# 2.4: Atomic Hydrogen

Atomic hydrogen has the electron conguration of $1s^1$ and as such represents the simplest atomic conguration. However, as a consequence there is dispute as to its proper position within the Periodic Table. Its electron conguration is similar to the valence electron conguration of the alkali metals ($ns^1$) suggesting it be listed at the top of Group 1 (1A). However, its reaction chemistry is dissimilar to the alkali metals. Hydrogen is also one electron short of a Nobel gas conguration, and therefore it is possible to think of its relationship to the halogens.

## Vapor phase

Atomic hydrogen ($H^{\cdot}$) is highly reactive and consequently has a short lifetime due to its reaction chemistry. Consequently, in order to generate and observe the reactivity they must be generate at low pressures.

Thermolysis of hydrogen compound (commonly halide) or photolysis at an energy above the bond dissociation energy results in the homoleptic cleavage of the H-X bond to generate the appropriate radical species.

$$H-X \xleftrightarrow{\Delta \; or \; h\nu} H + X \tag{2.4.1}$$

Alternatively, atomic hydrogen can be generated from elemental hydrogen.

$$H-H \xleftrightarrow{\Delta \; or \; h\nu} H^{\cdot} + H^{\cdot} \tag{2.4.2}$$

The reverse reaction (recombination of two hydrogen atoms) is highly exothermic (-434 $kJ.mol^{-1}$) and forms the basis of the heat generated in arc welding.

## Solution

Atomic hydrogen may be generated in aqueous solution through the solvation of electrons.

$$e^-_{(aq)} + H_3O^+ \leftrightharpoons H^{\cdot} + H_2O \tag{2.4.3}$$

The formation equilibrium constant ($K_{eq}$) is very small resulting in very low concentrations being generated ($10^{-5}$ M). As expected solvated atomic hydrogen is a strong reducing agent.

$$Ag^+ + H^{\cdot} \rightarrow Ag + H^+ \tag{2.4.4}$$

$$2I^- + 2H^{\cdot} \rightarrow 2H^+ + I_2 \tag{2.4.5}$$

## Solid state

Hydrogen atoms may be trapped in the solid state lattice upon generation by photolysis of HX. Observation by electron spin resonance (esr) of a signal split by s = $^1/_2$ nucleus (i.e., $^1H$) results in a doublet with a coupling of 1428 MHz.