



ELEMENTARY PARTICLE CARDS (LONG)

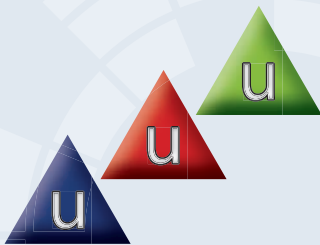
MATTER PARTICLES: QUARKS

This document contains 30 elementary particle cards. They should be printed out in color on thick paper, cut out, and laminated.

Use the cards to stimulate ideas as well as questions and answers for learning about elementary particles .

UP QUARK

DISCOVERED: 1969

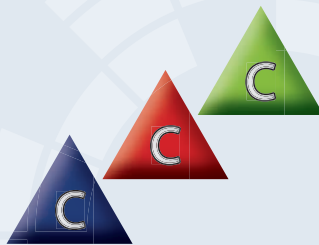


MATTER PARTICLE

Mass:	$2 \text{ MeV}/c^2$
Electric Charge:	$+\frac{2}{3}$
Strong Charges:	blue, red, green
Weak Charge:	$+\frac{1}{2}$
Lifetime:	unlimited

CHARM QUARK

DISCOVERED: 1974

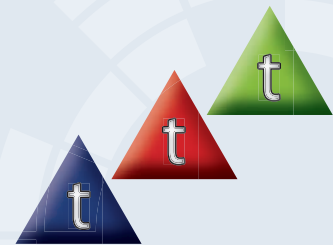


MATTER PARTICLE

Mass:	$1300 \text{ MeV}/c^2$
Electric Charge:	$+\frac{2}{3}$
Strong Charges:	blue, red, green
Weak Charge:	$+\frac{1}{2}$
Lifetime:	10^{-12} s

TOP QUARK

DISCOVERED: 1995

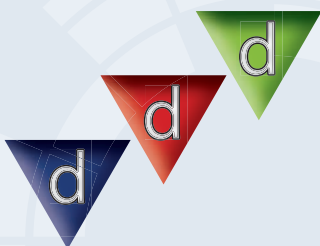


MATTER PARTICLE

Mass:	$173 \cdot 10^3 \text{ MeV}/c^2$
Electric Charge:	$+\frac{2}{3}$
Strong Charges:	blue, red, green
Weak Charge:	$+\frac{1}{2}$
Lifetime:	$6 \cdot 10^{-25} \text{ s}$

DOWN QUARK

DISCOVERED: 1969



MATTER PARTICLE

Mass:	$5 \text{ MeV}/c^2$
Electric Charge:	$-\frac{1}{3}$
Strong Charges:	blue, red, green
Weak Charge:	$-\frac{1}{2}$
Lifetime:	900s

STRANGE QUARK

DISCOVERED: 1969

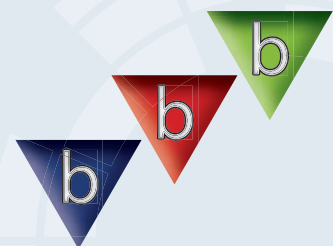


MATTER PARTICLE

Mass:	$100 \text{ MeV}/c^2$
Electric Charge:	$-\frac{1}{3}$
Strong Charges:	blue, red, green
Weak Charge:	$-\frac{1}{2}$
Lifetime:	$5 \cdot 10^{-8} \text{ s}$

BOTTOM QUARK

DISCOVERED: 1977



MATTER PARTICLE

Mass:	$4200 \text{ MeV}/c^2$
Electric Charge:	$-\frac{1}{3}$
Strong Charges:	blue, red, green
Weak Charge:	$-\frac{1}{2}$
Lifetime:	$2 \cdot 10^{-12} \text{ s}$



MATTER PARTICLES: LEPTONS

ELECTRON NEUTRINO

DISCOVERED: 1956



MATTER PARTICLE

Mass:	$< 2 \cdot 10^{-6} \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$+1/2$
Lifetime:	undefined

MUON NEUTRINO

DISCOVERED: 1962



MATTER PARTICLE

Mass:	$< 2 \cdot 10^{-6} \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$+1/2$
Lifetime:	undefined

TAU NEUTRINO

DISCOVERED: 2000



MATTER PARTICLE

Mass:	$< 2 \cdot 10^{-6} \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$+1/2$
Lifetime:	undefined

ELECTRON

DISCOVERED: 1897

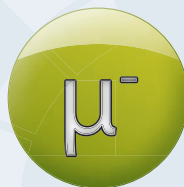


MATTER PARTICLE

Mass:	0.511 MeV/c ²
Electric Charge:	-1
Strong Charges:	-
Weak Charge:	$-1/2$
Lifetime:	unlimited

MUON

DISCOVERED: 1937

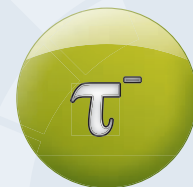


MATTER PARTICLE

Mass:	106 MeV/c ²
Electric Charge:	-1
Strong Charges:	-
Weak Charge:	$-1/2$
Lifetime:	$2.2 \cdot 10^{-6} \text{ s}$

TAU

DISCOVERED: 1975



MATTER PARTICLE

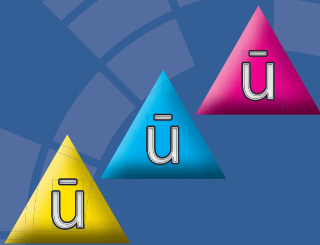
Mass:	1777 MeV/c ²
Electric Charge:	-1
Strong Charges:	-
Weak Charge:	$-1/2$
Lifetime:	$2.9 \cdot 10^{-13} \text{ s}$



ANTIMATTER PARTICLES: ANTIQUARKS

ANTI-UP QUARK

DISCOVERED: 1969

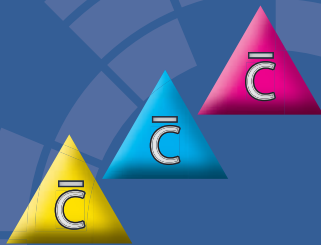


ANTIMATTER PARTICLE

Mass: $2 \text{ MeV}/c^2$
 Electric Charge: $-\frac{2}{3}$
 Strong Charges: **antiblue, antired, antigreen**
 Weak Charge: $-\frac{1}{2}$

Lifetime: **unlimited****ANTI-CHARM QUARK**

DISCOVERED: 1974

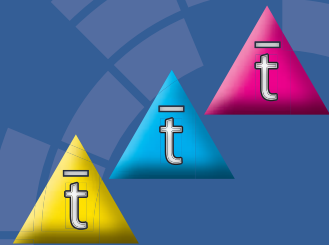


ANTIMATTER PARTICLE

Mass: $1300 \text{ MeV}/c^2$
 Electric Charge: $-\frac{2}{3}$
 Strong Charges: **antiblue, antired, antigreen**
 Weak Charge: $-\frac{1}{2}$

Lifetime: 10^{-12} s **ANTI-TOP QUARK**

DISCOVERED: 1995

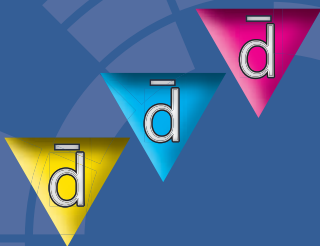


ANTIMATTER PARTICLE

Mass: $173 \cdot 10^3 \text{ MeV}/c^2$
 Electric Charge: $-\frac{2}{3}$
 Strong Charges: **antiblue, antired, antigreen**
 Weak Charge: $-\frac{1}{2}$

Lifetime: $6 \cdot 10^{-25} \text{ s}$ **ANTI-DOWN QUARK**

DISCOVERED: 1969

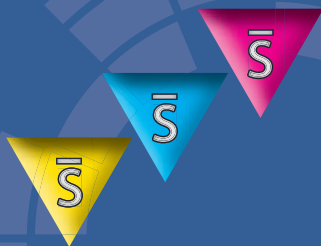


ANTIMATTER PARTICLE

Mass: $5 \text{ MeV}/c^2$
 Electric Charge: $+\frac{1}{3}$
 Strong Charges: **antiblue, antired, antigreen**
 Weak Charge: $+\frac{1}{2}$

Lifetime: **900 s****ANTI-STRANGE QUARK**

DISCOVERED: 1969

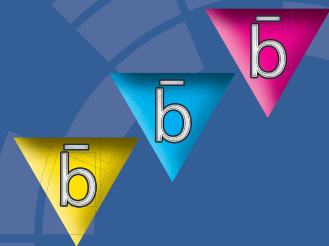


ANTIMATTER PARTICLE

Mass: $100 \text{ MeV}/c^2$
 Electric Charge: $+\frac{1}{3}$
 Strong Charges: **antiblue, antired, antigreen**
 Weak Charge: $+\frac{1}{2}$

Lifetime: $5 \cdot 10^{-8} \text{ s}$ **ANTI-BOTTOM QUARK**

DISCOVERED: 1977



ANTIMATTER PARTICLE

Mass: $4200 \text{ MeV}/c^2$
 Electric Charge: $+\frac{1}{3}$
 Strong Charges: **antiblue, antired, antigreen**
 Weak Charge: $+\frac{1}{2}$

Lifetime: $2 \cdot 10^{-12} \text{ s}$



ANTIMATTER PARTICLES: ANTILEPTONS

**ELECTRON ANTI-NEUTRINO**

DISCOVERED: 1956



ANTIMATTER PARTICLE

Mass:	$< 2 \cdot 10^{-6} \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$-1/2$

Lifetime: undefined

MUON ANTI-NEUTRINO

DISCOVERED: 1962



ANTIMATTER PARTICLE

Mass:	$< 2 \cdot 10^{-6} \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$-1/2$

Lifetime: undefined

TAU ANTI-NEUTRINO

DISCOVERED: 2000



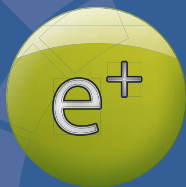
ANTIMATTER PARTICLE

Mass:	$< 2 \cdot 10^{-6} \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$-1/2$

Lifetime: undefined

POSITRON

DISCOVERED: 1932



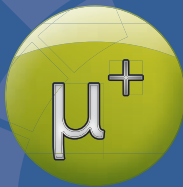
ANTIMATTER PARTICLE

Mass:	0.511 MeV/c ²
Electric Charge:	+1
Strong Charges:	-
Weak Charge:	$+1/2$

Lifetime: unlimited

ANTI-MUON

DISCOVERED: 1937

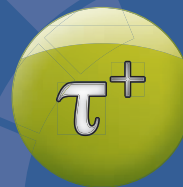


ANTIMATTER PARTICLE

Mass:	106 MeV/c ²
Electric Charge:	+1
Strong Charges:	-
Weak Charge:	$+1/2$

Lifetime: $2.2 \cdot 10^{-6} \text{ s}$ **ANTI-TAU**

DISCOVERED: 1975



ANTIMATTER PARTICLE

Mass:	1777 MeV/c ²
Electric Charge:	+1
Strong Charges:	-
Weak Charge:	$+1/2$

Lifetime: $2.9 \cdot 10^{-13} \text{ s}$



EXCHANGE PARTICLES AND HIGGS BOSON

W⁺ BOSON
DISCOVERED: 1983

EXCHANGE PARTICLE

Mass:	$80.4 \cdot 10^3 \text{ MeV}/c^2$
Electric Charge:	+1
Strong Charges:	-
Weak Charge:	+1
Lifetime:	$3 \cdot 10^{-25} \text{ s}$
Range:	10^{-18} m

W⁻ BOSON
DISCOVERED: 1983

EXCHANGE PARTICLE

Mass:	$80.4 \cdot 10^3 \text{ MeV}/c^2$
Electric Charge:	-1
Strong Charges:	-
Weak Charge:	-1
Lifetime:	$3 \cdot 10^{-25} \text{ s}$
Range:	10^{-18} m

Z BOSON
DISCOVERED: 1983

EXCHANGE PARTICLE

Mass:	$91.2 \cdot 10^3 \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	0
Lifetime:	$3 \cdot 10^{-25} \text{ s}$
Range:	10^{-18} m

PHOTON
DISCOVERED: 1905

EXCHANGE PARTICLE

Mass:	0
Electric Charge:	0
Strong Charges:	-
Weak Charge:	0
Lifetime:	unlimited
Range:	unlimited

GLUON
DISCOVERED: 1979

EXCHANGE PARTICLE

Mass:	0
Electric Charge:	0
Strong Charges:	red, blue, green + antired, antiblue, antigreen
Weak Charge:	0
Lifetime:	unlimited
Range:	10^{-15} m

HIGGS BOSON
DISCOVERED: 2012

Mass:	$125 \cdot 10^3 \text{ MeV}/c^2$
Electric Charge:	0
Strong Charges:	-
Weak Charge:	$-1/2$
Lifetime:	$2 \cdot 10^{-22} \text{ s}$