Supplemental notes for Lecture 3

Equation for the Bohr Model (Please read pp 219–221 of the BLB before you read this page!)

On your data sheet, we will be giving you the Rydberg constant as \( R_H = 2.18 \times 10^{-18} \text{ J} \).
Your book uses a different convention and value for the same constant.

Eq. 6.7 in your book is the form of the equation for the Bohr Model that I used in class, in my lecture notes, and the form that is given on your data sheet. The Rydberg equation (Eq. 6.4 on p 219) differs from this by some simple algebra. The value of \( R_H \) as given in your text is \( 1.097 \times 10^7 \text{ m}^{-1} \) (\( = 2.18 \times 10^{-18} \text{ J} \) divided by \( h c \); Planck’s constant \( \times \) the speed of light). Note: the value of the constant (and the UNITS) are different, but the two constants are proportional.

So why ARE there two different forms for this same equation and why are we putting the \( \Delta E \) form of the equation on your data sheet rather than the \( \frac{1}{\lambda} \) version?

Equation 6.4 (p 219) would be a useful form for spectroscopists (people who study spectroscopy or how light is emitted and absorbed by matter). These experimentalists measure the wavelength of light emitted or absorbed in their experiment, and to them, inverse wavenumbers (e.g. \( m^{-1} \) or \( \text{cm}^{-1} \), etc.) is an energy unit (just like Joules or calories). By using the constant \( h \) and \( c \), they can easily convert an energy in inverse wave numbers to an energy in Joules.

In our case, however, we are more interested in the change in energy when an electron goes from one energy level to another, so the form of the equation that is most useful to us is the equation for \( \Delta E \) (Eq. 6.7). Since we will often want to know this energy in Joules, using the constant \( 2.18 \times 10^{-18} \text{ J} \) saves us the step of converting our result from inverse wave numbers to Joules by using \( h \) and \( c \).

Sign convention for energy:

For changes in energy (\( \Delta E \)) (e.g. electronic energy level transitions or adding heat to the “system”)

\( + \) means adding energy to the system (endothermic)
\( - \) means removing energy from the system (exothermic)

For electrostatic attraction: (Coulomb’s Law: Eq. 5.2 in your text book)

\( + \) Like charges repel each other: the sign of the electrostatic energy is positive
\( - \) Opposite charges attract each other: the sign of the electrostatic energy is negative

So for ELECTROSTATIC ENERGY:

\( + \) means repulsive
\( - \) means attractive