Chemistry In Grades Seven To Nine

by

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A teacher takes on the task of conveying natural phenomena as well as insights into the relationships between natural events for young people, and preferably in such a way that they receive a powerful developmental impulse. Chemistry is relevant in the seventh grade. But in chemistry lessons the opposite effect can easily take place, either a cramping effect that leads to direct antipathy for the subject or the creation of rigid and abstract mental images. The first is more often found among girls and the latter among boys. This is not chemistry's fault, for this subject can answer some of the deepest riddles in nature and in the human being.

In addition we can practice active thinking. To do so, we cannot pack chemistry into a gray mass of formulas and experiments. If you start with methods that result in abstraction it is hard to make chemistry come alive again. The children's first meeting with chemistry must help them understand that the subject has to do with them and with the world around them. We should not believe we could introduce chemistry in the seventh grade according to scientific recipes. Chemistry must be embedded in a number of subjects, whether children are learning within the world of nature; culture, art or handicrafts. The subjects should support each other, in that way children are engaged from many sides and can respond from different sides of their beings.

Seventh grade: Combustion

The following is an attempt at a chemistry block with fourteen main lessons. It is built upon the method of providing children with phenomena they can judge themselves. We begin with combustion. A large and spacious zinc vessel is filled will all kinds of burnable materials. Everyone contributes his own things. There are many surprises in pockets and backpacks of thirteen to fourteen year olds. Soon the fire blazes and the atmosphere takes off. We feed it with paper, woodchips, birch bark, pine needles, dried grass, and so forth. The more things to burn the better. The whole first main lesson goes to the bonfire.

In the next lesson we have a conversation about it. Yesterday's experiences are a bit more distant and we try to remember them together. Before us lies a pile of gray ash, the only remains of warmth, light and smoke from yesterday. It provides valuable content for discussion if we do not lose ourselves in defining what has taken place. The more unanswered questions the better.

Then we try to research on our own. Experiments with burning candles under a glass are fascinating. Everyone knows that light will die after a while, but few have experienced it. The larger the glass the longer the flame can live. With this discovery we have taken a large step forward, flames need nutrition, they need air.

Here is a fine possibility to contribute a historical comment on fire. We have a lot of mythological materials from earlier years. We start with the first time fire came to the earth, then comment the moment when man learned how to control it and use it. Eventually man made fireplaces that enabled him to take it into the house. Smoke was a nuisance so a hole in the roof became necessary. Later we built fire into ovens and fireplaces. We learned how to regulate the air with vents. Such comments demonstrate how fire has become more and more distant from man. Where do we find it today in our houses if we are not lucky enough to have a fireplace? Down in a forgotten corner of the basement, built into cement and steel we have an oil burner. Through the little window we can see a flame. The rooms are heated by radiators under the window. But an evening in front of the radiator is not the same as a fireplace.

We also speak of body warmth, blushing, fever or heat waves. This awakens their consciousness. Now the children want to move on.

What happens if we reduce the air intake to a minimum? This is what we do in a charcoal-kiln and that is fun to describe. Children know the products from a kiln; charcoal, drawing charcoal and tar but few know where they come from. Now they learn that charcoal comes from an incomplete burning in a charcoal-kiln and that tar is left at the bottom of the kiln. Yet something else disappeared through the little hole at the top of the charcoal-kiln. What can that be?

Sulphur and Phosphorus

Here we take a little detour. We burn sulphur. Sulfurum or solferos is the scientific name that means, ”the sun carrier.” Sulphur has a close connection to volcanic areas where it may be found in beautiful yellow crystals. It burns with mystical, sluggish and blue flame that is best observed in a blinded room. It melts when it burns and if you pour the burning mass on a plate, the drops fall like blue torches through the air. Eventually it spreads the characteristic, sharp and piercing smell around the room and a coughing concert takes place among the children. Up with the windows and doors, take five minutes in fresh air! Children remember such an experience with sulphur the rest of their lives. Then we experiment with smaller dosages of sulphur, using ventilation to avoid the bad smell. We capture the sulphur smoke in a high measuring glass by letting the sulphur burn at the bottom of the glass. Soon the glass is filled with thick, white smoke and the spoon with sulphur is carefully removed. The collected sulphur smoke is "poured" out, a heavy gas compared with the air. We "pour" some of the gas in a glass containing water and mix it well. The gas disappears, it dissolves into the water. If we taste the water, we notice an acidic taste that pricks our tongues. If we pour some blueberry juice into the water the color changes quickly to red. The same happens with red beet juice and litmus. In this way we approach acids—sulphur's acid.

This process may be repeated and done more powerfully using phosphorus. With the yellow phosphorus we must be extremely careful. It is very poisonous.

With sulphur we had combustion with large warmth development and little light. With phosphorus it is the opposite, an almost cold flame, but with great light distribution. The yellow phosphorus is self-ignitable and must therefore be kept under water. The red phosphorus is neither poisonous nor self-ignitable and is most suitable for these experiments.

As with sulphur, phosphorus smoke can be collected. It is heavy and easily "poured" out, dissolves easily in water and colors litmus red. A new acid is "discovered", namely phosphoric acid.

Carbonic acid

From these experiments a question is often asked, "Can we make "charcoal acid" if we burn wood? Children are convinced that it is possible. We agree that we need some preparation in order to succeed. The type of wood we will experiment with should first have no moisture or tar in it. This is done on a large scale at the kiln, but can also be done on a smaller scale. The piece of wood is put in a large test-tube with a cork pierced by a glass rod. If we warm the test tube over the flame we can watch the whole process of charcoal combustion. Soon tar collects inside the wall of the tube while a gas streams out of the glass rod. The gas is ignitable. Here we tell the children about the lack of gas during World War II and that instead of burning gas we burned "wood gas," what we see streaming out of the rod.

Our piece of wood is now charcoal, but to make catch flame is not easy. We need help so we introduce oxygen. For the experiment we use oxygen from a steel bottle. We need quite a bit. Among other things we notice that the burning charcoal pieces light up so brightly that we must look away to avoid being blinded. Our thoughts move to diamonds and their power of light. It is made of similar materials. When we place oxygen on the sluggish, blue sulphur flame, we can hardly believe our eyes. The vitality of the flames reminds us vaguely of the sluggish flame we saw earlier. We conclude that oxygen strengthens and intensifies our combustion remarkably.

With the help of oxygen we burn the charcoaled piece of wood. In a special combustion-proof glass we set the little piece of wood together with other charcoal pieces so we see the whole process much better. Oxygen is led into the glass while it warmed up carefully from the outside. As soon as the pieces of wood glow, the flames are taken away and the stream of oxygen can control the combustion. The charcoal smoke is almost invisible. It is lead into a glass with red cabbage juice. After a while it is colored red—it is a new acid, ”charcoal acid,” say the children. Or, if we choose, coal acid. We also observe that the charcoal gas puts out a burning light. These experiments are exciting because the gas is invisible. Now one of the children is allowed to blow air through a straw down to the litmus colored water. Shortly thereafter it is colored red, an unbelievable experience for many.

People breath out acids, so there must be an inner combustion if not an invisible flame. The topic that unfolds will be followed up in the eighth grade. It is fine if some questions remain unanswered in the class.

We have now burned three separate substances with very different character. Now the teacher can explain that with these combustions and the help of air oxides are created, in particular sulpheric oxide, phosphoric oxide and carbonic oxide. When the oxides are dissolved in water we obtain the acids of the materials. All of these acids color litmus paper red.

The wonders of lime

From the fiery and colorful “world of acids” we turn to something quite different. We deepen our understanding of lime and its processes. In the introduction it is important to present rich materials that can demonstrate manifold uses: all kinds of mussels and shells, bird eggs, pieces of skeleton and various limestone. Children should see how lime sculptures forms. The stalactite caves should be mentioned. How did they evolve?

The cycle of nature is a wonderful thing to tell children, with all of the changing formations and transformations. Decomposition and edification, again and again.

But how can we set lime in process? A lot of warmth must be used. Lime-burning ovens obtain that warmth with the help of coal, but we do not have such an oven. We must use “explosive gas flames” to obtain the comparable effect so we can see what happens when lime combusts. That is how we introduce hydrogen gasses that unbelievably light gas, which together with oxygen forms “explosive gas flames.” The fact that the flames are very warm is shown by placing a steel bar in it. The steel bar quickly becomes fiery white and turns into a sparkling inferno. This effective flame burns a piece of limestone, marble, for a while. On the outside we see no difference and we set aside for cooling.

This piece and an unburned piece of marble are the prerequisites for the next experiment. Two children hold each their own piece while a third pours water over both pieces. Naturally water falls right off the unburned piece but the burned one sucks in the water. Soon it becomes warm, so warm that the child must put it down. Steam rises and soon the whole stone falls apart. It becomes a pile of white powder. There is great excitement and many comments from the children. They cannot believe what they have seen.

When exposed to heat, lime emits carbonic acid that disappears with the gasses. All that remains is burned lime. If we add water to burned lime, the lime is refreshed. Slake lime colors litmus blue. Now we have reached the bases, the opposite pole of the acids. Bases are as slippery as soap.

We knew that the carbonic acid that disappeared during the combustion was an acid. Our conclusion is that limestone contains both an acid and a base. Such connections are called salts. Now we must address the whole process of building walls. It has huge cultural, historical significance. Burning lime has been known since ancient times. Slake lime was mixed with sand and used for masonry. When the process of hardening occurs the refreshed lime sucks in carbonic acid from the air and thereby returns to its original condition, limestone. To do so water must be emitted. Therefore new brick houses are wet and unhealthy. The hardening process can be increased by setting in ovens that release carbonic acid.

Finally we allow acids and bases to meet. We use strong salt acid **and sodium lye.** The combination is very strong but soon settles down. Then salt falls down - cooking salt. The acid that represents the light, fiery and airy has combined with the base that represents the heavy, earthly. Such forces are combined in salt!

Eighth grade: Sugar

We start the eighth grade chemistry block with sugar as our theme. Standing in front of an eighth grade class with a bag of sugar I wondered how to awaken excitement among them. The tough guys demanded gunpowder and dynamite, they were served sugar! There are many ways in chemistry to inspire teens to discover new insight in their daily routines.

First I wanted to explore how sugar relates to water. We dissolved as much sugar as possible in a little cooking water and watched the continual expansion of volume. In the end the volume doubled many times. It is amazing to see how excited the teens become when they observe simple phenomena while learning something significant about the nature of sugar. We let the sugar water cool off. First it became syrupy, then fairly tough. We hung a thin thread down in the fluid, and after a few days we had the most beautiful sugar crystals. At this point children need time to think about how the process can be put into action for practical purposes. They understand that this is the way to sugar glaze, syrup, jelly, marmalade, etc. As the next step; we let sugar meet fire. In a testube we carefully warm up the sugar and notice that it melts into a clear fluid. With continued warming it becomes golden brown, caramel smelling fluid that awakens great excitement. But we continue warming and notice that it becomes darker and darker brown, before finally ending as a black, smelly mass that emits burning gasses. We continue the experiment by bringing sugar in an iron crucible with top and warming it up strongly. A black mass pours out of the crucible. Suddenly it is all over. The crucible acts comically as it stands with the top to the side and what is left of the sugar is a porous charcoal mass. We blow a little sugar in a gas flame and observe how a little corn flames up like a little star.

Then it is natural to speak about the creation of sugar in plants. We refresh our seventh grade concepts of oxygen and carbonic gas and discuss how these two gasses play a role in the world of plants. A more complete description of the carbon assimilation process in plants can wait for the ninth grade. At this time it is more fruitful to work on the relationship between air, light and water. Light, air and warmth represent more the cosmic side that is above the earth while water represents the "earthly".

With the experiment we completed: sugar's relationship to water and sugar's relationship to warmth, we found the correlation to both sides. We saw that sugar actually is a product where both polarities meet in a harmonious unity. Sugar can therefore, without transformation, be taken up in the blood of humans and animals where it contributes to body warmth. With plants it is different. Here a large part of the sugar transforms to solid substances that the plant uses to make its gestalt.

From the history of sugar

Honey, that represents the plant's flower-region, was known in ancient times and was considered a very important source of nutrition.

A new element came during Alexander the Great's conquests from Persia to India where they "discovered" sugar cane. It was already a cultivated plant in India. It did not take long before sugar cane was known and grown all over Europe. But sugar cane, which represents the plant's stem and leaf region, was considered a luxury substance rather than a nutritional substance during the Middle Ages. Columbus brought sugar cane to the Americas, where many plantations grew forth. All of the human suffering that is related to these plantations must be discussed at this time.

Beetroot sugar, that represents the sub-earthly part of plant life, had its breakthrough during the Napoleonic wars. Napoleon tried to weaken England by blockade, stopping all supplies to and from the European continent. The beetroot sugar industry became a necessity.

We then learn to distinguish between the various types of sugar and the sugar carrying plants. Also, Fehling's experiment, that can prove small amounts of glucose in urine, is important to emphasize. Glucose's ability to reduce makes it possible for copper-oxide to be released from Fehling's liquids. A more blinding example of glucose's ability to reduce can be demonstrated by creating a silver mirror. Pure silver is reduced from a silver nitrate solution. Helped by glucose the reduced silver sticks to the glass walls and makes excellent silver plating.

Starch

Our starting point for learning about starch is potato flour and other types of flour. Flour can remind us of loafsugar, but you quickly discover the difference when you rub them between your fingers. Potato flour, which contains most starch, is much "drier." We spread some in a glass with water. First it swims on the surface and later sinks to the bottom. But it does not dissolve. We also examined how the four relate to fire. Rather than melt like sugar it quickly becomes charred. It flames up longer but not as brightly as sugar.

We speak about starch in plants. Sugar always retains a streaming movement through the plants. A characteristic feature of sugar is that it is found in a thinned, streaming condition in nature. The abundance of sugar that plants produce is transformed to starch. Starch characteristically appears in numberless small grains distributed throughout the plant and remains still. The starch grains are continually stored by the streaming sugar as a reserve. With weak light or at night the starch grains are again transformed and dissolved into sugar. The plant also stores starch in areas that stagnate, for example in tubes and seeds that contain large quantities of starch. Trees collect starch in their trunks during the summer and when they awaken to new life in the spring the starch transforms to sugar that is taken into the sap streams. Under a microscope we discover that every starch grain is characteristically formed for every plant. A professional chemist can identify which type it is. The potato, which is a child of the west, has starch grains that remind us of mussel shells with eccentric middle points. The rice plant, that represents the East, has a multi-leafed starch grain centered on a middle point.

Wheat is a more European product and has its starch grains formed concentrically around a middle point. These observations lead to meaningful discussions with fourteen to fifteen year-olds.

If we spread put a little potato flour in cold water and carefully pour boiling water in it, we see that the gray-white starch grains disappear. The boiling water becomes more and more hard and streaming; the steam bubbles must fight their way to the surface. Soon we discover that we have a pudding-like mass. Every single starch grain swells and looses it structure when it is in boiling water. The border between water and starch is washed out. We call this a colloidal state.

We displayed sugar with Fehling's liquid. Starch can also be proven with potassium iodide, as a dark brown-violet liquid. With the slightest presence of starch, the liquid takes on a strong, deep blue color. Now we can experiment with all kinds of vegetables and foods. It is unlimited how often potassium iodide reacts to starch. For example a piece of bread or potato gives a strong reaction to starch while a piece of carrot shows the characteristic blue color more spread out on the piece. The class becomes convinced that starch is an important part of our nutrition. And all of the starch-rich foods are transformed into sugar in our digestion, a process that already begins in our mouth when the foods meet our saliva. This theme can be followed up in a block on the human body.

The starch-pudding we made by setting starch in boiling water has been set aside for further experimentation. The pudding is now very hard and stiff and gives a strong reaction to potassium iodide. If we now add some acid hydrochloric acid to the pudding, an acid that is strong enough to dissolve metals, we see before our eyes a genuine transformation. The colloidal state is broken down and all that remains is a thin, streaming liquid. We let that solution cook a long while. During the cooking we take out two samples at intervals. We add potassium iodide to one sample and the Fehlings's liquid to the other. The result is that we observe how starch gradually transforms to sugar as the blue color is continuously reduced. At the same time the sugar concentration increases the longer the solution is cooked.

Cellulose

This process is also used on an industrial scale. After removing the acid the sugar is cleaned and steamed and sold in stores as glucose, dextrose, sugar cane, etc. Before we leave the starch theme we create starch by finely grating the potato. The grated potato mass is mixed in a beaker with water and set aside for a while. At the bottom of the glass lies a fine snow-white powder—potato starch. This is how simple it is to create potato flour industrially. We also spoke about making homemade alcohol.

Now the theme is cellulose. It is also made from the plant's living sugar stream.

Cellulose cultivates no grain as starch does, but chemically both are closely related. Everything that gives plants form is cellulose; from the finest nerve network in the flower and leaves to the fibrous stalk and down to the root system. The purest cellulose in nature is found in the plants fruit hair, for example in the cotton plant or the bog grass. Flax also has a long traditional application and is worth mentioning. The luster of a bundle of flax thread provides many associations.

Cellulose has great resistance against chemical and mechanical stress. Therefore can all materials can be removed by chemical or mechanical processes, leaving a pure cellulose, cell substance—a good basis material for the paper and clothing industries. We took the time to describe a spruce tree's path from the forest to the piece of paper in front of us.

Cellulose is a substance that is eaten in large quantities without being nutritious. The grazing animals are able to digest cellulose. We notice how a plant's sugar stream is such a mighty transformer. But when a plant transforms sugar to cellulose it no longer can turn it back into sugar, as is the case with starch. A permanent, stiff substance is created.

A bit about perfume

Against the " hardening process" the sugar stream moves in a continuously finer and finer substance to the flower region and transforms the flower in color, pollen and scent. We could not resist touching upon the manufacture of perfume.

The home of perfume is France, in particular La Province known as "The Garden of France" a sun-filled garden with excellent climate and protected fields where Catherine of Medici built a garden for making perfume. In this countryside the air has been filled with flower scents since ancient times. The scents have since been reproduced in perfume manufacturer's laboratories to be made into clouds of scents that are sprayed all over the world. Her you find endless fields of roses, violets, carnations, hyacinths, narcissi and mimosas. All of these leaves shall be made into perfume for all of the women in the world.

Every month has its color. In the spring the violets spread out their beautiful violet blanket, followed by the Easter lilies' golden bells, and on and on! Early in the morning while the flowers are still wet from the mist the leaves are picked by hand upon the fields. They are placed in large baskets before taken to the factories where their valuable essence oils are extracted. It can happen in three different ways: distillation, transferring the essences to fat substances or washing out the essences through petroleumeters. That huge numbers of flowers are needed can be seen in the following proportions: we need 1000 kg orange flowers to extract 1 kg. essence, and 5000 kg of rose leaves to make 1 kg rose essence. The right distribution and mixture of the valuable essence is the great art and secret of perfume.

Albumen

Our next theme is albumen. This substance is specially related to living forces. It is natural to start with chicken eggs and describe how the albumen that is inside the shell creates a new animal with all of its organs within 3 weeks. This albumen creates many processes that we know as feathers, neb and claws. If you are able to describe such processes the following experiments will more easily guide the children into the secrets of this substance. What is special about this substance?

It is very fluid but not like water, a state between moving and hardness that gives it pliable but keeps it from flowing away. If you heat it up it does not make it more pliable, but it becomes fatter, it becomes stiff, therefore it can carry so much life.

Fats and Oils

Fats and oils were the next step. Once again we started with the world of plants. In the seeds, where the germs for new life lie, fats and oil are created. The oil from sunflowers, cotton and olives are well known for everyone. But how the oil is extracted by cold pressing, warm pressing or extraction and then used as food oils, animal food, etc. is interesting for most children. Also in the animal kingdom among the warm-blooded sea-animals fats and oils are created on the periphery of their skins. The outer layer of fat supports the inner warmth processes and protects them from the outside cold.

To understand what fats are, it is important to look at its own consistence. Fat has its own form, but does not crystallize in the transition from liquid to solid form. Even when fat stiffens it retains flexibility with its smooth, butter-like consistence. Here warmth is at work, like no other substance; every heating or cooling raises or lowers the degree of flexibility and movement. Nowhere else in natures does warmth express itself in this way. The same is true for oils.

We chose experiments with practical uses in daily life; grilling with fat, oil in water, fat and oil meeting fire, etc.

Very characteristic for oil and fat is their relation with water—the substance where most life processes and chemical reactions take place. Fat and oil separate sharply from water by floating lightly on the surface. If you powerfully shake oil and water together, the oil will separate from the water and climb to the surface and form a new cohesive layer. To the contrary fat and oil can dissolve in liquids such as gas and ethers; liquids that easily ignite, but do not mix with water.

We also discussed how to make butter, margarine, candles and soap.

Ninth Grade:

Now the children are in the middle of puberty. They are not only physically mature but they are slowly become mature in their lives on earth. If you chose to help young people find a healthy development you must awaken interest and engagement in the world. Perhaps they will have less introspection and self-conscience that easily dominates at this age. Teens have enormous interest and enjoyment when they deepen their understanding of everyday things. My role is not to give them certain opinions but to be as objective as possible when I show them where the problems lie. I provide the freedom to figure it out themselves. Alcohol and the arms industry in relation to Alfred Nobel are good themes to address.

A natural starting point for this block is:

Photosynthesis

When we study carbonic acid assimilation we enter transformational processes that provide a basis for plant-life, animals and human beings. It is called photosynthesis. Ingenhouse, the man who discovered photosynthesis, described it accurately in his treatise of 1779. The title was: "Experiments upon Vegetables discovering their great Power of purifying the common Air in the Sun-shine, and injuring it in the Shade and at Night."

In his words: "I registered that the plants do not clean the air, as Priestley claimed; first after six to ten days, but that they complete this valuable process within a couple of hours. The origin does not take place in the plant's growth, as Priestley stated, but in the influences from the sunrays. I found that plants have a remarkable ability to transform the air taken up by the atmosphere into truly oxygen rich air. This cleaned air flows continuously from plants and enables the atmosphere to support life. The lighter the day, the more the plants receive sunlight and the faster the process continues. Plants that stand in deep shadows do not meet the prerequisites for cleansing the air; they give off destructive air that disturbs the atmosphere. Not all parts of the plants can clean the air, merely leaves and the green stems. Bad-smelling, poisonous plants have the same ability to clean the air as healing plants. The strongest, oxygen-rich air streams from the underside of leaves. All plants pollute the air at night.

This theme provides an excellent educational moment, a concrete starting point for a mysterious process that the children can penetrate. We are at the core of pollution and ecology. We realize that pollution cannot be stopped easily or quickly but must be addressed by a new way of thinking.

We try to demonstrate how photosynthesis and breathing take place and how the gasses relate to each other. If you breath into a glass with a limewater solution we can prove carbonic acid in our exhaling as the limewater becomes paler. We refresh our knowledge of carbonic acid from the seventh grade.

We demonstrate the plant's ability to develop oxygen in sunlight by using water plants. The oxygen theta is developed under water is collected in a funnel with rubber hose and a clamp. The collected oxygen is proven with a glowing woodchip. We also refresh our knowledge of oxygen from the seventh grade.

It is useful to draw a plant that stands between heaven and earth, surrounded by air. From the root water is taken in with a certain amount of salts that stream through the stalks and into the leaves. In the heavenly part of the plant carbonic acid is taken in by sun forces. There are also starches and sugar in the leaves. Now it is good to present a simple formula. Photosynthesis can be formulated as:

Carbonic acid plus water gives sugar and oxygen.

A glowing woodchip is held over the vessel with limewater. It fades. Therefore: carbon and oxygen become carbonic acid. But in the plants the opposite takes place: carbonic acid minus oxygen gives carbon.

Yet we find nothing black in a plant, no hardened carbon but starch grains and dissolved sugar that are flexible, moving, life-giving substances. Sugar is created by carbon and water, we call it carbon hydrate. It is living and moving carbon.

Carbon plus water gives carbon hydrate.

In other words air is the plant's coal mine.

We should also mention sugar combustion within the human being. It is the opposite of photosynthesis. We take in sugar and oxygen and breath out carbonic acid and water.

Sugar plus water gives carbonic acid and water. Sugar and starch were already characterized in the eighth grade. Now we can approach it more scientifically.

This starting point gives the block many new areas in chemistry.

Alcohol

The fermentation process from sugar is demonstrated by making a "composition" that is set aside. In the meanwhile we make experiments to see how the mixture emits carbonic acid during fermentation and a special smell appears. How do you separate the alcohol? Using the liquids various boiling points and an ingenious apparatus a flowing liquid can become steam and then cooled and condensed to liquid again. In that way we separate different substances from a mixture. I try to explain how we make alcohol starting with starch from potatoes or grain. The starch must first be changed to sugar, as we learned in the eighth grade.

Wine grapes provide a different starting point for alcohol. First the grapes should be described in more detail. We are told that if you cut a grape vine at the root, a waterspout can be sent thirty yards in the air from the pressure the plant creates at the root. When you tell how much warmth the plant demands, that the farther south it grows the sweeter it becomes, you understand the polarity that is united in these grapes; namely fire and water. If you let grape juice ferment, carbonic acid will be emitted and the sweet taste must give way to a strong, burning taste.

Sugar becomes alcohol and carbonic acid.

Sugar is taken directly into the blood, only the liver can regulate the percent of sugar. Alcohol skips past the liver so that the alcohol spreads throughout the entire body.

Here is short description of how alcohol works in the human body. The basis sugar in the body that gives a harmonious body control and willpower is replaced by alcohol, a false feeling of body control without our abilities being

Improved. Instead of a peaceful warming effect, a condition for exaggeration takes place. You become weak in your personality and you Self.

We also experiment with alcohol. Its motion and ignitability plus the unlimited dissolvability in water are characteristic.

Sometimes pupils prepare arguments for and against the use of alcohol. They are allergic to moralizing and it helps to approach the growing abuse of alcohol from the insight they have gained in chemistry. What does the abuse mean for the individuals, families and society as a whole? Can the problems be solved with stricter laws or higher costs for alcohol consumption?

Our experiments can take their understanding of alcohol to the next level. A fermenting mixture of alcohol with potassium oxide produces ether. The ether has both increased movement and ignitability, but the dissolvability is reduced. We know how the ether works on people from the ether narcosis. While the Self is weakened under the influence of alcohol, it is shut out completely by ether narcosis.

It is important to write down the alcohol table s in order to characterize the various types. Other tables such as; plant acids, fat acids and their salts can be written down and learned by heart.

The chemical industry: Alfred Nobel

Fat and oils are a continuation of the eighth grade curriculum. In the ninth grade we approach industrial uses such as creating margarine from oils and soap.

We obtain fat acids and glycerin when we separate fats. Glycerin leads us into the explosives industries. Alfred Nobel's discoveries and adventuress biography are valuable sources. We describe his greatness, all-sidedness and noble character and also his deeply problematic endeavors. He was split between mind and heart. The work he did on glycerin paved the way for new weapons while his heart protested against the use of weapons. From him we find the hopeless idea that remain in our modern times: prevent war by developing weapons! The revolutionary character of dynamite as used in great tunnels casts a dark shadow over the Nobel Peace Prize when you realize that the prize money comes from the weapon industries.

By treating fatty acids and their salts we learn about stearine acids and their salts that produce light. Stearine candles have a long history and their development is worth describing. We burn our candles and enjoy the atmosphere but few realize how much work enabled the easily burning, drip-free object. Notice how the wick bends away from the flame's area. Therefore it burns out and disappears on its own. This was solved one hundred years ago by weaving three threads but allowing one thread to be shorter than the other. Sometimes the wick does not bend away and most people have experienced such a problem candle. The teacher can refer to Michael Faraday's book, "Lectures on the Chemical History of a Candle," a series of lectures at Christmas 1860 for a group of young boys and girls. Faraday teaches us how to observe.

When we learned about fat and oil we also discussed crude oil. How the oil is brought out of the sea is a theme that excites ninth graders. It is refined at huge oil refineries that are a technical triumph. This is where distillation technology has reached it high mark. In the high, distillation towers crude oil's various components are driven to different zones according tot heir boiling point. We know these products from everyday life; gas, petroleum, heating oil, lubrications, vaseline and asphalt. We are dependent on all of these products but our use of them is often subject to egotistical use.

We have seen a few moments from chemistry lessons in the seventh, eighth and ninth grades. Our conclusion is summarized in the fact that lessons are most successful when they relate to relevant themes and problems. Because chemistry grasps everyone's daily life our main lessons can quickly move in unexpected directions.