Change of quartz into coesite at 25°C.

Let’s use the equation we discussed in class to calculate the pressure at which quartz transforms into coesite at 25°C. Coesite is a form of SiO$_2$ that forms under extremely high pressures, like that experienced at a meteorite impact site.

**Step 1:**
In the space below, write a balanced reaction that shows the transformation of quartz into coesite:

**Step 2:**

<table>
<thead>
<tr>
<th>form</th>
<th>formula</th>
<th>$\Delta H^\circ$ KJ/mol</th>
<th>$\Delta G^\circ$ KJ/mol</th>
<th>$S^\circ$ J/mol/K</th>
<th>$V^\circ$ cm$^3$/mol</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$-quartz</td>
<td>SiO$_2$</td>
<td>-910.94</td>
<td>-856.64</td>
<td>41.84</td>
<td>22.668</td>
</tr>
<tr>
<td>coesite</td>
<td>SiO$_2$</td>
<td>-906.31</td>
<td>-851.62</td>
<td>40.376</td>
<td>20.641</td>
</tr>
</tbody>
</table>

At 25°C and 1 bar, which form of SiO$_2$ is stable? ________________

Why is this so? ____________________________________________

What happens to the *molar volume* when $\alpha$-quartz transforms to coesite? ________________

What happens to the *entropy* when $\alpha$-quartz transforms to coesite? ________________

Therefore, show on the graph below the “directions” to the $\alpha$-quartz / coesite equilibrium line (from 25°C, 1 bar) and sketch in an approximate reaction boundary:
Step 3:

Using the Gibbs Free Energies listed above, calculate the $\Delta G_{\text{rxn}}$. Express your final answer in J/mole.

Using the molar volumes listed above, calculate the $\Delta V^o_{\text{rxn}}$. Express your answer first in cm$^3$ and then your final answer in J/bar.

Step 4:

Using the equation discussed in class, calculate the pressure (at 25°C) where $\alpha$-quartz transforms to (is in equilibrium with) coesite. List your final answer in both bars and kilobars.

Step 5:

Calculate the $\Delta S^o_{\text{rxn}}$: Express your answer in J/mole/K.

Use $\Delta S^o_{\text{rxn}}$ and $\Delta V^o_{\text{rxn}}$ (calculated in Step 3) to determine the slope of the $\alpha$-quartz / coesite transformation using the Clapeyron Equation.

How much higher would the equilibrium pressure be at 500°C? Show your calculation below:

Plot the $\alpha$-quartz / coesite transformation boundary on the graph to the right. In the recent “science” fiction movie, “The Core,” the vessel used to penetrate the depths of the Earth passed from the crust into the mantle where it encountered an open region lined with crystals of amethyst (a gem variety of $\alpha$-quartz).

Can $\alpha$-quartz exist in the mantle? ________