Worksheet: Binary Expansion (Example 6)

Part A — Worked Example

Problem. Find the binary expansion of $(241)_{10}$.

Step 1: Recall. To convert a decimal number to binary (base 2), divide repeatedly by 2 and record the remainders. The remainders (read bottom-to-top) give the binary digits.

Step 2: Divide 241 **by** 2**.**

$$241 = 2 \cdot 120 + 1$$

Remainder $= 1$.

Step 3: Divide 120 **by** 2**.**

$$120 = 2 \cdot 60 + 0$$

Remainder $= 0$.

Step 4: Divide 60 **by** 2**.**

$$60 = 2 \cdot 30 + 0$$

Remainder $= 0$.

Step 5: Divide 30 **by** 2**.**

$$30 = 2 \cdot 15 + 0$$

Remainder $= 0$.

Step 6: Divide 15 **by** 2**.**

$$15 = 2 \cdot 7 + 1$$

Remainder $= 1$.

Step 7: Divide 7 **by** 2**.**

$$7 = 2 \cdot 3 + 1$$

Remainder $= 1$.

Step 8: Divide 3 **by** 2**.**

$$3 = 2 \cdot 1 + 1$$

Remainder $= 1$.

Step 9: Divide 1 **by** 2**.**

$$1 = 2 \cdot 0 + 1$$

Remainder $= 1$, quotient $= 0$. Stop here.

Step 10: Collect remainders. Reading bottom-to-top: 11110001.

$$(241)_{10} = (11110001)_2.$$

$\boxed{(241)_{10} = (11110001)_2}$

Part B — Easier Practice Problems

1. Convert $(13)_{10}$ to binary. 2. Convert $(100)_{10}$ to binary.

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Part C — Harder Challenge

Convert $(1023)_{10}$ into binary. (Hint: $1023 = 2^{10} - 1$.)