

GCE A LEVEL – COMPUTER SCIENCE UNIT 4 QUESTION PACK

1500U40-1 · 2015 spec Unit 4 Topic 9 · A2 unit, first sat 2017, 100 marks, 2h paper

REVISE.wales**COMPUTER SCIENCE – UNIT 4 · Computing Applications – Automation, AI, Cloud & Society**

Topic 4.9 – Real-time vs batch processing, expert systems, automation/robotics, voice and biometric interfaces, cloud storage and societal impact

Distinguishing batch processing from real-time transaction processing, the benefits and drawbacks of automation in manufacturing, the difference between safety-related and safety-critical control systems, the role of expert systems, voice and biometric input methods, cloud storage trade-offs, and the wider societal effects of online medical information.

2015 specification · current

Estimated time for entire question pack: ~1 h 14 min

Derived from the Unit 4 pace of ~1.5 min/mark, padded for written-prose answers (49 marks over 7 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **comprehensive topic question pack**, not a single mock paper. It contains every question from the WJEC A2 Unit 4 papers (Summer 2017 – Summer 2024, COVID gap) that maps onto Topic 4.9 of the 2015 specification.

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working. A calculator is allowed where useful.

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Q	Source	Max	Mark
1	S17 Q10	8	
2	S19 Q11	12	
3	S23 Q1	5	
4	S23 Q4	3	

Q	Source	Max	Mark
5	S23 Q9	6	
6	S23 Q15	3	
7	S24 Q12	12	
Total		49	

Computing Applications – Automation, AI, Cloud & Society – what the spec asks

WJEC GCE A Level Computer Science (from 2015) · Unit 4: Computer Architecture, Data, Communication & Applications · Topic 4.9.

Batch vs real-time

- Batch: collect transactions, run together later (e.g. monthly payroll, end-of-day banking).
- Real-time: transaction processed immediately, system state updated before next request (ATMs, booking).
- Trade-offs: batch is efficient, real-time is responsive.
- Some hybrid systems batch-process slow updates while serving real-time queries.

Automation in manufacturing

- Benefits: 24/7 operation, consistent quality, lower per-unit cost, safer for workers.
- Drawbacks: high capital cost, job-displacement and retraining, single-point-of-failure risk.
- Robotics + sensors + control software co-ordinate physical processes.
- Quality control: vision systems detect defects faster than humans.

Safety-related vs safety-critical

- Safety-related: an issue could harm but is part of normal operation (e.g. seat-belt warning).
- Safety-critical: failure could directly cause death, injury or environmental damage (medical pump, fly-by-wire).
- Safety-critical systems need redundancy, formal methods, certification.
- Often subject to standards like IEC 61508, DO-178 (aerospace), ISO 26262 (automotive).

Expert systems

- Encode domain expertise as *facts + rules* in a knowledge base.
- Inference engine applies the rules to user input to deduce conclusions.
- User interface presents questions and explains reasoning.
- Used in medical diagnosis, oil exploration, tax advice; complements but doesn't replace human judgement.

Voice & biometric interfaces

- Voice recognition: speech → text (Siri, Alexa); helps disabled users, hands-free input.
- Voice print: identifies *who* is speaking – biometric authentication.
- Voice control: hands-free device operation (good for surgeons, drivers).
- Trade-offs: accuracy in noisy environments, privacy implications.

Cloud & society

- IaaS / PaaS / SaaS – rent computing resources instead of buying hardware.
- Benefits: elasticity, lower up-front cost, geographic redundancy.
- Risks: vendor lock-in, data sovereignty, breach impact, service outages.
- Online health info: faster access, but mis-information / over-diagnosis / privacy trade-offs.

Computing Applications – Automation, AI, Cloud & Society in one page

Quick-reference notes – revisit before each question.

Batch vs real-time

Batch: queue, run later (payroll, end-of-day banking).
Real-time: instant (ATM, booking, control systems).
Trade-off: efficiency vs latency.

Automation pros / cons

+ 24/7, consistent quality, lower per-unit cost, safer.
- capital cost, job displacement, fragile to upstream faults.

Safety-related vs critical

Related: harm possible if it goes wrong (seat-belt alert).
Critical: harm probable on failure (pacemaker, fly-by-wire). Needs redundancy & certification.

Expert system parts

Knowledge base (facts + rules).
Inference engine.
User interface / explanation.
Knowledge-acquisition tool.

Voice / biometric

Voice recognition: speech → text.
Voice print: who is speaking (biometric).
Helps hands-free / accessibility.
Privacy / accuracy concerns.

Cloud trade-offs

+ elastic, low up-front cost, global redundancy.
- vendor lock-in, data sovereignty, breach impact, outages.

10. Expert systems are widely used by organisations for a variety of purposes. Describe the benefits to an organisation of using an expert system. [8]

11. Explain the use of multi-level indexes and draw a diagram to demonstrate the operation of a three-level index. [6]

12. Khan's Pharmaceuticals currently uses an ID card system to control employee access to its premises. This has proved problematical with employees swapping cards and the company now wishes to use a voice print recognition system in its place.

Describe how this system would operate and explain the benefits and drawbacks associated with a biometric system used for this purpose. [11]

END OF PAPER

8. Define the term **data mining** and describe how three different organisations might use data mining. [8]
9. Describe four data validation techniques. [4]
10. (a) Describe the types of malicious software which might be transferred to computers and the delivery mechanisms, and the steps that can be taken to protect against these. [6]
- (b) Computer data may be at its highest security risk during transfer from one location to another. Outline the risks that exist at this time, and how they can be minimised. [4]
11. A city is developing a new light railway system to connect the city centre to the surrounding suburbs. The system will use driverless trains, and several computer centres will control different areas of the network.
- (a) Give examples of input and output which might be required by control systems on board the trains. [3]
- (b) The system will be safety critical. Explain what is meant by a safety critical system, describing measures that are involved in ensuring safety. [5]
12. Describe the operation of a mainframe computer using a multi-programming, multi-user operating system. [7]
13. Explain what is meant by distributed processing, and describe how this will operate using an example that you have studied. [6]

END OF PAPER

Answer **all** questions.

1. Giving an example for each, describe why the following applications might be preferred over keyboard entry:

- (a) creating a text document by voice recognition. [2]
- (b) controlling an electronic device by voice input. [2]
- (c) managing a security system by voice print recognition. [2]

2. (a) A series of calculations must be carried out to complete a process:

Task 1: $a = bx + cy$

Task 2: $d = ex + f^2$

Task 3: $g = hy - d$

Explain why these tasks are **not** suitable for parallel processing. [2]

- (b) A computer model is to be used to predict economic forecasts for an industrialised country. The model involves many complex calculations. It is estimated that it will take 16 hours to run on a single processor computer.

80% of the algorithm can be carried out in parallel. The remaining parts of the algorithm must be carried out serially.

Determine the time taken to run the parallel processing elements of the economic forecast model on a parallel processing system using 8 processors. [2]

3. In a food factory, packages are filled as they travel along a conveyor belt. The packages are weighed and any underweight packages are rejected.

A control program for the weighing system is to be written in assembly language. The minimum acceptable weight is stored in memory location **R**. The required algorithm is:

```
LOOP continuously
    input package weight
    subtract the value stored in location R from the input weight
    IF the remainder is zero or greater THEN
        output value 1
    ELSE
        output value 2
    ENDIF
FND LOOP
```

The assembly language used by the microprocessor has an instruction set, which includes the following commands:

Assembly Language Command	Description
IN	Input a weight to the accumulator
OUT X	Output a numeric value X
ADD Y	Add the numeric value in location Y to the accumulator, leaving the result in the accumulator
SUB Y	Subtract the numeric value in location Y from the accumulator, leaving the result in the accumulator
JNG LABEL	Jump to LABEL if the contents of the accumulator are less than zero
JMP LABEL	Jump unconditionally to LABEL

Using the algorithm and instruction set, write a program in assembly language to control the weighing system. [6]

4. Giving an example for each, explain what is meant by batch processing and real time transaction processing. [8]

5. (a) Giving an example for each, describe the format of sign and magnitude and two's complement when representing negative binary integers. [4]

(b) A certain computer uses this floating point representation:

<p>Mantissa 10 bits in two's complement form. The binary point in the mantissa is immediately after the leftmost bit.</p>	<p>Exponent 6 bits in two's complement form.</p>
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Find the base-10 (denary) number represented by the floating point value:

0110010101 000110 [2]

6. Describe the process and effects of carrying out arithmetic shifts on a two's complement negative binary number. [4]

7. The owner of a shop requires a program to store stock records. Each stock item has a three-digit identification code in the range 000 to 999. The number of different stock items held by the shop is currently 95.

A programmer considers two different methods of storing the stock records:

- A direct access file with 100 storage locations. The location for each item is calculated using the hash function: $\text{identificationCode} \text{ MOD } 100$.
- A sequential access file with 1000 storage locations. The stock record is stored at the location corresponding to its identification code, so product 715 will be stored at location 715.

Explain the advantages and disadvantages of these two methods. [6]

8. Describe the three basic states of a process in a multi-tasking computer. [6]

9. Improved worker safety is a benefit of automation.

(a) Describe **two other** benefits and **two** drawbacks of automating a manufacturing process. [4]

(b) Explain, giving an example of each type of system, the main purpose of:

- a safety related control system
- a safety critical control system.

[4]

10. A kitchen equipment shop uses a database to record information about products and orders. Two tables with example records are shown:

Product

ProductID	Description	Model	Price
108	Cooker	Ultrachef	342.80
112	Dishwasher	Speedclean	291.50
134	Freezer	IceKing	188.80
196	Cooker	MasterKitchen	405.60

Order

OrderID	Customer	ProductID	OrderDate	Delivered
6291	R. Kelling	108	23 Mar 2020	True
7821	G. Hambleton	112	07 Apr 2020	False
9215	P. Yang	108	19 May 2020	False
9851	S. West	196	22 May 2020	True

- (a) Write an SQL command to list only the description and price for each Product record where the price is less than 300. [2]
- (b) Write an SQL command to list the customer and order date for all orders with a product description 'Cooker'. [3]
- (c) Write an SQL command to add the following record to the Product table:
 A refrigerator with the model name 'Coolstore 2000'. This has been allocated Product ID 288 and has a price of 150.60. [2]
11. A large company has many departments, each of which has different responsibilities. When a major project is carried out, employees from the departments need to work together.
- (a) The company currently uses a single flat file to store all details of the projects. They have discovered that the data structure has several shortcomings. Describe **two** disadvantages for the company of using a flat file to store its data. [4]
- (b) The company has decided to develop a relational database to store details of the projects. Each project will have a title and a project budget. Project teams will be made up of employees from various departments. Each time an employee joins the company they will be allocated to the department that matches their skills. An employee may be a member of more than one project team.
 Design a database system in third normal form for this situation. [5]

12. (a) Explain what is meant by a distributed system and describe what will be distributed in the system. [2]

(b) A car manufacturer has a number of dealerships across the UK. Car owners take their cars for servicing each year to a convenient dealership. Records are kept of servicing, any faults found, and replacement parts fitted.

Explain the advantages to the company of implementing a distributed database system across its dealerships compared with using a single centralised database. [4]

13. (a) Explain the advantages and disadvantages of single key (symmetric) encryption compared with double key (asymmetric) encryption, giving an example, for each method, of a situation where that method would be the most suitable. [6]

(b) Text is stored in 8-bit binary ASCII format, with numeric codes representing each character:

A = 65_{10} $0100\ 0001_2$

B = 66_{10} $0100\ 0010_2$

C = 67_{10} $0100\ 0011_2$

The text is encrypted using a sequential XOR method:

- The first character is encrypted by XOR with the key value $0110\ 1010_2$
- The second character is encrypted by XOR with the encrypted value of the first character
- The third character is encrypted by XOR with the encrypted value of the second character

Using this algorithm, encrypt the word CAB. [3]

14. (a) Identify **two** hardware devices required to make a wireless connection to a network. [2]

(b) State **two** protocols used for wireless digital communication. [2]

(c) Describe **one** disadvantage of using a public wireless network. [2]

15. Information and advice on medical and health issues are readily available to the public through the internet, including online expert systems. Discuss the possible effects of using the internet for this purpose on health professionals and the wider community. [9]

END OF PAPER

- (i) Write an SQL command to output the Make and Model only of the electric cars. [2]
- (ii) Write an SQL command to output the Name of all members who hired a car on 3 Mar 24. [2]
- (iii) Another table is required to record car hire payments. Write an SQL command to create a new table called HirePayments to contain the following fields: [2]

Field name	Example data entry
PaymentID	290
Date	3 Mar 24
MemberID	25
PaymentDue	60.00
Paid	TRUE

You do not need to add the data into the table.

12. Explain the main advantages and the associated security and integrity problems that may arise when using the cloud for storage, backup and online retrieval of files. [12]

END OF PAPER

END OF QUESTION PACK

7 questions · 49 marks · ~1 h 14 min

Source: WJEC A2 Computer Science Unit 4 (1500U40-1), Summer 2017–2024, COVID gap
Curated for WJEC Computer Science 2015 spec A2 Unit 4 – Topic 9 (4.9)

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