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Title of Study: THE THEMATIC APPROACH TO THE TEACHING OF NATURAL SCIENCE

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Major Field: Natural Science

Scope and Method of Study: This report involved the organization of an advanced course in the natural sciences for a limited number of junior and senior high school students selected on the basis of general academic achievement, achievement in previous science and mathematics courses, and interest. Many of the basic theories relative to cosmogony and evolution were utilized throughout the course. Such topics as interstellar gravitation, star evolution and transmutation of elements, physical and historical geology, and chemical and biological evolution were assigned places of prominence in the study. Furthermore, certain topics from School Mathematics Study Group algebra, trigonometry, and geometry were used as background material for the study of the natural sciences.

Findings and Conclusions: A review of pertinent data revealed that certain traditional science courses--especially physics--are losing their places as separate high school courses.

An advanced unified course, taught thematically, will provide more meaningful experiences than the traditional science courses. Such a course as the one proposed in this report would require very careful and thorough preparation on the part of both teacher and student. After a year's experimentation with the "thematic approach" as presented in this report, an attempt will be made to suggest how it can be used in the teaching of the traditional high school science courses.

ADVISOR'S APPROVAL James H. Zant

THE THEMATIC APPROACH TO THE TEACHING OF NATURAL SCIENCE

by

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NATURAL SCIENCE

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PREFACE

As a consequence of the ever-increasing emphasis being placed upon the natural sciences--both biological and physical--many of our nation's schools, from elementary to university level, have initiated plans to re-evaluate their curricular offerings in the light of present and future demands. In a large number of these schools the entire science curricula are in the midst of a revolution in which many changes are being made not only in the content of the courses but also in the methods by which these courses are being taught.

The purpose of this study is to outline a Science Survey course in which the "Thematic Approach" (which makes use of the various principles of cosmogony and evolution) will be utilized.

I believe, that such an approach will give more meaning to the study of secondary school science and will bring into sharp focus the interdependence of the various branches of natural science.

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CHAPTER I

INTRODUCTION

Manual Training High School, the institution for which this experimental course is being designed, is located in Muskogee, a northeastern Oklahoma city with a population of approximately 40,000. The school is organized on the 9-12 plan and currently enrols six hundred-thirty students who are taught by twenty-nine teachers, six of whom teach natural science and/or mathematics.

For the sake of clarity, it should be pointed out that the name "Manual Training High School" should not be taken literally. Although the school has what is reputed to be a very outstanding vocational program, twenty-two (22) of the twenty-nine (29) teachers devote full time to instruction in the "academic courses".

The diversification of courses--both academic and vocational--meets a very definite need since approximately forty per cent (40%) of our graduates attend college and a major portion of the other sixty per cent (60%) seek employment after graduation.

Pertinent data concerning pre-enrolment in mathematics and science courses for the 1962-63 school term are in the following tables.

TABLE I

PRE-ENROLMENT OF STUDENTS IN MATHEMATICS COURSES IN THE SCHOOL YEAR 1962-1963, MANUAL TRAINING HIGH SCHOOL, MUSKOGEE, OKLAHOMA

Courses	No. of Units	Grade Level	Pre-Enrolment
Algebra I (SMSG)	1	9	68
Algebra I (Traditional)	1	9-10	62
Algebra II (Traditional)	1	9-10	28
Plane Geometry (SMSG)	1	10	72
Trigonometry	$\frac{1}{2}$	11-12	18
Solid Geometry	$\frac{1}{2}$	11-12	18
Composite Mathematics	1	9	107
Totals	6		373

TABLE II

PRE-ENROLMENT OF STUDENTS IN NATURAL SCIENCE COURSES FOR THE SCHOOL YEAR 1962-1963, MANUAL TRAINING HIGH SCHOOL, MUSKOGEE, OKLAHOMA

Courses	No. of Units	Grade Level	Pre-Enrolment
General Science	1	9	174
Biology	1	10	111
Chemistry	1	11	48
Physics	1	12	26
Science Survey	1	11-12	25
Totals	5		384

Of the approximately 630 students who will be enroled in the school next year 373, or 59.0%, will be enroled in mathematics courses and 384, or 60.9%, will be enroled in science courses. (Actually, the percentage will be slightly less because a small number of students will be enroled in more than one mathematics or science course).

Manual Training High School is equipped with a combination chemistry-physics laboratory and a biology laboratory. Traditionally, science students in this school have spent two 60-minute periods in the laboratory and three 60-minute periods in "recitation" each week.

The contents of the foregoing paragraphs seem to indicate that the science program in the school is rather stereotyped and lacks the flexibility which would permit the utilization of the "Thematic Approach." However, there are other considerations which make the introduction of this new approach to science teaching highly feasible. Among these considerations are the following:

(1) The principal, who incidentally is a former science teacher, is highly enthusiastic about the possibilities of the "Thematic Approach."

(2) The author has been authorized to:

(a) Outline a Science Survey course in which the "Thematic Approach" will be utilized. The students comprising this class will be juniors and seniors selected on the basis of general academic achievement, achievement in previous science and mathematics courses, and interest in science and mathematics.

(b) Explore the possibility of using the "Thematic Approach" to a limited extent in the traditional science (general science, biology, chemistry, and physics) and mathematics courses.

Most of the students are products of four local elementary schools and a two-year junior high school, neither of which has an adequate science program. For this reason, as previously indicated, enrolment in the Science Survey course will be restricted to juniors and seniors who have completed ninth-grade general science, tenth-grade biology, first-year algebra (preferably School Mathematics Study Group) and the S.M.S.G. geometry. Furthermore, priority will be given to juniors who will be concurrently enroled in chemistry and to seniors who will have completed the chemistry course and who will be concurrently enroled in physics.

The following pages represent an attempt to accomplish the two-fold task of (1) outlining a pilot course in Science Survey in which the Thematic Approach will be highly utilized with a select group of students, and (2) outlining a scheme whereby the Thematic Approach may be used to a limited extent in the teaching of traditional science and mathematics courses.

CHAPTER II

THE MEANING OF SCIENCE

Realizing that many (if not all) of the students in this class will have a false or obscure impression of what science actually is, the course in Science Survey will be introduced by attempting to have each student see science in its proper perspective.

The introduction will take the following form:

I. A distinction between natural sciences and social sciences:

Natural Sciences	Social Sciences
Astronomy	Economics
Biology	Geography
Chemistry	History
Geology	Psychology
Physics	Sociology

(The class will discuss each of these sciences and subsequently will be directed to extend each list).

II. A definition of science.

Science is the human endeavor (attempt) to formulate the simplest logical and/or mathematical organization or systemmatization of those statements of experience that we can agree upon in common.

(This definition will be given prime importance, special emphasis being placed upon the understanding of the underlined terms. For example, it shall be pointed out that simplicity refers to (1) least number of assumptions, (2) no "ad hoc" assumptions, if possible, and (3) mathematical simplicity).

III. The scientific method

(a) Perception of problem

(b) Preliminary selective observation

(c) Formulation of hypothesis

(d) Testing of hypothesis (experimentation)

(e) Conclusion, or choice of workable solution of original problem.

The following films will be shown in this connection: "Scientific Method"[1] and "What Is Science?"[2].

IV. A discussion of certain philosophical principles (on the level of high school students)

For example---

Methods or Criteria of Knowledge, Meaning, Truth

(a) Habit or tenacity

(b) Traditionalism

(c) Empiricism

(d) Rationalism

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[1] "The Scientific Method," Encyclopaedia Britannica Films, (Chicago, 1958).

[2] "What Is Science?," Coronet Films, (Chicago, 1959).

(e) Aestheticism

(f) Pragmatism (utilitarianism)

(g) Intuitionism

(h) Authoritarianism

(i) Dogmatism

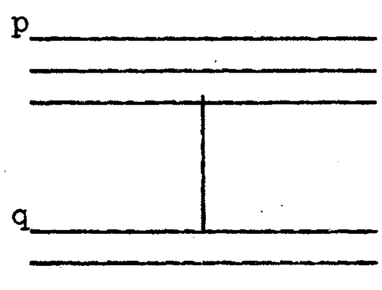
(j) Skepticism

(Each student will be requested to give definitions and examples of items a - j).

V. A distinction between "proof" and "verification."

(a) Proof is merely a "rational" operation.

(b) Verification means testing (with various types of instruments) conclusions which are reached on the basis of rationalization.



Statements (Assumptions)

-proof (rationalization)

Conclusion

Although "q" is verified, it does not necessarily follow that the assumptions in "p" are true. (This point will be discussed at length because the author believes that the development of an understanding of science depends upon its proper interpretation).

CHAPTER III

SOME BASIC MATHEMATICAL CONCEPTS

Realizing the important role which mathematics plays in all of the natural sciences--both physical and biological--the author proposes to devote a major portion of the first weeks of the course to reviewing and extending some of the more pertinent mathematical principles.

Among the areas to be studied are the following:

A. The Real Number System

(1) Natural Numbers and Zero

(2) Construction of Integers

(3) Rational Numbers

(4) The Number Line

(5) Order Relations

(6) Symbolism

(7) Equivalance Relations

B. Coordinate Geometry in the Plane

(1) The Coordinate System

(2) Three Useful Formulas

(a) Distance: $d(P_1, P_2) = \sqrt{(X_2-X_1)^2 + (Y_2-Y_1)^2}$

(b) Midpoint of $P_1P_2 = \left(\frac{X_1 + X_2}{2}, \frac{Y_1 + Y_2}{2}\right)$

(c) Slope of $P_1P_2 = \frac{Y_2 - Y_1}{X_2 - X_1}$, if $X_1 \neq X_2$

(Slope of P_1P_2 is undefined if $X_1 = X_2$).

(3) Parallel and Perpendicular Line Segments

(4) Curve Tracing (examples: $y = x^3 - 4x$, $x-y-1=0$, and $x^2 + y^2 = 4$).

(5) Analytic Proofs of Geometric Theorems

(6) Locus Problems

C. Linear and Quadratic Functions

(1) The Role of "m"

(2) The Role of "b"

(3) The Equation $x = c$

(4) The Quadratic Function

(5) The Function of $y = a\,x^2$

(6) The Function $y = ax^2 + c$

D. Quadratic Equations

(1) Formation of Quadratic Equations When Its Roots Are Known.

(2) Quadratic Inequalities

(3) Logarithms and Exponents

(4) Interpolation

(5) The Theory of Exponents

(6) Mathematical Induction

E. Introduction to Trigonometry

(1) Angles and Their Measures

(2) The Basic Trigonometric Functions

(3) Values of the Trigonometric Functions

(4) The Law of Sines and Cosines

(5) Trigonometric Identities

G. The System of Vectors

(1) The Development of the System of Vectors

(2) Force and Work in Physics

(3) Application of Vectors

(4) Vectors in 3-dimensions

H. Circular Functions

(1) Circular Motions and Periodicity

(2) Graphs of Sine and Cosine

(3) Uniform Circular Motion

(4) Vectors and Rotation

(5) Addition and Subtraction Formulas for Sine and Cosine

(6) Construction and Use of Tables of Circular Functions.

I. Ordered Geometry

J. Absolute Geometry and Hyperbolic Geometry

K. Polyhedra, Regular and Irregular

Certainly, time will not permit, nor will the nature of the course being outlined justify, an extremely detailed and exhaustive study of the topics enumerated above; however, the student will be unable to cope with the material which follows unless he has a rather good grasp of these mathematical concepts.

CHAPTER IV

COSMOLOGY

The author thinks it is pedagogically expedient that the class "examine" our Universe in its present state (cosmology) before launching into a detailed study of cosmogony. For this reason the first unit to be studied in detail is Astronomy.

I. The Earth

A. Shape (practically spherical): methods of determination

(a) Earth's shadow on moon

(b) "Distant star method"

(c) Other methods

B. Mass (6.6 x 10^{21} tons): methods of determination

(a) Gravity balance: $F = \frac{Gm_1 \times m_2}{r^2}$, or

$$m_2 = \frac{F \times r^2}{Gm.}$$

(b) Plumb bob (measuring mountain's deflection of pendulum bob from vertical)

C. Size (methods of determination will be investigated)

D. Density (calculated from mass and volume):

$$D = \frac{M}{V}$$

E. Study of other interesting facts concerning the earth.

II. The Moon

A. Shape (almost spherical); diameter (about 2160 miles); mass ($\frac{1}{82}$ mass of earth); density (3.3 gm/cm.^{3}); gravitational pull ($\frac{1}{6}$ that of earth).

B. When practicable, methods of determination of some of the above stated facts will be investigated and discussed.

III. The Sun

A. Distance from earth (average of 93,000,000 miles); density (1.41 gm/cm.^{3}); temperature (6000°K on surface and 20,000,000°K at center).

B. Methods of determination of the above stated facts will be explored and discussed; other important phenomena relative to the sun will be investigated, also.

IV. Our Planetary System

A. Relative positions of the nine planets with respect to our sun.

B. Pertinent information about each of the planets

C. Planetoids, comets, asteroids, meteors, meteorites

V. Astronomical Tools

A. Primary equipment

(a) Refractor telescopes

(b) Reflector telescopes

B. Accessory equipment

(a) Photographic plates

(b) Photoelectric cells

(c) Spectroscopes

(d) Thermocouples

(The class will be directed to procure information concerning the various types of astronomical tools from a variety of sources).

VI. The Stars

A. Stellar magnitudes (brightness)

(a) Apparent magnitudes

(b) Absolute magnitudes

B. Stellar Distances

(a) Parallax (for nearer stars)

(b) Cephied variables (the red shift)

(c) Novae (peak brightness)

(d) Blue super giants

VII. Stellar Systems

A. Clusters of stars

(a) Galactic star clusters

(b) Globular star clusters

B. Clusters of galaxies (complex organizations made up of stars, gas and dust, all of which are irregularly distributed).

VIII. Summarization of special topics pertinent to the study of planetary and stellar astronomy

A. Parallax

B. Hertzsprung - Russell Diagram

(a) Luminosity versus distance of individual stars

(b) Luminosity versis distance of extra-galactic nebulae

(c) Applications of the formula $I = \frac{I_o}{d^2}$

C. Black-body radiation and Planck's constant

D. Kepler's laws

(a) The planets move in ellipses, with the sun at one focus

(b) The radius vector sweeps out equal areas in equal times

(c) The square of the time of revolution is proportional to the cube of the mean distance--

$$\frac{T_1^2}{T_2^2} = \frac{R_1^3}{R_2^3}$$

E. Wien's law (The wave length of maximum energy is inversely proportional to the temperature).

Feeling quite confident that the foregoing preliminaries will have set the stage for a more detailed study of the theory regarding the origin of the Universe, the author shall now direct the attention of the class to an intensive study of the theories relative to Cosmogony and Evolution, a part of which appears in the following chapter.

In order to attain maximum results, the course will cut across the various fields of science (chemistry, physics, biology, et cetera) as the need arises. When expedient, the following will be utilized--the services of guest lecturers, field trips, and appropriate films.

CHAPTER V

COSMOGONY

According to an "authoritative source[3] the Universe some ten billion years ago consisted of a "substance" (Ylem), possessing extremely high energy-mass density, temperature and "radiant" energy. One conjecture is that Ylem was infinite "matter" occupying infinite space. (It should be pointed out that our most powerful telescope enables us to study the Universe for a distance of only 2×10^9 light years from earth; consequently, any statements made relative to the structure of the Universe at greater distances are highly speculative).

Two popular theories have been advanced to explain the dynamic nature of the Universe:

A. According to George Gamow's "Expanding Universe" theory[4], extra-galactic nebulae are receding from our galaxy at a rather rapid rate. Consequently, according to Gamow, the Universe is far different, spatially, from what it was thousands or millions of years ago.

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[3] George Gamow, The Birth and Death of the Sun. (New York, 1958), p. 197.

[4] Ibid, p. 197

B. According to Fred Hoyle's "Steady State Universe" theory[5], new galaxies are continually being formed to take the places of escaping ones. Consequently, as far as one is able to discern, it is essentially the same as it was millions of years ago. (This should not be construed to mean that our Universe is not expanding).

The class will be required to read detailed accounts of these two theories and to discuss their relative merits.

As background information for the investigation referred to in the previous paragraph, the class will distinguish between "finite" and "infinite". Under the discussion of "infinite", the following will be included:

A. Infinite series, from a mathematical standpoint.

B. George Gamow's comparison of infinite denumerable aggregates with infinite non-denumerable aggregates.

C. Theories concerning the shape of the "Faces" of the Universe.

1. Flat
2. Positively curved
3. Negatively curved

Now, back to Ylem! As was mentioned previously, the Ylem some ten billion years ago began to expand, consequently, to cool. As a result, the first particles--the hyperons--were formed. At this point the study of the "fundamental particles".

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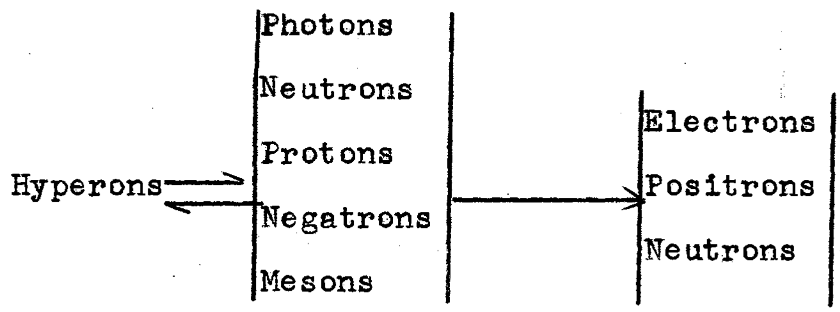
[5] Fred Hoyle, The Nature of the Universe (New York, 1955) p. 31

will begin. Specifically, the class will do the following:

A. Investigate current literature (science periodicals and popular books) and physics and chemistry texts in order to enhance their knowledge of the hyperons (lambda, sigma, and xi).

B. Discuss the following reactions:



Subsequently a detailed study of the theories relative to the origin and apparent properties of the fundamental particles will be made:

A. Protons
   (a) Mass.....1.6724×10^{-24} gm.
   (b) Positive charge.....1.6×10^{-19} coulomb.

B. Negatrons
   (a) Mass.....1.6724×10^{-24} gm.
   (b) Negative charge.....1.6×10^{-19} coulomb.

C. Photons
   (a) Proton + negatron $\rightleftharpoons$ 2 photons
   (b) Electron + positron $\rightleftharpoons$ 2 photons

D. Neutrons
   (a) Mass.....1.6724×10^{-24} gm.
   (b) Charge.......0

E. Mesons
   (a) May be positive, negative, or neutral.
   (b) Pi mesons are "glue" which helps keep the nucleus of an atom intact.

F. Electrons

(a) Mass..... 9×10^{-28} gm.

(b) Positive charge.....1.6×10^{-19} coulomb.

In conjunction with the investigation of the fundamental particles briefly described above such topics as the following will be studied:

A. Parity and anti-matter

B. Determination of the charge of the electron

(a) The oil-drop method

(b) The electrolysis method, utilizing Faraday's constant and Avagadro's number.

C. The cloud chamber method of making the paths of ions visible.

D. Coulomb's law-- $F = \frac{e_1 e_2}{r^2}$

E. Michelson and Morley's experiment designed to detect "ether".

F. Einsteins' famous equation, $E = mc^2$

G. The wave theory of light

H. The quantum theory of light, formulated by Planck

I. L. de Broglie's "fused" Einstein-Planck equations:

$$N = \frac{h}{mc} \quad \text{and} \quad N = \frac{ah}{mv}$$

At this stage the class will be directed to make a preliminary study of the structure of the nuclei of the atoms of some of the lighter elements--especially those of hydrogen and helium. Preliminary studies, or reviews, of such topics as isotopes and temperature scales (including the mechanics of conversion) will be made. Students will be referred to The

Periodic Chart of the Atoms (Welch), The Periodic Chart of the Elements (Fisher) and the Chart of the Nuclides.

According to Gamow[6], the Universe, after a long period of expansion and cooling had reached a temperature of 6000° K at 2×10^5 years past "zero" time and at 2.5×10^8 years past "zero time" the temperature had dropped to 173° K or -100° C. At this stage matter density, for the first time since zero time exceeded radiant energy density. This represented the critical point in the evolution of the Universe because, for the first time, the elements hydrogen and helium were able to condense and eventually give rise (either directly or indirectly) to the other elements. As the result of this condensation, proto-nebulae were formed.

This brings the class to the point at which they will be directed to check references for descriptions of the "hypothetical" plasmoids and to begin a rather detailed study of electricity and magnetism. The study of these two topics is quite necessary if the students are to understand the activity of the plasmoidal gases and attraction and repulsion, in general.

Study will include:

A. Magnetism

B. Static electricity

C. Current electricity

D. Relation of chemical action to electricity

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[6] Gamow, p. 162

E. Electromagnetism

F. Electrical measuring instruments

G. Power generation and use

Following the study of electricity and magnetism, the class will return to the fields of astronomy and cosmogony for a re-look at the various types of galaxies--spiral, elliptical, spherical-and theories which explain their formation. Subsequently, a study of the phenomena relative to the condensation of stars from nebular gas-populations I, II, and "intermediate" will be made.

This spot represents an ideal place to review the law of gravitation. This will include the study of such topics as center of gravity, paths of bombs and projectiles, and the pendulum.

References will be checked in order to determind, with some degree of security, how "giant" stars become "Dwarfs", and how the inner cores of stars synthesized various elements.

A rather comprehensive study of energy will be resumed at this time and application of the equation $E = mc^2$ will again be made in the interpretation of such equations as the following:

$$4H_{1.0080} \longrightarrow He_{4.003} \quad \text{(energy)}$$

(4 x 1.0080 = 4.032; 4.032 - 4.003 = .029; hence .029 u.a.w. (unit atomic weight) is converted into energy).

The equations below, representing possible nuclear transformations which take place in the interior of stars, will be studied and discussed:

(1) $_{1}D^{2} + {}_{1}H^{1} \longrightarrow {}_{2}He^{3}$ + radiation

(2) $_{3}Li^{6} + {}_{1}H^{1} \longrightarrow {}_{2}He^{4} + {}_{2}He^{3}$

(3) $_{3}Li^{7} + {}_{1}H^{1} \longrightarrow {}_{2}He^{4} + {}_{2}He^{4}$

(4) $_{2}Be^{9} + {}_{1}H^{1} \longrightarrow {}_{3}Li^{6} + {}_{2}He^{4}$

(5) $_{5}B^{10} + {}_{1}H^{1} \longrightarrow {}_{6}C^{11}$ + radiation

(6) $_{5}B^{11} + {}_{1}H^{1} \longrightarrow {}_{2}He^{4} + {}_{2}He^{4} + {}_{2}He^{4}$

Nuclear chain reactions, involving the atoms of some of the heavier elements, will also be studied:

(1) $_{92}U^{238} + {}_{0}N^{1} \longrightarrow {}_{92}U^{239}$ P gamma ray

(2) $_{92}U^{239} \longrightarrow {}_{93}N_{p}^{239}$ + B-

(3) $_{93}N_{p}^{239} \longrightarrow {}_{94}Pu^{239}$ + B-

(4) $_{94}Pu^{239} \longrightarrow {}_{92}U^{235} + {}_{2}He^{4}$

A rigorous investigation of theories relative to the structure of atoms and "atomic activity" will be made; included in this investigation will be:

A. Dalton's Atomic Theory

B. The Bohr-Rutherford Atom and the Lewis-Langmuir Atom

C. The Heisenberg Indeterminancy Principle

D. "K" Capture

E. Quantum Theory of Valency and Pauli's Exclusion Principle.

A re-examination of Spectrum, Electromagnetic Radiation, and Nuclide charts will be made.

According to Fowler,[7] during the latter stages of the evolution of the Universe the interstellar gases (dust) began to gravitate and to form the so-called proto-planets, proto-satellites, comets, and meteors. The "dust" consisted of such substances as hydrogen, helium, iron, calcium, ice particles and simple compounds. Mention of simple compounds suggests that certain chemical reactions must have preceded the formation of the bodies referred to above.

At this stage, an intensive study (and review) of chemical reactions involving inorganic compounds will be made; examples are shown below:

(1) $2H_2 + O_2 \longrightarrow 2H_2O$

(2) $N_2 + 3H_2 \longrightarrow 2NH_3$

(3) $Ag_2SO_3 + CaCl_2 \longrightarrow CaSO_3 + 2AgCl$

(4) $2K + 2H_2O \longrightarrow 2KOH + H_2$

(5) $4Al + 3O_2 \longrightarrow 2Al_2O_3$

(6) $FeS + H_2SO_4 \longrightarrow FeSO_4 + H_2S$

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[7] William A. Fowler, <u>The Origin of the Elements</u>, (New York, 1957), p. 19

Special attention will be given to oxidation-reduction reactions.

After completing this section, the class will check theories which propose to explain the formation of planetary systems. Von Weizsacher's "nebular" theory, perhaps the soundest of all, will claim most attention.

CHAPTER VI

A BRIEF STUDY OF PHYSICAL AND HISTORICAL GEOLOGY

With the conclusion of von Weizscher's "Nebular" theory dealing with the formation of planetary systems, the class sould have a fairly good idea of how its planet--the earth--could have been formed.

In its prior deliberations the class will have covered a period of approximately 5×10^9 years (the age of the earth is postulated to be between 3×10^9 and 5×10^9 years). Many years (billions) transpired before the earth was able to support life; consequently, the class will devote its immediate attention to the science of geology--both physical and historical--in order that it might gain insight into how the earth may have evolved from its primordial (primitive) state into its present form.

The class will first take a rather close look at the earth as it is now (physical geology) before studying historical geology (reserving the paleontological section until later, keeping in mind that there is no sharp line of demarcation separating the two). This is in agreement with the plan whereby cosmology was studied before cosmogony.

Some of the phases of physical geology to be studied are:

I. Materials of the earth (atoms, elements, compounds, isotopes)

II. Igneous rocks

III. Weathering and soils

IV. Sedimentary rocks

V. Mass movement of surface materials

VI. Glaciation

VII. Work of the wind

VIII. The oceans

IX. Mountain building

X. Earthquakes and the earth's interior

XI. Igneous activity and metamorphism

After completing the section on physical geology, the class will launch into a not-too-detailed study of certain historical aspects of geology (paleontology will be deferred until the work dealing with the origin of life is completed). The chief concern will be land-water distributions and types of formations associated with the various eras. A brief description of these eras follows:

Eras (years x 10^6 since era began)

AZOIC (5000)

Formation of earth (and moon) and our solar system. Pre-life: carbon compounds with hydrogen, nitrogen, iron, magnesium, oxygen, give rise to amino acids via volcanic heat, sunlight (ultraviolet), lightning. Subsequently, polypeptides were formed; these in turn, gave rise to helical primal proteins, nucleic acids, colloids, and nucleo-proteins.

ARCHEOZOIC (1,500)

Primal life: during this era, virus forms, bacteria, protozoa, and algae were formed.

PROTEROZIC (925)

Primitive marine invertebrates, were formed, very few fossils from this era exist.

PALEOZOIC (550)

Periods:

- Cambrian (55) - Trilobites, shelled invertebrates
- Ordivician (480) - Armored jawless fish, first land plants
- Silurian (390) - "Lung fish"
- Devonian (35) - Amphibians
- Mississippian (300) - Culmination of echinoderms, ancient sharks
- Pennsylvanian (25) - Primitive reptiles and insects
- Permian (215) - Modern insects, land vertebrates, mammal-like reptiles

MESOZOIC (190)

- Triassic (190) - Rise of dinosours, simple rare mammals.
- Jurassic (155) - Dinosours, flying and swimming reptiles, birds, small mammals
- Lower Cretaceous (120) - Flowering plants

Upper Cretaceous (95) - Specialization and extinction of dinosours, rise of archaic mammals.

CENOZOIC (55)

Tertiary Period

Epochs:

Paleocene (55) Spread of archaic mammals, lemurs, rise of modern plants.

Eocene (45) Evolution and extinction of archaic mammals, primitive horse (eohippus)

Oligocene (35) Rise of higher mammals

Miocene (19) Early monkeys and apes

Pliocene (7) Ape man to primitive man

Quarternary Period:

Pleistocene (1)-- "Ice Age", evolution of man, extinction of great mammals.

Holocene (40,000 years ago) (Recent)

Neolithic--Homo-sapiens (modern man) flourishes

Historic (7,000 years ago)-- Rise of civilization

A brief study of organic chemistry will be made in connection with this area. Some of the topics to be considered are:

A. General principles of organic chemistry

B. Saturated hydrocarbons

C. Unsaturated hydrocarbons

D. Aromatic hydrocarbons

E. Alcohols and phenols

F. Ethers

G. Fats and oils

H. Carbohydrates

I. Amines, amino acids, and proteins

J. Optical isomerism

K. Polymerization

CHAPTER VII

CONCLUSION

The foregoing pages represent an effort to outline a pilot course in Science Survey, utilizing the thematic approach. It is quite conceivable that certain minor revisions will be made in the outline as the course gets underway; however, generally speaking, it is believed that the outline, in its present form, will serve purposes for which it is intended.

An attempt has been made to maximize the importance of the chronological aspect of the course by using brief commentaries to show the temporal as well as the logical connection between various sections of the outline. This is considered very important.

Having been assured administrative cooperation and the caliber of students who are capable of making the necessary adjustments, it is fully expected that the Science Survey course, taught "thematically", will provide for more meaningful, stimulating, and rewarding experiences than could be realized in the traditional science courses.

After a year's experimentation with the thematic approach in the Science Survey course, it is expected that the school will be in a much better position to recommend its use in other areas.

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