

# High rank elliptic curves with prescribed torsion over quadratic fields

Maintained by [Andrej Dujella](#), University of Zagreb

Let  $T$  be one of 26 admissible torsion groups for an elliptic curve over a quadratic field [KM,Ka].

We define  $B(T)$  as the supremum of the ranks of elliptic curves defined over any quadratic field and having torsion group  $T$  (for the trivial torsion group we put  $T = 0$ ).

In the following table, in the second column we give the best known lower bounds for  $B(T)$ ,

while the third column gives the values  $d$  of the corresponding quadratic number fields  $\mathbf{K} = \mathbf{Q}(\sqrt{d})$ .

Values in the brackets in the second column are conditional, assuming the Parity Conjecture.

$T$	$B(T) \geq$	$d$	References
0	30	-3	[Na, E14], [E11, E13, Me]
$\mathbf{Z}/2\mathbf{Z}$	28	-1	[Wa, ACP, ADJBP]
$\mathbf{Z}/3\mathbf{Z}$	22	-3	[Na, ER]
$\mathbf{Z}/4\mathbf{Z}$	15 (16)	-25689	[ADJBP], [Na]
$\mathbf{Z}/5\mathbf{Z}$	10	*	[Le1, Er, Me]
$\mathbf{Z}/6\mathbf{Z}$	11	3521	[ADJBP]
$\mathbf{Z}/7\mathbf{Z}$	7	*	[Ku, E12, Er, Le2, Me]
$\mathbf{Z}/8\mathbf{Z}$	9	-227	[ADJBP]
$\mathbf{Z}/9\mathbf{Z}$	6	-155	[ADJBP], [Fi, Me]
$\mathbf{Z}/10\mathbf{Z}$	7	-2495	[ADJBP]
$\mathbf{Z}/11\mathbf{Z}$	2	-3239	[ADJBP]
$\mathbf{Z}/12\mathbf{Z}$	7	2014	[ADJBP]
$\mathbf{Z}/13\mathbf{Z}$	2	193	[Ra]
$\mathbf{Z}/14\mathbf{Z}$	2	265	[Ra, ADJBP]
$\mathbf{Z}/15\mathbf{Z}$	1	-7	[BBDN], [ADJBP]
$\mathbf{Z}/16\mathbf{Z}$	3 (4)	34720105	[Na]
$\mathbf{Z}/18\mathbf{Z}$	2	26521	[BBDN]
$\mathbf{Z}/2\mathbf{Z} \times \mathbf{Z}/2\mathbf{Z}$	19 (20)	$d_{22}$	[ADJBP, E12]
$\mathbf{Z}/2\mathbf{Z} \times \mathbf{Z}/4\mathbf{Z}$	13	-83201	[ADJBP]
$\mathbf{Z}/2\mathbf{Z} \times \mathbf{Z}/6\mathbf{Z}$	10	624341	[ADJBP]
$\mathbf{Z}/2\mathbf{Z} \times \mathbf{Z}/8\mathbf{Z}$	8	31230597	[ADJBP]
$\mathbf{Z}/2\mathbf{Z} \times \mathbf{Z}/10\mathbf{Z}$	4 (5)	1065333545	[BBDN], [ADJBP]
$\mathbf{Z}/2\mathbf{Z} \times \mathbf{Z}/12\mathbf{Z}$	4	2947271015	[BBDN]
$\mathbf{Z}/3\mathbf{Z} \times \mathbf{Z}/3\mathbf{Z}$	7	-3	[JB]
$\mathbf{Z}/3\mathbf{Z} \times \mathbf{Z}/6\mathbf{Z}$	6	-3	[JB]
$\mathbf{Z}/4\mathbf{Z} \times \mathbf{Z}/4\mathbf{Z}$	7	-1	[DJB]

$$d_{22} = -3901785498412536920668361993073821511$$

The marks \* in the table refer to the curves obtained by an application of Mestre's general construction (he proved that for any elliptic curve  $E$  over  $\mathbf{Q}$  there exist infinitely many quadratic twists with rank  $\geq 2$ ) which produces quadratic fields with huge discriminants.

## References:

- [ACP] J. Aguirre, F. Castaneda, J. C. Peral, [High rank elliptic curves with torsion group  \$\mathbb{Z}/\(2\mathbb{Z}\)\$](#) , Math. Comp. **73** (2004), 323-331.
- [ADJBP] J. Aguirre, A. Dujella, M. Jukic Bokun, J. C. Peral, [High rank elliptic curves with prescribed torsion group over quadratic fields](#), Period. Math. Hungar. **68** (2014), 222-230.
- [BBDN] J. Bosman, P. Bruin, A. Dujella and F. Najman, [Ranks of elliptic curves with prescribed torsion over number fields](#), Int. Math. Res. Not. IMRN **2014** (11) (2014), 2885-2923.
- [DJB] A. Dujella and M. Jukic Bokun, [On the rank of elliptic curves over  \$\mathbb{Q}\(i\)\$  with torsion group  \$\mathbb{Z}/4\mathbb{Z} \times \mathbb{Z}/4\mathbb{Z}\$](#) , Proc. Japan Acad. Ser. A Math. Sci. **86** (2010), 93-96.
- [DJBS] A. Dujella, M. Jukic Bokun and I. Soldo, [On the torsion group of elliptic curves induced by Diophantine triples over quadratic fields](#), Rev. R. Acad. Cienc. Exactas Fis. Nat. Ser. A Math. RACSAM, to appear.
- [El1] N. D. Elkies,  [\$\mathbb{Z}^{28}\$  in  \$E\(\mathbb{Q}\)\$ , etc.](#), Number Theory Listserver, May 2006.
- [El2] N. D. Elkies, Personal communication, 2006, 2009.
- [El3] N. D. Elkies, [Three lectures on elliptic surfaces and curves of high rank](#), Lecture notes, Oberwolfach, 2007, arXiv:0709.2908.
- [El4] N. Elkies,  [\$j = 0\$ ; rank 15; also 3-rank 6 and 7 in real and imaginary quadratic fields](#), Number Theory Listserver, Dec 2009.
- [ER] N. D. Elkies and N. F. Rogers, [Elliptic curves  \$x^3 + y^3 = k\$  of high rank](#), Proceedings of ANTS-6 (D. Buell, ed.), Lecture Notes in Comput. Sci. **3076** (2004), 184-193.
- [Er] Y. G. Eroshkin, Personal communication, 2009, 2011.
- [Fi] T. A. Fisher, Personal communication, 2009.
- [JB] M. Jukic Bokun, [On the rank of elliptic curves over  \$\mathbb{Q}\(\sqrt{-3}\)\$  with torsion groups  \$\mathbb{Z}/3\mathbb{Z} \times \mathbb{Z}/3\mathbb{Z}\$  and  \$\mathbb{Z}/3\mathbb{Z} \times \mathbb{Z}/6\mathbb{Z}\$](#) , Proc. Japan Acad. Ser. A Math. Sci. **87** (2011), 61-64.
- [JB2] M. Jukic Bokun, [Elliptic curves over quadratic fields with fixed torsion subgroup and positive rank](#), Glas. Mat. Ser. III **47** (2012), 277-284.
- [Ka] S. Kamienny, [Torsion points on elliptic curves and  \$q\$ -coefficients of modular forms](#), Invent. Math. **109** (1992), 221-229.
- [KM] M. A. Kenku and F. Momose, [Torsion points on elliptic curves defined over quadratic fields](#), Nagoya Math. J. **109** (1988), 125-149.
- [Ku] L. Kulesz, *Arithmetique des courbes algebriques de genre au moins deux*, These de doctorat, Universite Paris 7, 1998.
- [Le1] O. Lecacheux, [Rang de courbes elliptiques sur  \$\mathbb{Q}\$  avec un groupe de torsion isomorphe a  \$\mathbb{Z}/5\mathbb{Z}\$](#) , C. R. Acad. Sci. Paris Ser. I Math. **332** (2001), 1-6.
- [Le2] O. Lecacheux, [Rang de courbes elliptiques dont le groupe de torsion est non trivial](#), Ann. Sci. Math. Quebec **28** (2004), 145-151.
- [Me] J.-F. Mestre, [Rang des courbes elliptiques d'invariant donne](#), C. R. Acad. Sci. Paris **314** (1992), 919-922.
- [Na] F. Najman, [Some rank records for elliptic curves with prescribed torsion over quadratic fields](#), An. Stiint. Univ. "Ovidius" Constanta Ser. Mat. **22** (2014), 215-220.
- [Ra] F. P. Rabarison, [Structure de torsion des courbes elliptiques sur les corps quadratiques](#), Acta Arith. **144** (2010), 17-52.
- [SZ] U. Schneiders and H.G. Zimmer, *The rank of elliptic curves upon quadratic extensions*, in: Computational Number Theory (A. Petho, H.C. Williams, H.G. Zimmer, eds.), de Gruyter, Berlin, 1991, pp. 239-260.
- [Wa] M. Watkins, Personal communication, 2005.

---

[High rank elliptic curves with prescribed torsion](#)

[Infinite families of elliptic curves with high rank and prescribed torsion](#)

[History of elliptic curves rank records](#)

---