Task 2. Trestle Numbers

Available marks: 17

Trestle numbers are $2n$-digit positive integers that are the product of 2 n-digit numbers ($n > 1$), called *legs*, and consist of the digits of the legs in any order. Each digit in a leg must map to a digit in a particular position. At most one leg may end in 0.

A Trestle is drawn with the product on top and the legs vertically, the numerically smaller leg on the left.

For example, 6880 is a Trestle number because 6880 = 80 × 86 so it forms the trestle

1902 timber trestle bridge near Gundagai, NSW
photo: Marcus Wong, flikr

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8660
8  8
0  6
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However, 424296 is *not* a Trestle number because although it's the product of 426 and 996, the 4 is used twice and one of the 9s is unused.

Your Task

Write a program that generates all Trestle numbers of 4 and 6 digits. The same program could be used to generate longer examples, but would probably eat up serious amounts of CPU time.

More precisely, the program should produce three sets of output as described below. Each set carries a particular number of marks.

- [6 marks] Generate and display all 4-digit Trestles, in increasing numeric order. Each number must show the full structure so it takes 3 lines like the sample above.

- [7 marks] Generate and display all 6-digit Trestles, 10 per line in increasing numeric order, without structure, just the numbers. Show the total number of them too.

- [4 marks] Exactly one 6-digit Trestle can be produced by more than one pair of legs, so it is equal to different 3-digit products made up of the same combination of digits. Display all structurally different forms of that number in parallel, so the solution occupies exactly 4 lines.

The judges will be interested in how your program produces its output. Do not be tempted to hard-code any potential solutions in the program: it must implement an algorithm to make all decisions. There should be no reason for your program to use any constants greater than 10.