

1  **Unit 7: The Final Unit**

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2  **Matter Classification**

3  **Oxymorons**

4  **Elements**

- Atomic number = # of protons
- Neutrons in nucleus add mass
- Mass # = p + n
- Isotopes
 - Protium, deuterium, tritium 99.985%, 0.015%, trace
 - Heavy water fusion fuel
 - U-235 vs. U-238
 - Isotope separation and the *Manhattan Project*
 - U-234, U-235, U-238: 0.0055%, 0.71% and 99.2845%
 - In a reactor: 4% U-235 and 96% U-238
 - Weapons-grade uranium is over 90% U-235

5  **Two Types of Bonds**

- Ionic vs. Covalent

6  **Four Types of Crystals**

- Ionic Crystals
 - Hard, brittle, high melting points
 - Examples
 - NaCl: m.p. = 800°C
 - b) Inorganic mineral salts (remember a few?)
- Molecular Crystals
 - molecular units are maintained
 - soft, volatile, low m.p.
 - Examples
 - water, methane, atmospheric gases, iodine, CO₂
 - organic compounds
- Salt and sugar

7  **Four Types of Crystals**

- Metallic Crystals
 - the electron gas
 - conductors

- physical properties vary considerably
- Covalent Network Crystals
 - Macromolecules
 - Why is diamond so hard?
 - Examples
 - diamond
 - metallic oxides
 - quartz
 - The hardness scale
 - Diamond is 10, what is 9? (ruby red and sapphire blue)
 - aluminum oxide coating

8  **Carbon Allotropes**

9  **Carbon Allotropes**

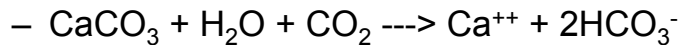
10  **Mixtures**

- Mix some stuff
 - How can you tell if it's a solution?
- Suspensions
 - Can suspensions be permanent?
- Colloidal Suspensions
 - “Gluelike,” Unfilterable
 - Translucent but not transparent

11  **Suspensions**

- Solid-solid
 - porcelain, colored glass
- Solid-liquid
 - ink, paint, gelatin, egg white, cement
- Solid-gas
 - smoke, dust
- Liquid-liquid (emulsion)
 - mayonnaise, blood, lotion, milk (homogenized)
- Gas-liquid (foams)
 - shaving cream, whipped cream, meringue
- Corn starch in water
 - A non-Newtonian fluid
- What do all these things have in common?
 - What makes them suspensions rather than solutions?

- 12 **Solutions**
- How can you tell which substance is the solvent and which substance is the solute?
 - Since there are three states of matter, how many different kinds of solutions are there?
- 13 **Solutions**
- 14 **Solutions**
- Brass: Cu and Zn
 - Bronze: Cu and Sn
- 15 **Miscibility**
- What dissolves in what?
 - Water-Ethanol solutions
 - Frustration Bottle
 - “Like dissolves like.”
- 16 **Molecular Polarity**
- 17 **Soap**
- 18 **Solubility**
- Why don't people dissolve in the bathtub?
- Degrees of solubility
 - sugar: 179 g in 100 g water at 0°, 487 g in 100 g at 100°
 - salt: 35.7 g in 100 g water at 0°, 39.8 g in 100 g at 100°
 - some things get *less* soluble in hot water
- 19 **Solubility of Gases in Liquids**
- Solubility increases under pressure (Henry's Law)
 - Soda in cans, champagne in bottles
 - Solubility decreases with temperature
 - Fish and oxygen
- 20 **Fish and Oxygen**
- 21 **Solubility of Gases in Liquids**
- Milky hot water
 - So why does soda fizz over ice?
- 22 **Solubility of Gases in Liquids**
- 23 **Hard Water**
- Dissolved mineral salts
 - Bicarbonates of Ca and Mg produce *temporary* hardness
 - can be removed by boiling
 - Reactions:



- Sulfates and chlorides produce *permanent* hardness
- Why is it called “hard”?
- Water softeners

24  **Chemical Reactions**

- Organic vs. inorganic
 - Inorganic types: comp, decomp, repl, ionic, etc.
- Two everyday chemical changes: Burning and Rusting
 - Metals oxidize slowly (rust), Non-metals oxidize quickly (burn)
- Burning
 - Common combustion products: CO_2 and water
 - Incomplete combustion: C, CO, CO_x

25  **Rusting**

- Iron rusting is a complicated multi-step process
 - depends on water, very sensitive to presence of acids
- Final product: $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- Rust coating is porous, unlike Al and Zn: rust-through
- Galvanized: zinc-coated (cathodic protection)
 - Mg works too: ship hulls
- Iron ore --> cast iron
- Wrought iron (purest form of iron used commercially)
 - wrought iron is work-hardened to make it hard
 - annealing it makes large crystals- soft iron

26  **Steel**

- Main impurities: carbon, phosphorus, sulfur
 - Carbon is most important: makes it hard and brittle
 - Iron can dissolve .01% carbon by weight
 - What’s the difference between iron and steel? Carbon, mostly.
- Case hardening = exposing surface to heat and extra carbon
- Stainless steel contains Cr and Ni.
 - 18-8 *stainless*- inexpensive and soft

27  **Carbon Percentages**

28  **Explosives**

- Black powder

- Charcoal, potassium nitrate, sulfur
- KNO_3 is an oxidizer
- T.N.T. (tri-nitro toluene)
 - treat toluene with conc. sulfuric acid
- Fuel-oxidizer mixtures
- World trade center and OK City bombs: NH_4NO_3 with fuel (ANFO)- some nitromethane, some diesel fuel
 - fertilizer and same stuff in cold-packs
- Potassium chlorate-sugar
 - recipe says 50/35/15 KClO_3 /sugar/charcoal: unstable, fairly slow burning

29  **Explosives**

- Thermite
 - half and half: powdered aluminum and iron oxide
 - aluminum oxidizes
 - hard to ignite, but burns at 2200°C
 - powdered metals are generally dangerous
 - fireworks
- Dust Explosion
- Napalm is a jellied gasoline and the modern day version is made up of polystyrene (46 parts), gasoline (33 parts) and benzene (21 parts).
- Rocket Fuel
 - Space shuttle main engine: Liquid O_2 and H_2
 - Saturn V first stage: Kerosene fuel
 - Solid fuel: Al and NH_4ClO_4

30  **Cooking**

- Meat is protein: carbon, oxygen, nitrogen, hydrogen
- Cooking is a multi-step process:
 1. Water is driven out
 2. Protein is de-natured
 3. long chains break
- Big molecules = flexible
- Small molecules = tougher, more rigid
- Final result: carbon
- Egg-white frying is also an example of denaturing
- Potatoes = starch

- cooking breaks into smaller starches
- it takes a long time, doesn't it?

31  **Guar Gum**

- FW = 220,000
- Ground endosperms of *cyamopsis tetragonolobus*- a legume cultivated in India as livestock feed.
- Five to Eight times the thickening power of starch.

32  **Science and Truth
(from Unit 1)**

Does science find truth?


- Are facts true?
- Are laws true?
- Are theories true?

33  **Science and Truth**

- Even though theoretical knowledge is provisional, it can still be certain, or at least pretty darn certain.
 - Does the earth really go around the sun?
 - Do atoms really exist?
 - Is genetic information really encoded in DNA?
 - Does continental drift really occur?
 - Is the earth really 4.5 billion years old?
 - Are humans and chimpanzees really descended from common ancestors?
 - Is space really 10 or 11-dimensional, with 6 or 7 of the dimensions compactified?
- These answers are all of the provisional, probabilistic, what-have-you-done-for-me-lately variety.

34  **God and Truth**

- How do we determine truth in religion?
 - Scripture \Leftarrow Revelation
- Why do we ultimately trust the Bible as the revealed Word of God?
 - Faith
- How do revealed truths compare to scientific truths?
 - Truth vs. truth

35  **God and Truth**

- Does God really exist?

- Did God really create the universe?
- Was Jesus really born to a virgin mother?
- Are we really born sinful?
- Did Jesus really save us by dying on a cross?
- Are we really going to live forever in heaven after we die?

36 **truth vs. Truth**

- Empirical vs. Revelatory
- Provisional vs. Absolute
- Tentative vs. Eternal
- Skepticism vs. Faith

37 **truth vs. Truth**

- So how do the two truths relate to each other?
- Truth is more important than truth, right?
- Can Truth inform truth?
- Does Truth trump truth?
- Can truth change Truth?
- Or is there any reason to distinguish between the two types of truth at all?

38 **Two Christian S&R Fault Lines**

- Question 1: When doing science, should you gather data only with your senses, or include scriptural revelations in the dataset?
- Question 2: When formulating scientific explanations, should you restrict yourself to only natural mechanisms, or be open to any explanation that matches your data, including supernatural?

39 **S&R Models**

- Let's make a catalog of approaches
- We should try to:

1. Be fairly comprehensive.
2. Include perspectives that people actually have.

40 **S&R Models**

Richard Bube, *Putting It All Together*, 1995.

Seven Patterns for Relating Science and the Christian Faith:

1. Natural Theology
 - Science Demands Christian Theology
2. Compartmentalism
 - Science and Christian Theology are Unrelated
3. Bible-Only
 - Christian Theology in Spite of Science
4. Science-Only
 - Science Has Destroyed Christian Theology
5. Scientific Theology
 - Science Redefines Christian Theology
6. Complementarity
7. New Synthesis

41 **S&R Models**

42 **Paranormal Phenomena**

- Paranormal Phenomena are “any phenomenon that in one or more respects exceeds the limits of what is deemed physically possible according to current scientific assumptions.” -Journal of Parapsychology

- A list:

- ESP
- Telekinesis
- Astrology
- Faith Healing
- UFOs
- Dowsing
- Channeling
- Homeopathy
- Psychic Surgery

43 **Paranormal Phenomena**

- Is any of this stuff real?
 - Is this a faith question or a sight question?
 - Have any of them been scientifically *disproven*?
 - You can't prove a negative! Can you juggle?
- The scientific approach
 - “Extraordinary claims require extraordinary evidence.” -- Carl Sagan

- Scientific facts are observable, verifiable and reproducible.
- Anecdotes are not evidence.
- Scientific Skepticism
 - “CSICOP members argue that nothing less than the strictest standards of scientific scrutiny should be accepted as convincing. Such standards include well-designed and controlled scientific experiments published in reputable peer-reviewed journals, followed by independent replication by other researchers.” --Wikipedia “CSICOP”

44  **Paranormal Phenomena**

- The One Million Dollar Paranormal Challenge from the JREF
- Christianity and the Paranormal
 - Since we Christians believe in some paranormal things, should we be less skeptical about all paranormal things?
 - Do you think that “natural” paranormal phenomena (e.g. ESP) conflicts with Christian beliefs? How about UFOs/ alien life?
 - How should a Christian approach Satanic cult conspiracy theories? Which tools do you use?
- Randi on Geller:
 - <http://www.randi.org/jr/2007-03/032307hope.html#i9>