

# Level 4 Diploma in Network Principles (9628-03)

Version (3.0) January 2017

Qualification Handbook

## Qualification at a glance

<b>Industry area</b>	IT Professional
<b>City &amp; Guilds number</b>	9628
<b>Age group</b>	16+
<b>Assessment</b>	Assignment
<b>Approvals</b>	Approval application required. Please see <a href="http://www.cityandguilds.com">www.cityandguilds.com</a> for details.
<b>Registration and certification</b>	Registration and certification of this qualification is through the Walled Garden, and is subject to end dates.

Title and level	GLH	TQT	City & Guilds qualification number	Ofqual accreditation number
Level 4 Diploma in Network Principles	90	450	9628-03	603/0412/1

Version and date	Change detail	Section
2.0 Jan 2017	Assessment method changed.	Assessment
3.0 Jan 2018	Test specification added	Assessment

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# 1 Introduction

This document tells you what you need to do to deliver the qualification:

Area	Description
Who is the qualification for?	This qualification is designed to support learners to develop a full range of underpinning knowledge that can be used in a variety of businesses and industries that demonstrate confidence and transferability in a Digital Technology Environment.
What does the qualification cover?	Network engineers need to maintain high levels of operation of communication networks in order to provide maximum performance and availability for their users, such as staff, clients, customers and suppliers. The unit will cover network configuration, cloud, network administration and monitoring tools, and giving technical advice and guidance.
What opportunities for progression are there?	<p>This qualification is part of the Digital Industries Apprenticeship programme and is not offered as a standalone product.</p> <p>On achieving this qualification the learner will have completed a section of the knowledge element as part of their apprenticeship journey.</p>
Who did we develop the qualification with?	It was developed in collaboration with employers, sector experts and training providers using the Standard as the baseline. The Standards have been created by The Tech Partnership and their Employer Groups for the specific areas. The qualification embodies the required learning for an apprentice to have the opportunity to successfully gain the relevant knowledge for their chosen career path in a Digital Technology environment.
Is it part of an apprenticeship framework or initiative?	Yes – 9648 Network Engineer

## Structure

Learners must complete the single unit 403 to gain this qualification.

## Total Qualification Time

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

TQT is comprised of the following two elements:

- The number of hours which an awarding organisation has assigned to a qualification for Guided Learning, and
- 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.

Title and level	GLH	TQT
Level 4 Diploma in Network Principles	90	450

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## 2 Centre requirements

### Approval

Fast Track Approval is offered to existing City & Guilds Centres offering the SASE framework for the Advanced and/or Higher Level Apprenticeship for IT, Software, Web and Telecoms, or the SASW framework for the Apprenticeship and/or Higher Level Apprenticeship for IT, Software, Web and Telecoms through City & Guilds. See the separate document on our website that provides details of the Fast Track Process and actions to be taken.

City & Guilds is offering the opportunity for existing City & Guilds centres delivering SASE framework for the Advanced and/or Higher Level Apprenticeship for IT, Software, Web and Telecoms, or the SASW framework for the Apprenticeship and/or Higher Level Apprenticeship for IT, Software, Web and Telecoms with other Awarding Organisations to gain approval for these Apprenticeship Standards through the Common Approval Framework. See the separate document at [www.cityandguilds.com](http://www.cityandguilds.com) which provides details of the New Programme Process and actions to be taken.

Centres that are not currently with City & Guilds will need to complete a Customer Application Form and once accepted they will be asked to complete the Centre Approval Process. See the separate document on our website that provides details of the New Centre Approval Process and actions to be taken.

Centre staff should familiarise themselves with the structure, content and assessment requirements of the qualification before designing a course programme.

### Resource requirements

#### *Resources*

Please see the individual unit information for any resources required.

#### *Centre staffing*

Staff delivering these qualifications must be able to demonstrate that they meet the following occupational expertise requirements. They should:

- be occupationally competent or technically knowledgeable in the area[s] for which they are delivering training and/or have experience of providing training. This knowledge must be to the same level as the training being delivered
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training.

While the Assessor/Verifier (A/V) units/TAQA are valued as qualifications for centre staff, they are not currently a requirement for these qualifications. However, City & Guilds encourage trainers and assessors to qualify to the current TAQA standard. Centre staff may undertake more than one role, eg tutor and assessor or internal verifier, but cannot internally verify their own assessments.

#### *Continuing Professional Development (CPD)*

Centres are expected to support their staff in ensuring that their knowledge and/or practice remains current. This includes currency within the occupational area and of best practice in delivery, mentoring, training, assessment and quality assurance. It should also take account of any national, international policy and legislative developments.

Internal quality assurance is key to ensuring that the assessment of evidence for units is of consistent and appropriate quality. They should:

- be occupationally competent or technically knowledgeable in the area for which they are internally quality assuring
- have recent relevant experience in the specific area they will be assessing
- have credible experience of providing training
- have a CV available demonstrating relevant experience and any qualifications held.

In certain circumstances, City & Guilds will recognise non-accredited learning and experience as equivalent as follows:

- If the Internal Quality Assurer does not hold a qualification they must be able to demonstrate evidence of working to their own organisation's internal quality assurance standards which clearly link to V1/TAQA or other equivalent standards for internal quality assurance.

### **Learner entry requirements**

City & Guilds does not set entry requirements for these qualifications. However, centres must ensure that learners have the potential and opportunity to gain the qualifications successfully and that they have the full engagement of the employers for the full programme.

### **Age restrictions**

City & Guilds cannot accept any registrations for learners under 16 as these qualifications are not approved for learners under 16.

## 3 Delivering the qualification

### Initial assessment and induction

An initial assessment of each learner should be made before the start of their programme to identify:

- if the learner has any specific training needs
- support and guidance they may need when working towards their qualifications
- any units they have already completed, or credit they have accumulated which is relevant to the qualifications
- the appropriate type and level of qualification.

We recommend that centres provide an induction programme so the learner fully understands the requirements of the qualifications, their responsibilities as a learner, and the responsibilities

### *Recording documents*

Learners and centres may decide to use a paper-based or electronic method of recording evidence.

City & Guilds endorses several ePortfolio systems, including our own, Learning Assistant, an easy-to-use and secure online tool to support and evidence learners' progress towards achieving qualifications. Further details are available at: [www.cityandguilds.com/eportfolios](http://www.cityandguilds.com/eportfolios).

City & Guilds has developed a set of *Recording forms* including examples of completed forms, for new and existing centres to use as appropriate. Recording forms are available on the City & Guilds website.

Although new centres are expected to use these forms, centres may devise or customise alternative forms, which must be approved for use by the external verifier, before they are used by learners and assessors at the centre. Amendable (MS Word) versions of the forms are available on the City & Guilds website.

## 4 Assessment

### Summary of assessment methods

#### *Candidates must:*

- successfully complete one assessment for the mandatory unit

#### Assessment Types

Unit	Title	Assessment method	Where to obtain assessment materials
403	Network Principles	Evolve on-line tests	www.cityandguilds.com

#### *Test Specifications*

The way the knowledge is covered by each test is laid out in the table below:

**Assessment type:** Multiple-choice online test

**Assessment conditions:** Invigilated examination conditions

**Grading:** Pass/Fail

**Number of questions:** 30

**Pass mark:** 21 (70%)

Unit 403 - Duration: 45 minutes		
Learning Outcome	Number of marks	%
1. Understand network infrastructure	16	53
2. Understand network protocol suites	5	17
3. Understand the concept of IP addressing and routing	9	30
<b>Total</b>	<b>30</b>	<b>100</b>

## Assessment strategy

### *Recognition of prior learning (RPL)*

Recognition of prior learning means using a person's previous experience, or qualifications which have already been achieved, to contribute to a new qualification.

For this qualification, RPL is not allowed.

## 5 Administration

### Quality assurance

#### *Internal quality assurance*

Registered centres must have effective quality assurance systems to ensure optimum delivery and assessment of qualifications. Quality assurance includes initial centre registration by City & Guilds and the centre's own internal procedures for monitoring quality. Centres are responsible for internal quality assurance and City & Guilds is responsible for external quality assurance.

Standards and rigorous quality assurance are maintained by the use of:

- internal quality assurance
- City & Guilds external moderation.

In order to carry out the quality assurance role, Internal Quality Assurers must have appropriate teaching and vocational knowledge and expertise.

#### *Access arrangements*

We can make arrangements so that learners with disabilities, special educational needs and temporary injuries can access the assessment. These arrangements must be made before the examination. For example, we can produce a Braille paper for a learner with visual impairment.

#### *Language of examinations*

We will provide this specification in English only.

### Other issues

#### *European Dimension*

City & Guilds has taken account of the 1988 Resolution of the Council of the European Community in preparing this specification and associated specimen units.

#### *Environmental Education*

City & Guilds has taken account of the 1988 Resolution of the Council of the European Community and the Report Environmental Responsibility: An Agenda for Further and Higher Education 1993 in preparing this specification and associated specimen units.

#### *Avoidance of bias*

City & Guilds has taken great care in the preparation of this specification and specimen units to avoid bias of any kind.

## 6 Units

### Availability of units

The unit information can be found in this document.

### Structure of the units

These units each have the following:

- City & Guilds reference number
- Title
- Level
- Guided learning hours (GLH)
- Learning outcomes, which are comprised of a number of topics

Centres must deliver the full breadth of the range. Specialist equipment or commodities may not be available to all centres, so centres should ensure that their delivery covers their use.

## Unit 403 Networking Principles

LEVEL	4
GLH	90

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### What is this unit about?

This unit provides learners with an understanding of the role of a network engineer who plans, installs, configures, maintains and supports complex computer networks. Learners will gain an understanding of different network layering models, physical and logical network components, TCP/IP network configuration, network servers and services, and associated security concepts.

The primary role of a network engineer is to design, install, maintain and support communication networks within an organisation or between organisations. Network engineers need to maintain high levels of operation of communication networks in order to provide maximum performance and availability for their users, such as staff, clients, customers and suppliers. They will understand network configuration, cloud, network administration and monitoring tools, and be able to give technical advice and guidance.

Upon completion, learners studying this unit will have gained the knowledge to support the competencies of a Network Engineer. Specific competencies supported by this unit include being able to undertake the following tasks:

- Identifies and resolves network problems following agreed procedures. Uses network management software and tools to collect agreed performance statistics. Carries out agreed network maintenance tasks.
- Installs or removes hardware and/or software, and associated connections, using supplied installation instructions and tools. Conducts tests and corrects malfunctions, calling on help from more experienced colleagues if required. Documents results in accordance with agreed procedures. Assists with the evaluation of change requests. Contributes, as required, to investigations of problems and faults concerning the installation of hardware and/or software and confirms the correct working of installations.
- Carries out agreed operational procedures of a routine nature. Contributes to maintenance, installation and problem resolution.
- Maintains the network support process and checks that all requests for support are dealt with according to agreed procedures. Uses network management software and tools to investigate and diagnose network problems, collect performance statistics and create reports, working with users, other staff and suppliers as appropriate.
- Installs or removes hardware and/or software, and associated connections, using supplied installation instructions and tools. Conducts tests and corrects malfunctions, calling on help from more experienced colleagues if required. Documents results in accordance with agreed procedures. Assists with the evaluation of change requests. Contributes, as required, to investigations of problems and faults concerning the installation of hardware and/or software and confirms the correct working of installations.
- Receives and handles requests for support following agreed procedures. Responds to common requests for support by providing information to enable resolution and promptly allocates unresolved calls as appropriate. Maintains records and advises relevant persons

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## Learning outcomes

In this unit, learners will be able to

- 1 Understand network infrastructure
- 2 Understand network protocol suites
- 3 Understand the concepts of IP addressing and routing

## Scope of content

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### Learning outcome

- 1 Understand network infrastructure
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### Topics

- 1.1 Role of networks
- 1.2 Different types of physical and wireless network
- 1.3 Key network components

### Depth

The learner will explore the fundamental concepts of networking including physical and logical networks and their roles.

#### Topic 1.1

The learner will be able to describe the role performed by a network of computers and shared devices (input, output and storage) including:

- Resource sharing
  - o Storage eg
    - NAS
    - Virtualisation
    - Cloud based
    - Input and output
  - Inter-device communications
    - o File sharing eg
      - FTP
      - TFTP
      - NFS
      - Email
      - IMAP
      - POP<sub>3</sub>
      - SMTP
    - o Remote execution eg
      - Telnet
      - SSH
    - o remote desktop
  - Workload distribution

- o Distributed computing eg
  - Virtualisation
  - Cloud computing

- Resource redundancy
  - o High availability
  - o Load balancing
  - o Clustering
  - o Disaster recovery eg
    - Warm site
    - Hot site

### Topic 1.2

The learner should be able to describe concepts of physical and logical networks and state their main features and the advantages and disadvantages of each, including

- Local Area Networks eg
  - o Ethernet
  - o Fibre-optic
  - o Powerline
- Metropolitan or Campus Networks eg
  - o ATM
  - o Gigabit Ethernet
- Wide Area Networks eg
  - o Cable Broadband
  - o ADSL
- Wired and Wireless Networks eg
  - o Wireless 802.11 standard
  - o IEEE 802.15 standard

### Topic 1.3

The learner should be able to explain the typical infrastructure components of physical networks.

- Infrastructure Components
  - o Physical cabling
  - o Repeaters
  - o Hubs and Switches
  - o Bridges
  - o Routers

Inter-protocol gateways

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## Learning outcome

- 2 Understand network protocol suites

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## Topics

- 2.1 Conceptual models
- 2.2 Layers associated with hubs, switches and routers.

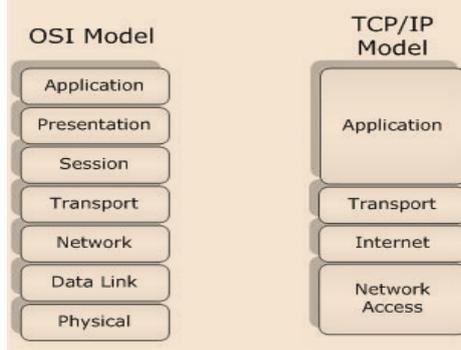
### Depth

In this learning outcome the learners will explore the fundamentals of network conceptual models.

#### Topic 2.1

The learner will be able to compare and contrast the layers and the functionality of the OSI and TCP/IP models

- Network layering models (OSI and TCP/IP)
- Function of each layer
- Protocols associated with layers (OSI and TCP/IP)



#### Topic 2.2

The learner will be able to identify interconnection devices associated with the appropriate layers of the models.

- Infrastructure Components
  - o Physical cabling
  - o Repeaters
  - o Hubs and Switches
  - o Bridges
  - o Routers
  - o Inter-protocol gateways

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## Learning outcome

- 3 Understand the concepts of IP addressing and routing

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## Topics

- 3.1 IP addressing schemes
- 3.2 Routing concepts and protocols

### Depth

#### Topic 3.1

The learner will be able to describe the differences between a class based (IPv4) and classless interdomain routing scheme. The learner would be able to explain each of the following:

- IPv4 addressing schemes for classes A-D
- Subnet IPv4 address
- Supernet IPv4 address
- Address format for IPv6

The learner will be able to calculate subnet values

- Converting binary notations to decimal
- Converting decimal to binary notations
- Convert binary and decimal notation to hexadecimal notations

#### Topic 3.2

The learner will be able to compare and contrast the advantages and disadvantages offered by static and dynamic for a Local Area Network.

- Default routing
- Static routes (Routing Tables)
- Dynamic Routing (Adaptive to topology changes)

The learner will be able to describe how routing protocols function:

- Link state (OSPF)
- Distance vector (IGRP, RIP)
- Interior and exterior gateway (BGP, EGP)

## Guidance for delivery

- Localhost address
- The concept of a logical network
- Multicasting and Broadcasting

TOPIC 3.2 – reference to the practical application – maths. It is important that the learner has an understanding of binary, hexadecimal, denary numbering systems.

Learners should be aware that each of the routing protocols uses a mathematical algorithm which apply to either hardware or software produce a specified outcome.

Wherever possible this unit should be delivered within a workshop environment providing the learners with paper based, or hands on practical exercises and case studies representative of IP networking in operation. Learners should be encouraged to explore and use as wide a range of hardware and software as possible, this should also include researching and utilising new an emerging technologies where available. Whichever method(s) are used, learners should experience a variety of technologies.

Note: When designing or creating a network the learner should incorporate at least two interconnection devices spanning three logical networks (i.e., two hops), more complex networks with multiple routes between hosts are desirable. Learners may also add peripherals to the network if required.

## Employer engagement

Employer engagement is essential in order to maximise the value of learners' experience. A partnership approach should be adopted where possible with employers with whom the consortium has links, and with employers used for work experience placements.

It would be helpful for teachers to develop a method of maintaining contact with a range of employers in the sectors may be able to help with keeping the examples of legislation, policies and codes of practice used in the taught content, up to date.

- Local branches of BCS The Chartered Institute for IT can often provide access to local employers, since many members will be senior practitioners and leaders in organisations that employ IT professionals. The BCS has an extensive branch network of volunteers operating across the UK, Channels Islands and Isle of Man. <http://www.bcs.org/category/5897>
- Invite local businesses to visit the delivery centre to talk about their experience in using Digital Technology for commercial advantage, especially in respect of their dealing with suppliers, customers and employees. Ask the students to identify aspects of the IT practices of local business that may be considered 'good practice'.

- Identify local small businesses that have no IT governance policy or guidelines. Invite them to attend a short presentation and discussion event wherein students outline by way of presentation and demonstration a short set of (maximum 10 items) good practices for IT governance and be prepared to answer questions from the audience.
- Invite the local constabulary to come and speak on examples of where businesses and individuals have been victims of crime as a result of their use of IT, and how IT is used in law enforcement (e.g., the Automatic Number Plate Recognition System (ANPR)).
- Approach the local chamber of commerce to attend a student debate on the need for greater awareness and engagement with the Digital Economy on the part of small business where. Choose a debatable question that can be supported or opposed such as 'This house believes that Internet sales channels are of equal importance to small/local retailers as they are to global corporates.'
- Larger enterprises and central government agencies with local offices are likely to have formalised IT governance policies, especially in technology enabled industries such as Banking, Insurance, Telecommunications and Logistics. These organisation may be willing to offer the time of their Chief Information Officer, an IT manager or technical professional to present to learners on the steps their organisation takes to protect against IT security threats.
- Website designers working in the local economy will often have extensive links with small business that have commissioned them to design, develop and maintain ecommerce sites. Invite a local web designer to come and speak about the challenges their clients face in implementing an online presence.
- The Computing/IT faculty of every university will have links to employers in the local economy and their faculty staff may be willing to introduce delivery centres to major employers of IT skilled graduates and apprentices. Such links should be developed by FE colleges so as to better understand the skills needs and career options for IT practitioners at all levels from school leaver to graduate (i.e., think of how your learners can develop their career beyond the FE stage, and open their eyes to a full career).
- Tech Partnership, the UK sector skills council for the IT/Telecoms industry, have an extensive list of small/medium sized employers of IT skilled apprentices and college leavers. They also provide a wealth of free resources for FE colleges to enable better engagement with local employers. <https://www.thetechpartnership.com/>

## Suggested learning resources

### Books

Network Design Cookbook: Architecting Cisco Networks  
Published by: lulu.com

Michel Thomatis

ISBN: 978-1257750245

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TCP/IP Network Administration  
Published by: O'Reilly Media;  
ISBN: 978-0596002978

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Craig Hunt

Network+ Study Guide  
Published by: Wiley

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Todd Lammle

CISCO CCNA Routing and Switching  
Published by: Cisco Press

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## Appendix 1 Relationships to other qualifications

### ***Links to other qualifications***

Centres are responsible for checking the different requirements of all qualifications they are delivering and ensuring that candidates meet requirements of all units/qualifications.

### ***Literacy, language, numeracy and ICT skills development***

This [these] qualification[s] can develop skills that can be used in the following qualifications:

- Functional Skills (England) – see [www.cityandguilds.com/functionalskills](http://www.cityandguilds.com/functionalskills)
- Essential Skills (Northern Ireland) – see [www.cityandguilds.com/essentialskillsni](http://www.cityandguilds.com/essentialskillsni)
- Essential Skills Wales – see [www.cityandguilds.com/esw](http://www.cityandguilds.com/esw)

## Appendix 2 Sources of general information

The following documents contain essential information for centres delivering City & Guilds qualifications. They should be referred to in conjunction with this handbook. To download the documents and to find other useful documents, go to the Centres and Training Providers homepage on [www.cityandguilds.com](http://www.cityandguilds.com).

*Centre Manual - Supporting Customer Excellence* contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification, as well as updates and good practice exemplars for City & Guilds assessment and policy issues.

Specifically, the document includes sections on:

- The centre and qualification approval process
- Assessment, internal quality assurance and examination roles at the centre
- Registration and certification of candidates
- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Management systems
- Maintaining records
- Assessment
- Internal quality assurance
- External quality assurance.

*Our Quality Assurance Requirements* encompasses all of the relevant requirements of key regulatory documents such as:

- SQA Awarding Body Criteria (2007)
- NVQ Code of Practice (2006)

and sets out the criteria that centres should adhere to pre and post centre and qualification approval.

*Access to Assessment & Qualifications* provides full details of the arrangements that may be made to facilitate access to assessments and qualifications for candidates who are eligible for adjustments in assessment.

The **centre homepage** section of the City & Guilds website also contains useful information on such things as:

- **Walled Garden:** how to register and certificate candidates on line
- **Events:** dates and information on the latest Centre events
- **Online assessment:** how to register for e-assessments.

*Centre Guide – Delivering International Qualifications* contains detailed information about the processes which must be followed and requirements which must be met for a centre to achieve 'approved centre' status, or to offer a particular qualification.

Specifically, the document includes sections on:

- The centre and qualification approval process and forms
- Assessment, verification and examination roles at the centre
- Registration and certification of candidates

- Non-compliance
- Complaints and appeals
- Equal opportunities
- Data protection
- Frequently asked questions.

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## Useful contacts

<b>UK learners</b> General qualification information	<b>E: <a href="mailto:learnersupport@cityandguilds.com">learnersupport@cityandguilds.com</a></b>
<b>International learners</b> General qualification information	F: +44 (0)20 7294 2413 <b>E: <a href="mailto:intcg@cityandguilds.com">intcg@cityandguilds.com</a></b>
<b>Centres</b> Exam entries, Certificates, Registrations/enrolment, Invoices, Missing or late exam materials, Nominal roll reports, Results	F: +44 (0)20 7294 2413 <b>E: <a href="mailto:centresupport@cityandguilds.com">centresupport@cityandguilds.com</a></b>
<b>Single subject qualifications</b> Exam entries, Results, Certification, Missing or late exam materials, Incorrect exam papers, Forms request (BB, results entry), Exam date and time change	F: +44 (0)20 7294 2413 F: +44 (0)20 7294 2404 (BB forms) <b>E: <a href="mailto:singlesubjects@cityandguilds.com">singlesubjects@cityandguilds.com</a></b>
<b>International awards</b> Results, Entries, Enrolments, Invoices, Missing or late exam materials, Nominal roll reports	F: +44 (0)20 7294 2413 <b>E: <a href="mailto:intops@cityandguilds.com">intops@cityandguilds.com</a></b>
<b>Walled Garden</b> Re-issue of password or username, Technical problems, Entries, Results, e-assessment, Navigation, User/menu option, Problems	F: +44 (0)20 7294 2413 <b>E: <a href="mailto:walledgarden@cityandguilds.com">walledgarden@cityandguilds.com</a></b>
<b>Employer</b> Employer solutions, Mapping, Accreditation, Development Skills, Consultancy	T: +44 (0)121 503 8993 <b>E: <a href="mailto:business@cityandguilds.com">business@cityandguilds.com</a></b>
<b>Publications</b> Logbooks, Centre documents, Forms, Free literature	F: +44 (0)20 7294 2413

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## City & Guilds Group

The City & Guilds Group is a leader in global skills development. Our purpose is to help people and organisations to develop their skills for personal and economic growth. Made up of City & Guilds, City & Guilds Kineo, The Oxford Group and ILM, we work with education providers, businesses and governments in over 100 countries.

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1 Giltspur Street

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London EC1A 9DD

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F +44 (0)20 7294 2413

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