

TAP 535- 2: Particle card student activities

1. Sorting particles and anti-particles.

Apart from the positron, all the anti-particles of baryons and leptons have obvious names. Not so for mesons! The mesons have baryon number 0 and lepton number 0. Some of them are anti-particles of others, but three of the mesons in these cards are their own anti-particles. Can you identify all these?

2. Decay reactions.

(a) Use the particle cards to check that the following decay reactions are all possible. The rules are:

- Mass/energy is conserved. In practice, this means that the mass on the left hand side of the equation must be more than the mass on the right hand side if the reaction is to go.
- (Electric) charge is conserved
- Baryon number is conserved
- Lepton number is conserved
- Strangeness may be conserved, or may change by 1

(The symbol γ refers to a gamma photon.)

$$K^+ \rightarrow \mu^+ + \nu_\mu$$

$$\Lambda \rightarrow p + \pi^-$$

$$\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$$

$$\Omega^- \rightarrow \Xi^0 + \pi^-$$

$$\Sigma^0 \rightarrow \Lambda + \gamma$$

(b) Here are some impossible decay reactions. For each one, use the particle cards to find why the reaction is not possible.

$$n \rightarrow p + e^- + \nu_e$$

$$\Delta^+ \rightarrow \pi^+ + \pi^0$$

$$\Xi^0 \rightarrow p + \pi^0$$

$$\Sigma^+ \rightarrow p + K^0$$

Answers and worked solutions

1. The particle – antiparticle pairs are: (π^+, π^-) , (K^+, K^-) , $(K^0, K^0\text{-bar})$, (ρ^+, ρ^-) and the particles which are their own antiparticles are: π^0 , η^0 , ϕ^0 and J/ψ^0 .

2. (b)

$n \rightarrow p + e^- + \nu_e$ lepton number not conserved

$\Delta^+ \rightarrow \pi^+ + \pi^0$ baryon number not conserved

$\Xi^0 \rightarrow p + \pi^0$ charge not conserved

$\Sigma^+ \rightarrow p + K^0$ mass/energy not conserved