1 ASCII code for plain text

Shown below is a hex table for standard ASCII code

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	TAB	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2		!	"	#	$	%	&	′	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	∧	_
6	‘	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	∼	DEL

The row number is the sixteens digit and the column number the units digit.

(a) If your name was the character string 'SPUNDE' then the hex equivalents for each character read from the table are: 53 50 55 4E 44 45
Convert each hexadecimal number to binary:
0101 0011 0101 0000 0101 0101 0100 1110 0100 0100 0100 0101
You can leave the spaces or not (for readability) but the string of "lights" in the computer is represented in ASCII code by the bit string:
010100110101000001010101010011100100010001000101

Decode
010101110110000101101100011101000110010101110010

Break the bit list into blocks of 8 and each block into two blocks of 4:
0101 0111 0110 0001 0110 1100 0111 0100 0110 0101 0111 0010
Convert each block into a hexadecimal number, each bundle of 4 being one place value in hex:
5 7 6 1 6 C 7 4 6 5 7 2
Now read the symbol from the conversion table:
W a l t e r

You can exchange messages with others in this course but the amusing thing is that the messages you send one another will be transmitted in ASCII code (or some super-set of it).

It is very convenient to have functions (in Matlab or J or functions in other software) to do the encoding and decoding. Maybe they are already available (?). Actually, in Matlab, the functions `char` and `double` will do the conversions but only from and to the *decimal* equivalents of the ASCII codes.

```
char([87 97 108 116 101 114])
ans =
      Walter
double('Walter')
ans =
    87    97   108   116   101   114
```

In **J** the supplied constant `a.` gives the list of (extended) ASCII symbols and locating where a symbol is in this list will give the decimal equivalent to the ASCII code.

In Matlab the functions `dec2hex` and `dec2bin` will convert decimals to hex and binary respectively and the functions `hex2dec` and `bin2dec` will perform the inverse operations.

In Matlab the command

```
bits= dec2bin(double('Walter')); reshape(bits',1,prod(size(bits)))
```

will produce the ASCII code for 'Walter'.

Similar functions can be written in **J** and will be defined if you run the script `conversions.ijs` (available from the website) in **J**.

2 Binary and hexadecimal representation of numbers

(a) **Convert the binary numerals 11000101 and 10000101010 to hexadecimal numerals and hence to decimals.**

$11000101_2 = (1100)(0101)_2 = C5_{16}$ $\quad 10000101010_2 = (0100)(0010)(1010)_2 = 42A_{16}$
$C5_{16} = 12 \times 16 + 5 = 197$ $\quad 42A_{16} = 4 \times 256 + 2 \times 16 + 10 = 1066$

(b) **Convert the binary numbers 10111.101 and 0.0010101 to decimals.**

10111.101 is $2^4 + 2^2 + 2 + 1 + 2^{-1} + 2^{-3} = 16 + 7 + 0.5 + 0.125 = 23.625$
0.0010101 is $\frac{1}{8} + \frac{1}{32} + \frac{1}{128} = \frac{21}{128} = 0.1640625$

(c) **Convert the decimal numeral 2008 to a binary one and hence to a hexadecimal one.**

The powers of 2 are tabulated below

n	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
2^n	1	2	4	8	16	32	64	128	256	512	1024	2048	4096	8192	16384

By subtracting 1024 from 2008 we are left with 984, which is 512+472. Continuing on in this way, we see that

$$\begin{aligned} 2008 &= 1024{+}512{+}256{+}128{+}64{+}0{+}16{+}8{+}0{+}0{+}0 \\ &= 2^{10} + 2^9 + 2^8 + 2^7 + 2^6 + 0 + 2^4 + 2^3 + 0 + 0 + 0. \end{aligned}$$

so that in a binary numeral system 2008 is represented by 11111011000.

Grouping in bundles of 16, we have

$$\begin{aligned} 2008 &= (2^2 + 2^1 + 2^0)2^8 + (2^3 + 2^2 + 2^0)2^4 + (2^3) \\ 2008 &= (4 + 2 + 1)16^2 + (8 + 4 + 1)16 + (8) \end{aligned}$$

so, in hex, 2008 is 7D8, which you could also have easily read from (0111)(1101)(1000).

Convert decimal 1943 to hexadecimal first and hence write down its binary representation.

The powers of 16 are tabulated below

n	0	1	2	3	4	5	6
16^n	1	16	256	4096	65536	1048576	16777216

from which we can deduce that $1943 = 7(16^2) + 151 = 7(16^2) + 9(16) + 7$ so that the hex numeral for 1943 is 797. Its binary representation is therefore 011110010111.

(d) **Write the ASCII code for: 2008**

From the ASCII table we get: 00110010000110000001100000011100 0.