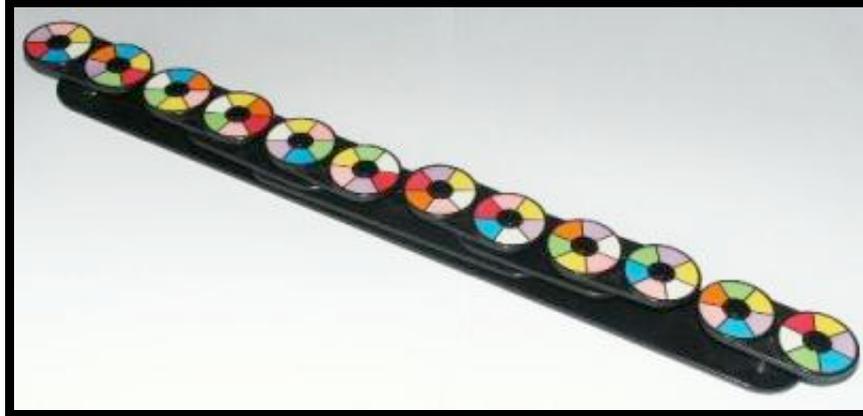


# Jaap's Puzzle Page

## Spectra



Spectra is a puzzle with 12 discs in a row, each disc with six coloured sectors. The discs all differ, using different combinations of six out of a total of eight colours. The discs are mounted on an arrangement of arms that looks a little like a car's windscreen wiper. An arm can be reversed so that the order of the discs attached to it is also reversed. The aim is to arrange the discs so that on every pair of adjacent discs the touching sectors match in colour, and also that the left sector of the first disc matches the right sector of the last disc. Not only that, but all eight colours must occur as such matching pairs of sectors.

The twelve discs are in six pairs, each pair mounted on one short arm, so it is possible to swap discs 1 and 2, 3 and 4, 5 and 6, ..., or 11 and 12. The second and third pair are mounted on a longer arm, so that discs 3-4 can be swapped with 5-6. Similarly pairs 7-8 and 9-10 can be swapped. Finally, the longest arm allows discs 3-6 to be swapped with discs 7-10. The linkages are illustrated below.



The colour arrangement on the 12 discs is as follows:

1. YWBRUI: Yellow, White, Blue, Red, Purple, Pink
2. YRGUOB: Yellow, Red, Green, Purple, Orange, Blue
3. YWIBGU: Yellow, White, Pink, Blue, Green, Purple
4. YGOUWI: Yellow, Green, Orange, Purple, White, Pink
5. YWIORU: Yellow, White, Pink, Orange, Red, Purple
6. YUWBRI: Yellow, Purple, White, Blue, Right, Pink
7. YGWBOI: Yellow, Green, White, Blue, Orange, Pink
8. YORIGW: Yellow, Orange, Red, Pink, Green, White
9. YIGBUW: Yellow, Pink, Green, Blue, Purple, White
10. YGWRUI: Yellow, Green, White, Red, Purple, Pink
11. YUBIOG: Yellow, Purple, Blue, Pink, Orange, Green
12. YUBGWR: Yellow, Purple, Blue, Green, White, Red

This is also illustrated below.



Spectra was made by Eng's I.Q. Company Ltd. in 1987.

### The number of positions:

The 12 discs are mounted on 9 arms. Each of these arms has 2 positions, so they allow the discs to be ordered in  $2^9 = 512$  different ways. Each disc of the discs has 6 orientations, so all together they have  $6^{12} = 2,176,782,336$  orientations. This gives a total of  $2^9 6^{12} = 1,114,512,556,032$  positions.

This is not really a good reflection of the difficulty, for the simple reason that once you have chosen an order and the orientation of the first disc, then the orientations of the remaining discs are immediately deduced. Thus it is more fitting to think of the number of positions being  $2^9 6 = 3,072$ .

### Solution:

There are twelve positions where all adjacent discs match colour. The table below lists them all. Only the last one uses all eight colours, so that is the only proper solution. For each position I show a diagram, the order of the discs from left to right (where the discs have the same numbering as used above), and the colour on the left of the leftmost disc (which is the same as the right colour of the right disc).

Diagram	Disc order	Outer colour
	2,1,8,7,9,10,5,6,3,4,12,11	Orange
	2,1,8,7,10,9,5,6,3,4,12,11	Orange
	2,1,8,7,9,10,6,5,3,4,12,11	Orange
	2,1,8,7,10,9,6,5,3,4,12,11	Orange
	2,1,8,7,9,10,5,6,4,3,12,11	Orange
	2,1,8,7,10,9,5,6,4,3,12,11	Orange
	2,1,8,7,9,10,6,5,4,3,12,11	Orange
	2,1,8,7,10,9,6,5,4,3,12,11	Orange
	1,2,8,7,9,10,4,3,6,5,11,12	White
	1,2,8,7,10,9,4,3,6,5,11,12	White
	1,2,3,4,5,6,7,8,9,10,11,12	Red
	1,2,3,4,5,6,7,8,10,9,11,12	Red

Note that the first eight are variations on one another, differing only in the order of the disc pairs 3-4, 5-6, and/or 9-10. The next two solutions only differ in the order of 9-10, as do the final two solutions.

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