You may want to use a template such as this as you guide the students step-by-step through the construction of this diagram. I start them off with a detailed description of the first calculation and then let them complete the construction of the reactions and the ∆Gr calculations for the rest. You may or may not want to include the balanced reactions and completed ∆Gr calculations in this template.

Use the Triangular diagram to determine the stable minerals that will go on the final activity diagram. Ubiquitous water – can be used to balance equations.

1. Determine what minerals to consider.
2. No hydrated pure silica phase-we won’t worry about SiO2 (am) for this example.
3. K2O & KOH
4. Al2O3 , Al (OH)3 , Al O (OH)

 corundum gibbsite boehmite

1. No pure K-silicates exist
2. No K-Al-O minerals exist
3. Common Al-Si minerals:

kaolinite pyrophyllite kyanite

1. Common K-Al-Si minerals:

microcline kaliophilite leucite muscovite

1. Collect necessary ∆Gf  for likely minerals (next page)
2. Compose a table showing the compositions of the phases of interest in mole %. Start with the number of moles of K2O, Al2O3,  & SiO2 in the mineral and then convert to mole percent. (next page)
3. Plot the minerals of interest on the triangular diagram. **(Figure A)**

**Examples of potential diagrams A – G are included in the PDF entitled: “triangular diagram demo-images”**

1. Determine which mineral is stable at the 3 apices. (Use ∆GR) {Any ideas how ?}
	1. ½ K2O (s) + ½ H2O (l ) ⇌ KOH (s)

∆Gr = ∆Gf ∘(KOH) –[ ½ (∆G f ∘ (K2O) ) + ½ (∆Gf ∘(H20) )]

 = -379.1 – [½ (-322.1) + ½ (-237.1)] = -99.5 kj/mol

**Goes as written - KOH stable - so it occupies the lower left hand corner.**

* 1. ½ Al2 O3 (s) + 1½ H20 (l) ⇌ Al (OH) 3 (s)

∆GR = -8.3 Gibbsite stable

Gibbsite stable

 c. AlOOH (s) + H2O (l) ⇌ Al (OH) 3 (s)

Gibbsite stable

∆GR = -2.2 Gibbsite stable

 [Now you have Figure B/C.]



1. Tie-lines connect stable coexisting phases.
2. On your diagram **(Figure B/C)** you see lots of colinear phases on the outside but are they all stable? That is, is every segment between 2 minerals a tie-line?
3. Start at one apex and work down
4. Is pyrophyllite stable or does it react to form kaolinite + quartz?

Al2 Si2 O5 (OH)4 (s) + 2SiO2 (s)⇌ Al2Si4O10(OH)2 (s)+ H2O (l)

 ∆GR = +9.7

Pyrophyllite ≠ Stable

1. Is kyanite stable w.r.t. kaolinite + gibbsite?

Al2 Si2 O5 (OH)4 (s)+ 2Al(OH)3 (s)⇌2Al2 SiO5 (s)+ 5 H2O (l)

∆GR = +36.6 Kyanite ≠ Stable

Kyanite ≠ Stable

1. Is kaolinite stable w.r.t. quartz + gibbsite ?

2SiO2 (s) + 2Al(OH)3 (s) ⇌Al2 Si2 O5 (OH)4 (s)+ H2O (l)

∆GR = -13.4 Kaolinite = Stable

Kaolinite = Stable

1. Now check internal collinear phases **(Figure D)**
2. leucite + quartz = microcline

KAlSi2O6  (s)+ SiO2 (s)⇌ KAlSi3O8 (s)∆ GR = -14.9

Microcline = Stable

1. microcline + kaliophilite ⇌ leucite ∆GR = +5.4

KAlSi3O8 (s)+ KAlSIO4 (s) ⇌KAlSi2O6 (s)

Leucite ≠ Stable

1. kaliophilite + quartz ⇌ microcline ∆GR =-24.4

KAlSIO4 (s)+ 2SiO 2  (s) ⇌ KAlSi3O8 (s)

Microcline = Stable

1. microcline + gibbsite ⇌ muscovite

KAlSi3O8 (s) + 2Al(OH)3 (s) ⇌ KAl3Si3O10(OH)2 (s) + 2 H2O (l)

∆GR = -29.5 Muscouite = Stable

Muscovite = Stable

1. kaolinite + kaliophilite ⇌ muscovite

Al2Si2O5 (OH)4 (s) + KAlSIO4 (s) ⇌KAl3 Si3 O10 (OH)2 (s) + H2O (l)

∆GR = -40.5 Muscouite = Stable

Muscovite = Stable

1. muscovite + KOH ⇌ kaliophilite

KAl3 Si3 O10 (OH)2 (s) + 2KOH (s) ⇌ 3KAlSiO4 (s) + 2H2O (l)

∆GR = -123.5 Kaliohphilite = Stable

Kaliophilite = Stable

**Remember a stable intermediate phase does not eliminate the endpoints**

(Left with **Figure E**)

Now

1. Draw all possible tie-lines **(Figure F)**

Eliminate crossing tie-lines:

muscovite + quartz ⇌ microcline + kaolinite

KAl3 Si3 O10 (OH)2 (s)+ 2SiO 2  (s) + H2O (l) ⇌ KAl Si3O8 (s)+ Al2 Si2 O5 (OH)4 (s)

∆GR = +16.1 (Quartz + Muscovite = Stable) **(Figure G)**