Computer Science

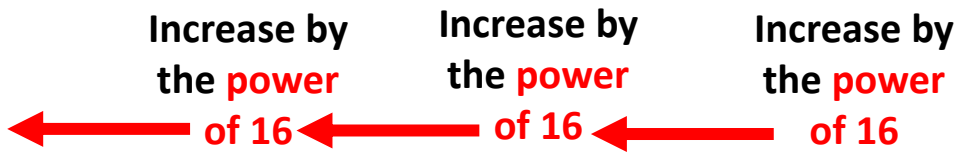
1.1 Data Representation - 1.1.2 Hexadecimal

Candidates should be able to:

- Represent positive numbers in hexadecimal notation
- Convert positive hexadecimal integers to and from denary
- Convert positive hexadecimal integers to and from binary
- Represent numbers stored in registers and main memory as hexadecimal

Hexadecimal is another number system used by computers.

Hexadecimal – A system of values with a **base of 16**. Each unit is increased by the **power of 16**.



16^3	16^2	16^1	16^0
4096	256	16	1

- It is fast and simple to convert between **hexadecimal** numbers and **binary**.
- **Hexadecimal** can be **used** to write large binary numbers in just a few digits which makes it easier to read, write and understand.

16 Symbols

0 – 9 Numbers

A – F Letters

Hexadecimal is sometimes referred to as "hex"

Theory of Computer Science

Computer Science

1.1 Data Representation - 1.1.2 Hexadecimal

128	64	32	16	8	4	2	1
				1	1	1	1

=15

Nibble: 4 Binary units: Example Hexadecimal

16 Symbols

0 – 9 Numbers

A – F Letters

		Binary			
Denary	Hexadecimal	8	4	2	1
0	0	0	0	0	0
1	1	0	0	0	1
2	2	0	0	1	0
3	3	0	0	1	1
4	4	0	1	0	0
5	5	0	1	0	1
6	6	0	1	1	0
7	7	0	1	1	1
8	8	1	0	0	0
9	9	1	0	0	1
10	A	1	0	1	0
11	B	1	0	1	1
12	C	1	1	0	0
13	D	1	1	0	1
14	E	1	1	1	0
15	F	1	1	1	1

Only one symbol is required in hexadecimal for each unit (15 – F)

Theory of Computer Science

Computer Science

1.1 Data Representation - 1.1.2 Hexadecimal

Example use of Hexadecimal: Colour system in HTML.

HEX	F				F				0				0				0				0			
FF0000	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
Binary	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Red #FF0000 → 11111111000000000000000

Zeros on the left do not need to be shown.

Green #00FF00 → 1111111100000000

Blue #0000FF → 11111111

Binary Conversion

Humans find it easier to read hexadecimal values rather than binary.

In the example above it easier to read and understand the hexadecimal for Red, Green & Blue.

Computers read and process binary values

Theory of Computer Science

Computer Science

1.1 Data Representation - 1.1.2 Hexadecimal

Hexadecimal >>>> Denary

	4096	256	16	1
Hexadecimal		1	2	E
Denary		1	2	14
Conversion		256	32	14

Steps to convert 21E (Hex) to Denary

1) Convert each Hex Value to Denary.

Hex	Denary
1	1
2	2
E	14

2) Multiply the Denary value by the Hex position (1, 16, 256 etc)

Hex	position	Conversion
1	256	1*256= 256
2	16	2*16 = 32
14	1	14*1 = 14

3) Add all of the multiplied Values

256 + 32 + 14 = 302

Theory of Computer Science

Computer Science

1.1 Data Representation - 1.1.2 Hexadecimal

Denary >>>> Hexadecimal

Convert 12040 into Hexadecimal

1. 12040 / 16 = 752 R8
2. 752/ 16 = 47 R0
3. 47 / 16 = 2 R15
4. 2 / 16 = 0 R0

Successive division by 16

Remainder is converted into Hex

Multiples of 16											
16	32	48	64	80	96	112	128	144	160	176	192

Division			Working Out	Remainder	Hex
12040	16	752	16 | 12040 = 0 0 7 5 2 R8 (1 12 8 4)	8	8
752	16	47	16 | 752 = 4 7 R0 (7 11)	0	0
47	16	2	16 | 47 = 2 R15 (4)	15	F
2	16	0	16 | 2 = 0 R2	2	2

4096	256	16	1
2	F	0	8

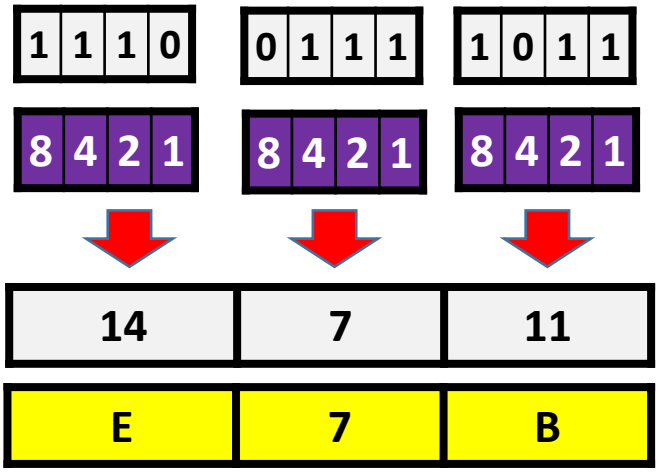
Theory of Computer Science

Computer Science

1.1 Data Representation - 1.1.2 Hexadecimal

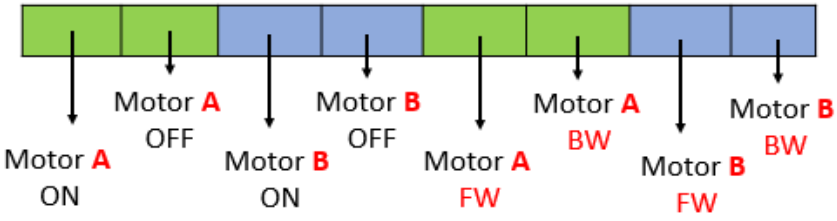
Represent numbers stored in registers and main memory as hexadecimal

4 Binary Bits = 1 Hex Value



Easier for humans to read and understand the Hexadecimal value compared to Binary.

An 8 Bit Register is used to control the movement of the Robot Vacuum cleaner:



Example Question: Convert the binary values into Hexadecimal.

	8	4	2	1	8	4	2	1
FW	1	0	1	0	1	0	1	0
Hex	A				A			
BW	1	0	1	0	0	1	0	1
Hex	A				5			

Denary	Hex
0	0
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	A
11	B
12	C
13	D
14	E
15	F

Theory of Computer Science