

Can you make particles with LEGOs?

Fermilab scientists study fundamental elementary particles such as quarks, electrons and neutrinos. They are the basic building blocks of ordinary matter. Scientists find out about the properties of matter when they learn the rules for combining quarks into composite particles such as protons and neutrons. Different rules would make different particles. Our universe emerged about 13.8 billion years ago from a hot, dense soup of particles. In the early universe, quarks combined to make two groups of particles. One group contains particles made of three quarks; they are called baryons. Protons and neutrons are baryons. The other group contains particles made of a quark and an antiquark; they are called mesons.



Materials: Colored LEGO blocks, adhesive letters

Activity: Label LEGO blocks as shown in this diagram below and make a set of 10 for each quark and antiquark. Use the charts for baryons and mesons, which shows the quark content for each particle, and build these composite particles from your labeled LEGO quarks and antiquarks.

Quarks			Antiquarks		
Up 	Charm 	Top 	Antitop 	Anticharm 	Antiup
Down 	Strange 	Bottom 	Antibottom 	Antistrange 	Antidown

Baryons			Mesons		
Symbol	Name	Quark content	Symbol	Name	Quark content
p	proton	uud	π^+	pion	$u\bar{d}$
\bar{p}	anti-proton	$\bar{u}\bar{u}\bar{d}$	K^-	kaon	$s\bar{u}$
n	neutron	udd	ρ^+	rho	$u\bar{d}$
Λ	lambda	uds	B^0	B-zero	$d\bar{b}$
Ω^-	omega	sss	η_c	eta-c	$c\bar{c}$

Questions to ask: How many quarks do you need to make a baryon? Which quarks make up a proton? Which quarks make up a neutron? Can you make a meson with only quarks?

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