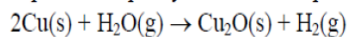


Q.12 The surface of copper gets tarnished by the formation of copper oxide.  $N_2$  gas was passed to prevent the oxide formation during heating of copper at 1250 K. However, the  $N_2$  gas contains 1 mole % of water vapour as impurity. The water vapour oxidises copper as per the reaction given below:



$p_{\text{H}_2}$  is the minimum partial pressure of  $\text{H}_2$  (in bar) needed to prevent the oxidation at 1250 K. The value of

$\ln(p_{\text{H}_2})$  is \_\_\_\_\_.

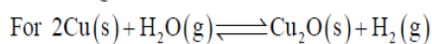
(Given: total pressure = 1 bar,  $R$  (universal gas constant) =  $8 \text{ J K}^{-1} \text{ mol}^{-1}$ ,  $\ln(10) = 2.3$ .  $\text{Cu(s)}$  and  $\text{Cu}_2\text{O(s)}$  are mutually immiscible.

At 1250 K:  $2\text{Cu(s)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{Cu}_2\text{O(s)}$ ;  $\Delta G^\theta = -78,000 \text{ J mol}^{-1}$

$\text{H}_2\text{(g)} + \frac{1}{2} \text{O}_2\text{(g)} \rightarrow \text{H}_2\text{O(g)}$ ;  $\Delta G^\theta = -1,78,000 \text{ J mol}^{-1}$ ;  $G$  is the Gibbs energy)

**Sol. -14.6**

From the given data:



$$\Delta G^\theta = 100000$$

$$\text{Hence } \Delta G^\theta = 100000 = -RT \ln K_p \text{ and } K_p = \frac{p_{\text{H}_2}}{p_{\text{H}_2\text{O(g)}}} \left( p_{\text{H}_2\text{O(g)}} = 0.01 \text{ bar} \right)$$

On calculating;  $\ln p_{\text{H}_2} = -14.6$