Augustine, Radiometric Dating, and First-Year Chemistry

A Guided-Inquiry Exercise

A Humbling Conversation…

- A mathematician, a physicist, and two chemists were drinking a cup of coffee…
- “You know whose fault it is?”
- “It’s our fault.”

One Opportunity

- First-Year General Chemistry
- Teach nuclear chemistry after kinetics
- Students already learn different decay processes and decay kinetics
- We can also include:
  - How old is the earth?
  - How should Christians discuss issues like this?

How to teach it?

- I assume:
  - If **I say it**, students neither remember nor understand.
  - If **they figure it out** for themselves they will both remember and understand.
- How can we get them to figure it out on their own?
- Guided-Inquiry Learning
- www.pogil.org ("The POGIL Project")

Guided-Inquiry Activity

- Model 1: The Bible, our senses, and the Christian mission
- Model 2: Radiometric Dating
- Model 3: Age of the Earth
- Model 4: Age of the Universe
- Applications

Model 1: The Bible, our senses, and the Christian mission

- Augustine: *The literal meaning of Genesis, Book 1*
- Christians **do know** about *"the resurrection of the dead, the hope of eternal life, and the kingdom of heaven"*
- Christians **do not necessarily know** everything about *"the motion and orbit of the stars… about the kinds of animals, shrubs, stones, and so forth…"*
- Some non-Christians **do know** about these things from *reason* and *experience*

Model 1, cont.

- If such a non-Christian hears a Christian "maintaining his foolish opinions"… "**how are they going to believe**…in matters concerning the resurrection of the dead…?"
- Evangelism is a reason to get science right!

Model 2: Radiometric Dating

- Shift gears… Lots of data from Wiens.html*

*www.asa3.org/ASA/resources/Wiens.html

Isotopes Used for Dating

Radioactive Isotope (Parent)	Product (Daughter)	Half-Life (Years)
Samarium-147	Neodymium-143	106 billion
Rubidium-87	Strontium-87	48.8 billion
Rhenium-187	Osmium-187	42 billion
Lutetium-176	Hafnium-176	38 billion
Thorium-232	Lead-208	14 billion
Uranium-238	Lead-206	4.5 billion
Potassium-40	Argon-40	1.26 billion
Uranium-235	Lead-207	0.7 billion
Beryllium-10	Boron-10	1.52 million
Chlorine-36	Argon-36	300,000
Carbon-14	Nitrogen-14	5715
Uranium-234	Thorium-230	248,000
Thorium-230	Radium-226	75,400

Model 2, cont.

- An isotope is only useful for something roughly as old as its half life
- Different isotopes are useful to date different samples
- Carbon-14 is useful for archeological artifacts

Model 3: Age of the Earth

- Table of dates from rocks in western Greenland
- 12 total experiments using five different dating systems all show an age of about 3.6 billion years

Experimental results for rocks in Western Greenland

Experiment	Technique	Measured Age (billion years)
1	uranium-lead	3.60±0.05
2	lead-lead	3.56±0.10
3	lead-lead	3.74±0.12
4	lead-lead	3.62±0.13
5	rubidium-strontium	3.64±0.06
6	rubidium-strontium	3.62±0.14
7	rubidium-strontium	3.67±0.09
8	rubidium-strontium	3.66±0.10
9	rubidium-strontium	3.61±0.22
10	rubidium-strontium	3.56±0.14
11	lutetium-hafnium	3.55±0.22
12	samarium-neodymium	3.56±0.20

Students conclude…

- “If you had to estimate the age of these rocks from reason and experience, what would you say the age was?”
- (Student’s idea, not mine…)

Model 4: Age of the Universe

- Missing isotopes in meteorites suggest that they are several half-lives old
- Longest half life is 82 million years (plutonium-244)

Missing isotopes in meteorites

Missing Isotope	Half-Life (Years)
Plutonium-244	82 million
Iodine-129	16 million
Palladium-107	6.5 million
Manganese-53	3.7 million
Iron-60	1.5 million
Aluminum-26	700,000
Calcium-41	130,000

Model 4: Age of the Universe

- “If you had to estimate the age of these meteorites from reason and experience, what would you say the age was?”
- (Student’s idea, not mine.)

Homework Question

- If Augustine were alive today, do you think he would worry about some Christians making a big deal out of the universe being only 6000 years old? What would his reason be?

Goals of the Activity

- Students come to realize (on their own), by looking at data, that scientists have good reason to believe that the earth is older than 6000 years.
- Students come to realize (on their own) that the manner in which Christians discuss the age of the earth may impact our credibility.
- For the sake of the gospel, we should be careful how we talk about science and the Bible!

Did it work?

- One-page survey asked
  - What the student has been taught (church, home, school)
  - What the student believed about the age of the earth at the beginning of the semester
  - What the student believed about the age of the earth after the activity
  - Whether Christians should try to convince non-Christians that the earth is 6000 years old
  - Did the activity change their views?

Survey Results (N=14)

- 40% of Westmont students came from young-earth churches. About half didn't take a position.
- 40% came from young-earth homes. About 20% came from old-earth homes.
- Mostly old-earth schools (two didn't discuss it!)
- 40% were young-earthers coming in. 60% old-earthers.

Survey Results, cont.

- No students thought that “Christians should try to convince non-Christians that the earth is about 6,000 years old.”
- Slight shift from undecided to old-earth position (young-earthers didn’t change)

Qualitative Comments

- Did the activity change your views on the age of the earth or how Christians should discuss these issues?
  - "Yes, it strengthened my views that Christian scientists are just as committed if not more to discovering truths about the age of the earth" (young-earther)
  - "Yes! It was the first time I was presented with real evidence of old stuff."
  - "Yes, it made me feel we should know what we are talking about before claiming anything big."