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

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

Mass $m = 1.5$ to 4 MeV [a] Charge $= \tfrac{2}{3} e$ $I_z = +\tfrac{1}{2}$
$m_u/m_d = 0.3$ to 0.7

d

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

Mass $m = 4$ to 8 MeV [a] Charge $= -\tfrac{1}{3} e$ $I_z = -\tfrac{1}{2}$
$m_s/m_d = 17$ to 22
$\overline{m} = (m_u + m_d)/2 = 3.0$ to 5.5 MeV

s

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

Mass $m = 80$ to 130 MeV [a] Charge $= -\tfrac{1}{3} e$ Strangeness $= -1$
$(m_s - (m_u + m_d)/2)/(m_d - m_u) = 30$ to 50

c

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

Mass $m = 1.15$ to 1.35 GeV Charge $= \tfrac{2}{3} e$ Charm $= +1$

b

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

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

Mass $m = 4.1$ to 4.4 GeV ($\overline{\text{MS}}$ mass)
Mass $m = 4.6$ to 4.9 GeV (1S mass)

t

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

$$\text{Charge} = \tfrac{2}{3}\, e \qquad \text{Top} = +1$$

Mass $m = 174.3 \pm 5.1$ GeV   (direct observation of top events)
Mass $m = 178.1^{+10.4}_{-8.3}$ GeV   (Standard Model electroweak fit)

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

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b' (4th Generation) Quark, Searches for

Mass $m >$ 190 GeV, CL = 95%   ($p\overline{p}$, quasi-stable b')
Mass $m >$ 199 GeV, CL = 95%   ($p\overline{p}$, neutral-current decays)
Mass $m >$ 128 GeV, CL = 95%   ($p\overline{p}$, 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] ℓ means e or μ decay mode, not the sum over them.

[c] Assumes lepton universality and W-decay acceptance.

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

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