

Clockwork: level design workbook

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Every number here is measured from the 40 shipped levels (Assets/_Project/Resources/Levels.txt) by Tools/levels.py report, which plays the game's own rules. Nothing is estimated. Blue cells are inputs; grey formulas update when you change them.

Sheet	What it shows
Levels	Every level: its shape (rings, notches, colours, gems, cogs, padlocks), its par and star thresholds, how open it is (best lines, opening odds, boards), what the cogs add, and how two bots fared.
Chapters	Each chapter's summary as formulas over the Levels sheet, and how the measures move together (correlations).
Tuning	The star rule's inputs (3 stars at par + margin, 2 stars within a wider margin). Change them and every threshold follows.
Retune	Levels 9 to 11 before and after the second playtest.

Measures

Measure	Meaning
Par	The fewest moves that clear the board (breadth-first search over every board).
Best lines	How many different move sequences win in exactly par moves. Few = one narrow path to find; many = forgiving.
Opening odds	The share of the first moves available that lie on some best line.
Boards	How many different boards can be reached from the start at all, and within par moves.
Cog effect	Par without the cogs minus par with them; 'unsolvable' when the level can't be won without them (padlocked rings need a cog).
Random bot	Plays any legal move. 400 runs a level, capped at 400 moves (a capped run counts as 400). Median moves and the share that would earn 3 stars.
Greedy bot	Takes a move that clears something when one exists, otherwise a random one; looks no further. A floor for a careless player, not a model of a person.

Tuning: the star rule

Blue cells are inputs; the Levels sheet reads them.

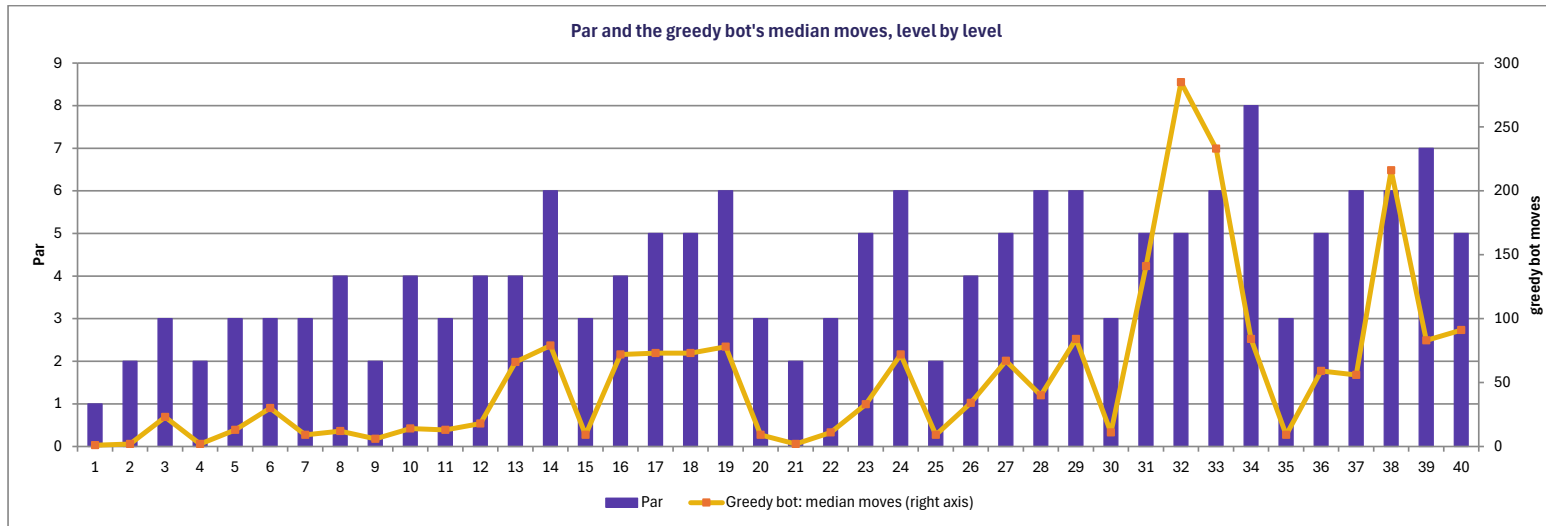
Input	Value	In the game
3 stars: at most par + this many moves		0 Stars.For: moves <= par
2 stars: at most par + this many moves		2 Stars.For: moves <= par + 2

The game uses 0 and 2. A margin of 2 means one wrong turn and its undo still earn 2 stars; every move is reversible, so a single slip never costs more than that.

Every level, measured

From Tools/levels.py report over the shipped level file. Green = easier, red = harder.

Level	Ch.	Name	Rings	Notches	Colours	Gems	Cogs	Padlocks	Par	3 stars up to	2 stars up to	Best lines	First moves	On a best line	Opening odds	Boards reachable	Boards within par	Par without cogs	Cog effect	Random bot: median moves	Random bot: 3-star share	Greedy bot: median moves	Greedy bot: 3-star share	Greedy bot: 2-star share	
1	1	First Turn	2	8	1	2	0	0	0	1	1	3	2	4	2	50%	57	4			3	48%	1	100%	100%
2	1	Two Colours	2	8	2	4	0	0	0	2	2	4	4	4	2	50%	57	11			8	18%	2	55%	65%
3	1	Three Rings	3	8	2	6	0	0	0	3	3	5	1	6	1	17%	505	63			63	0%	23	2%	8%
4	1	The First Cog	2	8	2	4	1	0	2	2	2	4	2	4	2	50%	57	13	1	-1	7	12%	2	52%	88%
5	1	Opposites	3	8	3	9	1	0	3	3	3	5	4	6	3	50%	505	62	5	2	57	2%	13	9%	21%
6	1	Same Colour Twice	3	8	2	9	0	0	3	3	3	5	2	6	1	17%	4,441	94			118	1%	30	0%	3%
7	1	Outer Cog	3	8	3	9	1	0	3	3	3	5	6	6	3	50%	505	63	2	-1	55	3%	9	17%	32%
8	1	Half Geared	3	8	4	12	1	0	4	4	4	6	28	6	6	100%	505	124	2	-2	62	3%	12	12%	23%
9	1	Steady Hand	3	8	2	6	1	0	2	2	2	4	2	6	2	33%	505	25	3	1	52	7%	6	31%	47%
10	1	Clockmaker	3	8	5	15	1	0	4	4	4	6	28	6	6	100%	505	124	3	-1	60	2%	14	11%	22%
11	2	A Chain	3	8	2	6	2	0	3	3	3	5	3	6	2	33%	505	63	2	-1	53	2%	13	8%	21%
12	2	Both Ways	3	8	3	9	2	0	4	4	4	6	4	6	2	33%	505	126	3	-1	64	0%	18	2%	8%
13	2	Quartet	4	8	3	12	1	0	4	4	4	6	12	8	3	38%	4,089	317	7	3	400	0%	66	3%	6%
14	2	The Long Chain	4	8	4	16	3	0	6	6	6	8	60	8	3	38%	4,089	1,125	3	-3	400	0%	79	1%	1%
15	2	Breather	3	8	1	6	1	0	3	3	3	5	3	6	2	33%	961	103	4	1	55	1%	9	26%	36%
16	2	Twins	4	8	2	16	1	0	4	4	4	6	6	8	2	25%	8,065	464	6	2	400	0%	72	0%	0%
17	2	Middle Out	4	8	4	16	2	0	5	5	5	7	60	8	4	50%	4,089	645	3	-2	400	0%	73	2%	4%
18	2	Counterweights	4	8	5	20	2	0	5	5	5	7	60	8	6	75%	4,089	644	8	3	400	0%	73	3%	5%
19	2	The Big Wheel	4	8	6	24	2	0	6	6	6	8	240	8	6	75%	4,089	1,123	4	-2	400	0%	78	0%	1%
20	2	Sunday	3	8	3	9	1	0	3	3	3	5	6	6	4	67%	505	62	4	1	55	3%	9	17%	35%
21	3	The Padlock	2	8	1	2	1	1	2	2	2	4	2	2	2	100%	4	4	4	2	4	50%	2	100%	100%
22	3	Locked Out	3	8	2	6	1	1	3	3	3	5	3	4	2	50%	63	25	5	2	31	4%	11	18%	32%
23	3	Inside Job	3	8	3	9	1	1	5	5	5	7	10	4	2	50%	64	51	3	-2	79	1%	33	4%	9%
24	3	The Keyholder	4	8	4	16	2	1	6	6	6	8	30	6	3	50%	511	302	4	-2	230	0%	72	0%	1%
25	3	Deep Breath	3	8	1	6	1	1	2	2	2	4	1	4	1	25%	183	16	3	1	35	7%	9	0%	27%
26	3	Twelve Notches	3	12	3	9	1	0	4	4	4	6	13	6	3	50%	1,717	128	8	4	130	1%	34	6%	9%
27	3	The Vault	4	8	4	16	2	1	5	5	5	7	10	6	2	33%	511	210	7	2	233	0%	67	1%	2%
28	3	Clock Face	3	12	4	12	1	1	6	6	6	8	30	4	4	100%	143	82	10	4	92	1%	40	3%	7%
29	3	Escapement	4	8	5	20	3	1	6	6	6	8	120	6	4	67%	511	301	3	-3	280	1%	84	1%	3%
30	3	Tea Break	3	8	2	6	1	0	3	3	3	5	6	6	4	67%	505	62	4	1	57	2%	11	17%	28%
31	4	Balance Wheel	4	8	3	12	2	1	5	5	5	7	30	6	3	50%	512	210	3	-2	400	0%	141	2%	4%
32	4	Mainspring	4	12	4	16	2	0	5	5	5	7	30	8	3	38%	20,725	681	8	3	400	0%	285	0%	1%
33	4	Pendulum	4	8	3	20	2	1	6	6	6	8	43	6	4	67%	18,229	948	5	-1	400	0%	233	0%	0%
34	4	The Tourbillon	4	8	6	24	3	1	8	8	8	10	560	6	4	67%	511	449	5	-3	258	0%	84	0%	0%
35	4	Quiet Hour	3	8	3	9	1	0	3	3	3	5	6	6	3	50%	505	63	2	-1	55	3%	9	18%	33%
36	4	Crown Wheel	4	12	4	16	2	1	5	5	5	7	30	6	3	50%	1,723	231	11	6	229	1%	59	3%	7%
37	4	Ratchet	4	8	5	20	2	1	6	6	6	8	120	6	5	83%	511	301	4	-2	244	1%	56	4%	6%
38	4	Grand Complication	4	12	5	20	2	1	6	6	6	8	30	6	3	50%	1,727	374	none	unsolvable	400	0%	216	0%	1%
39	4	The Master's Test	4	8	6	24	3	1	7	7	7	9	210	6	4	67%	511	386	6	-1	277	0%	83	1%	1%
40	4	Midnight	4	8	4	16	2	0	5	5	5	7	40	8	4	50%	4,089	644	4	-1	400	1%	91	1%	1%



Chapters: the shape of the curve

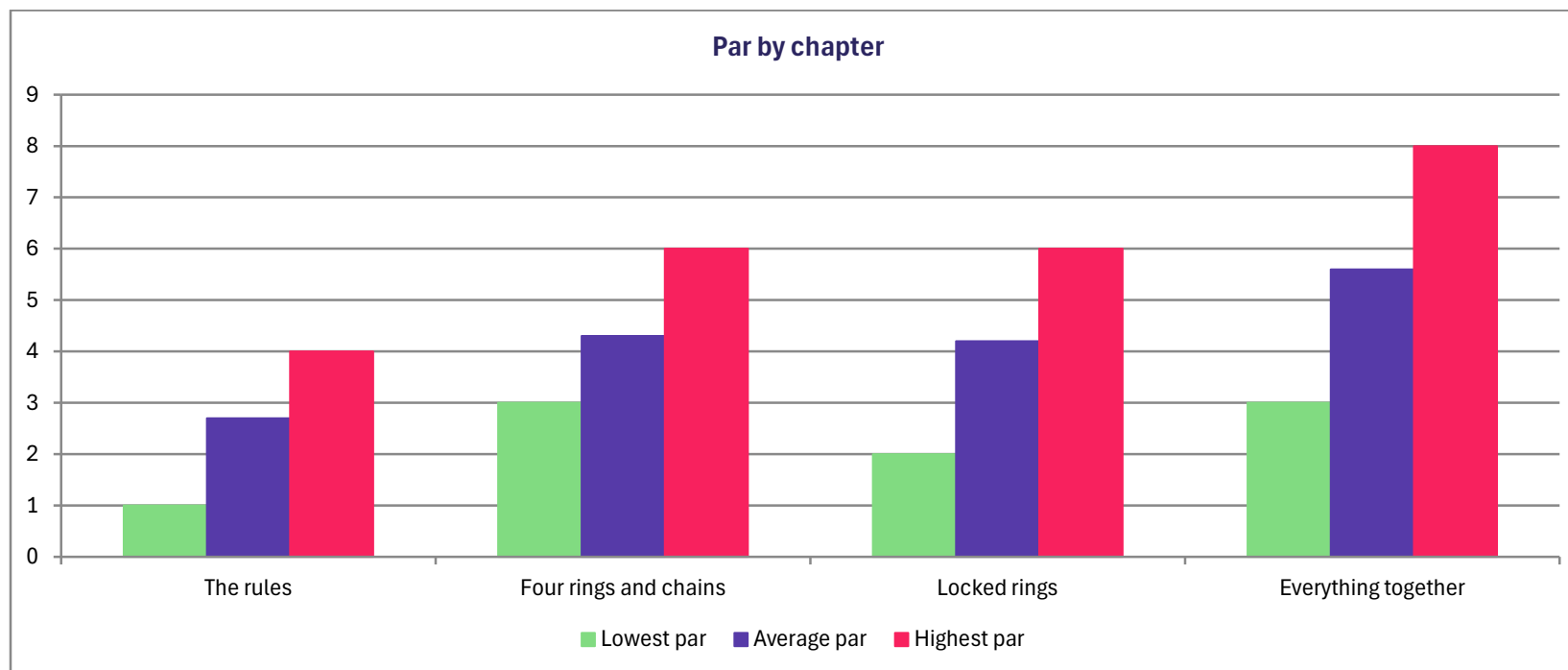
Formulas over the Levels sheet.

Chapter	Name	Levels	Average par	Lowest par	Highest par	Levels with cogs	Levels with padlocks	Average best lines	Average opening odds	Greedy bot: average median moves	Greedy bot: average 3-star share
1	The rules	10	2.7	1	4	6	0	7.9	52%	11	29%
2	Four rings and chains	10	4.3	3	6	10	0	45.4	47%	49	6%
3	Locked rings	10	4.2	2	6	10	8	22.5	59%	36	15%
4	Everything together	10	5.6	3	8	10	7	109.9	57%	126	3%

What moves together (Pearson correlation over the 40 levels)

Pair	r
Par and the greedy bot's median moves	0.61
Par and the greedy bot's 3-star share	-0.64
Colours and the greedy bot's median moves	0.44
Boards reachable and the greedy bot's median moves	0.77
Par and the number of best lines	0.65

How to read it: par is the designed difficulty; the bots show how far a careless player can stray. Where par is low but the bots wander for long (many boards, few best lines), the level punishes guessing more than its par suggests; those are the levels to watch first in playtests.



Retune after the second playtest (19 October 2026)

Finding: 'from level 9 it feels a bit too difficult'. Before: git 59e5af7; after: the level file today.

Level	Before	Par before	Now	Par now	Change	Why
9	A Chain: 3 rings, 2 cogs (a chain), 3 colours	4	Steady Hand: 3 rings, 1 cog, 2 colours	2	-2	A new rule (chains) came with no easier level to learn it on.
10	Clockmaker: 4 rings, 2 cogs, 5 colours	6	Clockmaker: 3 rings, 1 cog, 5 colours	4	-2	Four rings belong to chapter 2; the chapter that teaches the rules ends on what it taught.
11	Inward: 3 rings, 1 cog, 2 colours	3	A Chain: 3 rings, 2 cogs (a chain), 2 colours	3	0	Chains now open chapter 2 on an easy level, with their own tip.

Still to check: this came from one player. Whether levels 9 to 11 now read as easy should come from first-time players (the playtest kit).