# Particle Physics: Nuclei, Quarks and Leptons

Particle physics · 4 questions · step-by-step answers at the end

Name: Date: Score: / 4

**USEFUL EQUATIONS**

$\beta^-$: $n \rightarrow p + e^- + \bar{\nu}$ $\beta^+$: $p \rightarrow n + e^+ + \nu$

## Questions

Show your working in the space under each question.

**1.** A meson is made of an up quark and an anti-down quark. What is its charge?

**2.** Show that the quark model gives the correct charges for the proton and neutron, and that charge is conserved in $\beta^-$ decay.

**3.** What is the quark content and charge of a $\pi^-$ meson?

**4.** The $\Lambda^0$ (uds) decays to a proton and a $\pi^-$. Which interaction is responsible, and how do you know?

## Step-by-step answers

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**1.** $+\frac{2}{3} + \frac{1}{3} = \mathbf{+1}$ (it is a $\pi^+$).

**2.** 1. Proton (uud): $\frac{2}{3} + \frac{2}{3} - \frac{1}{3} = \mathbf{+1}$.
2. Neutron (udd): $\frac{2}{3} - \frac{1}{3} - \frac{1}{3} = \mathbf{0}$.
3. $\beta^-$ decay: $0 \rightarrow (+1) + (-1) + 0$ ✓. Baryon number: $1 \rightarrow 1 + 0 + 0$ ✓. Lepton number: $0 \rightarrow 0 + 1 + (-1)$ ✓

**Answer: Charges +1 and 0; all three quantities are conserved**

**3.** A down quark and an anti-up quark: $-\frac{1}{3} - \frac{2}{3} = \mathbf{-1}$.

**4.** Strangeness changes from $-1$ to 0, so it must be the **weak interaction**.