GCE A LEVEL MARKING SCHEME

SUMMER 2017

A LEVEL (NEW)
COMPUTER SCIENCE - COMPONENT 2
A500U20-1

INTRODUCTION

This marking scheme was used by WJEC for the 2017 examination. It was finalised after detailed discussion at examiners' conferences by all the examiners involved in the assessment. The conference was held shortly after the paper was taken so that reference could be made to the full range of candidates' responses, with photocopied scripts forming the basis of discussion. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners.

It is hoped that this information will be of assistance to centres but it is recognised at the same time that, without the benefit of participation in the examiners' conference, teachers may have different views on certain matters of detail or interpretation.

WJEC regrets that it cannot enter into any discussion or correspondence about this marking scheme.

GCE A LEVEL COMPUTER SCIENCE

SUMMER 2017 MARK SCHEME

		Mark	AO1	AO2	AO3	Total

1a	Accept either:
	
	`CREATE TABLE Order`
	`(`
	`orderNo int NOT NULL,`
	`customerNo int NOT NULL,`
	`orderDate datetime,`
	`handlingCost numeric(5,2),`
	`PRIMARY KEY (orderNo)`
	`)`
	
	or
	
	`CREATE TABLE Order`
	`(`
	`orderNo int NOT NULL PRIMARY KEY,`
	`customerNo int NOT NULL,`
	`orderDate datetime,`
	`handlingCost numeric(5,2),`
	`)`
	
	Award one mark for each of the following:
	• Correct construct (CREATE TABLE with brackets in correct places)
	• Identifying PRIMARY KEY
	• NOT NULL on key field
	• Numeric(x,2), 2 has to be present x can be any sensible number representing pounds
		1
		
		1
		1
		1
					b
					
					b
					b
					b
						4

1bi	`SELECT customerName, customerPhone FROM Customer ORDER BY customerPostcode` 1 mark for SELECT, 1 for ORDER BY	2			b	2

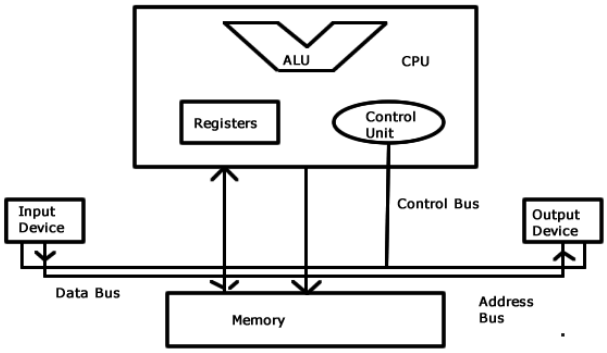
1bii	`SELECT customerName, customerPhone FROM Customer WHERE customerNo = (SELECT customerNo FROM Order WHERE orderDate < 01/03/2016)`
	
	1 mark for each SELECT…. FROM… WHERE …
	
	Accept but not expect:
	
	`SELECT customerName, customerPhone FROM Customer JOIN Order WHERE orderDate < 01/03/2016`
		2			b	2

		Mark	AO1	AO2	AO3	Total

1biii	`SELECT * FROM Order WHERE customerNo = 27 ORDER BY handlingCost DESC`
	
	Or
	
	`SELECT orderNo, orderDate, handlingCost FROM Order WHERE customerNo = 27 ORDER BY handlingCost DESC`
	
	1 mark for SELECT, 1 mark for ORDER BY with DESC
		2			b	2

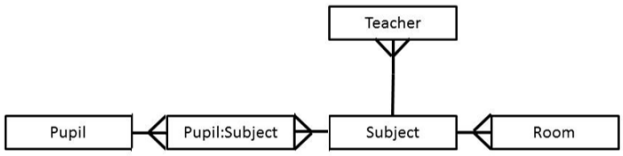
2	Example working solution
	
	`CLR`
	`LDA 1B`
	`STA 20`
	`ROW: LDA 1B`
	`STA 21`
	`COL: OUT 1A`
	`LDA 21`
	`DEC 1C`
	`STA 21`
	`JGT COL`
	`LDA 20`
	`DEC 1C`
	`STA 20`
	`OUT 1D`
	`JGT ROW`
	`CLR`
	
	Or any other working solution.
	
	Award one mark for each of the following:
						6

	• Output newline character and star	1			b	
	• Inner loop for printing stars	1			b	
	• Correct number of columns	1			b	
	• Outer loop for printing rows	1			b	
	• Correct number of rows	1			b	
	• Working solution	1			b	

		Mark	AO1	AO2	AO3	Total
3a	 **Award one mark for each of the following:** • Labelling the data, address and control bus paths correctly (arrows need not be shown) • Identifying all the components correctly • Using the accepted drawing convention for components in the CPU (as detailed in the specification)	 1 1 1	 a a a			3
3b	**Award one mark for each of the following, up to a maximum of four marks:** • Cache memory attempts to solve the "Von Neumann Bottleneck" where the processor runs much faster than the memory by acting as a middleman between main memory and the registers. • Cache is small, extremely fast memory • Placed near or on the processor. • Data and instructions that are used regularly are stored in cache and retrieved by the processor when necessary. • When the cache is full least recently used data is discarded. • Algorithms try to avoid a cache miss (when data has to be fetched from main memory rather than cache).	4	b			4

		Mark	AO1	AO2	AO3	Total
4	**Advantages (Award one mark for each of the following, up to a maximum of four marks [six marks in total]):** • Speech is a very natural way to interact, and it is not necessary to use a keyboard or work with a remote control • No training required for users • Voice is hands-free making it suitable for use in a variety of environments e.g. driving • Suitable for the disabled (qualified) • Can be used to drive several apps in a sequence e.g. Find John Smith and give me directions to him. • Faster than typing on a keyboard (must be qualified not just faster). **Disadvantages (Award one mark for each of the following, up to a maximum of four marks [six marks in total]):** • Even the best speech recognition systems sometimes make errors e.g. homophones • If there is noise or some other sound in the room (e.g. the television or a kettle boiling), the number of errors will increase • Regional accents can affect the outcome • Requires data connection to interpret speech and return results • Delivering sensitive information e.g. credit card details could be a security risk. • Only understands certain foreign languages Any other credible advantage / disadvantage. Advantages and disadvantages can't be the reverse of each other.	6		b		6

		Mark	AO1	AO2	AO3	Total
5a	**TCP/IP** • **Use:** allows any networked computers to communicate with each other • **Importance:** TCP/IP creates packets of data and specifies how packets are routed and transported around a network **FTP** • **Use:** allows the transfer of(large) files over a network. • **Importance:** the FTP protocol has in-built error checking / re-transmission request as necessary.	1 1 1 1	b b b b			4
5b	**Award one mark for each of the following, up to a maximum of four marks:** • Handshaking is the process by which two devices establish their readiness to communicate • Device 1 will send a signal (SYN) to device 2 • Device 2 will acknowledge the signal (SYN-ACK) • Device 1 sends another signal of acknowledgement • Device 1 begins transmission.	4	b			4
6a	**Award one mark for each of the following:** C_{16} -> 00001100_2 9_{16} -> 00001001_2 $00001100_2 + 00001001_2$ -> 00010101_2	 1 1 1		 a a a		3
6b	**Award one mark for each of the following:** B_{16} -> 00001011_2 7 -> 00000111_2 -7 -> 11111001_2 $00001011_2 + 11111001_2$ -> 00000100_2	 1 1 1 1		 a a a a		4
6c	**Award one mark for each of the following:** 45.75_{10} -> 101101.1100_2 -> 0.10110111000_2 with 0110_2 -> 0101101110000110_2	 1 1 1		 a a a		3
6d	**Award one mark for each of the following:** Calculate exponent: 5_{10} Move binary point: 010010.11_2 Decimal Equivalent: 18.75_{10}	 1 1 1		 a a a		3

		Mark	AO1	AO2	AO3	Total
7a	**Award one mark for each of the following, up to a maximum of 4:** Normalisation: • is a way of structuring data according to theoretical rules • normalising data usually reduces data duplication/redundancy • avoids danger of inconsistency / maintains integrity • avoids danger of data being lost during update • avoids wasting processing time • probably enables easier maintenance of the database • allows different views of the data. • 1NF makes field atomic, avoids duplication of items • 2NF Each field depends on the whole primary key • 3NF All data items depend on nothing but the primary key	4	b			4
7b	 **Award one mark for each of the following:** • Pupil to Subject (many-to-many accept not expect intermediate table) • Teacher to Subject (many-to-one) • Room to Subject (many-to-one)	1 1 1		b b b		3

		Mark	AO1	AO2	AO3	Total
8a	**Award one mark for each of the following:** • Over time, the file system fills up then file changes may result in blocks no longer being contiguous as they won't fit back into the space vacated • Files are then split and physically stored on different parts of the disk • Defragmentation consolidates data on a disk • By moving all parts of files to an empty contiguous area.	4	b			4
8b	**Master file** • Holds descriptive data; the actual data that is supposed to be processed and holds the resultant data after the process is completed i.e. long term data records which contain data which does not change or data which is periodically updated • Data is held sequentially, in key field order. • **Example**: Customer details for electricity company **Transaction file** • Contains the transactions i.e. changes that are supposed to be made to the data in the master file • Data is held serially in temporal order i.e. in the order it was collected • **Example**: Customer meter readings for electricity company	1 1 1 1 1 1	b b b b b b			6
9a	**Award 1 mark for each:** • Records are stored in key sequence order (within each data block) • An index allows data to be accessed directly / index contains key field and disk address of record / the key field and index are used to locate the correct position • Advantage - faster access - can use index to access required data directly	3	b			3
9b	**Award 1 mark for each:** • The physical location of the record is calculated using a hashing algorithm • This calculation is carried out on data in the key field(or other mandatory data item) • A data collision occurs when two data items are hashed to the same location • In this case there needs to be overflow areas where the latest data is stored • When there are many items in the overflow area, access may become slow • In which case a new hashing algorithm is required and a larger file may be needed.	6	b			6

		Mark	AO1	AO2	AO3	Total
10	**Award one mark for each of the following, up to a maximum of six marks:** • Asymmetric algorithms have two keys - a private and a public key • Symmetric algorithms have one key that has to be at both ends of a transmission • With asymmetric algorithms a shared secret key does not have to be exchanged over an insecure medium such as the Internet as it does with symmetric algorithms • Asymmetric keys are far slower to use and not feasible for use in transmitting large amounts of data because of the increase in transmission times • Symmetric is best used for data on your own disks as it's fast • Asymmetric is best used for keys, digital signatures, data sent over the web e.g. bank details etc. • In many cases, the public and private key pairs in an asymmetric system can remain intact for many years without compromising the security of the system. E.g. SSL certificates • Asymmetric keys are harder to generate.	6	b			6
11a	**Truncation** 0.10_2 -> 0.5_{10} **Rounding** 0.11_2 -> 0.75_{10} **Original number** 0.10110000_2 -> 0.6875_{10}	 1 1 1		 a a a		3
11b	**Errors** Absolute = original – new Relative = absolute / original **Truncation** Absolute = $0.6875_{10} – 0.5_{10} = 0.1875_{10}$ Relative = $0.1875_{10} / 0.6875_{10} \approx 27.27\%$ **Rounding** Absolute = $0.6875_{10} – 0.75_{10} = -0.0625_{10}$ Relative = $-0.0625_{10} / 0.6875_{10} \approx 9.09\%$ Therefore rounding is more accurate in this instance (only award if at least 2 correct values)	 1 1 1 1 1		 a a a a b		5

		Mark	AO1	AO2	AO3	Total
12	**Indicative content** • Weather forecasts are made by collecting quantitative - numerical - data about the current state of the atmosphere • Data is captured by using a variety of sensors • In the case of weather models, data such as rain fall, temperature and wind speed are fed into a computer • Data is transmitted and collected centrally from thousands of sensors • This data is then put into a mathematical model • Predictions are made based on current conditions • A series of calculations is performed on the raw data on it to determine how it will change over time • Normally, mathematical modelling is done by powerful computers, which can carry out many calculations per second • The computer uses equations produced from the scientific understanding of atmospheric processes • Such as fluid dynamics and thermodynamic equations • The more sophisticated and up-to-date your model is, the more accurate your forecast should be • Parallel processing is generally used for complex calculations in mathematical weather models • Distributed processing enables many computers to share the load • Collaboration across countries • Weather predictions are not always 100% accurate • Equipment is extremely expensive • Weather predictions cannot account for freak weather patterns			b		10

Band	AO3.1c Max 8 Marks
3	**8-10 Marks** The candidate has: • written an extended response that has a sustained line of reasoning which is coherent, relevant, and logically structured • shown clear understanding of the requirements of the question and a clear knowledge of the topics as specified in the indicative content. Clear knowledge is defined as a response that makes eight to ten points in both areas signalled in the indicative content. The top of the mark range would require a clear response in both areas. • addressed the question appropriately with minimal repetition and no irrelevant material • has presented a balanced argument and justified their arguments • effectively drawn together different areas of knowledge, skills and understanding from all relevant areas across the course of study • used appropriate technical terminology referring to the indicative content confidently and accurately.
2	**4-7 Marks** The candidate has: • written a response that has an adequate line of reasoning with elements of coherence, relevance, and logical structure • shown adequate understanding of the requirements of the question and a satisfactory knowledge of the topics as specified in the indicative content. • Satisfactory knowledge is defined as a response that makes four to seven points in either areas signalled in the indicative content. The top of the mark range would require a satisfactory response in both areas • presented an argument with limited justification • drawn together different areas of knowledge, skills and understanding from at least two areas across the course of study • used appropriate technical terminology referring to the indicative content.
1	**1-3 Marks** The candidate has: • written a response that that lacks sufficient reasoning and structure • produced a discussion which is not well developed, and the justification is weak • attempted to address the question but has demonstrated superficial knowledge of the topics specified in the indicative content. Superficial knowledge is defined as a response that makes one to three points as signalled in the indicative content. The top of the mark range would require a superficial response in both areas. • used limited technical terminology referring to the indicative content.
0	**0 Marks** Response not credit worthy or not attempted.

Assessment Objective		Elements	Question										Total	
			1	2	3	4	5	6	7	8	9	10		
AO1	**Demonstrate knowledge and understanding of the principles and concepts of computer science, including abstraction, logic, algorithms and data representation**	1a – Demonstrate knowledge of the principles and concepts of abstraction, logic, algorithms, data representation or others as appropriate		3					4				**7**	<=14
		1b – Demonstrate understanding of the principles and concepts of abstraction, logic, algorithms, data representation or others as appropriate		4		8	9	4	6	6			**37**	
		TOTAL AO1	**0**	**7**	**0**	**8**	**9**	**4**	**10**	**6**	**0**	**0**	**44**	44
AO2	**Apply knowledge and understanding of the principles and concepts of computer science, including to analyse problems in computational terms**	1a – Apply knowledge and understanding of the principles and concepts of computer science			6	6	9			2			**23**	
		1b – Analyse problems in computational terms				6		3				8	**17**	
		TOTAL AO2	**0**	**0**	**6**	**12**	**9**	**3**	**0**	**2**	**0**	**8**	**40**	40
AO3	**Design, program and evaluate computer systems that solve problems, making reasoned judgements about these and presenting conclusions**	1a – Design computer systems that solve problems											**0**	
		1b – Program computer systems that solve problems	6								10		**16**	>=7
		1c – Evaluate computer systems that solve problems, making reasoned judgements about these and presenting conclusions											**0**	
		TOTAL AO3	**6**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**16**	16
		TOTAL AO1 + AO2 + AO3	**6**	**7**	**6**	**20**	**18**	**7**	**10**	**8**	**10**	**8**	**100**	100
		Total Maths Content					**18**						**18**	>=10

		SAM	2017	
Hardware and Communication				
Architecture	Identify and describe the hardware and communication elements of contemporary computer systems and how they are connected			
	Identify and describe the main components of computer architecture, including Von Neumann and contemporary architectures		2a(3)	
	Describe different types of memory and caching		2b(4)	
	Describe and explain parallel processing and the limiting factors to parallelisation			
	Calculate the runtime of given tasks as a result of parallelisation and evaluate the effect of parallelisation			
Fetch-execute cycle	Describe the fetch-execute cycle, including how data can be read from RAM into registers	2a(3)		
Assembly language programming	Write simple programs in assembly language and demonstrate how these programs could be executed	2b(4)	1(6)	
Input / Output	Describe the use of contemporary methods and their associated devices for input and output			
	Explain the use of these methods and devices in contemporary computer systems and their suitability in different situations			
	Describe and differentiate between voice input for command and control systems to operate a computer system, vocabulary dictation systems for verbal input and voice print recognition for security. Discuss the suitability of each system in different situations		3(6)	
Secondary storage	Compare the functional characteristics of contemporary secondary storage devices			
Data storage on disk	Explain fragmentation and its consequences and describe the need for defragmentation		7a(4)	
Networking	Describe networks and how they communicate			
	Explain the importance of networking standards			
	Describe the importance and the use of a range of contemporary protocols including HTTP, FTP, SMTP, TCP/IP, IMAP, DHCP, UDP and wireless communication protocols		4a(4)	
	Explain the role of handshaking		4b(4)	
	Identify and describe applications where connecting a portable device to a network is required			
	Describe the hardware required to make a wireless connection and explain how this might be achieved using contemporary wireless technologies			
Data transmission				
Communication networks	Describe serial and parallel transmission, their advantages and disadvantages			
	Describe simplex, half duplex and full duplex transmission methods	6a(2)		
	Explain the need for multiplexing and switching			
	Describe using appropriate network protocols, such as TCP/IP the typical contents of a packet			
	Explain network collision, network collision detection and how these collisions are dealt with	6b(3)		
	Describe methods of routing traffic on a network			
	Calculate data transfer rates on a network			

	Calculate lowest cost routes on a network			
	Describe the Internet in terms of a world-wide communications infrastructure			
Data representation and data types				
Representation data as bit patterns	Explain the terms bit, byte and word			
	Describe and use the binary number system and the hexadecimal notation as shorthand for binary number patterns	7b(2)		
Storage of characters	Describe how characters and numbers are stored in binary form			
	Describe standardised character sets			
Data types	Describe the different primitive data types: Boolean, character,string, integer and real			
	Describe the storage requirements for each data type			
Representation of numbers as bit patterns	Apply binary arithmetic techniques			
	Explain the representation of positive and negative integers in a fixed-length store using both two's complement and sign and magnitude representation	1ab(3)		
	Describe the nature and use of floating point form			
	State the advantages and disadvantages of representing numbers in integer and floating point forms	1d(2)		
	Convert between real number and floating point form	1c(2)	5abc(9)	
	Describe truncation and rounding, and explain their effect upon accuracy		5d(9)	
	Explain and use shift functions: logical and arithmetic shifts. Interpret and apply shifts in algorithms and programs	7a(4)		
	Describe the causes of overflow and underflow			
Organisation and structure of data				
File design	Explain the purpose of files in data processing			
	Define a file in terms of records and fields			
	Describe how files may be created, organised, updated and processed by programs			
	Explain fixed and variable length fields and records and give examples of the appropriate use of each type			
	Design files and records appropriate for a particular application			
File organisation	Distinguish between master and transaction files		7b(4)	
	Describe sequential, indexed sequential and direct(random) file access.	4a(5)		
	Distinguish between the use of serial and sequential file access methods in computer applications			
	Describe and design algorithms and programs for sequential file access and update			
	Explain the purpose of, and be able to use, a hashing algorithm			
	Compare different hashing algorithms	4b(6)		

	Explain the use of multi-level indexes			
	Explain the techniques used to manage overflow and the need for file re-organisation			
	Explain the need for file security, including file backup, generations of files and transaction logs			
	Describe the need for archiving files			
Databases and distributed systems				
	Explain what is meant by data consistency, data redundancy and data independence			
	Describe and discuss the benefits and drawbacks of relational database systems and other contemporary database systems	8a(3)		
	Explain what is meant by relational database organisation and data normalisation (first, second and third normal forms)	3b(1)	6a(4)	
	Restructure data into third normal form	10b(6)		
	Explain and apply entity relationship modelling and use it to analyse simple problems.	10a(3)	6b(3)	
	Describe the use of primary keys, foreign keys and indexes	3a(2)		
	Describe the advantages of different users having different views of the data in a database			
	Explain how the data can be manipulated to provide the user with useful information			
Data validation and verification	Explain and apply appropriate techniques for data validation and verification of data in databases			
Searching data	Explain the purpose of query languages			
	Construct and run queries using SQL	3c(14)	9(10)	
Database Management Systems	Explain the purpose if a database management system and data dictionaries			
Big Data	Explain what is meant by Big Data, predictive analytics, data warehousing and data mining	8bc(5)		
Distributed systems	Explain that distribution can apply to both data and processing			
	Describe distributed databases and the advantages of such distribution			
The operating system				
Managing ressources	Describe the need for and the role of the operating systems kernel in managing resources, including peripherals, processes, memory protection and backing store			
Providing an interface	Describe the need for and the role of the operating system in providing an interface between the user and the hardware			
Managing Backing Store	Explain the hierarchical structure of a directory and describe file attributes			
Utility software	Explain the need for and use of a range of utility software			
Modes of operation	Describe the main features of batch processing, real time control and real time transaction systems	9a(6)		
	Identify and describe applications that would be suitable to these modes of operation			

Types of Operating System	Explain the following types of system: batch, single-user(standalone), multi-user (multi-access), multi-tasking and multi-programming	9bc(8)		
Consideration of human-computer interaction	Explain the need to design systems that are appropriate to the variety of different users at all levels and in different environments			
Interrupts	Describe a range of conditions or events which could generate interrupts			
	Describe interrupt handling and the use of priorities			
	Describe the factors involved in allocating differing priorities			
Memory management and buffering	Explain the reasons for, and possible consequences of, partitioning of main memory			
	Describe methods of data transfer including the use of buffers to allow for differences in speed of devices			
	Describe buffering and explain why double buffering is used			
Scheduling	Describe the principles of high level scheduling: processor allocation, allocation of devices and the significance of job priorities			
	Explain the 3 states of a process: running, ready and blocked			
	Explain the role of time-slicing, polling and threading			
The need for different types of software systems and their attributes				
Types of software	Explain the use of a range of types of software, including open source software, bespoke and off the shelf			
Safety related systems	Explain that some computer applications are safety related and require a high level of dependability, and hence that the development of safety critical systems is a highly specialised field	11(13)		
Industrial, technical and scientific	Describe the role of the computer in weather forecasting, computer aided design, robotics and the use of computer generated graphics and animation		10(8)	
Control systems	State the nature and scope of computer control and automation			
	Describe the benefits and implications of automation			
Expert systems	Explain the purpose, use and significance of expert systems			
	Discuss the possible effects of expert systems on professional groups and the wider community			
Internet and internet	Describe the use of search engines on the internet			
	Describe common contemporary applications			
	Discuss the possible effects of the internet upon professional groups and the wider community			
Data security and integrity processes				
Protecting data integrity	Explain the special security and integrity problems which can arise during online updating of files			
Privacy and security	Describe the dangers that can arise from the use of computers to manage files of personal data			
	Describe contemporary processes that protect the security and integrity of data including standard clerical procedures, levels of permitted access, passwords for access and write-protect mechanisms		8a(2)	

Cryptography	Describe the need for and the purpose of cryptography			
	Describe techniques of cryptography and their role in protecting data			
	Follow algorithms and programs using in cryptography			
	Compare cryptographic methods and their relative strength		8b(6)	
Biometrics	Describe the purpose and use of contemporary biometric technologies			
	Describe the benefits and drawbacks of biometrics technologies			
	Describe the complexities of capturing, storing and processing biometric data			
Disaster planning	Describe the various potential threats to computer systems			
	Describe contingency planning to recover from disasters			
Malicious and accidental damage	Describe malicious and accidental damage to data and identify situations where either could occur			
Malicious software and mechanisms of attack and defence	Describe types and mechanisms of malicious software and their vectors			
	Describe black hat hacking, white hat hacking and penetration testing			