Nonstandard States and Equilibrium – Reading Guide

*section 16.4 in OpenStax*

**Free Energy for Nonstandard States**

We can calculate the free energy changes for reactions under non-standard conditions using the following equation:

∆Grxn =

where Q represents the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Work through Example 16.11, then complete the following exercise.

Calculate ∆Grxn for the process below using the specified conditions.

T = 25 °C PICl = 2.55 atm; PI2 = 0.325 and PCl2 = 0.0221 atm. ∆G *=* –10.9 kJ

I2 (g) + Cl2 (g) → 2 ICl (g)

*(ans. ΔGrxn = 5.97 kJ)*

**Free Energy and Equilibrium**

Complete the following equation relating ∆G and K.

When the reaction is at equilibrium, Q = K and ∆G = \_\_\_\_\_\_\_.

Using this relationship, we find under **standard conditions**:

∆G=

Calculate Kp for the following reaction, given that ∆G *=* –10.9 kJ at 25oC.

I2 (g) + Cl2 (g) → 2 ICl (g)

(ans*.* Kp = 81.9)

Examine Figure 16.14 and the preceding text.

Equilibrium is established when the system’s free energy is at a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ *(maximum or minimum).* Label this point on the graph below Q = K.

If a system is present with non-equilibrium amounts, the reaction will proceed in the direction to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. Indicate which arrow shows conditions that are spontaneous in the **forward** direction and which are spontaneous in the **reverse** direction.

Based on how you labeled the arrows, indicate on the graph the regions where: Q > K and Q < K.



∆G *=* 0

**reactants**

**products**

**Reaction progress**

**End of Chapter 16 Practice Problems**

#41a–c, 61, 63, 67

For detailed solutions to these problems, go to the [OpenStax website](https://openstaxcollege.org/textbooks/chemistry/resources) and download the “Student Answer and Solution Guide.”