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COMPOUNDING ELEMENTS OF FAITH AND LEARNING IN THE CHEMISTRY CLASSROOM

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INTRODUCTION

Splashed wide across almost all the major dailies of the world recently on August 8, 1996, were the headlines,

"Life Existed in Mars Three Billion Years Ago"
- INDIAN EXPRESS, August 8, 1996, Pune (P. 1),

etc, not only raking up afresh the perennial and controversial issue of creation versus evolution, but also for the first time, suggesting the possible concept of finding dead organisms in other planets too, thus plunging us further into an additional dilemma of encountering another "fallen planet". It is my endeavour in this essay to go to the basics of science and review a few basic concepts of chemistry and view them perspectively in the light of the biblical revelation. It would be presumptous on my part, of course, even to make a feeble claim that this essay would answer this age-long question but an attempt is being made here to analyse the basic concepts of chemistry and see how they can be related to scriptural truths. I will first discuss the rationale in including chemistry in the school curriculum, highlighting its contribution to humanity in general, then emphasising its values to a student of chemistry. Finally I will relate it to the above issue by bringing out its nature through selected illustrations using three simple laws of chemistry, three common chemical substances and three ordinary chemical processes.

RATIONALE FOR INCLUDING CHEMISTRY IN THE SCHOOL CURRICULUM

Origin and Role of Chemistry in Creation

Chemistry is not a new science. Just when it started, nobody quite knows because its history is clouded by the mists of time. "In the beginning was chemistry, and chemistry was with God" may not after all be a bad statement to make to introduce the concept of the integration of faith and learning in the chemistry classroom. For chemistry is generally defined as

"the science of substances and their transformations"

or as some other author has put it, it is

"the study of matter and the changes it undergoes".

According to the Scriptures,

" In the beginning God created the heaven and the earth."
(Genesis 1:1)

and

"..the Lord made heaven and earth and all that in them is .."
(Exodus 20: 11).

Creation thus involves both God and matter. Before matter existed, it would be logical to assume that this science of matter certainly existed with God. For God would have not envisaged a creation which starts with a "big bang" or whatever, without first formulating an action plan or the blue print, even if He did create the universe with just a "word of the Lord" or the "breath of His mouth".(Psalms 33: 6). He perhaps had started with the smallest unit or building block of matter- call it an atom, if you please - along with its constituents like electron, proton, neutron, positron, meson, etc, and formed almost an infinite number of substances, both living and non-living in the literal six-day week of labour and rested on the seventh day. In this there is an evidence of a beautiful design, a deliberate planning, a purposive pattern, an intricate network, and of a sophisticated formula.

Matter and Energy

Chemistry, as mentioned before, is defined as the study of matter and the changes that it undergoes. Changes in matter are accompanied by changes in energy. Since the entire universe is made up of nothing more than matter in its myriad forms (both living and non-living) and energy, the field of chemistry spreads from atoms to stars, from roots to living organisms. Matter and energy are such fundamental concepts that definitions are difficult. Energy, often defined as the capacity to do work, is the basis for change in the material world. When something moves or breaks or cools or shines or grows or decays energy is involved. The source of nearly all our energy is the sun, another object of God's creation. Solar energy radiates though space as light. A small portion of this radiant energy reaches earth where part of it is converted to thermal (heat) energy. This heat causes water to evaporate and then rise to form clouds. The water in the clouds has potential energy. As the water falls through the air and then flows in rivers, the potential energy is converted to kinetic energy. The kinetic energy of the flowing stream can be used to turn a turbine which converts a part of the stream's energy to electrical energy. The electricity thus produced can be transported by wires to houses and factories where it is converted to light energy or to heat or to still other forms of energy.

Some of the energy striking the earth is absorbed by green

plants, which use a complicated chemical process called photosynthesis to convert radiant (solar) energy into chemical energy. The chemical energy stored by plants - now and in the ages past - is used by humankind for food and fuel. Plants of the current age are harvested in forestry and agriculture. Those of ancient ages are reaped as fossil fuels - coal, oil and gas.

Another kind of energy, nuclear energy was stored in the earth's crust and we reconvert it for use or misuse when we mine uranium and build nuclear reactors and atomic bomb. The discovery of X-rays by the German scientist, Wilhelm Konrad Roentgen a century ago in 1895 and the discovery of radioactivity by Marie Sklodowska Curie a little later, though quite by accident, have opened up new vistas of scientific knowledge. The radiation emanating from uranium, radium and other radioactive element was of three types, named alpha (α), beta (β), and gamma (γ) rays by Ernest Rutherford of New Zealand. His nuclear theory of the atom, set forth in 1911 was quite revolutionary indeed. The discovery of electron, proton and neutron and other subatomic particles called measons, positrons, etc. really do indeed suggest a master-mind behind. There is definitely a plan of action, and a well-pondered master plan by some superior intelligent being, by the Author or Creator for the creation. Though these particles are too small to be seen even through the very powerful microscope, the development of Quantum Mechanics, Eigen functions obtained by solving the wave equations of Erwin Schrodinger aided by the Uncertainty principle of Heisenberg, and the Relativity Theory of Albert Einstein, etc, suggest a very clear, though very intricate and very complex, picture of the atom, its nucleus and the electron and its contribution to the different structures and the subsequent properties of various elements and compounds. The recent developments in the concept of the inter-conversion of matter and energy has completely revolutionised various scientific theories opening up in its wake new vistas of knowledge and line of thinking.

USES OF CHEMISTRY

Science, defined both as a fund of knowledge, as well as the process of aquiring it, has best proved this claim in one of its various branches, chemistry. Chemistry is said to form the basis of all sciences as it pervades deep into all other branches of science, be it biology or geology, physics or aeronautics, medicine or agriculture, engineering or computers. The factual content of chemistry and the skills of a chemist are needed in the training of biologists, geoscientists, students of health science, soil scientists, ecologists, etc. And the impact of chemistry on the quality of human life is quite profound.

As our Patriarch Job describes beautifully in the Holy Bible

(in the twenty-eighth chapter, almost completely dedicated to chemistry), chemistry, since times immemorial, has enabled man to smelt metal from ores and minerals. And without chemistry even modern metallurgy will be impossible.

Chemistry creates out of animal, vegetable and mineral materials some wonderful and surprising substances. Chemistry does not simply copy nature or imitate it, but surpasses it in more and more different ways year by year. Thousands of thousands substances have been produced that are not found in nature but possess very important and useful properties of great utility for the life and work of man.

Chemistry feeds us, clothes us, shoes us, and gives us the things without which modern civilised society cannot function. Chemistry provides the fuel for the engines of the space rockets and strong heat-resistent materials for their design.

But chemistry in itself is such a fascinating piece of human knowledge that it is simply impossible to write about it in a dull, impassionate manner. Chemistry does not have any definite bounds, its horizons are constantly expanding.

Thanks to chemistry many diseases have virtually been eliminated. The coordination of chemistry and medicine has also made the difference between operations in which four strong men were employed to hold the patient down and ones in which the patient was painlessly anesthetized.

Fertilizers, pesticides, and scientific breeding have made food more abundant and varied. Nutritionists are applying their science to designing diets that could produce healthier, stronger people. New materials are developed to improve our clothing and shelters. Industry is offering an almost endless variety of products at relatively low cost to the average consumer.

Along with good medical care, and sufficient and varied food supplies, chemistry also provides comfortable housing, convenient transportations, rapid communication, and over-all personal comfort through scientific and technological development.

THE PLACE OF VALUES IN CHEMISTRY

" Values make up what we perceive to be quality in the world, including the scientist's world. In talking about this "value" world Robert Pirsig develops the idea that a **sense of the spiritual** creates its very heart. For him, quality is the same thing as excellence, virtue, and dharma,..... In fact the Greek word for enthusiasm, enthusiasmos, meant filled with theos, or God or quality". (Barry Hill)

Chemistry, as mentioned before, is an important ingredient of science, and as a result, is much more than just a body of organised facts or the process of aquiring them. It is the continuing search for understanding about ourselves and a changing physical, technological, and biological environment. It provides the students with an opportunity to explore and attempt to comprehend the order and perfection of the original creation. Although creation is marred by sin, men may possess a closer relationship with the Creator as they seek to understand His creation through the teaching of chemistry which advocates the following values in line with the suggestions made by the South Pacific Division Education Department :

1. Quest for knowledge and understanding: God created man as an intelligent being with a capacity for logical thought and creativity. Chemistry in virtue of its being a solid part of science, provides scope for the utilisation of these capacities in investigating God's creation and the laws by which it is governed and maintained.

2. Development of Scientific Method or Processes: Different processes- ways of doing and thinking- are used to investigate and generate ideas. These processes include observing, describing, classifying, measuring, guessing, hypothesizing, predicting, testing, experimenting, communicating, interpreting data, brainstorming, inferring from data, and identifying and controlling variables.

3. Development of Creativity: God himself has shown a great deal of imagination through His acts of creation. A student's creativity to ask questions, generate possible explanations, and test ideas is central to chemistry. Some important abilities include: visualising, combining objects and ideas in new ways, producing alternate or unusual uses for objects, etc.

4. Development of Positive Attitudes: Students bring to class a set of pre-determined attitudes to God, to themselves, to other people and to their environment. Chemistry today, especially in a Christian context, tries to address human feelings, values and decision making skills, and to direct them along positive lines. Positive attitudes that could be developed include willingness to explore human emotions, sensitivity to, and respect for the feelings of other people; expression of personal feelings in a positive way; making well-informed decisions about personnel values and social and environmentental issues; open-mindedness; curiosity, critical thinking, suspended judjment, freedom from superstition and false belief, a sense of responsibility and a willingness to test ideas and explore arguments on

either side of an issue.

5. Personal Relevance: Students experience chemistry in a number of different contexts or it relates to self, home, leisure, work, and the environment. Chemistry includes a lot of information, and a number of skills and attitudes that canbe used in energizing life.

6. Development of Ethical and aesthetic values: Right from the cradle to the grave, all our activities are controlled and fashioned by chemistry. Of the great values that condition our thoughts and actions and make our lives worth-living - "Sathyam, Shivam and Sundaram", (or Truth, Goodness and Beauty) the man of chemistry is mainly concerned with the disinterested passion for truth which ultimately leads him to goodness and beauty. Nevertheless, he is not a perfect man - he is only a seeker of truth. For "values, life meanings, purposes, and qualities slip through science like sea slips through the nets of fishermen. Yet man swims in this sea, so he cannot exclude it from his purview." (Huston Smith)

Hence the inclusion of chemistry, or for that matter any subject in the curriculum should satisfy the intellectual, utilitarian, vocational, cultural, moral and aesthetic values. Because, in the words of Dr D S Kothari, the Chairman of the Indian Education Commission,

> "While a combination of ignorance with goodness may be futile, that of knowledge with lack of essential values may be dangerous." - (Kothari D S)

The importance of the moral values is emphasized even by Dr Babu Rajendra Prasad, the first President of the Republic of India, who once remarked:

> "At present we get no time to think, to meditate, to delve deep into ourselves, we are out to conquer space not knowing that the little space of a few inches either in our own brains, or even more of our hearts, has not yet been conquered." - (Hegde V S)

INTEGRATION OF FAITH AND LEARNING

Meaning of the terms, Faith, Learning, and Integration

As beautifully illustrated by Rasi (1996), "Faith is both a gift of God and human response to the trustworthiness of God." It is a growing virtue exhibited in the following varied forms as a child passes though different stages of his life: borrowed faith

(0-6), reflected faith (7-12), personalized faith (13-16), internalized faith (17-22), reordered faith (22-35), reflective faith (35-50), and resolute faith (50 and above). One of the ways a mature christian indicates his faith is by integrating it with life. He sees lifestyle, work, family, social relationships, and political choices as part of one's religious life. He has committed his life to Jesus and His values. This commitment dictates his daily decisions and actions and pervades in all aspects of his life. A christian educator, thus based on a clear biblical worldview, approaches his task with the goal of permeating all realms of the educational enterprise with christian premises, values, and objectives. To him there is no dichotomy between faith and learning (which in modern parlance means a change of behaviour) but a perfect blend of both resulting in the harmonious development of the spiritual, the mental, and the physical aspects in the life of his student.

"The integration of faith and learning is a deliberate and systematic process of approaching the entire educational enterprise from a biblical perspective. Its aim is to ensure that students, under the influence of christian teachers and by the time they leave the school, will have freely internalized biblical values and a view of knowledge, life, and destiny that is Christ-centred, service-oriented, and kingdom-directed." (Rasi)

An attempt is being made below to show how a few concepts in chemistry could be integrated with faith. Every aspect of life involves an immense number of substances, processes and laws. It is impossible to understand the fundamentals of vital activities without the knowledge of the laws of chemistry. for illustrations, use is therefore made of three simple chemical laws, three very common substances, and three ordinary chemical processes below:

I Chemical Laws

A. The Law of Conservation of Mass and Energy:

Statement:

> "The amount of matter and energy of the reactants taken together is equal to the amount of matter and energy of products taken together" (Gadgil et al)

Explanation :

> According to the law of conservation of mass, matter can neither be created nor destroyed. Though formerly this concept would deny outright the creation story, the recent law (of conservation of mass and energy), modified to include energy along with mass, makes it possible for matter to be converted into energy and

vice versa. For according to Albert Einstein, who once proclaimed,

> "I cannot believe that God would choose to play dice with the world. Nature is subtle,but never malevolent. Science without nature is lame, religion without science is blind" (Gadgil et al),

$$E = mc2$$

where E stands for energy, m for mass and c for velocity of light

With God as source of all energy and power, the act of creation of matter through the power of God can be easily accepted now.

Possible Integration of Faith and Learning:

Here the student is exposed to the following elements of faith:

a. Belief in an omnipotent (all powerful) God who can create the universe by the word of His mouth.

b. Belief in an omniscient (all knowing) God knows everything from the beginning to the end (through eternity).

c. Belief in an omnipresent (present everywhere) God who is always close to each one of us.

d. Belief in a loving & caring God who has given the gift of life to each one of us.

e. Belief in a versatile God who can make different things of various patterns and designs.

f. Belief in a purposeful God who has created each one of us with a deliberate plan and vision.

g. Belief in a redeeming God who had in the beginning itself designed the plan of salvation if man were to sin.

h. Belief in an aesthetic God who has made beautiful and wonderful things for the happiness of man.

i. Belief in a Law-Giver who expects us to have respect for his laws and abide by them.

B. The Law of Definite Proportions:

Statement:

"A given chemical compound, irrespective of source or method of preparation, contains the same elements combined together in the same definite (fixed or constant) proportion of weight."

Possible Integration of Faith and Learning:

a. Belief in a God of order (of rule and law)

b. Belief in a God of exactness and accuracy

c. Belief in a God of changelessness

d. Belief in a God of unity in diversity as well

C. The Law of Multiple Proportions:

Statement:

"When one element combines with another to form more than one compound, the various weights of one of the elements which combine with a fixed weight of the other bear a simple numerical ratio to one another."

Possible Integration of Faith and Learning:

a. Belief in a God of logic

b. Belief in a God of order

c. Belief in a God of variety (yet in uniformity)

II Common Chemical Substances

A. Water (H2O)

Explanation:

Water is a chemical compound, which has lost the original chemical properties of its constituent elements, hydrogen (combustible) and oxygen (supporter of combustion) and has acquired a different, sometimes just the opposite property (quenches fire). It is a good illustration for the concept of integration of faith and learning (complete merger of both faith and learning losing their individual identity and having a

new compounded and integrated identity. (Hence the topic of this essay).

Water also is:

a. a universal solvent

b. a life sustaining substance

c. a cleansing agent

d. a transparent substance

e. a substance which exists in three states--solid (ice), liquid and gas (vapour) and easily interconvertible.

f. the most abundant liquid on the earth

Possible Integration of Faith and Learning:

a. Perhaps existed before the creation of the earth (premordial existence) (Gen. 1:1; Ps. 102:25; and 136:6)

b. "Jesus, the water of Life" (eternal water)

c. Is willing to be transformed (Jesus turned water into wine and Elisha turned bitter water into sweet water)

d. Samaritan woman repented at the well

e. Jesus was baptised by immersion in water

f. Hagar was provided a "bag of water" for her thirsty son, Ishmael.

g. It is present in heaven also (sea of glass)

B. Common Salt (Sodium Chloride - NaCl)

a. Formed from two unsafe elements, sodium, (a corrosive metal which catches fire on exposure to damp air) and chlorine, (a poisonous gas) but has quite the opposite property of being safe and useful (another good example for the concept of integration of faith and learning).

b. A good preservative

c. Adds taste to food

d. Essential for the body fluid balance

e. A good electrolyte

f. A strong salt (compound formed by the combination of a strong acid (HCL) and a strong base (NaOH).

g. Quite soluble in water

h. White gleaming crystalline and attractive substance

Possible Integration of Faith and Learning:

a. "Ye are the salt of the earth"

b. Add taste to others' lives

c. Annul the dangers of the meeting of two unpleasant people/events by bringing in a sweet harmony.

d. Be Attractive

e. Reminds of God who is the "preserver" (Neh 9:6).

C. Air (Oxygen - 21%, Nitrogen - 78%, CO2 & Water vapour)

a. A mixture of colourless and odourless gases

b. Yet each gas retains its individual properties

c. There is harmony among these constituents

d. O2 - A good supporter of life (essential for life)
- A very important element in chemical reaction
- Kills harmful germs
- Prepared easily by heating certain chemicals
- Only 21% in atmosphere-but has a major role
- Major component of the earth's crust (sand)
- Present in water, seas, oceans--etc.

O3 - Ozone also kills germs
- Ozone layer above atmosphere filters dangerous UV radiations from the sun
- Has a very low Boiling Point

N2 - Essential for plants (manure & proteins)
- Regulates respiration
- Forms many kinds of oxides

CO2- Used by plants for making starch

H2O- Maintains humidity level in the atmosphere

Possible Integration of Faith and Learning:

a. God as a source of life

b. God as a destroyer of evil

c. We can also can support life with God's help

d. In spite of being a minority, we can still exert great influence through our usefulness to society

III. Chemical Processes

A. Rusting

(Oxidation of iron in the presence of moisture)

a. A slow but steady process

b. Oxidation of iron

c. Great bane in the preservation of the metal

d. Strong metal (iron) just crumbles into powder after rusting

e. A small exposed point on the damp iron metal can lead to its complete crumpling effect by starting the chain process of rusting due to the layer-by-layer exposure to damp air

f. Can be preserved by painting/applying oil, etc.

Possible Integration of Faith and Learning:

a. Reminds of leprosy (eating away of 8the body)

b. Even a brief exposure to sin if not corrected immediately, can finally lead us to destruction

c. We can be protected/hidden from sin by preserving ourselves with the paint of purity / Holy Spirit/righteousness

B. Fermentation

$$C_6H_{12}O_6 \xrightarrow[\text{yeast}]{} 2C_2H_5OH + 2CO_2$$

a. Sugars/starch converted into alcohol and CO2

b. Brought about by yeast/bacteria

c. Slow but gradual process

d. An iota of the leaven can ferment the whole lot of substance when added to it

e. Can be prevented in the presence of oxygen

f. Excessive fermentation can lead to bad smell, ill-health and death

g. Is effective in the absence of air

Possible Integration of Faith and Learning:

a. We would also be "fermented" if we are not exposed to pure air, the righteousness of God

b. We can sour good relations in the absence of His Holy Spirit and Holy Word

C. Photosynthesis

$$CO_2 + H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_{12}H_{22}O_{11} + O_2$$

(from air) (from soil) (starch)

a. A process common to chemistry, botany and physics (a good example of correlation)

b. A poisonous gas like carbondioxide from the air and water from the soil are taken by the green plants having chlorophyll and are mysteriously combined together in the presence of sunlight into starch (food) and oxygen (life-sustaining gas)

c. A unique cycle maintaining the ratio of O2 and CO2 in air constant

d. Solar energy is stored in the plants & the same energy is released when coal, petrol, etc are burnt

e. Not possible in the night or in darkness

f. The solar energy is just a part of an omnipotent God's energy/power

Possible Integration of Faith and Learning:

a. Without God's power (energy) we cannot live useful lives

b. We need to have faith (chlorophyll) to claim God's promises

c. Useless & sinful people also(like carbondioxide) can be changed into useful people (like oxygen) when we invite God's power (solar energy) through faith (chlorophyll)

CONCLUSION

As seen in all the above examples, all matter, processes, and chemical laws declare silently the existence of an all-powerful (omnipotent), all-knowing (omniscient) and all-pervading (omnipresent) God. Neither matter, nor laws, nor processes could exist unless there is some one at the helm of affairs. He created the heaven and earth and the entire universe including man with a purpose and in love and revealed Himself to us through his Son Jesus Christ, through His Word the Bible and through nature. He proclaimed that He created the earth and its inhabitants in six days and rested on the seventh day and instructed us therefore to

> "Remember the Sabbath Day to keep it holy..... For in six days the Lord made the heaven and earth, the sea, and all that in them is, and rested the seventh day:...."(Exodus 20:8-11)

Then let us believe Him! It is futile to argue or doubt creation because someone else has come up with some theory or postulation which has no Biblical evidence or sanction. As christians with an adventist world view we need to take with a pinch of salt the yet-to-be-definitely proved claims like the accuracy in the radio-carbon dating techniques or the veracity in the semblance of some supposed-to-be fossils of certain microscopic organisms on the planet of Mars. Even some of the great scientists of the modern world in spite of the great scientific discoveries they have made do turn to religion and to God for the solutions to their problems. Arthur L Schawlow, a professor of Physics at Stanford University who shared the 1981 Physics Nobel Prize with Bloembergen and Siegbahn for their contribution to the development of laser spectroscopy once said:

> "It seems to me that when confronted with the marvels of life and the universe, one must ask why and just how. The possible answers are religious..... I find a need for God in the universe and in my own life." (Clausen)

Walter L Bradley, once head of the department of mechanical engineering at Texas A&M and a recipient of over US$ 3,000,000 in research grants and contracts resulting in the publication of more than 80 technical articles, agreed to give a Campus Crusade for Christ presentation, entitled "Scientific Evidence for the Existence of God" in 1987 and later said :

> "As I gave my presentation with eagerness that evening, I knew God was doing something special in and through my life". (Clausen)

Henry Schaefer, Director of the Centre for Computational Quantum Chemistry at the University of Georgia and a five-time nominee for the Nobel Prize who was recently cited as the third most quoted chemist in the world, was quoted as saying,

> "The significance and joy in my life comes in those occasional moments of discovering something new and saying to myself, 'So that's how God did it'".(Clausen)

Science, however impressive and infalible it may seem, is still a growing entity and its discoveries are liable to be misinterpreted, misrepresented, and misunderstood, or in the current parlance "misappropriated". What seemed almost certain and true in science once had to be abandoned in the light of a new revelation and this keeps happening all the time. Science, or to be more specific, chemistry, in itself is not wrong, but it is the dogmatic approach that a few people take while explaining various phenomena or making their inferences that sometimes goes out of tune with reality, as it were.

Hence It is easier to believe in a planned creation and the Creator rather than in an alternate view because we trust in God, trust in His word and trust in His creative powers. We also have faith in His love and His plan of salvation and His restoration of us to the pristine holy status.

Perhaps it behoves us thus to proclaim to our students in the chemistry classroom the existence and power of a wonderful God and loving Saviour while teaching in chemistry (and not from chemistry) every law, substance and process, in all reverence and humility believing in His promise "When He, the Spirit of Truth is come, He will guide you into all the truth" (John 16:13).

How wonderful it will be for us to heed the councel of our beloved Patriarch Job, a man "perfect and upright, and one that feared God, and escheweth evil" who while philosophically integrating faith and chemistry in Chapter 28 concluded finally:

> "And to man He said, Behold, the fear of the Lord, that is wisdom; and to depart from evil is understanding." (Job 28:28)

Let us also join the Seraphs, Prophet Nehemiah and the Psalmist in all reverence and gratitude, and praise His name proclaiming,

"Holy, holy, holy is the Lord Almighty" (Isaiah 6:3)

"Thou, even Thou, art Lord alone; Thou hast made heaven, the heaven of heavens, with all their host, the earth, and all things that are therein, the seas, and all that is therein, and Thou preservest them all; and the host of heaven worship Thee". (Nehemiah 9:6)

"Bless the Lord, all His works in all places of His dominion: bless the Lord, O my soul." (Psalm 103 : 22)

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