4 The table shows part of the instruction set for a processor. The processor has one register, the Accumulator (ACC).

Instruction		**Explanation**
Opcode	**Operand**	
AND	#n / Bn / &n	Bitwise AND operation of the contents of the ACC with the operand
AND	<address>	Bitwise AND operation of the contents of the ACC with the contents of <address>
XOR	#n / Bn / &n	Bitwise XOR operation of the contents of the ACC with the operand
XOR	<address>	Bitwise XOR operation of the contents of the ACC with the contents of <address>
OR	#n / Bn / &n	Bitwise OR operation of the contents of the ACC with the operand
OR	<address>	Bitwise OR operation of the contents of the ACC with the contents of <address>
LSL	#n	Bits in ACC are shifted logically n places to the left. Zeros are introduced on the right-hand end.
LSR	#n	Bits in ACC are shifted logically n places to the right. Zeros are introduced on the left-hand end.
<address> can be an absolute or symbolic address # denotes a denary number, e.g. #127 B denotes a binary number, e.g. B10010001 & denotes a hexadecimal number, e.g. &4A		

(a) The ACC currently contains the following positive binary integer:

0	0	0	1	1	1	1	0

Write a bit manipulation instruction that uses a binary shift to change the contents of the ACC to:

0	1	1	1	1	0	0	0

Instruction ..... [1]

(b) The ACC currently contains the following positive binary integer:

1	1	1	0	0	0	1	1

Write the contents of the ACC after the instruction `XOR &12` is carried out.

[1]

(c) The ACC currently contains the following positive binary integer:

1	1	1	0	0	0	1	1

Write the contents of the ACC after the instruction `AND #63` is carried out.

[1]

(d) The ACC currently contains the following positive binary integer:

1	1	1	0	0	0	1	1

The current contents of memory are:

Address	**Data**
98	00100100
99	00110001
100	00110011
101	10100011
102	10101100

Write the contents of the ACC after the instruction `OR 100` is carried out.

[1]

6 **(a)** The processor uses several registers, including the Accumulator (ACC) and the Current Instruction Register (CIR).

Complete the table by describing the role of each register.

Register	Role
ACC	....
CIR	....

[2]

(b) Increasing the number of cores in a processor can affect the performance of a computer.

Describe the drawbacks of increasing the number of cores in a processor.

.....

.....

.....

..... [2]

(c) State **three** differences between Dynamic RAM (DRAM) and Static RAM (SRAM).

1 .....

.....

2 .....

.....

3 .....

.....

[3]

3 (a) (i) State what is meant by relative addressing.

.....

.....

..... [1]

(ii) Registers such as the Accumulator (ACC) and the Index Register (IX) are used in the CPU.

Identify **two** special purpose registers used in the CPU. Do **not** include the ACC or IX in your answers.

1 .....

2 .....

[2]

(b) The following table shows part of the instruction set for a processor. The processor has two registers: the ACC and an IX.

Instruction		Explanation
Opcode	**Operand**	
LDM	#n	Immediate addressing. Load the number n to ACC
LDD	<address>	Direct addressing. Load the contents of the location at the given address to ACC
LDI	<address>	Indirect addressing. The address to be used is at the given address. Load the contents of this second address to ACC
LDX	<address>	Indexed addressing. Form the address from <address> + the contents of the index register. Copy the contents of this calculated address to ACC
LDR	#n	Immediate addressing. Load the number n to IX
<address> can be an absolute or symbolic address # denotes a denary number, e.g. #127		

The current contents of the main memory and the index register are shown.

Address	Instruction
98	8
99	16
100	3
101	98
102	32
IX	2

Write the contents of the ACC after each instruction is executed.

Instruction	Value in ACC
LDM #98	
LDI 101	
LDX 100	

[3]

(c) A student buys a new computer. The table shows the specifications of the old computer and the new computer.

Old computer	New computer
1.8 GHz dual core processor	2.3 GHz dual core processor
16 MB cache	32 MB cache

Explain why increasing the clock speed **and** increasing the cache memory will improve the performance of the computer.

Clock speed .....

.....

.....

.....

Cache memory .....

.....

.....

.....

[4]

2 **(a)** Data in a computer system is represented in binary.

Put **one** tick (✓) in each row to identify the minimum number of bits used to store each example of data.

Example of data	Number of bits						
	4	**8**	**16**	**24**	**32**	**64**	**128**
the hexadecimal value F139							
16 000 000 unique amplitude values							
an IPv4 address							
256 unique colours							
an IPv6 address							
the denary value 65 000							

[3]

(b) Convert the denary number –108 into a 12-bit two's complement binary number.

..... [1]

(c) A three-place arithmetic shift to the right is performed on the following two's complement negative integer.

Show the result of this arithmetic shift.

10010011

..... [1]

(d) Convert the following positive binary integer into hexadecimal.

1110001100111011

..... [1]

11 The table shows assembly language instructions for a processor that has one register, the Accumulator (ACC).

Label	Instruction		Explanation
	Opcode	**Operand**	
	LDM	#n	Load the number n to ACC
	LDD	<address>	Load the contents of the location at the given address to the ACC
	LDI	<address>	The address to be used is at the given address. Load the contents of this second address to the ACC
	ADD	<address>	Add the contents of the given address to the ACC
	SUB	<address>	Subtract the contents of the given address from the ACC
	STO	<address>	Store the contents of the ACC at the given address
<label>:		<data>	Gives a symbolic address <label> to the memory location with contents <data>
# denotes a denary number, e.g. #123 <label> can be used in place of <address>			

(a) Write **assembly language** code, using **only** the given instruction set to:

- store the denary value 100 as a named constant
- subtract the constant from the value contained in address 632
- store the result in variable Answer.

Show the initialisation of the constant and Answer in the table provided.

.....

.....

.....

.....

.....

.....

Label	Contents

[6]

(b) The address 632 contains the value 45.

State the value of Answer after the code described in part **(a)** has executed.

.....

[1]