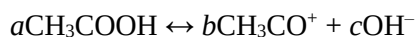


Finding solutions to systems of linear equations

1. Given the chemical reaction



where a , b and c are unknown, but related, we look at the number of atoms of carbon, hydrogen and oxygen, respectively, in each of the equations to get:

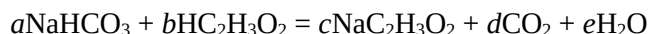
carbon	$2a = 2b$
hydrogen	$4a = 3b + c$
oxygen	$2a = b + c$

For example, in the molecule on the left, if there are a moles of that molecule, then there are $2a$ moles of atomic carbon. Solve this for a , b and c . Is there a unique solution?

2. In Question 1, what equation do you get if you add Equation 1 onto Equation 3?

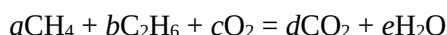
3. Find the square root of the complex number $3 + 4j$ by assuming the solution is $\alpha + \beta j$ and then equating the real components of $3 + 4j = (\alpha + \beta j)^2$, and then equating the imaginary components of that same complex equation to get two equations in two unknowns. Does this give you a system of two linear equations in two unknowns, or a system of two non-linear equations in two unknowns?

4. Given the chemical reaction of combining sodium hydrogen carbonate and acetic acid (the acid in vinegar) to produce sodium acetate (useful in many applications, but you may already be familiar with hand warmers if you have gone skiing), carbon dioxide and water.



Now, write down a linear equation for each of the four elements sodium, hydrogen, carbon and oxygen.

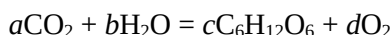
5. Suppose you are burning a mixture of methane and ethane in oxygen to produce water and carbon dioxide.



Once again, for each of the three elements carbon, hydrogen and oxygen, write a corresponding linear equation, and then use your skills from secondary school.

Hint: try to solve for c , d and e in terms of a and b , because you probably know how many moles of methane and ethane that is being burned, and you need to know how much oxygen is required and how much water and carbon dioxide are produced.

6. Now that you've polluted the atmosphere by burning that methane and ethane, a plant must now capture that carbon dioxide and, together with water, produce sugar which it uses not only to store energy, but to also build the structure of its cells (e.g., cellulose) as well as produce the backbone of proteins and nucleic acids.



In this case, solve for b , c and d in terms of a , the amount of carbon dioxide that is removed from the atmosphere.

Important: Do not solve these using the techniques you learned in secondary school or even university. Instead, always convert the equation into a system of linear equations. This is the only way finding such solutions can be automated. If you simply apply the balancing skills you learned in secondary school or even university, you are losing sight that this is a system of linear equations. We will go into this in an upcoming topic.