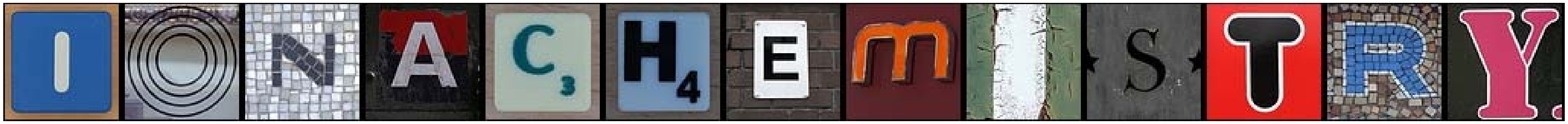


The Equilibrium Constant

Mercredi 18 maj

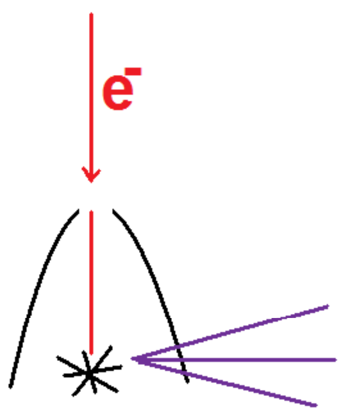
SCH4U1 – Mr. Dvorsky

While in central Europe, Mr. Dvorsky collects lichens on land that eight hundred years prior was a copper mine. Using an energy-dispersive spectrometer mounted on to a scanning electron microscope, plus the lichens he collected in the field, Mr. Dvorsky tests to see if the copper levels in the ground remain high centuries later. Outline using what you learned in class about atomic structure how this technique works. (4)

- Energy Dispersive X-Ray Spectroscopy (or EDX) used in conjunction with scanning electron microscopy is a method that can be used to perform an elemental analysis of a sample.

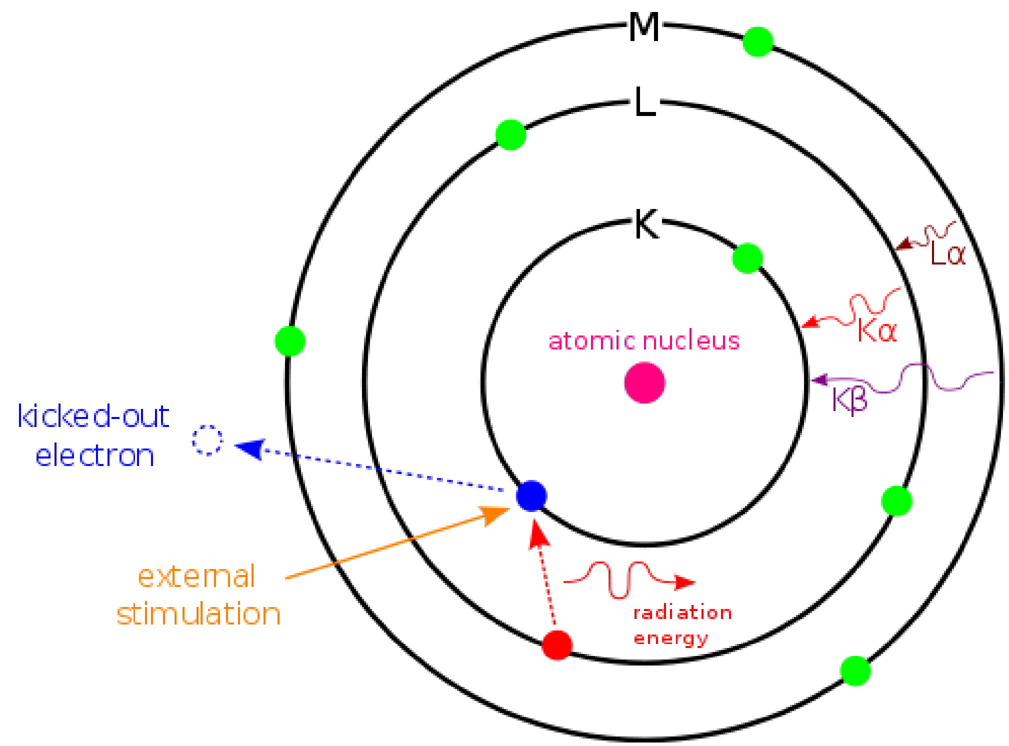
Here is how this technique works:

1. The sample is bombarded with an electron beam.



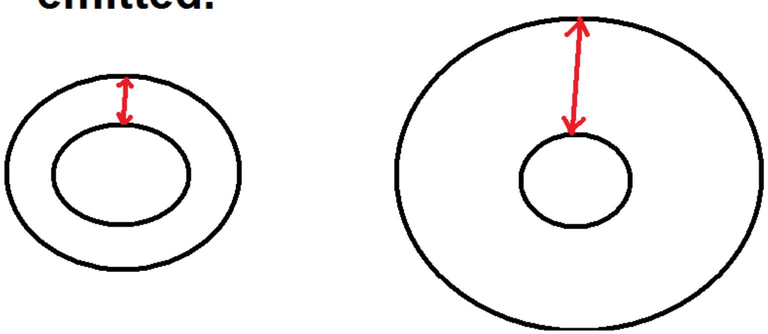
2. An electron in the beam hits an inner shell electron in an atom of the sample with a higher energy than ionization energy, so the inner shell electron is knocked out.

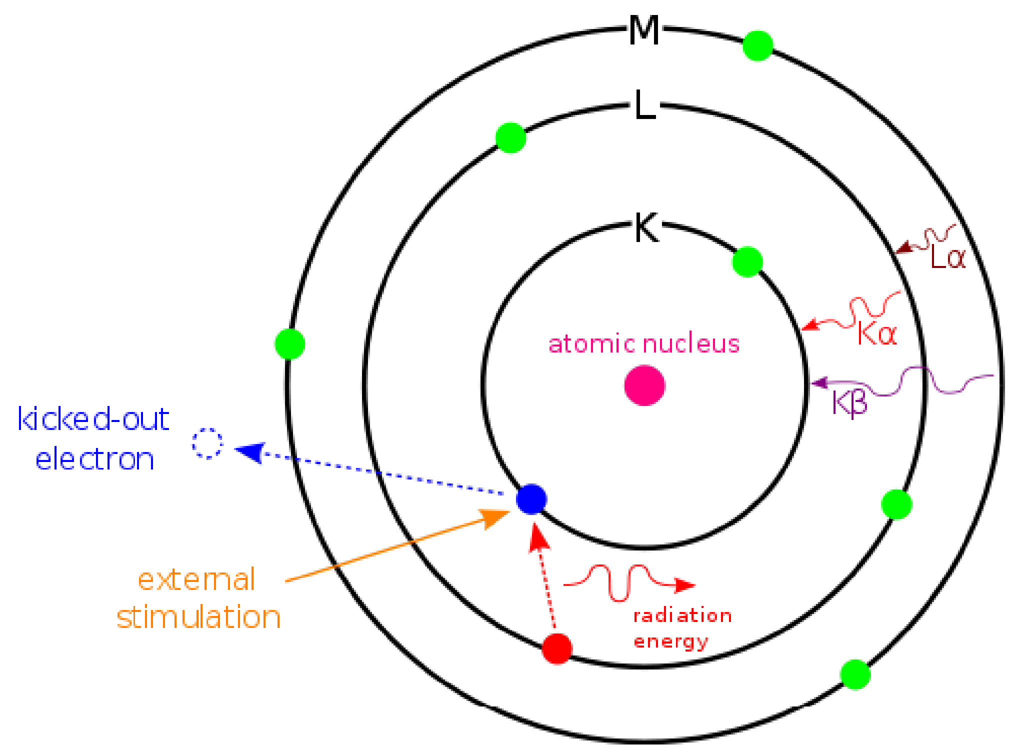
3. The gap left by the electron knocked out is filled by an electron in the next highest energy level



4. Since the electron filling the gap is moving from a higher energy level to the ground level, it gives off energy. This energy is emitted in the form of electromagnetic radiation, in particular X-rays.

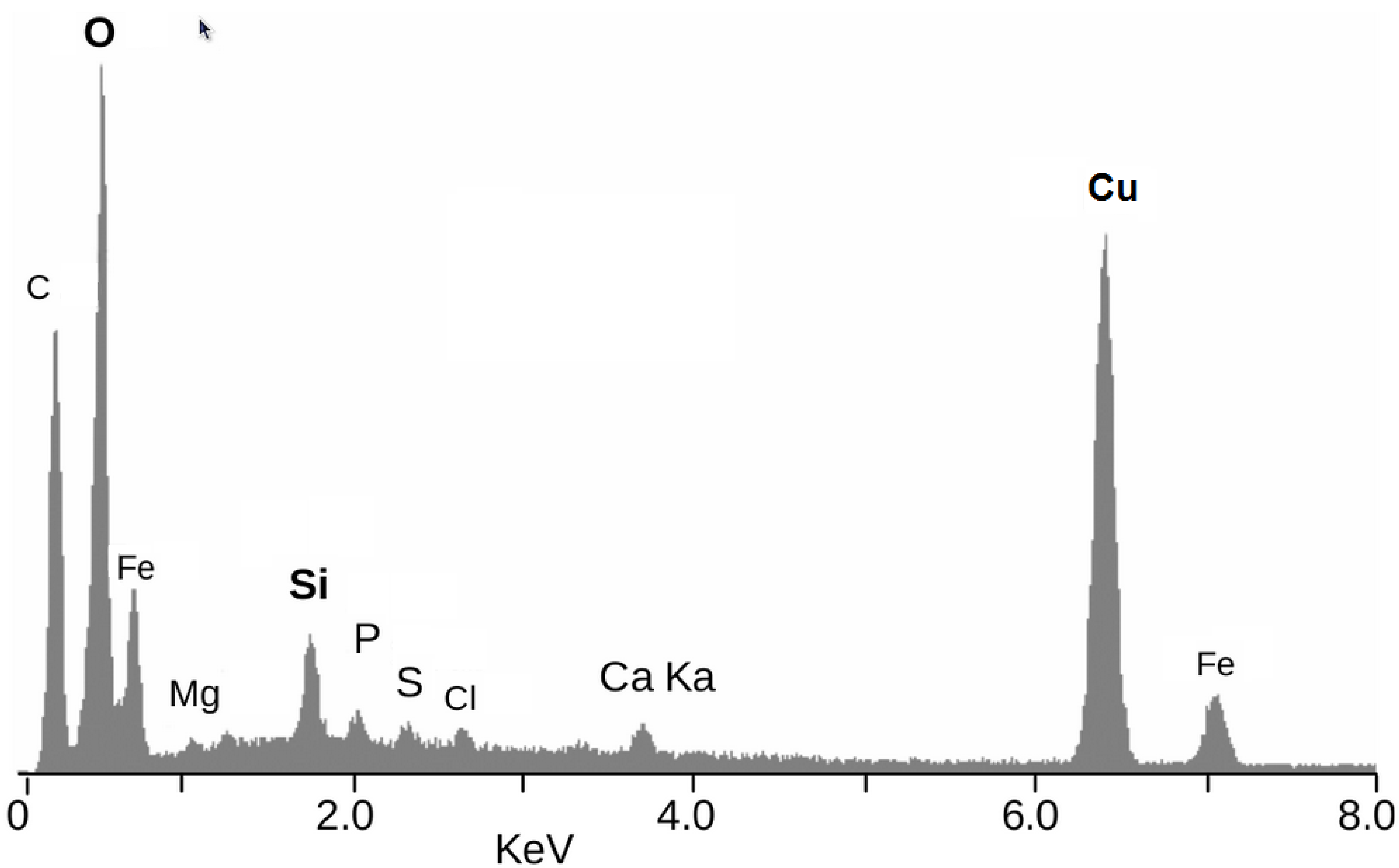
5. The X-ray energy is characteristic of the element from which it was emitted.

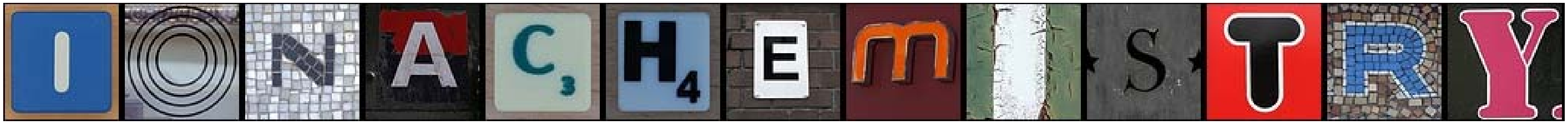




-you can think if it as the jump from the second energy level to the ground energy level being a different distance for each element

6. the EDX X-ray detector measures the relative abudance of emitted X-rays versus their energy and makes a plot.

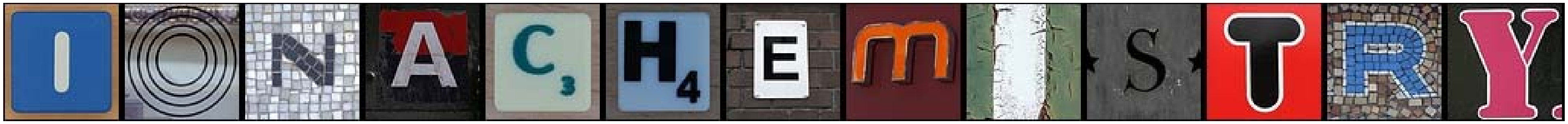


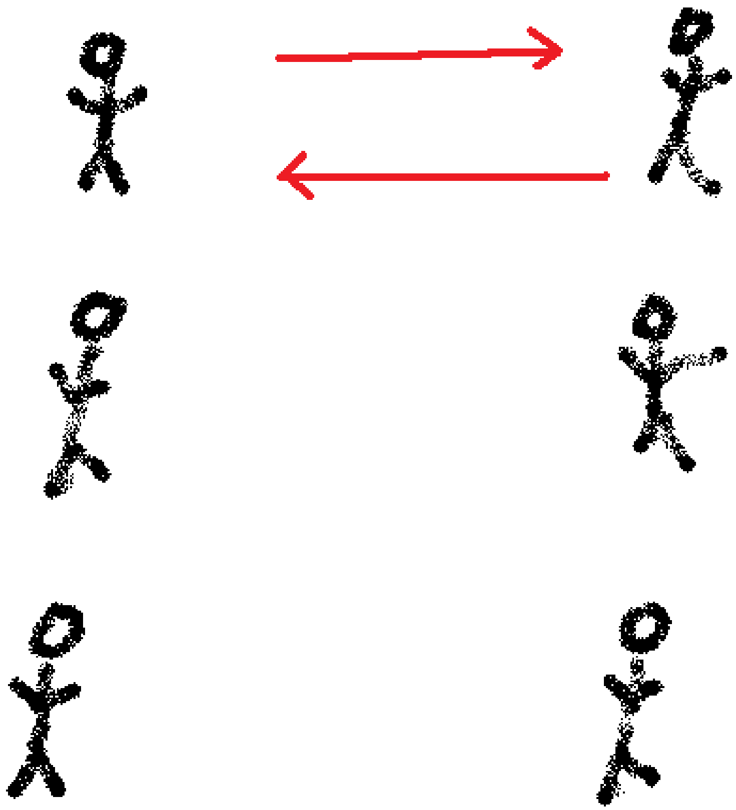


The Equilibrium Constant, K

- When chemical reactions take place in closed systems, the forward and reverse reactions occur continuously, and the reaction mixture always contains reactants and products.

- In a system in equilibrium, the reaction never proceeds to completion. As mentioned above, there are always both reactants and products in the reaction mixture.



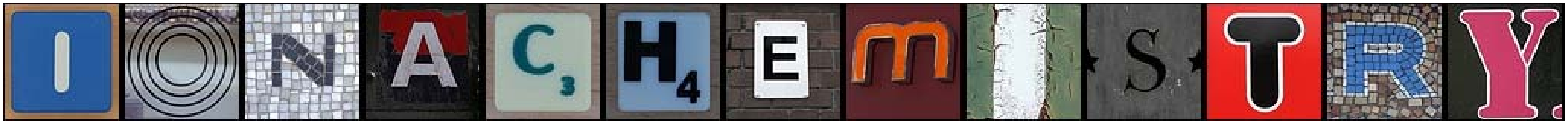


Students split into two groups, lining up on two sides of the classroom.

As students pass from one side of the room to the other at the same time and at the same rate, there is no net change in the count of students on either side.

Because there is no net change in these counts, we can divide the number of students on one side by the number of students on the other side and we'll always obtain the same number.

This same concept applies to equilibrium and we call it the equilibrium constant.



The Equilibrium Constant, K

We are going to look at a general case with the equation:

$$aA + bB \rightleftharpoons cC + dD$$

No state symbols have been given, but they will be all (g), or all (l), or all (aq) if the reaction was between substances in solution in water.

If you allow this reaction to reach equilibrium and then measure the equilibrium concentrations of everything, you can combine these concentrations into an expression known as an ***equilibrium constant***.

The equilibrium constant always has the same value (provided you don't change the temperature), irrespective of the amounts of A, B, C and D you started with. It is also unaffected by a change in pressure or whether or not you are using a catalyst.

$$K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

equilibrium constant

The square brackets show concentrations in mol/L

Right-hand side of the equation on top; left-hand side on the bottom.

The indices are the numbers in front of each substance in the chemical equation.

Compare this with the chemical equation for the equilibrium. The convention is that the substances on the right-hand side of the equation are written at the top of the K expression, and those on the left-hand side at the bottom.

The indices (the powers that you have to raise the concentrations to - for example, squared or cubed or whatever) are just the numbers that appear in the equation.