BCS HIGHER EDUCATION QUALIFICATIONS

Level 4 Certificate in IT

March 2015

EXAMINERS' REPORT

Computer and Network Technology

General comments on candidates' performance

Many candidates did not write sufficiently in-depth answers for 30 marks awarded for section A. Candidates attempted section B questions well. Centres need to provide guidance and support to candidates so that they are prepared to write sufficiently in depth answers in section A. The most popular question was 8 and the least popular was 3.

Please note that the answer pointers contained in this report are examples only. Full marks were given for valid alternative answers.

SECTION A

Candidates were required to answer **TWO** out of the four questions set

A1

{please include question}

Answer pointers

An assembly language is a human readable version of a computer's machine code; that is, it is the native or intrinsic language of the computer.

Each computer family (e.g. Intel, ARM) has its own assembly language that is different to all other assembly languages. Even within a given family of processors (e.g., Intel IA 32 architecture) there are variations between different models of processor; for example, Intel is continually adding new instructions to successive versions of its IA32 architecture.

To use assembly language requires a detailed knowledge of a processor's architecture (i.e., its instruction set, addressing modes, and register structure). Because assembly language is a reflection of a computer's own machine code, you cannot write code more efficiently than by using assembly language – for this reason, assembly language may be used to write parts of the operating system or graphics programs where the ultimate efficiency is necessary.

Similarly, input/output routines are sometimes written in assembly language because you have great flexibility in controlling the processors resources directly and in using bit operations.

Assembly language is used by professionals wanting high efficiency. It is also used by students studying computing because it provides an excellent introduction to the CPU. Today, assembly language is rarely used for general-purpose programming; that is, it is not used instead of high-level languages like Java.

A disadvantage of assembly language is that it provides no checking (data type checking or operation checking). If you wish to multiply someone's name by 12 (a meaningless operation), assembly language will let you do it. Moreover, maintaining assembly language programs is very difficult because the code is hard to read (i.e., understand) because operations happen at such a low level (i.e., the movement of data between registers and primitive operations on data).

Assemblers are produced by chip manufacturers or third-party organizations and are aimed either at the educational market of the professional engineering market.

A high-level language attempts to express actions in an almost natural language form; for example; Repeat … until.

A high-level language is designed by a programmer or a team of programmers (today, it is often a committee). The design team may be academics or people in industry. A high-level language is machine-independent; that is, it is not designed to run on any computer. A program called a compiler takes a high-level language program and converts it into a new machine-code program that can run on a particular machine.

For example, you can write a high-level program in C which is translated into the machine code that can run on an Intel-based machine. Note that the efficiency of a program written in a high level language is dependent on the quality of the compiler and the architecture of the target computer.

When we said that assembly language provides the most efficient way of writing programs, that statement was true in a very limited way. It is true that you can write an assembly language program that is faster and more efficient than the same algorithm in a high-level language. However, real programmers find it difficult to write complex programs in assembly language. In practice, the productivity of a programmer writing in a high-level language is far higher than one writing in assembly language.

High-level languages are used by all those who wish to write programs to their own specification; that is, computing professionals at all levels and students of computing. You do not require a knowledge of computer architecture to write a high-level language program.

There is a remarkably wide variety of high-level languages; there are hundreds of them. Many are similar to each other although there are different classes of high-level language. Most programmers use C, Java, or Python. These are procedural languages that execute instructions sequentially and they are not really too far from assembly language (in concept).

Other high level languages like LISP or Prolog are radically different to procedural language and algorithms are expressed in a very different way. These languages are used in special applications such as artificial intelligence.

Application-level languages are intended to be specific to a particular application. An application-level language is often translated first into a high-level language and then into assembly language or it may be translated directly into assembly language.

The importance of the application-level language is that it does not require a general understanding of computing or even programming. A simple illustration of the high-level language is the buttons in an elevator. When you get in an elevator you do not have to control the sequencing of its motors, nor the door opening and closing interlocks. You push the button corresponding to the floor you wish to visit. The application level language (or interface) hides all the complex realities of a system. For example, if you are using an image editor, you can move a slider to change the contrast of an image. If you were using a high-level language, you would have to write a program to determine the new intensity of each pixel in the image – this would require a knowledge of both programming and image processing. With an application's level package, any non-expert can perform very complex operations with ease.

The advantage of application level programs is that they make the application of computers easy for non-experts. Their disadvantage is that they are dedicated to one application and that cannot easily be modified by the user.

Examiner's comments

Most candidates were unable to distinguish between the various programming languages. This is a key area of the syllabus and it is expected that centres develop a good understanding of how languages have developed over the past years. Good answers showed a fair understanding of high level languages. Weaker answers did not manage to cover issues around assembly languages.

A2

{please include question}

Answer pointers

The term malware is a generic term used to describe all software that is either intended to harm a computer, or to perform an undesirable operation. Some malware can have devastating consequences and some malware is simply annoying.

Some of the major classes of malware are:

Viruses
Trojan horses
Worms
SPAM
Trackers

The virus is a form of malware that is able to replicate itself. Originally, viruses were spread by the exchange of programs (e.g., on floppy disks or pen drives). A virus is a piece of code that makes copies of itself and inserts the copies in other programs in order to spread. The virus may carry a payload that can execute a piece of code that may do anything from displaying a message to erasing data. A modern variant of the virus is ransomware which gradually encrypts all your data files and then demands that you hand over a large fee to an organization if you want your files back (i.e., decrypted).

Early generations of viruses were designed simply to surprise the user with messages that appears on the display or to destroy data. Today's viruses are often related to identity theft schemes that collect your personal data and return it to someone who can use it to defraud you. It is even possible to use a virus to take over a computer and use that computer to broadcast SPAM on the Internet.

Note that today's viruses are more sophisticated than earlier generations; for example, some can even disable antivirus software, system restore facilities, and various Windows tools. Some viruses mutate and change so that virus detectors find it difficult to detect them.

Although viruses were once spread physically by sharing programs, today viruses are spread via the internet which links most PCs together. In order for a virus to operate, its code must be executed. Computer users are warned about running unknown code and are generally cautious about executing executable programs (.exe). However, virus writers take advantage of macro and similar facilities built into applications such as word processors. A macro facility allows users to include computer operations (using a macro language) in word processors. Consequently, a virus can be introduced via an embedded macro. It is also possible to disguise the name of exe files so that the extension .exe does not appear on the screen.

Viruses also exploit weaknesses in operating systems and applications (from Adobe reader to Java to browsers). The classic technique is buffer overrun where data is stored in memory and the allocated storage limit is breached and data (i.e. the virus code) leaks into program space and is eventually executed.

The action of a virus may not be immediate; for example, it may be triggered by an event such as a specific calendar date.

The Trojan Horse is an example of malware that is not designed to self-replicate like a virus. It is so-called because it is usually embedded in software that appears to be legitimate.

SPAM is unwarranted email; that is, email that you did not invite, expect, or want. Typically, SPAM is used to advertise products or to invite the receiver to take part in some scheme (that may be illegal). The problem with SPAM is that it consumes bandwidth, storage space and time (because the receiver has to delete it). Some email readers have SPAM filters that are reasonably effective – but that means that important non-SPAM messages are sometime lost.

A relatively new form of malware is called PUP or potentially unwanted program. This is installed like viruses through email and Internet browsing. PUP covers a range of programs that may not actively cause harm but with may perform actions such as reporting on your browsing activities or changing your browser to a different company.

Preventing malware

Avoiding malware and its effects is not easy. However, the probability of infection can be significantly reduced by taking a number of precautions. One of the first lines of defence is the antivirus package that scans for software and even monitors the installation of all executable code. These packages look for the signature of a virus (a checksum generated from its code) or they look for anomalous (unusual) computer behaviour. Such software is not totally reliable (a signature cannot be generated until some computer has been infected and the infection reported to the antivirus company).

Another defence is education. All computer users must be taught correct operational techniques (this is important in organizations). Users must be taught never to open unknown attachments in email, never to run unauthorized programs.

Another line of defence is the back up. By backing up data regularly, you preserve older copies of data. However, there is a danger. A virus that changes data stealthily over a long time means that backups themselves may have already been modified. By the time you realize what is happening, it is too late.

Virtualization can be used to help prevent virus infections. New software is executed on a virtual computer that cannot make permanent changes to the system.

Examiner's comments

Good answers covered a range of malware. These also included relevant preventative measures. Weaker candidates provided vague answers lacking suitable technical details of identified malware.

A3

{please include question}

Answer pointers

Secondary storage is used to hold all programs and data that are not currently in the computer's main random access (DRAM) store. The characteristics of secondary storage are its cost (very low in terms of cost per bit stored), its size (up to tens of terabytes), its access time (very, very long compared to DRAM – of the order of 10^7 to 10^9 times slower), and its non-volatility (it retains data when the power is off). Today, secondary storage can be implements with hard disk drives, semiconductor-based technology (Solid state disk drives), or optical storage (CD/DVD/Blu-Ray.

Hard disk drives store data on rotating flat platters of aluminium or glass coated with a magnetic material. The rotating platter passes under a read/write head that can magnetize the surface (writing) and determine the state of the magnetization (reading). Because the magnetization is permanent until reversed, the HDD is non-volatile.

HDDs have remarkable storage properties. The latest 3 ½ in drives can store up to 6Tbytes per drive and are very cheap (currently of the order of US $40/Tbyte). They suffer from three disadvantages. They have long access times because the platter must rotate under the read head. Because of the inertia of rotating disks, they rarely rotate at more than about 7,200 revolutions per minute giving a rotational latency of about 40 ms. As well as rotational latency it is necessary to step to the required track which can add about 5 to 10 ms to the access time. The moving parts of a disk drive make them very vulnerable to physical shock (knocking and dropping). Moreover, hard disk drives can be a major source of heat in installations with many disks (data centres). This heat is expensive (energy is not free, and you have to find ways of dissipating it). Heat also degrades the life of components. Finally, the HDD is not reliable because of its nature – moving parts with a read/write head flying just a few nanometres above the surface (when the head hits the surface it is said to crash, and the disk may be ruined).

In recent years the HDD has been replaced by SSDs (solid state drives) in top-of-the-range portable computers. SSDs are often physically and electrically compatible with HDDs (that is, you just swap out an HDD and insert an SDD). SSD uses exactly the same technology as flash memory. Flash memory consumes far less power than magnetic memory and is more reliable. It also has a very much lower access time (no rotational latency) of about 0.1 ms. However, SSDs suffer two problems. They are currently far more expensive than HDDs, although it is expected that SSDs will fall in price sufficiently for them to compete with HDDs in applications where access time and reliability is important. Today, SSDs of up to about 1Tbyte are available.

An important limitation of SSDs is their vulnerability to erase and write operations. In flash memory, data is stored by injecting electrons through an insulator onto a floating gate. This operation physically damages the structure of the semiconductor. Its effect is that a flash memory will fail after a certain number of write cycles (of the order of 10^6). Software techniques called wear levelling are used to remap memory cells in a flash memory to even out the number of write cycles across the array. However, flash memory and SSDs are ultimately vulnerable to failure.

Optical storage is generally removable storage; that is, the data is recorded on disk that can be transported. In many ways, optical storage technology is very similar to magnetic disk technology. The optical disk is the preferred method of program distribution today.

Optical storage works by modifying the surface of a spiral track on a disk. A laser beam is used to follow a track and the data is extracted by observing the reflectivity of the surface. Like the hard disk drive, optical media uses electro mechanical technology (rotating disk and a read/write head that follows the track). Consequently, optical storage is slow – even slower than HDDs. Over the years optical storage has been changed from CD (compact disks) to DVDs to Blu-ray disks. These all use the same underlying technology; the only difference is the parameters (recording format, track dimensions, and wavelength of the laser beam).

CDs have a storage capacity of about 70 Mbytes, DVDs can store 4.7 GB (note that they can increase this by using multiple layers). Conventional Blu-ray disk can store 25 GB and multiple layer disks can store up to 128 GB.

Optical storage is used largely only to archive data and make programs transportable. Optical drives may be read only, or they may be read/write (which is more expensive).

The Operating System and Secondary Storage

Secondary storage must be managed by the operating system. Since it is normally impossible to put all data on secondary storage in main DRAM storage at the same time, it is necessary to decide what data is transferred from secondary to primary storage and how to deal with addressing (i.e., data from secondary storage must be loaded at a specific point in memory).

The operating system works in conjunction with hardware called a memory management unit, MMU. The MMU keeps track of that data in the primary memory and maps logical addresses generated by the CPU onto the actual address of the data in DRAM. If the processor generates an address of data/code that is not currently in DRAM (main store), the MMU is not able to perform an address translation.

The MMU generates an interrupt (called a page fault) and a page of data is brought from secondary storage (by the operating system). However, if DRAM is already full, an old page must be ejected to make room for the new page. The operating system checks whether the old page was change while in DRAM – if it was, it must be written back to disk. When the new page has been loaded in DRAM, the MMU is updated with its address so that logical CPU addresses can be translated onto physical DRAM addresses.

Together with the MMU, the operating system carries out another task – security. Data is DRAM can be made read-only or it can be made program only to ensure that one task does not access another task's data.

Examiner's comments

Overall, candidates did not have good understanding of storage devices. Answers were unclear and unstructured. Since storage devices have been developed in the past few years and are very important in a range of devices, candidates must not ignore this area of the syllabus. Centres should endeavour to explore up to date and contemporary storage mediums.

A4

{please include question}

Answer pointers

a. The truth table

D	C	B	A	Number	Divisible by 4	Divisible by 7	F (Divisible by 4 or 7)
0	0	0	0	0	0	0	0
0	0	0	1	1	0	0	0
0	0	1	0	2	0	0	0
0	0	1	1	3	0	0	0
0	1	0	0	4	1	0	1
0	1	0	1	5	0	0	0
0	1	1	0	6	0	0	0
0	1	1	1	7	0	1	1
1	0	0	0	8	1	0	1
1	0	0	1	9	0	0	0
1	0	1	0	10	0	0	0
1	0	1	1	11	0	0	0
1	1	0	0	12	1	0	1
1	1	0	1	13	0	0	0
1	1	1	0	14	0	1	1
1	1	1	1	15	0	0	0

b. From the truth table we get:

F = D! C B! A! + D! C B A + D C! B! A! + D C B! A! + D C B A!

c. Using Boolean algebra we can simplify this:

F = D! C B! A! + D! C B A + D C! B! A! + D C A! (B! + B)

F = D! C B! A! + D! C B A + D C! B! A! + D C A! as B! + B = 1

F = D! C B! A! + D! C B A + D A! (C!B! + C)

F = D! C B! A! + D! C B A + D A! (B! + C) as C!B! + C = B! + C

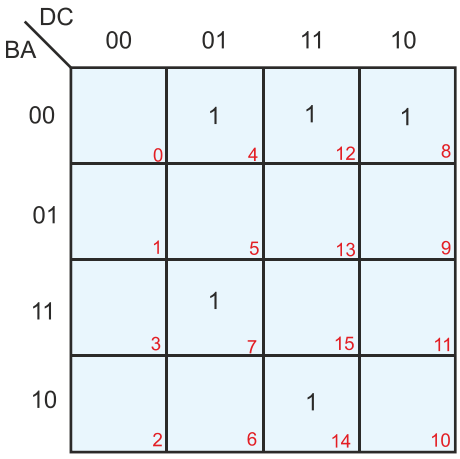
F = D! C B! A! + D! C B A + D B! A! + D C A! by expending the brackets

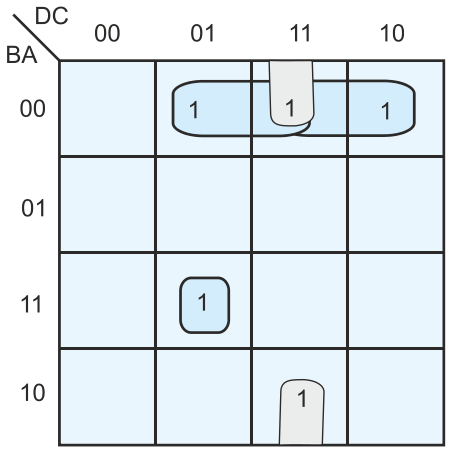
F = C A! (D! B! + D) + D! C B A + D B! A!

F = C B! A! + D C A! + D! C B A + D B! A! as D! B! + D = B! + D

F = C B! A! + D C A! + D! C B A + D B! A! This cannot be simplified

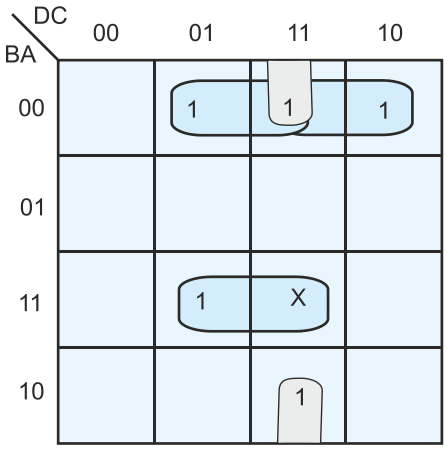
Using a Karnaugh Map





From the K-map we get F = C B! A! + D C A! + D! C B A + D B! A!

d. If D C B A = 1 1 1 1 and the state is don't care, the K-map becomes



If we assume that don't care condition X is 1, we can improve groupings to get:

F = C B! A! + D C A! + D! C B A + D C B A + D B! A!

F = C B! A! + D C A! + C B A + D B! A!

or

F = C B! A! + D C B + C B A + D B! A!

Examiner's comments

Most candidates who attempted this question scored well with many gaining full marks. The evidence suggested that previous guidance given in examiner's reports had been taken on board when answering this question. Weaker answers did not provide sufficient simplification in part d). A surprising number of candidates stated that there was no simplification possible when the don't care condition was included.

This question did not ask for any circuit diagrams to be drawn. Despite this, a number of candidates drew diagrams.

SECTION B

Candidates were required to answer **FIVE** out of the eight questions set

B5

{please include question}

Answer pointers

a) OSI provides the relevant standards, rules, guidelines on how to interconnect devices and applications in a computer network. Without, it would become difficult to provide interconnections between the devices and applications. In the OSI model, each layer provides services to the layer above, while hiding from that layer the processes used to implement the services. Ideally, changes can be made to any layer without requiring changes to any of the other layers, as long as the inputs and outputs of the changed layer remain the same.

b) Layer 7 (Application Layer) services make it possible for identical or non-identical applications running on different systems to use a network to exchange information. Services defined by this layer include file transfer, message handling, and remote management. For example, various types and versions of e-mail software can use the same Layer 7 protocols to exchange messages over the Internet.

Examiner's comments

The evidence suggests that many candidates did not read the question well. Only 4 marks were available for part a). Answers did not require a detailed explanation of the OSI model. Candidates had to cover layer 7 in part b). Unfortunately, most candidates provided lengthy answers on all 7 layers.

B6

{please include question}

Answer pointers

a) WIFI (short for Wireless Fidelity) A network which uses radio waves to transmit data. A computer wireless adapter translates data into a radio signal and transmits it. A wireless router receives the signal and decodes it. The router sends the information to the internet using a physical wired connection. WIFI is based on the IEEE 802.11 standards.

b) Broadband A signalling technology that sends signals simultaneously over a range of different frequencies as electromagnetic waves. The bandwidth of a broadband system can usually carry multiple, simultaneous data signals. These signals are unidirectional—traveling in only one direction at a time—so a broadband system can generally either transmit or receive but cannot do both simultaneously. Broadband signals can be regenerated using amplifiers in order to travel longer distances before becoming attenuated.

Examiner's comments

The evidence suggests that candidates did not perform well in this section. Candidates were unable to provide key elements of WIFI and broadband transmission. Centres are advised to develop suitable scenarios of these main networking topics and show how they are used in transmitting data.

B7

{please include question}

Answer pointers

A laptop computer replaces a PC and offers a range of facilities and services to users. It is useful in offices, businesses, homes, at schools, etc. Laptops have powerful processors and have sufficient storage (RAM and disk) to enable users to perform a range of tasks.

A tablet is a much smaller device which is primarily used for browsing the internet, playing games and conducting online video conversations. The tablet has limited capacity and is less powerful than laptops. However, newer models of tablets are highly versatile.

Both devices offer full WIFI connectivity.

Examiner's comments

Most candidates were able to clearly distinguish between the two types of devices. Good answers included detailed technical information as well as the uses of the devices. Weaker candidates merely covered uses of the devices.

B8

{please include question}

Answer pointers

a) A laser printer is able to produce high quality output fast; uses a combination of laser beams and toner to produce output. 32 Mb on printer enables the temporary storage of output before being transferred onto paper.

b) An ink jet printer is an alternative printer. It is slower and less efficient that a laser printer. Quality of prints can be as good as those produced by a laser printer.

c) A networked office printer is designed for far heavier use. It can often achieve high print rates. It is more robust and produces high-volume output. Networked printers are frequently shared, allowing more than one person in an office to access them. They cost more than personal printers because they are built more solidly.

Examiner's comments

The purpose of this question was to test candidates' basic understanding of output devices namely printers. Candidates were able to cover a range of issues on typical printers. Good answers included uses of the printers. Weaker candidates did not understand the operation and use of networked printers.

B9

{please include question}

Answer pointers

a) NIC – short for Network Interface Card, an adapter card that plugs into the system bus of a computer and allows the computer to send and receive signals on a network. A parallel stream of data is sent to the card and buffered before being packaged into discrete frames for serial transmission over the network. NICs are available in different speeds and also support fibre optic transmission.

b) LAN – short for Local Area Network, a type of network which is designed for limited geographical data transmission. A LAN is most suited within a location or site; e.g. a university campus, a building. LANs enable users to share devices such as printers and storage. A dedicated backbone Is used to set a LAN. Various subnets can be created around the LAN.

c) WAN – short for Wide Area Network, a type of network which is geographically distributed network composed of local area networks (LANs) joined into a single large network using services provided by common carriers. Wide area networks (WANS) are commonly implemented in enterprise networking environments in which company offices are in different cities, states, or countries or on different continents.

d) MAC – short for Media Access Control or MAC layer is one of the sub-layers of the data link layer of the OSI model. The MAC layer determines which computer on the network is allowed to use the media at any given moment. The MAC layer is thus responsible for implementing the media access control method for the particular network architecture, such as Ethernet or Token Ring. The MAC layer is also responsible for making sure that data is delivered without errors.

Examiner's comments

These topics have been examined in previous sittings. Most candidates who paid attention to guidance given in the past were able to write good answers. Candidates scored well in this question.

B10

{please include question}

Answer pointers

a) PING - Stands for Packet Internet Groper, a TCP/IP utility that verifies the integrity of a network connection with a host on a TCP/IP network. The ping command is one of the first commands to use to troubleshoot communication problems on a TCP/IP network. Ping can be followed by either the IP address or the fully qualified domain name (if the Domain Name System is implemented) of the host. One or multiple Internet Control Message Protocol (ICMP) echo packets are sent to the host, and if connectivity is working, an equal number of echo replies are received.

b) Traceroute - A utility that traces a packet from your computer to an Internet host, showing how many hops the packet requires to reach the host and how long each hop takes. If you are visiting a Web site and pages are appearing slowly, you can use traceroute to figure out where the longest delays are occurring. Traceroute utilities work by sending packets with low time-to-live (TTL) fields. The TTL value specifies how many hops the packet is allowed before it is returned. When a packet cannot reach its destination because the TTL value is too low, the last host returns the packet and identifies itself. By sending a series of packets and incrementing the TTL value with each successive packet, traceroute finds out who all the intermediary hosts are.

c) DNS Lookup - This test will list DNS records for a domain in priority order. The DNS lookup is done directly against the domain's authoritative name server, so changes to DNS Records should show up instantly. By default, the DNS lookup tool will return an IP address if you give it a name (e.g. www.example.com)

d) Port check - A port is a virtual address on your computer or network device which enables it to communicate with other computer or devices. If a program or service plans to work with the network, it opens the port with a unique number, through which it can work with remote clients / servers. A port check is a test that is carried out to find out which ports are available.

Examiner's comments

This question was set to test candidates basic knowledge of practical computing. The percentage of candidates attempting this question was low. Centres should endeavour to provide guidance on these key networking tools and techniques.

B11

{please include question}

Answer pointers

a) A silicon chip that contains a CPU. In the world of personal computers, the terms *microprocessor* and CPU are used interchangeably. At the heart of all personal computers and most workstations sits a microprocessor. Microprocessors also control the logic of almost all digital devices, from clock radios to fuel-injection systems for automobiles.

   Three basic characteristics differentiate microprocessors:
   - **Instruction set :** The set of instructions that the microprocessor can execute.
   - **bandwidth :** The number of bits processed in a single instruction.
   - **clock speed :** Given in megahertz (MHz), the clock speed determines how many instructions per second the processor can execute.

b) A brief coverage of some of the common Intel and/or AMD microprocessors is needed. Issues such as speed and cost can be covered,

Examiner's comments

Candidates were able to provide reasonably structured answers covering a range of reasons why a CPU is needed in a computer. Overall, PCs processors were referred to. Some candidates attempted to describe internal components of a computer covering elements such as control unit, ALU, etc. These were not required.

B12

{please include question}

Answer pointers

Typical services provided by ISPs include a connection line/medium, devices such as a router, access to the internet, browsing the internet, security facilities, data backup. Answers could consider candidates own home ISPs or those of their college or place of work.

Examiner's comments

Most candidates were able to appreciate the range of services offered by ISPs. Some candidates were able to provide detailed answers referring to their own how home/college ISP. Weaker candidates confused ISPs services to facilities offered on the internet.