Waldorf Science

Explorations in Phenomenology as Practiced in Waldorf Schools

A Science News Roundletter

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NOTE FROM THE EDITORS

As Waldorf Education becomes more recognized in North America and the demand for schools increases, there is an ever-expanding need for curriculum sharing, especially in the sciences. In an attempt to partially meet this need we would like to produce this science newsletter twice a year and send it gratis to every school that has classes above 6th grade.

This initiative will succeed only if there is a response from the schools. It will continue only if there are individuals in every school willing to contribute.

It is our intention to offer articles relevant to science teaching grades 5 through 12. We hope to stir debate about teaching methods, offer advice to new teachers, and to bring about a deepening of the science curriculum in all our schools. Also, we want to highlight research being undertaken on the basis of Anthroposophy.

We are grateful to Klaus Schickert the editor of *Erziehungskunst* for sending us articles from his magazine on science that have been published during the past seven years. We will translate these articles and offer them as part of the future Newsletters.

So, if you think this initiative is valuable and you would like to see it continue then please participate.

We look forward to hearing from you.

UPCOMING CONFERENCES

Jennifer Greene reports that in the summer of 1996 a conference entitled *"Boundaries, Surfaces and Membranes"* is being planned for Teachers, Doctors, Priests and Scientists.

Dennis Klocek will be heading a conference at Guadalupe River Ranch in Boerne, Texas on April 14-16. Working with specific places in nature the conference is titled *The Easter Imagination and the Eternal Feminine*..

Arthur Zajonc will be leading a conference January 20-21 in Los Angeles, CA entitled *Catching the Light: The Entwined History of Light and Mind.*

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RESOURCE NEEDS

In this space the editors hope that individuals and schools will write to us so that we can list the resources that you are looking for your teaching or research.

CURRENT RESEARCH

The Future Values Fund of the Anthroposophical Society in America is considering grants to the following individuals for the upcoming year:

Barbara Booth – Nature studies, learning to read the landscape: The Schooling of Perception.

Patti Corgine – Peat Fiber, research and textile project.

Jennifer Greene – The drop picture method in water research.

John Hoffman – Peripheral etheric forces in plants.

Ronald Milito – Threefold patterns in human anatomy, histology, physiology and biochemistry.

Mark Riegner – Goethean /.Anthro-posophical perspectives on evolution and ecology.

Michael Soulé & Joeseph Greif – Furthering practical applications of living water research.

Thomas Wilkinson – Research on buds and budding.

Ralph Marinelli – research on the heart and blood propulsion.

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SCIENCE IN GRADES 6, 7, & 8

There are five sources of preparing for Science Main Lessons:

1. Your own experience in the world.
2. Scientific books and articles.
3. The character and development of the children you will teach.
4. Dialogues with your colleagues.
5 Rudolf Steiner's lectures and the work of his students.

An inwardly sure presentation of science in grades 7 & 8 strengthens the waning authority of the class teacher and becomes a basis for developing moral security in the children. The children must develop a healthy relationship between thought and action.

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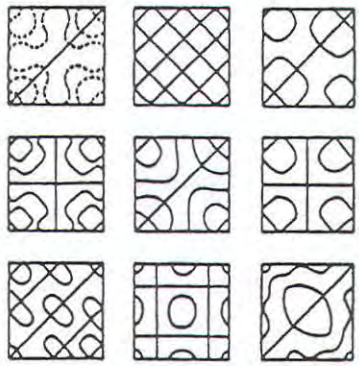
ACOUSTICS IN GRADE 6

(Ernst Chladni (1756-1821) studied the questions of sound and physics on metal plates upon which was sprinkled a powdery medium. The plate was then bowed like a violin until a tone arouse. The tone made the medium dance and form a pattern. Chaladni discovereed his figures in the same year that Goethe "discxovered" his "*Urplanze!*")



Chladni plates show the tone working into the physical. Finely sifted sand, glass, salt, or Semolina can be spread evenly on the plate with a salt shaker. A bass bow is best for bowing. First a vague shape will appear. When the Chladni plate is held at the right distance from the bowing (and the plate is fixed at the center) a clear six pointed star appears. Held closer to the bow, a four pointed star, and even closer a two-pointed star appears. One can show how a clear tone produces a clear form, an un-clear tone, a vague form. Later one can touch on sounds that are just noise: splintering of glass, crunching of wood, the clatter of nails falling on the floor, etc. This can be compared with the disintegration of music. The teacher can teach acoustics so that the children feel a recognition that deep tones lead into the will and sleep are incarnating and have qualities of peace and strength. High tones lead to greater consciousness and can lead to excarnation, they have the qualities of movement and consciousness. Each tone has meaning only in relationship to others; every tone points to the next; the quality of a tone relates it to others, How does man experience it? It is important to start from this point rather than the abstraction of vibrations. The octave involves a relationship of 1:2, the sixth of 3:5, the fifth of 2:3, the fourth of 4:3 or 3:4, the third (major) of 4:5, the second of 8:9, the seventh of 8:15. For the Greek civi-lization, music was an example of the harmony that rules throughout the world. Intervals are relationships of movement, and when the octave was divided (by Bach) into 12 equal parts, a compromise was made. We find C-D is 8/9ths of length, as is D-E. Thus CE should be 8/9 X 8/9 = 64/81 =1:1.266, but the third (4:5) is 1;1.25. Is this the end of true music? There has been a move from time relationship to more of a space relationship. There are three aspects of the number relationships of tones which the teacher can bear in mind:

1. The level of musical development.
2. The origin of rhythm.
3. The expression of relatedness.

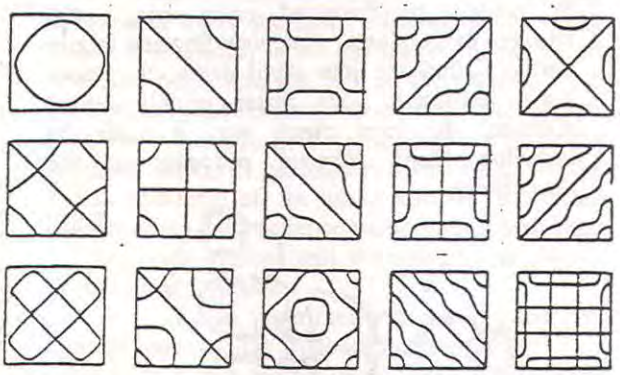
In our scale only the octave is uncompromised. But there is a relationship between the 12 tones, the twelve systems of the body and the 12 signs of the Zodiac.

The question of causality arises with the Chladni plate figures. It is common in conventional science to attribute the cause of one phenomenon to another phenomenon; but, the question arises, what, in turn, was the cause of that? Science likes to put cause into the natural world, but in fact the natural world provides **conditions,** not causes. The real cause is always human.

It is the holding of the Chladni plate that causes the form to appear. The sand, glass, salt or Semolina keeps still in certain places. The arising of a tone brings with it the form. A good musical tone like that of a violin is not yet fully understood by science. Steiner suggested the human larynx as a conclusion to this Main Lesson, but how does one bring this in? It should not be dealt with anatomically. One can point to the difference in tone between the animal world and the human. Vowels are a bridge between speech and song. In human speech and song there is a harmonious interplay between lungs, breath and sound. During this Main Lesson, there should be awakened in the children, at a feeling level, a recognition of the divinity of the origins of sound.

(Adapted from **Goethean Science in the Waldorf Curriculum** a study conference for class teachers held in Kassel, Germany in 1978 and led by Manfred von Mackinsen and Wolfgang Schad)

(Arthur Auer from the Pine Hill Waldorf School has advised the editors of two noteworthy articles on Chaladni Plates. One comes from *Scientific American* , October 1981, and is an article by Carleen Marley Hutchins entitled "*The Acoustics of Violin Plates*". The second is a classic work published in London by G. Bell and Sons Ltd. in 1961 by Mary Désirée Waller called, ***Chaladni Figures – A Study in Symmetry.***)



TEACHING ABOUT ALCOHOL IN GRADE 8

(The seventh grade Chemistry deals with combustion a subject which gives the teacher an opening to discuss the dangers of cigarette smoking. The eight grade Chemistry presents the teacher with a wonderful opportunity to speak about alcohol.)

We have all seen a grape vine. It is a climbing plant and is very exuberant. As it grows it shoots out tendrils which can grab onto trees, fences or houses. It appears to constantly pull itself close to the sun.

Its roots go deep into the soil and exerts great pressure to draw as much water up as it is able. If you cut a vine in the spring you could have a 10 foot column of sap squirt out.

The grape plant likes water and sunshine and lots of time to grow. This water and sunshine creates a powerful interplay of fire and water within the clusters of succulent grapes which form as fruit.

We see the water in the swelling of the grape. We taste the fire (sunlight) in the grape's sweetness. The more southern the location of the grape plant, the more sun it gets, and the sweeter the grape becomes.

After the grape has achieved ripeness a bacteria on its skin causes it to change. This change is called fermentation. As the grape ferments CO2 escapes. The sweet taste is replaced by a fiery one. What was formerly calm and nourishing now whips up. the senses and overheats us in its form of alcohol.

Sugar from the grape is taken immediately into the blood stream. Alcohol enters still faster – not even the liver acts as a barrier. When we drink the alcohol it spreads immediately and unhindered throughout our whole system and has an effect on our thinking and motor skills.

The gift from the grape as sugar is real. That received from the alcohol is an illusion. Sugar furnishes a base for our willing which gives us mastery over our body. Alcohol creates the feeling that we can do anything we like although it does not increase our capacities.

Sugar develops warmth in our stomachs. Alcohol overheats us. Instead of stimulating our forces, it creates as desire to bluff and make exaggerated demands.

Alcohol remains within our body for two weeks after we have tasted it. It stimulates us and makes us want to drink more. Anyone who drinks more than once in a two week period over an extended period of time is called an

alcoholic. One out of every five teenagers who drink are alcoholics. Alcoholism is considered a disease. It will slowly destroy your liver, and the activities of a drunk ruins many families and friendships.

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HUMOROUS PLAY / POEM FOR 7TH GRADE CHEMISTRY

(based on Lewis Carroll's *Jabberwocky*)

T'was smoky and the 7th grade Chemists
Did combust and explode in their lab.
All dirty were the test tubes,
And the air smelled pretty bad!

Beware the Carbon atom, my class!
The molecules that form, the vapors
that come to pass.

Beware the mixtures which rumble and grow
Observe them in detail and note
where they go!

She took her notebook in her hand
Eyes open in expectant gaze

Nose prepared for an unexpected smell
All ready for Sulfur's noxious ways.

He took his flint and steel in hand
Thrice he struck the hissing gas

Then rested he by the Erlenmeyer Flask
And waited for the explosion to pass.

One two! One two, O what a feat
The Phosphorus blazed with a white hot
heat.

As the energetic chemists made their case,
The litmus detected the acid from the base.

And, as in ulffish thought he stood
Carbon, embers, & ash appeared
from the wood

Crackle, pop, sizzle, hiss, and bang,
Then came a cheer from the
assembled gang

Organic was the crinkly brown leaf
And inorganic was the rock.

Oxidation brought an explosive relief
While Hydroxide cleaned the dirty sock!

And hast thou learned the formula right?
Come to my arms, my scientific boy!

O Bunsen burner day! sediment, and precipitate,
He chortled in his joy.

T'was smoky and the 7th grade Chemists,
Did combust and explode in their lab.
All dirty were the test tubes,
And the air smelled pretty bad

– DSM

WATER

Water is perhaps our most valuable and least respected resource. It is a deceptively simple substance. Consisting of two atoms of hydrogen joined to one of oxygen, who could imagine that something so simple would have so many of the properties essential for life?

Water molecules are held together by a powerful attraction to each other. Most molecules the size of water separate from each other to become gases at temperatures required for life. Fortunately, this attraction keeps most water liquid, making lakes and oceans possible.

This same attraction gives water surface tension, the property which causes droplets to hold together and form the oval shape found in rain droplets. Too the botanist, this "stickiness" of water molecules is important because it allows plants to move water through the microscopic water-conducting tubes (called the xylem) in vascular bundles in the stems. Water is pulled, not pushed through great distances under tremendous tension and yet the column doesn't break. Without this property there would be no land plants.

Water molecules also attract other kinds of molecules. Water is a great solvent, dissolving myriads of organic molecules. Otherwise, water would lack the necessary ingredients of life. All plants get their dozen or so essential minerals dissolved in water. This attraction has a negative aspect, because water also attract pollutants and can easily become contaminated because of its love to join with everything. This is one of the great hazards of our time.

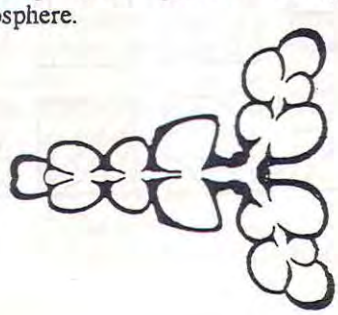
What would happen if water didn't have the capacity to dissolve gases as well as solids? There would be no carbonated beverages; there would be no oxygen in the ocean and seas and thus all aquatic life would cease. Without them there would be no bacteria, no plankton, or no fish.

Water is almost always moving. Inside tissues, it moves molecules around in sap, blood and other fluids.

Food is transported to cells and organs in water and they excrete their wastes into water.

Rain also carries many things within it. In addition to dissolved gases, rain brings nitrogen to the plants. The New England farmer always called the late April snow, the "poor mans fertilizer". This water soluble nitrate nitrogen, the form plants use, is made by lightning from gaseous nitrogen in the atmosphere.

– DSM



THE CHEMISTRY CURRICULUM:

THE DEBATE OVER TEACHER DEMONSTRATION VS. STUDENT EXPERIMENTATION

(The following is excerpted from a special seminar held in Spring Valley in the summer of 1993 with Manfred von Mackinson at a conference for science teachers entitled *Phenomena& Concepts in Science and Math* .)

Allowing students to experiment in the 8th grade corresponds with the main lesson teacher having exhausted himself or can not bring strong beautiful experiences through his own experimenting. On the other hand, however, at this age the students are lively and want to try out the world, but they are prone to do things which are on the boundary of morality. So, there is a demand hor "hands on" which we need to both meet and guide.

The main lesson should lead to experiences of individual thinking. In an individual fashion you are allowed to struggle with something and you are not afraid to look into the unknown.

The first step in this process of really meeting the world takes place in the demonstration of experiments. The next step is to review the experiments. Here one looks not for objective descriptions, but rather for experiences and feeling. Why *is it beautiful*? The will enters the feeling and brings the feelings to expression. The next step is for the students to carry the experiment into their sleep. The next day the teacher has the task of bringing the previous day's experiment into the realm of ego activity of the students. Only the ego can bring balance between thinking and feelings.

For example – describe an amethyst. In it is such a blue that it takes us into the blue of the stone (any blue pulls us into it, whereas orange comes toward us) The fifth grader can experience this. They are seeking for higher connections.

All our experiments should be constructed so that they have contradictions, whys(?) and create a sense of surprise. Your teaching becomes better the more difficult the questions are. The teacher is not any more the helper, but should hold back and call on the students for a response. The students should feel the obligation to **know** something. If the teacher can guide the lesson into problems that are open ended then the rich intuition of the class will be exercised. Only when the teacher constructs good problems, filled with tension, will the students be able to give good responses.

To do experiments in main lesson you must appeal to the student's understanding. You must do it in a careful order. You must have a motive.

In the 10th grade the 15-16 year olds can get superficial, be helpless, and can have a really hard time becoming quiet. They don't observe the entire experiment but jump quickly to the next thing. They have a hard time seeing the whole picture. Experimentation can be helpful at this age... Students learn in a circular line; sometimes they need to go through things twice. If they take notes during review it can be a help to them.

In the 9th grade one can also let the students do some experiments with alcohol and esters. The 9th grade is an age where the students want to explore the world. They want to see thing arising out of their own effort. They want to see what they can make happen. Rudolf Steiner suggested that the teacher present the 9th grader with things which exist as a result of human thinking.

There are two sides to this question of experimentation vs. demonstration. On the one side the teacher pricks the students and makes demands, on the other side there is complete freedom. In the demonstration what the teacher has shown is done and can't be redone. The teacher is able to point out different things. For example, with quartz; one can point out its relationship to the human sense organs, or can focus on its use in agriculture or the use of quartz in medicines. The main point is that the teacher must know what is important. If you leave the students alone they will tend to mix their feelings in with their thoughts. The teacher can present an overview. He can guide them through his use of calmness and drama in the demonstrated experiments.

The editors of this Newsletter would be interested in hearing from Waldorf high school teachers. How much of your main lesson is devoted to student's experimentation? Do you do lab projects in periods beyond main lesson?

(This bias toward demonstration is decidedly a Germanic approach. Are our students in America more willful and therefore more in need of will activity such as experimentation?)

SPIRITUAL ASPECTS OF 20th CENTURY SCIENCE

Introduction

In a recent article in the German "*Lehrerrundbrief*," Jos Verhulst describes his research into a very interesting pattern in the history of science (the birth-patterns of people who would play a major role in the development of 20th century quantum physics). He has investigated a provocative remark by Rudolf Steiner that there is a special connection between the intense Andromedid meteor shower of 1872 and the particular ideals living in those born in the next 33 years. Since this periodical is not well known in English-speaking countries, I'd like to give a summary of his ideas, and then pose a few questions about where we are headed in the close of the century – for discussion in future numbers of the Newsletter.

Quantum Physics Breaks Through to a New Consciousness

In the 20 years from about 1895 to 1925, scientists uncovered many surprising phenomena relating to the nature of matter, which were inexplicable in terms of classical physics: x-rays from vacuum tubes, and various types of 'rays' from particular (radioactive) materials suggested that atoms were not the ultimate 'building block' that Dalton proposed in 1810. During the 1920's an international community of physicists – including Niels Bohr (Denmark), Louis De Broglie (France), Erwin Schrödinger and Wolfgang Pauli (Austria), Werner Heisenberg (Germany), Paul Dirac (England) – collaborated and shaped a completely new set of ideas about the tiny sub-atomic world presumed to "lie behind" everyday phenomena.

The emissions from radioactive substances were further used for probing the innermost character of the fabric of matter, leading Sir Rutherford to the surprising conclusion that atoms were mostly empty space! And, no sooner had Bohr's 'planetary' model of the atom as electrons orbiting about a nucleus of protons and neutrons seemed to explain things, when Schrödinger's wave equations indicated that electrons were not a tangible thing (particle) at all but a "probability wave" in space! It seemed that every time physicists asked a new question in an atomic experiment, nature answered with an even more paradoxical reply, and the more they tried to clarify the situation, the sharper the paradoxes became.

Starting with Einstein's theories and extended by many others, relativity or quantum mechanics has had a profound influence on our picture of the nature of matter by forcing us to modify our concept of a particle in an essential way. In classical physics, the mass of an object had always been associated with an indestructible material substance, with some 'stuff' of which all things were thought to be made. Relativity theory showed that mass has nothing to do with any substance, but is a form of energy. Energy, however, is a dynamic quantity associated with activity, or with processes. The fact that the mass of a particle is equivalent to a certain amount of energy means that the particle can no longer be seen as a static object, but has to be conceived as a dynamic pattern, a process involving the energy which manifests itself as the particle's mass. The creation of material particles from pure energy is certainly the most spectacular effect of relativity theory, and it can only be understood in terms of the paradoxical view of matter arising out of quantum physics. Finally physicists were forced to accept that the problem lay with our conventional way of thinking about nature, and that perhaps the 'logic' of nature was a larger kind of logic. By 1925, Bohr and Heisenberg had synthesized the so-called "Copenhagen Interpretation" to account for all the paradoxes. It completely left behind the mechanistic and atomistic thinking of Nineteenth century "classical" physics. And, later on, the 20th century saw even stranger ideas, as Murray Gell-Man proposed quantum properties like "charm" and "strangeness number," and neutron diffraction experiments suggested that a 'particle' acts as if it can be in two places at once (see review of Dr. Zajonc's article on New Consciousness in the New Physics elsewhere in this issue).

The New Focus to Particle Physics

But, around 1933 was a pivotal time, where a number of apparently unconnected discoveries shifted the attention of physicists towards the particulate aspect of matter, promoting incredible developments in nuclear or 'particle physics;' In 1932 came the discovery of the neutron (Chadwick), positron (Anderson) and deuteron (Urey), culminating in the 1933 Solvay conference on the nucleus and Joliot-Cuire's discovery in 1934 of artificial radioactivity.. At the same time, the political events in central Europe in the mid-30's caused many physicists to flee Germany, so particle physics was advanced most rapidly in English-speaking countries, where their research led directly to the development of nuclear weapons. These events have certainly reshaped the face of our 20th century!

Other discoveries about the same time which prepared the ground for making WW II a war of technology include: synthetic plastics bakelite and polyethylene (first commercially produced 1939) served as an excellent insulator,

and facilitated the development of more complex electronic instruments, such as radar.

Spiritual Background

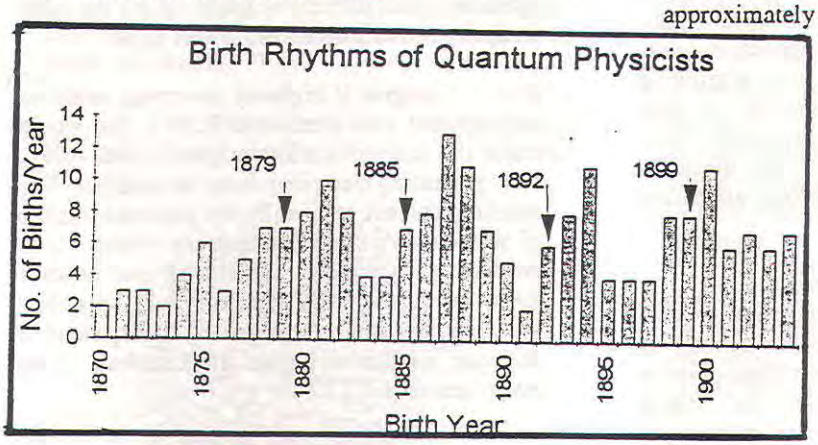
Rudolf Steiner has indicated on many occasions the importance of the period around 1933 in our century, and connected it with certain astronomical phenomena. He also has indicated that such astronomical rhythms have a connection with the unrecognized but potent impulses which people bring with them as they arrive here on earth. For example, that the intense meteor shower of 1872 is connected with a new, "Michaelic impulse" carried by those born soon afterwards[1].

Andromedid and Draconid Meteor Showers
Comet Belia & Andromedid Showers 1872-1900

We can find that astronomers connect this 1872 meteor shower with the comet Belia, and the regular Andromedid shower seen in mid-November raying out from near the constellation Andromeda. After its discovery in 1772 by the French astronomer Montagne, J.J. von Littrow calculated in 1837 that its orbit might take it on a collision with the earth in 1933. However, in 1845 comet split into two fragments; in 1852 the fragments were hardly perceptible; in 1872, an intense meteor storm or shower was observed instead, and again in 1885, 1892 and 1899 but weaker. In the 20th century this shower has become very faint and has almost disappeared. So, this comet which might have struck the earth in 1933 fell apart into a meteor-light shower coming every 6.6 years at the close of the nineteenth century and then nearly disappeared. This rhythm corresponds astonishingly with the peaks in the birth years of individuals who would play a role in quantum physics.

Check of Birth Rhythm

Emilio Segrè, a student of Enrico Fermi, surveyed the important physicists of his time, and the classic work of Thomas Kuhn provides us with a list of their birth dates.



When these birth data for 235 physicists are plotted (see Figure, below) we see birth peaks in 1881, 1887, 1894, and 1900 about every 6 years. The peaks of Andromedid showers were 1879, 1885, 1892, and 1899; note how they lie 1 or 2 years just before each of the birth peaks.

Comet Giacobini-Zinner & the Draconid Shower of 1933

Then, after 1900, the contents of the "New Physics" begins to be developed, giving mankind, through a scientific way of thinking, an opportunity to shake off the materialistic-deterministic world view of the nineteenth century. Christmas of 1900 saw the publication of Planck's constant, and also the discovery of a *new* comet: Giacobini-Zinner – in a certain way the successor to comet Belia. Both comets have the same orbit period and similar inclination to earth's orbit. In 1915, the astronomer Davidson suggested that this comet might be associated with a meteor showers, and in 1926 this was observed. Then in the evenings of October 9-10, 1933, an incredible meteor shower was experienced visible in Western Europe and America (about 100/second!). The apparent radiant lay in Draco, near the north polar star, specifically near the 'head' of the dragon. Following this, another storm occurred in 1946 just coinciding with the end of WW II. It is interesting that Rudolf Steiner has predicted a comet activity of 1933 would be of a kind which would "unleash the wild forces of the astral."[2] This incredible meteor shower confirms this anticipation and strengthens our sense that Steiner understood the connections he sketched out of a completely unexpected relationship between comet-meteor phenomena and certain historic occurrences.

Leonid Showers and The 33-year Rhythm

In astronomy, various 33-year rhythms are recognized. In 33-year intervals, the solar maxima reoccurs, at the same time of day as before, and thus in the same relation to the stars. Every 33 civil years the solar year and lunar year (12 synodic lunar months of 29.53 days) approximately coincide. Another 33 year rhythm is found in the periodic spectacular meteor showers called the Leonids because they appear to radiate from the sickle (head or breast) region of the constellation Leo, visible in late November just after the Andromedids. Earlier occurrences of this shower can be found in history, following rather closely the 33-year *rhythm. It is* interesting that the weak shower

[1] See the Pastoral Medicine Course (GA 318)

[2] see Rundbrief 3/1991

of 14 November 1901 was followed by almost no showers, until 1931 when a moderate shower was seen. Then, in Nov. 16-17, 1966, the most intense shower ever recorded was seen on the West coast of North America with rates of 155,000/hour (equivalent to almost 140/second)! The next intense storm should arrive just after the perihelion of the associated comet Temple-Tuttle in February 1998.

What sort of spiritual reality is manifested by the Leonid showers? In any case, it is exceptional that time is divided so regularly by this phenomenon. It is still more striking when we consider that the framework of our centuries is referenced to the birth of Christ, whose life in addition lasted about 33-1/3 years. So, in spite of how extravagant it may sound, the Leonids, which divide the centuries so nearly into thirds, appear as a kind of remembrance of a kind of Christ-rhythm in history. According to Steiner, this 33-year rhythm governs the social life between people; and he indicates further that people after 1933 should, in increasing numbers, come to a conscious relationship to the Christ-forces, which are active in the life of the earth. And, to make this possible, we will have to overcome another force which would appear in 1933 that he described as "an encounter with the beasts of the apocalypse," before mankind can meet the etheric Christ. This is a spiritual experience which can be found in a new relationship to Nature. This experience of nature is connected with the comets and meteor phenomena. So, within the scope of Steiner's indication, the absolutely exceptional Draconid shower of 1933 – which 'replaced' the Leonid shower – must be the influence he predicted, which would "unleash the wild forces of the astral," i.e., the apocalyptic beasts, which simultaneously darkened the social Christ-rhythm.

The period 1966-68, however, had a very different character; here there was no Draconid storm, but a mighty Leonid shower – the mightiest in history. This is evident in the cultural events of 1966-68: a cosmic-stormy period, with strong impulses to overthrow the remains of older authorities, however misguided; also evident in the "Prague Spring," which ended in a military clamp-down; or in the Olympic games in Mexico where the suppression was particularly brutal. At the same time, a growing technology which would mesmerize us was being born: in 1968 Intel corporation was founded, which was to produce the most incredible array of computer technology, appearing everywhere.

Questions for Discussion

It appears that the Leonid showers will be the mighty one at the close of the century in 1999. What are the impulses we should prepare for? What does this mean for social opportunities which Steiner indicated are connected with Leonid showers? Will technology continue to grow with amazing new discoveries which will claim our attention? Just now after 230 years, Pluto has entered sidereal Scorpio, perhaps a harbinger of even more profound revelations, and disclosures of things heretofore kept hidden, than in the 60's. What are the skills and faculties young people will need to enter creatively into this period? Should our science classes strive to strengthen people, placing less emphasis on involvement with glittery technology (despite parent's demands) but rather develop faculties of perception for living nature, and our human relationship to it, and to each other? How do we re-focus our curriculum to accomplish this?

J.P.

POSSIBLE POINTS FOR CLASS DISCUSSION

Ethics and morality issues need to be discussed in all our classes. The following are exampes of topics to initiate conversation.

A.– Geostationary communication satellites hovering above the equator are constantly relaying hundreds of TV programs to local broadcasters and cable TV operators who then re-transmit them to customers by cable or over the air. However, anyone who can afford a backyard dish antenna can also pick up the satellite signals directly without paying the cable company subscription fees. Is this right?

B – Imagine if highway pavement could be impregnated with a material XXYY that would make the surface act like a giant photo voltaic cell, generating electricity from the sunlight. The resulting current created by the immense surface of our country's interstate highway system would produce a substantial amount of our nation's electrical needs. The current would be at low voltage and could be transmitted underground in drainage ditches alongside the highway. Lets invent material XXYY.

C – Bacterial infections are the fifth most common cause of death in the United States today, and antibiotics such as penicillin are fast becoming useless against them. A new strain of gonorrhea, unlike its predecessors, is resistant to all kinds of penicillin. Leprosy is re-emerging in the United States carried by immigrants in a tenacious form that defies treatment with the standard drug, Dapsone.

Man has inadvertently encouraged this resistance by over consumption and careless use which assures development of resistant strains.

As a doctor under what circumstances do you think you should prescribe antibiotics – if at all?

D – Compare the amount of cropland needed to feed you for a year and the amount of cropland needed to run your family car on alcohol. The average car goes 10,000 miles per year.

A subsistence diet for one person for a year requires the food energy equivalent to 400 pounds of grain. It takes approximately 0.21 acres to grow this much grain.

On the other hand to make enough alcohol to drive a large American car 10,000 miles at 15 miles per hour requires 14,600 pounds of grain which in turn requires 7.8 acres of cropland.

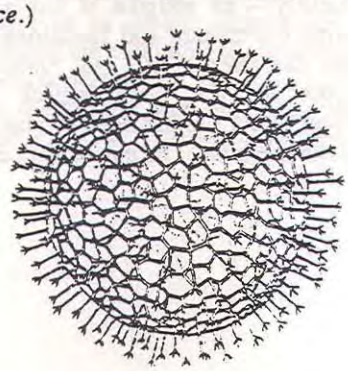
In other words, the car "eats" as much energy as 37 people would need to live. (7.8/0.21=37)

What do you think people in the third world think about this?

E – Television has profoundly affected many people's daily habits and their attitudes towards the world around them. For example, from kindergarten through 12th grade an average American student spends a total of 11,000 hours in a classroom and 16,000 hours in front of a television set.

Do you think you will want your children to watch this much TV? Why? Do you think you should? Why?

(The above has been adapted from Richard Brinckerhoff's *Values in School Science*.)



BOOK REVIEWS

AWSNA Publications has just brought out a revised and corrected copy of Sheen's **Geometry and the Imagination.** Also now in print from AWSNA are Manfred von Mackinsen's **Physics 6, Physics 7, Physics 8,** a write up on a Computer Conference with Waldorf Teachers and Professor Joeseph Weizenbaum from M.I.T

Review of Recent Publications: "New Consciousness, New Thinking, and the New Physics"

by Dr. Arthur Zajonc

There are many little gems which have been published in the *SES Journal* recently.[3] I would like to draw your attention to one very readable article: "New Consciousness, New Thinking, and the New Physics" by Dr. Arthur Zajonc in the *SES Journal*, Vol. 8, No. 1, Winter 1992. In this concise, readable article, Dr. Zajonc summarizes some key findings in modern quantum physics and examines their implications for us today.

Physicists today struggle with the question what sort of 'reality' does their mathematics and experiments indicate? As mentioned elsewhere in this newsletter, the more deeply they probe into the secrets of matter, the more paradoxical the results. Art Zajonc suggests that the metaphysical changes now taking place in physics might fruitfully indicate the "foundations of the 21st century ... what will be the figure and form of future 'reality' the shape of space and time."

Non-Locality (New Ideas of Space)

Two consequences of the strange world of sub-atomic physics are notions which push us beyond naive atomism, broadly termed 'non-locality' and 'entanglement.' In neutron diffraction experiments, quantum theory indicates that an individual neutron 'particle' has an equal probability of being diffracted or being refracted; each trajectory is equally likely.

"We should think of a unitary quantum state where the two modes $|a\rangle$ and $|b\rangle$ are both occupied. This is a new kind of concept, corresponding to a non-classical situation. The single neutron is in what physicists call a "superposition state." ... which is inherently non-local."

"The non-local nature of the neutron state after the beamsplitter can easily be made apparent in a number of ways. The simplest is to recombine the modes, thereby causing an interference pattern. ... In other words, doing

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[3] Direct subscription inquiries to Bruce Kirchoff, 1315 Oak Lane, Hillsborough, NC 27278

something in either path (and these can be separated by large distances) affects the single neutron interference pattern. **One neutron interferes with itself in a spatially non-local way."** ... The challenge, therefore, is to conceive of an indivisible object that can show a highly structured and sensitive non-local nature over all conceivable distances. Yet when detected, it always shows its entire self locally, as if instantly collapsing at detection."

Entanglement (Relatedness)

The other paradoxical quality which emerges from quantum physics is "entanglement" According to classical physics, when two 'particles' collide we could think of the collision as in a game of billiards, where after the collision, the two go their own separate ways. But, according to Erwin Schrödinger after the collision of sub-atomic quanta ('particles') they have a permanent 'entanglement' even long after the interaction. When presented with such puzzling ideas we may ask, "Is this *really* true?" The theories of John Bell does explain recent experiments, in a way where classical "local/realistic" theories fail. But, as Dr. Zajonc suggests:

"The interesting question is not whether the new physics is more true than the old physics, but rather to first acknowledge that it is radically different, and second, to see the new physics as indicative of a new consciousness, one that will gain dominance over the next two hundred years in much the same way that the Copernican and atomic views did. ... the move from old physics to new physics in indicative of a shift from Western consciousness toward a non-local and entangled imagination of our world."

Non-Linear Time

Another of the radically new ideas, now affecting thinking in many fields, is a radically different conception of time. Since the time of the Greeks, time has been conceived to flow onwards in a regular, steady stream, like the regular circling of the heavens or a regular beats of a pendulum. In this context, we could investigate what regular period a particular natural phenomena might have. However, in the recent work with 'chaos dynamics' we find another type of rhythm: a irregular "chaotic rhythm." In this type of situation, "subtle periodic influences can cause dramatic changes in the large-scale behavior of systems." This is the famous "chaos theory" that has captured the imagination of scientists in many fields, and leads us beyond the linear dynamics and atomism of space and time which has influenced science over the last few centuries.

Higher Realms

Then Zajonc introduces a new idea of his own: 'vertical entanglement;' the importance of a relation ship to higher realms involving ethical, spiritual dimensions. Although the work in physics that has produced such revolutionary notions as non-locality & entanglement has the value of clarity, it also lacks another essential, albeit less crystalline and quantitative element – the very aspect that Goethe strove particularly to develop, holding it as essential to keep the phenomena in view. And, as long as the beauty and grandeur of say a rainbow was visible, he felt the voice of the qualitative would be heard, balancing the quantitative. The danger he already recognized in his time was that when the phenomena are reduced to a schema or mere quantitative summary, a split is widened between the researcher and what they are investigating, between subject and object. Although chaos dynamics is not itself a phenomena, but a product of mathematical visualization with high-speed computers of Mandelbrot's fractal geometries. And although chaos dynamics still leaves the physicists somewhat an onlooker, nonetheless it has promoted a dawning consciousness urging us to develop a closer relationship with nature.

As Owen Barfield has indicated, the question really is 'how do we participate in Nature?' Can we really see phenomena that involve this new order, involving entanglement or participation and non-linear time? Goethe found them in *the world of life*: plant, animal, human realms. Here the non-mechanical acts in potent, often miraculous ways, rather than in a manner graspable mainly by linear logic, and we have an opportunity for a fuller engagement and participation. So Zajonc suggests the science of the next millennium should be "broad and deep enough to see science as a spiritual endeavor, as an aspiration of the human soul and an inseparable companion to art and religion (re-linking to the divine, spiritual). If we succeed in this, even if only modestly, then the transformation of society and culture will reach far beyond the provinces of academic science. Technology itself will change, becoming the hopeful basis for a sustainable future."

He then goes on to recount how many writers have found technology the most characteristic quality – an insignia of our age, both representing our culture and fundamentally defining the character of it. As Jaques Ellul pointed out in "The Technological Society" every aspect of our life has been recreated in the image of the machine. The mechanical clock

became a central metaphor; and as the paradigm of the clockwork universe became more and more dominant, it should not be surprising that a kind of mechanical "technique" came to invade subject areas once reserved for human or spiritual methods: sociology or economics. The early 20th century saw the rebellion against the mechanization of society in the factories for the goal of efficiency, where there was no place for the human being in that system. Dr. Zajonc quotes Martin Heidegger "But where danger is, grows the saving power also." He recounts a wonderful old legend of Hiram, artisan of Solomon's temple, who was casting his most mighty work of art, only to have it sabotaged by jealous apprentices. He had to find a way to save it; and found that he had to throw himself into the molten metal, and by doing so, magically saved the casting. Metaphorically, *by dying into one's craft we can save it.* In olden times, artisans had this connection; metallurgists had a conception of the world in which they were fully a participant in a sacred world where each action had spiritual significance. There is a longing for such a connection; spiritual values are increasingly in the foreground and not considered separate from science and technology. However, despite an occasional neo-romanticist longing to escape technology, one can also hear a yearning for noble values and actions that would move culture forward in solving the problems of technology.

Zajonc poses the most important question: how do we regain our connection, and participate in a fundamental way in the world. The answer lies in the recognition that time is not linear, and that the dynamics which underlie the tides of history are more than mechanically driven change. "The revolutions (in the history of science), the rise of novel artistic achievements or social and economic change are ... best understood not of external forces primarily, but of profound, if subtle, shifts in our consciousness, a shift that occurs very widely and so becomes of cultural as well as individual importance." As Steiner and Barfield suggest, the basis for such a change in consciousness is to be found in the soul-spiritual configuration of the human beings themselves. "The driving forces that determine these changes in the human soul are as much inward as outward. ... A linear mechanical conception of time can all too easily dominate our thinking in treatments of evolution. Perhaps nowhere is an organic or entangled notion of time of greater importance then [in understanding the evolution of consciousness]. It should be a conception in which the past is resurrected in the present and anticipates the future, where the future, as it were, works back into the present."

Zajonc then goes on to suggest that the reason that these yearnings are apparent in our present time is that *we* have already changed and sense the new possibilities. Why have we not noticed these possibilities of qualitative, connected, participatory relationship with the world until now? Because only now have we changed and become capable of apprehending such a relationship. After a discussion of the Anthroposophical idea of the four 'bodies' of the human being: physical, etheric, astral, and spiritual self or Ego, Zajonc relates Dr. Steiner's indication that at the close of the nineteenth century, certain events in the spiritual background have now become more visible on the stage of our culture. Forces from many sides began to shake the framework of the Victorian mechanistic conception, pushing for incorporation of wider aspects as also important. But, the development of these capabilities was not without difficulty as evidenced by two world wars and the challenge of the development of nuclear power. Nevertheless, Zajonc suggests a shift *is* taking place, moving thinking out of its connection to the physical body, to the body of form and dynamic, the "etheric" body, whereby these mere shadows of mere physical thinking would acquire a new life, and we will be able to think living thoughts because thinking itself had changed.

"Our thinking is being lifted into a realm of life. The laws of that realm are inherently non-local and entangled (participatory), and its rhythms are those of life. The new ventures in quantum physics, chaos dynamics, agriculture, medicine, cognitive science, and biology are at root a reflection of a dawning cultural shift toward "living thinking." Much hangs on our self-awareness of this fact and on our efforts to promote it, not only in ourselves, but also in others."

What a wonderful challenge!

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LETTERS TO THE EDITORS

The editors hope that controversy and interest in the Waldorf Community will keep this space filled with interesting points of view.

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HELP ME! I NEED THIS!

In this space the editors hope that letters will stream toward us filled with needs that we can publish.

THE SPELL OF CREATION

Within the flower there lies a seed
Within the seed there springs a tree.
Within the tree there spreads a wood

In the wood there burns a fire,
And in the fire there melts a stone,
Within the stone a ring of iron.

Within the ring there lies an 0
Within the 0 there looks an eye.
In the eye there swims a sea.

And in the sea reflected sky,
And in the sky there shines the sun.
Within the sun a bird of gold.

Within the bird there beats a heart
And from the heart there flows a song,
And in the song there sings a word.

In the word there speaks a world,
A word of joy, a world of grief
From joy and grief there springs my love.

Oh love, my love, there spring a world,
And in the world there shines a sun
And in the sun there burns a fire

Within the fire consumes my heart
And in my heart there beats a bud
And in the bud there wakes an eye,
Within the eye, earth, sea and sky
Earth, sky and sea within an 0
Lie like the seed within the flower.

– Kathleen Raine

Science Curriculum in the Waldorf School

CLASS 1: Nature stories (plants & animals) metals in Fairy Stories

CLASS 2: Animals, plants, stones speak from the Fables; Man speaks throug he Saints; cooking begins as a practical activity

CLASS 3: Farming, gardening, house building in principle with some life size examples such as a teepee or a Hogan or an igloo; soils, farm life, grains, root, leaf and stem vegetables; cycles of the year; a visit to a farm
Weights and measure;
Build a wall, oven or small house with mortar and stone or brick
Bake bread from harvested and threshed grain in a class-built stone oven

CLASS 4: Zoology - Man and Animal
Animal study - approached as an archetypal picture of Man
Threefoldness of Man; Head, trunk and limb animals;
Descriptive study of animals and their relationship to man

CLASS 5: Zoology — Lesser known animals such as the bat, dinosaur, etc. The adaptation of the Animal to its environment
Botany — Approached from the soul aspect: What is expressing itself?
The concept of the archetypal plant

CLASS 6: Geology — Minerals and crystals of the earth and their individual qualities, especially granite. All are approached from the formative character of landscape
Physics — Acoustics: from music in the classroom
Optics: from darkness, stages of dawn, light to shadow
Warmth: from heat and cold in surroundings
Electricity: arising and dispelling of static electricity
Magnetism: arising and dispelling of magnetism - direction relation
Botany — Continued from class 5 - with introduction to horticulture

CLASS 7: Chemistry: — Combustion, chemical transformation, acids, bases, salts, lime cycle
Physiology: — The nine bodily systems, nutrition
Physics: — Optics: light, image, lenses
Acoustics: tuning fork, mathematics of the octave
Warmth: expansion, the thermometer
Electricity: the circuit
Magnetism: fields
Mechanics: lever, pulley, plane etc.
Astronomy: — Geocentric to Heliocentric Universe

CLASS 8: Chemistry — The metals, water, photosynthesis, cellulose, chlorophyll, alcohol, proteins, albumen, oils and fats with relation to digestion, human nutrition and industry
Physiology: — Bones and muscles, the eye, the ear, body chemistry etc.; first aid
Physics: — Hydromechanics: buoyancy, pressure, etc.
Aerodynamics: climate, etc.
Electro-magnetism: the coil, build a simple motor

The Waldorf High School

In the High School there are track classes in advanced biology, computer science, microscope study, college level physics etc. the below lists only the outline of the main lesson blocks:

CLASS 9:
Chemistry: — Organic (biogenic) substances extend to alcohols, ketones, synthetic fibers.
Physiology:— senses, skeleton, anatomy, homeostasis, immunology
Physics:— principles of the power engine (steam and gasoline), telephone, electronics.
Earth Science:— weather, climate, erosion, mineralogy, etc

CLASS 10:
Chemistry: — properties of salts, acids, bases, & chemical reactions
Physiology:— embryology, inner organs and their functions
Physics:— mechanics and machines, forces and vectors,
Earth Science:— oceanography, ecology, crystallography, great biosphere cycles

CLASS 11:
Chemistry: — Survey of main elements and Atomic theory
Physiology:— comparison between plants and animals
Physics:— electricity and magnetism - radio, x-ray and nuclear technology
Botany: — structure of cells to monocotyledons and dicotyledons
Astronomy: — both observational and navigational astronomy

CLASS 12:
Chemistry: — Biochemistry - the chemical process within man and industrial chemistry
Physics: — optics, photometry, mirrors, light, color, polarization, etc.
Zoology: — study of the animal kingdoms and their relationship to man; Goetheanism and Darwinism
History of Science: — biographies and development of science to modern times

— David Mitchell

Characteristics of The Major Sugars

The characteristics and origin of the major mono- and di-saccharides are summarized below:

Name Chemical	Commercial	Source	Melting pt. °C	Optical Rot.$[\alpha]^{20}$	Notes
Mono-	Saccharides				
d-Fructose	Levulose	plant juices, sap, frutis, honey	102-4°	-92°	quick energy (metabolic)
d-Glucose	Dextrose	grape sugar, blood sugar	146°	+18.7° (fresh)	heart & blood (middle)
d-Galactose	-	milk sugar	165.5°	+81.5°	helps form cerebrosides (head)
d-Mannose	carubinose seminose	seaweed	132°	mutarotates -7 to +14.6	
Di-Saccharides					{hydrolysis products}
a-Maltose	malt sugar	malted (sprouted) barley	160-5°	+140.7	hydrolysis of sucrose {gluc•gluc}
Sucrose	cane sugar	cane - stalk beets - root maple sap	185-6°	+65.6°	not reducing {gluc•fruc}
a-Lactose	milk sugar	mammal milk	222-8°	(mutarotates) +92.6° to +52.3	{gluc•galac}

WHERE DOES BEAUTIFUL PROSE FIT IN SCIENCE?

(It is especially important that we train the ears of our students by reading them well crafted writing. The following, taken from Gwen Frostic's *A Walk With Me*, might be one example:)

"As the leaves finish their pageant of color and drop to the ground the trees stand in majestic beauty against a clear blue sky and disclose the secrets of the birds held so well all through the summer . . .

Masterpieces of artistic construction – these homes of the birds – some hanging on the tip ends of branches woven with such craftsmanship that they with stand the strongest winds that blow . . . yet sway with the most gentle breeze. Some are beautiful homes with fine strips of birch bark woven into the grasses with caterpillar's silk. Some are welded to the forks of trees with mud foundations – mud carried a bit at a time by the builder making hundreds of trips.

There are nests in low bushes and among the reeds of the swamplands – nests used year after year by adding a few more twigs, a few more grasses. There are delicate nests, smaller than a sycamore ball, covered with tiny lichens, saddled to a branch with spider's silk, yet, strong enough to hold tiny birds in a bed of down.

Each bird has its own secret of nest building, but no bird has more than a bill to weave with, a foot to shape with, and its own body with which to mold the clay – and so with grasses, roots, twigs, bark, string and mud they build their homes in which to raise their young and line them with thistledown, furs, mosses and feathers for comfort.

And there they are – just empty nests , and yet, what marvels they reveal."

MEDITATION ON GRANITE

by Goethe in 1783 when
he was 34 years of age

"In ancient times already, granite was a noteworthy kind of stone, and this has become more marked in our time. In antiquity, it was not known by this name. It was called *syenit*, after Syene, a place at the boundary of Ethiopia. The enormous masses of this stone gave the Egyptians ideas for enormous works. Their kings erected pointed pillars made of granite in honor of the sun and because of its reddish color it later received the name 'fiery-mottled'. The sphinxes, the Mennon images, the enormous pillars still are the admiration of travelers, and even today, the powerless master of Rome lifts up the ruins of an old obelisk which his all-powerful ancestors brought whole from a foreign continent.

Later ages gave to this stone the name it bears now because of its granulated appearance and in our days it had to suffer some moments of indignity before it rose to the esteem in which it is now held by all who study nature. The enormous masses of those pointed pillars and the wonderful variety of their granulation misled an Italian scientist into believing that they were artificially accumulated by the Egyptians from a fluid mass.

But this opinion was quickly superseded and the dignity of the stone was finally affirmed by many observant travelers. Every trip to unknown mountain ranges confirmed the old experience that granite is the highest and the deepest, that this kind of stone, now becoming better known and better distinguished from the others, is the solid foundation of our earth, all other manifold mountain ranges being built up on it. Within the innermost bowels of the earth, it rests unshaken, its high backs ascend, its summits are never reached by the all-surrounding water. So much we know about this stone and little more. Put together from known parts in a mysterious way, it does not allow us to deduct its origin from firs or from water. Highly manifold, in the greatest simplicity, its composition metamorphoses innumerably. The position and the relation of its parts, its duration, its color changes with every mountain range, and the masses of each range are often differentiated within themselves from one step to the other and, as a whole they are still always like the other. And so everyone who knows the charm that natural mysteries have for man, will not be surprised to see me leave the circumference of observations which I usually inhabit and turn with a truly passionate devotion to those mysteries. I do not fear the reproach that it must be a spirit of contradiction which leads me from the observation and description of the human heart, the youngest, most manifold, most mobile, most changeful, most easily upset part of creation to the observation of the oldest, firmest, deepest, most unshakable son of nature. For one

will gladly agree with me that all natural things are in a close relationship and that the inquiring spirit does not want to be excluded from something it might reach. May I then be

allowed, as a man who has suffered much through the changes of human attitudes, through their swift motion in myself and in others, to enjoy the lofty quiet given by that lonely mute nearness of the great soft-spoken nature and let him follow me who has an inkling of it.

With this attitude I approach you, greatest, most honorable monuments of time. Sitting on a high bare summit and overlooking a wide landscape, I can say to myself: here you are resting without intermediary on a ground which reaches down to the deepest recesses of the earth; no more recent layer, no heaped-up conglomerate debris have laid themselves between you and the firm foundation of the primeval world; you do not walk over a continuous grave as in those fair fruitful valleys; these summits have not brought forth anything living nor have they devoured anything living; they are before all life and above all life. At this moment when the inner attracting and moving forces of the earth have, so-to-speak, an immediate effect on me, when the influences of the sky hover nearer to me, my mood is raised to higher contemplations of nature and, as the spirit of man brings life to everything, a comparison comes alive in me the loftiness of which I cannot resist. So lonely, I tell myself, gazing down from this entirely bare summit, and hardly seeing in the distance at its foot a scantily growing bit of moss, so lonely, I say, is the mood of a man who desires to open his soul only to the oldest, first, deepest feelings of truth.

Indeed, he can say to himself, here, on the oldest, eternal Altar, built directly on the depth of creation, I offer a sacrifice to the Being of all Beings. I feel the first, firmest beginnings of our existence; I overlook the world, her rockier and her gentler valleys, and her distant, fertile pastures; my soul is lifted above itself and above everything, and longs for the closer sky.

But soon the burning sun recalls thirst and hunger, the human needs. Man looks around for those valleys above which his spirit already was soaring; he notices the inhabitants of those fertile, abundantly watered plains who have established their happy dwellings on the litter and the debris of errors and opinions, who scratch the dust of their ancestors and quietly satisfy the modest need of their days in a limited sphere. Prepared by these thoughts, the soul penetrates into the past centuries, she realizes all experiences of careful observers, all suppositions of fiery spirits. This cliff, I say to myself, stood steeper, craggier, higher in the clouds when this summit still stood there as an island, surrounded by the sea, in the old waters. Around it soared the spirit which brooded over the waves, when in their wide womb the higher mountains formed themselves from the debris of the primeval mountains and, from their debris and the remnants of their inhabitants, the later and more distant mountains. Already, the moss first begins to originate, already, more rarely, the scaly inhabitants of the sea move about, the water sinks, the higher mountains green, everything begins to teem with life.

But soon, new scenes of destruction oppose this life. In the distance, raging volcanoes arise; they seem to threaten the end of the world, but the solid foundation on which I still rest secure remains unshaken while the inhabitants of the distant shores and islands are buried under the faithless soil. I return from the roaming contemplation and look at the rocks themselves whose presence lifted up my soul and makes it secure. I see their mass cut by confused crevasses, standing upright here, slanting there, sometimes sharply stratified, sometimes as if thrown together in formless clumps and, at first sight, I am tempted to exclaim, here, nothing is in its first ancient position, here all is debris, disorder and destruction. The same opinion we may find when we retire from the living contemplation of these mountain ranges to our studies, and when we open the books of our ancestor."

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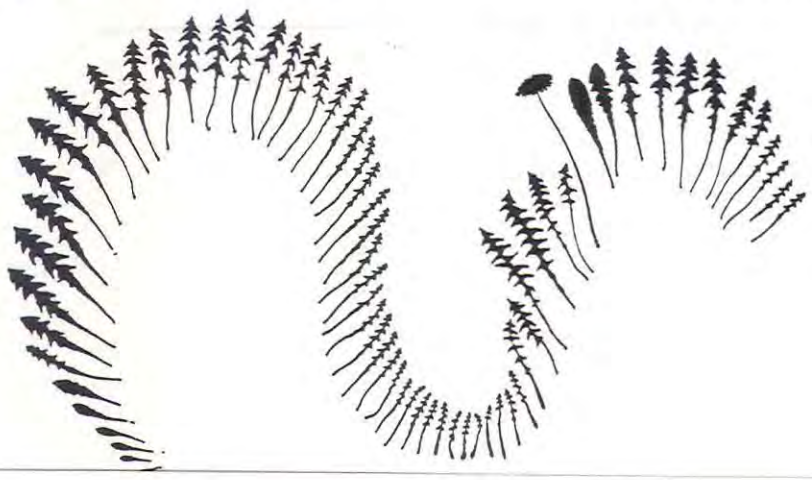


EXPERIMENTS

(The following are some interesting experiments that can be used in the classroom. The editors would welcome contributions to this section, done in the same format)

PHYSICS
Mechanics 7 or 8

Question: How do we calculate horsepower?

Bring your class outside to a stairway. Measure the vertical height of the staircase.

Ask for several volunteers. Measure the weight of each on with a bathroom scale.

Have a student stand at the top with a stop watch.

Time several students as they run up the stairway.

Ask the students to put their individual figures into the formula below and calculate the result:

$$\frac{\text{(weight) X (vertical height)}}{\text{time X 550}}$$

A horse power represents 550 foot pounds of work per second.

Notes:

A horsepower is defined as the force required to raise 33,000 pounds at the rate of one foot per minute.

An elevator lifting 10 people each weighing 150 pounds, from the bottom to the top of the Empire State Building (1200 ft.), does 1,800,000 foot-pounds of work (if we disregard the weight of the elevator.)

GEOMETRY

Question: How can we measure the circumference of a circle?

The perimeter of a circle is called its CIRCUMFERENCE. Take an empty tin can. Carefully measure the circumference with a slip of paper. With a ruler, carefully measure the diameter of the can, Divide the circumference by the diameter. Write down the number you arrive at (about 3.1).

Ask the students to do this at home using several different sized cylinders. If they wrap the paper around the can or cylinder and prick it with a pin where the paper overlaps, they will be able to accurately measure the circumference, Have them construct a table as follows:

	Circumference in cm.	Diameter in cm.	C/D
1.			
2.			
3.			

Ask them to record their findings. They are to come to class prepared to explain what they discovered. Help them understand what a "constant" is. After their explanation, derive the following formulas:

$$C/D = 3.1\ (\pi)$$
$$C = 3.1\ (\pi)\ D$$
$$C = \pi D$$
$$C = \pi\ 2r$$
$$C = 2\pi\ r$$

The class will come to the conclusion that when we divide the circumference by the diameter, the quotient is always the same and is approximately equal to 3.14159.

In other words the circumference in any circle is about 3.14159 times as long as the diameter.

This number is called a CONSTANT and is symbolized by the Greek letter π (pi).

PHYSIOLOGY 7 OR 8

Question: What is necessary to achieve our balance?

Ask for a student to volunteer to come to the front of the classroom and to stand with his/her feet firmly together.

The class must be very still because noise will disrupt this experiment.

Now the student should be blindfolded or asked to hold their eyes tightly shut.

Ask the class to observe and note exactly what happens.. After a few moments the student will begin to sway, to lose their balance. At first they will try to compensate with small, and later with larger, jerky movements.

As a variation you could ask the student to balance on one leg.

A discussion can now take place to try to understand what happened:

- Why did the student begin to lose their balance?

- How did he/she regain it?

- What happened when he/she reopened their eyes?

Note: This demonstration leads students to discover the intimate interrelationship of all our sensory processes. We balance with our eyes (and other sensory organs) as well as with our semi-circular canals.

PHYSICS

Question: How can we measure the speed of sound?

Take your students to a level strip of ground about two football fields long.

At a distance of 600 feet place two students with binoculars.

At point zero place two students; have one student with a "sound pulse generator" (either two boards, or a steel frying pan and a big spoon) and the other student armed with a "timing device" (a heavy weight on the end of a string). This pendulum is adjusted so that the swing of the arc takes one half a second. With a little practice the students can generate sound pulses at exactly half second intervals to coincide with the half second swings of the pendulum.

Other students can be busy measuring distances or relaying messages and instructions from one end of the field to the other.

The two students with the binoculars now begin their observations at point zero – right next to the student striking the skillet or clapping the boards together. They notice that the first clang coincides with the first swing of the pendulum, and so on. Now they begin to walk backwards, away from the source of the sound, to the point where they hear the sound later than they see the corresponding swing of the pendulum. As they move down field, the sound pulses will take more time to reach them. They continue to walk backwards until the first of a sequence of sound pulses is heard at the exact moment when they see through the binoculars the end of the second swing of the pendulum, the second pulse at the end of the third swing, and so on. They have now walked the distance which sound takes a half-second interval of time to travel. Double this distance, and they have discovered the distance which sound will travel in a full second.

Ask the students to compute the distance that sound travels. They should come within 10% of the officially recognized number.

Note: The speed of sound, which is a scientific concept arises out of the student's visual and aural experiences of phenomenon and from his own measuring of them.

At 0°C sound travels 1,090 feet/second increasing 2 feet/second for every degree rise in temperature.

PHYSICS
Optics: 6

Question: What causes atmospheric colors?

Light a candle on the table at the front of the classroom.

Take a ream of onion-skinned paper and sheet by sheet put a piece at a time in front of the flame. The color will change from bright yellow to orange to deep red as you add the paper.

A similar experiment can take place by putting a flashlight behind a fish tank filled with water. Gradually make the water turbid by adding soap. The light will appear to burn reddish. If we look at the medium with a light shining on one side, it will appear to be bluish-white.

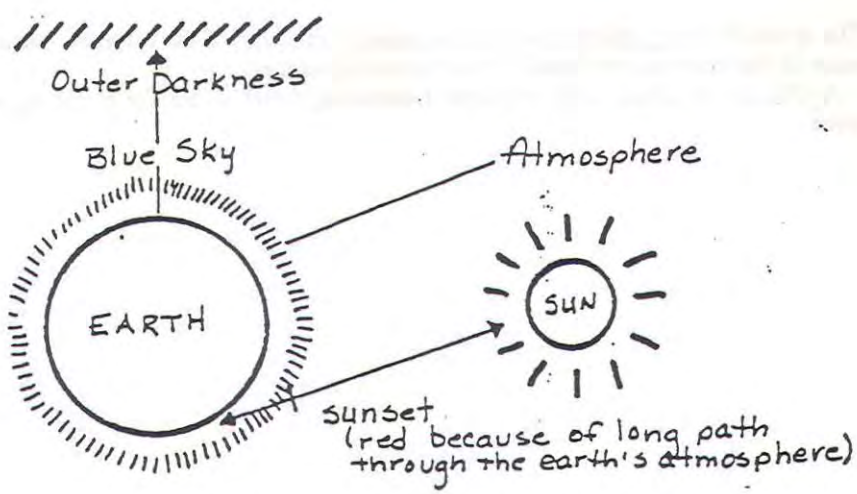
For homework ask the students to think about what they have observed and to prepare an explanation.

The next day, review the happenings of the pervious day. Ask the class what they understand to have taken place.

Then ask them to explain how this experiment could relate to the colors in the sky.

Notes:

This experiment shows us the underlying cause of atmospheric colors. The sun appears bright red when it sets and rises because we see the light through turbidity (dust) in the atmosphere.



PHYSICS;
Acoustics 6

Question: How is sound transmitted?

Take an old fork and suspend it from a string. Bang the fork with another fork and write down the sound that is heard. Repeat the above experiment only this time hold the string to the top inside of the ear and then strike the fork once again. Write down what you experience.

(The sound will last for quite a while and will sound like a loud bell)

What was the different quality of sound we experienced.

Why do we hear what we do with the string?

Hold the fork in your hand and try to make a ringing sound. Why doesn't this work?

Notes:

The string is stretched by the weight of the fork. The vibrating fork pulls the string and causes it to vibrate.

Sound is transmitted to your ear through the string.

METALS

(The following experiments with metals were worked out by John Davy and David Mitchell at Emerson College in Sussex , England. They can be used for both middle school and high school demonstrations.)

Exploring the Nature of Silver

Chloride precipitate
Crystals of $AGNO_2$

Fill a 2500 ml beaker up to 3/4 full with tap water (assuming it is chlorinated – if not add 5 ml of bleach.
Place on an Illumination box. Stir. Wait until all movement of the water has ceased.
Float one crystal of silver nitrate into the center of the beaker. (You can attach the crystal to a glass rod with a dob of Vaseline or a bit of Chap-stick wax!)
Observe the spreading white veils of chloride precipitate trailing from the crystal as it settles to the bottom.

Variation #1

Fill beaker with dilute silver nitrate solution (1-2 crystals in 3 – 500 ml of distilled water.

Place a crystal of salt (sea salt or cooking salt) on base of beaker.

Observe white veils again.

Note: This is an excellent medium for demonstrating the effects of a turbid medium (Goethe's color theory).

Variation #2

Drop a small silver nitrate crystal into a tall cylinder filled with tap water that is chlorinated.

Observe the "trail" left as the crystal falls to the bottom.

Silver Oxide Precipitate

Drop sodium hydroxide (0,5N solution) into dilute silver nitrate solution
(1 crystal in 300-500 ml distilled water.)

Observe brown silver oxide precipitate.

Variation #1 Mirror Formation

Dissolve above precipitate by adding dilute ammonia (5%)

Observe dark turbid color developing slowly. Gently warm the solution over a Bunsen burner.

Observe silver deposition as mirror on glass surface.

Basis of Photography

Place a milk solution of silver chloride in sunlight.
Observe it darken – blackish violet silver oxide.
Soak a filter paper in a weak salt (NaCl) solution. Dry it.
Moisten the above with a weak silver nitrate solution.
Place an object (coin, pencil, etc.) on a piece of paper and place it in the sunlight.
Observe the darkening of the exposed paper, light color of unexposed portions.

Exploring the Nature of Copper

1. Fill a 3 liter beaker with 2 liters of tap water and 50 ml. saturated $CuSO_4$ solution. Place it on a light box and notice as it grows gradually turbid – blue – slowly turning add a few ml of 10% HCl and it will clear. Slowly add a few drops of NaOH – it will cloud; dissolve it with NCl.

2. Take 2 liters $CuSO_4$ solution., slightly acid (HCl) plus $K_4Fe(Cu)_6$

   Take 2 liters $FeSO_4$ solution., slightly acid (HCl) plus $K_4Fe(Cu)_6$

3. NaOH, hang $CuSO_4$ crystal in that solution.

4. Place 1 teaspoon of copper turnings in a 1 liter conical flask, add 150 ml HNO_2 (2 parts NHO_3, 1 part H_2O), observe color of liquid and brown vapors (cover with a beaker). Fill up with water under the tap, observe nitrous gases and blue color of liquid.

Exploring the Nature of Mercury

Fill a large conical flask with distilled water. Add a small amount of NHO_3. Add a crystal of Mercuric nitrate and potassium iodide. Observe yellow/red precipitate appearing and disappearing at concentration boundaries.

$Hg(NO_3)_2$ solution + NaOH ⟶ yellow precipitate HgO

Exploring the Nature of Tin

1. Prepare a thin cylinder of tin by melting it in a test tube. Allow it to cool and remove. When the tip is bent you will hear the "Zinngeshrei" (the scream of the tin caused by loose mollecular structure)

2. Dip a stick of tin in concentrated HCl or H_2NO_3 to demonstrate crystalline structure.

3. Moisten surface of a piece of tinplate with Aqua Regia. Observe crystalline structure.

4 Combine SnCl and NaOH

Exploring the Nature of Lead

Colored solutions:

1. Mix weak solutions of Lead nitrate and Potassium dichromate and you will produce a strong yellow Lead chromate.

2. Mix weak solutions of Lead nitrate and Soda to produce Lead carbonate (white lead).

3. Lead oxide (red oxide) as suspension in water.

4. Mix Lead oxide (red lead) with dilute HNO_2. Heat to produce brown Lead dioxide.

Note and compare PbO (yellow, Pb_3O_4 (red) PbO_2 (dark brown).
Oxygen leads metals into the earth.

Lead with Potassium iodide

Mix solutions of Lead nitrate and potassium iodide to form brilliant yellow precipitate of lead iodide. On warming, the color disappears. On cooling again, the lead iodide reappears as small glistening yellow crystals.

Lead – comparing lead and silver chloride precipitates. Fill a large tall cylinder with tap water. Allow turbulence to subside. Drop in very small crystals of Lead nitrate and Silver nitrate (the smaller the better). They will dissolve as they fall to the bottom, precipitating silver and lead chlorides.

Lead Hydroxide precipitate

Prepare lead nitrate solution. Add sodium hydroxide solution, to form heavy white jellyfish precipitate. Adding further NaOH clears the solution. (Lead is
amphoteric
. this means that it has both acid and basic properties) This experiment is worth showing on a large scale.

Exploring the Nature of Iron

1. Take a small quantity of iron powder filings in a metal spoon. Blow through a glass tube so that the filings scatter into a tall weak Bunsen burner flame. Observe the tendency of this metal to produce sparks.

2. Add iron powder to H_2SO_4 30%. Observe boiling as H_2 is generated. Greenish $FeSO_4$ (Ferrosulphate) is formed. Add HNO_3 30%. Brown color of $Fe(NO_3)_3$ (compare colors of Ferro- and Ferri compounds).

The above are best done in a tall cylinder, against a white background: observe brown nitrous gases.

Colors Prepare 60 ml $FeCl_3$ solution (approximately saturated, 3 spoonfuls) place in highest cylinder 20 ml., in highest 500 ml., 10 ml. of this almost saturated orange solution. Dilute and observe yellow color. Add 10 ml to a 50% diluted HNO_3

and then add some fine potassium ferrocyanide, observe blue color;
and then add some fine potassium ferricyanide, observe red color;
and then add some fine potassium thiocynate, observe greenish color.

3. In a big beaker dissolve 4 spatula spoonfuls of ferrous sulfate in tap water. Squirt in through pipette a rather strong NaOH solution (3 Spoons/ 100 ml). Observe white or green jelly-like precipitate of Ferrohydroxide.

Shake well a quantity in test tube. Observe oxidation to Ferrichydroxide (red-orange).
O_2 : Filter, Expose filter paper to air
O_2 : Allow to stand a few days.

Try observing against a dark background in transmitted light

In a big conical flask add rather concentrated H_2SO_4 (or make a solution of Ferrous Sulfate in distilled water). Heat NaOH and cool (to remove O_2). Add to iron solution. White or greenish Ferrohydroxide is formed. On allowing to stand it will oxidize to orange Ferrihydroxide (try on filter paper and in cylinder.

Lab Report – Chemistry 9

Name:_____

Experiment number:____

Name of Experiment: Synthetic Rubber

List all apparatus used in experiment:

Directions:

1. Put approximately 100 ml of 1M NaOH (sodiuym hydroxide) into a 250 ml beaker. BE CAREFUL, THIS SOLUTION CAN CAUSE SKIN BURNS!

2. Add 6 grams powdered sulfur and several drops of liquid detergent. Stir.
   Observations:

3. Heat your solution carefully to boiling. BE CAREFUL NOT TO BOIL OVER! Boil for about one minute.
   Observations:

4. When your beaker cools enough to handle, bring it to Mr. Mitchell. He will adjust the temperature to 85 C and add 20 ml of 1,2 dichlorethane. (HAZARDOUS!)
   Observations:

5. Set your beaker in the hood for at least 20 minutes. Then discard the liquid carefully into the hazardous waste container. Look for a plug of solid material at the bottom of the beaker. Rinse it completely in clean water several times and squeeze all the water out.
   Observations:

What conclusion can you make?

Physiology 9 Lab Exercise

Blood Pressure

Name: _____ Date: _____

	Sitting	After Exercise	Date	Sitting	After Exercise	Date
Systolic						
Diastolic						
Pulse						
Heartbeats/minute						
Breaths /minute						

Average Systolic =

Systolic means: _____

Average Diastolic =

Diastolic means: _____

Lab Report – Chemistry 9

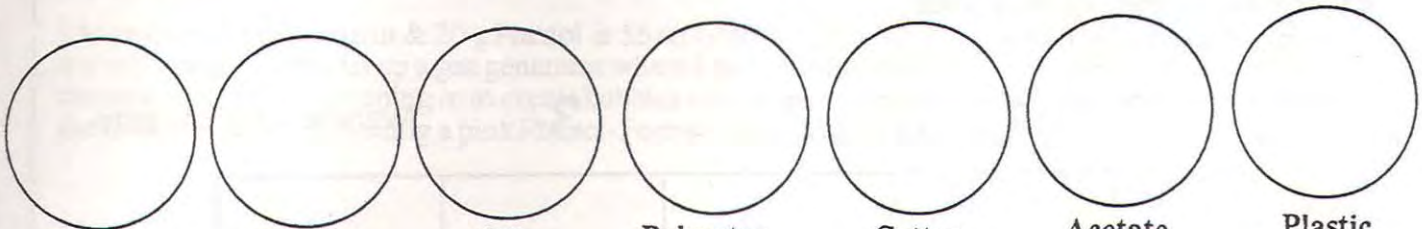
Name:_____

Experiment number:____

Name of Experiment: Fibers

List all apparatus used in experiment:

Microscopic examination (please draw each fiber as accurately as you can)



Wool Burlap Silk Polyester Cotton Acetate Plastic

Underneath each drawing above, skotch tape one thread, approximately 1/2 inch in length, and then describe each fibers qualities, in a few words.

Describe each fiber as it burns:

Wool:

Burlap:

Silk:

Polyester:

Cotton:

Acetate:

Plastic:

What conclusion can you make?

Physiology Lab Exercise

Lung Capacity

Touch Receptivity

Name: _____ Date: _____

Lung Capacity

1. Take a lung volume bag, hyperventilate 9 times, on the tenth breath pull all the air you can in and breath it into the bag. Using your hand, squeeze the bag from the mouthpiece toward the air trapped in the bag. Measure and note the volume. Do three times.

	1.	2.	3.	Average lung capacity
Volume of air				

Touch Receptivity

Randomly select one of the pin sets provided in the box, have your partner close their eyes, or blindfold them, and then lightly touch the pins to the surface of your partner's skin CAUTION: DO NOT PRESS HARD ENOUGH TO BREAK THE SKIN!. Record the number of pins that are feltl in the chart, then answer the questions at the bottom of the page – use a separate sheet if necessary.

Number of pins:	1	2	2	2	2
Spacing in cm:	0	0.5	1	2.5	5
Palm of hand					
Back of hand					
Forearm					
Back of neck					
Ankle					

Analysis :

1. What part of your body has the greatest concentration of touch receptors? Explain
2. List the parts of the body in the chart in order of decreasing sensitivity to touch.
3. What is the advantage of some parts of the body having a greater concentration of touch receptors?

Name:_____

Lab Report – Chemistry 9

Experiment number:____

Name of Experiment: Bakelite Plastic

List all apparatus used in experiment:

Procedure:

I have taken 25 g Formalin & 20 g Phenol & 55 ml Glacial Acetic Acd in a beaker which was wrapped n a wet towel. Then I set up a gas generator where I had concentrated HCL (hydrochlorc acid) with concentrated H_2SO_4 dripping in to create bubbles and gasses. I waited one minute until the mixture in the beaker frothed up forming a pink Phenol-Formaldehyde, called Bakelite.

Drawing of Set-up:

Observations:

What conclusion can you make?

Approval

Lab Report – Chemistry 9

Name:_____

Experiment number:_____

Name of Experiment: Esters

List all apparatus used in experiment:

Directions:

An ester is a product formed when an acid reacts with an alcohol. Do the following experiments in a test tube and note next to each what you think it smells like.

1. Put 10 drops Butyric acid & 10 drops. ethanol & 3 drops of Sulfuric acid in a test tube. Heat gently over a Bunsen burner and note smell. With your medicine dropper place a drop of the liquid here → Smell?

2. Put 10 drops.Acetic acid & 10 drops. ethanol & 3 drops of Sulfuric acid in a test tube. Heat gently over a Bunsen burner and note smell. With your medicine dropper place a drop of the liquid here → Smell?

3. Put 10 drops Acetic acid & 10 drops Amyl alcohol & 3 drops of Sulfuric acid in a test tube. Heat gently over a Bunsen burner and note smell. With your medicine dropper place a drop of the liquid here → Smell?

4. Put 10 drops Acetic acid & 10 drops octyl alchohol & 3 drops of Sulfuric acid in a test tube. Heat gently over a Bunsen burner and note smell. With your medicine dropper place a drop of the liquid here → Smell?

What conclusion can you make?

CULTURAL GEOGRAPHY

Each team will prepare a block book of their own research. The research will be as exhaustive as you can manage and will require library research, use of books provided in the classroom, and interviews with me, your teacher.

On your given date your team will be responsible for a 30 minute presentation of your topic. You may use visual aids, but your notes must consist of index cards. All partners of the team should share equally in the presentation. The rest of the class will be responsible for in-class notes in their block book identifying areas you cover. Be in comand of your subject, speak to your classmates, use humor, be clear on your facts and project your voice.

The topics are as follows:

I. Physical Geography of the Country
   - A. The land: including location, size (not just square miles but compared to the state of Colorado). What is the soil type? What type of minerals are there?
   - B. The climate and weather conditions – pay particular attention to what type of storm systems are most dangerous.
   - C. What are the effects and restrictions of the land & climate on the culture?
   - D. A large map of the country must be drawn showing all important features geographically and politically.

II. The People
   - A. What is the ethnic makeup? Language?
   - B. What is the history – how old is the culture, what major events have occurred there?
   - C. What are the religious beliefs, traditions?
   - D. What ARTS are practiced/

III. The Modern Conditions
   - A. What are the political conditions?
   - B. What are the Economic conditions (what kind of economy– capitalistic, socialistic, etc.)?
   - C. What are the major problems today?

Research Items: GEOGRAPHY 9

PreparingTeam:

I. Geography

A. Name of Country

B. Population:

C. Size in relatioship to Colorado:

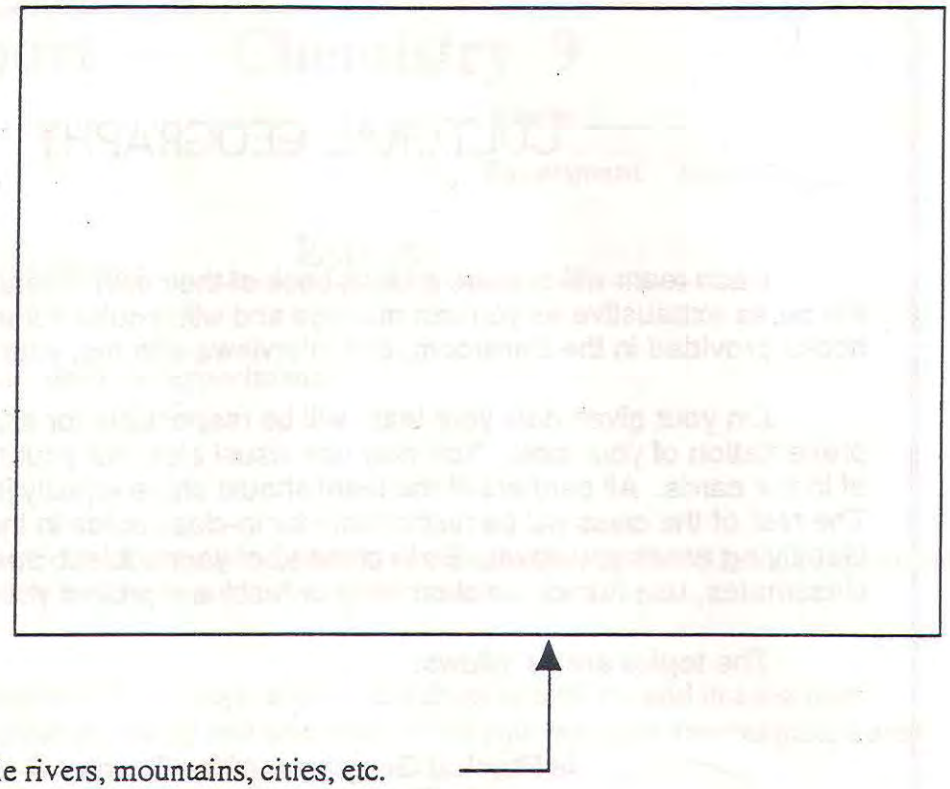
D. Locate on World Map

E. Soil Type:

F. Minerals

G. Climate and weather:

H. Draw a map showing the principle rivers, mountains, cities, etc.



I. What are the restrictions of the land and climate on the culture?

II. The people

A. What is the ethnic makeup?

B. What is the principle language or languages?

C. What is the religion and/or traditions?

D. Describe their Arts.

E. Give a brief overview of the country's history.

III. The Modern Conditions:

A. What is the country's relationship with its neighbors?

B. Describe the internal politics.

C. Economic Conditions

1. What is the currency called?
   What is its value compared with our dollar?
2. What is the major import?
3. What is the major export?
4. What is the chief agricultural product?
5. What is the chief industrial product?

D. What is this country's major contemporary problem?