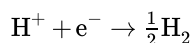


## 17.10: The Standard Hydrogen Electrode (S.H.E)

In [Section 17.4](#), we introduce the idea of a half-reaction and a half-cell in the context of balancing equations for oxidation–reduction reactions. The real utility of these ideas is that they correspond to distinguishable parts of actual electrochemical cells. Information about the direction of a spontaneous reaction enables us to predict the relative electrical potentials of the half-cells that make up the corresponding electrochemical cell. Conversely, given information about the characteristic electrical potentials of half-cells, we can predict what chemical reactions can occur spontaneously. In short, there is a relationship between the electrical potential of an electrochemical cell at a particular temperature and pressure and the Gibbs free energy change for the corresponding oxidation–reduction reaction.

Since cell potentials vary with the concentrations of the reactive components, we can simplify our record-keeping requirements by defining standard reference conditions that apply to a standard electrode of any type. We adopt the convention that a standard electrochemical cell contains all reactive components at unit activity. The vast majority of electrochemical cells that have been studied contain aqueous solutions. In data tables, the activity standard state for solute species is nearly always the hypothetical one-molal solution. For many purposes, it is an adequate approximation to say that all solutes are present at a concentration of one mole per liter, and all reactive gases at a pressure of one bar. (In [Section 17.15](#), we see that the dependence of cell potential on reagent concentration is logarithmic.) In [Sections 17.2](#) and [17.7](#), we discuss the silver–silver ion electrode; in this approximation, a standard silver–silver ion electrode is one in which the silver ion is present in the solution at a concentration of one mole per liter. Likewise, a standard copper–cupric ion electrode is one in which cupric ion is present in the solution at one mole per liter.

We also need to choose an arbitrary reference half-cell. The choice that has been adopted is the **Standard Hydrogen Electrode**, often abbreviated the S.H.E. The S.H.E. is defined as a piece of platinum metal, immersed in a unit-activity aqueous solution of a protonic acid, and over whose surface hydrogen gas, at unit fugacity, is passed continuously. These concentration choices make the electrode a standard electrode. Frequently, it is adequate to approximate the S.H.E. composition by assuming that the hydrogen ion concentration is one molar and the hydrogen gas pressure is one bar. The half-reaction associated with the S.H.E. is



We define the electrical potential of this half-cell to be zero volts.

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