IT: Networking linked to Units 1, 3, 5 and 8.<br><br>Draws on experience and knowledge of different types of hardware and software; particularly systems software (operating systems and utilities) as discussed in Unit 1.<br><br>Many faults found in computer systems are reported using non-denary number systems; Unit 5 develops the learner's abilities to convert and interpret such information correctly. In addition, investigations into hardware reliability, faults and software performance levels may provide fascinating data sets that can be used to exercise numeracy skills such as calculating probability, and gathering and interpreting data. Having the skills to compare data sets collected before and after learner solutions are applied helps them to tackle this unit's analysis needs.<br><br>In addition to honing the learners' communication skills, the Industrial project (Unit 8) explores planning a solution to a set problem using an organised methodology.<br><br>Extended guidance on synoptic assessment is provided later in this unit documentation. |

[5] Please visit the specification homepage to access the transferable skills standards and associated guidance and recording documentation.

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## Aim and purpose

This unit will equip learners with the knowledge and skills to support end users by resolving a range of technical issues. In doing so the learner will research faults, find and evaluate solutions and communicate effectively with the end user.

## Unit introduction

Developments in technology have created a demand for end user support personnel who can help individuals and organisations in different ways. This can include on site helpdesk support or remote support and field support.

End users are often under pressure; learners will develop effective communication skills to interact appropriately with customers and provide end user support as well as seeking support from colleagues, responding quickly and efficiently. Learners will cover diagnosis to solve hardware and software problems, making use of a range of tools and techniques, working safely so as not to endanger themselves and others.

On completing this unit, learners will be able to use their technical knowledge to help end users resolve technical problems. In order to do this, learners will develop skills to select relevant and reliable information from a range of sources.

Learners will also update documentation, eg fault logs, knowledge bases routinely and recognise their importance in future fault diagnosis.

This unit provides an opportunity to evidence achievement of the transferable skill of problem-solving.

## Unit content

| Building a computer system with hardware and software to meet specific requirements | |
|---|---|
| Computer equipment and components | (eg)<br>• Motherboard.<br>• CPU.<br>• Internal memory.<br>• PSU.<br>• Fan and heatsink.<br>• RAM.<br>• Hard drive.<br>• Cabling. |
| Peripherals | • Essential peripherals:<br>  • mouse<br>  • keyboard<br>  • monitor. |
| Software | (eg)<br>• Systems software.<br>• Applications software. |
| Configure BIOS | (eg)<br>• Setting date and time.<br>• Set password. |

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| Building a computer system with hardware and software to meet specific requirements | |
|---|---|
| Desktop configuration | (eg)<br>• Icon visibility and icon size.<br>• Font type.<br>• Font size.<br>• Colour.<br>• Background.<br>• Start-up options. |
| Tools | (eg)<br>• Screwdrivers (Phillips, Allen/hex, spade).<br>• Anti-static wristbands.<br>• Rubber matting.<br>• Multimeter.<br>• Wire strippers.<br>• Wire cutters.<br>• Cable straps. |
| Health and safety | (eg)<br>• *Health and Safety at Work Act (1974).*<br>• *Health and Safety (Display Screen Equipment) Regulations (1992).*<br>• *Waste Electrical and Electronic Equipment recycling (WEEE) (2006).*<br>• *The Manual Handling Operations Regulations (1992) (as amended).*<br>• *Workplace (Health, Safety and Welfare) Regulations (1992), Approved Code of Practice and guidance.*<br>• *Electricity at work: Safe working practices (HSE).*<br>• *The Electricity at Work Regulations (1989).*<br>• *Code of Practice for In-service Inspection and Testing of Electrical Equipment (4th Edition).* |

| How to communicate effectively with end users | |
|---|---|
| Type of end user | (eg)<br>• Novice.<br>• Experienced.<br>• Technical. |
| Communication methods | (eg)<br>• Email.<br>• Face-to-face.<br>• Telephone.<br>• Remote access.<br>• Instant messaging services. |

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| How to communicate effectively with end users | |
|---|---|
| Communication techniques | (eg)<br>• Body language.<br>• Face-to-face.<br>• Questioning:<br>  • direct questioning<br>  • open<br>  • closed.<br>• Written:<br>  • remote access<br>  • fault logs<br>  • solution/knowledge database. |
| Type of support | • Outsourcing.<br>• SLAs. |
| Types of advice | (eg)<br>• Recommendations.<br>• Replacement.<br>• Bug fixes.<br>• Installation of patches.<br>• Reset/reboot instructions. |
| Situational communication styles | (eg)<br>• Anger management (customer).<br>• Empathy, patience, tolerance.<br>• Assertive.<br>• Aggressive.<br>• Passive aggressive.<br>• Passive. |
| Effective communication | (eg)<br>• Clear.<br>• Relevant.<br>• Format (verbal, written).<br>• Interpersonal skills.<br>• Checking understanding.<br>• Response time.<br>• Escalation. |

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| Providing end users with advice and guidance | |
|---|---|
| Types of fault | • Single-stage faults (simple faults), eg common, easily identifiable, quick solution.<br>• Multi-stage faults, eg complex, unknown, non-specific symptoms. |
| Sources of information | (eg)<br>• Manuals.<br>• Product specification.<br>• Manufacturer's resources/website/knowledge base.<br>• Colleagues with specialist knowledge.<br>• Fault records and trends.<br>• FAQs.<br>• Technical forums. |
| Validity of information | (eg)<br>• Cross referencing.<br>• Reliable sources.<br>• Problem reproduction.<br>• Up-to-date.<br>• Valid. |

| Using appropriate tools to troubleshoot end user problems safely | |
|---|---|
| Organisation | • Policy.<br>• Procedure. |
| Working practices | • Obtaining permission.<br>• Preparing the work site.<br>• Documentation.<br>• Recoding information, eg product keys, licenses.<br>• Electrical safety and electro static discharge (ESD).<br>• Correct use of tools, eg screwdrivers, multimeters.<br>• Data security.<br>• Health and safety.<br>• Fire safety.<br>• Other, eg lasers, first aid, tiredness. |
| Troubleshooting techniques | • Problem replication.<br>• Substitution.<br>• Elimination.<br>• Test.<br>• Upgrade, eg BIOS flashing, device drivers.<br>• Reinstall software, eg drivers, applications.<br>• Bug fixes.<br>• Error codes and messages, different formats, eg Hexadecimal, Binary.<br>• Systematic approaches to troubleshooting. |

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| Using appropriate tools to troubleshoot end user problems safely | |
|---|---|
| Software tools | • Diagnostic tools:<br>  • virus/malware scanners<br>  • monitoring programs<br>  • memory testing<br>  • operating system tools and logs<br>  • specific software applications tools and logs<br>  • power on self-test (POST).<br>• Monitoring tools:<br>  • fault logs<br>  • event logs<br>  • performance monitoring.<br>• Remote connection:<br>  • ping test<br>  • remote connection<br>  • instant messaging (IM). |
| Hardware tools | • Hardware tools, eg screwdriver, pliers, paper clip, ESD kit.<br>• Test equipment, eg multimeters, cable testers, PSU tester, loop back plug.<br>• Test read instruments, eg CPU, Hard Disk, PSU.<br>• Test machine.<br>• Self-test routines, eg power on self-test (POST), self-monitoring, analysis and reporting technology (SMART). |
| Troubleshooting remedies | • Hardware:<br>  • repair<br>  • replacement<br>  • upgrade.<br>• Software:<br>  • reconfigure<br>  • patches<br>  • reinstallation<br>  • upgrade. |
| General legislation | (eg)<br>• *Communications Act (2003).*<br>• *Data Protection Act (1998).*<br>• *Computer Misuse Act (1990).* |

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| Testing solutions and analysing results | |
|---|---|
| Testing | (eg)<br>• Test data.<br>• Self-test.<br>• Diagnostic tools.<br>• System scans.<br>• Fault logs.<br>• Test reports. |

| Updating documentation | |
|---|---|
| Documentation | (eg)<br>• Support ticket.<br>• Fault log.<br>• Solution details.<br>• Test report.<br>• Required resources.<br>• Stock levels/ordering.<br>• Waste disposal.<br>• Feed back to the user.<br>• User feedback and signoff.<br>• Recommendations. |

## Performance outcomes

On successful completion of this unit, learners will be able to:

| | |
|---|---|
| Performance outcome 1: | Build a computer system with hardware and software to meet specific requirements. |
| Performance outcome 2: | Understand how to communicate effectively with end users. |
| Performance outcome 3: | Provide end users with advice and guidance. |
| Performance outcome 4: | Use appropriate tools to troubleshoot end user problems safely. |
| Performance outcome 5: | Test solutions and analyse results. |
| Performance outcome 6: | Update documentation. |

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## Grading criteria

| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO1: Build a computer system with hardware and software to meet specific requirements** | **P1** Set up a basic computer, installing all hardware components and essential peripherals, working safely. | | |
| | **P2** Install the operating system and **one** software application. | | |
| | **P3** Configure **one** setting in the BIOS and **two** desktop settings. | | |
| | **P4** Test the computer for functionality. | | |
| **PO2: Understand how to communicate effectively with end users** | **P5** Communicate support to **three** different end users using written and verbal techniques. | **M1** Identify instances where situational communication skills would be required. | **D1** Evaluate the effectiveness of communication used and highlight where improvements could be made. |
| | **P6** Use **four** different communication methods to provide advice and guidance. | | |
| **PO3: Provide end users with advice and guidance** | **P7** Analyse information provided by **three** different end users and in each case determine technical advice and guidance required. | | |
| | **P8** Respond to faults reported. | **M2** Explain how the advice and guidance has been checked for validity. | **D2** Evaluate the effectiveness of support provided. |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO4: Use appropriate tools to troubleshoot end user problems safely** | **P9** Solve **three** single-stage software problems safely, following working practices. | **M3** Solve **two** multi-stage software problem safely, following working practices. | **D3** Justify the solutions selected for solving software faults. |
| | **P10** Select and apply appropriate software tools to solve specific problems. | | |
| | **P11** Solve **three** single stage hardware problems safely, following working practices. | **M4** Solve **two** multi-stage hardware problems safely, following working practices. | **D4** Justify the solutions selected for solving hardware faults. |
| | **P12** Explore **two** complex hardware **problems**. | | |
| | **P13** Plan, select and apply appropriate hardware tools to **solve** specific **problems**. | | |
| **PO5: Test solutions and analyse results** | **P14** Test software and hardware solutions and resolve issues. | **M5** Analyse tests results and apply appropriate remedies. | **D5** Evaluate the importance of thorough testing on hardware and software resolutions. |
| | **P15** Check if the **problem** has been resolved by testing the hardware solutions and review the **problem-solving process**. | | |
| **PO6: Update documentation** | **P16** Complete support documentation accurately to meet organisational requirements. | | |

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## Assessment amplification

**This section provides amplification of what is specifically required or exemplification of the responses learners are expected to provide.**

**In completing performance criteria P12, P13 and P15, learners will be presented with an opportunity to demonstrate the transferable skill of problem-solving.**

Ideally evidence could come from naturally occurring opportunities (especially if the learner has a work placement) or from activities in other units. If this is the case witness statements and the completed logs and documentation produced naturally by the learner could be used to assess competence. Alternatively learners could be provided with a series of scenarios or fault logs to resolve.

For **P1** to **P4** learners will carry out a practical computer build. Learners should self-select the components, tools and safety equipment (rather than the teacher preparing tables set out with 'everything you need'). Photographs, a witness statement or video would provide good evidence, although teachers might ask learners to develop their own checklist of resources and processes that could then be signed off by the assessor.

For **P5** recordings (audio or video) of learners undertaking fault diagnosis and clearly demonstrating them communicating with users could provide evidence. In doing so learners should demonstrate the ability to communicate with the end user in a range of ways.

For **P9**, **P10**, **P11**, **P12** and **P13** the evidence could come from witness statements, diagnostic printouts, recordings or screen grabs. It is important that these faults should be varied and require different tools to solve in order to give the student a range of assessment opportunities. Examples for resolution could include: using monitoring software to identify operating system errors with services failing to start; using antivirus software to identify and remove viruses; installing patches to fix faults in software; testing a faulty power supply with a multimeter for a computer that does not start; using a cable tester to check an ethernet cable for a machine unable to connect to a network, followed by a ping test; and using POST to identify malfunctioning or poorly connected hardware devices.

For **M4** it important that tutors appreciate the differences between a single-stage solution and a multi-stage solution when designing a range of assessment activities. These faults should not simply be an expansion of those used for the assessment at pass level.

It is possible that evidence could be naturally occurring in other units and tutors should use evidence from other areas where possible.

It is important that tutors note the health and safety aspect of these criteria. Learners should demonstrate established working practices – for instance the use of an electro static discharge (ESD) kit, appropriate clothing, manual handing and health and safety procedures.

For **D5** learners should focus on two perspectives: the importance of testing from a user's viewpoint and how testing in general is important to industry.

For **P16** learners must generate evidence through records of activities completed.

## Employer engagement guidance

If learners are in the workplace then the centre could ask the employer whether there are any suitable projects that the learners could work on as part of the team. It would be helpful for the employer to be made aware of the sort of skills that learners have to practice.

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## Delivery guidance

Delivery of this unit would be most effective if learners can build links between the classroom and organisations that need to provide end user support. This could be the education centre's own technical support department. Learners will also need to have sufficient practical experience in troubleshooting and solving hardware and software problems.

Delivery could be based on the given order of performance outcomes. However, opportunities for learners to gain work experience where available should be taken. Evidence for practical assessments could be collected in the form of logs, notes, test reports, observation records or witness statements.

Video evidence and role plays can be valuable for developing soft skills and practicing techniques for communicating with end users. Learners will need to practice dealing with annoyed and frustrated users.

### Performance outcome 1

Learners should build a basic computer system as defined in the unit content. They will install the operating system and an application, carry out configuration and test to ensure that the system is working.

During the development of the skills for this outcome, there is an opportunity to introduce some non-working components to ensure that learners deal with a variety of situations. Some centres might choose to become involved with the *Computers for Africa* campaign to ensure a good supply of components and machines to be used as part of the learning process.

### Performance outcome 2

This centres on the learner's ability to communicate appropriately with end users. Learners could, for example, work with the centre's IT support department for a day (or even just a few hours), shadowing the technical support team to explore how effective communication should be undertaken.

### Performance outcome 3

Learners will need to establish skills in finding and validating sources of information from beyond their immediate knowledge. Different sources of information can be researched, analysed and evaluated. Deciding on whether something is valid can be difficult, especially when choosing from a plethora of internet sites that may seem genuine. Learners need to be able to recognise what to look out for to assess validity. Tutors may need to guide learners in methods of researching and using various resources, tools and techniques for troubleshooting.

### Performance outcome 4

It is important that learners develop skills in approaching problems. They will need to become familiar with the different tools and techniques used to troubleshoot hardware and software problems.

They need to analyse information and justify the methods they select and use to solve specific problems. They may need to be guided to troubleshoot more complicated problems and record their solutions for future reference.

Tutors must ensure that learners observe health and safety procedures, as well as good working practices when working with IT equipment. They should also understand the impact of good and poor practice.

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### Performance outcome 5

Learners would benefit from gaining a real understanding of testing in many different scenarios, as it is fundamental to the success of any IT activity – whether it's a network installation, computer build, programme or app. The importance of thorough testing should also be stressed and learners should be challenged not only to test, but to justify the level of testing they have undertaken.

There are many case studies of IT projects that have ultimately failed, or where the cost has risen exponentially, because of a lack of testing.

### Performance outcome 6

Learners need to use documentation such as logs methodically, as well as checking that solutions are appropriate. Practical troubleshooting exercises should include keeping logs and updating documentation as part of an ongoing routine.

## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other providing development on concepts and topics, reinforcing learning and skill development which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

#### P1: Set up a basic computer, installing all hardware components and essential peripherals, working safely

**Unit 1 – AO1: Understand the different types of computer**
Learners benefit from a firm understanding of computer types and their common applications as it helps them to identify their basic components.

**Unit 1 – AO2: Understand the hardware requirements of a computer system**
Learners explore the full hardware requirements of a computer system in this assessment outcome and, as such, it is likely to form their core understanding of the functions of each internal component and the essential peripherals that must be connected to ensure it is functioning correctly.

#### P2: Install the operating system and one software application

**Unit 1 – AO3: Understand the software requirements of a computer system**
Learners should be able to differentiate the operating system from a software application if they have a rounded understanding of the different types of software that are available. Unit 1's third assessment outcome focuses on the different types of software available, eg operating systems, applications, utilities etc, categorising them and explaining their basic features and functionality.

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## P3: Configure one setting in the BIOS and two desktop settings

**Unit 1 – AO2: Understand the hardware requirements of a computer system**
The basic input output system (BIOS) and extensible firmware interface (EFI) are typically introduced in this unit; consequentially the learner should have prior knowledge of their features and functions, including how to use them to configure the basic operation of the computer system to meet specific requirements.

**Unit 1 – AO3: Understand the software requirements of a computer system**
Learners may encounter desktop configuration (eg font type, size, colour, background etc) while exploring different operating systems (ie Windows, Apple Mac OS X etc), providing many desktop settings that could be selected here.

## P5: Communicate support to three different end users using written and verbal techniques

**Unit 8 – PO3: Follow a project plan as part of a team to meet a specified project outcome**
Related support information to an end user requires mastery of effective communication, both verbal and non-verbal. Learners hone these skills in the Industrial project (Unit 8) and this should aid them in achieving this grading criterion.

## P6: Use four different communication methods to provide advice and guidance

**Unit 1 – AO3: Understand the software requirements of a computer system**
Of the four most common communication methods that the learner may use to provide advice and guidance to the end user, it is likely that they will have already examined three of these as part of this unit's third assessment outcome: email, remote access and instant messaging. All of these are types of utility or application software.

## P7: Analyse information provided by three different end users and in each case determine technical advice and guidance required
## P8: Respond to faults reported

**Unit 8 – PO3: Follow a project plan as part of a team to meet a specified project outcome**
Learners should always consider the needs of the target audience which will differ depending on their relative technical ability. Making these judgements shapes the type of advice and guidance that should be offered. Learners hone these skills in the Industrial project (Unit 8) and this should aid them in achieving this grading criterion.

## P10: Select and apply appropriate software tools to solve specific problems

**Unit 1 – AO3: Understand the software requirements of a computer system**
This unit's assessment outcome focuses on the different types of software available, eg operating systems, applications, utilities etc, categorising them and explaining their basic features and functionality. Learners should have gained practical 'hands-on' experience with many of the utilities that are used to troubleshoot end user problems, providing extra support for achieving this goal.

## P12: Explore two complex hardware problems

**Unit 1 – AO2: Understand the hardware requirements of a computer system**
Learners explore the full hardware requirements of a computer system in this assessment outcome and, as such, it is likely to form their core understanding of the functions of each internal component and the essential peripherals that must be connected to ensure it is functioning correctly.

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**P13: Plan, select and apply appropriate hardware tools to solve specific problems**
**P14: Test software and hardware solutions and resolve issues**
**P15: Check if the problem has been resolved by testing the hardware solutions and review the problem-solving process**

**Unit 1 – AO2: Understand the hardware requirements of a computer system**
Many of the troubleshooting tools that the learner has to demonstrate correctly are introduced in this introductory unit. Learners could have knowledge and experience of these tools, their (often) acronymic names, eg Power On Self-Test (POST) and their functionality before commencing this unit.

**Unit 3 – PO5: Undertake end user network testing**
This unit's performance outcome also focuses on various diagnostic and monitoring tools that could be used by the learner to troubleshoot a specific problem safely. Learners should benefit from using similar tools, eg cable testers etc, in different contexts.

**Unit 5 – PO3: Calculate with sequences, series, probability and recursion**
Substitution or elimination of faulty hardware components represents a core testing techniques that may be used to achieve this grading criterion. The use of probability (and related calculations) can provide empirical support to judgements made by the learner; this technique can be found in this unit. It should also exercise learners' numeracy skills.

**Unit 5 – PO4: Gather and interpret data in a meaningful manner**
This performance outcome tasks the learner with the practical testing of computer systems for faults. As part of this activity they will gather data from event logs, fault reports, diagnostic tools etc which can be used to discover the underlying cause. It is likely that this data can be quantified in terms of speed, capacity, throughput, error occurrences etc which provides ample opportunity for interpretation.

Comparisons can be made easily between two data sets if these are recorded 'before' and 'after' hardware/configuration changes have been made, ultimately proving or disproving performance increases.

**P16: Complete support documentation accurately to meet organisational requirements**

**Unit 3 – PO5: Undertake end user network testing**
This performance outcome focuses on the different forms of documentation that an IT technician is likely to encounter (and complete) in their role. Many of these are also documents that a networking specialist might use. Using the same documents in different IT scenarios reinforces both their organisational (and sometimes legal) importance and their correct usage.

## Useful links and resources

### Books


- Meyers M, *CompTIA A+ guide to 802: managing and troubleshooting PCs*, 4th edition, ISBN-10 0071795979, ISBN-13 978-0071795975, McGraw-Hill Osborne, (2013).
- Sanchez A, *Technical support essentials: advice to succeed in technical support (beginner to intermediate)*, ISBN-10 1430225475, ISBN-13 978-1430225478, Apress (2010).


### Website

- UK Health and Safety Executive: hse.gov.uk

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## 12.5 Unit 5: Maths for computing

| | |
|---|---|
| **Title** | Maths for computing |
| **Unit number** | R/507/6437 |
| **Unit assessment type** | Centre assessed and externally quality assured |
| **Recommended assessment method** | Practical assignment<br><br>This is the preferred assessment method for this unit. A centre may choose an alternative method of assessment, but will be asked to justify as part of the quality assurance process. |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | N/A |
| **Resources required for this unit** | Suitable Windows PC, Linux, Apple Macintosh OS X, Apple iOS or other suitable platforms that offer access to the low levels of the operating system, eg debug or monitor facilities where RAM address content may be examined; this is often achievable through a virtualised platform. In addition, pathway relevant software should be available that demonstrates the use of different number systems, eg networking software for subnet masks, graphics software for red, green, blue (RGB) colour codes, email clients for MIME Base64 attachments etc.<br><br>Optional resources are indicated in each assessment outcome that may enhance the learners' experience in this unit.<br><br>Learners should also have access to suitable offline and online learning material, manuals, help sheets and coded examples in order to encourage self-sufficiency. |
| **Synoptic assessment within this unit** | IT: Networking linked to Units 1, 2, 4, 6, 7 and 8.<br><br>Investigations into hardware reliability, faults, network performance levels and, security issues may potentially provide fascinating data sets which can be used to exercise numeracy skills such as calculating probability, gathering and interpreting data.<br><br>Unit 7's focus on big data analytics and advanced internet search engine facilities relies on an understanding of computer logic, probability and statistics; skills which are introduced and refined in this unit.<br><br>The Industrial project unit (Unit 8) relies on planning a solution to a set problem using an organised methodology. Problems are often provided in terms of quantifiable data which need gathering and analysing, a key part of this unit's goals.<br><br>Extended guidance on synoptic assessment is provided later in this unit documentation. |

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## Aim and purpose

This unit will provide the learner with the necessary knowledge to understand the mathematical concepts that enable computers to store, process, communicate and transmit data. The learner will also develop a range of skills required to recognise its practical application in everyday computing, process numerical data correctly and interpret data they have collected in a statistical meaningful manner.

## Unit introduction

Maths is at the very heart of any computer system; from storing its data to displaying complex imagery on screen or simply loading a web page – maths is the 'magic' that makes it happen.

In this unit learners will gain an understanding of how computer internally represent data and make decisions, along with applying common mathematical techniques for creating algorithms that solve set problems, whether these are presented in terms of system, networking or programming situations.

The unit begins with a sound foundation in the number systems that are prevalent in the operation of computer hardware, software and systems. It then examines the underlying logic used in the digital circuits that power the micro-processors inside the computer; logic that is used every day by operating systems, networks and programmers alike.

Once the fundamental building blocks have been locked into place, it is possible to investigate the practical use of maths in computing, focussing on popular applications such as number series, recursion, probability and matrix manipulation.

## Unit content

| Working with number systems | |
|---|---|
| Number systems fundamentals | • Concept of a positional numeral system, eg positional weights.<br>• Base or radix terms; correct mathematic notational use, eg $12_2$.<br>• Base notation in computing, eg # or 0x prefix for hexadecimal.<br>• Common computer bases:<br>  • denary (Base 10)<br>  • binary (Base 2)<br>  • octal (Base 8)<br>  • hexadecimal (Base 16)<br>  • larger, eg multipurpose internet mail extensions (MIME) Base 64. |
| Base conversion | • Base conversion methods:<br>  • denary to binary and vice versa<br>  • binary to hexadecimal and vice versa<br>  • denary to hexadecimal and vice versa. |

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| Working with number systems | |
|---|---|
| Fractional and negative integers in binary | • Binary integer signing techniques:<br>  • unsigned<br>  • sign and magnitude<br>  • one's complement<br>  • two's complement.<br>• Representing fractional values in:<br>  • denary<br>  • binary.<br>• Fixed number storage in binary.<br>• Floating point number storage notation in Binary, ie significant/mantissa, exponent etc.<br>• Single and double precision. |
| Base arithmetic | • Performing basic arithmetic operations in other bases; binary, hex etc:<br>  • addition<br>  • subtraction<br>  • multiplication<br>  • division. |
| Computer use of bases | • Common use of different bases in modern computing, eg:<br>  • binary, eg:<br>  • internal data representation<br>  • Boolean logic and flags<br>  • internet protocol subnet masks<br>  • Classless Inter Domain Routing (CIDR) notation<br>  • character representation, eg 7 or 8 bit American Standard Code for Information Interchange (ASCII) characters etc<br>  • octal, eg<br>  • Unix/Linux CHMOD file permissions<br>  • escape strings, UTF-8<br>  • hexadecimal, eg<br>  • error codes<br>  • network (Media Access Control) MAC physical addresses<br>  • memory (eg RAM) addresses<br>  • 8-bit per channel RGB (Red Green Blue) colour codes, eg #FF0000 = red<br>  • internet uniform resource identifier (URI).<br>• Binary vs Gray code, rationale and use. |

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| Understanding and applying computer logic | |
|---|---|
| Foundation of computer logic | Boole, Boolean logic/algebra (true, false; 1,0). |
| Basic logical operators | • Processing and outputs of basic logical operations:<br>  • And (conjunction)<br>  • Or (disjunction)<br>  • Not (negation).<br>• Common logical operator symbols. |
| Composition and derived operators | • Processing and outputs of derived logical operations:<br>  • Exclusive or (EOR or XOR)<br>  • Negative or (NOR)<br>  • Negative and (NAND)<br>  • Exclusive Negative or (XNOR).<br>• Common logical operator symbols. |
| Visual representation of logical operations | • Representing logic in diagrammatic form:<br>  • truth tables for each using x and y as inputs<br>  • digital logic gate diagrams for circuits<br>  • Venn diagrams.<br>• Creating circuits using only one type of logic gate, eg NOR or NAND. |
| Working with Boolean algebra | • Notation and symbols<br>• Interpreting simple equations, eg $(x.y)+x$<br>• Interpreting complex equations, eg $(\overline{x+y.\overline{x}})+(x.y)$<br>• Common techniques used to simplify complex Boolean expressions:<br>  • Boolean identities<br>  • De Morgan's Laws<br>  • Karnaugh maps<br>  • truth tables. |

| Calculating with sequences, series, probability and recursion | |
|---|---|
| Sequence and series | • Sequences:<br>  • type, eg finite or infinite<br>  • notation, $n^{th}$ term<br>  • rules and finding rules<br>  • term and term number<br>  • arithmetic and geometric sequence.<br>• Series:<br>  • definition, contrast to a sequence<br>  • use of sigma ($\sigma$) notation. |

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| Calculating with sequences, series, probability and recursion | |
|---|---|
| Probability | • Probability terminology and usage, eg:<br>  • probability definition<br>  • probability line<br>  • experiment or trial<br>  • sample space and sample point<br>  • events and event types (dependent, independent, mutually exclusive).<br>• Space diagrams eg 'double' values when two dice are thrown.<br>• Visualising events, eg using Venn diagrams (mutually exclusive events), tree diagrams (dependent events). |
| Recursion | • Series eg Fibonacci, factorial.<br>• Rules of recursion:<br>  • have a base case<br>  • state change toward base case<br>  • must call itself.<br>• Common recursive algorithms used in computing, eg<br>  • factorial, quicksort, binary search, directory traversal, Sierpinski triangle.<br>• Instances where simple iterative techniques may be more efficient. |

| Gathering and interpreting data in a meaningful manner | |
|---|---|
| Gathering data | • Primary and secondary data.<br>• Quantitative and qualitative data.<br>• Common methods of gathering data, eg real world measurements, observation, questionnaires, surveys etc.<br>• Extraction of required information from raw data.<br>• Limitations of data gathered, eg accuracy, sample size, need for cleaning invalid data points (eg extreme outliers). |
| Representing data | • Concepts and techniques for comparing data sets:<br>  • range and range limits<br>  • averages, eg arithmetic mean, median (middle value), mode (most frequent)<br>  • relationship between mean, median, mode, eg symmetrical distribution, positive or negative skew<br>  • cumulative frequency diagrams, statistical dispersion measures, eg interquartile (IQR) range<br>  • Standard deviation (SD)<br>  • variance<br>  • histograms. |
| Interpreting data | • Analysing summary data.<br>• Identification of trends and recurring patterns.<br>• Proving a hypothesis. |

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| Applying matrix methods to solve problems | |
|---|---|
| Matrices | • Matrices to represent ordered data.<br>• Matrix terminology, eg rows, columns, elements or entries, subscripts, 'm-by-n' size definitions.<br>• Forms of matrix:<br>  • row vector<br>  • column vector<br>  • square matrix. |
| Matrix operations | • Basic operations include:<br>  • addition<br>  • scalar multiplication<br>  • transposition. |
| Common matrix applications and techniques | • Common practical applications of matrices, eg:<br>  • solving simultaneous equations<br>  • transforming vectors; shear, flip, scale and rotate. |

## Performance outcomes

On successful completion of this unit, learners will be able to:

| | |
|---|---|
| Performance outcome 1: | Work with number systems. |
| Performance outcome 2: | Understand and apply Boolean logic. |
| Performance outcome 3: | Calculate with sequences, series, probability and recursion. |
| Performance outcome 4: | Gather and interpret data in a meaningful manner. |
| Performance outcome 5: | Apply matrix methods to solve problems. |

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## Grading criteria

| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO1: Work with number systems** | **P1** Demonstrate an understanding of a positional numeral system. | | |
| | **P2** Represent denary unsigned numeric integers in **three** different bases using correct notation. | **M1** Convert a sequence of **five** unsigned integers between different bases using correct notation. | **D1** Convert **three** different non-denary values required for or generated by a computer for a specific processing purpose. |
| | **P3** Represent signed denary values in binary using **two** different techniques. | **M2** Explain the difference between storing a denary fractional value using fixed and floating point notation. | **D2** Analyse the impact on magnitude and accuracy of a stored number using single and double precision numbers. |
| | **P4** Carry out calculations involving the **four** common arithmetic operations using **two** different bases. | | |
| **PO2: Understand and apply Boolean logic** | **P5** Create suitable diagrams to represent the three basic logical operations using correct notation. | **M3** Create suitable diagrams to represent **four** derived logical operations using correct notation. | **D3** Design **two** circuits which solve set logical tasks using only one type of logic gate. |
| | **P6** Interpret a simple Boolean algebraic expression. | **M4** Interpret a complex Boolean algebraic expression. | |
| | **P7** Simplify a complex Boolean expression using a common technique. | | |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO3: Calculate with sequences, series, probability and recursion** | **P8** Identify and explain an arithmetic and geometric number sequence. | **M5** Explain the difference between a series and a sequence. | |
| | **P9** Describe different probability event types using industry examples. | | |
| | **P10** Use suitable diagrams to represent **two** different probability events. | | |
| | **P11** Identify and describe a simple recursive function. | **M6** Demonstrate how recursion is used to process a selected computing task. | **D4** Evaluate a recursion function to determine whether a simple iteration may be more efficient. |
| **PO4: Gather and interpret data in a meaningful manner** | **P12** Gather appropriate data for an investigation of a computer related event. | **M7** Analyse the data to identify any issues or limitations which need to be considered. | |
| | **P13** Use appropriate techniques to compare **two** data sets from an investigation of a computer related event. | **M8** Analyse the summary data generated. | **D5** Prove a hypothesis from the identification of trends and recurring patterns in the summary data generated. |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO5: Apply matrix methods to solve problems** | **P14** Demonstrate the correct use of matrices and matrix notation using industry data. | **M9** Perform at least **two** basic operations successfully on a given matrix. | |
| | **P15** Apply appropriate matrix techniques to solve an industry problem. | | |

## Assessment amplification

**This section provides amplification of what is specifically required or exemplification of the responses learners are expected to provide.**

There is no mandatory division of grading criteria although, as can be seen from the Grading criteria grid, some are naturally linked either by learning outcome or by a developmental theme. Connections between the various pass, merit and distinction criteria can therefore suggest logical assessment grouping but do not necessarily have to be followed.

Finding a single real world scenario that can cover all criteria is difficult, but not impossible. The key to assessment in this unit, as in others, is to make assessment a natural outcome of the learning experience, with skills being assessed at a level appropriate to the learner's level of experience.

Assessments that connect this unit to others via connected tasks are also encouraged and it is possible that evidence produced during work for this unit may be used to provide evidence for criteria in other units.

As with all units, in order to gain a pass grade, learners must generate evidence that meets all listed pass criteria.

For **D1** it is necessary for the learner to generate or interpret three non-denary (ie binary, octal or hex) numbers that are critically required for a particular processing aspect of a computer system. Learners should also be able to demonstrate an understanding of how these values are being used in each aspect.

For **P9** and **P10** it is expected that probability events being investigated will naturally be contextualised for the learner's study pathway.

For **M6** learners must specifically be able to explain, via demonstration, the workings of a recursive algorithm in terms of a well-known computer process. A list of possible processes is provided in Performance outcome 3, but once again, it should not be considered to be exhaustive and practitioners may choose other suitable examples if they prefer.

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Demonstrations could be evidenced through such means as presentation, video or role play.

For **P12**, **M7**, **P13**, **M8** and **D5** evidence can be generated by the learner investigating a computer related event; eg for programmes this could be the number of bugs in program code fixed over weekly periods before launch; for networking this could be the number of login errors reported from client PCs. The ultimate goal will be to prove (or possibly disprove) an initial hypothesis by collecting data about the event, summarising it and interpreting the results using appropriate statistical methods. The actual nature of the event may be selected by the learner but the assessor should ensure it is of suitable size and complexity to reflect study at Level 3.

For **P14** and **P15** this would also involve the selection of a real world event that can be represented and solved using matrices. Again care should be taken to ensure that the event or data set chosen is of a size and complexity commensurate with the level of study.

## Employer engagement guidance

If learners are in the workplace then the centre could ask the employer whether there were any suitable projects that the learners could work on as part of the team. It would be helpful for the employer to be made aware of the sort of skills that the learners have to practice.

## Delivery guidance

This unit may be delivered by either a maths practitioner with some computing experience or a computer practitioner confident with the maths content presented herein.

It should be taught, where possible, in conjunction with other units such as those covering programming, cyber security, networking or system support themes, depending on the learners' pathway. For example, Performance outcome 1 integrates well with delivery in Unit 1, Fundamental principles of computing.

Although the individual components have been identified, the order in which they delivered does not have to follow the sequence provided and, although underpinning concepts are introduced in Performance outcomes 1, 2 and 3 a case can be made for delivering Performance outcomes 4 and 5 in either order, especially if they can be planned to coincide with thematically relevant learner activities in other units.

A single case study, if sufficiently complex and contextualised for the learners' pathway, could be used to deliver this unit; this should allow learners to discover and appreciate how important mathematical skills are when solving real world problems. However, a number of small projects, each targeting a separate performance outcome, could also be used to good effect.

Presentations or discussions by those working in the computing/IT sector pertaining to the learners' pathway would be advantageous, especially if the importance and relevance of their underpinning mathematical skills could be highlighted.

### Performance outcome 1

Learners should consider different number systems and their vital use in computing, particularly when contextualised to their learning pathway, eg hexadecimal notation for error codes that system support technicians will be all too familiar with, or the use of binary to work out subnet masks in networking. Each learning pathway has many suitable examples; a sample is provided for illustration.

Learners could locate examples of different number systems being used in computing and be challenged to interpret these in terms of both the converted denary number and its application. A simple example of this might be to examine a computer's memory address, read the hexadecimal or binary value present, convert it to a denary code and then discover the ASCII character that is being stored.

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To summarise, learners must be able to interpret, convert and perform basic arithmetic on these values, demonstrating accuracy, correct notation and a working knowledge of how these values may be used or encountered by them in their computing career.

### Performance outcome 2

Boolean logic can be taught traditionally but comes alive when contextualised through the use of simple logic circuits, whether these are realised in physical kit form or via circuit design software tools.

There is opportunity here for active learning connections to be made with the delivery of computer programming (specifically 'if' statements and conditions involving logical operators), in networking (for example, firewall rules) and system support (processor architecture, ALU etc).

Learning opportunities can be driven through creating simple circuits for simple real world applications, eg traffic light systems, lift doors, vending machines etc.

### Performance outcome 3

Although this outcome aligns most closely with the developmental needs of someone involved in aspects of programming, understanding these topics can be contextualised with little difficulty for each pathway. For example, technicians may discover the probability of particular brands of hard disks failing by examining fault logs; network specialists may learn how DNS queries may be handled in a recursive manner; cyber security specialists may examine virus infection rates etc.

Recursion is best demonstrated through solving simple computer programming tasks, examples of which are listed in the content. For more able learners, differentiated examples could include concepts such as finding square roots using Newton's method.

### Performance outcome 4

This performance outcome can be delivered in a completely contextualised manner. Although learners should be able to visualise statistical information through hand-drawn diagrams, electronic means (eg graphs generated by a spreadsheet application) may also be considered.

Ideally a range of data collection techniques should be experienced and evaluated by the user and, ultimately, any data generated must be analysed and suitable hypotheses developed and presented. These are ideal for group-based activities, class presentations and peer review.

### Performance outcome 5

It is recommended that the standard matrix theory is delivered in a generic manner through practice of the basic operations listed in the content. It is likely that simultaneous equations may be creatively engineered for each discipline to solve problems with two unknowns, eg for networking it may be 'time' and 'packets lost', for user support it may be 'processor speed' and 'price'. The use of matrix transformation can support a visual aspect to learning that provides both a good insight and a practical application, eg manipulating 3D models for computer games, modification of 2D images in graphic editing software.

## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other providing development on concepts and topics, reinforcing learning and skill development which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

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The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

## P1: Demonstrate an understanding of a positional numeral system

**Unit 2 – PO1: Understand the fundamentals of data communication**
Although understanding the value of a positional numeral system is at the heart of any unit where numbers are used to measure sizes, speeds, quantities etc, it is possible to identify specific incidences where position is key. A simple application of this by the learner could be the use of parity bits (odd or even) used in error detection and correction of data communication.

Learners should also encounter applications such as sign bits (in signed integers) or binary weights as used to describe common multiples (eg kilobyte etc) in **Unit 1 – AO5: Demonstrate how computers process user requirements** or **Unit 7 – PO2: Understand the infrastructure** where position is an important aspect for generating subnet masks for IP addresses.

## P2: Represent denary unsigned numeric integers in three different bases using correct notation

**Unit 1 – AO2: Understand the hardware components of a computer system**
This assessment outcome should present the learner with opportunities to explore the architecture of the computer's internal components. Use of low level machine code or assembly by the learner may demonstrate how denary unsigned values are stored and coded in binary and hexadecimal.

**Unit 1 – AO5: Demonstrate how computers process user requirements**
ASCII and other character set types are used to represent denary digits in a computer system. Learners will often see these encodings written in binary, octal and hexadecimal and this will help them work with the three different bases correctly.

## P3: Represent signed denary values in binary using two different techniques

**Unit 1 – AO2: Understand the hardware components of a computer system**
This assessment outcome presents the learner with opportunities to explore the architecture of the computer's internal components. Use of low level machine code or assembly language could demonstrate how denary signed values are stored and coded in binary and hexadecimal.

## P4: Carry out calculations involving the four common arithmetic operations using two different bases

**Unit 1 – AO5: Demonstrate how computers process user requirements**
These assessment outcomes should present the learner with opportunities to explore the architecture of the computer's internal components. Use of low level machine code or assembly language may demonstrate how denary signed values are stored and coded in binary and hexadecimal.

Additional examination of these low level languages may practically demonstrate how typical opcodes such as ADD, SUB, MUL and DIV could be used to perform common arithmetic in these bases.

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## P5: Create suitable diagrams to represent the three basic logical operations using correct notation
## P6: Interpret a simple Boolean algebraic expression

**Unit 1 – AO4: Understand how data is converted to information**
This unit's assessment outcome considers the use of logical operations (such as AND, OR, NOT etc) as part of the data processing cycle. Contextualising specific data processing examples, eg online banking, can provide real-world examples of logic use.

**Unit 7 – PO1: Understand the internet**
Many learners find mathematical content difficult to understand without suitable contextualisation. Demonstrating how simple Boolean logic operators such as AND, OR etc can be used (along with wildcards) to form advanced internet searches provides a concrete example.

**Unit 7 – PO2: Understand infrastructure**
This performance outcome examines the internet protocol (IP) and in particular its addressing model. Subnet masks, used to create subnets, rely on Boolean AND operators and could provide the learner with practice when interpreting simple Boolean expressions.

## P9: Describe different probability event types using industry examples
## P10: Use suitable diagrams to represent two different probability events
## P12: Gather appropriate data for an investigation of a computer related event

**Unit 4 – PO4: Use appropriate tools to troubleshoot end user problems safely**
This performance outcome encourages learners to use hardware and software tools to perform diagnostics on computer hardware in order to determine faults. One consequence of mass component production can be inferior quality control which often leads to batch failure. Examination of these sorts of occurrences can help to predict component failure as a probability and, consequently, influence future purchasing decisions.

Software tools such as ping tests can be used to check basic network connectivity between devices. Reliability of these connections could be used to generate probabilities for transmitting data packets successfully.

**Unit 4 – PO5: Test solutions and analyse results**
This performance outcome tasks the learner with the practical testing of computer systems for faults. As part of this activity they will gather data from event logs, fault reports, diagnostic tools etc which can be used to discover the underlying cause. It is likely that this data could be quantified in terms of speed, capacity, throughput, error occurrences etc which provides ample opportunity for interpretation.

**Unit 6 – AO3: Understand how to categorise and apply security measures to a network system**
This performance outcome tasks the learner with the monitoring and application of security measures present on a network. A combination of different types of logs can provide a wealth of quantitative data that may provide ample opportunity for interpretation.

**Unit 7 – PO1: Understand the internet**
Big data analytics often involve concepts such as probability, statistics, trends etc. These are introduced in this performance outcome and could be used as a source of event types using industry examples, eg web browsing trends, user profiling etc.

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**P13: Use appropriate techniques to compare two data sets from an investigation of a computer related event**

**Unit 4 – PO5: Test solutions and analyse results**
This performance outcome tasks the learner with the practical testing of computer systems for faults. As part of this activity they will gather data from event logs, fault reports, diagnostic tools etc that can be used to discover the underlying cause. It is likely that this data can be quantified in terms of speed, capacity, throughput, error occurrences etc, which provides ample opportunity for interpretation.

Comparisons can easily be made between two data sets if these are recorded 'before' and 'after' hardware/configuration changes have been made, ultimately proving or disproving performance increases.

**Unit 6 – AO3: Understand how to categorise and apply security measures to a network system**
This performance outcome tasks the learner with the monitoring and application of security measures present on a network. A combination of different types of logs can provide a wealth of quantitative data that may provide ample opportunity for interpretation.

Comparisons can easily be made between two data sets if these are recorded 'before' and 'after' security changes have been made by the learner, ultimately proving or disproving performance increases.

## Useful links and resources


- Anonymous, *AS-Level Maths AQA complete revision and practice*, ISBN-10 1847625819, ISBN-13 978-1847625816, Coordination Group Publications Ltd, Broughton-in-Furness (2011).
- Hanrahan V, Porkess R and Pritchard D, *AQA Certificate in Further Mathematics*, ISBN-10 1444181122, ISBN-13 978-1444181128, Hodder Education, London (2013).
- Rumsey J, *Probability for dummies*, ISBN-10 0471751413, ISBN-13 978-0471751410, John Wiley and Sons, Chichester (2006).
- Rumsey J, *Statistics for dummies,* 2nd edition, ISBN-10 0470911085, ISBN-13 978-0470911082, John Wiley and Sons, Chichester (2011).

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## 12.6 Unit 6: Network security management

| | |
|---|---|
| **Title** | Network security management |
| **Unit number** | A/507/6495 |
| **Assessment** | Externally assessed |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | N/A |
| **Resources required for this unit** | Workstations; personal computers; modems or other connectivity devices; printers; hard drives; DSL modems; monitors; switches; hubs; other peripheral devices; monitoring and investigative software. |
| **Synoptic assessment within this unit** | Linked to Units 1, 2, 3, 4, 5, 7 and 8.<br><br>Draws on underlying principles of computer applications and data concepts discussed in Unit 1.<br><br>Networking relies on the fundamental communication technology introduced in Unit 2. As such the management of network security relies on a firm grasp of the media and methods being used to transmit and receive sensitive data.<br><br>Unit 3 provides the technical language and concepts that underpin working knowledge of the relevant hardware and software that are key to effective network security management.<br><br>There are many skills, tools and techniques that are common to both the IT technician and the network specialist; Unit 4 provides clear opportunities for linked learning and assessment through common operational needs.<br><br>Investigations into network performance levels, faults and suspect behaviour may provide fascinating data sets that can be used to exercise numeracy skills such as calculating probability, and gathering and interpreting data – both core aspects of Unit 5.<br><br>Any secured networking solution will ultimately feed into the larger internet; its uses and needs are reflected by connections found in Unit 7.<br><br>Extended guidance on synoptic assessment is provided later in this unit documentation. |

### Aim and purpose

This unit will equip learners with the necessary knowledge and practical ability to install and maintain secure communication networks through their understanding of common threats, vulnerabilities and exploits (CVEs).

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## Unit introduction

Network security has become a highly discussed topic in recent years with high profile security breaches capturing the headlines. The time between vulnerability and exploitation is diminishing and most organisations have been exploited before they can deploy appropriate action. In addition, internal hacking and similar attacks for personal gain or retaliation are becoming more frequent.

Mobile technologies, such as USB memory sticks, laptops, smartphones etc, are constantly on the move with their users and can allow encrypted traffic to bypass perimeter firewalls and intrusion prevention systems (IPSs). Although a strong perimeter security infrastructure is still critical, it is not enough in isolation. Therefore, it has become more and more important that internal network security complements the perimeter security solutions by providing additional layers of defence against attack.

The changing role of the network technician, engineer, administrator and manager has meant that they have had to develop specialist skills and knowledge in order to combat these vulnerabilities and threats by installing and maintaining secure networks.

Learners will enhance their understanding of CVEs relating to networked systems and be able to apply suitable strategies for their secure installation and maintenance. In addition learners will be introduced to the legal and operational requirements surrounding network security. Activities will allow the learners to evaluate existing networking structures and develop strategies to improve their security.

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## Unit content

| Security issues for a network system | |
|---|---|
| Network security testing | • Assess risks to an organisation's information:<br>  • mobility<br>  • Bring-Your-Own-Device (BYOD) security challenges<br>  • cloud computing<br>  • difference between exploits and exposures<br>  • approaches:<br>  • vulnerabilities vs penetration assessments<br>  • ethical hacking<br>  • how risks can be controlled and mitigated.<br>• Layered-security model of testing:<br>  • perimeter:<br>  • firewall<br>  • network based antivirus<br>  • virtual private network (VPN) encryption<br>  • network:<br>  • intrusion detection system (IDS)/intrusion prevention system (IPS)<br>  • vulnerability management system<br>  • network access control<br>  • access control/user authentication<br>  • host:<br>  • host IDS<br>  • host Vulnerability Assessment<br>  • network access control<br>  • antivirus<br>  • access control/user authentication<br>  • application:<br>  • application shield<br>  • access control/user authentication<br>  • input validation<br>  • data:<br>  • encryption<br>  • access control/user authentication. |

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| Security issues for a network system | |
|---|---|
| Threats and vulnerabilities | • Types of threats and vulnerabilities:<br>  • eavesdropping:<br>  • open network<br>  • Wi-Fi protected access (WPA)/Wi-fi protected access 2 – pre-shared key (WPA2-PSK)<br>  • captive portal<br>  • data modification<br>  • spam<br>  • phishing (including spear phishing)<br>  • pharming<br>  • denial-of-service attack (DoS Attack)<br>  • jamming/interference<br>  • authentication/association flooding<br>  • de-authentication flooding<br>  • extensible authentication protocol (EAP) attacks<br>  • distributed denial of service attack (DDoS Attack)<br>  • man-in-the-middle attack<br>  • captive portal (evil twin)<br>  • 802.1X/EAP<br>  • ARP and DNS poisoning<br>  • cypher attacks<br>  • WEP<br>  • WPA-PSK dictionary<br>  • WPA-TKIP<br>  • session hijacking<br>  • flash cookies<br>  • cookies and attachments<br>  • malicious add-ons<br>  • compromised key attack<br>  • password attacks<br>  • network sniffing<br>  • application layer attack<br>  • Identity spoofing (IP address spoofing)<br>  • URL hijacking<br>  • client-side attacks. |

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| Security issues for a network system | |
|---|---|
| Threats and vulnerabilities continued | • Malware:<br>  • virus<br>  • spyware<br>  • adware<br>  • back doors<br>  • polymorphic malware.<br>• Exploits:<br>  • client side<br>  • server side<br>  • scanner<br>  • module<br>  • payload<br>  • trigger<br>  • injection<br>  • pivoting<br>  • spoof<br>  • honeypot<br>  • shell code. |
| Current legislation | • *Computer Misuse Act (1990).*<br>• *Communications Act (2003).*<br>• *Regulation of Investigatory Powers Act 2003.*<br>• *Telecommunications (Lawful Business Practice) (Interception of Communications) Regulation (2000).*<br>• *Data Protection Act (1998).*<br>• *Privacy and Electronic Communications (EC Directive) Regulations (2003) and Amendment to the regulation (2011).*<br>• *Data Retention (EC Directive) Regulations (2009).* |

| Hardware and software to promote network security for a network system | |
|---|---|
| Intrusion detection and prevention systems | • Firewalls.<br>• Virus protection.<br>• Spyware protection.<br>• File and folder monitoring.<br>• Alarms.<br>• Honeypots. |
| Cryptography algorithms and protocols | • Encryption:<br>  • symmetric encryption<br>  • asymmetric encryption.<br>• Data integrity algorithms.<br>• Authentication protocols. |

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| Hardware and software to promote network security for a network system | |
|---|---|
| Access control | • Biometrics.<br>• Passwords.<br>• User permissions.<br>• Digital signatures.<br>• Protocols.<br>• Logins. |
| Wireless security features | • WEP/WPA keys.<br>• TKIP.<br>• MAC association. |
| Email security features | • Spam filters.<br>• Email encryption.<br>• Attachment scanners.<br>• Email scanners. |

| Maintaining network security | |
|---|---|
| Continuous network security monitoring (CNSM) | • Different phases of CNSM:<br>  • plan:<br>  • discover<br>  • classify<br>  • define policies (eg what to collect; when to alert; validation; escalation)<br>  • apply security measures, eg hardware, software, policies<br>  • monitor:<br>  • analyse<br>  • collect/aggregate<br>  • action:<br>  • escalate<br>  • validate. |
| Network monitoring | • Logs:<br>  • event<br>  • audit<br>  • security<br>  • access.<br>• Tools:<br>  • banner grabbing<br>  • vulnerability scanner<br>  • honeypots<br>  • honeynets<br>  • passive vs active tolls<br>  • port scanner<br>  • protocol analyser. |

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| Network security plans for an organisation | |
|---|---|
| Network policies | • Types of policies:<br>  • virtual private network (VPN)<br>  • password<br>  • audit, eg network and system components<br>  • acceptable encryption<br>  • information sensitivity<br>  • antivirus guidelines<br>  • wireless communications<br>  • risk assessment<br>  • EMS network and computer acceptable use<br>  • remote Access<br>  • acceptable Use<br>  • automatically forwarded email. |
| Service level agreements (SLAs) | • The role and purpose of SLAs:<br>  • services, priorities and responsibilities<br>  • information-gathering, analysing, documenting, educating, negotiating, consensus-building<br>  • measuring performance and quality.<br>• Advantages and disadvantages. |
| Network security plan format | • Section 1: Overview of organisation:<br>  • objectives<br>  • circulation<br>  • project team.<br>• Section 2: Assessment results:<br>  • priorities<br>  • assets<br>  • skills and knowledge<br>  • network and systems<br>  • security<br>  • risks.<br>• Section 3: Security plan:<br>  • action items<br>  • policy changes<br>  • user education<br>  • project timeline and responsibilities<br>  • response planning<br>  • ongoing maintenance and compliance.<br>• Section 4: Resources and budget:<br>  • software and hardware<br>  • professional advice<br>  • internal resources. |

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## Assessment outcomes

Learners will be able to:

| Assessment outcome 1: Understand security issues for a network system | |
|---|---|
| a | Mobility and cloud computing. |
| b | Approaches to risk assessment and testing for network security. |
| c | Threats, vulnerabilities and types of risk. |
| d | The scope of current legislation that contributes to and shapes network security. |

| Assessment outcome 2: Understand hardware, software and protocols used to promote security for a network system | |
|---|---|
| a | Components and functions of intrusion detection and prevention systems. |
| b | Types of cryptography algorithms and protocols. |
| c | Functions, features and limits of forms of access control. |
| d | Wireless security features. |
| e | Email security features. |

| Assessment outcome 3: Understand how to categorise and apply security measures to a network system | |
|---|---|
| a | The different phases of continuous network security monitoring. |
| b | Logs used to monitor a network. |
| c | Tools used to monitor a network. |

| Assessment outcome 4: Analyse and develop a network security plan for an organisation | |
|---|---|
| a | Network policies. |
| b | Service level agreements (SLA) from a network security perspective. |
| c | The structure and content of network security plan. |

## Assessment

This unit is assessed by an external examination set and marked by AQA. The examination takes place under controlled examination conditions and the exam date will be published at the start of each academic year.

Learners are allowed to use a non-programmable scientific calculator in the examination.

The examination consists of a written paper with two Sections, A and B. Learners have to complete both sections and there are no optional questions within either section.

The examination is 2 hours duration and the total number of marks available in the examination is 80.

Section A is worth 50 marks and consists of relatively short questions based on the whole of the specification for this unit. Learners are required to answer **all** of the questions in Section A.

Section B is worth 30 marks and includes longer questions worth up to 15 marks each. The questions in Section B do not necessarily cover the whole of the specification for this unit at each assessment. Learners are required to answer **all** of the questions in Section B.

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## Employer engagement guidance

Learners who are in appropriate working environments could be supported by the employer providing them with opportunities to conduct or participate in the audit of their organisation's and/or customer's network systems.

## Delivery guidance

### Assessment outcome 1

Through class discussions and/or individual research, learners should look at examples of network security breaches and the consequences for the organisations themselves as well as their clients. Examples include 'Samy' – MySpace XXS worm; CitiBank Hack, Nasa Hack etc.

Learners should have an opportunity to review different approaches to testing network security and the areas of testing required. They could be encouraged to look at the different areas of potential vulnerabilities and threats for each of the areas of the network and consider the potential risks and exploits involved. This can be followed by practical activities in small groups, where the learners have access to an unsecured network that they can test in order to identify CVEs. It is important that they have the opportunity to test for a wide range of security issues to expand their knowledge, skills and understanding.

It is important that learners research the different legislation associated with the storage and security of data and how breaches in network security can have severe consequences for organisations.

For assessment learners should be able to describe different tools used for network security testing and the different areas of testing that exist (and their coverage). An understanding of the common threats and vulnerabilities that exist in networks should be demonstrated by the learner, complemented by the ability to identify and detail the current relevant legislative frameworks that provide protection and limits.

### Assessment outcome 2

Learners should be taught about the different hardware and software tools available to promote network security. It is important that learners have access to as many different tools as possible so that they can see how they actually work on a system and their purpose in securing the network.

Learners could continue to work in their small groups and select appropriate hardware and software to address the security issues they had identified previously. They could then retest the system to ensure that the issues have been addressed.

For assessment learners should be prepared to categorise and describe the various hardware and software tools used to promote network security. They should be able to describe their purpose, coverage and effectiveness.

### Assessment outcome 3

Learners need to understand how to monitor a network system to ensure that appropriate security is maintained at all times. This could start with learners researching and using a wide range of monitoring tools. They need to know how to use them, what they monitor and to understand the information that is provided.

Planning plays an important role in the monitoring of networks and it is important that learners are provided with guidance on what should be planned, how it is planned and the importance of planning. Learners should also be made aware of the documentation that is used, why it is important to use it, how it is used and the purpose of completing it. Learners could work in small groups where they use a wide range of tools for monitoring a network and complete the associated documentation. They could then analyse the results within their groups and discuss the results. Based on the results, they would

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then need to make a decision on what action they would take.

Learners could work in small groups or as individuals to:

- plan the monitoring of the security of a network
- follow the plan to monitor the network
- analyse and document the results of the monitoring
- identify appropriate action to be taken.

During assessment learners may be asked to identify and describe the different aspects of continuous network monitoring, examine samples of various monitoring logs to answer specific questions or explain the purpose of a range of common network monitoring tools.

### Assessment outcome 4

Learners should have access to, or be encouraged to perform research into, the variety of network policies that organisations may require. This could include class discussions where the purpose and potential content of these policies could be discussed.

It is important that learners are provided with guidance on how to create a formal network security plan. They need to be made aware of the content of Sections 1 to 4 as per the guide in the unit content. It is important that they understand what is included and why, as well as the level of detail required.

As a practical activity, learners could be given a scenario of an organisation that has a networked system for which they have been asked to prepare a network security plan. Learners could work in small groups where they analyse the requirements for this particular organisation and prepare a formal network plan. They should be able to draw on their knowledge and understanding from the previous sessions as well as what they have learnt from the sessions for this particular section. It is important that learners are provided with sufficient information within the scenario to enable them to make judgements and recommendations. The teacher could also take on the role of the customer and provide learners with the opportunity to ask the 'client' questions.

During assessment is it likely that learners will be asked to explain the elements that form a network security policy and state the advantages and disadvantages that a Service Level Agreement (SLA) may contribute to network security. Learners should also be familiar with the sections of a formal network security plan and be prepared to interpret or explain suitable content as required.

## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other providing development on concepts and topics, reinforcing learning and skill development which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

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## AO1: Understand security issues for a network system

**Unit 1 – AO3: Understand the software requirements of a computer system**
Testing a network requires a number of different techniques; many of these are software-based. This assessment outcome focuses on different types of software, especially utilities that are often used to diagnose network problems.

**Unit 3 – PO2: Identify the different types of network architectures and technology type**
Many of the areas of testing (perimeter, network, host, application and data) are introduced in this unit. Definitions and coverage in this unit should contribute to the learner being able to not only identify the five areas required but be able to identify the different types of technology they employ.

**Unit 4 – PO4: Use appropriate tools to troubleshoot end user problems safely**
This unit's performance outcome also focuses on variable diagnostic and monitoring tools that could be used by the learner to perform network benchmarking. It also considers the pieces of legislation connected to computer usage, many of which are mirrored here, eg *Communications Act (2003)*, *Computer Misuse Act (1990)* etc.

**Unit 7 – PO1: Understand the internet**
This unit also examines the types of legal infringements that may be impacted by network security (eg theft of intellectual property) or create network security issues (eg illegal file sharing and downloads) that can be tackled through current legislation, eg *Communications Act (2003)*, *Computer Misuse Act (1990)* etc.

## AO2: Understand hardware, software and protocols used to promote security for a network system

**Unit 1 – AO3: Understand the software requirements of a computer system**
In this unit learners are introduced to different types of security software such as firewalls, antivirus, anti-spyware and the concept of encryption and biometrics, providing a solid foundation for this coverage. These can all be used to promote network security and apply access control.

**Unit 3 – PO2: Identify the different types of network architectures and technology types**
Part of this performance outcome focuses on basic network security, the concept of a honeypot which is typically introduced here and a number of other concepts (eg MAC filtering, wireless encryption etc).

## AO3: Understand how to categorise and apply security measures to a network system

**Unit 4 – PO4: Use appropriate tools to troubleshoot end user problems safely**
The use of software generated monitoring documentation such as event logs and fault logs is introduced in this performance outcome, albeit specifically for troubleshooting computer systems these tools also contain crucial networking information that can assist the selection and application of appropriate security measures.

**Unit 5 – PO4: Gather and interpret data in a meaningful manner**
Benchmarking is a core testing technique that can be used when networks are being examined for faults, vulnerabilities and performance as part of the monitoring process. Data gathering, probability, eg from speed tests, benchmark metrics, packet drops and response time can be gathered and interpreted like any set of quantitative data; this performance outcome provides support for this deeper level of fact finding, analysis and reporting. It also exercises learners' numeracy skills.

**Unit 8 – PO1: The project planning process**
The plan, monitor, action aspects of network security monitoring can be viewed as a realistic manifestation of a typical project life cycle, introduced in this unit.

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## AO4: Analyse and develop a network security plan for an organisation

**Unit 2 – AO1: Understand the fundamentals of data communication**
**Unit 2 – AO2: Analyse data communication methods**
**Unit 2 – AO3: Analyse basic mobile technology communication methods**
**Unit 2 – AO4: Understand the fundamentals of computer networks**
Risks are initially outlined in this unit's selected performance outcome, albeit briefly. They discuss the risks to the network itself, the organisational assets connected to it (eg sensitive or commercial data) and the harm this may cause the organisation. Considering these should complement the technical risks suggested by the assessment as part of the network security plan.

**Unit 2 – AO5: Understand network conceptual models, protocols and devices**
Auditing the network and system components required as part of a network security plan involves using subject specialist terminology correctly. The majority of these communication terms and concepts are introduced in this unit.

**Unit 3 – PO2: Identify the different types of network architectures and technology types**
Some aspects of network policies will reflect network architecture such as VPNs. Other policy items may reflect user-related concepts such as user account, access control lists etc. These types of concerns are introduced in this performance outcome and provide a foundation for attempting this criterion. Many of the network and system components present in an inventory are introduced in this unit. Definitions and coverage in this unit should contribute to the learner being able to accurately identify the technologies being used within an organisation.

**Unit 3 – PO4: Design and build a network from a specification**
Many of the network policies will reflect requirements discussed when creating the original network specification. This performance outcome dovetails neatly here to provide supplementary learning.

**Unit 3 – PO6: Maintain a network system**
This performance outcome supports the concept of a SLA by focusing on agreements made when creating an SLA for a network service; security concerns are likely to be part of the responsibilities and standards addressed.

**Unit 4 – PO2: Understand how to communicate effectively with end users**
This performance outcome is likely to be learners' introduction to the concept of an SLA. As such it provides the basis of the typical concerns that would be discussed and agreed through the SLA aspect of the network security plan.

## Useful links and resources

- Create your own security audit: itsecurity.com/features/it-security-audit-010407
- An overview of cryptography: garykessler.net/library/crypto.html
- Common types of network attacks: technet.microsoft.com/en-us/library/cc959354.aspx
- Identifying vulnerabilities and risks on your network: techsoupforlibraries.org/cookbook-3/networking-and-security/identifying-vulnerabilities-and-risks-on-your-network
- Top 20 free network monitoring and analysis tools: gfi.com/blog/the-top-20-free-network-monitoring-and-analysis-tools-for-sys-admins
- Networking, computers and the law: ja.net/support-advice/advice/regulatory-legal-information/laws-networking

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## 12.7 Unit 7: The internet

| | |
|---|---|
| **Title** | The internet |
| **Unit number** | F/507/6496 |
| **Unit assessment type** | Centre assessed and externally quality assured |
| **Recommended assessment method** | Practical assignment<br><br>This is the preferred assessment method for this unit. A centre may choose an alternative method of assessment, but will be asked to justify as part of the quality assurance process. |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | Research<br><br>Communication (oral and written)[6] |
| **Resources required for this unit** | Suitable Windows PC, Linux, Apple Macintosh OS X, Apple iOS or other suitable platforms.<br><br>It would be helpful, for demonstration purposes, if the centre's technicians could be on hand to allow the tutor access to relevant areas of the centre's system associated with the use of the internet. |
| **Synoptic assessment within this unit** | IT: Networking linked to Units 1, 2, 3, 4, 5, 6 and 8.<br><br>Draws on underlying principles of computer applications and data concepts discussed in Unit 1.<br><br>Unit 8 focuses on completing an industrial project. In preparing for this the learner will develop the critical research and rich reporting skills that are necessary to complete this unit.<br><br>Units 3, 4 and 6 provide the conceptual frameworks for the data communication and networking aspects covered in this unit.<br><br>Unit 4 has similar legislative concerns as this unit of study and may prove to be the learner's first practical introduction to them.<br><br>Unit 5 provides the background to logical operations that can be utilised by the learner when constructing advanced internet queries. It also provides background to trends, probability and statistics, which can be helpful when understanding the principles, advantages and uses of big data analytics.<br><br>Extended guidance on synoptic assessment is provided later in this unit documentation. |

### Aim and purpose

To equip learners with the knowledge to understand the internet, its functionality, technology and terminology, how society uses the internet and what future developments are on the horizon.

[6] Please visit the specification homepage to access the transferable skills standards and associated guidance and recording documentation.

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## Unit introduction

This unit begins with an investigation into how the internet is used to provide information to support business and education. It will also consider big data analytics and the privacy debate.

Within this unit, learners will develop their knowledge of the technology that maintains the internet, how the internet is being used today and how it will develop in the future. They will also be introduced to and asked to consider the important security and legal issues that are impacting our internet usage and behaviour.

To complete the unit learners will consider future developments by investigating an area of interest.

This unit provides an opportunity to evidence achievement of the transferable skills of research and communication (oral and written).

## Unit content

| The internet | |
|---|---|
| Search engines | (eg)<br>• General:<br>  • Google<br>  • Bing<br>  • Yahoo.<br>• Designated:<br>  • Bit Torrent<br>  • Blog<br>  • business<br>  • email<br>  • enterprise<br>  • jobs<br>  • music<br>  • games<br>  • multimedia<br>  • international<br>  • news<br>  • people.<br>• Using search engines:<br>  • smart searches<br>  • use of wildcards<br>  • advertising (including unsolicited)<br>  • search engine optimization (SEO). |
| Information and information services | • Proliferation of information.<br>• Need for structure.<br>• Use of metatags.<br>• Wikipedia.<br>• Wikileaks. |

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| The internet | |
|---|---|
| How businesses use the internet | • Web conferencing (eg Webinar).<br>• Voice-over-internet-protocol (VOIP).<br>• Instant messaging.<br>• Remote assistance and teamworking.<br>• E-commerce.<br>• Online marketing.<br>• Tracking of trends.<br>• Digital advertising.<br>• Online banking.<br>• Online payment processing. |
| Other uses | • Digital education:<br>  • massive open online courses (MOOCs)<br>  • benefits and drawbacks. |
| Crowd-sourcing | • Political and social campaigning (38 Degrees, change.org etc).<br>• Crowd-sourced purchasing (GroupOn).<br>• Kickstarter projects. |
| Legal infringements | (eg)<br>• Intellectual property.<br>• Copyright infringement.<br>• Illegal file sharing and downloads.<br>• Creative work theft (photographs, digital art etc).<br>• Plagiarism of the written word.<br>• Fair use.<br>• Limits of legal responsibility (eg internet service provider (ISP), policing).<br>• Financial impact on creative industries (eg music, film). |
| Personal considerations | • The importance of caring about your personal digital footprint and legacy.<br>• Security of personal details.<br>• Identity theft. |
| Big data analytics | (eg)<br>• Benefits and issues.<br>• Fair information practices. |

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| Internet infrastructure | |
|---|---|
| Internet technology | • General infrastructure.<br>• Servers and clients:<br>  • protocols<br>  • function of the Internet Engineering Task Force<br>  • 'Request for Comment' publications<br>  • internet protocol suite:<br>  • RFC 1123 – application and support protocol layers (client-server model, peer-to-peer paradigms)<br>  • RFC 1122 – communications protocol layers, transport layer, IP layer etc<br>  • internet layer – internet protocol version 4 (IPv4), IP addresses model<br>  • link layer – connectivity (TCP/IP).<br>• Speed testing your connectivity. |
| Connectivity terminology | (eg)<br>• Fibre optic service (FiOS).<br>• Gateway.<br>• Internet control message protocol (ICMP).<br>• Integrated services digital network (ISDN).<br>• SYN Flood.<br>• Tunneling.<br>• User datagram protocol (UDP).<br>• Virtual private network (VPN).<br>• Quality of service (QoS). |
| Applications terminology | (eg)<br>• Bot and botnets.<br>• Electronic data interchange (EDI).<br>• Multicasting.<br>• Streaming.<br>• Wide area information server (WAIS). |
| Routing infrastructure | • Tier 1 networks.<br>• Tier 2 networks.<br>• Internet exchange points.<br>• ISPs. |
| Peer-to-peer networks for file sharing | • Peer-to-peer (P2P).<br>• Use and misuse. |

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| Internet infrastructure | |
|---|---|
| Domains and lookup terminology | (eg)<br>• Domain name system (DNS):<br>  • hierarchy of domains.<br>• Domain names and domain registrations.<br>• DNS records.<br>• DNS lookup and forwarding.<br>• DNS problems (eg caching and proliferation).<br>• Windows internet name service (WINS). |
| Cloud technology | • Virtualization.<br>• Application Service Provisioning running remote client-server software:<br>  • 'SaaS ('Software as a Service')<br>  • 'PaaS' (Platform as a Service')<br>  • 'IaaS' (Infrastructure as a Service')<br>  • 'HaaS ('Hardware as a Service')<br>  • 'EaaS ('Everything as a Service')<br>• Methods of accessing remote cloud-based applications.<br>• Cloud management:<br>  • cloud storage<br>  • cloud processing. |

| Future internet technologies | |
|---|---|
| Future developments | (eg)<br>• Development of new wireless and wired access networks.<br>• Self-managing networks:<br>  • aims (eg cut overheads)<br>  • self-organised networks<br>  • wireless setting (eg with Wifi meshes or infrastructure-less wireless networks [MANETS])<br>  • wired setting (eg in peer-to-peer).<br>• Resilinets.<br>• Media internet/media-driven networks.<br>• Developments in the virtual world:<br>  • augmented reality<br>  • virtual worlds<br>  • real-time games<br>  • telepresence<br>  • service orchestrations. |

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## Performance outcomes

On successful completion of this unit learners will be able to:

| | |
|---|---|
| Performance outcome 1: | Understand the internet. |
| Performance outcome 2: | Understand the infrastructure. |
| Performance outcome 3: | Investigate future internet technologies. |

## Grading criteria

| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO1: Understand the internet** | **P1** Compare and contrast the functionality of **two** general and **two** designated search engines. | **M1** Explain giving **four** examples how the use of wildcards and smart searches produce more accurate results when using a search engine. | **D1** Evaluate the social implications of unsolicited advertising. |
| | **P2** Explain how the use of metatags improves search results. | | |
| | **P3** Select **three** different businesses and for **each one**, identify a different way in which the internet is used to improve the functionality of the business, providing real examples. | | |
| | **P4** Define MOOCs and their role in digital education. | **M2** Consider the benefits and drawbacks of learning online in order to assess its potential impact on society. | |
| | **P5** Explain crowd-sourcing and how it is used. | | |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| | **P6**<br>Describe **four** possible legal infringements that can occur when using the internet. | **M3**<br>Investigate and assess a local Internet Services Provider's limits of legal responsibility when dealing with legal infringements. | **D2**<br>Evaluate the financial impact of legal infringements on creative industries. |
| | **P7**<br>Create a plan to protect your digital footprint. | | |
| | **P8**<br>Define the concept of big data analytics. | **M4**<br>Analyse the concept and explain the benefits and issues. | **D3**<br>Evaluate how big data analytics impacts on personal privacy. |
| **PO2: Understand the infrastructure** | **P9**<br>Demonstrate the infrastructure used to connect clients and servers over the internet including:<br>• layers<br>• routing infrastructure<br>• connectivity<br>• applications. | **M5**<br>Demonstrate the process of tunnelling via a VPN. | |
| | **P10**<br>Explain how peer-to-peer networks can be used and misused when file sharing. | | |
| | **P11**<br>Demonstrate the process of domain registration. | **M6**<br>Explain the issues caused by DNS caching and DNS proliferation times. | |
| | **P12**<br>Explain how cloud technology has changed the way in which businesses operate. | | |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO3: Investigate future internet technologies** | **P13** **Research** one future internet-related development and its impact on a selected area of society. | | |
| | **P14** Create a **research report** to outline the findings. | | |
| | **P15** **Present** the key findings to a suitable audience. | | |

## Assessment amplification

**This section provides amplification of what is specifically required or exemplification of the responses learners are expected to provide.**

**In completing performance criterion P13 learners will be presented with an opportunity to demonstrate the transferable skill of research.**

**In completing performance criteria P14 and P15 learners will be presented with an opportunity to demonstrate the transferable skill of communication (written and oral).**

This unit would benefit from different types of assessment which could include logs, presentation slides, extended writing (particularly for PO3), video or audio evidence, alongside practical demonstrations.

For **M2** learners could also explain how they have been affected by the use of online learning as part of their course, although this can be more generic.

For **P9** and **M5** learners could use annotated process diagrams, real demonstrations, logs of activities to evidence this outcome.

For **P13** learners should create a research log that should be submitted as part of the evidence.

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The research could focus on any area of society including:

- business and commerce
- church
- distribution of media
- family
- the arts
- medicine
- education
- government
- economics.

For **P14** learners may choose their method, but a PowerPoint presentation is not permitted as extended writing is expected.

For **P15** learners will present either with or without a slide show as this is optional.

## Employer engagement guidance

If learners are in the workplace then the centre could ask the employer whether there are any suitable projects that the learners could work on as part of the team. It would be helpful for the employer to be made aware of the sort of skills that the learners have to practice.

## Delivery guidance

### Performance outcome 1

Learners will already be familiar with many aspects of the internet and they will be familiar with a range of search engines. In industry, learners will support a range of IT tools and will need to understand the different types and classifications of search engines (for example medical search engines, business search engines etc). This could be researched as a pair or small group activity; learners should be encouraged to discuss various search engines in terms of usability and functionality, comparing the first 10 hits on the different search engines used.

Learners should be able to carry out smart searches and should understand the use of quotes around search terms, '+' between different search terms and the concept of wildcards.

Learners should understand that with the proliferation of information available, there needs to be structure and they should understand how metatags are used.

They should understand the way that Wikipedia works and why information might not be reliable.

Learners would also be able to undertake an ethical debate on Wikileaks.

An investigation into how businesses use the internet will enable learners to consider web conferencing among other business uses; they could, for example, set up a webinar if technology allows. They should consider how the internet is used in education, particularly in the development of MOOCs.

The emergence of crowdsourcing should be explored with many examples available to support this area of learning.

Time should be spent discussing the legalities of internet content and in particular file sharing and downloading and the theft of intellectual and creative property. This will provide an opportunity to discuss plagiarism. A debate on the pros and cons of policing the internet would also be welcome.

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To complete this objective, learners should undertake an investigation into privacy, particularly considering big data analytics and the benefits and issues that arise. This will lead to a discussion on personal behaviour and their personal footprint. This is essential to enable learners to support the activities of others both privately and in a business context.

### Performance outcome 2

It is important that learners study how the internet works and the necessity for global standards with regard to both its development and its operation. Learners should have thorough understanding of the hardware that allows the internet to operate and could be asked to create their own simplified map of routes showing how global hardware connects together to make up the internet, such as undersea cabling and the important exchange points. They should include explanations of routing tiers, the purposes of internet exchange points and the role of ISPs.

Learners should be provided with a good knowledge of the common protocols and the organisation that oversees their administration. Group or individual research projects could be undertaken to explain how the Request For Comment (RFC) publication system of the Internet Engineering Task Force operates. Learners could complete essays focusing on the two important RFCs (1122 and 1123) and be asked to explain the purpose and significance of the different layers etc.

It may be useful to learners to listen to a representative from the centre's technical support staff, who could inform them about the issues they need to deal with in regards to the technical and security aspects of the centre's connectivity to the internet.

Learners will meet new terminology when exploring this unit including domain, connectivity and applications terminology that they might not have used before. This will provide an opportunity for them to learn how to use the internet to draw down definitions and explanations of some of the terms. As this terminology is ever growing, this will provide a useful skill.

An exploration of cloud technology completes the unit and learners could be introduced to Dropbox or other similar software.

### Performance outcome 3

This is an opportunity for learners to investigate an area of future technology development that interests them. It should culminate in an essay or report of about 1,000 to 1,500 words.

This will provide an opportunity to teach report and essay structure, plus a referencing methodology, although Harvard referencing is included in the content.

Learners will complete this unit by presenting the key points of their research in a formal presentation to the class.

## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other providing development on concepts and topics, reinforcing learning and skill development which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

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## P3: Select three different businesses and for each one, identify a different way in which the internet is used to improve the functionality of the business, providing real examples

**Unit 3 – PO1: Identify communication activities facilitated by computer networks**

This performance outcome also introduces the types of application that businesses and individuals use, differentiating typical business 'office-style' applications (ie spreadsheets, databases, word processing etc) from the more strategic e-business solutions such as banking, retail, marketing and finance. Learners may draw upon these examples when selecting the ways in which the internet has improved business functionality.

## P4: Define MOOCs and their role in digital education

**Unit 1 – AO3: Understand the software requirements of a computer system**

This assessment outcome introduces the concept of different types of software; distributed online educational applications such as MOOCs could be introduced to the learner here, complete with their role in digital education. computer system

## P6: Describe four possible legal infringements that can occur when using the internet

**Unit 4 – PO 4: Use appropriate tools to troubleshoot end user problems safely**

**Unit 6 – AO1: Understand security issues for a network system**

Guidance provided by legislation connected to Computer usage (Unit 4) and Network systems security (Unit 6) are mirrored here, eg *Communications Act (2003)*, *Computer Misuse Act (1990)* etc and may be cited by the learner when considering possible legal infringements when using the internet.

## P7: Create a plan to protect your digital footprint

**Unit 6 – AO1: Understand security issues for a network system**

Many aspects of this unit's first performance outcome focus on the numerous threats and vulnerabilities that networks face. By introducing concepts such as malware, phishing, spam, cookies and IP spoofing the learner could begin to appreciate the tactics that they can employ (eg anti-spyware) to protect their anonymity and recognise those designed by others to breach their personal privacy (eg third party cookies). Both enrich any approach the learner may take when planning to protect a digital footprint and avoiding consequences such as potential identity theft.

## P8: Define the concept of big data analytics

**Unit 5 – PO3: Calculate with sequences, series, probability and recursion**

**Unit 5 – PO4: Gather and interpret data in a meaningful manner**

Big data analytics often involve concepts such as probability, statistics, trends etc. These are introduced in these performance outcomes and provide the underpinning knowledge the learner may use for understanding how data can be analysed, regardless of the scales involved.

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## P9: Demonstrate the infrastructure used to connect clients and servers over the internet including:

- layers
- routing infrastructure
- connectivity
- applications.

**Unit 2 – PO4: Understand the fundamentals of computer networks**
**Unit 2 – PO5: Evaluate network conceptual models, protocols and devices**
**Unit 3 – PO2: Identify the different types of network architectures and technology types**
**Unit 3 – PO3: Understand the different types of local area networks (LANs) and wide area networks (WANs)**
**Unit 6 – AO2: Understand hardware, software and protocols used to promote network security for a network system**

These units present the foundation for networking architecture (hardware and software) that the internet uses to form its infrastructure. As such they collectively supply the vital building blocks needed by the learner to demonstrate practical skills when designing, implementing and testing internet connectivity from client to server.

## P10: Explain how peer-to-peer networks can be used and misused when file sharing

**Unit 3 – PO2: Identifying the different types of network architectures and technology types**

The general concept of peer-to-peer networking, its underlying architecture and functionality is typically introduced in this unit and may be duplicated inexpensively by the learner in the classroom using modern network operating systems, enabling simple explanation of its use and misuse.

## P13: Research one future internet-related development and its impact on a selected area of society

**Unit 8 – PO1: The project planning process**

Research is a vital aspect of the project planning process and, in particular, the analysis and design phases of the lifecycle. Consequently, this performance outcome should provide learners with a good grounding in the research techniques that will facilitate completing this performance criterion.

**Unit 3 – PO3: Understand the different types of local area networks (LANs) and wide area networks (WANs)**

This performance outcome requires learners to investigate real world networking situations and report on them. Having discovered the scope of existing networked facilities the learner may feel more enabled to establish a current baseline and, from there, extrapolate future interrelated developments and their potential impacts, drawing on the improvements already made in people's lives by this technology.

## P14: Create a research report to outline the findings
## P15: Present the key findings to a suitable audience

**Unit 8 – PO2: Plan a project with others to meet a specified outcome**

This performance outcome tasks learners with creating a project plan, an activity usually presented as part of a formalised report. Creating, organising and presenting the facts related to their research exercises the skills required by this performance outcome. This is particularly true when using appropriate communication skills to present key findings.

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# Useful links and resources

## Journal

- *International data privacy law* (Oxford University Press): idpl.oxfordjournals.org/content/current

## Websites

- Internet Engineering Task Force: ietf.org
- New internet technologies (Baccelli F and Crowcroft J): ercim-news.ercim.eu/en77/special/future-internet-technologies-introduction
- What is cloud computing? ibm.com/cloud-computing/us/en/what-is-cloud-computing.html

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# 12.8 Unit 8: Industrial project

| | |
|---|---|
| **Unit number** | A/507/6464 |
| **Unit assessment type** | Centre assessed and externally quality assured |
| **Recommended assessment method** | Practical assignment<br><br>This is the preferred assessment method for this unit. A centre may choose an alternative method of assessment, but will be asked to justify as part of the quality assurance process. |
| **Guided learning hours** | 90 |
| **Transferable skill(s) contextualised within this unit** | Teamwork[7] |
| **Resources required for this unit** | Prior learning and technical resources appropriate for the employer/client brief. |
| **Synoptic assessment within this unit** | The Industrial project unit allows centres to demonstrate explicit synoptic assessment.<br><br>Principally it represents the key opportunity for learners to demonstrate that they can identify and use effectively, in an integrated way, an appropriate selection of skills, techniques, concepts, theories and knowledge from across many of the units and outcomes delivered on the IT: Networking pathway.<br><br>It also affords centres with the chance to creatively exercise the teaching and learning links between the different units and can contribute and promote a holistic delivery programme that encourages the application of prior or concurrent learning.<br><br>In addition it can be used as a vehicle to provide amplification and aggregation for the grading criteria of internally assessed units into a coherent and technically relevant industry-based task with its sector-specific nature encouraging, developing and assessing learners' use of transferable skills in realistic and demanding contexts.<br><br>Extended guidance on synoptic assessment is provided later in this unit documentation. |

## Aim and purpose

To enable learners to participate in a technical project that requires them to work as part of a team. This will help to develop their knowledge, skills and understanding with respect to the project planning and implementation process and the importance of working effectively as part of a team. Learners will undertake a project that reflects the pathway they are following within the overall qualification.

[7] Please visit the specification homepage to access the transferable skills standards and associated guidance and recording documentation.

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## Unit introduction

The success of a project will depend on how efficient the project team are in executing the project goals and objectives during the project management lifecycle. This will be impacted, in part, by how well work roles are matched to individual competencies, how well members work within a group and whether project milestones are prioritised effectively.

This unit provides an opportunity to evidence achievement of the transferable skill of teamwork.

Teamwork is important because it creates **human synergy**. It amplifies by producing end results that are greater than the sum of the individual contributions.

The unit is a focal end point, providing opportunities for real synergy across the qualification. It is mandatory as it has been requested by industry. Learners will learn about the project life cycle, resources, issues and methodology. They will be able to produce a project specification and plan as a team for an identified project. Roles and responsibilities will be agreed between the team so that project expectations are clearly understood by all interested stakeholders.

Learners will also learn about the importance of good time management and communication skills in order to facilitate a successful project outcome.

This unit will provide the opportunity for synoptic assessment as learners may undertake projects that are linked to one or more units across the qualification spectrum.

## Unit content

| The project planning process | |
|---|---|
| Life cycle | • Analysis phase (eg defining goals, feasibility study, preparing project proposal).<br>• Design phase (eg identifying possible solutions, systems).<br>• Implementation phase (eg creating solution, testing, training).<br>• Evaluation phase (eg project review, feedback from client/user). |
| Project methodologies | (eg)<br>• Prince 2.<br>• Rapid application development (RAD).<br>• Waterfall model.<br>• Structured systems analysis and design methodology (SSADM).<br>• Critical path method (CPM).<br>• as required by client. |
| Project problems | • Poor communication (eg between project team members, between stakeholders).<br>• External factors (eg change of project team members, change in finance, timescales).<br>• Lack of project management and leadership.<br>• Conflict between members and/or clients.<br>• Poor tracking of project progress.<br>• Adhering to legislative and organisational requirements.<br>• Unrealistic timescales.<br>• Lack of testing.<br>• Poor quality of product. |

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| The project planning process | |
|---|---|
| Project planning software and its functionality | (eg)<br>• Project Libre.<br>• Microsoft Project.<br>• Freedcamp. |
| Benefits of project planning software | (eg)<br>• File sharing.<br>• Speed of response.<br>• Communication.<br>• Equal access to timescales and tasks. |

| Planning a project with others to meet a specified outcome | |
|---|---|
| Stakeholders | (eg)<br>• Project sponsor (funds the entire project).<br>• Business experts (define their requirements for the end product/result).<br>• Project manager (controls the project plan).<br>• Project team (builds the project outcome based on accepted roles and responsibilities).<br>• End user (may be the client or the employees of the client). |
| Stakeholder expectations | • Level and method of communication used to communication with them.<br>• Kept up-to-date with respect to progress.<br>• How will they measure success?<br>• Outcome of project.<br>• Timescales.<br>• Budgets.<br>• Resources. |
| Defining project goals | • Review context and requirements of project.<br>• Identify key attributes of project:<br>  • types of products/services to be delivered<br>  • critical constraints eg project duration, costs etc<br>  • technologies, tools and techniques to be used<br>  • quality requirements to be met<br>  • benefits to be achieved.<br>• How success will be measured.<br>• Must be well defined and measurable. |
| Project deliverables | • Product or service given to a client.<br>• Have due dates (deadline for delivery).<br>• Deliverables are:<br>  • tangible<br>  • measurable<br>  • specific<br>• For internal and/or external clients, satisfying a milestone as part of the project plan. |

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| Planning a project with others to meet a specified outcome | |
|---|---|
| Project schedule | • Required activities and tasks.<br>• Resources for each task/activity.<br>• Length of time to complete each task/activity.<br>• Resource constraints.<br>• Develop critical path (tasks dependent on other tasks).<br>• Develop schedule – calendar schedule of all tasks with:<br>  • estimate of time period<br>  • resource required for each task<br>  • project team member(s) involved<br>  • time on each task<br>  • begin and end dates of individual task. |
| Allocating roles and responsibilities | • Identify roles within project team.<br>• Identify tasks/activities to be carried out.<br>• Define roles based on relevant skills, qualities and knowledge. |

| Following a project plan as part of a team to meet a specified project outcome | |
|---|---|
| Time management skills | (eg)<br>• Set clear goals.<br>• Break down personal goals into discreet steps.<br>• Review personal progress towards identified goals.<br>• Prioritising – order of importance/urgency.<br>• Organisation of work schedule.<br>• List making (eg to do list).<br>• Perseverance (eg take a positive attitude).<br>• Avoid procrastination (eg avoid distractions from noise, emails). |
| Measuring progress against milestones | • Measure quantity of work output.<br>• Determine whether timelines within plan needs to be modified.<br>• Review their progress with others. |
| Effective communication | • Interpersonal skills (eg verbal communication skills).<br>• Cues in verbal communication (eg body language, tone of voice).<br>• Questioning techniques (eg open/closed probing).<br>• Written communication (eg note taking, reports, emails, letters).<br>• Understanding the audience (eg who are they, what their knowledge base is).<br>• Clarification of requirements.<br>• Verbal and non-verbal techniques. |

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| Following a project plan as part of a team to meet a specified project outcome | |
|---|---|
| Effective team meetings | • Agenda available prior to meetings.<br>• Start and end promptly.<br>• Check attendees.<br>• Establish and review ground rules.<br>• Assign administrative roles.<br>• Summarise decisions and assign action items.<br>• Debrief, evaluate and plan for improvement.<br>• Distribute meeting minutes promptly. |
| Giving constructive feedback | • Provide feedback promptly.<br>• Descriptive.<br>• Not judgemental.<br>• Supportive.<br>• Fair and reasonable.<br>• Positive as well as negative (feedback sandwich). |
| Receiving feedback | • Pay attention.<br>• Do not become defensive.<br>• Do not launch a counterattack.<br>• Avoid flippancy.<br>• Convey understanding.<br>• Indicate a willingness to work together towards a solution/improvement.<br>• Accept praise graciously. |

| Reviewing collaborative working as part of a project team | |
|---|---|
| Review process | • Success of project.<br>• Meeting of objectives.<br>• Factors influencing the outcome (eg work process, external changes, interpersonal aspects). |

## Performance outcomes

On successful completion of this unit, learners will be able to:

| | |
|---|---|
| Performance outcome 1: | Understand the project planning process. |
| Performance outcome 2: | Plan a project with others to meet a specified outcome. |
| Performance outcome 3: | Follow a project plan as part of a team to meet a specified project outcome. |
| Performance outcome 4: | Review collaborative working as part of a project team. |

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## Grading criteria

| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO1: Understand the project planning process** | **P1** Describe the **four** stages of the project life cycle. | | |
| | **P2** Compare the characteristics of **three** project methodologies. | | |
| | **P3** Identify **six** of the problems that can occur within a project. | **M1** Explain how the problems identified could be overcome. | |
| | **P4** Compare the functionality of **two** examples of project planning software. | **M2** Explain the benefits of using project planning software in managing a project. | |
| **PO2: Plan a project with others to meet a specified outcome** | **P5** Identify a minimum of **two** stakeholders for a specified project. | **M3** Explain the expectations of the stakeholders identified for a specified project. | |
| | **P6** Create a project plan for a specified project. | **M4** Describe in detail **three or more** goals required to complete a specified project. | **D1** Discuss the project deliverables required to meet the goals for a specified project. |
| | **P7** Check the plan with stakeholders to confirm accuracy. | | |
| | **P8** Outline the project schedule for a specified project setting clear timelines and milestones. | | |
| | **P9** Allocate the roles and responsibilities required for a specified project. | | |

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| Performance outcomes | Pass | Merit | Distinction |
|---|---|---|---|
| | **To achieve a pass the learner must evidence that they can:** | **In addition to the pass criteria, to achieve a merit the evidence must show the learner can:** | **In addition to fulfilling the pass and merit criteria, to achieve a distinction the evidence must show that the learner can:** |
| **PO3: Follow a project plan as part of a team to meet a specified project outcome** | **P10** Effectively plan and manage own time as part of a project team. | | |
| | **P11** Carry out agreed roles and responsibilities, negotiating and resolving any conflicts or shortcomings during the project. | **M5** Measure progress against identified milestones. | **D2** Justify any changes to resource and/or milestones. |
| | **P12** Participate in team meetings to discuss project progress. | **M6** Communicate effectively through verbal and non-verbal methods with project team members. | **D3** Explain the importance of effective non-verbal communication. |
| | **P13** Consider feedback received from project team members and make adjustments as appropriate. | | |
| **PO4: Review collaborative working as part of a project team** | **P14** Reflect on the effectiveness of collaborative working for a specified project. | **M7** Suggest a range of improvements to support collaborative working for future projects. | |
| | **P15** Evaluate your personal contribution to the project. | | |

## Assessment amplification

This section provides amplification of what is specifically required or exemplification of the responses learners are expected to provide.

In completing this unit, the process of teamworking will be continually developed and reflected upon.

This unit is best assessed through a single project and would benefit from employer involvement.

Minutes of meetings, development logs, emails, videos or recordings of discussions, written documentation, diagrams and charts, PowerPoint slides as well as the outcome of the project could provide evidence for this unit.

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**Note:** There will be an opportunity to bring in learning from all other units studied and learners should be encouraged to draw on their experience as well as what they have learned.

To address this particular learning outcome, learners must be provided with a scenario that has a specified project outcome. They will be expected to work in teams to produce the project plan, but the individual learner evidence must show how the learner met the assessment criteria for themselves.

For **D3** learners must demonstrate an understanding of non-verbal communication and the problems that inexplicit written communication can cause.

## Employer engagement guidance

If learners are in the workplace then the centre could ask the employer whether there are any suitable projects that the learners could work on as part of the team. It would be helpful for the employer to be made aware of the sort of skills that the learners have to practice.

## Delivery guidance

This unit could effectively be used alongside other practical units, which allows learners to work in a team environment.

### Performance outcome 1

It is important that learners understand the project planning process and that it is about collaborative working from the outset. Learners need to understand that when working as a team on any project, they have the opportunity to make suggestions, volunteer for specific tasks/activities etc.

Through a class discussion, learners could be given an overview of the project life cycle with emphasis on how they could contribute as a team member. Learners should also have an awareness of the different project methodologies and that different organisations/situations may use different ones.

Problems do occur when working on projects. Therefore it is important that learners have the opportunity to discuss the various issues/problems that could occur, the effect these could have on the project and how they can be overcome (if at all).

Learners could be given project scenarios and in small groups give presentations explaining the problems that may arise, whether they can be overcome and how.

It is also useful at this stage for learners to be introduced to project planning software such as Project Libre and Microsoft Project.

### Performance outcome 2

Learners need to understand who the stakeholders are within a project and the fact that the project team is also classified as a stakeholder. Learners could be asked to research different stakeholder types and through a group discussion explain what they believe the individual stakeholder expectations to be. Learners could be given a scenario where they interview different people taking on the roles of various stakeholders in order to establish their expectations.

Part of the project planning process requires discussions with and between stakeholders. Learners could work in small groups or a larger group and discuss the requirements for a specific project. Based on the information they are provided with, they could identify the stakeholders, their expectations, the project goals and deliverables and the project schedule. The groups could give presentations of their plans to the other groups.

Allocating roles and responsibilities is never an easy task when working on projects; learners should be made aware on what basis choices may be made eg experience, knowledge, skills etc. They also need to be aware that they could nominate people for different roles as long as they can justify their choices.

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Learners could be given different project scenarios to consider (eg setting up a new network) and then: a) identify the roles and responsibilities that would be required in a project team, and b) agree who would carry out the different roles.

## Performance outcome 3

In order to carry out their own individual roles and responsibilities effectively, whether working in isolation or as part of a team, it is important that learners develop their time management skills. They could consider the roles and responsibilities that they have been allocated based on the previous scenarios and consider how they will address their time management. They need to be aware of the importance of documenting their time management plans where timescales are involved eg prioritising tasks.

Measuring progress against milestones is important for individual team members as well as the team as a whole. They need to have an understanding of how they measure progress and what they measure it against. In their groups they could discuss how they would measure the team's progress for the project scenario as well as how the individual team members would check their personal progress.

Communication can make or break many a project and it is important that learners understand what effect poor and good communication could have on their project. They could be asked to work in small groups in order to come up with examples of poor communication and its effects on the project outcome. They could also identify examples of good communication and how it can overcome problems/issues as well as other positive effects on the project outcome.

Team meetings also play a big part in projects: they are used to review progress, discuss issues and problems etc. Learners should be taught how to plan, participate in and record team meetings. They could work as large or small project groups and practice planning team meetings, taking an active part in discussions and formally documenting outcomes.

Providing and receiving constructive feedback can be a challenge for many people. Learners need to understand that, especially when working on projects, they may have to provide feedback – for instance telling another team member that they are delaying the project because they have not finished a task, or telling someone that the results of their particular task are not satisfactory. It can also be difficult to give positive feedback without sounding patronising. Learners have to consider their reactions to positive and negative feedback. They should be provided with guidance on how they can provide constructive feedback as well as receive constructive feedback in a positive way. They could practice giving and receiving feedback in pairs based on fictitious scenarios. They could then be provided with feedback on how well they provided and/or received the feedback.

It is suggested that learners are provided with a mini project to work on as a team so that they can apply the knowledge, skills and understanding that they have learnt.

## Performance outcome 4

Learners need to understand that when reviewing the success of the project, they should also consider how well the team worked together and how things could be improved for future projects. They need to consider how well the team met the project outcome, and whether there were internal and/or external factors that influenced that outcome. Could these factors have been handled more effectively by the team, or did they play a part in the problems that the team had? Did everyone play their part as agreed, or was the team let down by others?

As a group, they could discuss the outcome of their mini project from PO3 and use their newfound skills in providing and receiving constructive feedback on how they carried out their individual roles and responsibilities, and how they felt other team members performed.

They could be asked to consider how they could improve their collaborative working as a team for future projects to prevent similar issues arising.

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## Synoptic assessment guidance

Synoptic assessment is a mandatory requirement of all AQA Tech-levels and this qualification has been designed with synoptic learning and assessment at its heart. Units link to each other, providing development on concepts and topics, reinforcing learning and skill development which enables learners to bring knowledge and skills from other units to contribute to the assessment of units as shown. Being able to work synoptically is the cornerstone of work-based problem-solving as learners make judgements on assessed prior learning in the context of new situations.

The mapping provided below shows where opportunities to undertake synoptic assessment can be found across the units of this qualification. Centres must ensure that these opportunities are built into their programmes of learning and assessment activities.

### IT: Networking project #1

A local estate agent is moving into a suite of new offices and requires new computer systems that are securely connected to process customer sales, client bookings and monitor legal processes with suitable external links to permit internet access (world wide web and email etc) for researching the area, market trends and their rivals' activities.

Administration users will need suitable client PCs, secured from threats, that will provide the typical office-style business software suites, sector-specific applications and safe access to the internet. It is also felt that estate agents should have mobile devices that not only provide communication while out of the office (especially for lone workers) but can also securely access office data and help them organise and plan customer viewings and book estimates.

One of the key attractions of the business is the tracking software being used to monitor house sales nationally and in the locality. This typically involves calculation of average price levels, probabilities of selling a house quickly in different postcodes and selling trends.

Having worked successfully with your company before, the estate agent has asked you to draw up suitable plans for the installation of the hardware and software needed and the network infrastructure that is also required to meet their needs. Full documentation is required before a presentational handover occurs and it is assumed that further consultation may also be needed to refine details and answer further queries should they arise.

Although management and employees of this company have basic IT skills, documentation should be as inclusive as possible and use jargon sparingly while explaining technical details clearly and concisely.

You are part of the team assigned to complete this task and must complete it within the desired timeframe. How you manage your time, resources and priorities to finish this project is your decision.

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## IT: Networking project #1

**Unit 1 – Fundamental principles of computing**

This unit provides underpinning knowledge that supports learners' investigation into the client's needs, principally the hardware and software that is required to fulfil the project. For hardware this would include not only the actual computer systems required but the communication methods and external hardware (input, output and external backing storage devices).

In addition the learner will benefit from an appreciation of data, information and the data processing cycle as these will assist their planning and problem-solving when considering how the client will use the computer systems to support their business needs, eg data entry, processing, storage and required outputs.

**Key synoptic links:**

**Unit 1 – AO1: Understand the different types of computer**
**Unit 1 – AO2: Understand the hardware components of a computer system**
**Unit 1 – AO3: Understand the software requirements of a computer system**
**Unit 1 – AO4: Understand how data is converted to information**
**Unit 1 – AO5: Demonstrate how computers process user requirements**

**Unit 2 – Communication technologies**

This unit supports learners to complete this project by introducing them to the basic communication technologies that may be used to meet the client's needs, principally the use of mobile technology and computer networks to collect, access and share house, customer and appointment data and information in a secure and efficient manner.

**Key synoptic links:**

**Unit 2 – AO1: Understand the fundamentals of data communication**
**Unit 2 – AO2: Analyse data communication methods**
**Unit 2 – AO3: Analyse basic mobile technology communication**
**Unit 2 – AO4: Understand the fundamentals of computer networks**
**Unit 2 – AO5: Understand network conceptual models, protocols and devices**

**Unit 3 – Developing and maintaining computer networks**

It is clear from the client's project brief that they will require an office network that can also be accessed remotely via mobile devices (notebooks, tablets, smartphones etc). This unit provides the learner with opportunities to design, plan and implement simple networks to meet user requirements. It considers both the hardware and software required and the transmission media, standards and protocols that are required to connect them. In addition, coverage is provided that should help the learners test and benchmark their network's performance and reliability.

**Key synoptic links:**

**Unit 3 – PO1: Identify communication activities facilitated by computer networks**
**Unit 3 – PO2: Identify the different types of network architectures and technology types**
**Unit 3 – PO3: Understand different types of local area networks (LANs) and wide area networks (WANs)**
**Unit 3 – PO4: Design and build a network from a specification**
**Unit 3 – PO5: Undertake end user network testing**
**Unit 3 – PO6: Maintain a network system**

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## IT: Networking project #1

**Unit 4 – Supporting end users**

Part of this project will involve learners investigating the client's processing needs and matching these to suitable hardware and software to meet these specific requirements. This unit supplies learners with an understanding of the correct tools and techniques required to build, configure, test and troubleshoot hardware and software in a safe and responsible manner. Emphasis is placed on following the correct health and safety legislation whilst working on equipment and the correct skills needed to communicate progress and outcomes effectively to the client, something that is essential for this type of project. In addition this unit focuses on first- and third-party research and the expertise required to document professionally.

**Key synoptic links:**

**Unit 4 – PO1: Build a computer system with hardware and software to meet specific requirements**
**Unit 4 – PO2: Understand how to communicate effectively with end users**
**Unit 4 – PO3: Provide end users with advice and guidance**
**Unit 4 – PO4: Use appropriate tools to troubleshoot end user problems safely**
**Unit 4 – PO5: Test solutions and analyse results**
**Unit 4 – PO6: Update documentation**

**Unit 5 – Maths for computing**

Maths features prominently throughout the project, from the basic arithmetic needed to calculate project costs and timeframes to the statistical analysis required to determine selling trends and average house prices in certain postcodes. Learners could also benefit from skills developed when working with different number systems: many hardware error codes are displayed in hexadecimal format, and networking the office effectively will require an understanding of both binary and Boolean logic when creating potential subnets. Techniques used to gather and interpret data should also provide vital support for learners when testing their project solution and supporting the success (or otherwise) of its outcome.

**Key synoptic links:**

**Unit 5 – PO1: Work with number systems**
**Unit 5 – PO2: Understand and apply Boolean logic**
**Unit 5 – PO3: Calculate with sequences, series, probability and recursion**
**Unit 5 – PO4: Gather and interpret data in a meaningful manner**
**Unit 5 – PO5: Apply matrix methods to solve problems**

**Unit 6 – Network security management**

In the modern world it is a sensible precaution to secure any network, especially those used in businesses that share and process sensitive customer information. The network required for this project is no exception and learners should benefit from this unit's focus on the threats and vulnerabilities that may be present, the legislation that must be observed and the hardware and software that may be used to provide appropriate protection. For learners this should result in the creation of a suitable network security plan, which makes an important contribution to the successful completion of the project.

**Key synoptic links:**

**Unit 6 – AO1: Understand security issues for a network system**
**Unit 6 – AO2: Understand hardware, software and protocols used to promote network security for a network system**
**Unit 6 – AO3: Understand how to categorise and apply security measures to a network system**
**Unit 6 – AO4: Analyse and develop a network security plan for an organisation**

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## IT: Networking project #1

**Unit 7 – The internet**

It is clear from the project brief that the company uses the internet to research local and national house selling trends, their business rivals and the community in order to serve their customers as effectively as they can. Learners could apply their understanding of the internet, its uses, underlying infrastructure and future trends to advise the company on how to leverage it most effectively in this sector.

**Key synoptic links:**

**Unit 7 – PO1: Understand the internet**
**Unit 7 – PO2: Understand the infrastructure**
**Unit 7 – PO3: Investigate future internet technologies**

## IT: Networking project #2

A local entrepreneur is refitting a suite of empty offices and warehouses to start an all-ages 'laser tag'-style franchise. He will require new computer systems that are securely connected as a network to process customer bookings, provide computerised scoring and automated features in the arenas, with suitable external links to permit internet access (world wide web and email etc) and data connectivity to other sites in the business to promote inter-site competitions and league tables. Effective management of the business will also rely on using the internet to survey competitors and promote the business, eg through a dynamic and interactive website that customers can use to check latest offers and their playing statistics etc.

Administration users will also need suitable client PCs, secured from threats, that will provide the typical office-style business software suites, sector-specific applications and safe access to the internet. Game marshals, who patrol the arenas, will need constant mobile communication and the ability to check game scores and clocks in real-time.

One of the key attractions of the business is the tracking software being used to monitor individual customer and team performances in the laser arenas. This typically involves calculation of average performance levels, winning probabilities and playing trends.

Having worked successfully with your company before, the entrepreneur has asked you to draw up suitable plans for the installation of the hardware and software needed and the network infrastructure that is required to meet their needs. Full documentation is required before a presentational handover occurs and it is assumed that further consultation may also be needed to refine details and answer further queries should they arise.

Although management and employees of this company have basic IT skills, documentation should be as inclusive as possible and use jargon sparingly whilst explaining technical details clearly and concisely.

You are part of the team assigned to complete this task and must complete it within the desired timeframe. How you manage your time, resources and priorities to finish this project is your decision.

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## IT: Networking project #2

**Unit 1 – Fundamental principles of computing**

This unit provides underpinning knowledge that supports learners' investigation into the client's needs, principally the hardware and software that is required to fulfil the project. For hardware this would include not only the actual computer systems required but the communication methods and external hardware (input, output and external backing storage devices).

In addition the learner will benefit from an appreciation of data, information and the data processing cycle as these will assist their planning and problem-solving when considering how the client will use the computer systems to support their business needs (eg data entry, processing, storage and required outputs). The unique nature of this project may also require an examination of specialist operator consoles, another aspect covered by this unit that the learner may connect conceptually.

**Key synoptic links:**

**Unit 1 – AO1: Understand the different types of computer**
**Unit 1 – AO2: Understand the hardware components of a computer system**
**Unit 1 – AO3: Understand the software requirements of a computer system**
**Unit 1 – AO4: Understand how data is converted to information**
**Unit 1 – AO5: Demonstrate how computers process user requirements**

**Unit 2 – Communication technologies**

This unit supports learners to complete this project by introducing them to the basic communication technologies that may be used to meet the client's needs, principally the use of computer networks to collect, access and share customer and game data and information in a secure and efficient manner. In addition, learners may rely on their knowledge of mobile communications technology to advise how best to equip the sites' roving Marshals.

**Key synoptic links:**

**Unit 2 – AO1: Understand the fundamentals of data communication**
**Unit 2 – AO2: Analyse data communication methods**
**Unit 2 – AO3: Analyse basic mobile technology communication**
**Unit 2 – AO4: Understand the fundamentals of computer networks**
**Unit 2 – AO5: Understand network conceptual models, protocols and devices**

**Unit 3 – Developing and maintaining computer networks**

It is clear from the client's project brief that they will require a network that can also be accessed remotely via mobile devices (notebooks, tablets, smartphones etc). This unit provides the learner with opportunities to design, plan and implement simple networks to meet user requirements. It considers both the hardware and software required and the transmission media, standards and protocols that are required to connect them. In addition, coverage is provided that should help learners test and benchmark their network's performance and reliability.

**Key synoptic links:**

**Unit 3 – PO1: Identify communication activities facilitated by computer networks**
**Unit 3 – PO2: Identify the different types of network architectures and technology types**
**Unit 3 – PO3: Understand different types of local area networks (LANs) and wide area networks (WANs)**
**Unit 3 – PO4: Design and build a network from a specification**
**Unit 3 – PO5: Undertake end user network testing**
**Unit 3 – PO6: Maintain a network system**

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## IT: Networking project #2

**Unit 4 – Supporting end users**

Part of this project will involve the learners investigating the client's processing needs and matching these to suitable hardware and software to meet these specific requirements. This unit supplies the learners with an understanding of the correct tools and techniques required to build, configure, test and troubleshoot hardware and software in a safe and responsible manner. Emphasis is placed on following the correct health and safety legislation whilst working on equipment and the correct skills needed to communicate progress and outcomes effectively to the client, something which is essential for this type of project. In addition this unit focuses on first and third-party research and the expertise required to document professionally.

**Key synoptic links:**

**Unit 4 – PO1: Build a computer system with hardware and software to meet specific requirements**
**Unit 4 – PO2: Understand how to communicate effectively with end users**
**Unit 4 – PO3: Provide end users with advice and guidance**
**Unit 4 – PO4: Use appropriate tools to troubleshoot end user problems safely**
**Unit 4 – PO5: Test solutions and analyse results**
**Unit 4 – PO6: Update documentation**

**Unit 5 – Maths for computing**

Maths features prominently throughout the project, from the basic arithmetic needed to calculate project costs and timeframes to the statistical analysis required to determine player statistics and team winning probabilities. Learners could also benefit from skills developed when working with different number systems as many hardware error codes are often displayed in hexadecimal format and networking the sites effectively will require an understanding of both binary and Boolean logic when creating potential subnets. Techniques used to gather and interpret data should also provide vital support for learners when testing their project solution and supporting the success (or otherwise) of its outcome.

**Key synoptic links:**

**Unit 5 – PO1: Work with number systems**
**Unit 5 – PO2: Understand and apply Boolean logic**
**Unit 5 – PO3: Calculate with sequences, series, probability and recursion**
**Unit 5 – PO4: Gather and interpret data in a meaningful manner**
**Unit 5 – PO5: Apply matrix methods to solve problems**

**Unit 6 – Network security management**

In the modern world it is a sensible precaution to secure any network, especially those used in businesses that share and process sensitive customer information. The network required for this project is no exception and learners should benefit from this unit's focus on the threats and vulnerabilities that may be present, the legislation that must be observed and the hardware and software that may be used to provide appropriate protection. For learners this should result in the creation of a suitable network security plan that makes an important contribution to the successful completion of the project.

**Key synoptic links:**

**Unit 6 – AO1: Understand security issues for a network system**
**Unit 6 – AO2: Understand hardware, software and protocols used to promote network security for a network system**
**Unit 6 – AO3: Understand how to categorise and apply security measures to a network system**
**Unit 6 – AO4: Analyse and develop a network security plan for an organisation**

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## IT: Networking project #2

**Unit 7 – The internet**

It is clear from the project brief that the company uses the internet to research their business rivals, promote their business and supply playing statistics in order to serve their customers as effectively as they can. Learners could apply their understanding of the internet, its uses, underlying infrastructure and future trends to advise the company on how to leverage it most effectively in this sector.

**Key synoptic links:**

**Unit 7 – PO1: Understand the internet**
**Unit 7 – PO2: Understand the infrastructure**
**Unit 7 – PO3: Investigate future internet technologies**

# Useful links and resources

Resources will very much depend on which scenarios the centre wishes to use, as this unit could be used for any of the pathways.

## Book

- Major I, Greenwood A, Goodman M, *The definitive guide to project management*, ISBN-10 0273663976, Financial Times/Prentice Hall (2003).

## Websites

- Freedcamp (free project management software): freedcamp.com
- Project Libre (free project planning software): projectlibre.org
- Project management lifecycle: mpmm.com/project-management-methodology.php

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# 13 Externally set and marked examinations

## 13.1 Introduction

The Foundation Technical Level (360 GLH) in IT: Technical Support (TVQ01014) qualification units Y/507/6424 (Fundamental principles of computing) and H/507/6426 (Communication technologies) are assessed via an externally set and marked AQA examination.

The Technical Level (720 GLH) in IT: Networking (TVQ01011) qualification unit A/507/6495 (Network security management) is assessed via an externally set and marked AQA examination.

External examinations are set by AQA (sometimes in collaboration with an employer or a professional body) and are sat by learners in a controlled examination environment, at a preset time and date and marked by AQA.

Examinations are available for externally assessed units in January and June and entries must be made in accordance with AQA's procedures.

Further information on how to make entries for examinations can be found in the AQA *Centre Administration Guide for Technical and Vocational Qualifications*.

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## 13.2 Examination format and structure

| | |
|---|---|
| **Unit title** | Fundamental principles of computing |
| **Exam sessions** | January and June |
| **Duration** | 2 hours |
| **Type of exam** | Written exam<br>A mixture of multiple choice, short answer and case study type questions. |
| **Number of marks** | 80 |
| **Weighting of unit** | 25% of IT: Technical Support (TVQ01014)<br>12.5% of IT: Networking (TVQ01011) |

| | |
|---|---|
| **Unit title** | Communication technologies |
| **Exam sessions** | January and June |
| **Duration** | 2 hours |
| **Type of exam** | Written exam<br>A mixture of multiple choice, short answer and case study type questions. |
| **Number of marks** | 80 |
| **Weighting of unit** | 25% of IT: Technical Support (TVQ01014)<br>12.5% of IT: Networking (TVQ01011) |

| | |
|---|---|
| **Unit title** | Network security management |
| **Exam sessions** | January and June |
| **Duration** | 2 hours |
| **Type of exam** | Written exam<br>A mixture of multiple choice, short answer and case study type questions. |
| **Number of marks** | 80 |
| **Weighting of unit** | 12.5% of IT: Networking (TVQ01011) |

## 13.3 Reasonable adjustments and special considerations

Information on the reasonable adjustments allowed for the external examinations within this qualification can be found in the AQA *Centre Administration Guide for Technical and Vocational Qualifications*.

## 13.4 Availability of past examination papers

Sample and past examination papers for this qualification are available from AQA.

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# 14 External quality assurance

## 14.1 Overview

AQA's approach to quality assurance for this qualification is described within each unit specification.

External quality assurance for Tech-levels takes the form of verification and is concerned with maintaining the quality of assessment and checking that the assessment process has been undertaken appropriately by centre staff. It focuses on auditing the whole process and enables the head of centre, and all individuals involved in the assessment process, to understand what is required by them.

## 14.2 Quality assurance visits

When a learner is registered or a centre wants to submit work, this triggers a verification visit from an AQA external quality assurer (EQA).

Once a centre has registered learners, these visits will occur, as a minimum, every six months and will be face-to-face at a centre.

Our EQAs offer advice and guidance on any aspect of quality assurance in between formal visits, via telephone or email, and additional visits can be arranged.

These meetings will involve verifying that:

- all of the staff, resources, processes and procedures are still in place
- the centre is continuing to meet the approved centre criteria (those signed off during the initial centre approval visit)
- there is evidence of meaningful employer involvement in delivery.

A major part of the verification process is to check that the centre's policies and procedures (including internal standardisation minutes, record keeping, IQA/assessor records and materials) meet AQA's requirements and ensure valid and reliable assessment.

The EQA will look at a representative sample of learner work to verify that the results awarded by the centre are valid, as well as reviewing evidence of the activities that have been undertaken to standardise assessments.

These samples will be taken from different sites if the centre operates at more than one location, from different centre assessors or IQAs and at different stages of delivery – all samples will be selected by the EQA.

As part of the sample, the EQA will request examples of learner work at Pass, Merit and Distinction. This will also support the centre in their internal standardisation.

If centre assessment decisions are found to be inconsistent, adjustments can be made (at a learner and cohort level) or in more severe cases (where a fundamental inconsistency or non-compliance is identified), sanctions (from a Level 1: Action plan through to Level 4: Suspension of delivery) can be put in place.

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## 14.3 Sanctions

Sanctions are used to help process improvement and are a way of protecting the validity of assessments or assessment decisions. We will only ever impose sanctions on a centre that are proportionate to the extent of the risk identified during the quality assurance process.

Sanctions can be applied at a learner, centre or centre staff level – and they can be at qualification or centre level and take the following form:

Level 1: Action point in EQA report

Level 2: Suspension of direct claims status (where applicable)

Level 3: Suspension of learner registration and/or certification

Level 4: Withdrawal of centre approval for a specific qualification.

Further information on levels and application of sanctions can be found in the AQA *Centre Administration Guide for Technical and Vocational Qualifications*.

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# 15 Internal assessment and quality assurance

## 15.1 Overview

The Foundation Technical Level (360 GLH) in IT: Technical Support (TVQ01014) qualification units K/507/6427 (Developing and maintaining computer networks) and M/507/6428 (Supporting end users) are internally assessed by the centre.

For the Technical Level (720 GLH) in IT: Networking (TVQ01011) qualification units R/507/6437 (Maths for computing), F/507/6496 (The internet) and A/507/6464 (Industrial project) are internally assessed by the centre.

All assessment decisions that are made internally within a centre are externally quality assured by AQA.

AQA has worked with employers and professional bodies to produce guidance on what is the most appropriate form of assessment or evidence gathering for all internal centre assessment.

The most appropriate method of assessment (or evidence gathering) is detailed against each unit. Should a centre wish to use an alternative method of assessment to that detailed, then justification must be provided during AQA quality assurance visits to the centre.

This justification needs to lay out why the centre feels their approach to assessment is more appropriate, efficient or relevant to the learner and/or subject and should be provided in writing to the AQA external quality assurer.

Centres should tailor the assessment to suit the needs of the learner, and internal assessments can take place at a time to suit the centre or learner.

Centres should take a best practice approach with learners being assessed through real life or work-based activity to generate the required evidence (see Section 8.1 Meaningful employer involvement).

## 15.2 Role of the assessor

The role of the assessor is to:

- carry out initial assessments of learners to identify their current level of skills, knowledge and understanding and any training or development needs
- review the evidence presented against the requirements of the qualification, to make a judgement on the overall competence of learners
- provide feedback to learners on their performance and progress. This feedback needs to give learners a clear idea of the quality of the work produced, where further evidence is required and how best to obtain this.

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## 15.3 Assessor qualifications and experience

In order to assess learners working towards this qualification, assessors must:

- have appropriate knowledge, understanding and skills relevant to the units within this qualification
- have experience as a practitioner and/or teaching and training with significant experience of creating programmes of study in relevant subject areas
- undertake activities which contribute to their continuing professional development (CPD).

## 15.4 Applying portfolio assessment criteria

When assessing learner's work, the centre should consider the level of attainment in four broad areas:

1 the level of independence and originality
2 the depth and breadth of understanding
3 the level of evaluation and analysis
4 the level of knowledge, skills or competency demonstrated.

## 15.5 Authentication of learner work

The centre must be confident that a learner's work is their own. You must inform your learners that to present material copied directly from books or other sources such as the internet, without acknowledgement, will be regarded as deliberate deception. This also includes original ideas, as well as the actual words or artefacts produced by someone else.

Learners' work for assessment must be undertaken under conditions that allow the centre to authenticate the work. If some work is done unsupervised, then the centre must be confident that the learners' work can be authenticated with confidence – eg being sufficiently aware of an individual learner's standard and level of work to appreciate if the evidence submitted is beyond the level of the learner.

The learner is required to sign a declaration that the work submitted for assessment is their own. The centre will also countersign this declaration that the work was carried out under any specified conditions – recording details of any additional assistance. This must be provided with the learner's work for external quality assurance purposes.

Any assistance given to an individual learner beyond that given to the group as a whole, even if within the parameters of the specification, must also be recorded.

If some work is done as a part of a team, the centre must be confident that the learner's contribution to that team activity can be clearly identified and authenticated.

## 15.6 Tutor assistance and feedback

Whilst learners are undertaking assignment tasks, tutors must ensure that any assistance given, or offered as a result of a learner's question and/or request for help, does not compromise the learner's ability to independently perform the task in hand.

During assessment, tutors can give general feedback and support to learners, most notably, on the following:

- development of the required knowledge and skills underpinning the assignment at hand
- confirmation of the assessment criteria being assessed
- clarification of the requirements of the *Assignment brief*
- identification of assignment deadlines.

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Tutors, however, must **not** assist learners directly and specifically with assignment tasks.

Tutors are not permitted to provide 'formative' feedback on learner's work, ie feedback, prior to submission for marking, on an assignment/task that will enable the learner to amend the assignment/task to improve it.

Once learner work has been submitted for marking, then tutors must give clear and constructive feedback on the criteria successfully achieved by the learner. Tutors should also provide justification and explanation of their assessment decisions. Where a learner has not achieved the performance criteria targeted by an assignment, then feedback should not provide explicit instructions on how the learner can improve their work to achieve the outstanding criteria. This is to ensure that the learner is not assisted in the event that their work is considered for resubmission.

## 15.7 Research and references

Where learners are required to undertake research towards the completion of a task, they should reference their research results in a way that is informative, clear and consistent throughout their work. We do not prescribe a specific way to organise references, but we expect tutors to discuss this with learners and identify a 'house style' that learners are then expected to use. Learners may include a bibliography of relevant sources on larger assignments where there has been significant research and there is value in recording all sources fully.

## 15.8 Role of the internal quality assurer

An internal quality assurer (IQA) must be appointed to ensure the quality and consistency of assessments within the centre. Each assessor's work must be checked and confirmed by an internal quality assurer.

The IQA must observe assessors carrying out assessments, review assessment decisions from the evidence provided and hold standardisation meetings with the assessment team to ensure consistency in the use of documentation and interpretation of the qualification requirements.

All assessment decisions made within a centre must be standardised to ensure that all learners' work has been assessed to the same standard and is fair, valid and reliable.

Evidence of all standardisation activity should be retained by the centre and could take the form of, for example, records of training or feedback provided to assessors, minutes of meetings or notes of discussions.

Our external quality assurers (EQAs) will always be happy to provide guidance and assistance on best practice.

Internal standardisation activity may involve:

- all assessors marking trial pieces of work and identifying differences in marking standards
- discussing any differences in marking at a training meeting for all assessors
- cross-moderation of work between assessors.

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## 15.9 Internal quality assurer qualifications and experience

In order to internally quality assure the assessment of learners working towards this qualification, IQAs must:

- have appropriate knowledge, understanding and skills relevant to the units within these qualifications
- have experience as a practitioner and/or teaching and training with significant experience of creating programmes of study in relevant subject areas
- undertake activities which contribute to their continuing professional development (CPD).

## 15.10 Record keeping

The centre must be able to produce records that show:

- the assessor and IQA allocated to each learner
- the evidence assessed
- the dates of assessment and IQA
- details of internal standardisation activities of the assessor – (what, when and by whom)
- the grade awarded and rationale for this.

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# 16 Resits, resubmissions and retakes

## 16.1 Note on terminology

**Resits** refer to learners taking further attempts at an examined/externally assessed unit.

**Resubmissions** refer to learners undertaking a second attempt at an internally assessed unit task/assignment prior to external quality assurance.

**Retakes** refer to learners undertaking a second attempt at an internally assessed unit after external quality assurance.

## 16.2 Rules on resits, resubmissions and retakes

Resits and retakes are permitted where a learner has either failed the requirements of the unit, or where they wish to improve on a grade awarded.

For certification purposes, AQA will recognise the best achievement by the learner and not the most recent.

**Resitting an exam or external assessment**
The learner is permitted **three** attempts (one initial and two resits) in relation to each examined/externally assessed unit of the specification.

Learners who have been awarded the Foundation qualification and have progressed to the full Technical Level are allowed to use the resit opportunities to go back and improve the grade achieved in the external assessment. Any improvement cannot be used to upgrade and reclaim the previously awarded Foundation qualification.

**Resubmitting internal assessments**
The learner is permitted **one** resubmission in relation to each internally assessed unit of the qualification, but only when the tutor believes the learner can achieve the outstanding criteria without further guidance. Any resubmission of work must be undertaken prior to external moderation.

**Retaking internal assessments**
The learner is permitted **one** retake in relation to each internally assessed unit of the qualification. This could mean the learner doing the entire unit work again, or simply correcting a task/assignment before the unit is again submitted for external moderation by AQA. With a retake, learners are not allowed a resubmission opportunity.

Any retake and/or resubmission of work must be completed within a defined and reasonable period of time following learner feedback of the initial assessment. Any work provided as evidence must be authenticated by the learner as their own.

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# 17 Grading

## 17.1 Overview

Performance in all units is graded at Pass, Merit or Distinction. These unit grades are then converted into points and added together to determine the overall grade for the qualification.

The overall Foundation Technical Level in IT: Technical Support (TVQ01014) qualification is graded as P, M, D, D*.

The overall Technical Level in IT: Networking (TVQ01011) qualification is graded as PP, MP, MM, DM, DD, D*D, D*D*.

## 17.2 Internally assessed units

Centres must ensure that all assessment criteria in the unit are covered during the teaching and learning process so that learners can meet the requirements. Work should be assessed against the grading criteria provided within each unit.

- To achieve a Pass, a learner must have satisfied all Pass criteria.
- To achieve a Merit, a learner must achieve all of the Pass and all of the Merit criteria.
- To achieve a Distinction, a learner must achieve all of the Pass, Merit and Distinction criteria.

## 17.3 Externally assessed (examined) units

These units are assessed by AQA using a marks-based scheme. After the assessment has taken place and been marked, the grade boundaries are set by AQA. These grade boundaries are based on the level of demand of the assessment and learners' performance – all learners that took the assessment, not just those in your centre.

When the assessment results are shared with the centre, AQA will report on the grade boundaries.

**Note**: These grade boundaries may change for each assessment window according to the demand of the assessment – this is important to maintain standards across each window.

Learners' grades are converted into points.

## 17.4 Points per grade – unit level

Table 1 shows the points for each grade at a unit level.

### Table 1: Points per grade

| Grade | Internally/centre assessed unit |
|---|---|
| Pass | 36 |
| Merit | 54 |
| Distinction | 72 |

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# 17.5 Final grade for overall qualification

The total possible number of points that can be achieved for the Foundation Technical Level (360 GLH) in IT: Technical Support is 288.

The total possible number of points that can be achieved for the Technical Level (720 GLH) in IT: Networking is 576.

## Points for overall qualification grade

### Table 2: Foundation Technical Level (360 GLH) in IT: Technical Support (TVQ01014)

| Grade | Points boundary |
|---|---|
| P | 144 |
| M | 198 |
| D | 252 |
| D* | 270 |

### Table 3: Technical Level (720 GLH) in IT: Networking (TVQ01011)

| Grade | Points boundary |
|---|---|
| PP | 288 |
| MP | 360 |
| MM | 396 |
| DM | 468 |
| DD | 504 |
| D*D | 522 |
| D*D* | 540 |

# 17.6 The 'Near Pass' rule

A near pass will be applied to an **externally assessed unit or external assignment** for those learners who may fall just short of a pass grade. The unit grade will still be reported as a grade U, since the learner will not have performed to the minimum standard required for a Pass grade, but will qualify as a near pass for the purposes of determining the overall qualification grade.

The actual mark required to achieve the 'near pass' grade on an examined unit will change from year to year, depending on the grade boundaries that have been set. For an external assignment a learner will achieve a 'near pass' if they satisfy all bar one of the Pass criteria for the unit. A learner will receive 27 points if they achieve a Near Pass.

A learner is allowed one Near Pass in an externally assessed unit or external assignment in a Foundation Technical Level or up to two Near Pass results (six or eight unit Technical Level) or up to three Near Pass results (12 unit Technical Level).

All other eligibility requirements for achieving the qualification will remain the same:

- the total points score is above the Pass threshold; **and**
- all other units are passed

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# 18 Administration arrangements

Full details of all of the administration arrangements relating to AQA Tech-levels can be found in the AQA *Centre Administration Guide for Technical and Vocational Qualifications*, including:

- how to apply for centre approval
- registration of learners
- dealing with recognition of prior learning (RPL)
- how to make examination entries
- dealing with missed examination dates
- examination invigilation arrangements
- how to make claims for certificates
- how to appeal against an assessment, IQA or EQA decision
- retention of learner work and assessment/IQA records
- dealing with potential malpractice or maladministration.

Details of all AQA fees can be found on the AQA website at aqa.org.uk

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# 19 Appendix A: Transferable skills standards and guidance

## 19.1 Transferable skills – communication standards (oral)

Evidence must clearly show that the learner can:

| | | |
|---|---|---|
| **CO1** | Prepare a suitable presentation. | 1.1 Research suitable topics for the presentation.<br>1.2 Research the most appropriate format for the presentation.<br>1.3 Plan the structure of the presentation.<br>1.4 Make use of any appropriate supporting materials and prepare any other resources needed for the presentation. |
| **CO2** | Use language, vocabulary, tone and style suited to the complexity of the topic and the context. | 2.1 Use appropriate language and vocabulary.<br>2.2 Structure what is presented to help the audience follow the sequence of the main points and ideas.<br>2.3 Use tone and style of presentation appropriate to the audience and environment. |
| **CO3** | Use a variety of methods to engage the audience. | 3.1 Provide examples to illustrate complex points.<br>3.2 Use relevant images from appropriate sources to illustrate key points.<br>3.3 Use at least one additional method to engage the audience. |

### Required evidence[8]

- Learner preparation evidence (planning notes, research).
- Learner presentation including all support materials.
- Assessor observation record*.

### Learner guidance

The learner should consider the purpose, topic and audience as follows:

- the presentation should be eight minutes long to allow the learner to demonstrate the appropriate skills
- the presentation must always be contextualised within the technical subject content, and should not be simulated
- an audience of at least two or three people which may or may not include peers.

[8] For evidence marked with an asterix (*) recording documents are available for centres to use – please see aqa.org.uk/tech-levels/transferable-skills

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## CO1

There should be evidence showing that the learner has:

- researched the technical subject content of a complex matter
- selected information relevant to the purpose of the presentation
- planned how to structure the presentation
- planned to use a relevant image or images to illustrate key points of the presentation – that adds value to the overall presentation
- included one additional method to engage audience for example questioning, completion of handout, discussion etc.

## CO2

Learners should:

- give a well-structured delivery and must clearly highlight the main points of their presentation using tone, gesture or expression
- use appropriate vocabulary suited to the audience and environment.

## CO3

Learners must:

- give examples to explain ideas
- make effective use of an image or images and other support materials to engage the audience and to illustrate key points, for example through use of video clips, explanatory notes or other technically related activities.

## Tutor guidance

- Tutors should use an observation record to support their assessment.
- Tutors should ensure that those observing are familiar with the observation record content and purpose.
- The presentation may be delivered through spoken communication or using sign language.
- Tutors should look for fitness of purpose and styles of presentation. Brief notes may be used as a prompt, but learners should not rely on them entirely.

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# 19.2 Transferable skills – communication standards (written)

Evidence must clearly show that the learner can:

| | | |
|---|---|---|
| **CW1** | Select appropriate formats for presenting information as a report. | 1.1 Decide on the most appropriate format for the technical report.<br>1.2 Plan the structure of the technical report.<br>1.3 Make use of any appropriate supporting materials and prepare any other resources needed for the technical report. |
| **CW2** | Select and use an appropriate style and tone to suit their audience. | 2.1 Use appropriate language and vocabulary.<br>2.2 Structure the technical report to help the audience follow the sequence of the main points and ideas.<br>2.3 Use tone and style appropriate to the intended recipient(s). |
| **CW3** | Organise material coherently, to suit the length, complexity and purpose of their technical report, proofread and where necessary, re-draft documents. | 3.1 Spell, punctuate and use grammar accurately.<br>3.2 Make their meaning clear.<br>3.3 Use relevant images from appropriate sources to illustrate key points.<br>3.4 Proofread their technical report.<br>3.5 Obtain feedback and amend technical report accordingly. |

## Evidence required[9]

- A learner technical report of at least 1,000 words excluding support materials.
- An assessor recording form*.

## Learner guidance

The learner should:

- produce a technical report about a complex subject which must be at least 1,000 words long
- include subject matter, which may well have a number of strands that is challenging to the individual learner in terms of the ideas it presents.

[9] For evidence marked with an asterix (*) recording documents are available for centres to use – please see aqa.org.uk/tech-levels/transferable-skills

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## CW1

It is essential that learners know how to:

- organise their technical report
- link paragraphs in various ways
- use features, such as indentation and highlighting, to suit different types of documents.

## CW2

Learners should know how to:

- produce a technical report that takes account of the vocabulary, tone and techniques normally used when producing documents for particular purposes and different recipients
- write with confidence and with the appropriate degree of formality.

## CW3

In supporting key points:

- images that could be used include: graph, sketch, picture or material taken from a presentation
- learners should know how to check their work to ensure that spelling, punctuation and grammar are accurate
- learners should know how to write grammatically correct sentences, including correct use of a variety of verb tense, form and person (for example passive voice); spell accurately, complex, irregular and technical words and use punctuation effectively for example bullet points, semicolon, colon, apostrophes) to ensure their meaning is clear.

## Tutor guidance

For the technical report produced, assessors should look for evidence that the learner has:

- selected an appropriate format for report
- organised relevant information using a clear and coherent structure
- used technical vocabulary when appropriate
- ensured that text is legible with accurate use of spelling, grammar and punctuation.

The learner should not be penalised for one or two errors providing meaning is still clear.

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# 19.3 Transferable skills – problem-solving standards

Evidence must clearly show that the learner can:

| | | |
|---|---|---|
| **PS1** | Identify a problem and the tools and techniques that could be used to explore the problem. | 1.1 Identify, analyse and describe the problem.<br>1.2 Identify a variety of tools and techniques which could be used to explore the problem.<br>1.3 Plan how you will investigate the problem highlighting which tools and techniques will be used. |
| **PS2** | Implement both the plan to investigate the problem and the plan to solve the problem. | 2.1 Implement the plan for investigating the problem and seek support and feedback from others as necessary.<br>2.2 Record and analyse the results of the investigation.<br>2.3 Identify the solution(s) to solve the problem.<br>2.4 Plan the steps to be taken in order to solve the problem, identifying any risks, and implement the solution. |
| **PS3** | Check if the problem has been resolved and review the approach to tackling problems. | 3.1 Check whether the problem has been resolved/ solved.<br>3.2 Analyse the results and draw conclusions on the success of the problem-solving process.<br>3.3 Review the approach to tackling/solving the problem, including whether other approaches might have proved more effective. |

## Evidence required[10]

- Explore/plan* – to be completed by the learner.
- Do* – to be completed by the assessor.
- Review* – to be completed by the assessor.

## Learner guidance

The learner must demonstrate:

- a systematic approach to tackling problems, including identifying which is the most appropriate method, then developing a plan and implementing it
- how they went about the problem-solving process.

Evidence should be on individual performance. A group approach to problem-solving does not allow learners to achieve specific elements of the standards.

**Activities must always be in relation to the core subject content and should not be simulated.**

Effective definition of the problem will help the learner tackle it systematically and produce valid evidence. Tutors may discuss with learners the most appropriate definition of the problem and what sort of results might be expected so the learner is clear on what would show that the problem had been solved.

[10] For evidence marked with an asterix (*) recording documents are available for centres to use – please see aqa.org.uk/tech-levels/transferable-skills

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## PS1

Learners should:

- recognise, identify and describe the main features of the problem
- identify how they will explore the problem and the tools and techniques they will use
- use a variety of methods for exploring the problem.

## PS2

Learners should:

- obtain approval to implement their plan from an appropriate person, which could be the tutor or supervisor
- make effective judgements, based on feedback and support available, when putting their plan into action
- check their plan regularly for progress and revise it accordingly.

## PS3

Learners should:

- use an appropriate method for checking if the problem has been solved. For example if a learner designed a procedure or process for improving a system that records information, they would need to test this out and report back on their findings
- know how to describe the results in detail and draw conclusions on the success of their problem-solving skills
- reflect back on the process considering areas such as:
  - did they spend enough time considering the features of the problem?
  - were they effective in planning action points to tackle the problem?
  - did they take a logical approach to checking if the problem had been solved/resolved?

In some circumstances, achievement of the standard may be possible even if the problem has not been solved or resolved, especially if factors were outside of their control, and the learner was able to demonstrate the process of tackling the problem.

## Tutor guidance

- Tutors should check problem-solving implementation planning.
- Tutors may be required to provide a witness statement in support of evidencing the processes.

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# 19.4 Transferable skills – research standards

Evidence must clearly show that the learner can:

| | | |
|---|---|---|
| **R1** | Design a research study. | 1.1 Identify possible topics for research.<br>1.2 Choose one topic, identifying appropriate objectives for detailed research, and plan how to carry out the research.<br>1.3 Select a variety of resources to gather relevant information and identify appropriate methods and techniques to carry out the research. |
| **R2** | Conduct data collection and analysis. | 2.1 Collect data using the appropriate methods to test the hypotheses/theories.<br>2.2 Carry out an appropriate analysis of the data.<br>2.3 Draw appropriate conclusions that are supported by the evidence from the data analysis. |
| **R3** | Present findings of the research and evaluate the research activities. | 3.1 Prepare and present results of research.<br>3.2 Present the information in a clear and appropriate format adapted to the needs of the audience.<br>3.3 Seek feedback and use it to support own evaluation of research skills. |

## Required evidence[11]

- Plan* – to be completed by the learner.
- Do* – to be completed by the assessor.
- Review* – to be completed by the assessor.
- Results of research.

## Learner guidance

The learner should demonstrate they can:

- identify clear and appropriate objectives for the research study
- plan and carry out research activities with the particular objectives in mind
- design their research study in a systematic way
- present their findings as well as evaluating their research skills and activities
- be clear about the objectives of the research study, for example to assess the positive and negative impact of digital photography on sports journalism to predict future trends
- identify sources, methods and strategies they plan to use to investigate the topic
- carry out the research within a clearly defined structure, with a measure of complexity that should be reflected in the breadth and nature of the research objectives
- undertake the analysis required to make the best use of information/data and the requirement to give a clear justification for their conclusions
- make different research methodologies.

Activities must always be contextualised within the core subject content, and should not be simulated.

[11] For evidence marked with an asterix (*) recording documents are available for centres to use – please see aqa.org.uk/tech-levels/transferable-skills

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## RS1

The learner should explore:

- a variety of possible topics to research and should spend time deciding on clear and measurable objectives when designing their research study
- objectives and discuss and agree them with a tutor or supervisor
- a wide variety of sources when gathering their information
- the use of at least three different types of resource
- one source that is primary (gathered by the learner), for example, interview, questionnaire, survey, rather than from secondary for example encyclopaedia, interpretations of original material.

The learner should produce a plan detailing how they will carry out the research.

## RS2

The learner should:

- keep a record of the sources used
- independently collect information including data
- analyse information collected and identify information and data most relevant to their research objectives.

## RS3

When presenting their findings, learners should:

- use a format that is most appropriate to the content in terms of audiences, subject matter and research objectives
- communicate research findings clearly
- seek feedback from appropriate people
- show how they have used this feedback to help evaluate their research skills
- evaluate their research activities addressing all aspects including identifying the research objectives, collecting and analysing data and/or information, and recording, presenting and explaining findings.

## Tutor guidance

- Tutors should agree research objectives with learner.
- Tutors should check that different types of resource have been used.

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# 19.5 Transferable skills – teamwork standards

Evidence must demonstrate the learner can:

| | | |
|---|---|---|
| **TW1** | Plan the work with others. | 1.1 Agree realistic objectives for working together and what needs to be done in order to achieve them.<br>1.2 Share relevant information to help agree team roles and responsibilities.<br>1.3 Agree suitable working arrangements with other team members. |
| **TW2** | Develop and maintain cooperative ways of working towards agreed objectives checking progress on the way. | 2.1 Organise and complete own tasks efficiently to meet responsibilities.<br>2.2 Seek effective ways to develop cooperation such as ways to resolve conflict and maintain open communication.<br>2.3 Share accurate information on progress and agree changes where necessary to achieve objectives. |
| **TW3** | Review working with others and agree ways of improving collaborative work in the future. | 3.1 Agree the extent to which working with others has been successful and objectives have been met.<br>3.2 Identify factors, including their own role, in influencing the outcome.<br>3.3 Provide details of how they could improve working with others in the future, including interpersonal skills. |

A group/team is defined as **three or more** people (eg peer, co-worker) who are working towards shared objectives. It is not acceptable for tutors/assessors to be part of the team. The nature of the teamworking should reflect the sector in which the qualification sits, eg engineering, business or IT.

## Required evidence[12]

- Plan*.
- Do*.
- Review*.
- Minutes of meetings.
- Witness statement.
- Peer statements.

## Learner guidance

Meeting the standard will confirm that the learner has:

- demonstrated the ability to work cooperatively with others
- be clear about the objectives the team or group is working towards and their own responsibilities
- planned and carried out the work supporting others, reviewing outcomes and suggesting ways of improving work with others.

Activities must always be contextualised within the core subject content, and should not be simulated.

[12] For evidence marked with an asterix (*) recording documents are available for centres to use – please see aqa.org.uk/tech-levels/transferable-skills

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## TW1

As part of the initial team planning meeting the learner should:

- offer suggestions and listen to others to agree realistic objectives, prioritise tasks and identify resources and timescales
- be clear about their own responsibilities and the areas of work for which they are answerable to others
- produce a plan showing what needs to be done by the team clarifying own responsibilities and arrangements for working with others in the team.

## TW2

Learners should take responsibility for:

- organising their own work to meet the agreed deadlines
- the use of correct and appropriate techniques and approaches when carrying out tasks
- actively looking for ways to develop and support cooperative working, including helping to deal with conflict and taking a lead role in anticipating the needs of others
- considering the rights and feeling of others
- ensuring at least one team progress meeting should be held before the final review meeting.

## TW3

During the team review meeting learners should:

- provide information about their own contribution to the work of the team ie what did they do and how did they interact with other members of the group
- explain how improved inter-personal skills could contribute to more effective collaboration in the future (for example 'I should listen more carefully when negotiating activities/tasks')
- identify improvements they could make in managing tasks (for example 'I could have been better organised with notes at team meetings').

## Tutor guidance

Tutors are encouraged to support the evidence process by completing a witness statement.

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