Physical Chemistry Problems and Why We Care

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1 Introduction

There are several concepts in *physical chemistry* that turn out to have wide applications and we are going to explore some of them here.

First, we should acknowledge that the early history is filled with people who had the luxury to explore rather esoteric topics, while we might be learning these as a matter of our own 'development' and with a sense of what for! I'll try to make an argument that this stuff really does matter, but for now, let's start the problem set!

Second, we also need to understand that these assignments have been developed as hurtles that have almost nothing to do with the end-goal of being a health-care professional. Instead, it's better to reflect that being able to think about problem solving is actually the real goal here and we need to learn to problem solve in a systematic way.

2 Problem #2

In this problem we are trying to determine (calculate) the 'de Brogie' wavelenth. So, let's first determine the units of a wavelength, so we have a clue where we are heading! In general, wavelength is measured as length per time, in SI units, we often see this as m/s, but for atomic particle scales, the units are often Å/second, where an Angstrom (Å) is $1 \cdot 10^{-10}$ meters, i.e very short disances! Note: an Å is not an SI unit, which is terribly lame. But let's let that go for now, I think $1 \cdot 10^{-9}$ is the SI units, which is nanometers. Whatever!

We are given the a number that includes temperature, as measured in Kelvin. Okay, that seems to be a weird parameter to be given! But let's back up. We are told that a particle accelartor generate nuetrons at 2500K, where K is degrees Kelvin, i.e. a temperature. By knowing temperature, we are supposed to figure out a wavelength, weird!!!

We are given the following equation to determine velicity of the nuetron

$$\mu_{rms} = \sqrt{(3k_B T/m)} \tag{1}$$

where μ_{rms} is room-mean-speed (m/s), k_B is Boltzmann's Constant ($1.38e^{-23}$ J/K) and T is temperature (degrees K) and m is the mass of the particle (kg).

This equation is the root-mean square of speed (velocity) of particles – I think it's a kind of a measure of variation of speed, see `http://www.studyphysics.ca/2007/20/ap_thermodynamics/42a_ap_kinetic_theory_gases.pdf` for a decent explanation. For now, we'll use μ_{rms} as root-mean-square speed defined as the square root of mean square (the arithmetic mean of the squares of a set of numbers). The RMS is also known as the quadratic mean and is a particular case of the generalized mean with exponent.

Thus, the μ_{rms} is

```
> k_B = 1.38e-23
> T = 2500
> m = 1.6750e-24; m

[1] 1.675e-24

> mu = sqrt(3*k_B*T/m); mu

[1] 248.578
```

Thus, we have now calculated the speed as 248.58. However, I am not sure this is right. Did you get this as a intermediate answer with your prof? I need to figure out the units too!

Next, what do we do with the velocity?

Using this site: `http://chem.libretexts.org/Core/Physical_and_Theoretical_Chemistry/Quantum_Mechanics/02._Fundamental_Concepts_of_Quantum_Mechanics/De_Broglie_Wavelength`, we might be able to evaluate the question with some sense that we understand what in the world is happening:

$$\lambda = h\rho = hm\nu \tag{2}$$

Based on this equation, we have velocity, μ, and we know the mass of the nuetron, which is XX. Thankfully, h, or planckt's constant is a known quanity, altough we derive it in problem #4!

3 On Plank's Constant

`https://en.wikipedia.org/wiki/Planck_constant`

$\lambda/\text{Å}$ is in the units of wavelenth per meter or meter/second/meter thus we are left with a time unit! Neat. I am not sure why they can tell us that! Whatever...

V_s/V so velocity of something over another velocity. Okay, this seems werid – what is the s?

Finally, the hint is anything but a real hint – basically driving more questions that it answers.

The equation given is

$$KE = EV_s \tag{3}$$

where KE is kenetic energy (units?) and E is the charge of an electron (volts) and V_s is velocity of ??.

We can use the photo-electric equation,

$$E = h\nu \tag{4}$$

```
> one=c(2536, 2830, 3039, 3302, 3663, 4358)
> two=c(2.6, 2.11, 1.81, 1.47, 1.1, .57)
> coef(lm(one~two))

(Intercept)         two
  4713.1565   -885.1904

> plot(one,two)
```