The University of Georgia

Mathematics Education Program

J. Wilson, EMAT 6600

Chicken McNugget

By Leighton McIntyre

Goal: To calculate the maximum that cannot be purchased given combinations of boxes

Problem

McDonalds sells Chicken McNuggets in boxes of 6, 9, or 20. Obviously one could purchase exactly 15 McNuggets by buying a box of 6 and a box of 9.

Could you purchase exactly 17 McNuggets? No; because no combination of 9s and 6s can give 17.

How would you purchase exactly 53 McNuggets? One 6, three 9s, and one 20, or Four 6s, one 9, and one 20.

What is the largest number for which it is **impossible** to purchase exactly that number of McNuggets?

The answer is 43.

Solution

For any desired number if it is divisible by 3 it can easily be made with 6 and 9 packs, except if the number is 3 itself. If you can't use all six packs then use one 9 pack and you can do the rest with six packs.

If the number is not divisible by 3 then use one 20 pack. If the remaining number is divisible by 3 then use the above method for the rest.

If the number still isn't divisible by 3 use a second 20 pack. The remainder <u>must</u> be divisible by 3, in which case use the 6 and 9 packs as above.

The largest impossible number would be such that you would have to subtract 20 twice to get a remainder divisible by 3. However, you can't make 3 itself with 6 and 9 packs. So the largest impossible number is 2*20+3=43.

The table.

6, 9 and any combination of 6 and 9 are divisible by 3

Key red divisible by 3

Blue Combination divisible by 3 and add 20

Purple Combination divisible by 3 and add twice 20

1	11	21	31	41	51
2	12	22	32	42	52
3	13	23	33	**43**	53
4	14	24	34	44	54
5	15	25	35	45	55
6	16	26	36	46	56
7	17	27	37	47	57
8	18	28	38	48	58
9	19	29	39	49	59
10	20	30	40	50	60

What if the McNuggets were available in boxes of 7, 11, and 17? What is the largest number for which it is impossible to purchase exactly that number of McNuggets?

The answer is 37

1	11	21	31	41	51
2	12	22	32	42	52
3	13	23	33	**43**	53
4	14	24	34	44	54
5	15	25	35	45	55
6	16	26	36	46	56
7	17	27	**37**	47	57
8	18	28	38	48	58
9	19	29	39	49	59
10	20	30	40	50	60
	ANSWER IS 37				

Multiples of 7 are in red

Multiples of 17 are in purple

Multiples of 11 are in bright green

Combinations of multiples of 11 and 7 are in pink

Combinations of multiples of 17 and 7 are in brick red

By combinations of 11 and 17 are not specified because up to the last impossible number these combinations can be formed by other combinations above. For example the 11 = 17 = 28

Final thought

In solving problems of this type using combinations of the different numbers it is important to know when to stop. This can be determined by the very first continuous run of the smallest number in the combination. For example in the first section with the numbers 6, 9 and 20, we can stop after the first consecutive run of 6 numbers because we can get any number above that by adding 6. In the second set we know we are done when we have had a consecutive run of 7 numbers.
