Exercises:

1. Suppose there are two sylvinites, one with 47.7% KCl (52.3% NaCl) and another with 25% KCl (75% NaCl and 5% H2O). Propose a conceptual design for the sylvinites separation in pure NaCl and KCl.

Table 1. Equilibrium Data for KCl + NaCl + H_2O System at 30 and 100ºC

T (ºC)	Key	Saturated Solution (wt %)			Solid Phase
		KCl	NaCl	H_2O	
30	C	11.70	20.25	68.05	KCl + NaCl
100	H	22.20	15.90	61.90	KCl + NaCl

2. Consider the Na2SO4–(NH4)2SO4–H2O system at 25 and 60°C, which tends to form double salts at low temperature that disappear at higher temperatures, such as 60°C (see Table 2). Using the feasible pathway diagram develop all the alternative processes for the separation of the double salt $Na_2SO_4{\cdot}(NH_4)_2SO_4{\cdot}4H_2O$ in Na_2SO_4 and $(NH_4)_2SO_4$

Table 2. Equilibrium Data for $(NH_4)_2SO_4$-Na_2SO_4-H_2O System at 25 and 60ºC

T (ºC)	Key	Saturated Solution (wt %)			Solid Phase
		% Na_2SO_4	% $(NH_4)_2SO_4$	%H_2O	
25	C1	25.76	14.10	60.14	A + SD
25	C2	8.00	38.70	53.30	SD + C
60	H1	16.33	36.91	46.76	B + C
	SD	41.04	38.15	20.81	-

A = $Na_2SO_4{\cdot}10H_2O$; B = Na_2SO_4; C = $(NH_4)_2SO_4$; SD = $Na_2SO_4{\cdot}(NH_4)_2SO_4{\cdot}4H_2O$

3. Suppose we seek to separate a mixture that contains both lithium and magnesium chloride. The values of the multiple saturation points compositions at 30 and 102°C are given in Table 3. The system forms the compound LiCl.MgCl2.7H2O. Propose a separation process for a mixture of 33.3% of lithium chloride and 33.3% of magnesium chloride. Represent the equilibrium data and the process proposed in a ternary phase diagram.

Table 3. Equilibrium Data for LiCl-$MgCl_2$-H_2O System at 30 and 102ºC

T (ºC)	Key	Saturated Solution (wt %)			Solid Phase
		% LiCl	% $MgCl_2$	% H_2O	
30	C1	39.90	6.27	53.83	A + SD
30	C2	26.60	16.60	56.80	SD + B
102	H	17.40	35.60	47.00	B + C
	SD	16.08	36.12	47.80	-

A = $LiCl{\cdot}H_2O$; B = $MgCl_2{\cdot}6H_2O$; C = LiCl; SD = $LiCl{\cdot}MgCl_2{\cdot}7H_2O$