Problem 1: The following formula matrix occurs in a chemical system given by a rock sample [3]. The elements are Si, Al, Fe, Mg, K, H and O. The species are

- **qu** = quartz (SiO₂)
- **si** = sillimanite (Al₂SiO₃)
- **Kf** = K feldspar (KAlSi₃O₈)
- **st** = steam (H₂O)
- **al** = almandine (Fe₃Al₂Si₃O₁₂)
- **py** = pyrope (Mg₃Al₂Si₃O₁₂)
- **an** = annite (KFe₃Si₃AlO₁₀(OH)₂)
- **ph** = phlogopite (K₂Mg₃Si₃AlO₁₀(OH)₂)
- **Fec** = Fe-cordierite (Fe₂Al₄Si₅O₁₈)
- **Mgc** = Mg-cordierite (Mg₂Al₄Si₅O₁₈).

Thus, the formula matrix is

\[
A = \begin{pmatrix}
1 & 1 & 3 & 0 & 3 & 3 & 3 & 5 & 5 \\
0 & 2 & 1 & 0 & 2 & 1 & 1 & 4 & 4 \\
0 & 0 & 0 & 0 & 3 & 0 & 3 & 2 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\
0 & 0 & 0 & 2 & 0 & 2 & 2 & 0 & 0 \\
2 & 5 & 8 & 1 & 12 & 12 & 12 & 18 & 18
\end{pmatrix}
\]

(i) Determine possible reactions for this system.
(ii) Is there a fixed ratio of molar amounts of the elements in every possible sample composed of species from this system?