

Prime numbers to 100 (the 25, marked on the hundred square) and the 168 primes to 1,000

A prime has exactly two factors, 1 and itself. 1 is not prime (one factor); 2 is the only even prime. On the square the primes are in brackets.

To check a number up to 100, test 2, 3, 5 and 7 only ($11 \times 11 = 121$ is past 100).

1	[2]	[3]	4	[5]	6	[7]	8	9	10
[11]	12	[13]	14	15	16	[17]	18	[19]	20
21	22	[23]	24	25	26	27	28	[29]	30
[31]	32	33	34	35	36	[37]	38	39	40
[41]	42	[43]	44	45	46	[47]	48	49	50
51	52	[53]	54	55	56	57	58	[59]	60
[61]	62	63	64	65	66	[67]	68	69	70
[71]	72	[73]	74	75	76	77	78	[79]	80
81	82	[83]	84	85	86	87	88	[89]	90
91	92	93	94	95	96	[97]	98	99	100

2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97. England's Year 5 objective: know the primes to 19 by heart, work out the rest. Traps: $51 = 3 \times 17$, $57 = 3 \times 19$, $87 = 3 \times 29$, $91 = 7 \times 13$.

The primes to 1,000 by hundred (168 in all)

Range	Count	Primes
1-100	25	2 3 5 7 11 13 17 19 23 29 31 37 41 43 47 53 59 61 67 71 73 79 83 89 97
101-200	21	101 103 107 109 113 127 131 137 139 149 151 157 163 167 173 179 181 191 193 197 199
201-300	16	211 223 227 229 233 239 241 251 257 263 269 271 277 281 283 293
301-400	16	307 311 313 317 331 337 347 349 353 359 367 373 379 383 389 397
401-500	17	401 409 419 421 431 433 439 443 449 457 461 463 467 479 487 491 499
501-600	14	503 509 521 523 541 547 557 563 569 571 577 587 593 599
601-700	16	601 607 613 617 619 631 641 643 647 653 659 661 673 677 683 691
701-800	14	701 709 719 727 733 739 743 751 757 761 769 773 787 797
801-900	15	809 811 821 823 827 829 839 853 857 859 863 877 881 883 887
901-1000	14	907 911 919 929 937 941 947 953 967 971 977 983 991 997

303 primes to 2,000 and 1,229 to 10,000. After 3 every prime ends in 1, 3, 7 or 9 and sits one above or one below a multiple of 6. Twin primes (two apart): 3-5, 5-7, 11-13, 17-19, 29-31, 41-43, 59-61, 71-73, 101-103, 107-109, 137-139, 149-151, 179-181, 191-193, 197-199.

From

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The Sieve of Eratosthenes, the four-step check, and a practice set

The sieve: colour the square below

[] Cross out 1. Circle 2 and cross out every second number after it (4, 6, 8 ...)

[] Circle 3, the next number not crossed out, and cross out every third number (6, 9, 12 ...)

[] Circle 5 and cross out every fifth number; circle 7 and cross out every seventh (49 is the first new one)

[] Stop: $11 \times 11 = 121$ is off the square. Everything not crossed out is prime: 25 numbers

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

The four-step check for any number

[] Even (ends 0, 2, 4, 6, 8) and not 2: not prime. Digits add to a multiple of 3 and not 3: not prime. Ends in 5 or 0 and not 5: not prime

[] Then try 7, 11, 13 ... and stop when the prime squared is bigger than the number: nothing divides it, it is prime

[] Up to 100 test 2, 3, 5, 7; up to 200 add 11 and 13; up to 1,000 the primes to 31. Worked: 97: odd, $9 + 7 = 16$, not 5, $97 / 7 = 13 \text{ r } 6$, $11 \times 11 > 97$: prime

Prime factors

Factor tree: $72 = 8 \times 9 = (2 \times 4)(3 \times 3) = 2 \times 2 \times 2 \times 3 \times 3 = 2^3 \times 3^2$. HCF of 72 and 60 ($2^2 \times 3 \times 5$): shared primes, lowest powers, $2^2 \times 3 = 12$.

LCM: every prime, highest powers, $2^3 \times 3^2 \times 5 = 360$.

Practice

- Write all the prime numbers between 20 and 50.
- Is 87 prime? Show the check.
- Is 101 prime? Which primes must you test, and why can you stop there?
- Write 84 as a product of its prime factors.
- Find the HCF and the LCM of 36 and 90 using prime factors.
- Which numbers between 1 and 30 have exactly three factors?

Answers

- 23, 29, 31, 37, 41, 43, 47.
- No: $8 + 7 = 15$, so 3 divides it ($87 = 3 \times 29$).
- Yes: test 2, 3, 5, 7 ($11 \times 11 = 121 > 101$); none divides 101.
- $84 = 2 \times 2 \times 3 \times 7 = 2^2 \times 3 \times 7$.
- $36 = 2^2 \times 3^2$, $90 = 2 \times 3^2 \times 5$; HCF = $2 \times 3^2 = 18$; LCM = $2^2 \times 3^2 \times 5 = 180$.
- 4, 9, 25 (the squares of primes: factors 1, p, p^2).