Bride of the Lazy Man

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The Lazy Man's wife said, "All your methods for arithmetic are no good for me, because I never learned the multiplication table, and now I'm 22 and too old to learn anything new."

"Don't worry about that," said the Lazy Man. "You can multiply just fine if you only know how to add. Suppose you need to find 16 times 31, for instance. Just do it like this."

16	31	
8	62	
4	124	$16 \times 31 = 496$
2	248	
1	$*\,496$	

Even I can understand that," said the Lazy Man's wife. (EXPLAIN!) "But suppose I want to mutliply by 17 or 18 or 24."

"No problem. $17 \times 31 = 16 \times 31 \;\; + 31$.
$24 \times 31 = 12 \times 62 = 6 \times 124 = 3 \times 248 = 496 \;\; + \;\; 248$.
Write it like this:

17	$*$ 31	18	31	24	31
8	62	9	$*$ 62	12	62
4	124	4	124	6	124
2	228	2	248	3	$*\,248$
1	$*\,496$	1	$*\,496$	1	$*\,496$
	527		558		744 ."

"I don't quite understand," said the Lazy Man's wife. "What are the asterisks for? All this must have something to do with the distributive law, I suppose. Most everything seems to."

1. Complete the description of the method by explaining what the asterisks are for and where to put

them. Explain why the method works. (HINT: Sometimes when you move down one line in a pair of columns, the product of the two numbers remains the same. For instance, 18×31 is the same as 9×62. But sometimes it gets smaller, for instance 9×62 is bigger than 4×124. What makes the difference, and how is this difference compensated for in the final calculation?)

2. Use the method to do the following calculuations:

a) 31×31 **b)** 27×31 **c)** 19×31

d) 19×52 **e)** 26×52

3. The method above suggests that any number (for instance 16, 17, 24, etc.) can be expressed in terms of a code: Write a left-hand column as if using the above multiplication method to multiply the number in question by some other number, and put in the asterisks. Now write a 1 to represent an asterisk and a 0 to represent no asterisk. Read this **from the bottom up.**
Some examples of one-zero codes for numbers:

16 — 10000	17 — 10001	18 — 10010
20 — 10100	24 — 11000	31 — 11111

Find the one-zero codes for the following numbers:

a) 19 **b)** 27 **c)** 30 **d)** 20 **e)** 26 **f)** 39

4. Invent an efficient method for taking a one-zero code and recovering the original number. Describe your method clearly (using words and examples) and use it to find the original numbers producing the following coes:

a) 10 **b)** 111 **c)** 100101 **d)** 11001100

5. It is a fact that every positive integer can be written as a sum of different powers of 2 (including $2^0 = 1$). For instance,

$$25 = 16 + 8 + 1 = 2^4 + 2^3 + 2^0.$$

Show how this is related to the one-zero codes. The following example may help.

16	8	1 *	25 *
8	4		12
4	2		6
2	1 *		3 *
1 *			1 *

"Who invented this method of multiplication anyway?" the Lazy Man's wife asked.

"I don't know. It's very old, in any case. People sometimes call it Russian Peasant Multiplication, or just Peasant Multiplication."

But this turned out to be the wrong thing for the Lazy Man to tell his wife, and it was quite a while before he was able to talk to her about mathematics again, or in fact to get her to speak to him at all.