## CHEM 102 - Recitation Week 6 - Answer Key

Ch. 15, 46. Consider the reaction indicated by the chemical equation below:

$$CO_{(g)} + 2 H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$$

A reaction mixture in a 5.19 L flask at a certain temperature contains 26.9 g CO and 2.34 g H<sub>2</sub>. At equilibrium, the flask contains 8.65 g CH<sub>3</sub>OH. Calculate the equilibrium constant ( $K_c$ ) for the reaction at this temperature.

### Concepts needed:

- dynamic equilibrium;
- stoichiometric coefficients;
- definition of equilibrium constant, K<sub>c</sub>;
- definition of molar concentration or molarity (M) = number of moles of solute per liter
   (L) of solution;
- mass to moles conversion based on molar mass (see CHEM 101);
- ICE tables

### Answer:

Divide the given mass by the corresponding molar mass to find the number of moles of each substance, and then divide the number of moles by the volume of the flask to find the molar concentration of each substance.

Initially in the reaction mixture:

- 0.960 mol CO; [CO]initial = 0.185 M
- 1.16 mol H<sub>2</sub>; [H<sub>2</sub>]<sub>initial</sub> = 0.223 M

## At equilibrium:

0.269 mol CH<sub>3</sub>OH; [CH<sub>3</sub>OH]<sub>eq</sub> = 0.052 M

Set up an ICE table (I - initial molar concentrations; C - change in molar concentrations as the reaction progresses towards reaching equilibrium; E - molar concentrations in the reaction mixture at equilibrium). For easier calculations, let "x" be the molar concentration of the substance that has a stoichiometric coefficient of 1. Each mole of CO requires 2 moles of hydrogen to react, so the ratio between the change in [CO] and the change in  $[H_2]$  will be 1:2, as shown below:

	$\omega$	+ ZHz ;	≥ CHJOH
r	0.185	0.223	0
د	- ×	- 2 ×	+ ×
Ε	0-185-X	0.223-2x	·×

$$x = [CH_3OH]_{eq} = 0.052 M$$

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