QUARKS

The u-, d-, and s-quark masses are estimates of so-called "current-quark masses," in a mass-independent subtraction scheme such as $\overline{\text{MS}}$ at a scale $\mu \approx 2$ GeV. The c- and b-quark masses are the "running" masses in the $\overline{\text{MS}}$ scheme. For the b-quark we also quote the 1S mass. These can be different from the heavy quark masses obtained in potential models.

u

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

$m_u = 2.2^{+0.6}_{-0.4}$ MeV Charge $= \frac{2}{3}\ e$ $I_z = +\frac{1}{2}$
$m_u/m_d = 0.38$–0.58

d

$I(J^P) = \frac{1}{2}(\frac{1}{2}^+)$

$m_d = 4.7^{+0.5}_{-0.4}$ MeV Charge $= -\frac{1}{3}\ e$ $I_z = -\frac{1}{2}$
$m_s/m_d = 17$–22
$\overline{m} = (m_u+m_d)/2 = 3.5^{+0.7}_{-0.3}$ MeV

s

$I(J^P) = 0(\frac{1}{2}^+)$

$m_s = 96^{+8}_{-4}$ MeV Charge $= -\frac{1}{3}\ e$ Strangeness $= -1$
$m_s\ /\ ((m_u + m_d)/2) = 27.3 \pm 0.7$

c

$I(J^P) = 0(\frac{1}{2}^+)$

$m_c = 1.27 \pm 0.03$ GeV Charge $= \frac{2}{3}\ e$ Charm $= +1$
$m_c/m_s = 11.72 \pm 0.25$
$m_b/m_c = 4.53 \pm 0.05$
$m_b - m_c = 3.45 \pm 0.05$ GeV

b

$I(J^P) = 0(\frac{1}{2}^+)$

Charge $= -\frac{1}{3}\ e$ Bottom $= -1$

$m_b(\overline{\text{MS}}) = 4.18^{+0.04}_{-0.03}$ GeV
$m_b(1\text{S}) = 4.66^{+0.04}_{-0.03}$ GeV

t

$I(J^P) = 0(\frac{1}{2}^+)$

Charge $= \frac{2}{3}\ e$ Top $= +1$

Mass (direct measurements) $m = 173.21 \pm 0.51 \pm 0.71$ GeV [a,l
Mass ($\overline{\text{MS}}$ from cross-section measurements) $m = 160^{+5}_{-4}$ GeV [a
Mass (Pole from cross-section measurements) $m = 174.2 \pm 1.4$
$m_t - m_{\overline{t}} = -0.2 \pm 0.5$ GeV (S = 1.1)
Full width $\Gamma = 1.41^{+0.19}_{-0.15}$ GeV (S = 1.4)
$\Gamma(Wb)/\Gamma(Wq(q = b, s, d)) = 0.957 \pm 0.034$ (S = 1.5)

t-quark EW Couplings

$F_0 = 0.690 \pm 0.030$
$F_- = 0.314 \pm 0.025$
$F_+ = 0.008 \pm 0.016$
$F_{V+A} < 0.29$, CL = 95%

t DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	p (MeV/c)
$t \to Wq(q = b, s, d)$				–
$t \to Wb$				–
$t \to \ell\nu_\ell$ anything	[c,d]	(9.4±2.4) %		–
$t \to e\nu_e b$		(13.3±0.6) %		–
$t \to \mu\nu_\mu b$		(13.4±0.6) %		–
$t \to q\overline{q}b$		(66.5±1.4) %		–
$t \to \gamma q(q=u,c)$	[e]	$< 5.9 \times 10^{-3}$	95%	–
$\Delta T = 1$ weak neutral current (T1) modes				
$t \to Zq(q=u,c)$	T1	[f] $< 5 \times 10^{-4}$	95%	–
$t \to \ell^+\overline{q}\overline{q}'(q=d,s,b;\ q'=u,c)$		$< 1.6 \times 10^{-3}$	95%	–

b′ (4th Generation) Quark, Searches for

Mass $m >$ 190 GeV, CL = 95% ($p\overline{p}$, quasi-stable b')
Mass $m >$ 755 GeV, CL = 95% (pp, neutral-current decays)
Mass $m >$ 675 GeV, CL = 95% (pp, charged-current decays)
Mass $m >$ 46.0 GeV, CL = 95% (e^+e^-, all decays)

t' (4^{th} Generation) Quark, Searches for

$m(t'(2/3)) > 782$ GeV, CL = 95% (neutral-current decays)
$m(t'(2/3)) > 700$ GeV, CL = 95% (charged-current decays)
$m(t'(5/3)) > 800$ GeV, CL = 95%

Free Quark Searches

All searches since 1977 have had negative results.

NOTES

[*a*] A discussion of the definition of the top quark mass in these measurements can be found in the review "The Top Quark."

[*b*] Based on published top mass measurements using data from Tevatron Run-I and Run-II and LHC at $\sqrt{s} = 7$ TeV. Including the most recent unpublished results from Tevatron Run-II, the Tevatron Electroweak Working Group reports a top mass of 173.2 $\pm$ 0.9 GeV. See the note "The Top Quark' in the Quark Particle Listings of this *Review*.

[*c*] ℓ means e or μ decay mode, not the sum over them.

[*d*] Assumes lepton universality and W-decay acceptance.

[*e*] This limit is for $\Gamma(t \to \gamma q)/\Gamma(t \to W b)$.

[*f*] This limit is for $\Gamma(t \to Z q)/\Gamma(t \to W b)$.