Number Conversions and Operations

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Number systems

A number system is a way of writing numbers. Its **base** is how many digits it uses. We write the base small after the number, like $(101)_2$.

System	Base	Digits	Example
Binary	2	0 1	$(1011)_2$
Octal	8	0 1 2 3 4 5 6 7	$(57)_8$
Decimal	10	0 1 2 3 4 5 6 7 8 9	$(46)_{10}$
Hexadecimal	16	0 1 2 3 4 5 6 7 8 9 A B C D E F A = 10, B = 11, C = 12, D = 13, E = 14, F = 15	$(2E)_{16}$

Three parts

Part 1

Q1 – Q6

From a smaller base to a bigger base

Binary → Decimal	2 → 10
Octal → Decimal	8 → 10
Binary → Octal	2 → 8
Binary → Hexadecimal	2 → 16

Special case

Hexadecimal → Decimal 16 → 10

bigger to smaller, but we still multiply

Part 2

Q7 – Q12

From a bigger base to a smaller base

Decimal → Binary	10 → 2
Decimal → Octal	10 → 8
Octal → Binary	8 → 2
Hexadecimal → Binary	16 → 2

Special case

Decimal → Hexadecimal 10 → 16

smaller to bigger, but we still divide

Part 3 · Operations

Q13 – Q15

Binary addition and subtraction

For Dr. Ismail only in this quiz.

PART 1

From a smaller base to a bigger base

Q1 Binary → Decimal

Multiply each digit by the base raised to its position, then add.

Convert to decimal.

a) $(10110)_2$

b) $(1100101)_2$

c) $(101.11)_2$

d) $(11010.101)_2$

Q2 Octal → Decimal

Multiply each digit by the base raised to its position, then add.

Convert to decimal.

a) $(47)_8$

b) $(365)_8$

c) $(12.4)_8$

d) $(207.14)_8$

Q3 Hexadecimal → Decimal

Multiply each digit by the base raised to its position, then add.

Change letters to numbers first: A = 10, B = 11, C = 12, D = 13, E = 14, F = 15

Convert to decimal.

a) $(3B)_{16}$

b) $(1A7)_{16}$

c) $(F.8)_{16}$

d) $(A9.C)_{16}$

Q4 Binary → Octal

Split into groups of 3 from the point. Read each group like Q1, with (2) and its powers.

Add zeros only at the two ends to complete a group (red zeros).

Convert to octal.

a) $(110101)_2$

b) $(1011100)_2$

c) $(101.11)_2$

d) $(11010.0101)_2$

Q5 Binary → Hexadecimal

Split into groups of 4 from the point. Read each group like Q1, with (2) and its powers.

Add zeros only at the two ends to complete a group (red zeros).

Convert to hexadecimal.

a) $(11011110)_2$

b) $(1010111)_2$

c) $(1111.01)_2$

d) $(101101.1011)_2$

Q6 Check yourself

Convert $(11101.1)_2$ **to:**

a) decimal

b) octal

c) hexadecimal

d) Convert your answers to (b) and (c) back to decimal. Do you get (a)?

PART 2

From a bigger base to a smaller base

Q7 Decimal → Binary

1 Whole part: divide by 2, read **up** 2 Fraction: multiply by 2, read **down**

Convert to binary.

a) $(13)_{10}$

b) $(46)_{10}$

c) $(10.5)_{10}$

d) $(19.375)_{10}$

Q8 Decimal → Octal

1 Whole part: divide by 8, read **up** 2 Fraction: multiply by 8, read **down**

Convert to octal.

a) $(59)_{10}$

b) $(250)_{10}$

c) $(9.25)_{10}$

d) $(87.125)_{10}$

Q9 Decimal → Hexadecimal

1 Whole part: divide by 16, read **up** 2 Fraction: multiply by 16, read **down**

Remainders 10 to 15 become letters: A = 10, B = 11, C = 12, D = 13, E = 14, F = 15

Convert to hexadecimal.

a) $(47)_{10}$

b) $(300)_{10}$

c) $(26.5)_{10}$

d) $(255.25)_{10}$

Q10 Octal → Binary

1. Write each digit as 3 bits, with (2) and its powers
2. Keep the point in its place

Red zeros complete 3 bits. In the answer, drop zeros at the two ends.

Convert to binary.

a) $(63)_8$

b) $(470)_8$

c) $(7.2)_8$

d) $(31.64)_8$

Q11 Hexadecimal → Binary

1. Write each digit as 4 bits, with (2) and its powers
2. Keep the point in its place

Red zeros complete 4 bits. In the answer, drop zeros at the two ends.

Convert to binary.

a) $(9F)_{16}$

b) $(2B4)_{16}$

c) $(C.4)_{16}$

d) $(5E.A)_{16}$

Q12 Check yourself

Convert $(45.75)_{10}$ to (a) binary, (b) octal and (c) hexadecimal. Then (d) convert your answers to (b) and (c) to binary, the way you did in Q10 and Q11. Do you get (a)?

PART 3

Operations: binary addition and subtraction

For Dr. Ismail only in this quiz.

Q13 Binary addition

Write the numbers under each other, lined up on the right. Add one column at a time, from right to left.

$0 + 0 = \mathbf{0}$

$0 + 1 = \mathbf{1}$

$1 + 1 = \mathbf{0}$ carry 1 to the next column

$1 + 1 + 1 = \mathbf{1}$ carry 1 to the next column

Add.

a) $(100011)_2 + (100110)_2$

b) $(111110)_2 + (10111)_2$

c) $(1110111)_2 + (110110)_2$

d) $(11111)_2 + (11011)_2$

Q14 Binary subtraction

Write the bigger number on top, lined up on the right. Subtract one column at a time, from right to left.

$0 - 0 = \mathbf{0}$

$1 - 0 = \mathbf{1}$

$1 - 1 = \mathbf{0}$

$0 - 1 = \mathbf{1}$ borrow 1 from the next column on the left

Subtract.

a) $(10101)_2 - (1010)_2$

b) $(101001)_2 - (11011)_2$

c) $(100001)_2 - (11)_2$

d) $(1010000)_2 - (101011)_2$

Q15 Check yourself

Let $A = (10110)_2$ and $B = (1011)_2$.

a) Find $A + B$.

b) Subtract B from your answer to (a). Do you get A back?

c) Convert A, B and your answer to (a) to decimal, like Q1. Does the sum still match?