3) Given the following reaction; $CO_{(g)} + H_2O_{(g)} \rightleftarrows CO_{2(g)} + H_{2(g)}$

a) Write the equilibrium constant expression for this reaction. Note: gaseous-phase H_2O is included in the equilibrium expressions, unlike liquid phase H_2O.

b) The equilibrium constant for the reaction is 8.62×10^{-2} atm^2 at 350°C and under constant pressure. If the initial partial pressures of CH_4(g) and H_2O (g) are 9.64 atm and 28.37 atm, calculate the pressure of all species at equilibrium. Use the quadratic formulae to solve the second degree equation you will obtain.

c) An approximation can be used to simplify the equilibrium constant equations in certain situations, as demonstrated below.

$$1A + 1B \rightleftarrows 1C + 1D$$

$$K_{eq}\frac{[C]^1[D]^1}{[A]^1[B]^1} = \frac{(x)(x)}{([A]_0\text{-}x)([B]_0\text{-}x)}$$

Approximation : $([A]_0\text{-}x) \approx [A]_0$ and $([B]_0\text{-}x) \approx [B]_0$

$$K_{eq}\frac{[C]^1[D]^1}{[A]^1[B]^1} = \frac{(x)(x)}{([A]_0)([B]_0)}$$

where $[A]_0$ and $[B]_0$ are the initial concentrations of the reagents

This approximation is only justified when x is less than 10% of $[A]_0$ and $[B]_0$. If the approximation cannot be accomplished, the quadratic equation must be used to solve for x.

Use this approximation to solve the second-degree equation developed in b). Compare the values of x obtained with $[A]_0$ and $[B]_0$. Is the approximation justified or must you use the quadratic equation to solve this problem.