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OBJECT LESSONS FROM THE BASIC PRINCIPLES OF CHEMISTRY.

INTEGRATION OF FAITH AND CHEMISTRY CONCEPTS

by

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INTRODUCTION

What Hath God Wrought.[1] "God is the author of science...true science contributes fresh evidences of the wisdom and power of God. Rightly understood, science and the written word agree, and each sheds light on the other."[2] Isaac Newton (1622-1727), the scientist who developed theories of light and of universal gravitation and shared with Leibniz the credit of inventing calculus stated that the wonders and the complexities of nature point to a wise and benevolent deity and an intelligent Creator. Lord Kelvin (1824-1907), the scientist who discovered the Second Law of Thermodynamics, believed that the universal natural law was written by a God who created the Universe. Joseph Henry (1797-1878), the renowned American physicist who discovered self-inductance, considered the study of science as the contemplation of God's creation. Louis Pasteur (1822-1895), a well-known biologist who made many advances in biology, believed that spontaneous generation is not possible and that the reason why matter is organized is only because there is an Infinite power who organized it.[3] These renowned men along with other *founding fathers* of science like Michael Faraday, James Joule, Robert Boyle, James Maxwell, Blaise Pascal and many others see that the astounding design in nature and the amazing law that governs it are evidences of a mighty and loving Creator. *What hath God wrought* certainly points back to Him.[4]

The Large Hadron Collider (LHC) located at CERN, the European Centre for Nuclear Research, in Geneva was switched on last September 10, 2008. The LHC project is considered as "the biggest experiment ever," [5] and "the largest collaborative efforts ever attempted in the physical sciences."[6] Thousands of scientists and researchers representing about 500 universities and 80 nationalities were attracted to this project. Professor Stephen Hawking said that the work of the LHC "is crucial for the survival of humanity."[7] So what is this highly esteemed project all about? Why do so many eagerly anticipate to see what this project can accomplish? Why have the leaders of these mighty nations decided to contribute resources into this scientific endeavour? Professor Brian Cox gave the simple answer when he wrote that the LHC machine "will revolutionise our understanding of the universe by recreating the conditions which were present less than a billionth of a second after the Big Bang."[8]

There has been a transformation in the focus of particle science these last few decades. Where once only the study of electrons, protons, and neutrons, now it is the piercing deep into the bosons, fermions, mesons, hadrons, gluons, and quarks. Scientists, by becoming more and more acquainted with these "deeper" things, are also becoming more and more convinced (it seems, as what they claim) that matter and the universe came into existence without an Intelligent Designer behind it, that no Engineer is needed for its maintenance and support.

Two generations of scientists, two different approaches to science. It is now quite alarming that the discipline once used by great minds to point to the existence of an intelligent Creator now is employed to discredit Him. The "Biggest Experiment on the Planet" today has

just begun running with one main mission—to set aside Genesis creation and invite us to *Come, let's look at the Big Bang*. Of course, they did not say it that way; but the "Big Bang" thing alludes to it. Obviously, the worldviews of most of the scientists today are conversely different from those of their "founding fathers."

A New King.[9] Exodus 1 tells of "a king who did not know about Joseph." Many scientists today are just like that new king. They do not know Joseph's or Newton's or Kelvin's God anymore. They have forgotten that during those times of famine—of knowledge and truth, these men brought awareness and understanding of scientific principles that significantly contributed to the modernization of our society. Instead of approaching science in a Biblical perspective, they put the Bible and its teachings aside. These "new king" scientists are out to "kill" our children spiritually too by their "strange" teachings. Look at what they're doing in public schools today. Evolution is preached in every science class. Thus, if Shiphrah and Puah (God-fearing midwives)[10] and Amram and Jochebed (God-fearing parents) were needed then, they are much more needed now.

Committed Christian teachers all over the world are the Shiphrahs, Puahs, Amrams and Jochebeds of today. When they are delivering their services they are doing them fearing God. Like those midwives, they're making sure that the "babies" whom they have touched and handled are alive after leaving their hands. Like those godly parents, they're "seizing the moments" to train the Moseses who will be going to the "palace" after just a short while.

This brief essay shows how we, teachers, can integrate faith and learning in our classes. This is the key factor that makes our teaching *Christian*. We have to showcase to our students God's character and might while teaching the courses that we are handling. Although the presentations here are using chemistry concepts, the examples outlined here will serve as guides or bases for other fields or disciplines. The similitudes in the principles of Chemistry and Faith are bountiful and I included examples of them in this essay. I call the particulars of these similitudes as *Object Lessons*.[11] Just as Christ associated the common experiences of the builder, the traveller, the shepherd, or the familiar objects like a coin, salt, and a city on a hill to the divine truths and principles, one can link the principles of chemistry to the principles and experience of faith. "The Author of nature is the Author of the Bible. Creation and Christianity have one God. God is revealed in nature, and God is revealed in His word."[12]

The integration of faith and learning in this project is mainly presented in Analogous, Textual, and Thematic instructional strategies.[13] The first portion of this paper outlines the reasons why integrating faith in chemistry classes is not only proper but important as well. This part presents the reasons for the compatibility and the benefits of doing Chemistry and Bible study simultaneously. The second portion lists examples of the integrational strategies, providing one or more illustrations on how they are employed in the classroom and other examples are given in tabular form for quick reference and for easy reading.

Reasons for Employing Integrational Strategies in Teaching Chemistry Concepts

1. Chemistry Studies God's Illustrated Word

Chemistry is the study of matter and the changes that matter can undergo. Matter is anything that has mass and takes up space. Matter makes up the whole physical universe.

We Christians acknowledge that God's Word comes in three forms: the Living Word (which is Jesus), the Written Word (the Bible), and the Illustrated Word (all nature and creation). It was the Living Word who spoke and created all nature (Genesis 1 and John 1:1-4) and it was He who sent the Holy Spirit to reveal to mankind His love and His truth through the Written Word (John 16:13). Therefore the science that investigates matter (from minute atoms to huge planets) and the changes that matter undergoes (from the metabolism taking place inside the cells to the nuclear reactions in gigantic stars) is not only mere chemistry but a study of God's Illustrated Word as well. As pointed out earlier, the Creator of the Illustrated Word and the Author of the Written Word is one and the same, thus the principles that run through both Illustrated and Written Words will also be the same. If both the Illustrated and Written Words are rightly studied, the experience should and would always point to their Creator and Author, the Living Word, resulting in praise and honour to Him who is the source of all these wonderful things.

I believe that it is from this perspective that Chemistry, and other natural science subjects, must be taught in Christian schools. Ellen G. White wrote that "Science, in order to be fully appreciated, must be viewed from a religious standpoint.... The attributes of God as seen in His created works can be appreciated only as we have a knowledge of the Creator."[14] In lectures and sermons, well-chosen illustrations are very useful; they paint pictures that are worth a thousand words. But if lectures and sermons are all illustrations, no matter how captivating their delivery, they have a tendency to become confusing, sending messages that are unclear and devoid of any point or purpose. Likewise, the investigation of God's Illustrated Word must be integrated with the study of His Written Word in order for the experience to be meaningful and productive.

2. Chemistry Concepts May Serve as God's Object Lessons

If the Bible, God's Written Word, is the primary Book that reveals God's truth and character, then nature, which includes matter and all creation, may be considered as the second Book that displays God's creative wisdom and might. Science may serve as a source book for many spiritual lessons. "Next to the Bible, nature is to be our great lesson book"[15] because "Nature and revelation alike testify of God's love."[16] I fully believe that Chemistry holds an important and significant portion of that second great lesson book. In my years of experience of teaching Chemistry, I discovered that many basic concepts of Chemistry have spiritual implications. Many of these concepts serve as excellent illustrations or analogies to the Biblical principles and precepts. Others may be used as part of the integrational themes or they may serve as motivation for spiritual discourses. Jesus Christ, the Master Teacher, used

parables as the major element in His teaching techniques. Ellen White wrote a volume of this method of Christ's teachings in her book *Christ's Object Lessons*, from which this essay's title was based upon. Mark gave us a quaint description of Christ's main teaching or speaking strategy when he wrote, "He did not say anything to them without using a parable" (Mark 4:34[17]). What made this teaching technique so effective? It is the tying of symbols or objects to the truths that were being taught. He used pearls and treasures when He preached about heaven; sheep and goats when He taught Christian duties; the story of the prodigal son when He told about His Father's love. So every time His hearers would come across those objects or similar situations they would be reminded of what Jesus had taught and might even get some hands-on learning experience. What used to be just a common surrounding of everyday life now has a richer meaning. Through this technique, Jesus "was able to teach even when He was not physically present."[18] That made His teaching style more effective. Chemistry concepts may also be used as object lessons for learning faith.

3. **Chemistry Classes May Serve as the "Out of Season" Seasons to "Be Ready"**

I consider engagements that are not related to religion courses or church and Sabbath services as "out of season" seasons that a committed Christian should be prepared for. Paul charged Timothy to "preach the Word; be prepared *in season and out of season*" (2 Timothy 4:2, emphasis supplied). The apostle's charge still applies to every Christian today. We simply are tasked and expected to preach (to proclaim) the Word (God's truth) all the time. In our classes, we can do the preaching by integrating *object lessons* in our lectures and activities. If we are doing this in a regular basis then the "out of season" will become "seasons" for sowing precious seeds of truths in the hearts of our students.

Paul also added, "be prepared." This means that we are not only to prepare our object lessons but ourselves as well so that we can "correct, rebuke, and encourage—with great patience and faithful instruction." And this is the harder part of "preaching." Spiritual preparation is the most important aspect in our "preaching" preparation. A Christian teacher must have a saving relationship with Jesus for him to be an effective witness for his or her students.

4. **Integrational Strategies Enhances Students' Learning and Remembering.**

Learning is the primary goal of teaching. Learning here, of course, means that the subject matter or the concepts taught are well understood. But in order for the learned concepts to be of great use for a learner, they must also be remembered well. One technique for remembering is through association. If a learner can associate the learned concepts to some previously-learned concepts or experiences or to some familiar objects, he will be better able to assimilate and retrieve the new concepts learned.[19] Integrational approaches do just that. It associates the topic or lesson that is being discussed to familiar faith concepts. Integrational strategies, if properly executed, may also liven up seemingly monotonous discussions of some less interesting topics.

OBJECT LESSONS FROM CHEMISTRY: EXAMPLES GROUPED ACCORDING TO STRATEGIES

ANALOGOUS STRATEGIES

Analogous strategies use symbols, like allegories and metaphors to convey a message or truth in a more illustrative or pictorial representation. The Theory and Research-based Principles of Learning that is the basis and the hallmark of the Eberly Center's approach to teaching presents much evidence that one of the components necessary for deeper learning is through "meaningful engagement."[20] And this engagement is achieved by creating analogies, illustrations, connections to related ideas, and representations of gained knowledge which are meaningful to students. This is the strategy that, when employed properly, will truly help the students appreciate more the science concepts that they are studying. Ellen White counselled that students "should be encouraged to search out in nature the objects that illustrate Bible teachings, and to trace in the Bible the similitudes drawn from nature...those that He employed in illustrating truth."[21] Chemistry is undoubtedly both a science and a study of nature, and thus, appropriate to be approached in manner as pointed out in the quotes above. **Table 1** contains examples of the analogous strategies I used in my General Chemistry classes.

Table 1: Analogous Strategies in Teaching Chemistry Concepts

TOPICS AND KEY CONCEPTS	FAITH CONCEPTS
Strong Electrolytes, Weak Electrolytes and Non-electrolytes Electrolytes are molten or dissolved substances in which an electric current is made to flow by the movement and discharge of ions. Non-electrolytes do not conduct electricity even in molten state or in aqueous solution. Strong electrolytes are ionized completely while weak electrolytes are ionized only partially. Nonelectrolytes are not ionized at all. The degree of ionization is related to the strength in which they "hold" what "belongs" to them. The stronger they hold the less they ionize.	**Holding things Loosely** Electrolytes are conductors of energy that powers useful machines and runs equipment that give light to those around. They are channels of blessings that refresh others. Nonelectrolytes act as resistors; electricity cannot pass through them. The same soluble substances, yet two different properties. The difference lies on their affinity to "things." One solution lets go, the other refuses.
Force and Pressure The average kinetic energy (KE) of gas particles is proportional to the temperature in Kelvin. Energy is related to force, so as long as the temperature is above 0 K gases have force (only in theory, since most gases have condensed already at relatively higher temperature) that would cause pressure if made to collide (contact)with some surface. Pressure is force per unit area.	**The "how" and "why" of Influence** Forces, no matter how great or big in magnitude, could not result in pressure without contact. A body could only feel the pressure if there is contact. Lesson? Avoid contact if you don't want the pressure it would produce. Peer pressures can be avoided if contacts with "undesirable" peers are avoided. However, the avoidance can only be realized if one would choose in advance. Just like what Daniel did. "But

	Daniel *purposed* in his heart that he would not defile himself" (Daniel 1:8 KJV emphasis supplied). The NIV rendition of *purposed* is *resolved*, both implying a settled issue in Daniel's heart.
Gas Pressure The normal atmospheric pressure is equivalent to 14.7 pounds per square inch. This means that every square inch of our body is subject to the pressing of 14.7 pounds of force. That's a lot of pressure. The atmospheric pressure pushes the air into our lungs, prevents the dissolved gases in our blood from bubbling, keeps our body intact, and keeps our lakes and oceans from vaporizing.	**Pressures can be good or bad.** While some pressures are bad, many others are beneficial and important. The atmospheric pressure that makes our existence here on earth possible can crush an empty (vacuumed) container and can cause strong winds that can devastate our land. Trials, burdens, and persecutions may make or break an individual. While many become bitter, others become better. Paul said, "We are hard pressed on every side, but not crushed; perplexed, but not in despair; persecuted, but not abandoned; struck down, but not destroyed" (2 Corinthians 4:8, 9 NIV). Obviously, Paul was not like that vacuumed container. He withstood extreme pressures because he was not empty. For he had Jesus within.
Gas Laws (Charles's law) Charles's law states that at constant pressure, the volume of gas varies linearly with temperature. Raising the temperature of the gas means making the gas lighter for its density decreases.	**Heavenward** Why do balloons fly? Because they're light—lighter than other objects that surround them. Christians are light too—lighter in burdens and sorrows, in cares and worries of this world than those of this world. That's why they're going heavenward. ("For my yoke is easy and my burden is light" Matthew 11:30.) Christians are like hot air balloons. The hot air is like the Holy Spirit. When the Holy Spirit enters a Christian, He lifts him heavenward.
Strong and Weak Acids (and Bases) Acids are acidic because of their abilities to release protons (H^+) in solution. The more protons they can release relative to their number the more acidic they are. Some acids release their protons completely; they are considered strong acids. Those that give up their protons only partially are weak acids. The extent to which the acids are giving up their protons is related to how weak or strong their affinity on them.	**"For when I am weak, then I am strong."** Strong acids are strong because their hold on the protons is so weak. Weak acids are weak because they're holding the protons too tightly. In God's sight, those who think they are strong (the self-sufficient) are actually weak; but those who recognize and acknowledge their weakness are made strong. "But God chose the foolish things of the world to shame the wise; God chose the weak things of the world to shame the strong" 1 Cor. 1:27.

Limiting Reagent Chemical reactions in laboratories or in manufacturing plants are carried out by supplying one or more reactants (or reagents) involved in the reaction in excess to that which is needed to complete the reaction. In any chemical reaction, if one of the reagents is consumed the reaction stops. The reagent that is consumed first is called the limiting reagent.	**Be a Peacemaker** When the limiting reagent is consumed, all types of reactions, including violent ones, also stops. In an argument or a fight, if one stops the fighting also stops. "A gentle answer turns away wrath" Proverbs 15:1.
Oxidation and Reduction Oxidation is the opposite of reduction. When one reagent is oxidized, the other is reduced. One process could not happen without the other. The giving up of electrons of a particular species results in the increase of its oxidation state. Likewise, the gaining of electrons would decrease its oxidation state.	**"He must increase, but I must decrease."** –John the Baptist It is like a see-saw, they must go together. When a person chooses to walk with Jesus, there is this see-saw aspect in their relationship. In this component of their union, when self is humbled, Jesus is glorified and when self is exalted, Jesus' power through him is weakened. "It is better to give than to receive."
Covalent and Ionic Bonding *Covalent bonds* are formed when atoms *share* their electrons with each other. *Ionic bonds* are formed when there is a transfer (*giving* and receiving) of electrons between atoms which is usually the case if the two atoms have exactly opposite properties (i.e., metals and non-metals). The metal after giving becomes positive while the non-metal that receives becomes negative. Attraction then develops because of their differences in charges. Covalent bonds are relatively (in comparison with secondary bonds) strong bonds but ionic bonds are generally stronger than covalent bonds.[22] However, covalent bonds are usually stable in the presence of water while most of the common ionic compounds dissociates (or break apart) in the presence of water.[23]	**What results to better bonding?** We "bond" with others because we may "share" some interests with them. Whether for friendship or for a lifetime marriage relationship this type of "bonding" is good for the ties formed are strong. That's why we are counselled not to be yoked together with unbelievers" (2 Cor. 6:14) for we don't share the same "properties" with them. Others "give" to form "bonds." Interestingly, the bonding between two parties with different "properties" is also strong, probably because of the added "strings attached." But its strength is quite unstable for in "rainy days" the bond with "strings" breaks apart. [When I am sharing this concept with my students I usually tell them that the one who receives feels indebted (+) to the one who gives (–). Forced attraction then ensued. "So, be cautious in receiving gifts."]
Dalton's Law of Partial Pressures "The total pressure, P_T, of a mixture of gases is the sum of the partial pressures of each individual gas."	**We must interact.** If there are no interactions, the pressure of different gases inside a container adds up. Inside a home, a church, an institution, a community, if there are no interactions among its members, the pressure may build up. And this kind of pressure is bad.

Kinetic Molecular Theory Some assumptions of the KMT are: 1. Gas particles have no volume. 2. Gas particles have no attraction between them. 3. Molecular collisions are elastic.	**We all have influence—for good or for evil.** Ideal gases are assumed to be moving at high velocities that they don't have time to stop and interact or influence one another. But ideal gases do not exist. Real gases do influence each other. Likewise, real Christians have the power to influence. They are the light and salt of the earth.
Secondary Forces and Miscibility Secondary forces are weak attractive interactions that hold molecules together. They are dipole-dipole force, London dispersion force, and hydrogen bonding. Polar substances are held by dipole-dipole force and/or hydrogen bond; Nonpolar substances are held by London dispersion force. **Hydrophobic molecules does not hate water; they love water—only less.** Polar substances, like water and ethyl alcohol, are not miscible with nonpolar substances, like oil and gasoline. Polar substances are *hydrophilic* for they seem to *love* water very much; nonpolar substances are called *hydrophobic* for they seem to *hate* water. But if polar and nonpolar substances are brought into contact they actually have a very slight attraction upon each other—the dipole-induced dipole force—and which is only confined at their interface.	**"To Hate" Means "to Love Less"** Hydrophobic molecules are water-hating molecules, as so often described. But this truth is not the whole truth. Actually, hydrophobic molecules still love water, only less, and so they appear to hate water; they cannot be mixed together. We are commanded to "love the Lord your God with all your heart and with all your soul and with all your mind." (Matthew 22:37) Loving God less than what He requires is not acceptable. If we do we appear as though we are hating Him. "In the Bible, 'to hate,' often should be understood simply as . . . 'to love less.' "[24] Like loves like. "No servant can serve two masters.... You cannot serve both God and Money" (Luke 16:13). "Do not love the world or anything in the world. If anyone loves the world, the love of the Father is not in him" (1 John 2:15).
Radioactive Decay and Nuclear Half-life Radioactive materials have unstable nuclei that result in the emission of alpha, beta, or gamma radiation.	**Instability** All unstable things decay. Unstable individuals are disintegrate.
Nuclear Reactions Nuclear reactions or transmutations are represented by nuclear equations which can be balanced. Here are some examples: $^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}\alpha$ $^{44}_{22}Ti + {}^{0}_{-1}e \rightarrow {}^{44}_{21}Sc$ $^{53}_{27}Co \rightarrow {}^{52}_{26}Fe + {}^{1}_{1}p$	**There's hope!** Even things that are disintegrating can be balanced.

I observed that employing strategies like these reinforces the learning experience of my students. In some cases, the approaches I used provided an opportunity for a "quick-

feedback"[25] on the way the students have perceived the concept. In a way, it helped them view the learned concept in another perspective. And this observation is backed by research on the, as Schachl puts it, "Chemistry of Memory." He pointed that if the learning process is repeated, revised, and repeated, the exercise stabilizes the synapses so that it is easily retrieved if it's needed. He gave this caution about the repetition process though: that it should be done in a creative and motivating way so as not to produce stress which in turn hinders learning.[26]

Limitations. This technique however has some limitations. Just as no illustration is perfect in all regards, the analogous method of presenting spiritual truths has some restrictions. In many cases only one specific aspect of a particular science concept is useful to convey one faith concept; all other aspects may have different or opposing implications or may have no relevance at all. Take for instance the *Oxidation and Reduction* concept in the table above. The faith concept "It is better to give than to receive" is related to the "giving up of electron" aspect of the oxidation concept. But oxidation may also mean the "gaining of oxygen atoms" that, when related to the faith concept considered, may seem contradictory. The imperfection of this method, however, should not be considered its weakness but rather should be seen as a warning sign to keep teachers that are using this technique from dogmatising principles solely based upon science concepts. Our main objective for using this IFL strategy is to have classroom discourses that would allow us teachers to present spiritual truths while teaching a non-religion course and not prove to our students that we have truthful doctrines or beliefs. This does not mean, however, that we will not present truths that are doctrinal for if we are presenting truths we will inevitably present truthful doctrines; this simply means that we will not use science to push our doctrines because science "facts" may be interpreted in different ways and the mistaken use of science in pushing our doctrines may put our doctrines into disrepute.

There are also other examples that I have given in the table above that, when considered together, may not be consistent with each other. Well, this is part of the limitation of this IFL strategy. For example, there's nothing wrong with ionic bonds and it's definitely normal to give and accept electrons. But the IFL concept given under "Covalent and Ionic Bonding" implies that relationships that are "ionic" in flavour are rather not very good. Sometimes, IFL concepts are also drawn in ways that may appear "out of context" as in the "Nuclear Reactions" section. Again this is acceptable for our objective is to find concepts from our lecture that will serve as launch pads for faith discussions.

The rule therefore is simple: any piece or portion of our course lessons that has a corresponding object lesson may be used in integrational strategies—analogous, textual, thematic, and narrative.

TEXTUAL STRATEGIES

Textual strategies identify scriptural passages that are pertinent to a particular topic and then incorporate these in the teaching/learning experience. In my planning, I identify core concepts and ideas to be taught and with the aid of a topical concordance I can search for

appropriate Biblical passages. Many times though, the scriptures just came to my remembrance from my previous Bible study and daily devotions. Although this may appear very religious I count it a worthwhile experience for me and for my students. Remember, in a Christian school, the teachers and students must learn to think Christianly. Jesus was very explicit about the importance of the study of God's Words when he said, "You are in error because you do not know the Scriptures or the power of God" (Matthew 22:29). Knowing God's truths through Bible study means knowing His power. And therefore I always endeavour to integrate Scriptural passages in my lectures.

In teaching the buffer system (buffers are solutions that resist changes in pH when small amounts of strong acid or base are added) for example, I use the verse that states "Do not be overcome by evil, but overcome evil with good" (Romans 12:21). Of course there are no good or evil reagents; the idea here is to link the subject matter to a faith concept using textual passages. In my presentation of the polar and nonpolar substances in the context of them being insoluble with each other, I may tell my students about the determination of Daniel and present to them the Bible text: "But Daniel resolved not to defile himself..." (Daniel 1:8) and tell my students the great importance of guarding our body by choosing wisely what we eat or drink. **Table 2** lists some additional textual strategies.

Table 2: Textual Strategies in Teaching Chemistry Concepts

<table>
<tr><th>TOPICS AND KEY CONCEPTS</th><th>FAITH CONCEPTS</th></tr>
<tr><td colspan="2">S C R I P T U R A L P A S S A G E S</td></tr>
<tr><td>Matter and Energy
"Matter can be converted to energy and energy to matter."</td><td>Creation (ex nihilo) and Support
God is the Creator and Upholder of the universe. Without His control, the natural laws of chemistry and physics could not keep the universe rolling.</td></tr>
<tr><td colspan="2">"Let them praise the name of the Lord, for he commanded and they were created" Psalm 148:5.
"The Son is the radiance of God's glory and the exact representation of his being, sustaining all things by his powerful word" Hebrews 1:3 emphasis supplied.</td></tr>
<tr><td>Atomic and Subatomic Sizes
The average diameter of an atom is 10^{-10} m.
The average diameter of a nucleus is 10^{-15} m.</td><td>Honesty, Diligence, Mindful of Details
Little matter matters a lot.</td></tr>
<tr><td colspan="2">"Whoever can be trusted with very little can also be trusted with much, and whoever is dishonest with very little will also be dishonest with much." Luke 16:10</td></tr>
<tr><td>Dalton's Atomic Theory
When Dalton originally wrote the atomic hypothesis, he stated that atoms could not be divided into smaller parts. 90 years later, the discovery of the electron and radioactivity forced a revision of this part of the hypothesis.</td><td>God's Law
God's Law works even when we don't have the right explanations for them. Even scientific theories may require some modifications from time to time but "The law of the Lord is perfect..." It always works and does not need any revision.</td></tr>
</table>

In science, observation and experimental results (facts and scientific laws) are considered more fundamental than explanations (theories).	
"The law of the Lord is perfect.... The statutes of the Lord are trustworthy.... The precepts of the Lord are right.... The ordinances of the Lord are sure." **Psalm 19:7-9**	
Gas Laws and other Scientific Laws Scientific laws are constant. They are permanent and that's why we can rely on them.	**The Permanency of the Law** God's laws are unchanging. We can rely upon them.
"Long ago I learned from your laws that you established them to last forever." **Psalm 119:152** "The grass withers and the flowers fall, but the word of our God stands forever." **Isaiah 40:8** (Also **1 Peter 1:25**)	
Chemical Reaction Chemical reaction is always accompanied with chemical change. Chemical changes are always producing new substances that have new properties, which in all cases are perceptible.	**Change must be evident** Just as the conversion of substances results in new substances with new properties, true conversion involves a change in character and outlook. And the change must be evident too.
"Therefore, if any man be in Christ, he is a new creature: old things are passed away; behold, all things are become new." **2 Corinthians 5:17** KJV "Put off your old self,...be made new in the attitude of your minds...put on your new self, created to be like God in true righteousness and holiness." **Ephesians 4:22-24 (Colossians 3:10)**	
Stoichiometry and Percent Yield Based on a balanced chemical equation and conditions for percent yield, a chemist or a chemical engineer can predict how much product will be produced for a given amount of reagents or raw materials. Or they can calculate how much raw material is needed for a desired amount of product/s.	**Faith and Certainty** Real faith is not blind faith. It is based on Biblical principles (the stoichiometry) and on what you have learned from past experiences (the percent yield). That's why when Christians hope, they're not just hoping—they're certain.
"Now faith is being sure of what we hope for and certain of what we do not see." **Hebrews 11:1**	
Buffer Systems Buffers are usually a combination of a weak acid and its conjugate base, a combination that act together to prevent a drastic change in pH.	**Overcoming** Though weak, a Christian who is with Jesus will surely overcome.
"Do not be overcome by evil but overcome evil with good." **Romans 12:21** "To Him who overcomes, I will give the right to eat from the tree of life, which is in the paradise of God." **Revelation 2:7** "I can do everything through him who gives me strength." **Philippians 4:13**	

Thematic Strategies

Thematic strategies are exceptionally effective approaches in the integration of faith and learning. Themes that can be directly related to areas which are of great importance to students would not only be helping them relate to and remember the topics but would also make them realize that their learning after all makes sense. This is especially helpful for courses that tend to get boring, difficult, and seemingly hard to relate to their majors or line of interest. Learning that makes sense is important to the learner, for this will encourage retention and a desire for further learning.[27]

Themes that can serve as springboards for the "right hemisphere breaks," a term used by Bill Walthall to refer to the activity in the right portion of our brains when we do spiritual or religious dialogues,[28] and for other integrational strategies, can be located by examining course goals and objectives, lists of core concepts and key terms.[29] But they can also be found within the subject content. Take for instance the theme *Eternity*. The thing that comes to mind first is the concept of infinity. But infinity is simply too abstract for my first year students. Besides, there is no topic in chemistry that can be directly related to that concept. So I use the mole concept to serve as a springboard for this very important theme. Here's how I employ it in my class after they have understood what a mole is:

Dale C. Claveria (DCC): "I want you to determine how many mL of H_2O is equivalent to one mole of H_2O."

Expected Students' Response (ESR): 18 mL of H_2O.

DCC: (I show them a sample of 18 mL water or let one of them measure it in a cylinder.)

DCC: "If each of the 3000 students of MVC is given a laptop computer with a special external gadget that can count molecules at a rate of 1000 molecules per second, how long would it take them to completely count this 18-mL sample of water if this is the only task or assignment they have to work on? Condition: They can let the computers work 24 hours a day, 6 days a week; they and their computers have to rest on the Sabbath."

ESR: 7.5 billion years (approximately).

DCC: I would smile and say, "You certainly would be very old by that time."

ESR: (Blank and deep looks, Frowns and worried looks.)

DCC: "Well, what if you are to count all the molecules present in a barrel filled with water?"

ESR: More smiles, although some might ask "How big is the barrel, Sir?"

DCC: "And what if you were to count all the water molecules present in the Pacific Ocean?"

ESR: (I allow them to imagine or make any comments.)

DCC: I go closer to them, and with some gestures I appear as though I have an important secret to utter, and say in a soft voice, "This is only the beginning of eternity."

(I then dismiss the class after that and allow the students to discuss the activity and its faith implications among themselves. Many times I learn that they even share what we discuss in class with their roommates and friends.)

The execution of thematic strategies may be subtle. The strategies do not sound very religious and many times students are unaware of it at first. Just like the example shown above, the punch line of the strategy can be delivered in only few seconds; all the other activities involve deeper learning, synthesis, and application of the concept learned—which are few of the many components of effective learning.[30] But it is not obscure either. Students must always know where you stand; they must know what your principles are.

Table 4 outlines some of the themes and strategies I used in my classes. Topics listed in Table 1 and Table 2 also have themes in them written under *IFL Concepts*.

Table 3: Thematic Strategies in Teaching Chemistry Concepts

Topics	Faith Themes
Atoms and Atomic Structures The modern atomic theory tells of an atom with indistinct boundaries but with elaborate internal architecture of subatomic particles. Atoms are so small that a line 1 cm across is equivalent to 100 million atoms wide. The nucleus is incredibly dense: it occupies only 1 ten-trillionth of the atom's volume but contributes 99.97% of its mass. A nucleus the size of a period on this page would weigh about 100 tons. The electrons around nucleus act as particles and wave. They move fast but are not colliding, much like planets around the sun.	**Distinctiveness, Order, and Design** The order and design of the seemingly insignificant matter is amazing. If God has a wonderful design for atoms so small, surely He got a much more wonderful design for the lives of His beloved children! Remember the sparrows. (Luke 12:6, 7) Each element is unique—in shape, size, mass, properties or behaviour, and usefulness. We need to understand that in God's big family we don't have to be uniform in traits, temperaments, talents or usefulness. But as atoms of different elements consistently do each of their assigned tasks, we too can do our duty, no matter how small or grand, for His glory. In God's field, no assignment is insignificant; all is important.
The Periodic Table The groups and periods in the periodic tell of its amazing and predictable arrangement.	**Importance of the Bible to a Christian** What the periodic table is to a chemist the Bible is to a Christian (and much more). Everything in nature has a pattern. Our God is a God of order, not of confusion.
Effects of Radiation; Radioactive Detection and Measurement	**Sin and its Consequences** There are things that we can't see that are destroying us. And

	sin is the most pernicious. Even things that can't be seen or felt by our senses can be recognized through its short-term or long-term effects.
Reactivity of Elements, Octet Rule, Electronic Configuration The closer the elements to a noble gas configuration (stable form), the more reactive they become (the metals and non-metals alike).	**Waiting is—guess what? Not easy!** One very important observation: It seems that the desire to be stable is innate in nature; that the closer nature is to the state of stability the more impatient (reactive) it becomes. Be patient, you are almost there. Learn to wait just a little longer.
Discovery of radioactivity Serendipity—that's how the French physicist Henri Becquerel discovered the radioactivity phenomenon.	**Chances—don't depend on them.** Chances happen to everyone. But the ones who usually profit from them are the ones who don't depend or rely on them but those who are prepared for them. Lesson? Don't leave your life to chances!
Conversion of Units When converting one unit to another, the value with the old unit is multiplied to a conversion factor. Although not numerically equal to 1, conversion factors have values always equal to 1.	**True Conversion** In conversion of units, the "undesirable" needs "1" (that is the conversion factor which has a value of one) to turn it into the "desirable." In the process the unit is changed but the value stays the same. Likewise, the value of the converted and unconverted person before the One is the same. But when the unconverted meets the One and the undesirable traits are changed into desirable ones, that's when true conversion happens.
Scientific Notation "Scientific notation is a way of writing numbers that accommodates values too large or small to be conveniently written in standard decimal notation."[31]	**Trust and Faith** No matter how big or small a number is, it can be properly handled by scientific notation. If this is true to numbers, then I believe this is also true with all our cares. "He's big enough to rule this mighty universe, yet small enough to live within my heart," says a song.

Narrative Strategies

Narrative strategies is an illustrative approach that provides Christian examples that can be linked to a particular topic under consideration. The illustration might be a story from the Bible that highlights a particular point like stories of heroes and scientists from where we can derive lessons, and personal narratives or experiences that give a spiritual perspective. Narratives can also be in a form of history or the development of a certain concept or understanding.

In introducing the metric system to my students for instance, I try to tell them how the concept of standards evolved or came about. I would narrate to them that, before standards were developed it was customary that the measurement of length was made by comparing an

object or distance to some portion of the human anatomy. Greeks used the foot, Romans used the pace; digits were used to measure relatively small things. By the end of the 18th century, practically every country, province, and many smaller governmental units operated with its own system of weights and measures.[32] The outcome was chaotic; and it created a serious problem for trade between countries. The problem with the earlier units was that they were not standardized. Whose foot is going to be used? Mine or yours? After this I would then continue to tell them the history of the development of the metric system. Now they are settled and convinced that standards are important. (Pause.) Then I would add, "so standards are important!" I could then give further evidences for that statement and then add, "God has standards for His people too—the 10 Commandments."

In my chemistry classes I often mention the contributions of the founding fathers of science like Isaac Newton (when studying electromagnetic spectrum), Robert Boyle (history of chemistry, gas laws, acids and bases), Joseph Henry (Henry's law), James Joule (conservation of energy), and Lord Kelvin (temperature and second law of thermodynamics). Citing even just a brief description of their contributions and their faith profession is especially important in our times today where atheism or the belief in evolution is the widely accepted worldview among many leading men of science. Of course, there are still many scientists who believe in God and creation but whose contributions to science are not directly related to chemistry.

CONCLUDING NOTES

I suppose that Big Bang*er* scientists agreed with Hawking when he said that the LHC is crucial for our survival. But they didn't tell us exactly why. Probably they are venturing the most ambitious project on the planet for it is crucial for the survival of science—the materialistic science—science without faith. Perhaps they want to affirm their confidence in the *science* that they hold so dearly, the *science* that they claim can leap into waters where religion is afraid to wade. Their *science,* they claim, respects more deeply the potential of humanity than religion ever can for while religion is encouraging awe in things unseen, science is elucidating them.[33]

The materialistic scientists are usually polemical, willing to take great risks, and always on the offensive side of the controversy in pushing for their products. They seem to have a very noble project when they said it is "crucial for the survival of humanity." But my Bible tells me that it is not important at all. Jesus said, "I have come that they may have life, and have it to the full."[34] It is God's purpose to bring salvation to everyone. And the ultimate goal of all our activities in and inside our classrooms must be geared toward that end. "For this is what the Lord has commanded us: '"I have made you a light . . . that you may bring salvation to the ends of the earth."'[35]

If scientists are bold in their proclamations, we Christians must be bolder; for we have a nobler purpose. And our success and failure along this line have eternal consequences. They are probing deep to what is hidden; we are acting on what is plainly heard and seen. Yes, there is no hiding about it. God's immutable qualities must be *preached* in our classes. Our students must know.

Although the ideal faith integration must go beyond the confines of the classrooms—it must be the "Christianization of the entire school program"[36]—it is still the regular, visible teacher inside the classroom that is the major factor in the whole process of integration. It is he who has the most telling influence upon his students.

Can employing *object lessons* makes teaching a class truly Christian? It certainly will if done with care and with God's blessings. Employing the techniques outlined in this paper is only part of the process of doing integration of faith and learning. But this can be a good, if not an excellent, start. If a teacher prepares his materials well, and study carefully in advance how he would deliver them with their corresponding faith integration, I believe that meaningful engagement will be experienced by both the teacher and the students. Learning and faith will then flourish.

Ellen G. White Quotations on Witnessing

"But no one can impart that which he or she has not received.... It is the love of God continually transferred to men and women that enables them to impart light."

—Christ's Object Lessons, p. 419.

"He calls upon every one to crucify self. Those who respond grow strong in Him. They learn daily from Christ, and the more they learn, the greater is their desire to build up God's kingdom by helping their fellow beings. The more enlightenment they have, the greater is their desire to enlighten others."

—To Be Like Jesus, p. 255.

"The truth is not merely to be spoken by those who work for Christ; it is to be lived. People are watching and weighing those who claim to believe the special truth for this time. They are watching to see wherein their life represents Christ."

—To Be Like Jesus, p. 269.

"From a heart filled with gratitude for the love of God, which has been imparted to the soul, the teacher should labor tenderly and earnestly for the conversion of his scholars."

—Counsels on Sabbath School Work, p. 62.

ENDNOTES AND REFERENCES

1 This phrase is originally from the KJV of Numbers 23:23. This was the first message sent by Morse using the Morse Code. This is also the title of the newest Pulitzer Prize winner book written by Daniel Walker Howe.

2 White, Ellen G. 1943. Counsels to Parents, Teachers, and Students. Mountain View, CA: Pacific Press Publishing Association. p. 426.

3 Claussen, Ben. (2001). A believing scientist approaches the sciences. *Christ in the Classroom, 28,* 520-521.

4 "Since what may be known about God is plain to them, because God has made it plain to them. For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse" Romans 1:19, 20, NIV.

5 The figures and quotes in this paragraph were all taken from the internet news. http://www.telegraph.co.uk/earth/main.jhtml?xml=/earth/exclusions/CERN_large_hadron_collider.xml.

6 http://www.eurekalert.org/pub_releases/2008-02/bu-llp022908.php.

7 http://www.telegraph.co.uk/news/2710348/Stephen-Hawking-Large-Hadron-Collider-vital-for-humanity.html.

8 http://www.telegraph.co.uk/opinion/main.jhtml?xml=/opinion/2008/09/06/do0604.xml.

9 See Exodus 1:8.

10 See Exodus 1:15–17.

11 The idea was taken from Ellen G. White's book *Christ's Object Lessons* (abbreviated as COL). This book studies and expounds Christ's parable teachings in the hope of drawing the readers to the Saviour through a deeper understanding of the principles of God's kingdom. Christ's parables link common things and occasions to divine truths. "In Christ's teaching: the unknown was illustrated by the known; divine truths by earthly things with which the people were most familiar" (from COL page 17). In similar manner, this paper presents chemistry concepts (which are common to students) and link them to faith concepts. Many of the "links" in this paper are in the form of analogies or metaphors but some are drawn through contrasts just as the drawing of lessons from a few of Christ's parables.

12 White, Ellen G. 1941. Christ's Object Lessons. Washington, D. C.: Review and Herald Publishing Association. p. 17.

13 The definitions used in this paper related to Instructional strategies are based from the essay of John Wesley Taylor V published on Christ in the Classroom. For a more detailed presentation of these Instructional Strategies, see: Taylor V, J. W. 2000. Instructional strategies for the integration of faith and learning. Christ In the Classroom 27: 409-425.

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21 White, Ellen G. 1952. Education. Mountain View, CA: Pacific Press Publishing Association. p. 120.
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33 See Peter W. Atkins' essay entitled, *The Limitless Power of Science* in "Nature's Imagination", John Cornwell, ed.; 1995 Oxford University Press, p.125.
34 John 10:10.
35 Acts 13:47.
36 Knight, George R. 1985. Myths in Adventism. Washington: Review and Herald Publishing Association. p. 143.