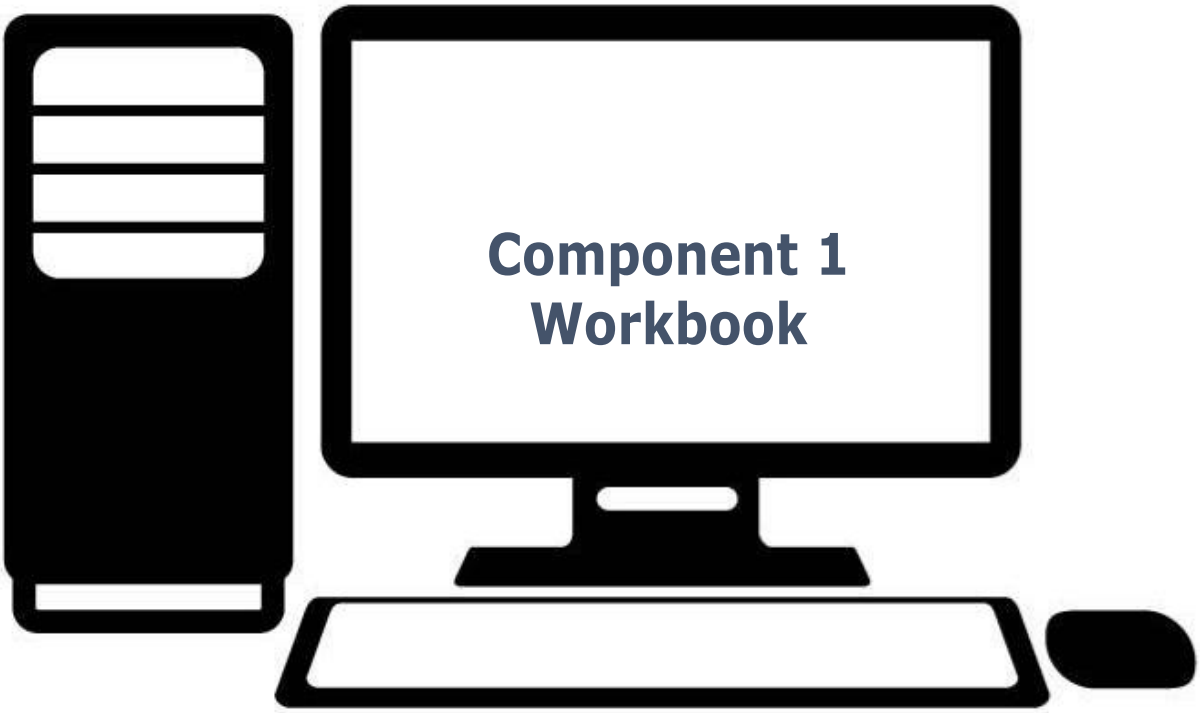
Name: _____



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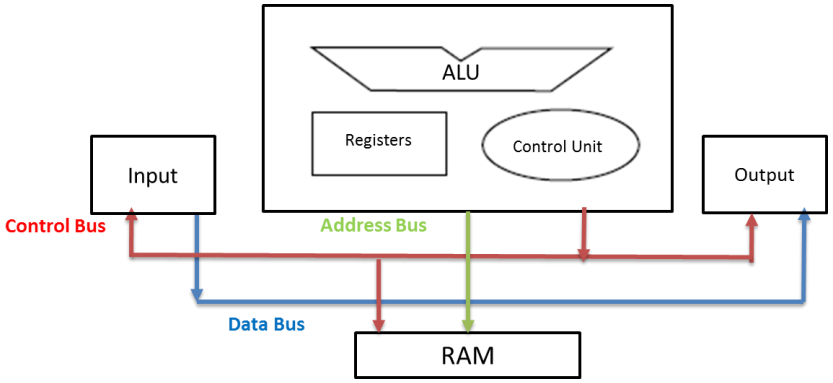
1. Hardware

CPU Central Processing Unit



DEFINITIONS

Controller: manages the execution of instructions
ALU: processes and manipulates data
Register: fast access temporary data store
Internal memory: fast access memory on the CPU

1. Tick (✓) the correct boxes below to show which four of the following items are usually found on the Central Processing Unit (CPU) of a personal computer. [4]
   - ☐ Hard disk drive
   - ☐ Controller
   - ☐ RAM
   - ☐ Internal Memory
   - ☐ Arithmetic Logic Unit (ALU)
   - ☐ BIOS
   - ☐ Registers
   - ☐ ROM

2. Name four components of the Central Processing Unit (CPU) and describe the function of each named component. [8]

   Component 1:
   Function:

   Component 2:
   Function:

   Component 3:
   Function:

   Component 4:
   Function:

3. Describe the stages of the fetch-decode-execute cycle, stating the components involved and their functions in the cycle. [6]

Component 1

CPU Performance and Specification

1. Explain how performance is affected by the cache size, clock speed and number of cores. [6]

2. Explain the difference between RISC and CISC types of processors. [4]

Input and Output

Input devices	**Output devices**
An input device allows data, such as text, images, video or sound, to be entered into a computer system.	There are many outputs created by a computer system. These include printed documents, on-screen data and sound.

1. Sort the following peripheral devices into input and output devices depending on their function. Do any fall into both categories? [3]

   Keyboard Monitor Printer Mouse Touchscreen
   Webcam Speakers Graphics Tablet Projector Scanner

Input	
Output	
Input & Output	

2. Additional hardware components are used in most computer systems. Describe the role of each of the following.

   a. Motherboard [2]

   b. GPU [2]

Primary and Secondary Storage

1. Complete the table below comparing the typical uses of different frequently used backing storage. The first row has been completed for you. [3]

Backing storage	**Typical use (Suitability)**
Compact Disc	Storing and transferring music files or photographs

	Moving small files from work to home
External hard drive	
	Backing up a large commercial server

2. Tick (√) the correct boxes below to show which four of the following items are secondary storage media. [4]

☐ External hard disk drive
☐ CPU
☐ DVD
☐ Cache
☐ Network interface card
☐ Solid state hard drive
☐ USB memory stick
☐ ROM

2. Logical Operations

NOT

The NOT logical operator has only one input and one output. The output is the opposite of the input.

Input (A)	Output (NOT A)
0	**1**
1	**0**

AND

The AND logical operator has two inputs and one output. The output is 1 only if A and B are both 1.

Input (A)	Input (B)	Output (A AND B)
0	0	**0**
0	1	**0**
1	0	**0**
1	1	**1**

OR

The OR logical operator has two inputs and one output. The output is 1 if either A or B is 1.

Input (A)	Input (B)	Output (A OR B)
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**1**

XOR

The XOR logical operator has two inputs and one output. The output is 1 only if A and B are different.

Input (A)	Input (B)	Output (A XOR B)
0	0	**0**
0	1	**1**
1	0	**1**
1	1	**0**

1. Complete the following truth table for the logical **OR** operation, by writing either **False** or **True** in the last column: [4]

A	B	A OR B
True	True	
True	False	
False	True	
False	False	

2. Complete the following truth table for the logical **AND** operation, by writing either **False** or **True** in the last column: [4]

A	B	A AND B
True	True	
True	False	
False	True	
False	False	

3. Complete the following truth tables:

A	B	A AND B	NOT (A AND B)
1	1		
1	0		
0	1		
0	0		

A	B	A AND B	NOT B	(A AND B) OR (NOT B)
1	1			
1	0			
0	1			
0	0			

Boolean Algebra

Notation

- a bar on top of an input variable represents the NOT operator. NOT A = $\bar{A}$
- a dot "." represents the AND function. A and B = A.B
- a plus sign "+" represents the OR function. A or B = A + B
- a plus sign with a circle represents the XOR function. A exclusive or B = $A \oplus B$

Laws of Boolean Algebra

Annulment Law

A.0 = 0 A variable AND 0 is always equal to 0

A + 1 = 1 A variable OR 1 is always equal to 1

Identity Law

A + 0 = A A variable OR 0 is always equal to the variable

A.1 = A A variable AND 1 is always equal to the variable

Idempotent Law

A + A = A A variable OR itself is always equal to the variable

A.A = A A variable AND itself is always equal to the variable

Complement Law

$A.\bar{A} = 0$ A variable AND its complement is always equal to 0

$A + \bar{A} = 1$ A variable OR its complement is always equal to 1

Commutative Law

A.B = B.A The order of two variables with AND makes no difference

A + B = B + A The order of two variables with OR makes no difference

Double Complement Law

$\bar{\bar{A}} = A$ A double complement of a variable is always equal to the variable

Distributive Law

A(B + C) = A.B + A.C (OR Distributive law)

A + (B.C) = (A + B).(A + C) (AND Distributive law)

Absorptive law

A + (A.B) = A (OR Absorption law)

A(A + B) = A (AND Absorption law)

Associative Law

A + (B + C) = (A + B) + C = A + B + C (OR Associative law)

A(B.C) = (A.B)C = A.B.C (AND Associative law)

Component 1

Simplify the following equations. Make sure you show your working for ALL answers.

1. (A.B) +A

2. (A.$\overline{B}$)+B

3. B.(A+A.B)

4. (A.$\overline{B}$)+ $\overline{A}$

3. Communication

Networks

1. A large comprehensive school has over 500 computers connected to their Local Area Network (LAN) with a connection to the Internet.
   Describe, in detail, **four** *disadvantages* for the school of having a network of computers compared to stand alone computers. [8]

   Disadvantage 1:

   Disadvantage 2:

   Disadvantage 3:

   Disadvantage 4:

2. For each network topology below, draw a diagram of the topology and give the advantages and disadvantages of each:

Ring Topology

Diagram	Advantages	Disadvantages

Bus Topology

Diagram	Advantages	Disadvantages

Star Topology

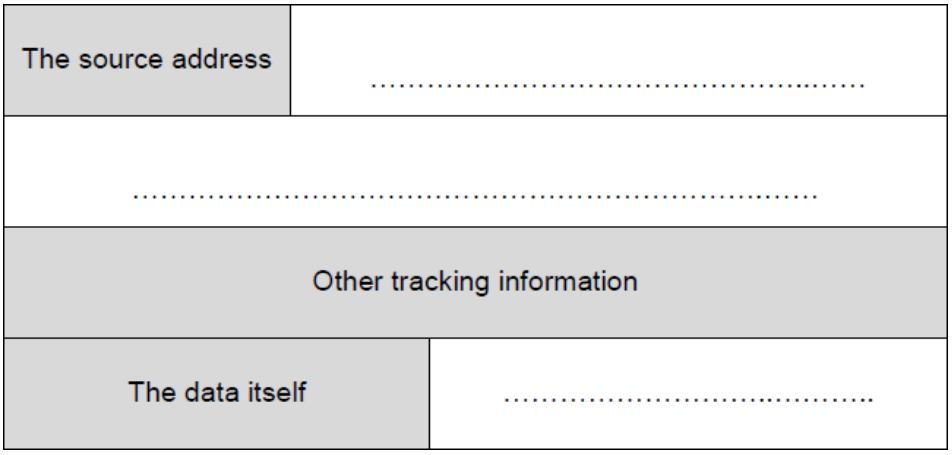
Diagram	Advantages	Disadvantages

Mesh Topology

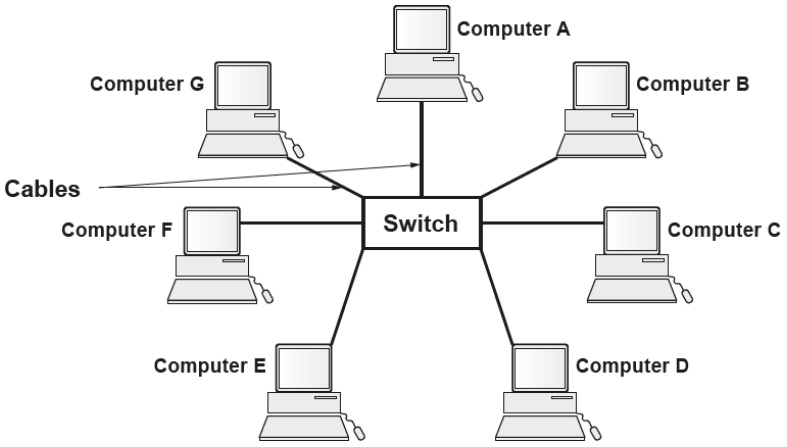
Diagram	Advantages	Disadvantages

Routing

1. Complete the diagram below, which shows the typical contents of a TCP/IP packet. [3]



2. Below is a labelled diagram of a star topology network.



Describe how a packet is transmitted from computer A to computer D, including the role of the switch. [5]

Protocols

1. State a suitable use for the following protocols:

   HTTP (Hypertext Transfer Protocol) [1]

   FTP (File Transfer Protocol) [1]

   SMTP (Simple Mail Transfer Protocol) [1]

2. TCP/IP is a protocol stack used in networking. Complete the table below by placing the five layers of the TCP/IP stack into order (1 – 5), where 1 is the top layer and 5 is the bottom layer). [5]
   Describe the function of each layer. [5]

Layer	Order (1-5)	Description
Network		
Physical		
Application		
Data Link		
Transport		

Internet

Domain names are used because IP addresses are difficult to remember. Explain how a domain name is used to access a web site including the role of Domain Name System (DNS) servers. [6]

4. Organisation and Structure of Data

Representation of Numbers

1. Convert the denary number **212** to a binary number with 8 bits. [2]

2. Convert the denary number **212** to hexadecimal. [2]

3. Convert the hexadecimal number **2F** to denary. [2]

4. Showing your workings, complete the table below, converting between denary, binary and hexadecimal numbers as necessary. [6]

Denary	Binary	Hexadecimal
27_{10}	00011011_2	$1B_{16}$
	10100110_2	$A6_{16}$
39_{10}		27_{16}
44_{10}	00101100_2	

5.

i. Showing your workings, add 010001012 and 001100112. [2]

ii. Using an example of binary addition, explain the concept of overflow. [4]

6. Perform arithmetic shifts on the numbers below and state the effect of each of these operations.

i. Arithmetic shift left by one place on 001010102. [2]

ii. Arithmetic shift right by one place on 00110110_2. [2]

Representation of Graphics and Sound

1. Image files can be stored on a computer using compression.
   a. Give three reasons why image files are compressed. [3]

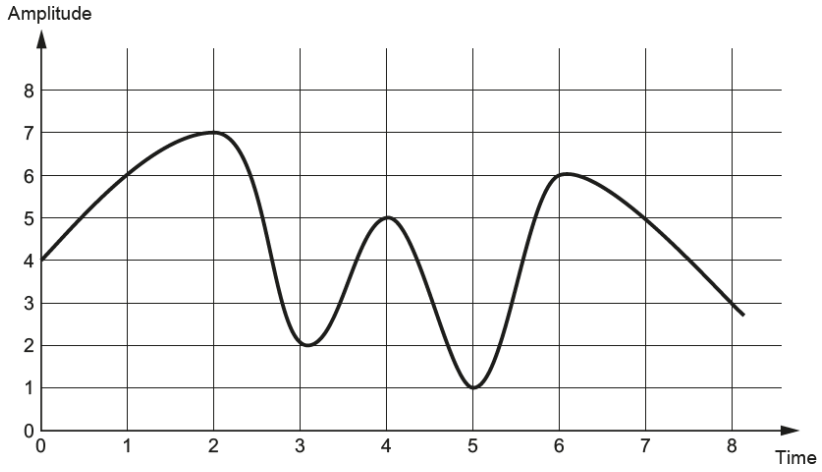
Reason 1:

Reason 2:

Reason 3:

b. Give two examples of metadata that might be stored with an image. [2]

2. Below is a representation of a simple sound wave. The wave is sampled every second and the amplitude is stored as a 4-bit binary number.



3.

a. Complete the table below to show how the wave would be represented in binary. [5]

Time	1	2	3	4	5	6	7	8
Amplitude	6	7	2					3
Binary	0110	0111						0011

b. Taking a sample every second produces a very poor quality sound. Explain how the sample rate could be altered to improve the sound quality. [1]

c. If ten samples were taken every second, state the effect on the size of the file. [1]

Data Structures and Data Types

1. Below is an algorithm.

```
Total is ?          {stores the total of the numbers input}
Mean is ?           {stores the mean of the numbers input}
Count is ?          {stores the loop control value}

startmainprog

        set Total = 0   {initialise variables}
        set Count = 0

        repeat

                set Count = Count + 1
                set Total = Total + Count

        until Count = 20

        output "The total is ", Total

        set Mean = Total / 20
        output "Mean is ", Mean

endmainprog
```

The algorithm has three variables.

State, giving a reason for each, the most suitable data type for the variables below. [4]

Variable: **Mean**

Data Type:

Reason:

Variable: **Count**

Data Type:

Reason:

2. An estate agent stores details about the properties for sale on a computer system.

   For each of the following items name the most suitable data type: [4]

   - the number of bedrooms:
   - the postcode of the property:
   - whether the property is still for sale (e.g. TRUE):
   - the council tax band (e.g. A, B, C):

3. Items of data can be combined together to form a data structure.
   a. Give an example of a data structure that can be used in Python. [1]

   b. A programmer is developing a program that needs to store the names and ages of a group of students. Give **two** advantages of using a data structure to hold this information instead of using individual separate variables for each name and age. [2]

Validation and Verification

1. The table below includes input data for a payroll system. Some of the data can be sensibly validated. Complete the table by filling in the type of validation algorithm. [6]

Data	**Data Type**	**Validation Algorithm**
Surname	String, e.g. Jackson	
National Insurance (NI) number	Standard format LL123456L	
Job title	Apprentice, semi-skilled, skilled, supervisor	
Week no.	Integer	
Full time	Y or N, Full time = 38 hours per week	
Hours worked	Integer, hours worked in current week, maximum 10 hours overtime in one week. Overtime rate = 1.5 x pay rate	
Pay rate	Real, hourly pay rate, max £15.00 / hour	

2. Design an algorithm that will sensibly validate the input data for a diving competition, where entrants must be between 16 and 19 years of age. The competition is to involve 5 dives, with each dive being awarded a score of between 0 and 20. [5]

   The algorithm should verify the entrants age, check that they are eligible for competition and ensure that sensible scores are recorded.

5. Operating Systems

1. Identify and describe **four** roles of the operating system when managing the resources of a personal computer. [8]

Role 1:

Role 2:

Role 3:

Role 4:

2. Command Line Interfaces (CLI) are often used in the computer industry.
   Describe who might use a CLI and give three reasons why they might choose to use a CLI. [4]

3. A restaurant has a computer-based ordering system which is running slowly. A technician has said that the hard disc drive is fragmented. The technician has suggested using utility software to defragment the drive.
   a. Explain how the restaurant's hard disc could have become fragmented. [4]

   b. Explain how defragmentation software could overcome the issue of the slow computer system. [3]

6. Principles of Programming

1. High and low level languages are used by programmers.
   Tick (✓)the correct boxes below to show whether the statements apply to a high or low level language. [3]

STATEMENT	HIGH LEVEL	LOW LEVEL
They are easier to understand, learn and program as commands are similar to natural language.		
They require less time for translation into machine code.		
They are preferred when the execution speed is critical.		

2. Computer programs require translation to execute.
   a) Compilers and interpreters translate high level programming languages into machine code. Describe the main differences between a compiler and an interpreter. [4]

   b) State the main difference between an assembler and both a compiler and an interpreter. [1]

7. Software Engineering

1.

a) One facility of a Software Development Environment is to convert source code to machine code.
Name and briefly describe **four** *other* facilities commonly found in a Software Development Environment. [8]

Facility 1:

Facility 2:

Facility 3:

Facility 4:

b) Give **two** examples of private functions or subprograms commonly stored in a programming library. [2]

Example 1:

Example 2:

8. Program Construction

1. There are four main stages of compilation: lexical analysis; syntax analysis; semantic analysis; code generation.
   Describe what happens at each of these stages of compilation. [8]

   Lexical analysis:

   Syntax Analysis:

   Semantic Analysis:

   Code Generation:

2. Computer programs can contain different types of error.
   a) Giving an example, state what is meant by a syntax error. [2]

   b) Giving an example, state what is meant by a run time error. [2]

   c) Giving an example, state what is meant by a logical error. [2]

3. There are many different types of errors that can occur when developing computer programs.
   a) State the name of the two different types of programming error described below.
      i) Unexpectedly halts the program. [1]

      ii) The program produces the wrong output. [1]

b) Another error can result from incorrectly using the rules or grammar of the programming language.

i) Name this error. [1]

ii) State when this error is detected. [1]

9. Security and Data Management

1) A large comprehensive school has over 500 computers connected to their Local Area Network (LAN) with a connection to the Internet.

a) All staff and pupils have a unique username and a password to access the network. State **three** rules that should apply to users' passwords to reduce the possibility of someone guessing a password. [3]

Rule1:

Rule 2:

Rule 3:

b) All pupil and staff files are stored on servers located in a secure server room.

i) Describe the user access levels pupils should be given for their own files. [1]

ii) Describe the user access levels that should be given for files a teacher wants pupils to view, such as a homework task. [1]

2) A small business stores data about customers on its computer system.
Describe how the business ensures that only employees can access the network.
Describe other security measures the business will have in place to limit how data is accessed by employees.

The business encrypts their data so it cannot be used by hackers even if they gain access to the network. Describe how the data could be encrypted and decrypted by the business.

Describe the procedures the business should have in place to recover data from a natural disaster. Explain how data would be recovered after a fire destroyed the hard discs holding all the customer data.

[10]

3) Image files can be stored on a computer using lossy or lossless compression.

a) Compare lossy and lossless compression, in terms of their effect on quality and file size. [2]

4. A doctor's surgery stores hundreds of patients' details on its computer network. The surgery is concerned about the security of its patients' sensitive medical data.

a) Staff are already required to use strong passwords to protect systems. Explain, with reference to system security, **three** *other* ways that the surgery could protect the system. [6]

b) Identify **three** errors that the surgery's staff could make, that may endanger the security of the network and outline a procedure that could be put in place to prevent each error. [6]

5. Cyber security is essential in the protection against different types of malware.

a) Describe two methods of protection against the use of key loggers. [4]

b) Describe two characteristics of a worm. [2]

10. Ethical, Legal and Environmental Impacts of Digital Technology

1. When a cybersecurity researcher stopped the spread of *WannaCry*, the headlines praised him as a saviour. But just a few short months later he was in handcuffs for allegedly creating a piece of malware that steals banking information.

   Explain the difference between white hat, black hat and grey hat hackers, using the story above as well as other real life examples. [6]

2. Members of staff of a software company each sign a code of conduct when they join the company.

   Describe what would be included in this formal code of conduct. [5]

3. A large organisation stores confidential data about its customers on its network. The Data Protection Act (DPA) applies to the data stored by the organisation.

   Identify **two** principles of the DPA that such an organisation would breach if an unauthorised person incorrectly amended customer data. [2]

4. A software company has employed several new members of staff. As part of their initial training, the company wants to make sure that they are aware of current legislation relevant to computing.

   You have been asked to inform the new employees about their responsibilities under:

   a) The Data Protection Act
   b) The Computer Misuse Act
   c) The Copyright, Designs and Patents Act

   Write a clear set of guidelines for the new employees. [12]

5. Ethical and environmental considerations:

a) Explain what is meant by e-waste. [1]

b) Discuss the environmental issues that arise when computers are disposed of in landfill sites. [4]

c) Describe how the recycling of electronic equipment in Europe and America can cause serious problems for countries such as Ghana in Africa. [4]