On Being Epistemologically Self-Conscious in General Chemistry: An Integration of Christian Philosophy of Science with a Core Laboratory Science Course

A paper submitted in partial fulfillment of the tenure requirements at Covenant College

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(w/ corrections of 9/99)

Perspective on the Tenure Paper

Based upon the brief stipulations contained in the Faculty Manual and my general knowledge of the history and culture of Covenant, it is my understanding that the main purposes of the tenure paper are to provide the Board of Trustees (as well as other interested parties) with written evidence that the author does possess a Reformed view of his discipline and to assure them that this view pervades the faculty member's teaching. Such purposes are consistent with the College's claims in its Statement of Purpose to be pervasively Christian and with the responsibilities of the Board to guard the college's integrity. I am in complete agreement with the requirement. The fact that I have not met the requirement until my eighth year is mostly due to the demands of re-starting the advanced chemistry laboratories and of my involvement in various aspects of the Mills Hall construction project rather than any lack of interest on my part.

However, there is an aspect of this requirement that I would like to clarify, perhaps more for those who come after me than for myself. My doctoral degree is in inorganic chemistry. A paper “in the field” such as might be appropriate for publication in a professional journal (re: the statement in the Faculty Manual) would not meet the purposes of the tenure paper. [I am told that this issue has arisen before, but to illustrate the point I have appended a copy of a paper I co-authored last year.] The professional journals are for the purpose of reporting research work in a particular field not in the philosophy of the field. A person authoring a paper in the American Chemical Society's Inorganic Chemistry might be considered an “expert” in the subject of the paper. It is very likely that the expertise grew out of extensive training. However this by no means is evidence that the person is expert or even knowledgeable in the metaphysics of inorganic chemistry. It is likely that such an author never had even a single course in philosophy of any kind!!1 I suspect that the same is the case in many (most?) other academic fields.

The difficulty is that the tenure papers are really “philosophy of...” papers. As a faculty we un-fairly depreciate the discipline of philosophy by failing to recognize it when we are doing it. This is true for any academic discipline, but it may be that those in the sciences are particularly insensitive to this distinction. For example, a definition of “science” is frequently given on the opening pages of our introductory textbooks. Moreland has pointed out bluntly:2

“For the question What is the proper definition of science? is itself a philosophical

1 This is not to imply that inorganic chemistry is a-philosophic, rather that undergraduate and graduate curricula generally ignore such aspects of the discipline.

2 J. P. Moreland, Christianity and the Nature of Science (Grand Rapids, Michigan: Baker Book House, 1989) p. 20-21. He goes on to show the inadequacies of several textbook definitions. See also his discussion of specific ways in which philosophy is foundational to science on pages 44 and 45.
question about science that assumes a vantage point above science; it is not a question of science. One may need to reflect on specific episodes in the history of science to answer the question. But the question and the reflection required to answer it are philosophical in nature, a point not diminished merely because a scientist may try to define science. When she does so, she is doing philosophy.”

I believe that the some of the reticence on the part of some faculty members to undertake writing a tenure paper can be attributed to a recognition of this difficulty. A survey of all the papers written by faculty in the sciences:

Science Faculty Tenure Papers
Lothers (1968) Relation of Biology to the Doctrine of Providence of the Reformed Faith
Donaldson (1971) A Christian Perspective of Natural Science
Clumpner (1987) Mathematical Modeling and Education at Covenant College

shows that in most cases the degree to which a knowledge of philosophy was required was minimized by attempting to deal only with a relatively narrow problem. (I believe this is a perfectly appropriate approach, particularly because it helps other faculty members who are interested in the same problem, but I would like to suggest another approach.) Also, when most of these papers were written there were in fact relatively few bibliographic sources cited as appropriate.

For example, the review of the field in Charles Donaldson's paper (which is the most perspectival of the tenure papers) cites five references. This may have been a fairly complete list in 1971. Since then the number of such works has greatly increased and a faculty member seeking to make a contribution to the field would find trying to become acquainted with the views already proposed by various colleagues a daunting project:

Christian Views of Science and Science Teaching
A Christian Appreciation of Physical Science H. Van der Laan
A Christian View of Modern Science R. Reymond
Being a Christian in Science W. R. Hearn
Calvinism and the Philosophy of Nature V. Hepp

3 By this term I mean material on a radically Christian understanding of how science is to be understood, done, or taught based upon exposition of biblical texts. I mean to exclude the very large literature (that I refer to as “bible-science”) that is primarily concerned with defending what we believe the scriptures teach against conflicting “scientific” works. Most of this excluded literature does not deal with science or Christianity on a philosophic level nor show concern for what it might mean to do science in a Christian way. For example, a bibliography prepared by Gordon Keddie in the mid-1970’s listed 43 book-length works, however the large majority of them dealt directly only with the origins issue. See “Christian Faith and Modern Science”, G. J. Keddie, Science Pamphlet One from the Committee of the Scottish Reformed Fellowship, Edinburgh (undated).

4 This is by no means a complete list. Rather it is a survey of book-length works selected to illustrate the wide range of views proposed by those who are claiming a biblical approach. A large number of relevant articles have also appeared in journals such as Christian Scholar's Review, Pro Rege, and Perspectives on Science and Christian Faith (the journal of the American Scientific Affiliation). See also other works cited in this paper.
Some reading in this area reveals that there are substantive differences even among the authors who would be considered “in the reformed tradition” as well as among a more general group of Christian writers. I believe those of us in the sciences should be aware of the questions being asked and the answers being given in order to be able to present to our students what we responsibly believe to be a thoroughly biblical approach to our disciplines. Several authors have proposed specific techniques and/or objectives for science teaching. We should be able to justify whatever it is we ourselves are doing in the light of these proposals. I am concerned that we be able to say as much as the Scriptures would allow in the area of science. We should not settle for some minimum. However, these objectives do not require the same level of study/preparation as would be expected if we were going to make an original contribution to the discussion, such as for publication.

Working out the relatedness of our philosophies to our teaching is part of what the tenure papers and the preliminary presentations are about. I value this effort greatly. I believe we should not only have a self-conscious Christian philosophy of science “behind” our teaching but also we should communicate this philosophy explicitly and effectively to our students.5 (I also believe that the fact that the Philosophy Department now plans to offer the Philosophy of Science course on a regular basis is very helpful for our majors but should not relieve us of the latter responsibility.)

How can these various purposes and limitations be accommodated in the tenure requirements at Covenant College? I suggest we divide the purposes among two requirements. First, we require a faculty member study and then subscribe to an approved, consensus philosophy of science statement. This would be a form of “Academic Confession of Faith” that would specify what we believe a Christian philosophy of science should include. It would attempt to be comprehensive and so be fairly general. Second, we require the faculty member to prepare a paper which would indicate how this philosophy affects his teaching on the level of actual course design and/or content. Such a paper would give evidence that the faculty member's Christian commitments are actually being communicated in the classroom. This paper would not

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5 The Phi Chi and Senior Integration papers of many of the science majors reveal that this kind of education is going on right now at least in some programs. See below.
be required to be comprehensive and could be as specific as particular “lesson plans”.

I recognize that there are difficulties associated with both of these requirements, particularly the first. Also, I recognize that developing the required statement ourselves may not be practical given our heavy teaching loads. However, I do believe both of them are defensible, should there be interest on the part of the board and faculty in pursuing them.

**Perspective on Curriculum Goals**

I am specifically concerned with the role Christian philosophy of science should play in my General Chemistry course but this should not be addressed apart from the context of the role of the sciences in general in the liberal arts curriculum here at Covenant. Can we communicate a Christian understanding of science both explicitly and effectively to our students? Yes, I believe this can be done within our present curriculum, without (for example) requiring the Philosophy of Science course, in the following way.⁶

Science is involved in the core curriculum in at least two places - it is touched upon in the Self & Society II course and is the substance of the “laboratory science” core requirement.⁷ The discussion in the Self & Society course, as I understand it, is mostly on the level of the technological implications of science and of its influence on other areas of philosophy and culture. The major part of our students’ growth in understanding and appreciating the knowledge-content of the sciences will probably come from the laboratory science course. However there are in fact two distinctly different types of these courses in our curriculum. The first type includes the “Problems of ...” series of courses and the new course which Doctors Davis and Petcher are offering. These were developed specifically to include philosophic issues. The second type consists of what the science faculty would call the “standard courses”, such as General Chemistry. These courses are primarily introductions to majors and are usually organized as a survey of the state of the discipline. Students with any major in the sciences (or pre-engineering) do not normally take any courses of the first type. It is only the design of courses of the second type that I will consider here.

At present then the standard science courses must serve a double role for all those majoring in the sciences or engineering. Any set of educational objectives should include the perspectival aspect of the college's purpose. Again I say “include” because few (if any) of these courses can be designed around student's philosophic needs without compromising their function within the major. The Departmental Goal Statements (from both before and after the introduction of the new core) indicate that the various departments are aware of this function of their programs. However these Statements (I would say, properly,) do not deal with the extent or

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⁶ This should not be taken to mean that I would oppose requiring a Philosophy of Science course or a philosophy unit in a core course.

⁷ By “sciences” I usually mean the physical sciences. I have had physics and chemistry principally in mind in developing my thoughts but astronomy, geology, meteorology, and sometimes mathematics are commonly also included in the term. However, due to the organization of the curriculum here at Covenant, discussions of “the science requirement” include the life science biology but not (the social science?) psychology. Here I will try to use the term with this latter meaning.
the specifics of what philosophic content is to be presented in the courses. By way of presenting my own views I would like to make some suggestions in this area - but first it is helpful to review the present state-of-affairs.

Currently we are trying to assess (among other things) the understanding of philosophic issues and the importance attached to them by our graduates through their Senior Integration Papers. I have surveyed some of what has been written by our science majors in these papers as well as their old-curriculum equivalents, the Phi Chi Papers. Where they are specifically philosophic, these papers have several views in common, such as founding the Christian's call to scientific work in the “cultural mandate.” However on other subjects, such as the status given to the “laws” of science, they reflect a variety of opinions. The ideas expressed are generally those of one of a relatively few Christian authors on these subjects. It may not be reasonable to expect more breadth than this, considering the very limited exposure which most of these science-major students may have had to these issues prior to their Senior Paper course.

There are two difficulties with evaluating our curriculum with respect to perspective-on-the-sciences in this way: we do not have any information for students who take the standard courses but do not graduate as science majors and we do not know, in most cases, whether the thoughts expressed in the Senior Integration Papers were developed while the student was writing the paper, or before. Assessment questions aside, all students need to know something about science and about the philosophy science in order to be responsible children of God. Our majors particularly should see the pervasive importance of a Christian approach - otherwise they may consciously or unconsciously restrict “thinking Christianly” to courses such as Self and Society or the Senior Integration Paper.

I believe we could better achieve the College's goals if the science faculty could agree on a set of general guidelines regarding at which points, to what extent, and to which ideas each Covenant student would be exposed. This would require science faculty consensus because our students have a wide range of course options for fulfilling the science core requirement. Some students, particularly non-science majors, may study under only one or two science faculty members. Given the diversity of the courses and of the faculty, I would not expect a uniform level and extent of philosophic instruction of all students. Nor do I think that a rigid uniformity 

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8 Among older papers in the library's files, some are completely philosophy of science essays (such as: William Acker, "A Study of the Function of Science"; Yusuf Mosih, "It Could Run Without His Interference; Could It?"; Sharon Turner (1970), “Towards a Christian Perspective of Science”). Many papers that are principally concerned with a Christian approach to a particular issue also contain a section which present the author's thinking about general issues in the philosophy of science (such as: Claudia Allender, “Towards a Christian Approach to Teaching Mathematics”; Patricia Fikkert, “A History of Science: The Scientific Method; And Statement on Knowing”; Bruce Tilton, “An Investigation of the Carbohydrate-Producing Capacity of Soil Organisms”; Rodney Stortz, “A Christian Approach to Science”). [To be honest, there are a few which do neither (see Peter Shaw, “The Use of Gas Chromatography, Mass Spectrometry, and Activated Charcoal in the Analysis of Hydrocarbons Present in Ambient Air and Exhaust Emissions”).] We are just now graduating students who have been completely through our new core curriculum and most Senior Integration Papers are not sent to the library but the papers that I am familiar with fit these same categories and show similar variations in the level of the content (compare Sarah Roberts, “A Christian Philosophy of Science” and Elizabeth Wynja, “Review of Christianity and the Nature of Science” in the first category; Rory Ramsey, “Towards a Christian Philosophy of Science: Carolus Linnaeus and the Compte de Buffon, Their Concepts of the Species, and its Evolutionary Significance” and Edward Sunder, “Review of Meditations at 10,000 Feet” in the second category; John Waggoner, “1, 2, 3-Tris(Methylthio) Propane: Synthesis of TMP and Complexation to Nickel(II)” in the third).
is desirable - some students need to know more in their callings than others.

As an example of what I do mean, some guidelines could be particularly important in the case of our presuppositions. Just because they are “pre-” - that is, they come before the main subject/content of the courses - it is easier than we like to admit for them to go unnoticed by the students. For this reason our presuppositions should be applied explicitly to the philosophic questions that will arise during the progress of various science courses, not restricted to a few introductory lectures at the beginning of a science course. No doubt the particular issues dealt with will vary with the nature of the different science courses that are available to the students. More important than the particular applications themselves is that students see how the presuppositions actually function in the context of doing science (or at least how they function in the in the context of learning science). I don't mean to suggest that integration of our presuppositions with other course material is not being done now, though perhaps not as explicitly as I am proposing. I also recognize that our opportunities are limited, given the minimal science requirements in the core curriculum. We do not have time to pause after every mention of a new observation or principle and launch into an extended philosophic discussion of the issues involved. But we can mention at least a few issues in passing and at some points in some courses illustrate more fully how a Christian physical scientist would approach a particular subject in a distinctively Christian way.

Perspectival / Philosophic Content

There are at least two levels for discussion remaining after any agreement on the principles of the above sections. First, what subjects can/should be introduced in these standard science core courses? Second, what specifically should be taught on the subjects? The science faculty spent some time on the first of these questions when we wrote a syllabus for a core science course that was proposed during our development of the current core curriculum. Some subjects which I believe should be discussed somewhere in our curriculum and can be in the standard courses as well as in the other science-core-requirement courses are:

Philosophic Subjects Appropriate for the Core Science Courses

- Mandate
- Presuppositional Base
- Implications for Specific Issues (such as ...)
  - Bible versus Science Debates
  - Providence and Law
  - Data and Interpretations
  - Limited Domain of Science
  - Chance and Order
  - Origins

(The specific issues I have listed are simply examples of topics that might be included, not a definitive list). To make concrete what I intend by “discussion” of “subjects”, I will illustrate what I believe is appropriate in the introductory level courses by presenting (with commentary for this paper in italic typeface) some of the actual content which I discuss in my General
Chemistry course. Before some of these discussions I distribute a packet of background readings consisting of short (1 to 5 page) articles, a list of thought-provoking quotations, and a bibliography of works that I will cite in lecture. In what follows I will include some excerpts from the packet material in text boxes.

Mandate

The biblical call to do scientific work ought to be presented explicitly, preferably in an introductory lecture to a course such as General Chemistry. Many of the students are freshmen who may well not be acquainted with our reformed view of culture and may not yet have been introduced to any rationale for our core curriculum's science requirement. I also make reference to the question “why do we need this course?” frequently in opening prayers as the semester proceeds.

A profitable approach is one which stresses the stewardship responsibilities that arise from the “creation mandate”. This leads to motivation based upon obedience rather than exploitation or curiosity. We must be aware that relatively few of our students come to us with Christian views of academics. For those who have taken Carl Sagan as spokesman for science, statements like:

“I meet many people who are offended by evolution, who passionately prefer to be the personal handicraft of God than to arise by blind physical and chemical forces over aeons from slime. They also tend to be less than assiduous in exposing themselves to the evidence. Evidence has little to do with it. What they wish to be true, they believe is true.”

make them wonder what any Christian is doing in “science”. Others have uncritically accepted a reaction popularized in the 1970's against what is seen as the scientism of our time:

“[expertise is:] A bewilderingly perverse effort to demonstrate that nothing, absolutely nothing, is particularly special, unique or marvelous, but can be lowered to the status of mechanized routine. More and more the spirit of 'nothing but' hovers over advanced scientific research: the effort to degrade, disenchant, level down. Is it that the creative and the joyous embarrass the scientific mind to such an extent that it must try with might and main to degrade them?”

In addition, many students come from an Evangelical sub-culture which does not encourage them to value scientific work. Speaking of this, John McIntyre of Texas A&M University, has commented:

“There is a steady unconscious pressure on our young people to devote their lives to the approved activities and, of course, to admire others who do so. One hears Christians speak proudly of their sons or daughters who have married seminary students or missionaries. But where is the encouragement for our young people to enroll into the graduate schools of our great research universities to enter a


It is especially important to consider the attitudes which we as Christians should have toward chemistry or toward the study of any science in a course such as this one. Our goal should be good stewardship of our abilities and of the physical creation that has been committed to us. These are aspects of what we often call the “cultural mandate”. The mandate first given at creation (i.e. Gen. 1:26ff, Ps. 8, I Cor. 10:31) implies an extensive responsibility for doing science. We want to understand and to participate in scientific work in a way that is consistent with this mandate.

At least four things are implied by these texts:

1. Our goal in carrying out the mandate should be chiefly God's glory.
2. Scientific research is needed to discover the nature of the creation.
3. We are commanded to develop some of the possibilities which are latent in the creation.
4. This development must be regulated (“stewarded”) for the honor of God.

From the quotation of Psalm 8 in the context of Hebrews 2:5ff and also from I Corinthians 15:24ff we know that apart from Christ any completion of this mandate is impossible. He alone is the one who will finally subject all things to His Father (see Isaiah 65:17-25). The Christian doing any scientific work in this new age of the Spirit is both discovering the latent possibilities God has created in the world and is discovering the restorative results of its redemption in Christ.

For those of you who are considering a vocation in the physical sciences, this understanding has obvious application to your motivations. Part of what is restored in Christ is a true love for creation in general and in particular for that part of creation which God has given you to study. You should see that in the laboratory we don't “simply” handle elements and compounds, we handle God's elements and God's compounds in a stewardly responsible way seeking to find what God has made and how it behaves within the law-structures which He has ordained. We do this with real interest and appreciation for this aspect of God's handiwork.

This is not a new way of looking at science but it is one that has been lost in many branches of the church in this century. At the time of the Reformation, John Calvin, in his Commentary on Genesis 1:16 wrote:

“For astronomy is not only pleasant, but also useful to be known; It cannot be denied that this art unfolds the admirable wisdom of God. Wherefore, as ingenious men are to be honored who have expended useful labor on this subject, so they who have leisure and capacity ought not to neglect this kind of exercise.”

About 100 years later over half of the founders of the Royal Society of London (one of the best


known scientific societies in the world) were Puritans.\(^\text{12}\) This same appreciation has continued among those who have continued in the theology of the reformers:\(^\text{14}\)

“A Calvinist who seeks God, does not for a moment think of limiting himself to theology and contemplation, leaving the other sciences, as of a lower character, in the hands of unbelievers; but on the contrary, looking upon it as his task to know God in all his works, he is conscious of having been called to fathom with all the energy of his intellect, things terrestrial as well as things celestial; to open to view both the order of creation, and the "common grace" of the God he adores,...”

You should recognize that we are called to do much more than science-for-apologetics. I would urge those of you who are pursuing a vocation in the sciences to read Walter Hearn’s new book, *Being a Christian in Science*, for an introduction to many of the practical implications of such a calling.

I also want to say in this context, that merely seeking to “satisfy curiosity” is not a proper (i.e. God-honoring) motive. I say this because it is likely that many of you have had teachers who believe that this is the chief means of motivating their students to learn science.\(^\text{15}\) Nor do we principally seek greater power for ourselves either to do harm (the terrorist in search of a better weapon) or to provide assistance (pre-meds take note).

**Presuppositional Base**

*It may be best to make students aware of our presuppositions in a distinct unit at the beginning of a course. They can then be alert to their influence both on the way in which the course is taught and the subject matter itself. On the other hand there is a pedagogical advantage to exploring the idea of presuppositions or conceptual frameworks in the context of arguments for and against particular scientific theories as they arise during the course. In either case, I generally repeat these discussions in the upper-division courses since the students there are more aware of the difficulties involved and are the ones who have a greater need-to-know.*

*If the presuppositions are being discussed before students have “discovered” their relevance to the content of the course, one possible approach is to compare and contrast the views of Christian authors who differ widely. Several authors state their presuppositions*

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\(^\text{12}\) For documentation and other examples, see Hearn, p. 11f.

\(^\text{14}\) Abraham Kuyper, “Calvinism and Science” in *Lectures on Calvinism* (Grand Rapids, MI: Eerdmans Pub., 1931), p. 125. These lectures were delivered in 1898.

\(^\text{15}\) *Note for this tenure paper:* This has implications for teaching methods. The author of what was a very widely used textbook in its day, Robert Plane, complained: “Drawing on the science mystique, the teacher subjects the students to one prestidigitation after another. Science is presented as magic. The science instructor plays a cockamamie Mr. Wizard, wherein the bigger the puff of smoke and the louder the bang, the better. For example, some teachers like to demonstrate the spectacular action of concentrated sulfuric acid on sugar. Naturally, it impresses students with the danger of this acid. Left unmentioned is the fact that the preponderance of sulfuric acid goes toward the production of a very helpful commodity - fertilizer.” Plane called such teaching inexcusable. See “Revising the Scientific Method” *The Chronicle of Higher Education* 16(4), 56 (3/20/78).
As an illustration, I consider Ream and Dye because I can refer students who want to pursue the issues involved to a more-complete-than-we-have-time-for analysis of their differences found in Ream.¹⁷

What you believe this course is really about is something that comes before the first page of your textbook; it is a whole collection of ideas that you presuppose. These presuppositions are a part of (or perhaps we should say: “are determined by”) your world-and-life view. A context for discussing what it is we should be presupposing is provided by the range of answers to the question: What is the ontological (i.e. “based upon an analysis of the nature of being”) status of the cosmos (i.e. the entire material [and immaterial?] world)? Some historically important answers to this question are summarized in the following chart.

<table>
<thead>
<tr>
<th>Status? Deity</th>
<th>Nature</th>
<th>Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>- pantheism,</td>
<td>- i.e. self-existent (no creator), self-governed (no governor) “machine”</td>
<td>- by a “Clockmaker” (still self-governed) or - by a Sustainer (everything is providential)</td>
</tr>
<tr>
<td>1650's), modern neo-paganism</td>
<td>- Secular Humanists (e.g. Paul Kurtz)</td>
<td>- Deists (e.g. Ben. Franklin)</td>
</tr>
<tr>
<td>- Eastern Religions, Spinoza (Dutch, Albert Einstein, Gaia)</td>
<td>- Christian Theists</td>
<td></td>
</tr>
</tbody>
</table>

The common public perception of science is usually based upon “spokesman” like Kurtz who make statements like quote #1 on your handout for today.¹⁸

#1 “Secular humanists may be agnostics, atheists, rationalists, or skeptics, but they find insufficient evidence for the claim that some divine purpose exists for the universe.” “We believe the scientific method, though imperfect, is still the most reliable way of understanding the world. Hence, we look to the ... sciences for knowledge of the universe and man’s place within it.” “Secular humanism places trust in human intelligence rather than in divine guidance.”

- Paul Kurtz, 1980. A Secular Humanist Declaration

What the Bible teaches (see for example Neh 9:6, Col 1:16f, Heb 1:2f) is more than just a point-in-time creation - the entire existence and operation of the cosmos depends upon God willing it moment-by-moment. Unfortunately many Christians are practicing Deists in their scientific

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¹⁶ See Moreland’s discussion of twelve such presuppositions, op. cit., pp. 109-133. In his study of John Calvin’s writings, Lee finds a total of eighteen “principles” which I think would fit the term “presupposition” as I am using it. See Francis Nigel Lee, Calvin on the Sciences (Foxton, England: Burlington Press, 1969) pp. 29-39.

¹⁷ See Ream, op. cit., pp. 3-10.

The fourth choice in my chart (above) is properly expressed in quote #2.

#2 “[T]heists have agreed that in any natural transaction, God conserves the transactors in existence; were he to withdraw this conserving activity the created universe would vanish like a computer image when you pull the plug.”

If we restrict our discussion to just those with the right answer to the status question, the excerpts in the supplemental material I’ve handed-out (from works cited in the bibliography at the supplement’s end), [See quotes #3 and #4] indicate there are still many conflicting views of science proposed by Christians.

#3 “The student should see that behind the observations are simple laws and that behind these laws is God...”  “Every person knows that there are facts, not just observations, and that cause-and-effect is real, not merely apparent ... because he knows of the eternal power of God.”
- Russell Maatman, 1978. *The Unity in Creation*

#4 “...science [is] a method for dominating and utilizing nature ... not a way to any knowledge [except] of what to do in a laboratory.”
- Gordon H. Clark, 1964. *The Philosophy of Science and Belief in God*

At least some of this conflict can be understood in terms of differing answers to another question: How should our ontology inform our science? Some of you may be aware of the recent controversies in the Christian Reformed Church surrounding the views of Howard Van Till. He argues that we do not observe the “status”, we only observe the “properties” of the cosmos - namely “uniformly patterned behavior”. He therefore proposes we carefully separate questions along these lines. This puts up a wall, as it were:

<table>
<thead>
<tr>
<th>Domain of philosophy &amp; religion</th>
<th>Domain of science</th>
</tr>
</thead>
<tbody>
<tr>
<td>origin?</td>
<td>formation?</td>
</tr>
<tr>
<td>governance?</td>
<td>behavior?</td>
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</tbody>
</table>

which limits the use of Scripture to inform our science and leads to (or perhaps “is the basis for”) what others call “methodological naturalism”.

19 For an example of the error this can cause and the weakness of the “God of the Gaps” apologetic that often accompanies it see: Jack Lothers, *Where is the Salt* (Lookout Mtn, Ga: Covenant College, 1997) p. 60.


21 See for example the contribution to this discussion from Wheaton College: Paul de Vries, “Naturalism in the Natural Sciences: A Christian Perspective” *Christian Scholar’s Review* 15(4), 390-391 (1986). This paper also contains a critique
act this way, even if they may not say so or have thought it out. Other believers think that either scripture or creation or both speak to questions in both of these domains.22

On what basis are we to evaluate these views? The differences are reducible to a question of authority. There are at least three answers that have been given:

**Authority Choices**

1. Use our reasoning alone. This has been the view of most non-Christians.

2. Use our reasoning and God's revelation. This was the position of Thomas Aquinas and is the position of several of the contemporary Christian writers cited in the *(handout)* bibliography.

3. Use God's revelation alone. I believe this was the position of John Calvin and is the position of other contemporary Christian writers cited in the bibliography.

Choosing one of these positions determines to a large extent the kind of scientific presuppositions that are acceptable. Personally, I believe that the third is most consistent with Biblical principles. You are perhaps familiar with the “spectacles” analogy from Calvin's *Institutes*:

“For just as eyes, when dimmed with age or weakness or by some other defect, unless aided by spectacles, discern nothing distinctly; so, such is our feebleness, unless Scripture guides us in seeking God, we are immediately confused.”23

The assertion here is that reasoning without scriptural guidance is vanity. For example, reason is made subject to revelation in II Cor. 10:5, “...and we take captive every thought to make it obedient to Christ.” By the third choice we mean that the Scriptures alone must be foundational for a proper understanding of all physical reality, including the study of chemistry. I say “foundational” because I do not intend that we use the Bible as our chemistry text book in the sense of looking for verses about chemical reactions (though there are some, such as Prov. 25:20). Neither do we expect to find God revealing specific scientific theories.

This latter can, however, be more problematic. See Ream's discussion of the question of “models” in Scripture and also Wolterstorff’s criticism of the failure of Christian scholars to provide formative direction within the sciences based upon their religious commitments.24

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22 Wolterstorff had previously made the claim that the “religious beliefs of the Christian scholar ought to function as control beliefs within his devising and weighing of theories.” See Nicholas Wolterstorff, *Reason within the Bounds of Religion* (Grand Rapids: Eerdmans, 1976), p. 66.

23 From I.xiv.1 but see also I.v.12, 15 and I.vi.1.

As an illustration of where this authority choice may lead, I'll summarize the presuppositions which Robert Ream has suggested follow from this first or fundamental one.\textsuperscript{25}

Presuppositions for a Christian Physical Science - after Ream\textsuperscript{26}

<table>
<thead>
<tr>
<th>Presupposition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scripture</td>
<td>inerrant, authoritative source of information</td>
</tr>
<tr>
<td>God</td>
<td>self-existent, tripersonal, infinite, creator</td>
</tr>
<tr>
<td>Creation</td>
<td>a reality which reveals God to us</td>
</tr>
<tr>
<td>Providence</td>
<td>creation actively preserved and governed by God in accordance with his pre-determined plan</td>
</tr>
<tr>
<td>Man</td>
<td>God's image with responsibility to be king and steward of creation</td>
</tr>
<tr>
<td>Fall</td>
<td>mankind now spiritually blind</td>
</tr>
<tr>
<td>Curse</td>
<td>includes re-structuring some aspects of physical reality in burdensome ways</td>
</tr>
<tr>
<td>Redemption</td>
<td>physical as well as spiritual restoration</td>
</tr>
<tr>
<td>Hope</td>
<td>physical restoration will be complete in new heavens and new earth</td>
</tr>
</tbody>
</table>

You should contrast this approach with others that you may find put forward by Christians that tend to give equal or almost equal weight to both our “independent” thinking and/or additional, revealed ideas. An example of this reason-plus-revelation approach is found in David Dye's alternative presuppositions:

Presuppositions for a Christian Physical Science - After Dye\textsuperscript{27}

<table>
<thead>
<tr>
<th>Presupposition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fundamental Criteria</td>
<td>logical consistency</td>
</tr>
<tr>
<td></td>
<td>psychological adequacy</td>
</tr>
<tr>
<td>Physical Reality</td>
<td>exists</td>
</tr>
<tr>
<td></td>
<td>logic applies</td>
</tr>
<tr>
<td></td>
<td>causality applies</td>
</tr>
<tr>
<td>God</td>
<td>exists</td>
</tr>
<tr>
<td></td>
<td>is revealed in Jesus Christ</td>
</tr>
</tbody>
</table>

It may not be clear to you why a list such as this second one is an inadequate base for a Christian philosophy of science. In addition, you may not see how some of the presuppositions, especially in the theologically fuller first list, apply to the scientific enterprise. A thorough discussion of these issues is beyond the scope of this lecture and properly belongs in a Philosophy of Science course.

\textsuperscript{25} Other examples of such lists are found in J. Moreland’s discussion of twelve such presuppositions, \textit{op. ct.}, pp. 109-133 and Francis Nigel Lee’s eighteen “principles” extracted from Calvin in \textit{Calvin on the Sciences} (Foxton, England: Burlington Press, 1969) pp. 29-39

\textsuperscript{26} Ream, p. 10.

Specific Issues in General Chemistry

Instead of attempting a general discussion, I would like to illustrate how these presuppositions apply to some widely-recognized specific issues. To provide a context for this, we can consider several topics which will arise in this course and/or which affect the way any educated person thinks about “science” in general. I'll designate the topics:

(a) Bible versus Science Debates
(b) Limited Domain of the Physical Sciences
(c) Creation’s Revelatory Nature
(d) Relationship between Providence and Law
(e) Distinction between Observations and Interpretations.

Actually my current practice is to present the following material at various points in the course as issues arise. Many students, even those with substantial backgrounds in High School science courses, do not seem to have been introduced to any epistemological or methodological “difficulties” before. For example, I postpone introducing the last two issues until students are well in to the historical development of the laws and theories which form the interpretive framework which will be used for the remainder of the General Chemistry courses.

(a) Bible versus Science Debates

Some people would have us believe that there is a conflict between the discoveries of scientists and the teachings of the Bible. Christians who accept this thesis have often seen “science” as an enemy of “faith”. This results from a false (although popular) view of science and an incomplete knowledge of scriptural teaching. A model of the controversy as they see it is:

```
“Bible - Science” Debates
Christians Say ➔ ⊗ ↔ Scientists Say
(based upon Biblical revelation) ➔ Scientists Say
(based upon physical reality)
```

But this model conflicts with Ream's set of presuppositions at several points. Therefore allowing the “debate” to be put in these terms precludes any properly Christian resolution. A more biblical model of the same controversy is:

```
Scripture - Reality “Debates”
God's Works ➔ ⊗ ↔ Men's Interpretations
(physical creation and Biblical revelation) ➔ Men's Interpretations
(flawed by spiritual blindness)
```

Several important differences between these two models can profitably be noted, but for now let us consider just one. In the second model, God is both the creator of the physical and the
revealer of Scripture. There can be no disagreement between physical reality and the Bible. Any apparent disagreement is a result of misunderstanding the Bible, misunderstanding the physical creation, or both. There is no challenge to the credibility of our faith, only illustration of work that remains to be done to improve our understanding.28

That this work may be difficult, as Reg McLelland has pointed out, I do not introduce except in response to student questions.29 This is perhaps most obvious in the origins debate which is now continuing far faster than I could hope to follow. To show students the extent to which the disagreements have philosophic/theological roots and are related to the above presuppositions, I refer them to the debates between Giberson and Moreland and between Hasker and Johnson in which this seems particularly clear.30 [There may be an even more useful case study in the disagreement between Charles Hodge and Abraham Kuyper presented in David Hall’s new book, but I haven’t had time to pursue this.]31

(b) Limited Domain of the Physical Sciences

The physical sciences focus our attention on the causal and logical aspects of physical reality but there are also other aspects, such as the aesthetical, ethical, and theological (to name a few) that coexist with and are an integral part of the objects and processes that we are observing. (There is of course also more to reality than that which is physical.) We must avoid a reductionist mentality which is often attributed to scientists, and sometimes even championed by a few. This is not a uniquely Christian warning, of course. That “science” was often out of its place was a common theme of the counter-culture when I was in your place (see quotation #5).32
Proper appreciation of context is important here. In our study of the make-up of matter we move away from common experience and the range of things discernable with our unaided senses. We do this by use of the only additional tool God has given us: our rational capacity. So we become increasingly explicit about our logic, abstract, and mathematical as we develop theoretical explanations on a molecular level. Because this is so, we do tend to leave behind the other aspects of things. We are not by this process entering deeper into the whole of reality, into “what is really there”, rather only into one narrow aspect of it. In other areas of our lives this is obvious; we do not expect to gain deeper understanding of our national government by going down into a subway tunnel in Washington! Similarly, when we study the heat capacity of water we have to keep in mind that water is more than a composite of its various physical properties.

That some of these aspects are not material makes them no less “real” nor any less important. What I want you to consider is that such thing as emotional and aesthetic aspects are not simply our responses to a merely physical world, or our projection onto the physical world of something that is not inherently there. When ever we follow the pathway of abstractions we must remember to retrace our steps back to common experience, where we were created to function as a whole and where objects are not only physical and chemical properties.

(c) Creation’s Revelatory Nature

Acknowledgment of one of these “non-scientific” aspects (the revelatory nature of the physical creation) is critical for us if we are to be honoring God in this chemistry course, so I want to speak to it specially. The scriptures present a personal view of the world and of all reality. For example: “The heavens declare the glory of God; And the firmament shows His handiwork. Day unto day utters speech, and night unto night reveals knowledge.” (Ps 19:1-2). It is our duty to analyze the physical creation in order to properly rule and develop it, but it is also important to use it as the means of communication which it was intended to be. Please consider carefully the argument for a distinctly Christian chemistry which Maatman makes on this basis in the handout that I’ve given you.

33 Of course the extent of this varies, but “hard” scientists take exactness to be a virtue. There is a fable in laboratory folk culture about three scientists hiking in Scotland. The social scientist spots a sheep on a hillside and says, “Look, the sheep in Scotland are black.” The biologist replies, “Don’t jump to conclusions. What you mean is, ‘In Scotland there is at least one black sheep.’” The physicist scoffs, “No, no. Why can’t you be more precise? All we can conclude from this observation is that, ‘In Scotland there is at least one sheep, one side of which is black.’”

34 Russell Maatman, Chemistry, A Gift of God (Sioux Center, IO: Dordt College, 1985). p. 6-8. Here Maatman argues on the basis of his exegesis of Prov. 12:10 that any knowledge the ungodly may have of chemistry will show itself false by resulting in cruelty.
This is not necessarily to claim that this message is intelligible to the unbeliever. However Maatman does claim some appreciation when he maintains that even the unbelieving scientist “knows” the Central Principle (quote #6). 

![Image of the Central Principle](image)

Also we do sometimes find statements close to this in the reflections of unbelievers, such as Paul Davies’ “...the greatest scientific miracle of all: science works. [i.e.] we live in a rational, ordered cosmos subject to precise laws that can be uncovered by human reasoning. Yet why this should be so remains a tantalizing mystery.” But you should be aware that Romans 1:20 may be more subtle than we often think. We will come back to this as we consider (at the beginning of some classes) what God expects Job & friends to know in Job 38 - 39.

I have in mind here Luther’s view (according to Bainton) that “Nature cannot reveal God. Nature is indeed very wonderful, and every particle of creation reveals the handiwork of God,... But who sees all this? Only faith and spirit. ...nature is a revelation only to those to whom God has already been revealed.” I wonder if Berkouwer had criticism of this view in mind when he wrote: “[We must protest placing] Scripture and nature, or Scripture and history, on one line, as sources of knowledge of equal import. Any such equalization has always resulted in a devaluation of Holy Scripture. But also every attempt to prove, on the basis of fallen mankind’s blinded eyes, that God has revealed himself only by his Word, and not already in the works of his hands, must be rejected.” 

35 For his defense of this see: R. Maatman, *The Unity in Creation* (Sioux Center, IO: Dordt College Press, 1978). pp. 74-77. He answers objections to the “central principle” including the charge that it is (traditionally-rejected because it is man-centered) natural theology in: R. Maatman, *Pro Rege* IX(1), 2 (Sep 1980).


39 But perhaps his distinction between “general” and “natural” revelation is discussed in connection with neo-orthodoxy in a doctrine class. Later in the book (ibid., p. 287-289) Berkouwer says “This view of general revelation as being ‘nature revelation’ often played an important role in the discussions about the relationship between theology and science. On this view the Holy Scriptures were regarded as the book of the special revelation of God and nature (with or without an appeal to Article II) as the book of general revelation. It was thought that both theology and natural science were concerned with the revelation of God, theology dealing with special revelation and natural science with general revelation. Thus Schouten speaks of general revelation as ‘God’s revelation in the realm of nature,’ and he places ‘nature’ and ‘scripture’ side by side. From this it follows that in the main we owe our knowledge of the revelation of God in nature to the natural sciences. And the distinction between general and special revelation is then interpreted as follows: On the one hand, special revelation governs our life and world view (wereldbeschouwing), but it does not present us with a complete picture of reality; on the other hand general revelation affords us a cosmic picture (wereldbeeld), but leaves us without a life and world view. Our picture of the world is, we are told, our knowledge of general revelation, given by God in nature. Thus we have two revelations (existing side by side) and both of these possess absolute authority,
For now I will leave this subject with the third in the list of Ream’s presuppositions (above) and the quotation (#7) from his discussion of it that is on your handout.

<table>
<thead>
<tr>
<th>#7</th>
<th>“And just as it may be important, admittedly, to “scientifically” analyze physically, chemically, and even biologically the paper and ink in a book, it is nevertheless more important to read the book and thereby use it for what it was intended to be, a means of communication and revelation. It is precisely the same for the cosmos.”</th>
</tr>
</thead>
</table>

(d) Relationship between Providence and Law

Much of this course is a presentation of chemical laws and discussion of how they may be “explained” and applied, so it is particularly important that we think about just what sort of “laws” these are. For example, a very popular but wrong view is assumed in the Deist argument against miracles. The major types of views that have historically been important are reviewed in the “Paradoxical Universe” article that I distributed.\(^{40}\) I have tried to summarize them in Chart #8.

<table>
<thead>
<tr>
<th>#8</th>
<th>Realism - Laws are facts. A scientific theory/model is a picture of the world, a literal representation of reality.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positivism - Only observations are “real”. A scientific law (or a theory) is a useful summary of past observations.</td>
<td></td>
</tr>
<tr>
<td>Instrumentalism - Laws are reliable. A scientific theory is a tool for predicting what will occur under certain circumstances. They're more than summaries, less than representations.</td>
<td></td>
</tr>
</tbody>
</table>

since they are two independent sources of God's revelation. This point of view creates the impression that our knowledge of nature is as it were automatically also a knowledge of God's revelation. Thus Schouten writes that the study of God's general revelation in nature has led to important discoveries concerning the age of the earth and that 'in his general revelation' God acquaints us with the form and measurement which he gave to the universe. However, this view ignores the fact that it will not do simply to equate the knowledge of nature with the knowledge of God's general revelation, for this revelation deals with the knowledge of God himself. In our opinion, therefore, it is wrong to say, as is sometimes done, that the natural sciences 'investigate' God's general revelation; and surely it is just as wrong to state that we owe our knowledge of God's revelation in nature primarily to the natural sciences. This, it seems to us, is a toning down of the idea and the reality of revelation, although that certainly is not intended. And we, of course, acknowledge wholeheartedly that it is our calling to investigate respectfully God's handiwork. **But the revelation of God in his works is a matter of God's self-revelation, and that is not apprehended first of all by scientific investigation, but through faith, as is evident already in the Psalms of Israel.** These psalms of praise are not based on scientific investigation; rather the God of salvation is praised in these hymns in all his greatness and glory. In general revelation we are not dealing with an independent source of knowledge; on the contrary, by faith we understand the act of divine revelation in created reality. The so-called nature psalms are not concerned with the concept ‘nature’ of the natural sciences; but they reveal the insight of faith into the works of God's hands. Consequently, the nature-psalms never deal with abstract aspects of cosmic reality, but rather with naive (in the good sense of the word) reality. That also accounts for the fact that in this outlook nature is never divorced from living history, in dynamic movement, as is especially evident in Psalm 33, but even in Psalm 104, that nature-psalm par excellence.” \[^{[boldface added.]}\]


-18-
Note that the latter two of these are more or less agnostic views toward reality. In the last, theories should be judged as more or less successful not as true or false. Osborn’s article ends by illustrating how the view you accept makes a huge theological difference when extended to religious belief, but we will stick with physical science.

*I refer those who are more interested in the history of these views to Moreland’s book. Though it may not be best for this purpose because he does not use the same terminology, it is available in the bookstore.*

There are major disagreements among Christians who have written on this subject, even among those who would call themselves Reformed - see for example quote #9 compared to quote #13. However, as Hearn says “Most scientists, like most Christians, are realists of one kind or another.” Assuming he is correct, the question becomes: Is this naivete or can this view be justified?

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41 Moreland sets up similar categories but uses the less traditional terms rational realism (“...holds that science progressively secures true, or approximately true, theories about the real, theory-independent world ‘out there’ and does so in a rationally justifiable way.”), rational nonrealism (“is a group of different views... ...instrumentalists agree that science is an objectively rational approach to the world. ...[and] that scientific theories are not true or approximately true descriptions of the theoretical entities, structures, or processes that underlie our observations. ...Rather, a scientific theory is a device or instrument that is justified by its utility, not its truthfulness.”), and nonrational nonrealism (“...nonrational nonrealists add to their rejection of scientific realism their view that rationality is not an objective, normative notion.”). *J. P. Moreland, Christianity and the Nature of Science* (Grand Rapids, Michigan: Baker Book House, 1989). pp. 139, 172, 194 - 195.


43 W. R. Hearn, *Being a Christian in Science* (Downers Grove, IL: Inter-Varsity Press, 1997). p. 17. “Most people recognize science as the study of natural phenomena by observation and experimentation. Scientific explanations are best characterized as simple chains of cause-and-effect restricted to physical (i.e., secondary or proximal) causes and thus excluding primary, ultimate or supernatural causes. To a theist who trusts in God as both beyond nature and active within it, scientific statements can be only partial descriptions of the way the world works, not comprehensive explanations of the real world.

In *The Limits of Science* [(Berkeley: University of California Press, 1984) p.159] philosopher of science Nicholas Rescher concluded his argument concerning scientific realism this way: ‘Realism prevails with respect to the language of science (that is, the asserted content of its declarations); but it should be abandoned with respect to the status of science (that is, the ultimate tenability or correctness of these assertions). What science says is descriptively committal in making claims regarding “the real world,” but the tone of voice in which it proffers these claims is (or should be) provisional and tentative.’

Most scientists, like most Christians, are realists of one kind or another. Philosopher of science Larry Laudan [in *Science and Values* [(Berkeley: University of California Press, 1984) p. 104] cautioned that ‘scientific realism fails to offer a viable account of scientific values and aims.’ Though most people believe that science describes a real world, any human description of reality remains to some extent a distortion because of its incompleteness. Scientists seldom claim to understand the world as a whole. Each studies only part of the totality of reality.”
| #9 | “None of the treatments of scientific law is inherently any more Christian than the others.” |
| #10 | “...Christians like Gordon Clark and John Byl adopt Instrumentalism as an appropriate philosophy of science for developing a coherent Christian world view. |
| #11 | “...On the realist side are Christian thinkers like Del Ratzsch [who] argues that Christianity lends support to realism because, on a Christian view, God created us with sensory and rational faculties appropriate for a true knowledge of creation, including the unobservable aspects of creation. |
| #12 | “...we are not forced to choose one option or the other. I see no reason why one cannot adopt an eclectic approach to science that adopts a realist/anitrealist view on a case-by-case basis.” |
| #13 | “Scientific laws are man-made representations or attempted representations either in word or mathematical symbols of the personal God's constant patterns of operating his creation.” |

Once again, to sort this out we should begin not in the laboratory but in the Scriptures. On this particular issue it is full appreciation of the biblical doctrine of providence that informs our understanding of the nature of scientific laws. Some of the relevant passages are: Col. 1:16ff, Heb. 1:2ff, Neh. 9:6. In these the existence of the physical creation is seen to depend upon God on a moment-by-moment basis. Even the most common things are the subjects of God's constant care and control (cf. Prov. 16:33 and Luke 12:24, 28). Therefore we claim that our observation of a “rational, ordered cosmos” (see Davies quote, above) is due to His covenant faithfulness (e.g. Gen. 8:22, 9:1-17) not “clockwork” mechanism. The article by Vern Poythress in your handout package applies this doctrine to this issue.44 His conclusion is summarized in quotation #14 on the overhead:

| #14 | “We must understand the comprehensive character of God's sovereignty. ... [The] lawfulness of events in the physical and biological world... is the exhibition of God's faithfulness and his constancy of purpose. God rules all things by his word (Ps. 147:15-18; Heb. 1:3). The only real ‘law’ is not scientific law but God's word.” |
|    | Vern S. Poythress, 1990, “Christian-theistic Transfiguration of Science” |

Giving this concept a major place, but also considering some other implications of our presuppositions, I believe the best definition of scientific law that I have seen is Ream’s (quotation #13, above).45

(e) Distinction between Observations and Interpretations

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Proper discernment regarding scientific statements is often hindered by confusion of observations and interpretations of those observations. (When I release my pencil I observe it fall to the table top. I do not observe the law of gravity.) Note how these two categories are distinguished in the definition (see quotation #13 above) given by Ream:

“constant patterns” - What we observe God doing. The data collected in an experiment are our attempts to record these patterns.

“representations” - Our attempts to summarize and organize what has been observed.

I believe that this is a strength of the definition: it makes it obvious that human creativity is deeply involved in the development of a scientific law. (In any definition we might consider for “theory” it would be even more involved.)

*I realize the distinction I am pointing out here may not always be as clear as this implies.* 46 If this comes up in the discussion I have another brief reading for the class which presents a more sophisticated a three-level hierarchy. 47 However that is not germane to my purpose here.

We expect as a consequence that a scientist’s own world-view will affect the “laws” that he or she formulates to some extent. A little more subtly, the world-view as well as the representations it allows will also influence directly which data of all those possible the scientist will chose to collect to begin with and thus have available to be developed into subsequent scientific laws. I introduce this because it raises questions about how to receive the information presented to us by non-Christian scientists. To what extent have their rebellious attitudes toward God affected the laws that they have formulated to describe his works? I believe a proper answer depends upon a proper understanding of the doctrine of common grace, which is an aspect of several of the presuppositions on Ream’s list. God graciously continues among all mankind, regenerate or not, the ability to make certain reliable observations. (But see Maatman’s understanding of this in your handout.) 48 As a believer, I do not expect to find a different product from the combustion of carbon in air than Lavoisier did nor even a different crystal structure for DNA than Watson and Crick. We accept these as gifts from God. We are recognizing what is

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46 For example Moreland concludes: “the observation/theory distinction, though difficult to specify precisely, is still correct and is best viewed as a continuum - clear cases of observation and theory can be identified at each end, and there are several borderline cases in the middle where the line cannot be drawn”. Ibid., p. 204.

47 From James Hofmann (Philosophy Department, Cal. State Univ.- Fullerton) extending Bogen and Woodward’s work [see: J. Woodward,”Data and Phenomena” in Synthese 79, 393-472 (1989) and J. Bogen and J. Woodward, “Saving the Phenomena” in The Philosophical Review 97, 303-352 (1988)]. The categories are:

“Data” - The more or less direct results of observation and measurement, i.e., the “raw” products of experimental procedures or field observations (such as the position of a planet at a given time, relative to fixed stars). Data can be described as scientific “facts”.

Phenomena - Phenomena are inferred from patterns of data, and thus cannot be straightforwardly observed. Kepler’s laws of planetary motion, for instance, are phenomena inferred from a large body of observational (astronomical) data. Phenomena may also be called “facts”, but they are far more complex than data.

Theories - Theories provide explanations for phenomena. Newton’s theory of gravitation explains the phenomena of Kepler's laws of planetary motion and Galileo’s law of falling bodies. Theories are not facts.”


properly ours although presently held inconsistently by others, providentially waiting for us, by analogy with Deut. 6:10f. I see this as a case of the principle that there is no truth that is not Christian truth. Calvin is often quoted in this context:

“... let that admirable light of truth shining in them teach us that the mind of man, though fallen and perverted from its wholeness, is nevertheless clothed and ornamented with God's excellent gifts. If we regard the Spirit of God as the sole fountain of truth, we shall neither reject the truth itself, nor despise it wherever it shall appear, unless we wish to dishonor the Spirit of God.” (Institutes, II, ii, 15)

In fact he applies this view specifically to physical science in the next section:

“But if the Lord has willed that we be helped in physics, dialectic, mathematics, and other like disciplines, by the work and ministry of the ungodly, let us use this assistance. For if we neglect God's gift freely offered in these arts, we ought to suffer just punishment for our sloths.” (Institutes, II, ii, 16)

Of course there are difficulties, even dangers, in this. In many areas we must distinguish between false interpretive models that do not represent God's working and valid ones that are providentially waiting for us to redeem for God's glory.

I hope that you will be realizing more and more that this kind of discernment is just as important when you are reading a news article on ecology as it is when reading our textbook. For example, we may revise the introductory chapter of the chemistry text to use a more truthful (at least in the sense of more complete) definition of the science of chemistry. I suggest that the best definition is the composite:49

Chemistry is that field of activity wherein mankind, in response to God, attempts to understand God's constant patterns of operation for the composition of matter and for changes in the composition of matter, to the glory of God.

*I trust that we agree that fulfillment of this hope for discernment is a major goal of the science core requirement here at Covenant College.*

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49 This is a synthesis of the terminology used in Ream's definition of scientific law (given above) and a definition of chemistry written in Dooyeweerdian terms by Charles Adams, *Chemistry and the Kingdom of God: syllabus for Grade 11 Chemistry*, (North Haledon, NJ: Eastern Christian High School, 1975).