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**Westfield Studios**  
**CHEMISTRY 101**

# Guidebook and Quizzes

A companion guide to the Chemistry 101 DVD set

**Wes Olson**

CHEMISTRY 101

# Guidebook and Quizzes

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Special thanks to  
Michael Bost and Cody Bost  
for their laser-like ability in proof-reading.

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# A Guide to the Guidebook

**Side Bar Trivia**  
The text on the left side of the page contains interesting facts on a whole host of chemistry related subjects.

## Chemistry Trivia.

And just what kind of "trivia" might I put here? Well, not just trivia but additional facts or data that supplements what is in the main text.

Like I might say did you know that sodium is the first element in the periodic table whose atomic symbol is not based on its English name? The symbol Na is Latin for *natrum*. And hey, wouldn't you be impressed?

## Alkali Metals

This is the place where I say all manner of wise and clever things, maybe. Things you may have wondered about and LOTS of things you never wondered about...but do now. You might especially wonder why I would even mention them or put them in a video on chemistry. Like, what in the world does a squirting nickel and a snake-in-the-can possibly have to do with chemistry? And will it be on the test? It could happen!

### 1. Introduction

1. The real question here is this: "How many people ever read sections like this?" I do and only a handful of people ever write in and say, "Mr. Olson, I read it! I read that quirky section that no one reads!" If you read this, send me that email!
2. Noble gases are almost always being misspelled as Nobel gases. This would be fine except Nobel is a person and noble is a quality that a person or object should have. In other words, *Nobel* is a noun whereas *noble* is an adjective. Except in this case where *Noble Gas* is a noun also.
3. The number three, as we have here, is representative of the third number. It is the first odd prime number. In literature there were *three little pigs*, *three musketeers*, *three blind mice* and *three bears*. Clearly an important number.

**Radioactive Elements.** Radioactive elements are literally active with radios. This may come as a surprise to many of you who thought the word *radioactive* meant something else. A common mistake I assure you. Radioactivity was much more common in the 1950's through the 1990's. But with the advent of mp3 players, most elements of this kind are now considered *ipodactive* instead.

1. Dr. Bob Schwartz, *Lithium Lollipops and other Commercial Failures*, P. 16. Dr. Schwartz follows the history of bad commercial ideas. Great for the beginning entrepreneur!

**Footnotes.**

**Video Information.**  
This area with black text is information from the film.

**Stories & Commentary**  
The text in a box contains interesting biographies and observations.

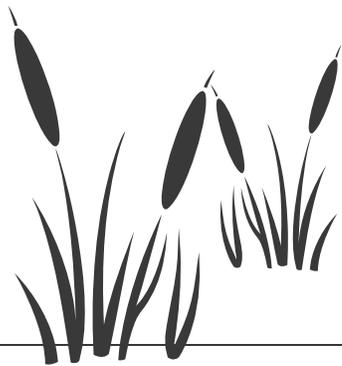
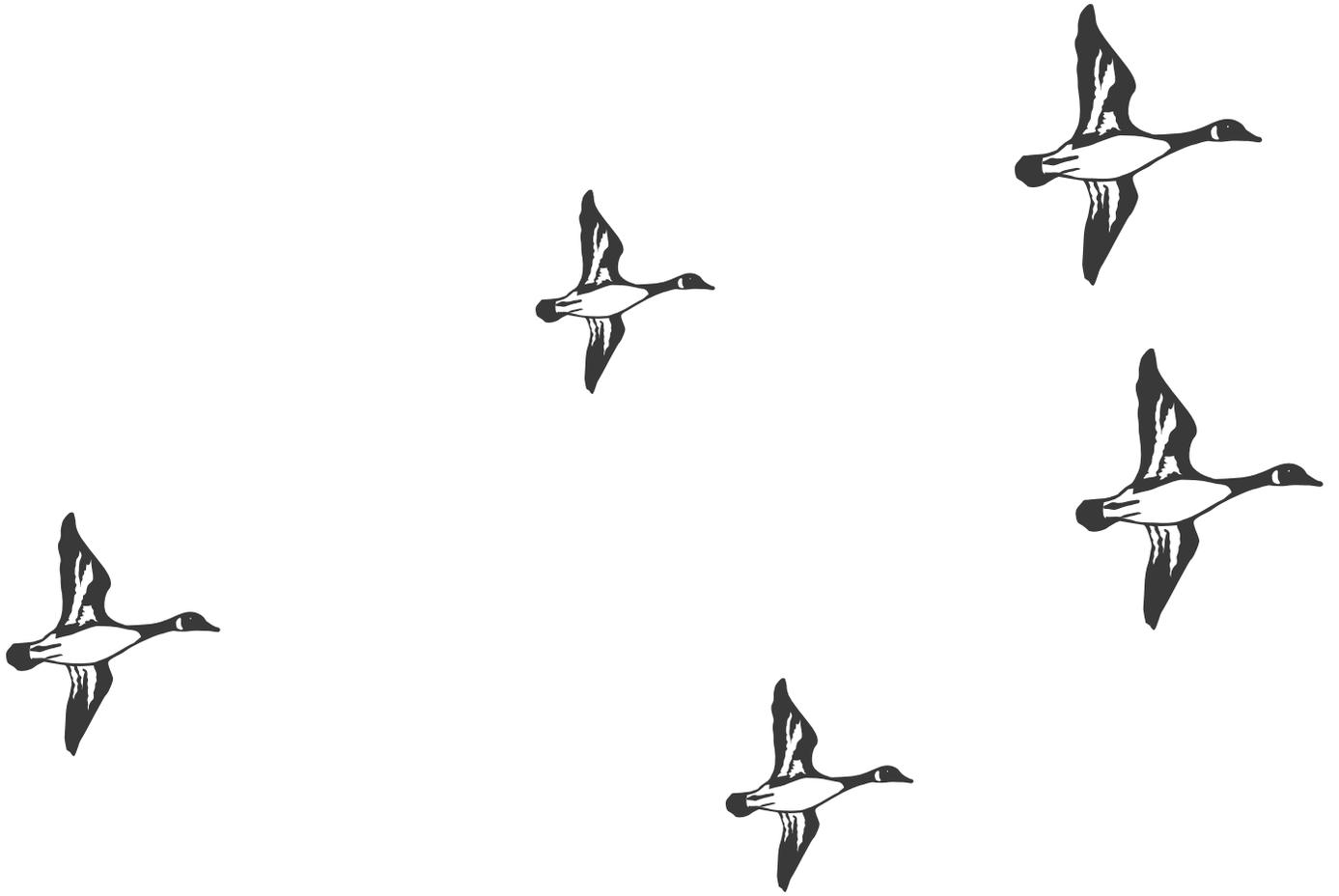
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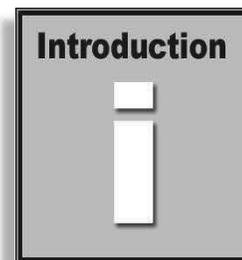
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## Introduction

There was a time, and it wasn't that long ago, when people would be digging in the hills making a house or a garden or playing. They would move dirt and rocks and then come across something different—something that wasn't rocks or dirt. It was metal and the curiosity regarding these metals and how to manipulate them was the beginning of what we call *Chemistry*.



1. Chemistry: "The study of matter and energy and the interactions between them."
2. Physics: "The study of matter and energy and the interactions between them."
3. *Chemistry* disassembles the watch into the component pieces so you can reassemble it again into new and useful things.
4. *Physics* is like the watch of the universe and how it all works. The sound, the light - the physical mechanism.
5. *Solve et coagula* is the Latin phrase for *Separate and Join Together*. This phrase from the alchemists is the essence of modern chemistry. The chemist separates the pieces— the element— then rejoins the pieces to make something new.



# PART 1 - THE ROAD TO THE PERIODIC TABLE



## I. The Last Alchemist

**E**arly chemistry spans nearly 5,000 years, from earliest times to 1700 AD.



### Vulcan

The idea that the word "Vulcan" comes from the Biblical "Tubal-Cain" is mildly controversial because there is not a lot of hard evidence for it. It sounds plausible but it's largely based on conjecture and conjecture is not hard evidence. Thus, it's controversial.

### 1. Early Chemistry

- A. One of the earliest recorded statements regarding chemistry comes from the Bible, in Genesis 4. It specifically mentions Tubal-Cain was a worker in iron and bronze. This testimony means that from earliest recorded history men had a working knowledge of some of these basic metals.
- B. Seven metals have been known from ancient times: gold, silver, copper, lead, tin, iron, and mercury. Of these seven, mercury is the only one not mentioned in the Bible.
- C. The alchemists never adequately answered the question, "What is everything made of at the smallest level?" Most cultures believed the smallest level was made of things like earth, wind, and fire.
- D. The Greeks said the basic essences were earth, water, air, and fire. They were called "The Four Essences." There was also a fifth essence called *ether* which bound them all together.
- E. Democritus was the Greek who said that everything was made of uncuttable particles. He used the word *atoms*: "A-tomos" means "uncuttable."
- F. The word *alchemy* probably comes from the Arab word meaning "Art of the Egyptians." Apparently, the Egyptians were pretty skilled in this and the Arabs learned it from them. Our word *chemistry* comes from this word. Nearly every scientist or curious person in the 1700's toyed around with alchemy to one extent or another. It was the "chemistry" of the day.

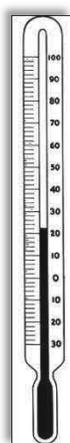
## Distillation

Water distillation involves boiling water and then collecting the vapor that condenses back to water. The condensed vapor will not include salt and other impurities.

Evaporation does the exact same thing... only slower.

## Freeze at 32°?

Why would someone invent a weird scale on which water freezes at the bizarre number 32? As the story goes, Daniel Fahrenheit got water as cold as he could in a salty solution and used this as his 0°F and used the average human body temperature (98.6°F) as his 100°F. A few years later Anders Celsius made a scale on which water boiled at 0 and froze at 100. This was obviously confusing and was later reversed so water freezes at 0°C and boils at 100°C. The United States is virtually the only country in the world still using the Fahrenheit scale (and since I live in the United States...)



- G. The objective of the alchemist was to discover the "Philosopher's Stone" which would turn ordinary metals into gold. It might also prove to be the key to eternal life. They never found it, by the way.
- H. They thought things burned because they contained a material called *phlogiston*. Things stopped burning because they gave up all the phlogiston, which literally means "burning up."

**Video Note:** In the section on the Renaissance, there is a list of events and persons. People ask what they are so here's the list: Shakespeare, Vitruvian man, Heliocentric Model, The 95 Theses, Mona Lisa, Martyr's Mirror, Modern Warfare, School of Athens, Printing Press, Bartholomew's Day Massacre, Telescope, Mechanization, Florence, Machiavelli, Sistine Chapel, The Pieta, St. Peter's Basilica, da Vinci.

**Who is The Father?** Boyle and Lavoisier are pretty much universally acknowledged as the Fathers of Modern Chemistry. But there is a Persian contender for the title. He is Abu Musa Jābir ibn Hayyān, whose name is completely unpronounceable in the west so he is generally called "Geber." The identity and collected works of Geber have been disputed for centuries so he is generally regarded as "The First Practical Alchemist," which is obviously a step down from being "The Father of Modern Chemistry."

## Celsius Temperature Rhyme

When it's zero it's freezing,  
When it's 10 it's not,  
When it's 20 it's warm,  
When it's 30 it's hot!

°C



### Boyle's Law

Take a balloon down into the ocean. When the pressure squeezes the balloon to half of its original size, the pressure in the balloon has doubled. Then, take the balloon way up in the atmosphere where there is less pressure. If the pressure on the balloon is cut in half, then the balloon will be double in size. It doubles in volume.

Q: When you go camping in the mountains, why does your unopened bag of potato chips look fat?

A: Because the manufacturer probably sealed the bag at a lower altitude than you are camping at. Less pressure means the bag now increases in volume.



## 2. Robert Boyle

- A. Robert Boyle lived around 1650 AD. He is considered one of the two Fathers of Modern Chemistry. Boyle broke away from the mysticism of alchemy and insisted on rigorous recordkeeping and experimentation. His book was called "*The Skeptical Chemist*." (although he spelled it 'Sceptical Chymist'.)
- B. Boyle believed atoms actually existed and that the reason gases compress is because there is lots of space between the atoms in a gas. Solids have no such space and thus they could not be squeezed together as easily.
- C. Boyle believed the reason the universe was orderly and systematically understandable was because it was created by God to be orderly. It was the same God who revealed himself in the Bible-a book which Boyle believed to be God's revealed word to mankind.
- D. The Boyle Lectures continued for nearly 200 years before they were suspended between 1900 and 2000. They were revived in 2004.

### Boyle Quotes



*"The vastness, beauty, orderliness of heavenly bodies; the excellent structure of animals and plants; and other phenomena of nature justly induce an intelligent, unprejudiced observer to conclude a supreme, powerful, just, and good author."*

*"God would not have made the universe as it is, unless He intended us to understand it."*

### Discussion Questions



-Note that the Bible says Tubal-Cain was an *instructor of craftsmen* of iron and bronze. Does that suggest this man was actually the main teacher or professor at an early school of metallurgy ?

-Why do you think belief in God and the Bible was important to Robert Boyle?

-The Renaissance artists are not known for being particularly modest artists and freely made art of people with no clothes, then assigned Biblical names to the statues or the paintings. Just because a work of art is done well, does this justify the content of the art? Is anything so sacred we shouldn't depict it in art? Are there limits to what even the "*masters of old*" should or should not have created?

## Quiz 1 - The Last Alchemist

- Solve et coagula* literally means
  - Heat and join together
  - Dissolve the chemicals
  - Separate and join together
  - Solve the problem
- The Bible mentions an early chemist in Genesis 4. What was his name?
  - Naamah
  - Tubal-Cain
  - Cain
  - Enoch
- Which of these metals is NOT one of the seven oldest known element metals?
  - Iron
  - Tin
  - Lithium
  - Mercury
- Quintessential* literally means what?
  - The fifth essence
  - The essential quint
  - Carried away
  - The best of the best
- Atom* literally means
  - First
  - Earth
  - Foundations
  - Essential
  - Uncuttable
- The word *chemistry* comes from the word
  - To protect the seeds
  - Alchemy
  - To defend the plant
  - To hold the plant up
  - None of the above
- The primary objective of the alchemist was to
  - Find new elements
  - Find the quintessential element
  - Find the Philosopher's Stone
  - Find the universal solvent
- Phlogiston* means
  - Burning up
  - Essence of life
  - Alchemy
  - Iron rust
- The Skeptical Chemist* was written by
  - Lavoisier
  - Robert Boyle
  - George Bailey
  - Robert Hook
- Why did people generally wear big wigs?
  - It was popular because the rich and famous were doing it
  - Their heads were cold and there was little heat
  - It covered their baldness
  - Nobody knows
- Air is an element.
  - True
  - False
- Boyle wanted the Christian religion taught as historically accurate and true.
  - True
  - False

Answers are on page 114