

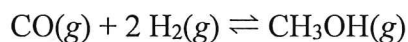
Dr. Fantini

Name: _____

Key

SB#: 007

1. With a suitable catalyst, carbon monoxide (CO) and hydrogen (H₂) are transformed into methanol (CH₃OH) according to the following balanced equation for which $K_c = 14.5$ at 483 K.



For a reaction with $[\text{CO}]_{\text{initial}} = 0.75 \text{ M}$ and $[\text{H}_2]_{\text{initial}} = 1.25 \text{ M}$, answer these questions about the attainment of equilibrium:

- a. Write the equilibrium constant expression.

$$K_c = \frac{[\text{CH}_3\text{OH}]}{[\text{CO}][\text{H}_2]^2}$$

- b. Write an "ICE-box" setup for the problem. Use the template given below and confine your answers to the boxes. Use x as your variable in the problem; one box has been filled in to get you started.

	CO(g)	+	2 H ₂ (g)	\rightleftharpoons	CH ₃ OH(g)
I	0.75		1.25		—
+ C	-x		-2x		+x
E	0.75-x		1.25-2x		x

- c. Write the equation to solve to find the value for the variable x . *To conserve time, do NOT solve it.*

$$K_c = 14.5 = \frac{x}{(0.75-x)(1.25-2x)^2}$$

you would solve this

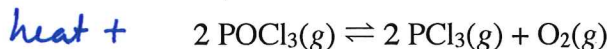
$$\begin{array}{r} 1.25 \\ -0.92 \\ \hline 0.33 \end{array}$$

$$\begin{array}{r} 0.75 \\ -0.46 \\ \hline 0.29 \end{array}$$

- d. When the problem is solved, we find $x = 0.46$. What are the equilibrium concentrations of the three compounds in the reaction?

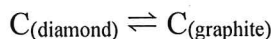
$[\text{CO}]_{\text{eqm}} = 0.29 \text{ M}$	$[\text{H}_2]_{\text{eqm}} = 0.33 \text{ M}$	$[\text{CH}_3\text{OH}]_{\text{eqm}} = 0.46 \text{ M}$
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2. For the following reaction, at equilibrium, circle the best response in each row of the table below to say how the reaction will respond to reestablish equilibrium. This reaction is endothermic.

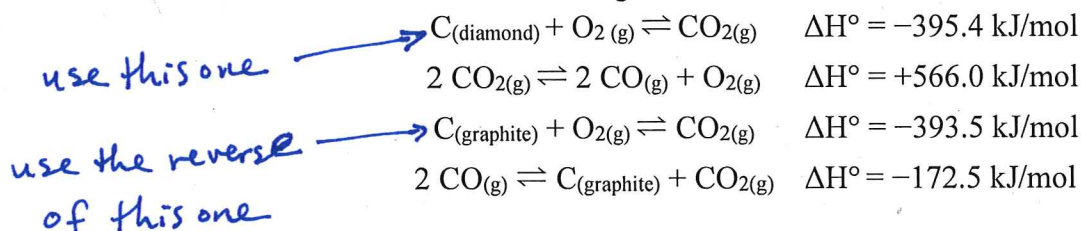


Action	Result (circle one per row)		
add oxygen gas	shift toward reactants	no change	shift toward products
remove phosphorus trichloride	shift toward reactants	no change	shift toward products
raise temperature to 1000 K from 500 K	shift toward reactants	no change	shift toward products
add a catalyst for the reaction	shift toward reactants	no change	shift toward products
decrease the volume of the container by half	shift toward reactants	no change	shift toward products

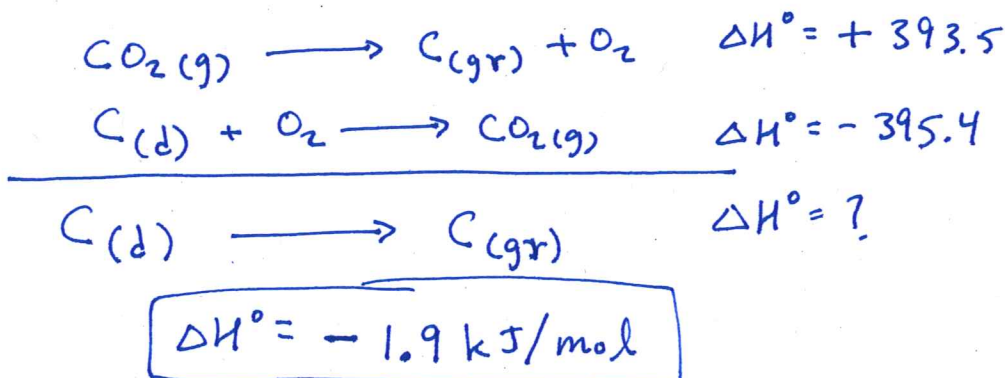
3. Diamond and graphite are two crystalline forms of carbon. At 1.0 atm and 25 °C, diamond changes to graphite so slowly that the enthalpy change of the process must be obtained indirectly. Determine $\Delta H^\circ_{\text{rxn}}$ for the reaction.



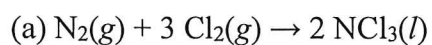
You will need **SOME** of the following reactions:



$$\begin{array}{r} 395.4 \\ - 393.5 \\ \hline 1.9 \end{array}$$



4. For each of the following reactions, predict whether the entropy change for the system is positive or negative. Give a **brief** explanation for each answer.



$\Delta S = \ominus$ b/c gases become liquids means more order, less random

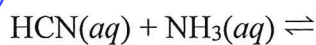


$\Delta S = \oplus$ b/c one gas becomes two gives a more random system



$\Delta S = \ominus$ b/c two things becoming one and the result is more ordered

5. Write the products of this acid-base reaction:



6. Mark this equation to show the conjugate acid-conjugate base pairs.

