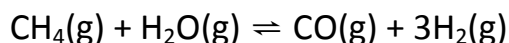


Equilibria – part questions from past NCEA exams 2010-2014**QUESTION ONE**

Hydrogen can be produced industrially by reacting methane with water. An equation for this reaction can be represented by:



$$K_c = 4.7 \text{ at } 1127^\circ\text{C}$$

(a) (i) Complete the equilibrium constant expression for this reaction:

$K_c =$

(ii) The concentrations of the four gases in a reaction mixture at 1127°C are found to be:

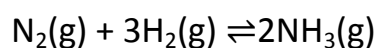
Gas	CH_4	H_2O	CO	H_2
Concentration / mol L^{-1}	0.0300	0.0500	0.200	0.300

Use these values to carry out a calculation to determine *if the reaction is at equilibrium*. Hint: Put the values into your answer for (a)(i) - see if the answer is 4.7.

Calculation:

QUESTION TWO

(a) Ammonia gas, $\text{NH}_3(\text{g})$, is formed from hydrogen gas and nitrogen gas, as shown in the following equation.



Complete the equilibrium constant expression for this reaction.

$K_c =$

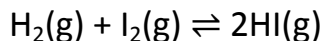
(b) The K_c for a different reaction is

$$K_c = \frac{[\text{SO}_3(\text{g})]^2}{[\text{SO}_2(\text{g})]^2 [\text{O}_2(\text{g})]}$$

Write the chemical equation that corresponds to this expression in the box below.

\rightleftharpoons

(c) For the reaction below, the K_c value is **46.8** at 491°C



Calculate the concentration of HI(g), at equilibrium, at 491°C, if the concentration of H₂(g) is 0.0190 mol L⁻¹ and the concentration of I₂(g) is 0.210 mol L⁻¹.

Hint: write the K_c expression for the equation, substitute 46.8 for K_c , 0.0190 for H₂(g) and 0.210 for I₂(g); find [HI]² and then calculate [HI].

QUESTION THREE

Phosphorus pentachloride gas, PCl₅(g), decomposes to form phosphorus trichloride gas, PCl₃(g), and chlorine gas, Cl₂(g). The equilibrium can be represented as:



(a) Complete the equilibrium constant expression for this reaction

$$K_c =$$

(b) The table below shows the value of the equilibrium constant, K_c at two different temperatures.

Temperature / °C	Value of K_c
200	8.00×10^{-3}
350	0.612

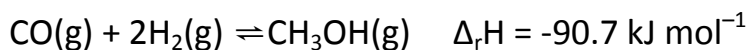
(i) Circle the species that will be in the highest concentration at 200°C.



- (ii) Explain your answer.
- (c) Calculate the concentration of PCl_5 at equilibrium at 350°C , if the concentrations of PCl_3 and Cl_2 are both 0.352 mol L^{-1} . *Hint: $K_c = 0.612$; substitute the values of 0.352 in the K_c expression you wrote in (a) for $[\text{PCl}_3]$ and $[\text{Cl}_2]$ and calculate $[\text{PCl}_5]$.*

QUESTION FOUR

The following reaction can be used to produce gaseous methanol, CH_3OH , from carbon monoxide and hydrogen.



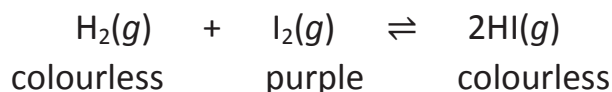
- (a) (i) Complete the equilibrium constant expression for this reaction.

$$K_c =$$

- (ii) At 25°C , the equilibrium constant, $K_c = 2.20 \times 10^{-4}$. Explain what this indicates about the relative amounts of reactants and product at equilibrium.

QUESTION FIVE

Hydrogen gas and iodine vapour are placed in a sealed container at 445°C . These gases combine to form hydrogen iodide gas. This equilibrium can be represented by:



- (a) Describe how an observer would know that the system had reached equilibrium.
- (b) Complete the equilibrium constant expression for this reaction.

$$K_c =$$