

R Programming Challenge: Bohr Model

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1 Introductory Reading

For this R programming challenge, you are asked to do a study of how electrons behave in an atom. In this case, electrons are particles, like BB pellets. Because electrons have a negative charge, they "live" a certain distance from the nucleus. They reside at specific levels, called "orbits". These orbits are numbered, using the variable "n" for the orbits, and going from n=1,2,3,4,etc. Electrons, when behaving as particles, can't be in-between orbits.

When electrons move from one orbit to another (typically from a "higher" orbit to a "lower" one. You can see this behavior in Figure 1, where we have an electron moving from Orbit 3 to Orbit 2. When this happens, energy is released in the form of light energy. Depending on the wavelength of that light energy, we can see it (visible light) or not see it (infrared light, ultraviolet light, etc.). Figure 2 shows the electromagnetic spectrum, where you can see these wavelengths.

Mathematically, there are a series of calculations that you need to do, but first you need some constants:

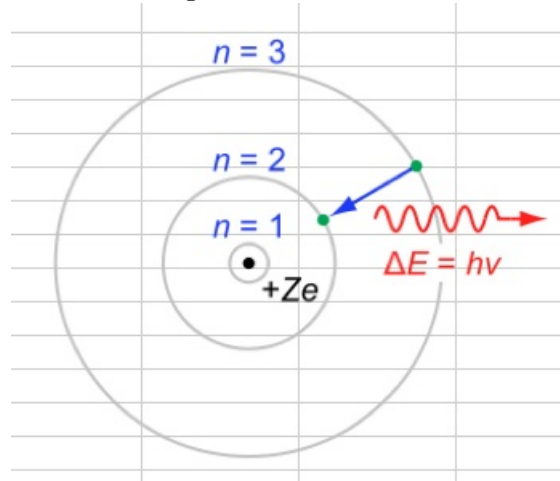
1. Speed of light (c) = 2.99×10^8 m/sec
2. Rydberg constant (R) = -2.17×10^{-18} Joules (J)
3. Planck's constant (h) = 6.63×10^{-34} J-sec

Now, you need to calculate the value of the energy for each of the two conditions: the initial energy and the final energy. These are calculated using these equations:

$$E_{initial} = \frac{R}{n_{initial}^2} \quad (1)$$

$$E_{final} = \frac{R}{n_{final}^2} \quad (2)$$

Figure 1: Bohr model



Using the picture as a guide, $n = 3$ for the initial orbit and $n=2$ for the final orbit.

Now, you need to know the change in energy, ΔE . "abs" means to take the absolute value:

$$\Delta E = \text{abs}(E_{\text{final}} - E_{\text{initial}}) \quad (3)$$

Once you have ΔE , you can calculate the frequency (ν) of the system:

$$\text{frequency} = \frac{\Delta E}{h} \quad (4)$$

Finally, we can calculate the wavelength (λ). We're multiplying this by 1,000,000,000 in order to get the units converted. For this challenge, you don't need to worry about units. You're welcome!

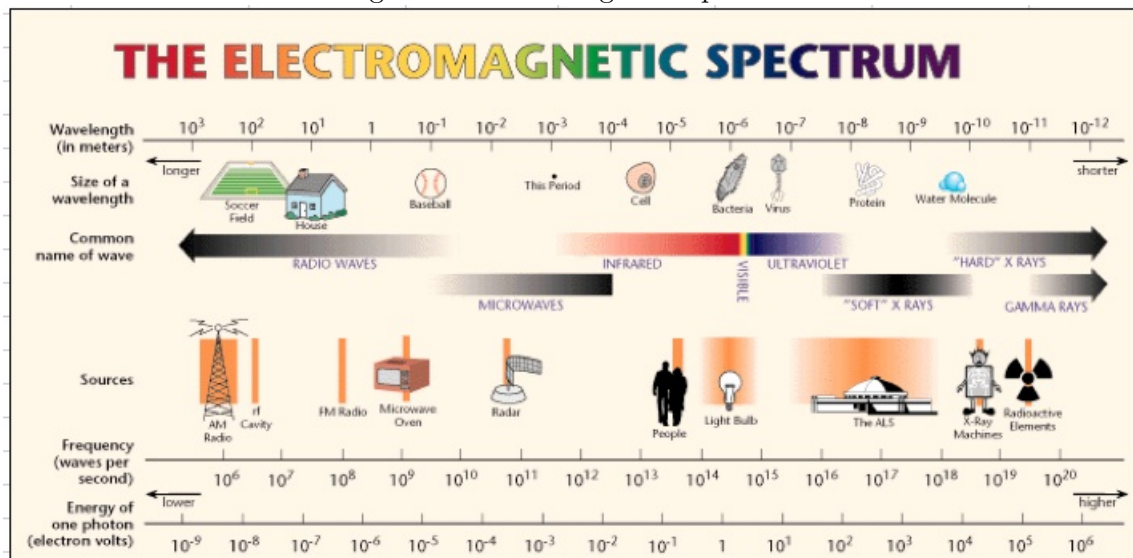
$$\text{wavelength} = \frac{c}{\text{frequency}} * 1000000000 \quad (5)$$

2 Computational Approach

Your challenge is to create functions for each of the five equations shown above. You should, of course, also code in your constants (with no worries about units). Once this is done, you should apply your functions to some system, for example, an initial value of 3 and a final value 2 (these are the orbit numbers). Based on these numbers, you should get a wavelength of approximately 655.

It should be noted that creating functions for these five equations is probably overkill – you could do this without programming functions. The goal of this challenge, however,

Figure 2: Electromagnetic Spectrum



is to give you experience with some VERY simple functions prior to moving on to more challenging problems!

3 Deliverable

For submission for this activity, you should submit a well-documented copy of your R script. For uploading to Canvas, it's easiest simply to copy the entire script, go to the Submit page on Canvas, and paste it into the text box. I should be able to run your R script and get a value for the wavelength without errors.