

- 1 Base-10: 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
 Octal: 20 21 22 23 24 25 26 27 30 31 32 33 34 35 36 37 40
 Hex: 10 11 12 13 14 15 16 17 18 19 1A 1B 1C 1D 1E 1F 20
 Base-13: A B C 10 11 12 13 14 15 16 17 18 19 23 24 25 26
- 2 (a) 32,768 (b) 67,108,864 (c) 6,871,947,674
- 3 $(4310)_5 = 4 * 5^3 + 3 * 5^2 + 1 * 5^1 = 580_{10}$
 $(198)_{12} = 1 * 12^2 + 9 * 12^1 + 8 * 12^0 = 260_{10}$
 $(735)_8 = 7 * 8^2 + 3 * 8^1 + 5 * 8^0 = 477_{10}$
 $(525)_8 = 5 * 6^2 + 2 * 6^1 + 5 * 6^0 = 197_{10}$
- 4 14-bit binary: 11_1111_1111_1111
 Decimal: $2^{14} - 1 = 16,383_{10}$
 Hexadecimal: 3FFF₁₆
- 5 Let b = base
 (a) $14/2 = (b + 4)/2 = 5$, so b = 6
 (b) $54/4 = (5*b + 4)/4 = b + 3$, so $5 * b = 52 - 4$, and b = 8
 (c) $(2 * b + 4) + (b + 7) = 4b$, so b = 11
- 6 $(x - 3)(x - 6) = x^2 - (6 + 3)x + 6*3 = x^2 - 9x + 18$
 Therefore: $6 + 3 = b + 1$ so b = 8
 Also, $6*3 = (18)_{10} = (22)_8$
- 7 $68BE = 0110_1000_1011_1110 = 110_100_010_111_110 = (64276)_8$
- 8 (a) Results of repeated division by 2 (quotients are followed by remainders):
 $431_{10} = 215(1); 107(1); 53(1); 26(1); 13(0); 6(1) \quad 3(0) \quad 1(1)$
 Answer: $1111_1010_2 = FA_{16}$
 (b) Results of repeated division by 16:
 $431_{10} = 26(15); 1(10)$ (Faster)
 Answer: $FA = 1111_1010$
- 9 (a) $10110.0101_2 = 16 + 4 + 2 + .25 + .0625 = 22.3125$
 (b) $16.5_{16} = 16 + 6 + 5*(.0615) = 22.3125$
 (c) $26.24_8 = 2 * 8 + 6 + 2/8 + 4/64 = 22.3125$

$$(d) FAFA.B_{16} = 15 \cdot 16^3 + 10 \cdot 16^2 + 15 \cdot 16 + 10 + 11/16 = 64,250.6875$$

$$(e) 1010.1010_2 = 8 + 2 + .5 + .125 = 10.625$$

$$10 \quad (a) 1.10010_2 = 0001.1001_2 = 1.9_{16} = 1 + 9/16 = 1.563_{10}$$

$$(b) 110.010_2 = 0110.0100_2 = 6.4_{16} = 6 + 4/16 = 6.25_{10}$$

Reason: 110.010_2 is the same as 1.10010_2 shifted to the left by two places.

$$11 \quad \begin{array}{r} 1011.11 \\ 101 \overline{) 111011.0000} \\ \underline{101} \\ 01001 \\ \underline{101} \\ 1001 \\ \underline{101} \\ 1000 \\ \underline{101} \\ 0110 \end{array}$$

The quotient is carried to two decimal places, giving 1011.11

$$\text{Checking: } 111011_2 / 101_2 = 59_{10} / 5_{10} \cong 1011.11_2 = 58.75_{10}$$

$$12 \quad (a) 10000 \text{ and } 110111$$

$$\begin{array}{r} 1011 \\ +101 \\ \hline 10000 = 16_{10} \end{array}$$

$$\begin{array}{r} 1011 \\ \times 101 \\ \hline 1011 \\ 1011 \\ 1011 \\ \hline 110111 = 55_{10} \end{array}$$

$$(b) 62_h \text{ and } 958_h$$

$$\begin{array}{r} 2E_h \quad 0010_1110 \\ +34_h \quad 0011_0100 \\ \hline 62_h \quad 0110_0010 = 98_{10} \end{array}$$

$$\begin{array}{r} 2E_h \\ \times 34_h \\ \hline B^38 \\ 8^2A \\ \hline 9\ 5\ 8_h = 2392_{10} \end{array}$$

$$13 \quad (a) \text{ Convert } 27.315 \text{ to binary:}$$

	Integer Quotient		Remainder	Coefficient
27/2 =	13	+	$\frac{1}{2}$	$a_0 = 1$
13/2	6	+	$\frac{1}{2}$	$a_1 = 1$
6/2	3	+	0	$a_2 = 0$
3/2	1	+	$\frac{1}{2}$	$a_3 = 1$
$\frac{1}{2}$	0	+	$\frac{1}{2}$	$a_4 = 1$

$$27_{10} = 11011_2$$

	Integer	Fraction	Coefficient
.315 x 2 =	0	+ .630	$a_1 = 0$
.630 x 2 =	1	+ .26	$a_2 = 1$
.26 x 2 =	0	+ .52	$a_3 = 0$
.52 x 2 =	1	+ .04	$a_4 = 1$

$$.315_{10} \cong .0101_2 = .25 + .0625 = .3125$$

$$27.315 \cong 11011.0101_2$$

(b) $2/3 \cong .666666667$

	Integer	Fraction	Coefficient
.6666_6666_67 x 2 =	1	+ .3333_3333_34	$a_1 = 1$
.3333333334 x 2 =	0	+ .6666666668	$a_2 = 0$
.6666666668 x 2 =	1	+ .3333333336	$a_3 = 1$
.3333333336 x 2 =	0	+ .6666666672	$a_4 = 0$
.6666666672 x 2 =	1	+ .3333333344	$a_5 = 1$
.3333333344 x 2 =	0	+ .6666666688	$a_6 = 0$
.6666666688 x 2 =	1	+ .3333333376	$a_7 = 1$
.3333333376 x 2 =	0	+ .6666666752	$a_8 = 0$

$$.666666667_{10} \cong .10101010_2 = .5 + .125 + .0313 + .0078 = .6641_{10}$$

$$.10101010_2 = .1010_2 .1010_2 = .AA_{16} = 10/16 + 10/256 = .6641_{10} \text{ (Same as (b)).}$$

14	(a)	1000_0000	(b)	0000_0000	(c)	1101_1010
	1s comp:	0111_1111		1s comp:	1111_1111	1s comp: 0010_0101
	2s comp:	1000_0000		2s comp:	0000_0000	2s comp: 0010_0110

(d)	0111_0110	(e)	1000_0101	(f)	1111_1111
1s comp:	1000_1001	1s comp:	0111_1010	1s comp:	0000_0000
2s comp:	1000_1010	2s comp:	0111_1011	2s comp:	0000_0001

15	(a)	52,784,630	(b)	63,325,600
	9s comp:	47,215,369		9s comp: 36,674,399
	10s comp:	47,215,370		10s comp: 36,674,400

(c)	25,000,000	(d)	00,000,000
9s comp:	74,999,999	9s comp:	99,999,999
10s comp:	75,000,000	10s comp:	00,000,000

16	B2FA	B2FA:	1011_0010_1111_1010
15s comp:	4D05	1s comp:	0100_1101_0000_0101
16s comp:	4D06	2s comp:	0100_1101_0000_0110 = 4D06

17	(a)	3409 → 03409 → 96590 (9s comp) → 96591 (10s comp)
		06428 - 03409 = 06428 + 96591 = 03019

(b)	1800 → 01800 → 98199 (9s comp) → 98200 (10 comp)
	125 - 1800 = 00125 + 98200 = 98325 (negative)
	Magnitude: 1675
	Result: 125 - 1800 = 1675

(c) $6152 \rightarrow 06152 \rightarrow 93847$ (9s comp) $\rightarrow 93848$ (10s comp)
 $2043 - 6152 = 02043 + 93848 = 95891$ (Negative)
 Magnitude: 4109
 Result: $2043 - 6152 = -4109$

(d) $745 \rightarrow 00745 \rightarrow 99254$ (9s comp) $\rightarrow 99255$ (10s comp)
 $1631 - 745 = 01631 + 99255 = 0886$ (Positive)
 Result: $1631 - 745 = 886$

18 Note: Consider sign extension with 2s complement arithmetic.

<p>(a)</p> <pre> 10001 1s comp: 01110 2s comp: 01111 10011 Diff: 00010 </pre>	<p>(b)</p> <pre> 100011 1s comp: 1011100 with sign extension 2s comp: 1011101 0100010 1111111 sign bit indicates that the result is negative 0000001 2s complement -000001 result </pre>
<p>(c)</p> <pre> 101000 1s comp: 1010111 2s comp: 1011000 001001 Diff: 1100001 (negative) 0011111 (2s comp) -011111 (diff is -31) </pre>	<p>(d)</p> <pre> 10101 1s comp: 1101010 with sign extension 2s comp: 1101011 110000 0011011 sign bit indicates that the result is positive Check: $48 - 21 = 27$ </pre>

19 $+9286 \rightarrow 009286$; $+801 \rightarrow 000801$; $-9286 \rightarrow 990714$; $-801 \rightarrow 999199$

(a) $(+9286) + (+801) = 009286 + 000801 = 010087$

(b) $(+9286) + (-801) = 009286 + 999199 = 008485$

(c) $(-9286) + (+801) = 990714 + 000801 = 991515$

(d) $(-9286) + (-801) = 990714 + 999199 = 989913$

20 $+49 \rightarrow 0_110001$ (Needs leading zero indicate + value); $+29 \rightarrow 0_011101$ (Leading 0 indicates + value)
 $-49 \rightarrow 1_001111$; $-29 \rightarrow 1_100011$

(a) $(+29) + (-49) = 0_011101 + 1_001111 = 1_101100$ (1 indicates negative value.)
 Magnitude = 0_010100 ; Result $(+29) + (-49) = -20$

(b) $(-29) + (+49) = 1_100011 + 0_110001 = 0_010100$ (0 indicates positive value)
 $(-29) + (+49) = +20$

(c) Must increase word size by 1 (sign extension) to accomodate overflow of values:
 $(-29) + (-49) = 11_100011 + 11_001111 = 10_110010$ (1 indicates negative result)
 Magnitude: $1_001110 = 78_{10}$
 Result: $(-29) + (-49) = -78$

- 21 $+9742 \rightarrow 009742 \rightarrow 990257$ (9's comp) $\rightarrow 990258$ (10s) comp
 $+641 \rightarrow 000641 \rightarrow 999358$ (9's comp) $\rightarrow 999359$ (10s) comp

(a) $(+9742) + (+641) \rightarrow 010383$

(b) $(+9742) + (-641) \rightarrow 009742 + 999359 = 009102$
 Result: $(+9742) + (-641) = 9102$

(c) $-9742 + (+641) = 990258 + 000641 = 990899$ (negative)
 Magnitude: 009101
 Result: $(-9742) + (641) = -9101$

(d) $(-9742) + (-641) = 990258 + 999359 = 989617$ (Negative)
 Magnitude: 10383
 Result: $(-9742) + (-641) = -10383$

- 22 8,723

BCD: 1000_0111_0010_0011

ASCII: 0_011_1000_011_0111_011_0010_011_0001

- 23

1000	0100	0010	(842)
<u>0101</u>	<u>0011</u>	<u>0111</u>	(+537)
1101	0111	1001	
<u>0110</u>			
0001	0011	0111	0101 (1,379)

- 24 (a)

6	3	1	1	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	1	0	0	3
0	1	1	0	4 (or 0101)
0	1	1	1	5
1	0	0	0	6
1	0	1	0	7 (or 1001)
1	0	1	1	8
1	1	0	0	9

- (b)

6	4	2	1	Decimal
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
1	0	0	0	6 (or 0110)
1	0	0	1	7
1	0	1	0	8
1	0	1	1	9

- 25 (a) 5,137₁₀ BCD: 0101_0011_0111
 (b) Excess-3: 1000_0100_0110_1010
 (c) 2421: 1011_0001_0011_0111
 (d) 6311: 0111_0001_0100_1001

- 26 5,137 9s Comp: 4,862
 2421 code: 0100_1110_1100_1000
 1s comp: 1011_0001_0011_0111 same as (c) in 1.25

28 G (dot) (space) B o o l e
01000111_11101111_01101000_01101110_00100000_11000100_11101111_11100101

29 Bill Gates

30 73 F4 E5 76 E5 4A EF 62 73

73: 0_111_0011 s
F4: 1_111_0100 t
E5: 1_110_0101 e
76: 0_111_0110 v
E5: 1_110_0101 e
4A: 0_100_1010 j
EF: 1_110_1111 o
62: 0_110_0010 b
73: 0_111_0011 s

31 62 + 32 = 94 printing characters

32 bit 6 from the right

33 (a) 897 (b) 564 (c) 871 (d) 2,199

34 ASCII for decimal digits with odd parity:

(0):	10110000	(1):	00110001	(2):	00110010	(3):	10110011
(4):	00110100	(5):	10110101	(6):	10110110	(7):	00110111
(8):	00111000	(9):	10111001				