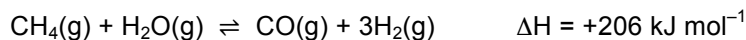




EQUILIBRIA (C)

Hydrogen can be made by the reaction of methane with steam in a reaction that reaches a state of dynamic equilibrium in a closed system.



At temperature T , in a container of volume 12 dm^3 , 2.00 moles of methane is mixed with 10.00 moles of steam. At equilibrium, it is found that there are 4.50 moles moles of hydrogen.

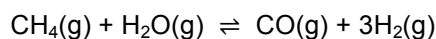
a What is happening when the system is in dynamic equilibrium?

both reactions are taking place simultaneously and at the same rate

b Write an expression for the equilibrium constant K_c , and state its units.

$$K_c = \frac{[\text{CO}][\text{H}_2]^3}{[\text{CH}_4][\text{H}_2\text{O}]} \quad \text{mol}^2 \text{ dm}^{-6}$$

c Calculate the value of the equilibrium constant K_c at this temperature.



moles at start	2.00	10.00	0	0
change in moles	-1.50	-1.50	+1.50	+4.50
moles at equilibrium	0.50	8.50	1.50	4.50

$$K_c = \frac{[\text{CO}][\text{H}_2]^3}{[\text{CH}_4][\text{H}_2\text{O}]} = \frac{\left(\frac{1.50}{12}\right)\left(\frac{4.5}{12}\right)^3}{\left(\frac{0.50}{12}\right)\left(\frac{8.50}{12}\right)} = 0.22 \text{ mol}^2 \text{ dm}^{-6}$$

d What happens to the yield of hydrogen and the value of K_c if the pressure is increased? Explain your answer.

equilibrium position moves left to side with fewer gas molecules to oppose increase in pressure
decreases yield of H_2
no change in K_c

e What happens to the yield of hydrogen and the value of K_c if the temperature is increased? Explain your answer.

equilibrium position moves right in endothermic direction to oppose increase in temperature
increases yield of H_2
 K_c increases

f Calculate K_c and state its units for this equilibrium at the same temperature: $\text{CO}(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g})$

$$K_c = \frac{1}{0.22} = 4.5 \text{ mol}^{-2} \text{ dm}^6$$