

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

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

Mass $m = 1.5$ to 3.0 MeV [a] Charge = $\frac{2}{3} e$ $I_z = +\frac{1}{2}$
 $m_u/m_d = 0.3$ to 0.6

d

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

Mass $m = 3$ to 7 MeV [a] Charge = $-\frac{1}{3} e$ $I_z = -\frac{1}{2}$
 $m_s/m_d = 17$ to 22
 $\bar{m} = (m_u + m_d)/2 = 2.5$ to 5.5 MeV

s

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

Mass $m = 95 \pm 25$ MeV [a] Charge = $-\frac{1}{3} e$ Strangeness = -1
 $(m_s - (m_u + m_d)/2)/(m_d - m_u) = 30$ to 50

c

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

Mass $m = 1.25 \pm 0.09$ GeV Charge = $\frac{2}{3} e$ Charm = $+1$

b

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

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

Mass $m = 4.20 \pm 0.07$ GeV ($\overline{\text{MS}}$ mass)
 Mass $m = 4.70 \pm 0.07$ GeV (1S mass)

t

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

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

Mass $m = 174.2 \pm 3.3$ GeV ^[b] (direct observation of top events)

Mass $m = 172.3^{+10.2}_{-7.6}$ GeV (Standard Model electroweak fit)

t DECAY MODES	Fraction (Γ_i/Γ)	Confidence level	$\frac{P}{(\text{MeV}/c)}$
$Wq (q = b, s, d)$			—
Wb			—
$\ell\nu_\ell$ anything	[c,d] (9.4±2.4) %		—
$\tau\nu_\tau b$			—
$\gamma q (q=u,c)$	[e] < 5.9	$\times 10^{-3}$	95%
$\Delta T = 1$ weak neutral current (T1) modes			
$Zq (q=u,c)$	T1 [f] < 13.7	%	95%

b' (4th Generation) Quark, Searches for

- Mass $m > 190$ GeV, CL = 95% ($p\bar{p}$, quasi-stable b')
- Mass $m > 199$ GeV, CL = 95% ($p\bar{p}$, neutral-current decays)
- Mass $m > 128$ GeV, CL = 95% ($p\bar{p}$, charged-current decays)
- Mass $m > 46.0$ GeV, CL = 95% (e^+e^- , all decays)

Free Quark Searches

All searches since 1977 have had negative results.

NOTES

- [a] The ratios m_u/m_d and m_s/m_d are extracted from pion and kaon masses using chiral symmetry. The estimates of u and d masses are not without controversy and remain under active investigation. Within the literature there are even suggestions that the u quark could be essentially massless. The s -quark mass is estimated from SU(3) splittings in hadron masses.
- [b] Based on published top mass measurements using data from Tevatron Run-I and Run-II. Including also the most recent unpublished results from Run-II, the Tevatron Electroweak Working Group reports a top mass of $172.5 \pm 1.3 \pm 1.9$ 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 $\Gamma(t \rightarrow \gamma q)/\Gamma(t \rightarrow W b)$.
- [f] This limit is for $\Gamma(t \rightarrow Z q)/\Gamma(t \rightarrow W b)$.