Review of *Exploring Creation With Physical Science, 3rd Edition*
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*Exploring Creation With Physical Science, Third Edition* was published this year. The first two editions were written by me, but the third edition was crafted from the second by Vickie Dincher, who holds an earned Master of Science degree in Biology. After reviewing the course, I am very disappointed with the result. There are a lot of reasons for this, but in summary:

**I. The student text is a softcover book**. Unlike most softcover books of this size, the binding is strong, so I don't think the pages will fall out of the book easily. However, a softcover book just isn't very durable. Most homeschooling parents would like several students to use the book over the course of a few years, so these books need to be rugged. The other student texts produced by the same publisher prior to this edition were hardcover. I sincerely hope that this doesn't mean the other student texts will start coming out as softcover books as well. This is even more mystifying because, in general, softcover books are less expensive than hardcover books. However, the listed price for this text is $72, which is the same as the listed price for the hardcover book, *Exploring Creation With General Science, 3rd Edition*, which came out last year. Also, the student notebook for this course is also softcover, and it has a spiral binding. The kind of spiral binding used is generally more expensive than the binding used in the student text, and the page count of the student notebook is larger than the page count of the student text. Yet, the notebook's listed price is merely $39. That is more what I expect for a softcover book.

**II. There are 13 serious scientific or historical errors I found in the text**. In my opinion, some of them will produce difficulties for the student when he or she ends up studying science from an accurate source. There are 20 additional errors that probably won't affect the student's future education, but are nevertheless quite wrong. These serious and minor errors are not typographical. They are conceptual errors or factual errors.

**III. There are 14 instances of discussions in the book that I think most students will find confusing**. This is very troubling for a book that is focused on homeschooled students, as homeschooled students need to learn independently. Confusing discussions do not promote independent learning.

In addition, if you used *Exploring Creation With General Science, Third Edition*, which the publisher says should be done the year before the student takes this course, there is another problem. About 15% of that book is repeated in this book. While it is common in education to repeat topics, especially when using the spiral method, you rarely repeat topics year after year. You usually wait at least 2-3 years before spiraling back to a topic you have already covered.

The details of the errors and points of confusion are given below. In addition, I list some things I don't like about the book. They aren't really errors, but I personally don't think they promote effective, independent learning. In addition, there were three things that make no sense to me, and I thought I would include them as well. Needless to say, I cannot recommend this book to anyone who is homeschooling.

Serious Errors in the Text

(1) **Page 15**: The title of the first section on this page is "When the Scientific Method is not Possible." However, the section actually describes what scientists do when *direct observation* is not possible. For example, it discusses things like paleontology, where inferences must be made. The title makes it sound like inferences aren't a part of the scientific method and, worse, that direct observation is necessary for the scientific method. That's just not true! All of the nuclear chemistry I do involves indirect observation and inferences. Nevertheless, I am using the scientific method as described in the book!

(2) **Page 23**: "In science, temperature is a measure of how much heat energy as substance has." This is wrong. The error is made even worse near the bottom of the page, where it says, "In this course we will use the Celsius scale for heat measurements." Degrees Celsius cannot measure heat. Heat is measured in *energy* units like Joules, not temperature units. In fact, the text itself indicates that temperature *is not* a measure of heat on page 481, where it says, "Most people think that temperature measures heat. They think this because as temperature gets higher, we feel hotter. Although that is true, it doesn't mean that temperature measures heat." On the next page, it gives the proper definition of heat (energy exchanged as a result of temperature differences), which is incompatible with the idea that temperature measures heat. On p. 483, the proper definition of temperature is given – a measure of the energy of random motion in the molecules of a substance. That's not heat!

(3) **Page 60**: "Every pure substance has a unique temperature at which it changes from a solid to a liquid." This is not true. Melting point depends on pressure. For the same substance, the higher the pressure, the higher the melting point. This is why the inner core of the earth is solid, while the outer core is liquid. The inner core is hotter, but it is under higher pressure. The students learn about this on p. 438, but it contradicts what is said here.

(4) **Page 60**: "Every pure substance also has a unique temperature at which its liquid form changes into its gaseous form." This is not true. Water changes from liquid to vapor at 100 °C at sea level on an average day, but it changes from liquid to vapor at 95 °C in Denver, CO on an average day. That's because boiling point depends on the pressure to which the liquid is being exposed. The atmospheric pressure in Denver is, on average, lower than the atmospheric pressure at sea level, so water boils at a lower temperature in Denver.

(5) **Page 82**: The historical discussion here has two major errors. First, it says that Aristotle's wrong ideas persisted because the works of the Greek philosophers lost influence as the Western world Latinized, and then they were not "rediscovered" until the Renaissance. Nothing could be further from the truth! John Philoponus (490-570) specifically discussed Aristotle's work and argued against some of his ideas, as did Thomas Bradwardine (c. 1300-1349), Leonardo da Vinci (1452-1519), Copernicus (1473-1543), etc. Most importantly, Thomas Aquinas (1225-1274) took great pains to integrate Aristotle's work into Christian theology, spawning an entire scholastic philosophy called "Aristotelian Thomism." The idea that Aristotle's work lost its influence until the Renaissance is demonstrably false! Second, the discussion makes it sound like not much happened with the concept of atoms between Democritus and Dalton. However, that's utterly false as well. There are well-know atomists throughout the history of science,

including Galen (lived in the second century AD), Autrecort (1299-1368), Boyle (1627-1691), and Newton (1643-1727). What made Dalton's theory so important, which the book ignores entirely, is that he used it to predict something that had never been observed before (what is now called the "Law of Multiple Proportions"). When experiments confirmed that prediction, his atomic theory became the dominant view.

(6) **Page 93**: "With most elements it's hard to notice any difference in the physical or chemical properties of their isotopes. That's not the case with hydrogen. Heavy water has slightly higher melting point, boiling point, and density than ordinary water." The idea that there is something special about hydrogen is wrong. There is virtually no difference in the *chemical* properties of *all* isotopes, including the isotopes of hydrogen. However, *all* isotopes (including those of elements other than hydrogen) can be distinguished based on melting point, boiling point, and density. If that were not the case, we couldn't make atomic bombs or have nuclear power! The scientifically correct statement is that isotopes have nearly identical chemical properties but different physical properties, regardless of the element.

(7) **Page 127**: "We've discussed how atoms in Groups 1A, 2A, 3A, and 7A transfer electrons to form ionic bonds. I hope you're wondering what atoms with 4, 5, or 6 valence electrons do! Well atoms in these groups do not gain or lose electrons easily." That's very wrong. They don't lose electrons easily, but O and S (6 valence electrons) and N (group 5 valence electrons) gain electrons VERY easily. If that weren't the case, rust couldn't form, because rust is made when iron loses electrons and oxygen gains them! Metal sulfides exist because S gains electrons easily. In fact, the text employs this fact later on (**pages 156 and 157**), when it uses S and O in its example problems for determining the chemical formula of ionic compounds. In those examples, S and O gain two electrons to become the sulfide and oxide ions. N gains electrons to form magnesium nitride, zirconium nitride, titanium nitride, tungsten nitride, vanadium nitride, tantalum nitride, and niobium nitride. Zirconium nitride and tantalum nitride are especially useful hard ceramics. Carbon (4 electrons) gains electrons to form metal carbides like calcium carbide, and phosphorus (5 electrons) gains electrons to form aluminum phosphide, zinc phosphide, calcium phosphide, magnesium phosphide, and copper phosphide. The proper statement is that nonmetals gain electrons to become negative ions, while metals lose them to become positive ions.

(8) **Page 178**: In describing the results of an experiment, the book says, "If they worked out correctly you should have seen that the water-salt substitute, the water-Epsom salt, and the vinegar-baking soda solutions were endothermic reactions." That's not true. The water-salt substitute and water-Epsom salt trials made solutions, but that means they experienced *physical* changes, so they were not reactions. The vinegar-baking trial was not a solution; it was a chemical change. Thus, it was a reaction. This is important, since the text has the students make the distinction between chemical and physical change. Here, they are mixed up together.

(9) **Page 211**: "…acceleration can be negative. This happens when velocity decreases (the object is slowing down) which makes the numerator of equation 6.2 negative." This is a really big problem. Negative acceleration does not mean slowing down. Negative acceleration speeds up an object that has a negative velocity. In the kind of motion being discussed here, signs are used to indicate direction. The problems all focus on a single direction, so it doesn't come up in

these specific problems. However, in a lot of physics problems, you have more than one direction, and you keep track of direction with signs. If an object is traveling in the negative direction, a negative acceleration speeds the object up. The only correct way to say this is that when the direction of acceleration is opposite the direction of the velocity, the object slows down. This is why #7 appears in "Things I Don't Like." The author avoids using signs for direction, but that causes this problem. She has already made the distinction between vectors and scalars, and signs are the way to keep track of direction in vectors.

(10) **Pages 214:** "The slope of a speed-time graph is acceleration." That is not true. Acceleration is a vector. Speed is a scalar. You can't get a vector from a graph involving scalars. The slope of a *velocity-time* graph is the acceleration. The slope of a speed-time graph is the *magnitude* of the acceleration. Similarly, on **page 215** the book says, "Remember that the slope of a distance-time graph indicates velocity." No. That's speed. The author says this correctly when presenting distance-time graphs on pages 197 and 198. However, here she says it's velocity, which it is not. You cannot get a vector quantity from a scalar graph! This is important, because students must be able to distinguish vector quantities from scalar quantities.

(11) **Page 351**: "An electromagnetic wave begins when an electrically charged particle vibrates or accelerates." The statement is redundant, and the subsequent discussion is misleading. If a particle is vibrating, it is also accelerating. Thus, the proper statement is "An electromagnetic wave begins when an electrically charged particle accelerates." This would be a minor error, except that the rest of the discussion is focused solely on vibration. Thus, it gives the student the impression that electromagnetic waves come from vibrating charged particles. However, the vast majority of electromagnetic waves do not come from vibrating particles. They come from electrons accelerating within an atom as they switch orbitals.

(12) **Page 363:** The book discusses Herschel's experiment, where he used a prism to separate light into colors and then put a thermometer in the path of each different color. The thermometer read the lowest temperature on violet, and the highest temperature on red. He then moved the thermometer beyond red, and the temperature reading increased. Thus, he discovered infrared light. That is all true. However, because of serious error #2, the author says, "Did you know that different colors of the rainbow have different temperatures?" That is not true. Light does not have temperature. Temperature is a measure of the kinetic energy of random motion in molecules. There are no molecules in light. Light has energy, but it is not energy that can be measured by a thermometer. Also, that energy is *opposite* of what Herschel observed. It is highest for violet and lowest for red and even lower for infrared. This is something the student most know, and the discussion here gives the student the opposite idea! What Herschel measured was *how well the bulb of the thermometer absorbed light*. A thermometer doesn't absorb a lot of blue light, so most of the blue light (and its energy) doesn't affect the thermometer. As a result, the thermometer doesn't increase in temperature much. The lower the wavelength (the more towards infrared), the better the light is absorbed by the thermometer, so the hotter the thermometer got.

(13) **Page 398:** "Mathematics is the language in which God has written the universe – Galileo." This is a false quote. You might think a false quote is a minor error, but when it is from a famous scientist, and when it is used as an apologetic device, it better be right. This is not at all.

Here is what he actually wrote: "…I mean the universe; cannot be read until we have learnt the language and become familiar with the characters in which it is written. It is written in mathematical language, and the letters are triangles, circles and other geometrical figures, without which means it is humanly impossible to comprehend a single word." (*Opere Il Saggiatore*, p. 171.) Notice that "God" is not in the quote at all. I think Galileo believed that God was the author, but he didn't phrase it that way at all. If we are being honest, we cannot put words into a famous scientist's mouth!

## Minor Errors in the Text

(1) **Page 16:** The definition of "model" says that it is a "Useful simplification used to make…" A model is not necessarily a simplification. It can be as complex as or even more complex than the actual process or structure being studied. Models are often simplified to make them easier to produce, but as time goes on, they tend to get more and more complicated.

(2) **Pages 18-24**: The author doesn't seem to understand what SI units really are. In Table 1.1, she lists the three "Base SI Units." She correctly identifies them as meter, kilogram, and second. When she discusses length, however, she says, "The basic SI unit for length is the meter." There is no such thing as a basic SI unit for length. There is a *single* SI unit for length – the meter. The term "base SI" unit refers to the fact that other SI units (like Newton, Joule, etc.) are the result of a combination of those three units. Now the meter is also the *basic metric unit* for length. In the metric system, there are basic units (meter, gram, seconds) and there are prefix units (kilogram, milligram, microseconds). However, for each kind of measurement, there is *only one* SI unit: kilogram for mass, meter for length, second for time, Newton for force, etc. That's because SI lists the *standard* unit measuring each physical quantity, and there is only one. The difference is very important with mass, and she doesn't mention it at all when she discusses mass. The basic metric unit for mass is the gram, but the SI unit is the kilogram. In this case, then, the SI unit *is not* the basic metric unit. This is further compounded in Table 1.3, where she lists many units. She has a star next to several of them (like liter) and notes that the starred units are not SI units. That's true, but *most* of the units in the table are not SI units. She lists gram, milligram, kilometer, centimeter, millimeter, millisecond, and cubic millimeter. *None of those* are SI units, but they don't have stars next to them. Of the units listed in the table, only kilogram, meter, and second are SI units.

(3) **Page 23:** "A millisecond is 1/1000 of a second and is also an SI." That's not true. It is a metric unit, but not an SI unit. The SI unit for time is the second.

(4) **Page 41:** "So what is everything made of? In chemistry we call it matter…" Light is not made of matter, so not everything is made of matter.

(5) **Page 49:** "But most of the matter we observe in the universe exists in a fourth state of matter called plasma. The fourth phase of matter exists where temperatures reach millions of degrees Celsius – such as in stars or the sun." Actually, plasmas can form at temperatures as "low" as tens of thousands of degrees Celsius.

(6) **Page 52:** "In fact, at room temperature, gas molecules can move, on average, at about 440 m/s – that's 990 miles per hour." This is heavily dependent on mass. At room temperature, the average speed of hydrogen gas molecules is 1,750 m/s, while the average speed of $CO_2$ gas molecules is 375 m/s. If the book is trying to discuss the average speed of molecules in *air*, it is close but not correct. 520 m/s is the average speed of gas molecules in air.

(7) **Page 56:** The book shows a picture of food wrapped in aluminum foil on a hot grill with an aluminum grate. The caption states, "Whether aluminum is in foil or a grill grate, it's [sic] density will always be 2.7 g/cm$^3$." Of course, that's not true. The hotter the aluminum, the lower the density. Now…the book does get around to mentioning that (see #8 below), but the figure is just wrong. They should have shown foil and something else made out of aluminum which were at the same temperature. In the picture that is presented, the aluminum's density changes significantly, with the grate being lowest density and the top of the foil being highest.

(8) **Page 63**: Here, the book points out that the previous statement about density is wrong. However, it starts the discussion by saying, "Gases change volume and density with temperature." This is not only true for gases, but for all phases. Indeed, the text discusses the difference in density between liquid and solid water. However, the only statement it makes that connects temperature and density in general is for gases.

(9) **Page 85:** "…many during Thomson's time thought that electric current was positively charged and behaved like light rays…" They thought that electric current flowed from positive to negative, but they did not think that it was actually a flow of charges. Indeed, the concept of electrical *charges* didn't exist at that time. The terms "positive" and "negative" referred to an excess of electrical energy (positive) and a deficit of electrical energy (negative). They also didn't have any concept that it was like light rays, because it could flow through solids.

(10) **Page 85:** The book says that Thomson came up with the plum pudding model. However, the only Thomson the book has been discussing is J.J. Thomson, who discovered the electron. The plum pudding model was developed by William Thomson (Lord Kelvin), who was not related to J.J. Thomson.

(11) **Page 88**: The book gives a great quote by Rutherford and says it was from an interview. Jeremy Bernstein is the generally-recognized source for this quote. In his book, *Nuclear Weapons: What You Need to Know*, he says it was from a speech.

(12) **Page 130**: "Of the 90 naturally occurring elements in creation, only carbon atoms have the ability to form long stable molecules made of chains, ringed structures, 3D structures, single bonds, double bonds, or triple bonds with itself or other atoms." This is false. Silicon does as well. That's why it is in the same group as carbon on the periodic table and why astrobiologists often suggest that alien life can be based on silicon. (See the Original *Star Trek* Episode, "Devil in the Dark." I couldn't resist.)

(13) **Page 173**: One of the chemicals listed in the top figure is "potassium manganate (VII)." There is no such thing. There is a chemical called potassium manganate, but I don't think that's what is in the picture. It looks like potassium permanganate to me.

(14) **Page 237:** The author claims that Aristotle had a hard time explaining how an arrow travels through the air once it leaves the bow. Aristotle explained it easily; the explanation was just incorrect. More importantly, the author says, “During and following the time of the Renaissance, however, scientists began to notice many discrepancies between the theories of Aristotle and their observations of the world around them.” Once again, this went on throughout history, long before the Renaissance. Interestingly enough, the natural philosopher who most effectively argued against Aristotle’s explanation of an arrow’s motion was John Philoponus (490-570), who lived long before the Renaissance.

(15) **Page 294:** Experiment 8.2 wants the student to compare the power of his or her arms and legs. However, the experiment doesn’t really do that, because the tasks are too different. In the “arms” part of the experiment (which really tests the hands, not the arms), the hands are twisting. That uses fine muscle movements. In the legs part, the student is climbing, which uses gross muscle movements. Since the movements are so different, you aren’t comparing “arms” to legs. You are comparing fine muscles to bulkier muscles.

(16) **Page 338**: The definition of Doppler effect says, “A change in sound frequency caused by the motion of the sound source, the listener, or both.” The word “perceived” should come before “change.” There no change in the sound waves coming from the source. There is a change in how they are perceived. You might think that by “sound,” she is talking about what the ears perceive, but the author has already correctly made it clear that sound exists whether or not anyone perceives it, because the waves are what define the sound.

(17) **Page 402**: “The electric field of a charge is the effect it has on other charges in the space around it.” That is not true. It represents the force per unit charge that it exerts on a positive charge in the space around it. First, then, it is not the effect. It is the effect per unit charge. If the charge in the space around it is bigger, the effect is bigger. Also, it is the *opposite* of its effect per unit charge if the charge in the space around it is negative.

(18) **Page 483:** The line labelled “outer core” is really pointing at the mantle. The mantle makes up the largest section of the earth’s interior. In the photo, the red, glowing region is the outer core, and the “heat rays” spread into the mantle.

(19) **Page 454**: “Sometimes carbon dioxide in the air can mix with water as raindrops fall.” This *always* happens, which is why rain is always acidic, with pH between 5 and 5.5.

(20) **Page 520:** “The most reliable sites belong to the government (.gov), universities (.edu), and well-known organizations (.org).” First, I think lots of homeschoolers would have problems with the idea that government sites are reliable. Second, the “.edu” extension is not just universities. K-12 educational institutions can get it, as can associations that are composed of *mostly* higher-education organizations. Their non-higher-education members can use the extension if the association has it. Finally, the “.org” extension doesn’t mean a well-known organization. It used to mean a non-profit organization, but now *any* company or organization can get that extension, if it requests one properly.

Sources of Confusion

(1) **Page 56:** The book gives a unit for density: $g/cm^3$. This is true, but it doesn't explain the unit, which is a *derived unit*. It comes from dividing two numbers (mass and volume), each of which has a unit. The equation for density is given on p. 49, so why not explain how a student should approach using units in a mathematical equation? Not only would that help the student understand why $g/cm^3$ is a unit for density, but the student actually has to do that later on. In fact, on **page 64**, there is an example problem where the author divides mass by volume. She includes the units, but doesn't explain how she gets the final unit. She doesn't explain how to deal with units in equations until **page 195**. Students are used to using numbers in equations, not words. The discussion of the factor-label method, which occurs early on, give them experience cancelling out words in equations, but it doesn't tell them what to do when words are left over!

(2) **Page 102:** Experiment 3.2 isn't a very good experiment to begin with, but it is made worse by the fact that the student is supposed to arrange squares in terms of differences in their shades. The squares are found in the student notebook. I had a really hard time distinguishing between some of the shades. In addition, the introduction to the book says that the student notebook is recommended. However, for this experiment, it is required.

(3) **Page 124**: "Elements of the alkali metals form ionic compounds with elements of the halogen family. *Ionic compounds are formed by a cation (usually a metal) and an anion (usually a nonmetal)*. Other examples include potassium bromide (KBr), magnesium chloride ($MgCl_2$), and lithium chloride (LiCl)." (italics hers) This is a confusing statement. First, elements of the alkali metals form ionic compounds with nonmetals from other of groups besides the halogens. Second, magnesium is not an alkali metal. It is in a different group – the alkaline earth metals.

(4) **Page 155**: In the discussion of polyatomic ions, the author gives the electron dot diagram for the carbonate ion. She doesn't show how it is built, which most students would like to see, but she wants the students to count electrons. She has them count the dots, but then she also wants them to include the electrons that are not part of the diagram (the ones in the lower energy level). She then wants them to compare that to the total number of electrons they counted to the number of electrons in all the elements. That gives the charge of the carbonate ion. That's very confusing. The student already knows that the electron dots are the valence electrons, and the student knows how to determine the valence electrons for any atom in groups 1A – 8A. It would be less confusing for the student to compare the number of dots (which represent the valence electrons) to the number of valence electrons (as given by the groups in the periodic table). That gives the charge in a less confusing way.

(5) **Page 156**: Students are given a strategy for how to determine the chemical formula of an ionic compound. That strategy includes, "Using the periodic table determine the charge of the cation and anion by finding what group the element is in." However, that's never explained for anions. A couple of examples are given, but the student has not been told how to determine the negative charge of an ion from the periodic table. The student is told that positive ions take on the same charge as the group they are in, but he or she is not told that the elements which form anions add electrons so that their group number plus the extra electrons add to 8. Instead, the

sample just says things like, “Sulfur is in group 6A, so the sulfide ion has a charge of 2-.” Nowhere does the author explain how she got the 2-.

(6) **Pages 163-165**: Experiment 5.1 is notoriously hard to get to work properly. You are supposed to see twice as much hydrogen gas as oxygen gas, but you rarely do. It is usually about 5x as much hydrogen gas, because the oxygen produced usually reacts with the terminal of the battery. That’s fine, but the student needs to be made aware of that. The best way is with a discussion of experimental error. This is a great example of an experiment that has error in it, and so its bad result ends up producing a “teachable moment.” However, this book doesn’t tell the student that he or she probably won’t get the correct answer and why, which will leave the student confused.

(7) **Pages 172-173:** The mole concept is one of the most difficult concepts for introductory chemistry students. I spend multiple pages explaining it in my high-school chemistry book. This author tries to explain it in just over one page. It will be very confusing to most students.

(8) **Pages 35, 192, 197, 198:** The author changes what is meant by “straight line.” In pages 35 and 192, she seems to mean “horizontal line.” On page 35, she starts with “straight horizontal line” and later on refers to the same line as a “straight line,” which may just be a typo. On page 192, however, she draws a straight diagonal line for a displacement that is made up of several horizontal and vertical movements, but the figure is titled “Displacement not in a straight line.” Nearly identical lines on page 197 are then referred to as “straight lines.” This is confusing, because on page 198, the student must properly distinguish between straight lines (which can be vertical, horizontal, or diagonal) and non-straight lines, which are curved.

(9) **Page 198**: “From the graph we can see that the car travels 200 meters in 40 seconds.” The graph indicates that it is more than 200 meters. It looks to be 240 meters. If this is an estimate, the author should say “about.” However, the next reading from the graph is 340 m. On the graph, it extends from just above 350 to 700. So that second reading is correct and not an estimate. Also, that reading is not explained. The student has no idea how to get 340 m from the graph.

(10) **Page 249**: At this point, the author uses algebra to solve a problem and expects the students to do it as well. She starts with $F = F_w – F_f$ and then rearranges it to get $F_f = F_w – F$. Now this is really simple algebra, but the author doesn’t explain how she did it. In the next example, she does more algebra and then tries to explain it. She starts with $F_w = F_m – F_{kf}$ and then rearranges it to get $F_m = F_w + F_{kf}$. She then says, “Notice, when I rearranged the equation for the unknown, I had to add $F_{kf}$ to both sides.” Even that explanation, however, assumes the student has taken algebra. This book is targeted at 8$^{th}$ grade, and most students aren’t taking algebra in 8$^{th}$ grade. The non-confusing way to do this for an 8$^{th}$-grader is to just use the numbers. If you know, for example, that $F = 36$ N and $F_w$ is 400 N, just put them in the original equation as it is, without rearranging it: $36 = 400 – F_f$. Then ask the student what $F_f$ is. The student ends up doing algebra but doesn’t really think about it as algebra; the student thinks about it as subtraction. Symbols in math are a stumbling block for students, even when they have started algebra. As my daughter once said, “The Devil put the alphabet in math!” Early on, it is best to put numbers in whenever you can. They are more concrete for students.

(11) **Page 351:** "But when electromagnetic waves travel through empty space, no energy is lost, so they don't get weaker as they travel. If electromagnetic waves travel far, however, the energy spreads out over a larger distance. That is why the sunlight is still so bright even after traveling all the way from the sun." These three sentences make no sense together. I think the author is saying that the sun's light doesn't lose energy traveling to the earth. However, energy is not brightness! The brightness is determined by the number of photons, so the perceived brightness dims the farther you are from the sun. The proper statement would be something like, "The energy of each wave packet doesn't change as light travels from the sun to the earth, but the number of wave packets that hits the earth is smaller than what the sun makes, since the packets spread out as they travel. Thus, the sun appears much brighter the closer you get to it."

(12) **Page 354:** Figure 10.4 is supposed to show wave interference, but I don't see any. There are lots of great pictures of wave interference that could be used to dramatically illustrate the effect. In my seventh-grade book, I use a picture of a bee on the surface of the water. Its wings are making waves that produce easily-seen interference patterns. If I don't see the interference in this figure, I think it will confuse students, who need to see a striking example of the effect.

(13) **Page 411**: There is a figure with all sorts of symbols used in electric circuits. Only two of them are used or discussed in the text. Many of them have names the student won't recognize, like galvanometer, polarized capacitor, unbalanced antenna, etc. Students typically want the contents of a figure explained, but that's not why this is a source of confusion. It's a source of confusion because of the two symbols that are discussed and used in the text, *one of them does not match what is in the figure*! The symbol for a battery used and discussed in the text is two parallel lines, one longer than the other. In the figure, it's two of those sets put together. Both can be used for batteries, but for a student looking at circuits for the first time, the text should have the same symbol each time, or at least explain why there is a difference.

(14) **Page 509:** In experiment 14.1, the students add a solution of vitamin C to iodine and watch the iodine turn clear. They are then supposed to add lemon juice, apple juice, orange juice, and grapefruit juice to iodine as a measure of how much vitamin C there is in each. The problem is that the color of the juices will add to the solution, so the solution will not turn clear when the juices are added. The student isn't told that.

## Things I Didn't Like but Aren't Errors

(1) The student is asked to use the periodic table a lot, which is good. It should therefore be on the inside cover of the book. It is not, so it is hard to access.

(2) **Throughout the book:** The book wants the students to write a hypothesis for each experiment. In the scientific method, you *start* with the hypothesis, then design an experiment to test it. In this book, the students *start* with an experiment and are told to develop a hypothesis. Not only do students lack the knowledge to come up with a reasonable hypothesis, this reverses the scientific method, which I consider to be bad.

(3) **Pages 71-73**: Experiment 2.3 is a great experiment, and the author uses it properly to discuss chemical change. However, she never explains *why* the experiment gives the results that it does. The electricity is breaking water down into hydrogen and oxygen. The students also have no idea why baking soda was added (the electricity needs an electrolyte to move through the water). When students see a great experiment, they want to know *why* it happened.

(4) **Modules 3 and Module 12:** There is a lot of descriptive science in the book. In module 3, each of the main groups of the periodic table is discussed, and the chemistry that those elements do is surveyed. In Module 12, there are lots of descriptions of geological land features. Most university courses skip the descriptive material, because they are focused on helping students understand how processes work. I don't see the value in these parts of the book, but others might.

(5) **Page 92**: The definition of isotopes is given as, "Atoms of an element with the same number of protons but different numbers of neutrons." This is redundant. Atoms of an element all have the same number of protons. I think scratching "of an element" is best.

(6) **Page 166**: Since the book covered descriptive chemistry, the student knows that Na is very reactive. In fact, it must be stored under oil to keep it from reacting with water in the air. However, in this discussion on airbags, one of the products is Na. That is correct, but the airbag is designed to get rid of it via another reaction so that it won't build up to dangerous levels. That should be discussed, since the student supposedly knows that elemental Na is dangerous.

(7) **Page 203**: The author sets up rules for calculating relative speed. The rules are fine, but it is better to use signs for direction and then just say relative speed is the absolute value of the difference between the velocities. This is important, because in one-dimensional motion, the student needs to get used to using signs to denote direction.

(8) **Page 206**: The book shows a diagram of a ball bouncing in two dimensions. However, the discussion focuses on the vertical dimension without telling the student to focus on it. For example, the book says, "The distance between the first image of the ball and the second image of the ball is fairly large." But that is only true vertically. Horizontally, the distance between the images is the same the entire time (as it should be). How does the student know to ignore the horizontal dimension? Had this been a drawing of a ball being *dropped or bounced vertically*, there would be no problem.

(9) **Page 258:** The book talks about the electromagnetic force and the weak force, but there is no discussion of the electroweak force, which unifies the electromagnetic and weak force. While it's not necessary to discuss, it does show that most physicists long to unify all forces, and the electroweak force is a step in that direction.

(10) **Pages 302,303, 440, 442, 443, 484, 497, 499, 501:** The book uses "infographics" on these pages. In my view, infographics can be effective in situations where you are trying to communicate basic facts in a tight space. However, that's not what a course is about. A course isn't supposed to just fill the student's head with facts. It is supposed to help the student understand a topic and make connections. Infographics work against that, because students tend

to skim the words and mostly take in the pictures. An effective book will have mostly text when the student is supposed to read and then illustrations which are mostly pictures to illustrate what is being discussed in the text. That way, the student uses both properly.

(11) **Page 439**: I was disappointed that there was no discussion of the rapid-decay theory in the text. It is a great example of how science is done, how Christians can use their faith in their science, and it relates directly to the discussion. However, the students are just told that there are two theories, and they can read more about the theories at the course website. There is no indication that the theories relate to faith at all. Since there are all sorts of references to faith in the book, and many of them have little or no relationship to what is being discussed, it would be nice to have a reference to faith where it actually relates to the material!

(12) The final module is really a waste. It suggests the student pick a topic that interests them and do some more research on the topic. It then gives extremely vague, general ideas for how to do a research project. I don't see any value to it at all. In addition, it barely discusses internet research.

## Things I Didn't Understand

(1) Some experiments (and the "You Do Science" activities) call for items that are not common, household items. These include beakers, pony beads, microscope slides, and test tubes, yet I see no mention of a kit. Additionally, consider the experiments that call for beakers. In some cases, it is suggested that the students use small glasses if they don't have beakers, but in others, it is not. I see no reason why this isn't suggested in all experiments that call for beakers. If anything, the *first* experiment that mentions a beaker should suggest substituting a small glass, but it does not.

(2) The book starts off using "we" in its conversational tone, even though there is only one author. That didn't bother me much, but later in the book, it switches to "I." So sometimes more than one person is "talking" to the student, and at other times only one person is "talking."

(3) The discussion of pitch and frequency has a flow that I don't understand. The experiment relates wavelength and pitch, and then the author uses that to discuss pitch in terms of frequency. She then says, "Sound waves with low pitch have low frequency. Sound waves with high pitch have high frequency." She then follows with, "We usually think of pitch in terms of frequency, however, since it is the frequency of the waves that your ear detects." All of that is true, but what's the purpose of the last sentence, especially the "however"? The previous sentences used the term "frequency" as well.