Revision – equilibrium and ICE tables

1. A mixture of two gases composed of 0.820 mol carbon monoxide, CO, and 0.455 mol of hydrogen, H_2, was placed in a 650 mL container and allowed to reach equilibrium. At equilibrium the mixture contained 0.182 mol of methanol. The chemical reaction of the synthesis of methanol from hydrogen and carbon monoxide gases is given below.

   $$CO(g) + 2H_2(g) \rightleftharpoons CH_4O(g)$$

   Calculate the equilibrium constant, K_c.

2. Sulfur trioxide, SO_3, is made by the reaction of sulfur dioxide, SO_2, and oxygen, O_2, in the presence of a catalyst, according to the equation below.

   $$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H < 0$$

   In a closed system in the presence of the catalyst, the reaction quickly achieves equilibrium at 400°C.

   a. A mixture of 2.00 grams of $SO_2(g)$ and 2.00 grams of $O_2(g)$ was placed in a 4.00 L evacuated, sealed vessel and kept at 400°C until equilibrium was reached. At equilibrium, the vessel was found to contain 0.0172 mol of $SO_3(g)$. Calculate the equilibrium constant, Kc, at 400°C.

3. Carbon monoxide gas, CO, is placed in a sealed reaction vessel with gaseous H_2O where upon a reaction occurs to form carbon dioxide and hydrogen gas according to the equation below.

   $$H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2(g)$$

   Initial concentrations of reactant gases are as follows, 0.450 M H_2O and 0.450 M CO. Given that the equilibrium constant, K_c, at this, particular, temperature is 25.00, calculate the concentrations of each chemical species present at equilibrium.