USING MORE REAL LIFE EXAMPLES TO ENHANCE LEARNING IN A GENERAL CHEMISTRY LECTURE

Andrew E. Burns
Kent State University Stark Campus (USA)

Abstract. Below are a few more "real life" examples that have been continually used successfully over the years to help students remember and understand some of the concepts taught in general chemistry. These examples try to reinforce the chemical ideas as well as provide a way for students to remember these ideas. They are taught with the idea of having fun and trying to relate experiences that the students may have had or heard about while learning chemistry on a given topic.

Keywords: chemistry education; lecture; examples

Do whatever it takes attitude

When discussing atoms and their bonding, one always mentions the octet rule and/or obtaining a full valence shell. This is so critical for both forming ions in ionic bonding and covalent bonds in Main Group elements, that our class makes it a goal. In the class, we use a phrase which is the "bite, scratch, kick, claw, knee, and crawl" saying, demanding atoms obtain a full shell.

– This attitude and phrase make students appreciate the importance of a full shell.

– It makes the students understand the charges of the groups on the periodic table and why they are those charges.

– Covalent bonding is appreciated more.

– Ionic bonding is appreciated more.

– It helps the students remember the ideas of bonding.

Gamma decay and parenting

When studying radioactive decay, gamma decay is usually a strange thing for students. It is an easy equation to balance, but a little difficult at times to explain.

The reaction is as follows:

$$^{99}_{43}\text{Tc} \text{ ----------> } ^{99}_{43}\text{Tc} + ^{0}_{0}\gamma$$

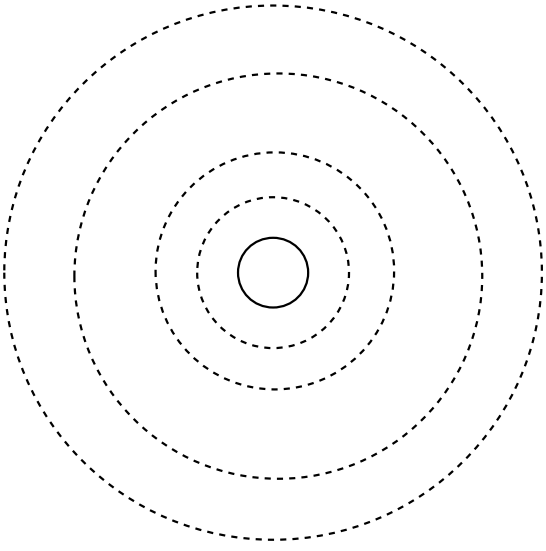
Typically, this reaction is explained as the parent material being in an excited state and releasing energy through gamma light emission, relaxing the parent atom to a lower energy or ground state. Most students do not truly grasp this, so an example of family life is a great way to help out, plus it gives the students a funny way to remember.

Being a dad, I am personally a little biased in this exercise, but it seems to work. I use the example of a child who has done something wrong. I claim the mom calmly talks to the child, explaining the problem, yet is still mad, and of course takes it out on somebody afterwards. As I ask the class whom they think mom takes it out on, they all yell "you" or the "father". Everybody laughs, and I just smile and say "I know!" Then, I discuss how a dad deals with the mischievous child, as the father is upset and in an excited state. I claim the father yells at the child, and then the child cries and runs to their room. I mention that this relieves the problem, as the child is no longer around and it is much quieter, and then later would go and talk with the child. As a result, the father is less stressed and is now in a lower energy or ground state. The students all roar in laughter from this family example, and all of the fathers in the room nod their head in agreement.

Electron probability and Vegas

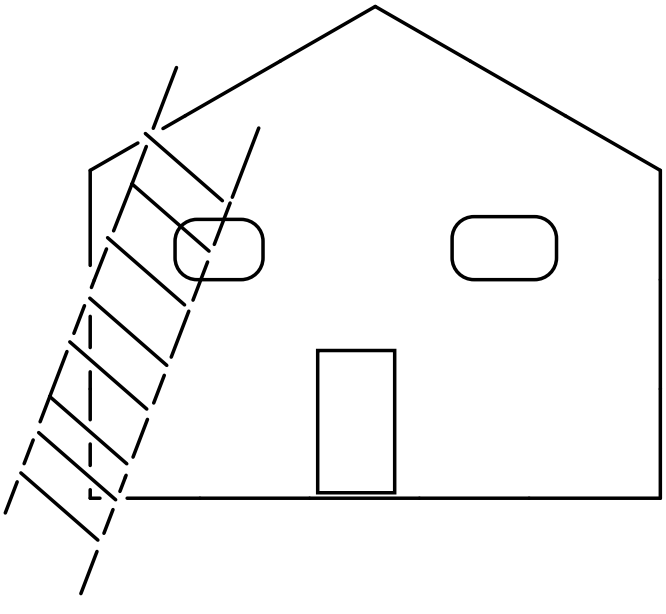
An example from human nature is easy to relate to the idea of an electron being in an orbital, with probability and not pure certainty. Obviously, the ideas of Heisenberg's uncertainty and all else in quantum mechanics explains all of this, but to a student, not knowing the exact parameters on an electron initially is a little strange. For most of the students' lives, they have known pure answers to things, and have not really had to deal with an answer that only has a probability associated with it.

Using the idea of playing poker in Los Vegas puts things in perspective. I discuss how the Vegas Casino (House) always has favorable odds of winning, and yet some people do win so it keeps people gambling. It is the same with an electron being in an orbital, with greater than 95% probability. To relate it and have fun, I ask the class, how many would bet in Vegas if they had greater than 95% odds to win money, and of course they all raise their hands. Unfortunately, the odds in Vegas are a little less I tell them, and they all laugh.



Bohr model

When discussing the Bohr model, which puts electrons in orbits or shells around the nucleus, a helpful suggestion is a ladder set up on a house. These are things students can relate to "human life," as the Bohr model reminds one of the solar system and people have seen and/or used ladders.



You can mention that electrons want to be in the first shell, as it is closer to the nucleus with its positive charge. Conversely, it is much less stressful to be on the bottom rung of a ladder, as it is closer to the ground in case one falls.

I discuss how electrons are always on their orbit or shell, and have minimal chance of being in between the shells, even when transitioning between the shells. This can be a little strange to a student, so again, the ladder example helps. Ask the students how long a foot can last in between the ladder rungs, and if they would fall! A personal story of me falling off the ladder always gets them laughing. Plus, one can ask the class who has been on a ladder and if this makes sense, or has anyone fell off a ladder.

Mnemonics can always be helpful

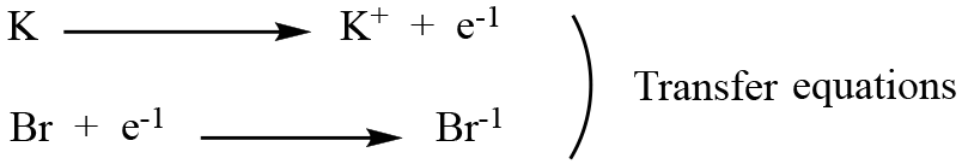
I try and use mnemonics that can make students remember things more easily. Here are three useful and fun mnemonics I use every year and work.

CITGO
C = change
I = initials
T = then
G = Go
O = operational

Here is the idea and use of this mnemonic. Whenever one does buffer or titration problems, you always have the acid react with the base and then put back into an appropriate place. So here, "change initials" involves reacting of the acid with the base 100%. The "then go operational" relates to placing those new values into the Henderson-Hasselbalch or pH formulas. I believe this helps students remember things and perform the problems better. In addition, it is a fun way to relate to life, through the CITGO sign outside of Fenway Park in Boston.

GOLLOR
G = gain
O = on
L = left
L = lose
O = on
R = right

This mnemonic really works for ionic bonding and Redox problems. The idea in my class for ionic bonding is through what I call the transfer equations. For example, to make KBr, potassium loses an electron and bromine gains an electron. What is important is that the electrons on both sides equal for balancing.



Here, it is seen that you "gain on the left" for Br, or GOL, and "lose on the right" for K, or LOR. As I have used this for a while, most students remember this, or even write it out on their test! REDOX reactions are similar of course, as the reduction part is GOL and the oxidation half is LOR.

BOGO
B = buy
O = one
G = get
O = one (free or half price)

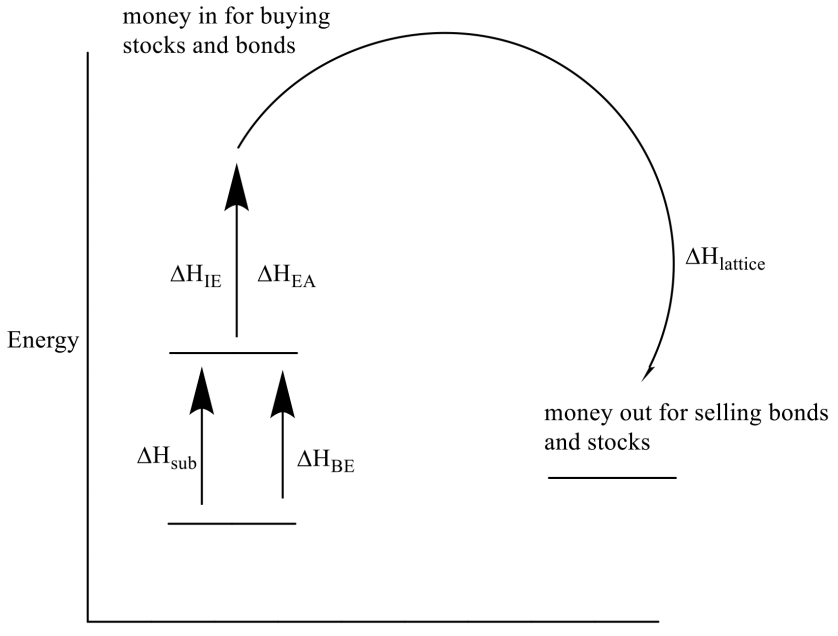
This is something all students have seen from shopping. I will use this for dimensional analysis, as it is used to show how a converter can be used either in two ways, because it always equals one and it is about canceling units.

For 1inch = 2.54 cm, you get the following two, or BOGO
1inch/2.54 cm or 2.54cm/1 inch

Either works, it just depends on what you want and are canceling and which direction you are converting.

Haber process and investing

Forming a salt in an ideal way is a difficult topic for many students. Adding the idea of money and investing really helps. Using the concepts of energy, in terms of sublimation, BE, IE, EA, and lattice energy is easily discussed, yet difficult for students to grasp. What also helps, is you can introduce the concepts of stocks, mutual funds, and bonds if you want, something students might not know much about or appreciate. For the example of NaCl, I use a picture as well as an investing discussion to show how the salt is formed. To create sodium and chloride ions, it takes energy, or money for stocks and bonds. Then, to get the sodium chloride solid lattice, it releases energy, or you sell your stocks and bonds.



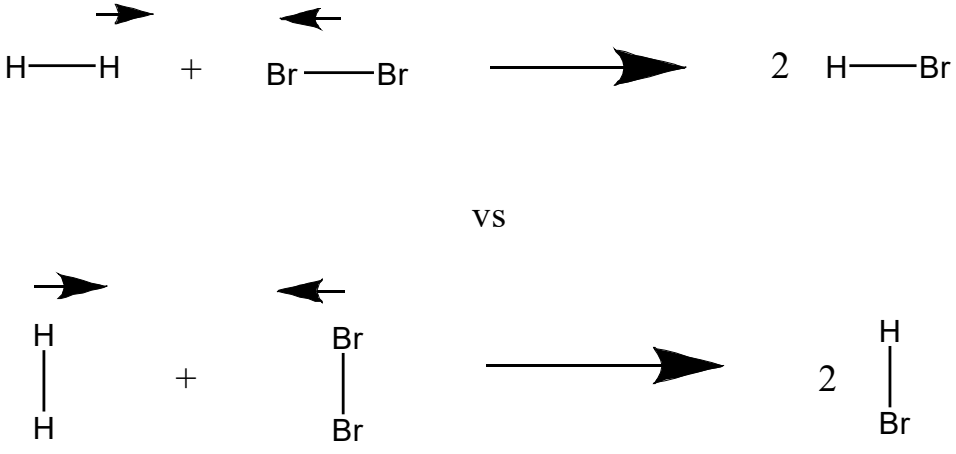
$Na(s) + Cl_2(g) \text{ ----------> } NaCl(s)$

You can then discuss with the class, if you made money (exothermic) or lose money (endothermic).

How reactions occur, and the idea of using a catalyst, and why

When I teach this topic, I try to really make sure that students understand how a chemical reaction occurs and what it takes for this to happen**.** You need energy to break bonds and forces, molecules to collide, and proper orientation of the molecules for the whole reaction to work. Also, using the Arrhenius equation: $k = Ae^{-Eact/RT}$, one can use to explain these topics.

I often use a picture to help students out with the idea of orientation, as well as other factors in reactions.



the bottom rxn is much more probable, due to orientation

I then bring catalysts into discussion. Catalysts work by reducing the E_{act} through providing a new pathway. I use the ideas of dating to help out with this concept, as I know most students are involved or interested in dating. To get more collisions, you can mention higher temperature for faster motion, or more molecules. In terms of dating, you can go to places where there will be more people, and thus more "collisions", such as dances, bars, gyms, etc. One way catalysts work, is providing orientation. In the dating world, I use on-line dating as an example for this. On-line dating lets one select many options for their possible date, such as age, interests, religion, sex, and many others. This is a perfect catalyst for this idea, and a way that certainly relates "real-life" ideas to this topic.

Conclusion

Using "real life" examples in a general chemistry class not only enlivens the discussion and allows for laughter, but reinforces the chemical topic and aides in the students' understanding (Burns, 2011). These are simple ideas, but these techniques get the message through to the students, and add some fun to the classroom. The students will remember these ideas and perform better on exams. Furthermore, they will remember these concepts for years after their chemistry class is over.

Acknowledgements. The work was supported as part of a sabbatical from Kent State University. The author is grateful to many of his past students for their years of listening to these examples and providing many nice comments, and to his son and sister for reviewing the manuscript. The author is also grateful to faculty at a recent American Chemical Society meeting who mentioned that these examples were good and should be published.

REFERENCES

Burns, A.E. (2011). Using "real life" example to enhance learning in a general chemistry lecture. *Chemistry, 20,* 130 – 133.

✉ **Dr. Andrew E. Burns**
Department of Chemistry
Kent State University Stark Campus
6000 Frank Ave
North Canton OH, 44720, USA
E-mail: aburns@kent.edu