# Unsigned Multiplication

Q = 171 = 10101011  
M = 213 = 11010101

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Count | C | A | | | | | | | | Q | | | | | | | | M | | | | | | | | Step |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | Values |
|  |  | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Add |
| 7 |  | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Add |
| 6 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
| 5 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Add |
| 4 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
| 3 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Add |
| 2 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
| 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | Add |
| 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |

Product = 1000111001000111 = 36423

# Signed Multiplication (Booth’s Algorithm)

## One negative sign

Q = 111 = 01101111  
M = -43 = 11010101

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Count | A | | | | | | | | Q | | | | | | | | Q-1 | M | | | | | | | | Step |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | Values |
|  | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 7 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |
| 6 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |
| 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A+M |
| 3 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A+M |
| 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |

Product = 1110110101011011 = -4773

By taking 2’s complement   
Product’s magnitude = 0001001010100101 = 4773

## Both negative sign

Q = -111 = 10010001  
M = -43 = 11010101

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Count | A | | | | | | | | Q | | | | | | | | Q-1 | M | | | | | | | | Step |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | Values |
|  | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 7 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A+M |
| 6 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
| 5 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
| 4 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 3 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A+M |
| 2 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
| 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |  |  |  |  |  |  |  |  | Shift |

Product = 0001001010100101 = 4773

# Unsigned Division

Q = 246 = 11110110  
M = 123 = 01111011

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Count | A | | | | | | | | Q | | | | | | | | M | | | | | | | | Step |
| 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | Values |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |
|  | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |
|  | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 4 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |
|  | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 3 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |
|  | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
|  | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | A-M |
| 2 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |
|  | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  |  | Shift |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  | A-M |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |  |  |  |  |  |  |  |  | Shift |
| 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |  |  |  |  |  |  |  | 1 |  |  |  |  |  |  |  |  | A-M |
|  | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |  |  |  |  |  |  |  | 0 |  |  |  |  |  |  |  |  | A+M |

Quotient = Q = 00000010 = 2; Remainder = A = 00000000 = 0