Supplementary Worksheet #3
Mostly about the Eightfold Way

Terminology and Concepts

1. What is meant by the terms:

a) parity transformation,

b) scalar,

c) pseudo-scalar,

d) vector,

e) pseudo-vector

The Pseudoscalar Meson Octet (Eightfold Way)

2. Starting from the triangles of the Eightfold Way for the quark flavours u, d, s and their antiquarks, construct the **pseudoscalar meson octet**.

Playing with Spin (Two, spin $1/2$ particles)

3. Spin states of a system made up of two spin 1/2 particles.

a) We typically use $\uparrow$ and $\downarrow$ notation for spins. What do the arrows physically represent?

b) List all possible spin states.

c) Identify which combinations correspond to total spin $S = 0$ and $S = 1$.

Playing with Isospin (Two, iso-spin $1/2$ particles)

Consider a quantum number $I = 1/2$ that behaves mathematically like spin, but acts in an internal space with axes (I_1, I_2, I_3) (akin to axes (x, y, z)).

4. **Internal states** What are the possible states of a two-particle system, each with $I = 1/2$? Write down their total iso-spin and the corresponding states.

5. **Quark mapping** Recast the possible isospin states of a particle–antiparticle pair with $I = 1/2$ by rewriting your iso-spin states with the following substitutions:
   - **For particles:** Replace $\uparrow$ with u and $\downarrow$ with d
   - **For antiparticles:** Replace $\uparrow$ with $-\overline{d}$ and $\downarrow$ with $\overline{u}$

6. **Complete the table**

Isospin state	Quark mapping	Electric charge	Possible (ordinary) spin
$\uparrow\uparrow$			
$\uparrow\downarrow$			
$\downarrow\uparrow$			
$\downarrow\downarrow$			

7. Reconcile the results of the above table with the quark compositions in Pseudoscalar Meson Octet (previous page) and the table from the previous worksheet.