12. a. ΔS ⊕ gas is being produced - more disorder

b. find ΔG° @ 25°C

$CaCO_3 \rightarrow CaO + CO_2$

$-1128.79 \quad -604.03 \quad -394.359$

$\Delta G^\circ = (-604.03 - 394.359) - (-1128.79) = +130.40$ kJ NO nonspont.

c. Need to determine signs of ΔH°, ΔS°

just look at sign of ΔH.
ΔH° is ⊕ endothermic
so more favorable at higher T

	$CaCO_3$	CaO	CO_2
ΔH_f	-1206.92	-635.09	-393.509
S	92.9	39.75	213.74

$\Delta H^\circ = (-635.09 - 393.509) - (-1206.92) = +178.32$ kJ

~~$\Delta S^\circ = (39.75 + 213.74) - (92.9) = +160.59$ J/K~~

sign of ΔS doesn't matter

~~$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$ both ΔH° and ΔS° are ⊕~~

~~will be spontaneous at higher temps ... $|T\Delta S|$ term > $|\Delta H|$ term~~

d. $\Delta G^\circ = 0 = \Delta H - T\Delta S^\circ$

$T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{178.32 \text{ kJ}}{0.16059 \text{ kJ/K}} = 1110 \text{ K} = 837 \text{ °C}$

e. Yes. You could (if you felt like it) determine K at any temp.

At 837°C, ΔG° is 0, so $K = 1$

at temps higher than 837°C, $K > 1$

at temps lower than 837°C, $K < 1$ (reactant favored)

but even a reactant favored reaction will occur to some extent. There just won't be much products at equilibrium.

13. K_{sp} $PbBr_2 = 6.3 \times 10^{-6}$ K_{sp} $AgBr = 3.3 \times 10^{-13}$

will ppt when $Q = K_{sp}$

$K_{sp} = [Pb^{2+}][Br^-]^2$

$[Br^-] = \sqrt{\frac{K_{sp}}{[Pb^{2+}]}}$

$[Br^-] = \sqrt{\frac{6.3 \times 10^{-6}}{0.010}} = 0.025$ M

$K_{sp} = [Ag^+][Br^-]$

$[Br^-] = \frac{K_{sp}}{[Ag^+]} = \frac{3.3 \times 10^{-13}}{0.20} = 1.65 \times 10^{-12}$ Br^-

AgBr will ppt first.
(starts to ppt at a lower $[Br^-]$)

when $PbBr_2$ starts to ppt,

$[Br^-] = 0.025$ M

so $Ag^+ = \frac{K_{sp}}{[Br^-]} = \frac{3.3 \times 10^{-13}}{0.025} = 1.3 \times 10^{-11}$ M Ag^+