

Ammonia worksheet 4

1) Nitrogen and hydrogen gases were mixed in a reaction vessel within a bomb calorimeter and allowed to form ammonia gas. A volume of 100.0 mL of water in the calorimeter at 25.0 °C was heated to 33.1 °C. If 70.0 % of the energy released by the reaction goes into heating up the water and 1.70 grams of ammonia formed write a balanced thermochemical equation for the reaction between hydrogen and nitrogen gases to form ammonia gas.

Step 1 calculate the mol of NH₃ formed

$$\Rightarrow 1.70/17.0 = 0.100 \text{ mol}$$

Step 2 Calculate the amount of energy released knowing that only 70% goes into heating up the water.

$$\Rightarrow \text{Energy} = (4.18 \text{ J/g/}^\circ\text{C} \times 100.0 \times 8.1^\circ\text{C}) / 0.70 = 4837 \text{ J}$$

Step 3 Calculate the energy released per mol of ammonia formed = 9614/0.100 = 48370 J

Step 4 Write the balanced chemical equation

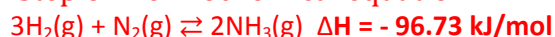


Step 5 Find the ΔH

\Rightarrow since two mol of ammonia form

$$\Rightarrow \Delta\text{H} = -48370 \times 2 = -96.73 \text{ kJ/mol}$$

Step 6 Thermochemical equation



2) In an experiment, a mixture of H₂, N₂ and NH₃ was placed in a sealed reaction vessel and allowed to reach equilibrium at a temperature of 470°C. The concentrations of gases at equilibrium were analysed and found to contain 0.121M H₂, 0.0400M N₂ and 0.00272M NH₃. Calculate the equilibrium constant at this temperature

a) Write the equilibrium expression for this reaction.

$$K = [\text{NH}_3]^2 / [\text{N}_2][\text{H}_2]^3$$

b) Calculate the equilibrium constant at 472 °C.

$$K = [0.00272]^2 / [0.0400][0.121]^3 = 0.104 \text{ M}^{-2}$$

3) In one experiment, 0.015 mol of H₂(g) and 0.010 mol of N₂(g) are combined in a 2.00 L vessel at 470°C. The mixture is allowed to come to equilibrium and the concentration of NH₃(g) is observed to be 3.20 x 10⁻³M. Calculate the equilibrium concentration of H₂(g) at this temperature.

Step 1 Calculate the mol of NH₃ formed.

$$\Rightarrow n = C \times V = 3.20 \times 10^{-3} \text{ M} \times 2.00 = 6.40 \times 10^{-3} \text{ mol}$$

Step 2 Calculate the amount of H₂ gas that reacted to form this amount of NH₃

\Rightarrow Stoichiometric ratio 3 (H₂) : 2 (NH₃)

$$\Rightarrow 3/2 \times 6.40 \times 10^{-3} = 0.00960$$

Step 3 find the amount of H₂ left unreacted.

$$\Rightarrow 0.015 - 0.00960 = 0.0054 \text{ mol}$$

Step 4 Calculate the [H₂]

$$\Rightarrow 0.0054 / 2.00 = 2.7 \times 10^{-3} \text{ M}$$