A GREAT FILE ON PYRO-LOSIVE

VERY SIMPLIFIED AND INFORMATIVE

A MUST READ

PDA

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Boris
October 2nd, 2002, 07:23 PM
This has a bunch of black powder and ball mill files...They are all true,tried,and tested.....Most are written by me but if they are not I have permission from the author to post it....I am no where near done.I will have about 7-8 chapters when I am done and the high explosives chapter will have over 15 lessons...here is what I have so far...tell me if you see any mistakes....

The KGB Files

By Boris

Disclaimer: I hate disclaimers so I am not going to have one….even if I did write one you wouldn't read it… just don't fuck up.

Chapter 3 Low Explosives

Lesson 1 Definition of Low Explosives
Lesson 2 Safety for Low Explosives
Lesson 3 Flash Powder Safety
Lesson 4 Flash Powder Compositions
Lesson 5 Black Powder
Lesson 6 Thermite

Lesson 2

Lab Set-Up & Safety

By The Real

This was written mostly by The Real. This is a wonderful write up on setting up a lab and safety in the lab. This will be updated when ever The Real (when he gets out of prison) adds more.

This is the first of an on-going series on simple Lab. setup and techniques. I will post each section as I have time, so watch for them. Wherever possible I will suggest pieces of home hardware that can substitute for "official" lab-ware. I shall start with the basics and work up to special methods for organic chemistry. CHEMHEAD and others please feel free to comment and post any information that I have missed.

SAFETY: Leather work gloves are essential for cutting and bending glass tubing. To protect yourself from chemical splashes you need plastic apron, safety glasses, and sometimes rubber gloves. Speaking of splashes ALWAYS pour acid into water, slowly while stirring. NEVER pour water into acid as it may bubble and splash you.

LOCATION: You should locate your lab out of sight, but with excellent ventilation. In front of an upper floor openable window is ideal. loose drapes can be a fire hazard, a roll-down blind is better. Install on the window sill a small hook for the pulldown string, so that blind won't flap in the breeze. Venetian blinds are OK, except in strong winds. Any exhaust fan should not have sparking 'brushes" in its motor, these could ignite volatile vapours. Gas for the Bunsen can come from a portable propane tank hung outside the window like a flower box. Propane leaks will thus be outside the building. You will need running cold water and a drain pipe, also one or two electric outlets.

BENCH: Your work table (called a "bench") should be belt buckle high or a bit more. The bench may be raised by stepping each leg onto a brick or a cement block. It should be strong, able to support about a 100 lbs. safely - you do NOT want chemicals and flame dumped onto the floor. Hardware stores have various metal angle braces that go on with wood screws. You might get elaborate and install a small bar-style sink hooked up with rubber hoses. If you do this the faucet should have a high curve gooseneck, and a graduated "hose barb" on the wet end. This fitting is useful for feeding a distillation condenser by means of soft rubber tubing,

STORAGE: Install extra strong shelves near the bench but not over it. It is hazardous to reach over working apparatus for the next bottle of chemical! An old cupboard with locking doors is ideal for dangerous chemicals such as acids. A strong horizontal board with upwards angled finger-thick pegs (about 4 to 6 inches long) makes a good drying and storage rack for flasks. This resembles an old style coat rack, but is mounted head high on the wall. Liquid chemicals are stored in pourable bottles, dry or paste chemicals in wide mouth jars; all with tops on of course. Empty any bags or boxes of dry chemical into clean dry jars. these new containers must be clearly labeled with a band of packing tape and waterproof felt pen. Both container and top should not react with the chemical. Certain chemicals (such as silver compounds) are light sensitive and need a dark coloured container.

WASTE DISPOSAL: Never mix waste paper or rags with chemicals in an INDOOR waste basket. Some combinations are a fire hazard. Never sweep broken glass crumbs with hands, use a whisk and dust pan. Solid chemical waste can usually be put down a sink NOT fitted with a garbage disposal machine. flush down with lots of water. Waste acids may be neutralized in an earthenware crock half-full of broken up oyster or clam shells or marble stone chips. carbon dioxide will bubble up, when bubbles stop, drain off liquid and flush down drain with lots of water. Inflammable liquids do NOT go down drain, but pour out onto vacant land away from buildings, gardens, grass or trees.

LAB WARE: Glass is two types, "soft" or lime glass that can be re-shaped at home in Bunsen flame. "Hard" or pyrex glass is very heatproof, but cannot easily be reworked into different shape. Most flasks and beakers are "hard" glass but must be heated on asbestos wire-gauze pad, not over naked flame.

Glass Tubing: The common size 6MM O.D. glass tubing should be purchased 'soft" except for special applications such as the "hard" central tube in a distillation condenser. a couple of pounds of 6MM out side diameter (not bore size!) "soft" tube should last you for years. Hold "soft" tube with leather gloves and heat bend spot bright red with fan-shaped flame spreader on propane torch. a wide-wick kerosene lamp (no chimney) loaded with methyl alcohol will work. Practice to judge the correct bright red heat on about 2 inches of tube, then bend your angle. Place on heat proof surface to cool-BEWARE! it will be very hot even when glow stops. To cut glass tube, score crosswise with new sharp triangle file. Be sure to put some sort of handle on the pointed file tang. Hold tube either side of score in leather gloves -wear safety glasses- and bend the tube away from the score. The sharp cut ends are smoothed (flame polished) by simply heating past bright red to slightly molten.

Rubber Tubing: You need perhaps 10 to 15 feet of soft rubber tube that can be pushed over your glass tube. A drop of glycerine will lubricate the fit. There are tiny adjustable clamps called "pinch cocks" that can stop or regulate the flow through a rubber tube. There is a clear plastic lab tube called TYGON that is quite good, but does not "pinch" as well as rubber. The ends of plastic tubing are dipped into hot water just before fitting.

Cleanliness-practice it like your a religous fanatic, concerning labware, work areas, the floor, and of course yourself. Organic chemicals have the nast tendency of being readily absorbed through skin. Yes you should wear gloves, but that does not stop everything.

Know your chemicals, have an MSDS for everything you have, know how to use the MSDS, and have proper supplies for suppressing fires and cleaning spills.

Absolutely no food or drink in the lab whatsoever, no smoking, or drug use for that matter.

If possible transfer liquids via pippette or containers specifically designed for pooring (ie tip container, self dispensing, or able to use TFPE/glass stopcocks), this will eliminate spills and does allow for accurate measuring. To help reduce the risk of splashing Erlenmeyre flasks are great, but don't use if you expect a large amount of foaming.

Rubber Stoppers: When a stopper is TIGHT in the flask, nearly 1/3 should protrude. Plain fine grained cork is easier to drill, but rubber usually lasts longer and is less reactive. It is easier to buy 1, 2, and some 3 hole rubber stoppers as rubber is difficult to drill neatly. The correct drill for rubber has a sharp concavity; rather than a sharp point as in a normal twist drill. It is just possible to twist-drill rubber a 1/4 inch at a time by frequently lubricating the bit with damp bar soap. The stopper is gently held in pliers with ( ) shaped jaws. A drill press (medium speed, slw feed) really helps keep your hole straight and plumb. The drill bit should be about 3/4 the diameter of the glass tube. Lube stopper hole and tube with a little glycerine and wear leather gloves while twisting the tube into the hole. Never try to use the bent portion of a glass tube as a lever, as it will break. never try to insert glass tube while stopper is in a flask. If a tube is left in a stopper for some time, it may become stuck there. This is OK for permanent apparatus like wash bottles and distillation heads. Home brewery/wine-making stores have large diameter rubber stoppers that may fit old pyrex glass coffee pots.

Test Tubes: these are for testing reactions while using a minimum of chemicals. Typically there will be a row of them with slight variations in contents, to compare the effect of these small changes. They come in either "soft" or "hard" glass. The 'hard" of course stand heating better without breaking. perhaps the best size for home use is 1/2 to 3/4 dia. and about 6 inches long. The Chemical type has a pouring lip, the Biological type has no lip. There are small tongs available to hold hot test tubes. a test tube rack is easily made from scrap wood.

Beakers: These are 'hard" glass cylindrical cups with a pour spout and often milliliter volume calibrations. A group of different sizes can be nested together on a shelf say 50ml., 100ml., and 250 ml. there are kitchen pyrex measuring cups in several larger sizes up to 1/2 gallon. Note that a milliliter is "close enough" to a cubic centimeter C.C.

Flasks: These are "hard" glass but are not heated over naked flame because of breaking risk. There are two main types: "Florence' round bulb with small flat bottom. Used mainly for INDIRECT heated setups, such as water or sand bath over the Bunsen. "Erlenmeyer" has a conical bulb with large flat bottom, used in DIRECT heated setups with flask perched on wire gauze / asbestos pad over Bunsen. The necks are available in different diameters. For stoppers with multiple holes, or with a fractional distillation tower through a single large stopper hole; then a wide neck is necessary. The neck of a flask should be padded with asbestos or glass-fiber cloth whilst supported in a retort clamp. Otherwise the expanding hot glass may be cracked by the clamp.

Stands, Rings and Clamps: One useful stand is a inch diameter iron ring set about 8 inches high on tripod legs. These were intended to hold clay flower pots. A friend with a torch to do bronze-welding can make you retort stands, rings and flask clamps out of angle iron and Re-bar rod. From a Lab supply buy several wire-screens with asbestos center discs. These are called lab gauze, never heat beakers or flasks over naked flame.

Funnels: You need at least one glass funnel with a long stem. The most common size takes 11 cm. diameter filter paper formed into a cone. This is used for "through the stopper" applications on flasks. I have a white nylon long funnel that is quite good for most things. You must use filter paper, as regular papers are coated and do not work. Fold your disk of filter into quadrantal segments. One of these segments is folded across to overlap into a cone of paper. This fits well enough the 60 degree funnel cone. The household coffee filter funnel works for large volume filtration into beakers or jars. This funnel has a shoulder to make it perch on the rim of the receiving vessel. They come in single cup or whole pot sizes, use the ones that take filter paper not metal screen. The specialized "thistle tube" funnel is not used for filtration but for "through the stopper" direct introduction into flasks such as gas generating apparatus. There is also a "separating funnel" with a ground glass valve useful for adjusting the drip rate into a flask. Some of the esoteric branches of organic chemistry use filter funnels with most of the spout removed to prevent deposits condensing in the spout. Still others involve glass funnels warmed by sheet copper hot-water jackets!

Porcelain Ware: There are many small porcelain dishes from Oriental stores that will substitute. For example I have a suction flask made of a small Japanese teapot! The rubber suction hose goes over the narrow spout, a wide rubber stopper from Wine-Arts carrys the filter funnel and replaces the lid of the pot.

MEASURING: It is possible to make a two-pan balance with coiled bits of copper wire for weights. You will need to borrow some standard weights to calibrate the wire. A graduate column will be necessary for liquid volumes, and may also float a hydrometer for Specific Gravity (S.G.) measurements. You might need one or two pipettes for routine small volumes. Later I will explain simple "glass blowing" to make pipettes, but you will need a good one to calibrate the homemade. Some stick-form thermometers may be necessary, select them to clearly show the temperature ranges that interest you. A single all-purpose thermometer will not display small variations in temperature. I will explain this in the Distilling section where it becomes critical to hit correct boiling points (B.P.)

Keep the copper coil weights in a solvent to keep them free of oils and other organic chemicals. Also try to use good enameled wire to prevent oxidation. Calibrate at least 6mos and replace as necessary. MW35 18ga copper wire works great for such applications.

This is the second part of basic chemistry series. We will cover solutions, filtration, crystallisation, and several kinds of distillation.

SOLUTIONS: Solutions are two parts; the solvent and the solute.The solvent is the dissolving fluid, and the solute is the sobstance dissolved therein. Common solvents for Organic chemistry are: (single solvent class I) water, alcohol, ether, Ligroin (petroleum ether) , glacial acetic acid, benzene. (mixed solvents class II) water+ alcphol, water + glacial acetic acid, ether + Ligroin, and benzene + Ligroin. There are 3 ways of expressing solution; Percentage, Molar, and Normal.

Percentage Solutions: There are two ways to express percent solutions; percent solute by volume, and percent solute by weight. In the first way both liquids are measured by volume. In the second way both liquid and dry are weighed. To weigh a liquid, subtract the empty container weight from the weight of container + liquid. Molar Solutions: These are based on the molecular or Formula Weight of the solute. This weight is found by adding (the atomic weights using a table) of chemical elements in a typical solute molecule. M solutions are seldom prepared, and in many cases the solute will not dissolve in the theoretical amount of solvent. Fractional Molar solutions are thus more common, for example; M/4 meaning 1/4 gram formula weight per Liter of solution. Other examples are: 0.1M or M/10 each meaning 1/10 gram formula weight of solute per liter of solvent.

Normal Solutions: This is the most common expression of solution. The advantage is that equal quantities of reacting solutions having same normality N will combine with no left over waste. (I can't enter the simple equation on this one line entry.) In simple practise Normal Solutions are prepared using Equivalent Weights table rather than formula weight.

DISSOLVING the SOLUTE: Using water, glacial acetic acid, or not easily inflammable solvents, these may be heated in flask on wire-gauze pad over direct flame. Frequently stir or shake the flask to dissolve crystals on bottom, lest heat difference may break the flask. Flammable alcohol and benzine may also be heated

on wire-gauze over direct flame if small quantities are used. ......
Dont forget solvents such as dichloromethane (DCM, methylene chloride), toluene, chloroform (trichloromethane), acetone, nitromethane, nitroethane etc.
....If it ignites do not blow on it, but remove from flame and snuff flask with glass cover such as inverted small beaker. For large quantities of alcohol, benzine, ether, ligroin, carbon disulphate or other low B.P. (boiling point) solvents they are heated indirectly in flask nested in sand or water bath. These are supported metal bowls of water or dry sand surrounding a Florence flask. The bowl is heated from beneath by a bunsen. The flask stopper should have thick vertical glass tube to act as air cooled condenser and to spout vapour much higher than the flame. If the solvent is not miscible (mixable) with water, then the solute should be dried of water before adding to the flask. To achive the best crystallisation later, use ONLY ENOUGH solvent. Start with too little solvent to dissolve, and after heating add just enough new warm solvent for the stirred solute to disappear. Upon later cooling you will have supersaturation yielding lots and lots of crystals. Sometimes a mixed solvent (class II) is used; one solvent which easily dissolves solute, and another solvent that dissolves it with difficulty. first dissolve in hot "easy" solvent, then add the hot "difficult" solvent. Sometimes the solute will not disappear completely when the correct amount of "difficult" solvent has been added. Do not spoil your chance of future crystallisation by being tempted to add more solvent, just leave the little bit of slute undissolved.
FILTRATION: A suitable funnel containing a cone of filter paper is supported over the receiving vessel, often a beaker. This receiver is often pre-heated a bit to avoid cracking if hot solution is used. The spout of the funnel should touch the inside wall of the receiver so that the liquid runs down the wall rather than falling. To pour into the funnel without tearing thin wet filter paper, pour along a vertical glass rod you hold touching the inside of the funnel. Do not touch the rod to the inside bottom of filter cone, lest you puncture the wet paper. for hot organic liquids, the funnel spout may be shortened to prevent condensation in the spout. There are small abrasive cut-off wheels for the Dremel power tool that can cut glass. There is a thin rapid-filter paper available. For large crude chemical work use coffee filter funnels, most of which are designed to perch on a jar rim. these coffee papers are strong enough not to need the glass rod pouring technique, but do pour slowly. If inflammable solvents are used, turn off flame and sources of ignition before pouring. Boiling nitrobenzine, analine, phenol, may be filtered using regular filter paper. Some acids may require a nitrocellulose filter. This material is explosive when dry, and is stored wet in a jar. Only a few crystals should form in filter paper using HOT solvent. If lots of crystals form on paper whilst pouring, then too little solvent was used. You may elect to puncture the paper and return everything to the heating flask with a bit more solvent this time. It helps to keep records of amounts used so that future batches become

easier. Remember you can easily have too much solvent! Sometimes differently soluble crystals will condense between paper and funnel wall. For large quantities you need a large glass funnel kept warm by a custom made hot water jacket. For small quantities, a pyrex funnel may be gently pre-heated over a flame just before filtering.

CRYSTALLISATION: The size and shape of the container influence crystallisation. generally a beaker is good, as long as it is 1/2 to 1/3 full. the mouth is then covered with a filter paper, then a large watch glass or plate. The paper insulates the glass cover preventing condensation. The beaker must be left UNDISTURBED in a cool place during crystallisation, say the back of the refrigerator. If crystals form slowly, "seed" the solution by throwing in a pinch of the correct crystals. A common mistake is that you get a melted-looking substance rather than crystals. This is because the solution was too concentrated. so it's back into the heating flask with more solvent this time. See why careful experimental records are important? When you win crystals you need to remember exactly why and how for next time.

SEPARATION: Now the crystals are to be separated from the liquid (mother liquor). It is not good practise to simply dump into filter because crusts on side and rim of beaker are considered impure for Organic purposes. Suck out the crystal strata with a meat baster (like a huge eye-dropper). This is gently squished into a filter that has been moistened with solvent. The crystals caught in the filter are gently spray washed with fresh solvent to remove the last traces of the mother liquor. a small flat bottomed coffee filter is better than a conical lab filter, in that it spreads the crystals out for washing. In this it resembles the special BUCHNER organic filter. Do not wash too much, and begin to re-dissolve! A gentle little mist spray is enough.

If your solvent will not evapourate easily in air (i.e. glacial acetic acid, toluene, nitrobenzene, etc.) these must be mist-washed off the crystals with a more volatile solvent: drain and mist with half-and-half original and volatile solvents. Now drain and mist with pure volatile solvent. Example: original acetic acid solvent may be displaced in this technique by distilled water that will air dry.

DRYING CRYSTALS: The damp crystals must now be dried 1. air drying, 2. gentle heating by warm air stream, 3. chemical drying. For air-dry the crystals are spread out in thin layer upon several thicknesses of filter paper and covered with a large inverted funnel. A bit of air flow is important, so the funnel rim is stepped up on thick slices of cork. Forced drying by GENTLE heat is tricky as crystal form may be damaged. Always test a small amount before committing the entire batch and perhaps spoiling it. Crystals not easily soluuble in ether but crystallise from a solvent muscible with ether; can be thus quickly air dried after ether misting.

SECOND "RUN" CRYSTALS: Some substances are easily soluble in ALL available solvents and will crystallise only on partial evaporation. A good crystallisation dish is the pyrex kitchen casserole with matching flat glas lid. For air flow but to keep out most dust; this lid is to be lifted up with cross rods (I use chopsticks across small dishes.) Sometimes to get good crystals you need very slow evaporation, and a filter paper covered 1/3 full beaker is used instead of an evap. dish. leave undisturbed for a long time.

The rim and sides of the crystallisation vessel may now be scraped down to dissolve in the mother-liquor. A second 'run' of crystals may often be obtained by evaporating a bit of the solvent. the liquor may also be diluted with a second solvent that does not easily dissolve the solute. Examples: a solution in alcohol or glacial acetic acid may be diluted with water; OR a solution in ether or benzine diluted with ligroin to force crystals out of solution.

EVAPORATION may be rushed by surrounding the beaker with a desiccant in an enclosed space such as a covered plastic bucket. For absorption of water and/or alcohol use calcium chloride surround (granulated or fused) or sulphuric acid. Glacial acetic acid is absorbed by soda-lime, solid potassium hydroxide, or with sodium hydroxide.....

..Dehydrated magnesium sulphate or fused sodium sulphate are sometimes used for drying. Crystal purity depends on impurities being left behind in the mother-liquor, so do not allow solvent to evap. completely. Your crystals must be suctioned out meat baster) while still covered by solvent. After filtering your abundant crystals are mist washed and drained as before. If you have only tiny amount of crystals from small batch, spread them on clean dry unglazed porcelain plate such as the back of a ceramic tile. They are moistened only with the smallest possible mist of solvent (a perfume spray bottle)and the plate left tilted to dry.

DISTILLATION: This is a method of purifying a substance in solution by means of relative boiling points. The boiling point (B.P.) of a substance is characteristic and usually expressed at or about sea level atmosphere pressure. As air pressure drops with altitude B.P. also drops. This is why Mountaineers carry tiny pressure cookers so that they can still cook their (mostly liquid) food! There are several kinds of distillation technique roughly grouped by the heat range employed. At a given heat of the flask every substance that boils at or below that B.P. will distill over and be condensed into the receiving vessel. Every substance with a higher B.P. will be left behind in the flask.

Destructive Distillation: This is a very high heat range industrial method of cracking crude petroleum into various liquid fuels. Products are naptha, gasoline, kerosene, diesel, etc. Dry wood is so distilled for turpentine, creosote, methyl alcohol, etc.

Direct Heat Distillation: This is the most common for crude distillation; an Erlenmeyer upon a lab. gauze heated by Bunsen or large alcohol lamp. Distillation flasks should contain a few pieces of broken glass (about sugar-cube size) to prevent the boiling vibration known as "bumping". The stopper carries a stick-form thermometer 9with its bulb within the flask neck to read vapour temperature. The L shaped glass tube exiting the stopper is connected to the central condensation tube of a water-cooled condenser by rubber tubing. This condensing tube is long for low B.P. (up to about 100 C.) and short for high B.P. (well over 100 C) The idea is to get proper condensation without the substance depositing in the condensation tube.

Fractional Distillation: This means the separation of several substances by more precise attention to the B.P. of the desired distillate 'fraction". To prevent "hot spots" in the Florence flask, it is often seated in a stainless steel bowl of water or dry sand; the bowl being heated by the burner. I have a 2 liter Florence sand-nested in the base of an electric 1100 watt deep-fat fryer. The thermostat switch helps to regulate the heat, but I wish there were a more precise thermostat probe through-the- stopper. As it stands, I must monitor and hand regulate to some extent. Also the little spark at the thermostat contacts could ignite volatile vapours unless bench ventilation fan is working. I DO have an electronic thermometer through the stopper into the vapour. it looks a bit like a lolli-pop with a digital readout in either 14 to 392 F. OR -10 to 200 C. within about 1 degree. There is an automatic minimum / maximum recorded in memory for batch records. This is item BA 080008 from <a href="[Only registered and activated users can see links]" target="_blank">[Only registered and activated users can see links]>

The "head" of a fractional still is more complicated. The flask neck is short and wide to accommodate a fractional column, often called a bubble tower. Their purpose is that the higher B.P. fractions do not pass over, but condense and drain back into the flask. The vapour thermometer is inserted into the top most tower stopper, below which a glass tube exits on a downward angle to the condenser. There are three main forms: Wurtz, Linnemann, and Hempel. Wurtz has several ascending simple glass bubbles, and condensation occurs on upper surfaces of the bubbles. Linnemann has small platinum screens between the bubbles and is more efficient but can be a bastard to clean. Hempel has a simple neck rising through the flask stopper, then widening to the appearance of a fat test tube with a condenser side stem. This column is packed with glass beads, and the top-most stopper carries the vapour thermometer. In my homemade version I use white glass beads about the size of pearls. The Hempel is simple and best suited to serious production of distillate. It is necessary to slack off on the heat from time to time to allow the bubbles or beads to drain themselves back into the flask.

Collecting Fractions: ideal condenser action should be a steady drip, drip, drip with very little escaping steam. If there is considerable steam lost at correct vapour temperature, then your condenser column is not long enough or the cooling water flow should be increased. Usually the first few drips from a still are impure as they pass over below true boiling point. Until you stabilize at the desired B.P. the "first runnings" are often collected in a small beaker and discarded. Now comes the real fraction passing over at the true constant B.P. When the flask level becomes low vapour temperature often begins to rise in spite of your care. These "last runnings" are collected in a separate beaker. Never allow a still to run dry as the flask may break! Note that the best fraction is considered to be the long middle run at correct substance B.P. vapour temperature in the still "head".

Distillation in Steam: This technique is best known for extracting 'essential oils' from herbs. The distillation flask is not directly heated; rather water is boiled in another flask and live steam is piped into the bottom of the distillation flask. The distillation flask contents are so heated by this steam-hose effect, that fractions arise within the waste steam to the condenser.

Vacuum Distillation: The above methods are considered Normal distillation, in that evaporation occurs at roughly normal atmosphere pressure. Vacuum distillation uses considerably reduced and regulated air pressure. This method is often used for exotic Organic substances not volatile at normal atmosphere, in partial vacuum these fractions may be distilled without damage to the molecule. I have only assisted with Vac rig, and so am not competent to talk about them.

THIS ENDS THIS TWO PART ARTICLE.

Lesson 3

Common Chemicals

Probably the MOST asked questions are "where do I get chemicals?"
Here is a list that should answer many of those questions.

Acetaminophen generic Tylenol, grocery store/drugstore

Acetylsalicylic acid - aspirin, grocery store/drugstore (may require purification from binders and fillers for some purposes)

Acetic acid, dilute available as vinegar at grocery stores. Buy the cheapest white vinegar you can find; you don't want the flavorful organic traces of the more costly brands.

Acetic acid, glacial (concentrated) photo chemical

Acetone available as a solvent in paint stores/aisles and as an art supply.

Aluminum, foil - pretty obvious, at the grocery store. Be aware that most foil will not be pure aluminum but will contain small amounts of other elements such as silicon and iron.

Aluminum, powder - available as a filler for certain mixtures used with fiberglass; found at fiberglass suppliers (you may want to look online). The powder may come coated with some waxes or oils; these can generally be removed with cautious heating in an oven (BEWARE: aluminum powder is a flammable solid that burns with great heat once ignited) or rinsing with acetone.

Ammonium bifluoride, solution - hardware stores, as toilet bowl cleaner/rust stain remover
Ammonium hydroxide, dilute this is clear household ammonia. Beware, you don't want perfumed, colored, cloudy, or sudsy ammonia. Before buying, pick up the bottle and shake it. If it forms suds, you don't want it. I found plain, clear ammonium hydroxide at the local Thriftway as "Western Family Clear Ammonia."
Ammonium hydroxide, concentrated you can purchase a far stronger ammonia solution as a blueprint supply; search online (I've never seen a local blueprint supply store). This is not as concentrated as ammonia can get in water, but it is quite strong.
Ammonium nitrate available as prills at larger agricultural centers, in large sacks. You probably don't want to buy so much. Besides which the salespeople may be suspicious, since ammonium nitrate is easily converted to a blasting-grade explosive. More manageable amounts of ammonium nitrate (at much higher unit prices) can be found inside of instant chemical cold packs found in pharmacies/health aid aisles. Carefully cut open the outer plastic bag without puncturing the water bladder within, and store the pellets in an airtight container, since it is quite hygroscopic (absorbs moisture from the air).
Ammonium persulfate used to etch printed circuit boards; electronics store (catering to professionals; not Circuit City) or online
Ammonium phosphate available as a fertilizer, from agricultural/garden centers. I have actually seen this in chain stores too. Of course, you're once again stuck with a large container.
Ammonium sulfate another fertilizer that may not be too difficult to find.
Borax see sodium borate
Boric acid available from drugstore; I found mine at Bi-Mart.
Calcium chloride may be sold as a granular de-icing mixture at hardware stores; also sold as moisture absorbant in smaller containers.
Calcium carbonate chalk, marble, limestone - find these and you've found calcium carbonate.
Calcium hydroxide hardware store, garden supply center; may be called "lime," "hydrated lime," "slaked lime."
Calcium hypochlorite "shock treatment" chlorinating agent for pools. The purity varies considerably according to brand (examine the label). The purest materials may be hard to find outside of a dedicated pool/spa center.
Calcium nitrate a fertilizer - again, one that you're not likely to find at the local Target.
Calcium phosphate fertilizer
Calcium sulfate zounds, another fertilizer
Carbon, bulk charcoal. Get activated charcoal (expensive; drug stores) or natural lump charcoal (found near charcoal briquettes). Do not get charcoal briquettes. They

are full of grit and binding compounds.
Carbon, rods welding supply shop or the inside of non-alkaline dry cell batteries (increasingly hard to find these nowadays)
Carbon dioxide, solid "dry ice," useful for low-temperature condensations and (rarely) as a chemical; often found at party supply outlets. I get mine from the nearest Baskin Robbins.
Camphor drugstore
*Caustic soda, found in crystal Drano, and other brands of drain cleaner.
Dextrose drugstore, health food store, even (some) well-stocked grocery stores
Diammonium phosphate - nutrient for wine fermentation. I found mine in the brewing/wine section of the local Thrifway. Hooray for the Northwest, land of DIY alcohol!
Copper sulfate root killer, available at hardware/general stores, usually in the plumbing section; also at some pharmacies.
Citric acid I found mine in the drugstore section of the local Thriftway. But it was expensive - $9.00 for 113 grams! I have since found that citric acid is sold in conjunction with home soap making (search online) for far less. It is also a photo chemical and used in brewing. Some grocery stores may stock it (one alternate name is "sour salt.")
Corn starch baking aisle at grocery store
Diammonium phosphate nutrient for wine fermentation. I found mine in the brewing/winemaking section of the local Thrifway. Hooray for the Northwest, land of DIY alcohol!
Dichloromethane, is found in chemical paint strippers (not the newer, less-toxic ones); it is generally mixed with another chemical or even multiple other chemicals. For some purposes it may be used as-is. For others it will need purification (not covered here). Look in paint store/aisle or hardware store and read the labels on the cans of paint remover.
Ethanol most famous of all alcohols. The stuff people like to drink. You can purchase denatured alcohol as a solvent and fuel in paint stores/aisles, and this is mainly ethanol, but such alcohol also contains a significant percentage of methanol, which may interfere in some reactions. 95% pure ethanol (the remainder is water) can be purchased at liquor stores under a variety of names; the most famous is probably Everclear. You will, of course, need the cooperation of someone 21 or older, and it is pretty expensive due to heavy taxes. It would also be a good idea to explain beforehand to parents why you need this.
Ferric (iron) chloride etchant for printed circuit boards; good electronics store or online (not Circuit City); I've seen it at Fry's Electronics.
Glycerin drugstore
Hexamethylenetetramine, solid fuel tables for portable stoves, barbecues, and

campfires; found in sporting goods stores/aisles.

Hexamine see hexamethylenetetramine

Hydrochloric acid sold in paint stores/aisles, hardware stores, pool centers, agricultural centers, as "muriatic acid." As sold it is usually quite concentrated and will emit fumes of hydrogen chloride so it's not a great idea to use it indoors.

Hydrofluoric acid, dilute sold in grocery stores (cleaning aisle) and some hardware stores in brown plastic bottles as Whink rust stain remover. It is quite low concentration as sold; nonetheless, make sure you really do heed the safety warnings on the bottle.

Hydrogen peroxide, dilute grocery stores and drugstores

Hydrogen peroxide, less dilute sold in hardware stores, paint stores as part of "2 part wood bleach" kits or solutions. This hydrogen peroxide is generally between 30% and 40% concentration, as opposed to the 3% antiseptic solution from the drugstore. Thus it is not "concentrated," but it is far more potent than your garden-variety peroxide. Caution is definitely advised. You may be forced to buy 2 bottles of solution together in a kit when you really only want the peroxide bottle. The other bottle usually contains a solution of sodium hydroxide, sodium silicate, or a mixture of the two. Locally, at Portland Paint and Supply, I have found that "Daly's" brand wood bleaching solutions are sold unbundled, so I can just buy as much peroxideas I want without wasting money on the other solution. Solutions of 30% concentration, of very high purity (and no stabilizers!) can be ordered from a variety of places online. It seems to be used as a sort of home remedy for everything under the sun, so you might check health food stores also. Solutions in this approximate strength range (not as good as wood bleach, but close) can also be found at pool/spa centers. Salon centers sell concentrations between 6% and 12% for bleaching hair, but it is weaker than all of the above sources and fairly expensive too.

Iodine, tincture you know as well as I do that this is found in a variety of drugstores or pharmacy areas. Can be purified to yield solid iodine or used as-is for some experiments. The related "Betadine," which comes in larger containers, might be substituted for some purposes. Very large containers of iodine tincture may be available at agricultural supply centers for animal use, but you risk suspicion, since this has recently been a preferred iodine source for drug labs.

Iron oxide pottery supply

Iron sulfate pottery supply, some agricultural centers

Isopropyl alcohol grocery store, drugstore; many places stock 99% purity now, so get it in preference to 70% or 91%.

Lithium carbonate - pottery glaze material

Lithium hypochlorite - rare chlorination chemical; likely impossible to find outside of a dedicated pool/spa center or online retailer.

Lead easily found as balls and wire in sporting goods store/department

Lead oxide pottery/ceramics; may be sold as "red lead" or "lead red."
*Magnesium, found in camping stores as "firestarter bar".
Magnesium carbonate drugstore, perhaps some sporting goods stores
Magnesium sulfate "Epsom Salt(s)," often found at grocery store or drugstore; pottery supply; photo chemical; may also be sold as fertilizer.
Manganese dioxide pottery supply, fresh dry cell batteries (they need to be carefully disassembled and the black material removed).
Methanol this is the simplest alcohol of them all. Found as automotive gas-line antifreeze and water remover ("Heet" or similar), also available as photo chemical. If you just need a little bit and don't mind it being highly diluted with ethanol, denatured alcohol works.
Methylene chloride see dichloromethane
*Naptheline, found in mothballs bought in hardeware stores
Nitrogenous matter, organic once in a while books (especially older ones) may call for or reference "nitrogenous organic matter." Basically, this means anything that came from living creatures that has a considerable amount of nitrogen (usually indicates proteins) in it. Blood meal, made from dried animal blood, generally fits the bill. It is available as a fertilizer at many garden/agricultural centers (including ordinary chain stores).
Oxalic acid available as fairly pure crystals in the form of wood bleach powder; found in hardware stores and paint stores/aisles; photo chemical.
Potassium bromide photo supply; for some reason this is much cheaper than the sodium salt.
Potassium carbonate also known as pearl ash, or potash; may be found in some pool/spa pH raising products; used in pottery/ceramics; photo chemical; clean hardwood ashes contain a considerable amount (but for most purposes would want purification).
Potassium chloride found as a sodium-free alternative to salt in materials for softening hard water (found at supermarket, hardware store); beware that it comes in big sacks. May also be found in big sacks as fertilizer. Found in more convenient sizes (and greater unit price) as salt substitute in grocery stores; check label to make sure there is no sodium contained; also photo chemical.
Potassium dichromate pottery, photo supply
Potassium hydroxide, solution the main (only?) ingredient in some drain openers; check the label to be sure it's not sodium-based or an acid opener; found at grocery stores, hardware stores.
Potassium iodide photo chemical, also sold (generally as pills, sometimes pure) as an emergency supply to help prevent the body from absorbing radioactive iodine in case of a nuclear disaster (look at stores, online or off, catering to survival gear).
Potassium nitrate found as fertilizer in large quantities, also as stump remover (found

at garden centers) (this is my favorite compromise between price, size, and quality: $3.75 for a 5 pound box with some impurities); found at some drugstores (good purity, also expensive); may raise suspicions due to popularity of making pyrotechnics/smokebombs/black powder). Sold as a ceramic glaze component.
Potassium monopersulfate pool/spa non-chlorine shock treatment
Potassium permanganate sold for manually recharging water iron filters; I found mine at Sears in the plumbing section. I have checked around though, and not all Sears stores have it. So if a local Sears doesn't have it, order it from Sears' web site, or obtain it as a photo chemical (more expensive, though neither is exactly cheap). I believe that it was once found in drugstores, but I have never found it there. This may be another eye-raising chemical, since it can be used for fireworks/explosives and drugs.
Potassium phosphate fertilizer
Potassium sulfate fertilizer
Saltpeter see potassium nitrate
Silver nitrate photo supply or pottery; this is a very expensive chemical, so expensive that's almost worth buying some bullion silver and dissolving it in nitric acid yourself (pure silver is less than $6.00 an ounce and this chemical is more than $20.00/ounce).

Sodium bicarbonate "baking soda," grocery stores
Sodium bisulfate pH lowering chemical (solid) for pools
Sodium borate available as "laundry booster" for washing clothes; also used as flux for torch welding and ceramics
Sodium bromide sold in small packets for initial bromination of spas; also a photo chemical. Either way it's not cheap.
Sodium carbonate "washing soda" used to aid washing of clothes (grocery store, cleaning aisle); also sold as pH raising chemical for pools.
Sodium chloride ordinary table salt; don't get the iodized variety; you may want to recrystallize the salt to purify it of anti-caking agents (or try kosher salt if you can find it).
Sodium hydroxide grocery store or hardware store, sold as Red Devil Lye; small pellets in plastic bottle.
Sodium hypochlorite, solution liquid bleach, sold at grocery stores, or "liquid chlorine" (more concentrated) sold for chlorinating pools; both contain a good deal of sodium hydroxide although the bottle won't list it.
Sucrose this is ordinary white sugar
Sulfur may be available at drugstores as "flowers of sulfur"; sold for agricultural/garden use as dusting sulfur. The dusting sulfur may have up to 10% non-sulfur materials in it.
Sulfuric acid, concentrated when I first discovered this source I practically did a little

jig because sulfuric acid is such a commonly used chemical, yet hard to obtain (or so I thought). There are a number of "professional strength" drain opener liquids that contain sulfuric acid. They are not generally found in grocery stores, but should be in any decent hardware store with the plumbing things. Some brands are more concentrated than others, and some contain dyes and extra additives to protect your pipes. I have been pleased with "Rooto" brand; it seems to be concentrated acid with minimal additives. Other brands that are supposedly good include "Crystal Power," "Instant Power," and "Liquid Fire." All of these are easily recognizable because they come in a plastic bottle enclosed in a heavy clear plastic sack. The concentration of these acids is good (not azeotropic, but greater than 90%) but they may contain substantial impurities, because they are made with waste industrial acid (or so I have heard). Oh, and they really do open up drains like a charm.

Sulfuric acid, dilute sulfuric acid of approximately 30% strength is available as replacement battery electrolyte for lead/acid cells. It is found at automotive stores. Acid of 48% strength is available as a photo chemical. Per unit of acid, these are both more expensive than the drain opener, but should also be higher purity (especially the photographic). I have seen 10% sold as pH reducer for pools, but it's hardly worth buying at that concentration.

Tartaric acid I have seen this sold as a wine making supply

Toluene sold as solvent in paint store/department

Trichloroethylene Sold as Sunnyside Carbo-Sol, available at paint stores; may also be sold under other brand names.

Trisodium phosphate hardware store, cleaning aisle of grocery store. TSP is harder to find nowadays because of marine pollution concerns, so check the label to make sure it's not a similarly-named substitute.

Turpentine paint store/aisle, crafts/hobbies; the turpentine that I have smells deliciously of evergreens, but I understand that there are some varieties which smell foul. The natural stuff is harder to find than synthetic substitutes.

Xylene sold as solvent in paint store/department

*Zinc, can be found in hardeware stores as "moss remover". I have found it in two different forms: Pellets, and sheet (used on roofing).

Lesson 4

Incompatible Chemicals

By Boris

A wide variety of chemicals react dangerously when mixed with certain other materials. Some of the more widely-used incompatible chemicals are given below, but the absence of a chemical from this list should not be taken to indicate that it is safe to mix it with any other chemical!

acetic acid: chromic acid, ethylene glycol, nitric acid, hydroxyl compounds,

perchloric acid, peroxides, permanganates
acetone: concentrated sulphuric and nitric acid mixtures
acetylene: chlorine, bromine, copper, fluorine, silver, mercury
alkali and alkaline earth metals: water, chlorinated hydrocarbons, carbon dioxide, halogens, alcohols, aldehydes, ketones, acids
aluminium (powdered): chlorinated hydrocarbons, halogens, carbon dioxide, organic acids.
anhydrous ammonia: mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid
ammonium nitrate: acids, metal powders, flammable liquids, chlorates, nitrites, sulphur, finely divided organic combustible materials
aniline: nitric acid, hydrogen peroxide
arsenic compounds: reducing agents
azides: acids
bromine: ammonia, acetylene, butadiene, hydrocarbons, hydrogen, sodium, finely-divided metals, turpentine, other hydrocarbons
calcium carbide: water, alcohol
calcium oxide: water
carbon, activated: calcium hypochlorite, oxidizing agents
chlorates: ammonium salts, acids, metal powders, sulphur, finely divided organic or combustible materials
chromic acid: acetic acid, naphthalene, camphor, glycerin, turpentine, alcohols, flammable liquids in general
chlorine: see bromine
chlorine dioxide: ammonia, methane, phosphine, hydrogen sulphide
copper: acetylene, hydrogen peroxide
cumene hydroperoxide: acids, organic or inorganic
cyanides: acids
flammable liquids: ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
hydrocarbons: fluorine, chlorine, bromine, chromic acid, sodium peroxide
hydrocyanic acid: nitric acid, alkali
hydrofluoric acid: aqueous or anhydrous ammonia
hydrogen peroxide: copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, oxidizing gases
hydrogen sulphide: fuming nitric acid, oxidizing gases
hypochlorites: acids, activated carbon
iodine: acetylene, ammonia (aqueous or anhydrous), hydrogen
mercury: acetylene, fulminic acid, ammonia
mercuric oxide: sulphur

nitrates: sulphuric acid
nitric acid (conc.): acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulphide, flammable liquids, flammable gases
oxalic acid: silver, mercury
perchloric acid: acetic anhydride, bismuth and its alloys, ethanol, paper, wood
peroxides (organic): acids, avoid friction or shock
phosphorus (white): air, alkalies, reducing agents, oxygen
potassium: carbon tetrachloride, carbon dioxide, water
potassium chlorate: acids
potassium perchlorate: acids
potassium permanganate: glycerin, ethylene glycol, benzaldehyde, sulphuric acid
selenides: reducing agents
silver: acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
sodium: carbon tetrachloride, carbon dioxide, water
sodium nitrate: ammonium salts
sodium peroxide: ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulphide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
sulphides: acids
sulphuric acid: potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium, etc.)
tellurides: reducing agents
zinc powder: sulphur

Lesson 5 Glossary of Explosives

By Boris

AMMONIUM NITRATE

Is classified as an oxidizer. An oxidizer is a substance that readily yields oxygen or other oxidizing substances to promote the combustion of organic matter or other fuel. Ammonium nitrate alone is not an explosive material. However, Federal explosives storage regulations require the separation of explosive magazines from nearby stores of ammonium nitrate by certain minimum distances.

ANFO

An explosive material consisting of ammonium nitrate and fuel oil.

BLACK POWDER

A deflagrating or low explosive compound of an intimate mixture of sulfur, charcoal, and an alkali nitrate (usually potassium or sodium nitrate). See LOW EXPLOSIVES.

BLASTING AGENT

Any material or mixture consisting of fuel and oxidizer intended for blasting, not otherwise defined as an explosive, provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test blasting cap when unconfined.

BOOSTER

An explosive charge, usually a high explosive used to initiate a less sensitive explosive. A booster can be either cast, pressed, or extruded.

BULK MIX

A mass of explosive material prepared for use in bulk form without packaging.

COMMERCIAL EXPLOSIVES

Explosives designed, produced, and used for commercial or industrial applications, rather than for military purposes.

COMMON CHEMICALS

Any chemical compound or element that, as part of a physical mixture, would be necessary for that mixture to be considered an explosive mixture; or any chemical compound or element that could be classified as an oxidizer or as a readily available fuel.

C4

A military plastic/moldable high explosive.

DEALER (FEDERAL)

Any person engaged in the business of distributing explosive materials at wholesale or retail.

DETECTION TAGGANTS

A marker or taggant placed into an explosive material that has utility before a bomb explodes.

DETECTION TAGGANTS WITH IDENTIFICATION CAPABILITIES

A marker or taggant placed into an explosive material that has both pre-blast and post-blast utility.

DETONATION

An explosive reaction that moves through an explosive material at a velocity greater than the speed of sound.

DETONATOR

Any device containing an initiating or primary explosive that is used for initiating a detonation. A detonator may not contain more that 10 g of total explosives by weight, excluding ignition or delay charges. The term includes, but is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with safety fuses, detonating cord delay connectors, and nonelectric instantaneous and delay blasting caps which use detonating cord, shock tube, or any other replacement for electric leg wires.

DETONATING CORD

A flexible cord containing a center core of high explosive and used to initiate other explosives.

DMNB
2,3-Dimethyl – 2,3-dinitrobutane. One of four high-vapor pressure chemicals approved by the U.N. Council of the International Civil Aviation Organization (ICAO) to be added to plastic explosives as a detection marker.

DYNAMITE
A high explosive used for blasting, consisting essentially of a mixture of, but not limited to, nitroglycerin, nitrocellulose, ammonium nitrate, sodium nitrate, and carbonaceous materials.

EMULSIONS
An explosive material containing substantial amounts of oxidizers dissolved in water droplets surrounded by an immiscible fuel.

EXPLOSIVE
Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion.

EXPLOSIVES INCIDENTS
This term encompasses actual and attempted explosive/incendiary bombings, stolen, and recovered explosives, hoax devices, and accidental explosions, as defined in ATF’s Arson and Explosives Incidents Report.

EXPLOSIVE MATERIALS
These include explosives, blasting agents, and detonators. Explosive materials include, but are not limited to, all items in the List of Explosive Materials.

EXPLOTRACER TAGGANT
ExploTracer is based on synthetic granules dyed with fluorescent pigments and iron particles. To ensure that each particle has a distinctive code of its own, rare earth elements are added.

FERTILIZER
A substance used to make soil more fertile, such as ammonium nitrate.

FILLER
A type of explosive/incendiary/chemical substance which, in combination with a fusing and/or firing system, constitutes an improvised explosive device (e.g. dynamite, match heads, gasoline).

FLAMMABLE LIQUID
Combustible. A flammable material is one that is ignited easily and burns readily, i.e., gasoline, charcoal lighter fluid, diesel fuel, and paint thinners.

FUEL
Any substance that reacts with the oxygen in the air or with the oxygen yielded by an oxidizer to produce combustion.

HIGH EXPLOSIVES
Explosives which are characterized by a very high rate of reaction, high pressure development, the presence of a detonation wave in the explosive, and which can be

caused to detonate by means of a blasting cap when unconfined.

HF-6 TAGGANT

HF-6 is similar to the 3M (Microtaggant) and is coded according to its several layers of color. The HF-6 taggant was developed by Swiss Blasting, and is used exclusively in its own products.

HMTD

An abbreviation for the name of the explosive hexamethylene triperoxide diamine.

ICPM

A minute post-blast taggant manufactured by Synthesia, Czech Republic. The taggant is comprised of Urea Formaldehyde Resin, Silicon Oxide, Rhodamin B, Iron, and oxides of metal.

IDENTIFICATION TAGGANTS

A marker or taggant placed into an explosive material that has utility after an explosion to identify the manufacturer, the date, and shift when it was manufactured. Once this type taggant is located and identified, the information it provides would allow law enforcement to trace all of the same type explosives manufactured on that specific date and shift to all of the legal purchasers.

IMPORTER

Any person engaged in the business of importing or bringing explosive materials into the United States for purposes of sale or distribution.

INTERSTATE OR FOREIGN COMMERCE

Commerce between any place in a State and any place outside of that State, or within any possession of the United States (not including the Canal Zone) or the District of Columbia, and commerce between places within the same State but through any place outside of that State.

INTRASTATE

Pertaining to or existing within the boundaries of a State of residence.

ISOTAG

A readily identifiable, mass-enhanced, non-radioactive molecular marker that employs the unique chemical structure of the host product without harm to the quality of the product or the environment.

LICENSE (FEDERAL)

Required if a person is intending to engage in the business as an explosive materials manufacturer, importer, or dealer and allows a person to transport, ship, and receive explosive materials in interstate or foreign commerce.

LICENSEE

Any importer, manufacturer, or dealer licensed under the Federal explosives laws.

LOW EXPLOSIVES

Explosives which are characterized by deflagration (a rapid combustion that moves through an explosive material at a velocity less than the speed of sound).

MARKER

See Taggant.

METRIC TON

2,204.6 pounds or 1,000 kilograms.

MICROSPHERE

A solid glass ball, 37-840 microns in size, which can be manufactured to contain different chemical compositions to be used as identifiers.

MICROTAGGANT

Color-coded, polymer microchip consisting of ten layers including a magnetic layer and a fluorescent layer, which is intended to function as an identification taggant. The chip was developed by the 3M Company, but is now manufactured by Microtrace, Minneapolis, Minnesota, which acquired the rights to production in 1984.

NITROGEN (N)

N is one of the three primary plant nutrients, together with phosphorus (P) and potassium (K).

OTHER

For purposes of the AEIR, the category of Other includes: match heads, military explosives (excluding C4 and TNT), improvised mixtures, flares, boosters, detonating cord, gases, blasting caps, PETN, RDX, HMTD, model rocket propellant, and smoke grenades.

OXIDIZER OR OXIDIZING MATERIAL

A substance, such as a nitrate, that readily yields oxygen or other oxidizing substances to stimulate the combustion of organic matter or other fuel.

PERMIT

Is required if any person intends to acquire for use, explosive materials from a licensee in a State other than the State in which he/she resides, or from a foreign country, or who intends to transport explosive materials in interstate or foreign commerce.

PERMITTEE

Any person who has obtained a Federal User Permit to acquire, ship, or transport explosive materials in interstate or foreign commerce.

PERSON

Any individual, corporation, company, association, firm, partnership, society, or joint stock company.

PETN

An abbreviation for the name of the explosive pentaerythritol tetranitrate.

PHOTOFLASH AND FIREWORKS POWDER

An explosive material intended to produce an audible report and a flash of light when ignited, and typically containing potassium perchlorate, sulfur or antimony sulfide, and aluminum metal.

PRECURSOR CHEMICALS

Any chemical compound or element which can be subjected to a chemical reaction or series of reactions in order to synthesize the chemical compound or element into an explosive compound.

PYROTECHNIC

A chemical mixture which, upon burning, produces visible, brilliant displays, bright lights, or sounds.

RDX

An abbreviation for the name of the explosive cyclonite, hexogen, T4, cyclo-1,3,5,-trimethylene-2,4,6- trinitramine; hexahydro-1,3,5,-trinitro S-triazine.

REWORKED EXPLOSIVES

Any residual or off specification material which can be recycled within the manufacturing process.

SMOKELESS POWDER

Any of a class of explosive propellants that produce comparatively little smoke on explosion and consist mostly of gelatinized cellulose nitrates.

SPECIALTY EXPLOSIVES

Any specialty tool used for a particular purpose other than blasting, such as explosive-actuated device (jet-tappers, jet perforators), propellant-actuated power device (construction nail guns), commercial C-4, detasheet, oil well perforating guns, etc.

SLURRY

An explosive material containing substantial portions of a liquid, oxidizer, and fuel, plus a thickener.

TAGGANT

A solid, liquid, or vapor emitting substance put into an explosive material for the purposes of detection or identification. Also known as a marker or tracer element. (For purposes of this report, "tagging" is the act of marking or adding a taggant to an explosive material.)

TATP

Triacetone Triperoxide – A highly sensitive primary explosive manufactured from common chemicals such as acetone, peroxide, and acid.

TNT

An abbreviation for the name of the explosive trinitrotoluene.

TON

2,000 pounds or 0.907 metric ton.

TRACER ELEMENT

See Taggant.

UNDETERMINED

For purposes of the AEIR, the category of Undetermined captures incidents in which fillers could not be identified through laboratory analysis or incomplete data that was reported.

UREA AMMONIUM NITRATE (UAN)

UAN solution is a popular liquid fertilizer in the United States and other industrialized areas.

USERS

Any persons who purchase and use explosives within their State of residence and are not Federal licensees or permittees.

WATER GEL

An explosive material containing substantial portions of water, oxidizers, and fuel, plus a cross-linking agent which may be a high explosive or blasting agent.

Lesson 6

How to Make Your Own Ball Mill

By Boris

A ball mill is device that can be used to grind chemicals much more easily and to a finer consistency than can possibly be done by hand with a mortar and pestle. It is often usefull to grind chemicals in order to increase their surface area. This will generally increase the rate at which they react in a pyrotechnic composition and make mixtures more homogenous which results in a steady burn rate. For making good quality black powder at home a ball mill is essential, and black powder is needed in very many pyrotechnic devices.

Note: ball milling inevitably causes friction and shocks and possibly leads to static electricity buildup as well depending on the design. Ball milling of mixtures should only be attempted when an appropiate place is available to operate the mill (ie one where it causes no damage or injury in case of explosion) and it must be turned on and off remotely. Most chemicals can be milled more safely but several sets of balls and containers must be available to prevent contamination and milling of metal powders can be dangerous as they may become pyrophoric.

Materials

I used whatever I could get cheaply to construct my mill,you can always buy one for a couple hundred dollars at a pyrotechnic web site,I've even tried buying rock tumblers but they are really are not for the job most people do, if you just need like 1/8 lb of something or dont really want to get into the big steps and everything by all means go to your local rock or science shop and get one,they are relativly cheap but they are known to break easliy and any ways most only hold like less than a half a pound,so if you dont want to fool around with that heres how to make one of a higher capacity.You will probably not be able to get the exact same materials and you'll have to improvice somewhat.

Motor: I used to use a electrically powered drill to drive my mill, but several people have advised against it as these are not designed to operate for extended periods of time. They tend to get excessively hot and eventually fail. Old motors can be found in many places for little or no money. Washing machines for example contain durable motors and are often plentifull at scrap yards. Mine came from a pump from an old coffee machine.

Container: A piece of PVC sewer tubing works well. I use a 34 cm long 11 cm diameter piece, with two fitting end caps. PVC is hard and will not suffer from erosion as much as most other materials I've tried. This container has lasted about 150 hours of operation thus far and shows no visible signs of wear. One point of discussion is that PVC may accumulate significant amounts of static electricity during operation. I've tested if the container is able to attract small chips of polyethylene right after use, which it doesn't. I'm not entirely convinced PVC is harmless though. For some more ideas on this matter, check out this page on the charging of powders in a rotating drum. Strips of rubber from a bicycle tire are glued around the casing with hot melt glue to improve its grip on the roller.

Roller: The roller is conveniently made of PVC tubing as well. I used 2.5 cm outer diameter sewer tubing, but the diameter may be chosen depending on the speed of the motor availalable. The ratio of 2.5 cm (roller) to 11 cm (container) yields a factor 4.4. reduction in speed. As the motor operates at about 250 rpm, the container would theoratically rotate at a rate of about 60 rpm. In practice it reaches 50 rpm due to slipping. Somewhat faster would be more efficient. It used to operate at 80 rpm when I was still using the drill, and black powder would be ready in 3 hours. Now, it takes 5 hours to obtain a similar quality, but the time gain is not worth an expensive tool. The roller is coated with rubber to improve grip on the container. I did this by sliding the ends of cut inner tube from a bike tire on the ends of a piece of 2.5 cm PVC tubing. Inflating the tube allows it to slide over the PVC as the air escapes.

Media: Most of the money was spend on media. I bought 150 lead balls of 1.78 cm diameter in a hunting supplies store. They are used for reloading rifles. Lead and brass media are preferred as they don't spark. Sparks could accidentially ignite the mixture you are milling, with disastreous results. Other media such as glass, steel or ceramic can be used for pure chemicals and non explosive mixtures but not for ignitable substances. How much media will you need? I recall that it is most efficient to fill exactly half of your container with balls. My container is 11 cm diameter and 34 cm length, which took 150 lead balls of 1.78 cm diameter.

Assembling

Constructing the mill is fairly simple. The container rests on the roller and two small wheels. A copper rod lengthwise through the roller is driven by the motor on the right.

Using the mill

Ball milling can be dangerous. It inevitably causes friction and shocks that could ignite a mixture. Depending on your container and media material and the substance you are milling the process can generate static electricity as well. Milling metals can make them pyroforic. When a mixture ignites inside the mill the results can obviously be disastrous. The explosion will produce large amounts of shrapnell from the media and the milling container that can be hurled away hundreds of meters. Under no circumstances should you attemp to mill explosive mixtures such as black powder inside or near a building. Operate it on a piece of open terrain and turn the ball mill on and off remotely. Barricade it with sand bags. You can often safely mill pure compounds, but be aware that metals (which can be milled with steel media) can become pyroforic and ignite when you open the milling container (thereby letting oxygen in).

Pyroforic metal powders can be very treacherous. They do not necessarily ignite immediately (although it could happen), but after some time when you think they are safe since there has been no reaction upon contact with air. When ignition occurs expect a large, extremely hot ball of flame, the burns of which can easily cause a painfull death. Use your common sense when ball milling and be prepared for the worst.

I do not know wheter the materials I chose for my ball mill (PVC and lead) generate static electricity. I have prepared many batches of black powder in my mill (using a wet process) and have not had any accidents so far.

Lesson 7

CHEMICALS

Acetone, 2-propanon

Formula: C3H6O

Description: Acetone is a very volatile flammable liquid which is commonly used as a solvent. Nitrocellulose and red gum both dissolve very well in acetone. The solution of nitrocellulose is called nitrocellulose lacquer. Working with acetone can be difficult as compositions dry out very quickly. The evaporation of the acetone also causes cooling of composition, sometimes even below 0 deg C. This can result in condensation of water.

Hazards: Acetone is very volatile and flammable. Acetone vapour is heavier than air and spreads over the ground. Only work with acetone outside or in a well ventilated area.

Sources: Acetone can usually be bought at any paint store. Making acetone at home is very impractical and unneccessary as it can be bought just about anywhere at low cost.

Antimony trisulfide, realgar

Formula: Sb2S3

Description: Antimony trisulfide is a fuel which is sometimes used in glitter compositions, fountain compositions and flash powder. For the latter purpose however it is used less and less as it is very poisonous and can usually be replaced by sulfur or completely ommited. Flash compositions containing antimony trisulfide are very sensitive to friction, shock, and static electricity.

Hazards: Antimony trisulfide should never be used in any mixture containing chlorates or spontaneous ignition may occur. Mixtures with antimony trisulfide and perchlorates are very sensitive to friction and shock and extra caution should be exercised when handling these mixtures. These mixtures are best avoided at all. Wear proper protective clothing including a dust mask, when working with compositions containing antimony trisulfide as it is very poisonous.

Sources: Antimony trisulfide is sometimes sold as a pigment in (art) paint stores, but is not used very commonly these days due to it's toxicity. It can be made at home by fusing a stochiometric mixture of antimony metal and sulfur. This is a very dangerous operation since extremely toxic fumes will form and it should only be performed with proper safety precautions taken.

Aluminum

Formula: Al

Description: Aluminum powder is one of the most often used fuels in pyrotechnics. A wide range of effects are possible with different types of powder, depending on particle size, shape and impurities. The finest powders (sometimes reffered to as 'dark' aluminum) such as the well known 'german dark' are used mainly in flash. Fine aluminum is also used in small percentages in some rocket fuels. Coarser powders are generally used for spark effects. Depending on the particles shapes, sizes and compositions many different effects such as flitter, glitter, firefly and snowball can be achieved.

Hazards: A dust mask should be worn when working with aluminum powder. Mixtures containing nitrates and aluminum powder are prone to heating up spontaneously and may ignite, especially when wet. This is caused by the reduction of the nitrate by aluminum, forming amides. These very basic compounds react further with aluminum powder in a very exothermic reaction that can cause spontaneous ignition. An ammonia smell is often produced in this reaction. Adding 1 to 2% boric acid to compositions containing nitrates and aluminum is common practice and will often prevent spontaneous ignition, although this should never be relied upon. It is advisable to avoid using water to bind such compositions. Red gum or shellac with alcohol or nitrocellulose lacquer are preffered binder and solvents.

Sources: Aluminum powder is sometimes sold as a pigment in (art) paint stores. This powder, known as 'aluminum bronze', is a flaky powder with a stearin coating. It is quite expensive but readily available and a source for small quantities. Aluminum grit and turnings can sometimes be found in machine shops were aluminum is processed. If fine enough this can be used as is, but it can also be ball milled into flakes. These flakes are quite reactive as they have a large surface area and can be used for several effects. Aluminum powder can also be made by sanding aluminum chunks. I've heard of people building a machine to do this, and the results can be quite good depending on the sanding paper used and the setup.

Ammonium chloride

Formula: NH_4Cl

Description: Ammonium chloride is used in smoke compositions. When heated ammonium chloride decomposes to HCl and NH_3, both gasses. These recombine in the air to give a smoke consisting of fine particles of ammonium chloride.

Hazards: Ammonium chloride based smoke is irritating to the eyes and lungs as it contains some remaining HCl and NH_3. Ammonium chloride itself is not poisonous and is even used in some type of candy. Ammonium chloride is an exception to the rule that ammonium compounds should never be mixed with chlorates. In most mixtures that would result in the formation of ammonium chlorate which is likely to result in spontaneous ignition. Ammonium chloride can be used in mixtures containg potassium chlorate since potassium chlorate is much less soluble than ammonium chlorate. Hence no double decomposition reaction will occur.

Sources: Ammonium chloride solution is easily prepared by neutralising ammonia solution with hydrochloric acid. It is advised to use a slight excess of ammonia. That is to make sure no remaining acid will be present in the ammonium chloride obtained on evaporation and crystallisation. Otherwise traces of the acid solution may be enclosed in the crystals, possibly leading to spontaneous ignition of mixtures made with it.

Ammonium nitrate

Formula: $NH_4 NO_3$

Description: Ammonium nitrate is an oxidiser. It is very hygroscopic and therefore not used very often in fireworks. It finds some use in composite propellants, but performance is not as good as perchlorate based propellants.

Hazards: Large masses of ammonium nitrate have been known to explode on some occasions although it is very unsensitive. Smaller quantities are less likely to detonate. The risk of detonation increases when ammonium nitrate is molten or mixed with fuels such as metal powders or organic substances. Ammonium nitrate should never be mixed with chlorates as this may result in ammonium chlorate formation, possibly leading to spontaneous ignition. Mixtures of metal powders and ammonium nitrate are likely to heat up spontaneously and may ignite, especially when moist. This can sometimes be prevented by the addition of small amounts of boric acid (1 to 2%), but in general it is better to avoid these mixtures at all. The hygroscopic nature of ammonium nitrates makes this problem worse (also see aluminum).

Sources: Ammonium chloride solution can be prepared by neutralising ammonia solution with nitric acid. It is advised to use a slight excess of ammonia. That is to make sure no remaining acid will be present in the ammonium nitrate obtained on evaporation and crystallisation. Otherwise traces of the acid solution may be enclosed in the crystals, possibly leading to spontaneous ignition of mixtures made with it. Large quantities of ammonium nitrate can also be cheaply bought as fertilizer. In the Netherlands a fertilizer called 'kalkammonsalpeter' is sold. This consists of ammonium nitrate mixed with 'mergel', a mineral consisting mainly of calcium carbonate. The ammonium nitrate can be extracted with water.

Ammonium perchlorate

Formula: NH_4ClO_4

Description: Ammonium perchlorate is an oxidiser used in a large number of compositions. Very impressive color compositions can be made with it, but their burn rate is often too low for use in star compositions. For lancework and torches slow burning is an advantage and it is therefore commonly used in these items. Ammonium perchlorate is also used in composite rocket propellants, including the propellants used in the solid propellant boosters used for the space shuttle. The decomposition products of ammonium perchlorate are all gasses which is very beneficial for rocket propellants.

Hazards: Ammonium perchlorate can detonate by itself, although it is not very sensitive. Larger amounts and mixtures of ammonium perchlorate with metal powders or organic substances are more likely to detonate.

Sources: Ammonium perchlorate is usually bought from chemical suppliers and from dedicated pyro suppliers such as skylighter. Fine ammonium perchlorate powder is a regulated substance in most countries and cannot easily be bought or transported. Since it is such a usefull chemical in pyrotechnics it can be worth the time and effort to try to prepare it at home. This can be done by first making sodium perchlorate followed by double decomposition with ammonium chloride (other ammonium compounds can be used). The preparation of sodium perchlorate is most easily accomplished by electrolysis, the procedure for which is described elsewhere on this page.

Barium carbonate

Formula: $BaCO_3$

Description: Barium carbonate is used both in white and green color compositions. When chlorine donors are present in a composition a green color will result from the formation of $BaCl^+$ in the flame. Without chlorine donors BaO will be formed which emits white light. Barium carbonate is convenient to use in chlorate based color compositions since it will neutralize residual acid which reduces the risk of spontaneous ignition.

Hazards: Most barium compounds are very poisonous, especially the more soluble barium compounds such as the chlorate and nitrate. A dust mask should be worn at all times when working with barium carbonate.

Sources: Barium carbonate is cheaply available in kilogram quantities from ceramic supply shops. However, this material is often contaminated with small amounts of barium sulfide which are left over from the production process. Therefore, ceramics grade barium carbonate should never be used in mixtures incompatible with sulfides such as chlorate based mixtures. Barium carbonate is not easily made at home.

Barium chlorate

Formula: BaClO3

Description: Barium chlorate is used as an oxidiser in green color compositions. Fierce burning and high color purity compositions can be made with it.

Hazards: Barium chlorate is poisonous and a dust mask should be worn at all times when handling it. Barium chlorate should never be mixed with sulfur or sulfides or allowed to come in contact with mixtures containg sulfur or sulfides since this could result in spontaneous ignition. (Sulfur reacts with water and air to form small amounts of sulfuric acid. Sulfuric acid and chlorates react producing ClO2, an explosive gas which will ignite many organic materials on contact). Mixtures made with barium chlorate are often especially sensitive to friction and shock (even more so than potassium chlorate based mixtures) and should be handled with extra care.

Sources: Barium chlorate is usually purchased from chemical suppliers and from dedicated pyro suppliers such as skylighter. It can be made at home from sodium chlorate and barium chloride by double decomposition. Barium chlorate can also be prepared from barium chloride by electrolysis in a process analogous to that used for preparing sodium chlorate.

Barium nitrate

Formula: BaNO3

Description: Barium nitrate is used as an oxidiser in both white and green color compositions. When chlorine donors are present in a composition a green color will result from the formation of BaCl+ in the flame. Without chlorine donors BaO will be formed which emits bright white light. Barium nitrate is seldom used as the sole oxidiser in green color compositions. It is usually combined with perchlorates to improve the color and increase the burning rate.

Hazards: Barium nitrate is poisonous and a dust mask should be worn at all times when handling it. Mixtures of metal powders and barium nitrate sometimes heat up spontaneously and may ignite, especially when moist. This can usually be prevented by the addition of small amounts of boric acid (1 to 2%). It is advisable to avoid using water to bind such compositions. Red gum or shellac with alcohol or nitrocellulose lacquer are preffered binder and solvents (also see aluminum).

Sources: Barium chlorate can be made at home from sodium chlorate and barium chloride by recrystallisation. It can also be prepared from barium chloride by electrolysis in a process analogous to that used for preparing sodium chlorate.

Boric acid
Formula: H_3BO_3
Description: Boric acid is a white powder which is used as an additive to compositions containing aluminum or magnesium and a nitrate. The metal powder can reduce the nitrate to an amide which will react with the metal powder in a very exothermic reaction that can lead to spontaneous ignition of the composition. This process is often accompanied by a smell of ammonia and is most likely to occur with wet compositions. Addition of a few percent boric acid can often prevent this reaction from taking place since it neutralizes the very basic amides forming ammonia and a borate. It is also advisable to avoid using a water soluble binder for these composition. Using red gum or shellac with alcohol or nitrocellulose lacquer is safer. Boric acid will also impart a green color to a flame but is hardly ever used in color compositions since barium compounds in combination with a chlorine donor produce much more spectacular colors.
Hazards: Boric acid is not particularly toxic or dangerous.
Sources: Boric acid is cheaply and in kilogram quantities available from ceramic supply shops. It is also sold in many drug stores at a somewhat higher price, but since only small quantities are needed the price is not really important.
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Calcium sulphate
Formula: $CaSO_4.x\ H_2O$ where x= 0, 2, 3 or 5
Description: The trihydrate is commonly known as plaster of paris. The dihydrate occurs as a mineral known as gypsum . Calcium sulphate can be used as a high temperature oxidiser in orange color compositions. Excellent strobe compositions can be made with it.

Hazards: Calcium sulphate is not particularly toxic or dangerous.

Sources: Plaster can be used as is in strobe compositions, but is better to remove the water which is easily accomplished by heating.

Charcoal

Formula: mixture with variable composition.

Description: Charcoal finds widespread use in pyrotechnics. Many types of charcoal exist, each with its own properties. Charcoal made from willow or grapevine is considered great for black powder, while paulownia and pine charcoal are commonly used for spark effects. The particle size and the process used to make the charcoal also play an important role in the quality of the charcoal for a specific purpose. Very fine charcoal floats in air and is therefore sometimes referred to as 'airfloat'.

Hazards: Fine charcoal dust is easily breathed in a dust mask should be worn when working with fine charcoal. Freshly prepared charcoal can be pyrophoric even when not powdered and it must be allowed to stand for a day at least before it is used to prepare compositions with.

Sources: Barbeque briquettes are mixed with clay and are not suitable for making black powder. It will however produce long lasting sparks and can be used for that purpose. Charcoal is easily prepared at home, although it can be hard to get reproducible results. Simply placing some twigs (1 to 2 cm diameter) in a steel pan with a lid and heating it on a camping stove will make reasonable quality charcoal. It is important to make sure you don't heat for too long. Good charcoal looks like the original twigs but black with a brown tinge. It should not have split lengthwise and it should break easily with a sharp snap. The rings in the wood should still be visible. It is possible to tell when the charcoal is done by the smoke emerging from the pan. During 'pyrolysis', the process of heating the wood in the absence of oxygen, smoke will form. After some time less smoke will form and that's the time to stop heating. Leave the lid on the pan while the charcoal cools to exclude air.

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Colophonium

Formula: Mixture of compounds.

Description: Colophonium is an alcohol soluble resin which is sometimes used as a binder. It is not used very often since it is expensive and doesn't have much adhesion capacity.

Hazards: Colophonium is not particularly toxic or dangerous.

Sources: Artist paint stores often sell colophonium. It is also used by violin players and in the paper industry.

Copper acetoarsenite, Paris green

Formula: $Cu_3As_2O_3Cu(C_2H_3O_2)_2$

Description: Copper acetoarsenite is a green powder which is used in blue color compositions. It can produce great blues but it is also very poisonous and is used less and less for that reason. Today alternatives are available that will produce deep blues with less poisonous and cheaper compounds.

Hazards: Copper acetoarsenite is very poisonous and should only be handled wearing a dust mask. Smoke from compositions containing this compound should not be inhaled. It is best to avoid the use of this compound altogether as several safer alternatives have become available in the past decades.

Sources: Copper acetoarsenite was used in the past as a pigment known as emerald green, kings green or vienna green. Nowadays it is no longer used and it is very hard to find a paint supplier that still has it. It can be prepared at home but extreme caution must be excercised since arsenic compounds are very poisonous. The following preparation originates from Shimizu: "300 g of copper sulphate is dissolved in 1000 ml water, to which 250 g of glacial acetic acid is added; This solution is named 'A'. Then 200 g of sodium carbonate and 200 g of ersenious acid are added to 1000 ml water and boiled to form a solution, this is named 'B'. B is added little by little to A with constant stirring. Carbon dioxide gas is generated with active bubbling. When all the solution B has been added, it is boiled for about 30 minutes, when copper acetoarsenite appears gradually as green particles in the solution. The mother liquor is removed by vacuum filtration, and then green substance, copper acetoarsenite, is washed with water untill the sulphate ion dissapears; it is then dried. The yield is about 180 g."

Copper benzoate

Formula: Cu(C6H5COO)2

Description: Copper benzoate is a fuel which is used in some blue color compositions. It is not used very often as it is more expensive than most alternatives.

Hazards: Copper benzoate is poisonous and should be handled wearing a dust mask

Sources: Copper benzoate is easily prepared at home from a solution of sodium or potassium benzoate and a soluble copper salt. When these solutions are added together a green precipitate of copper benzoate forms. This is filtered, thoroughly rinsed with hot water and left to dry.

Copper chromite

Formula: ?

Description: Copper chromite is employed as a catalyst is certain rocket propellants. It is typically added in 1 to 5% quantities to whistle or composite rocket fuels which increases the burn rate. A range of other catalysts exist which can often be substituted for copper chromite. Examples are Fe2O3 and MnO2

Hazards: Copper chromite is poisonous and should be handled wearing a dust mask.

Sources: Copper chromite is very hard to make or obtain other than from dedicated pyro chemicals suppliers.

Copper(II)oxide

Formula: CuO

Description: Copper oxide is a black powder employed in blue color compositions in combination with chlorine donors.

Hazards: Copper(II)oxide is poisonous and should be handled wearing a dust mask.

Sources: Copper(II)oxide is usually available from ceramic suppy stores. It is also easily prepared at home as follows: Add a solution of sodium or potassium hydroxide to a solution of a soluble copper(II) compound (copper sulfate for example). This will yield a blue gel-like precipitate of copper(II)hydroxide. Then bring to solution to a boil. The precipitate will turn black and powdery. Boil for a minute or two to complete the reaction and allow the black copper(II)oxide precipitate to settle. Then decant the liquid. Add some boiling hot water to the precipite, stir and allow to settle again. Then decant and repeat 5 more times. This will remove all soluble impurities from the copper(II)oxide. Then the precipitate is filtered and allowed to dry.

Dextrine

Formula: mixture of polysacharides

Description: Dextrine is one of the most commonly used binders in pyrotechincs as it is very cheap and readily available. It is water soluble and can produce rock hard stars.

Hazards: Colophonium is not particularly toxic or dangerous.

Sources: Dextrine is easily prepared from starch. Potatoe and corn starch will both work fine. The starch is spread out on a sheet in a layer about 1 cm thick and placed in the oven. The oven is then heated to 220°C for several hours. The dextrine will turn slightly yellowish brown. One way to check if all the starch has been converted is to dissolve a small sample in boiling hot water and add a drop of KI_3 solution. A blue color indicates presence of starch, which means the conversion hasn't completed yet. KI_3 solution is conveniently prepared by dissolving a crystal of elemental iodine in a potassium iodide solution.

Iron

Formula: Fe

Description: Iron powder is used for spark effects, mainly in fountains and sparklers. It produces golden yellow branching sparks. Not every iron alloy will work equally well. Iron alloys with a high carbon content generally work best. Stainless steel will produce hardly any sparks.

Hazards: Iron needs to be protected before use in pyrotechnic compositions. Otherwise it will corrode and render the composition useless or even dangerous. Iron containing compositions are generally best kept dry and not bound with water soluble binders. Iron can be coated with linseed or tung oil. The latter was used in ancient China (and may still be used today). Linseed is very convenient to use and easy to obtain. Blackpowder-like compositions (ie Charcoal/sulfur/saltpeter based) with added metal, such as they are often used in fountains, are more sensitive than the composition without added metal. Extra caution, especially when pressing or ramming, should be excersised.

Sources: Iron turnings can often be had for free from places were iron is used for construction. Drilling, sawing etc produces a powder with wide range of particles. This powder is treated with mineral oil to remove oil and grease, sieved, and then coated with linseed oil.

Iron oxide (red)

Formula: Fe_2O_3

Description: Red iron oxide is used as a catalyst in composite and whistling rocket propellant formulations. It is also added to some glitter formulations and used for 'thermite', a mixture that produces enormous amounts of heat, forming molten iron.

Hazards: Red iron oxide is not particularly toxic or dangerous.

Sources: Common rust is not iron oxide. It is a mixture of oxides and hydroxides. A cheap source for red iron oxide is the ceramics supply shop.

Lead tetraoxide

Formula: Pb_3O_4

Description: Lead tetraoxide, sometimes called 'lead minium', is used to make crackling microstars. The composition is very sensitive, explosive and poisonous. It is in fact one of the most dangerous mixtures used commonly in modern pyrotechnics. An alternative mixture based on bismuth trioxide exists (which is less poisonous), but the high price of bismuth trioxide restricts its use.

Hazards: Lead tetraoxide, like most lead compounds, is extremely poisonous. Lead is an accumulative neurotoxin and extreme care should be taken to prevent direct contact. Lead tetraoxide may be absorbed by inhalation and ingestion. Wear a respirator, gloves, and protective clothing.

Sources: Lead tetraoxide may be prepared from a solution of lead nitrate and sodium hydroxide. Note that the procedure involves extremely corrosive and poisonous chemicals and should only be attempted by those who have access to (and know how to use) the right equipment and can handle the waste properly. Prepare a concentrated solution of sodium hydroxide by dissolving 300 grams of sodium hydroxide in water. The solution will heat up during this. To prevent it from boiling suddenly add only small portions at a time. When all has dissolved, allow it to cool down to room temperature. Dissolve 50 grams of lead nitrate in 200 ml of water, and slowly add the sodium hydroxide solution to this solution while stirring continuesly. A white precipitate will form first, which will turn orange when all sodium hydroxide solution has been added. Stir this solution well for another hour, and then allow the lead tetraoxide to settle. Carefully decant the supernatant, add water to the residue, stir, allow to settle and decant again. Repeat this 5 more times. Then filter and rinse the lead tetraoxide in the filter several times with hot water.

Manganese dioxide

Formula: MnO2

Description: Manganese dioxide can be used as a catalyst in composite and whistling rocket propellant formulations. A thermite-like mixture can also be made with it. The manganese dioxide thermite burns more slowly than the iron oxide based mixture with a bright white glow.

Hazards: Mangese dioxide is poisonous and leaves brown stains on glassware etc. The stains can be removed with dilute hydrochloric acid (ofcourse, only when the stained object is not attacked by it).

Sources: Mangese dioxide can be obtained from old batteries or from the ceramics supply store. The mangese dioxide in batteries is mixed with several other compounds from which it must be separated. An easy, though messy way to do this is as follows: Find a couple of depleted carbon-zinc batteries. Only carbon-zinc type batteries will do. Do not use other types such as rechargable or lithium based batteries. These, especially the rechargable ones, contain extremely dangerous and/or poisonous compounds such as cadmium, mercury and metallic lithium. Carbon-zinc batteries may contain small amounts of mercury as well, especially the older types, so precautions should be taken to prevent skin and eye contact and to prevent breathing or swallowing of dust. So: wear your dust mask, glasses, gloves and old clothing. Then carefully take the battery apart. You'll find a greyish white (zinc oxide) or metallic coating (zinc metal) inside, depending on wheter the battery is empty or not. This surrounds a black, sometimes wet, mass. This black stuff contains among other things the mangese dioxide. Peel the coating off and save the black mass. There is also a black rod inside attached to the anode. This is a graphite rod and can be safed for chlorate (and maybe perchlorate) preparations. We'll assume you use 2 batteries from here on. (if not, adjust amounts accordingly). Place the black mass in 200 ml of 30% hydrochloric acid. The manganese dioxide will slowly dissolve, giving off chlorine gas. Chlorine gas is dangerous: it attacks the lungs and is poisonous. Do this outside or better yet: in a fume hood if you have one. Allow the manganese dioxide several days to dissolve. The solution is then filtered which should yield a clear solution of manganese(III)chloride. In a separate container dissolve 200 grams of sodium hydroxide in a liter of bleach. Add the manganese(III)chloride solution slowly to the bleach/sodium hydroxide solution. This results in a brown precipitate of manganese dioxide which is filtered, rinsed several times with boiling hot water and dried.

Magnalium

Formula: Alloy of magnesium and aluminum. Sometimes written: MgAl

Description: Magnalium is a very brittle alloy of magnesium and aluminum. Some common uses are in for spark effects, in strobing compositions and in crackling stars.

Hazards: Magnalium dust is harmfull and a dust mask should be worn when handling fine dust. Mixtures containing nitrates and mangalium sometimes heat up and may ignite spontaneously, especially when moist. This can usually be prevented by treating the magnalium with potassium dichromate. This is done by boiling the magnalium in a 5% potassium dichromate solution. Adding fine potassium dichromate powder to such compositions may also help.

Sources: Magnalium can be made at home. Plan well and prepare yourself for working with molten metals that may ignite if you plan to make it at home. If the metal ignites expect it to burn very brightly and hot. Explosions are not common but may occur if the hot melt is allowed to contact water or oxidisers. Do it outside and away from anything flammable. If it ignites don't try to extuingish it but get away from the burning mass and let it burn out and cool before approaching it. Don't look directly into the burning metal as it may damage your eyes. Start by melting aluminum in a stainless steel container. The molten metal should be covered with a blanked of inert gas. In this case neither nitrogen nor carbon dioxide will function as an inert gas. It is best to get a cylinder of argon gas at a welding supply store. Using an electric furnace for the melting is very convenient and allows good control over the temperature. To the molten aluminum magnesium is added in solid form. The melt should be stirred from time to time. When all the magnesium has melted, the melt is allowed to solidify. It is then easily crushed up in smaller chunks with an heavy hammer. These chunks are crushed further and sieved. It can also be ball milled into a fine powder using steel media but this can be dangerous since the metal powder can become pyrophoric.

Magnesium

Formula: Mg

Description: Magnesium powder is used in a wide variety of compositions, both for spark effects and 'normal' fuel purposes. Relatively coarse magnalium is used for spark effects. In flares and some bright colored star compositions it functions as a normal fuel. It is superior to aluminum in color compositions since $MgCl_2$ and MgO are more easily vaporised than the corresponding aluminum compounds. This reduces the amount of black-body radiation and improves the color purity.

Hazards: Magnesium dust is harmfull and a dust mask should be worn when handling fine dust. Mixtures containing nitrates and magnesium sometimes heat up and may ignite spontaneously, especially when moist. This can usually be prevented by treating the magnesium with potassium dichromate. This is done by boiling the magnalium in a 5% potassium dichromate solution. The magnesium will turn brown when this is done. Adding fine potassium dichromate powder to such compositions may also help.

Sources: Making magnesium at home is very difficult. Magnesium can be bought in boating supply stores. It is used to prevent corrosion of a ships hull. For that purpose it is welded to the hull. The lower position of magnesium in the electrochemical series will make the magnesium corrode before the steel will. Making such a block of magnesium into a fine powder will not be easy. Filing or cutting and ball milling may be tried. Ball milling of metals can be dangerous however since the metal can become pyrophoric.

Nitric acid

Formula: HNO_3

Description: Nitric acid is not used in pyrotechnic compositions but it can be used to prepare a variety of usefull nitrates from carbonates, hydroxides, oxides or free elements. It is used in the explosives industry in the preparation of a lot of commonly used explosives (eg TNT, RDX, PETN, nitrocellulose). Most high explosives have no use in fireworks, though nitrocellulose is used in some fireworks compositions as an acetone soluble binder.

Hazards: Nitric acid is corrosive. The fumes are dangerous to the lungs, eyes and skin. Skin will be stained yellow upon contact. Avoid all contact with both liquid and fumes. Wear eye and skin protection (lab apron, gloves, safety glasses, etc). In some reactions (especially those with metals) a brown gas will develop: nitrogen dioxide. It is very toxic, corrosive and will attack your lungs badly. Only work with nitric acid with adequate ventilation and proper protective clothing. Don't use any solutions more concentrated than 60%. Don't try to prepare high explosives at home and don't allow any organic material to contact nitric acid accidentially because that may result in the formation of dangerously explosive and/or sensitive materials.

Sources: It is possible to prepare nitric acid in several ways. It can also be bought at some drug stores. Here (in the Netherlands) it is sold under it's Latin name, 'acidum nitricum'. Other places where it is sold is at professional gardening suppliers and at welding shops (it is used to passivate stainless steel after welding). One way to prepare it is by distilling a mixture of sulphuric acid and sodium nitrate. This process is dangerous and requires some equipment. This method is probably too dangerous for the average amateur pyro. Another possible method is by precipitating barium sulphate from a barium nitrate solution by adding sulphuric acid. What remains is a nitric acid solution. It should be possible to prepare quite concentrated solutions by using concentrated sulphuric acid and a saturated (-not- hot!) barium nitrate solution. It is important that the sulphuric acid is added to the barium nitrate solution and not the other way around. The mixing of the liquids will produce heat and if the barium nitrate solution is added to the sulphuric acid it could cause sudden boiling and splatting. Therefore, add the sulphuric acid slowly to the barium nitrate while constantly stirring. Allow the mixture to cool from time to time if it gets too hot. A white precipitate of barium sulphate should form. The mixture is then filtered through a sintered glass filter to obtain clear solution of nitric acid.

Nitrocellulose

Formula: nitrated cellulose, mixture of compounds

Description: Nitrocellulose is used as a binder in pyrotechnic compositions. It is also used in some items without any other oxidisers or fuels. In other fields of pyrotechnics than fireworks it is widely used as a propellant, sometimes mixed with nitroglycerine and other materials (so called double- or triple base propellants).

Hazards: Nitrocellulose can detonate in large quantities. It is also extremely flammable and must be handled as if it is a mixed composition (which it is in fact, on the molecular level, unlike most pure chemicals). Pure nitrocellulose is thermally instable and will decompose over time. Double and triple base powders contain nitroglycerine and are probably best avoided for use in fireworks.

Sources: Nitrocellulose is sold in gun shops to those with the proper licences in some countries. Double and triple base powders seem to be most common though. A less nitrated but usable form of cellulose, called celluloid, is also used in some household items: ping-pong balls. This may be a source for small amounts. Celluloid is also used for film but that is getting a little scarce these days with digital cameras taking over the market. It is probably too expensive for pyro uses anyway. Finally, it is possible to make nitrocellulose at home. The procedure is too lengthy to describe well here, but it involves treating cellulose (preferably cotton or paper) with a mixture of sulfuric acid, nitric acid and water. The product is then washed extensively and stabilised. Properly stabilising the product at home may be difficult and commercial nitrocellulose is preferred for that reason.

Potassium benzoate

Formula: KC7H5O2

Description: Potassium benzoate is commonly used in whistle compositions. It is a white powder

Hazards: Potassium benzoate is not particularly dangerous.

Sources: Potassium benzoate can be prepared from benzoic acid and potassium carbonate or hydroxide. Benzoic acid is not very soluble, but both potassium carbonate and hydroxide are. Dissolve 140.2g potassium carbonate or 56.1g potassium carbonate in 250 ml water, and add 146g benzoic acid. Bring the mixture to a boil. If potassium carbonate is used, CO2 gas will evolve. Continue boiling untill all benzoic acid has dissolved, occasionally adding some water to make up for what has evaporated. When all benzoic acid has dissolved, continue boiling untill the first crystals of potassium benzoate are observed (ie the saturation point has been reached). Then allow the solution to cool to room temperature. Potassium benzoate will crystalise in needle shaped crystals. Filter, and rinse the crystals twice with ice-cold water. The crystals may be dried in an oven at 100 deg C.

Potassium chlorate

Formula: KClO3

Description: Potassium chlorate is a very common oxidiser in pyrotechnics, even though it has some treacherous properties and other oxidisers would sometimes be safer to use. Part of the reason of its popularity in commercial pyrotechnics is that it is cheap and easily available. The large scale production of this compound made the first quality colored fireworks possible, about a century ago.

Hazards: Potassium chlorate is toxic, and breathing protection should be worn when handling fine powder. Compositions made with potassium chlorate tend to be more sensitive than those based on nitrates and perchlorates and should therefore be handled accordingly. Potassium chlorate, or any chlorate for that matter, should never be used in combination with sulfur and sulfides. Mixtures containing both are very sensitive and may spontaneously ignite. In general, when using chlorates great care should be taken to avoid contamination of other compositions or tools. Also read the general safety page for more information on this problem.

Sources:Potassium chlorate can be prepared at home. For this purpose, sodium chlorate is prepared first by electrolysis. It may also be obtained as a herbicide in some countries (France, for example) Then, by double decomposition with potassium chloride, potassium chlorate is prepared from this solution. The product is recrystallised, dried and powdered.

Potassium perchlorate

Formula: KClO4
Description: Potassium perchlorate is a very common oxidiser in pyrotechnics. Composition based on perchlorates tend to be less sensitive than those based on chlorates, and perchlorates can be used with sulfur and sulfides. For these reasons potassium perchlorate is much preferred above chlorates. Drawback is its slightly higher price.
Hazards: Potassium perchlorate is toxic, and breathing protection should be worn when handling fine powder.
Sources:Potassium perchlorate can be prepared at home. For this purpose, sodium perchlorate is prepared first by electrolysis. Then, by double decomposition with potassium chloride, potassium perchlorate is prepared from this solution. The product is recrystallised, dried and powdered.

Sodium chlorate

Formula: NaClO3
Description: Sodium chlorate is hardly ever used in pyrotechnics, since it is very hygroscopic. It finds occasional use in composite rocket propellants. It is however very usefull as a starting point in the preparation of several other (less hygroscopic) chlorates for which reason it is included here.
Hazards: Sodium chlorate is toxic, and breathing protection should be worn when handling fine powder. Compositions made with sodium chlorate tend to be more sensitive than those based on nitrates and perchlorates and should therefore be handled accordingly. Sodium chlorate, or any chlorate for that matter, should never be used in combination with sulfur and sulfides. Mixtures containing both are very sensitive and may spontaneously ignite. In general, when using chlorates great care should be taken to avoid contamination of other compositions or tools. Also read the general safety page for more information on this problem. Acidic solutions containing chlorates generate a very poisonous and explosive gas, ClO2.
Sources:Sodium chlorate can be prepared at home. It involves electrolysing a sodium chloride solution under certain circumstances. A description of the process, cell and anode design, etc. for home produciton may be found in the chlorate and perchlorate section of this page. In some countries, France for example, sodium chlorate may be obtained as a herbicide.

Sodium perchlorate

Formula: NaClO4
Description: Sodium perchlorate is hardly ever used in pyrotechnics, since it is very hygroscopic. It finds occasional use in composite rocket propellants. It is however very usefull as a starting point in the preparation of several other (less hygroscopic) perchlorates for which reason it is included here.
Hazards: Sodium perchlorate is toxic, and breathing protection should be worn when handling fine powder.

Sources:Sodium perchlorate can be prepared at home. It involves electrolysing a sodium chlorate solution under certain circumstances. A description of the process, cell and anode design, etc. for home produciton may be found in the chlorate and perchlorate section of this page.

Chapter 2 **Basic Introduction into Explosives and Chemistry**

Lesson 1

Chemical Formulas

By Andy

In pyrotechnic compositions you see many chemicals represented by many different symbols. Just what do all of these symbols mean? In this webpage, I will explain that to you. Remember, the better you understand basic chemistry, the beter you'll understand pyrotechnics!

You know that all matter in this whole universe is made of atoms right? Well do you really know what an atom is? An atom is defined as the smallest particle of an element that still retains all the properties of that element. Here is another question, do you have a peridioc table? If not you really should get one. The periodic table is a list of all of the elements in order of atomic mass(I 'll cover that later, maybe). With a periodic table you can figure out what ANY pyro composition means.

If you read the news group rec.pyrotechnics you have seen people talking about a chemical called KClO3. Just what is KclO3? Here is how to break it down. All elements are named with a capital letter or a capital letter with a lower case one. So in the fomula KclO3 you have K=potassium, Cl=Chlorine and O=Oxygen. Hey but what about the 3?? Well this is where it gets tough. The chlorine and the oxygen combine to form a polyatomic ion. The ion is ClO3-. This ion is called chlorate. So when the polyatomic ion, chlorate and the element potassium combine the form a compound called potassium chlorate. Do you understand? Lets try another one.

You've heard of a chemical called KNO3, right? Well lets break it down. The K we know =Potassium, the N=Nitrogen, and the O=Oxygen. Ahhh... but here we go again! There is a polyatomic ion in there. The nitrogen and the oxygen combine to form an ion called nitrate, NO3-. So when the element otassium and the ion nitrate combine they form potassium nitrate. Pretty cool,eh?

Here is a list of all the common elements used in pyro:

Al=aluminum
Ba=barium
c=carbon
Cl=chlorine
Cu=copper

Fe=iron
K=potassium
Mg=magnesium
Na=sodium
O=oxygen
Pb=lead
Sb=antimony
Sr=strontium
Ti=titanium
Zn=zinc

Here is a list of common polyatomic ions:
ClO3=chlorate
ClO4=perchlorate
Cr2O7=dichromate
NO3=nitrate
SO4=sulfate
NH4=ammonium

I really hope this helps you

Lesson 2

Oxidation-Reduction Reactions Made Simple

By Andy

Before you get started you must first know some deffinitions. Learn these now and be less confused later.
Oxidation: Loss of electrons, or gain of oxygen.
Reduction: Gain of electrons, or loss of oxygen.

I've seen many questions about how sulfer can be an oxidiser in the zinc sulfer rocket fuel. This semes simple enough so I will explain that. There is much more to redox reactions than I have here. If you would like to know more find a chemistry book at you local library.

In reactions between a metal(Zn) and a non metal(S) electrons are transfered from the atoms of the metal to the atoms of the non- metal.
The substance that donates electrons is called the reducing agent. By losing electrons, Zn reduces S.

The substance that gains electrons is called a oxidizing agent. By S gaining electrons in the redox reaction the S oxidises the Zn.

This is a very simplefied way of explaining Redox. If you would like to know more, get a chemistry book from you library, as I said before.

Lesson 3

Balanced Equations, or Stoichiometry

By Andy

An equation is simply a statement of chemical change using chemical symbols. For example, when sulfur is burned in air (one of my favourite chemical reactions ;-), it is combining with the oxygen in the air to produce an oxide. Let's look at this reaction in the form of a chemical equation:

S (sulfur) + O2 (oxygen) -----|> SO2 (sulfur dioxide).

Examine the equation closely. Is it consistent with the Law of Conservation of Matter? In other words, are there equal numbers of each type of atom on each side of the equation? There is. This equation is therefore said to be balanced. An equation is meaningless unless it is balanced. When an equation is balanced, it is said to be stoichiometric.

This equation tells us more than merely that sulfur combines with oxygen to produce sulfur dioxide. It tells us that one atomic weight's worth, of sulfur withh combinr with one molecular weight's worth, of oxygen to produce one mole of sulfur dioxide. The molecular or atomic weight's worth of something is properly called a mole. If the units of grams are used, this would be:

S (sulfur's atomic weight is about 32.1, so you would use 32.1 grams of this subtance) + O2 (the atomic weight of O is about 16, so therefore the molecular weight of O2 is 32, so 32grams of this would be used) -----|> SO2 (this substance's mole is equal to the sum of the previous subtances moles; a mole of this would therefore weigh 64.1 grams).

In other words, this equation tells us that 1 mole of sulfur combines with 1 mole of oxygen to form 1 mole of sulfur dioxide.

Let's look at another chemical oxidation reaction, in this case the marvelous reaction of the oxidation of magnesium (oh joy! ;-). When magnesium is oxidized, it forms an oxide (duh ;-). This reaction is indicated as follows:

Mg (magnesium) + O2 (oxygen) -----|> MgO (magnesium oxide).

What about our beloved Law of Conservation of Matter now? Do you see that we have apparently destroyed some of our beloved oxygen? This equation is not balanced. It is called a skeleton equation, for it indicates only the names of the substances involved.

This equation would be balanced if we could put a 2 after the O of the MgO to make it MgO2. But this would violate the Law of Definate Proportions, because magnesium oxide always has the formula MgO. In balancing equations, the subscript in the formulas may NOT be changed.

A skeleton equation is balanced by placing numbers, called coefficients, in front of the formulas of the substances in the reaction. Look again at our skeleton equation. By placing the coefficient 2 in front of our lovely MgO, we would have two oxygen atoms on each side of the equation, for the coefficient multiplies all the symbols in the formula immediately after it. This would change our equation to this:

Mg + O2 -----|> 2 MgO.

However, looking at this equation, it is apparent we have too much Mg at the right side of the equation. This can be remedied by placing another coefficient of 2 in front of the Mg at the left side of the equation, giving us the following:

2 Mg + O2 -----|> 2 MgO.

Now the equation is balanced. We have 2 magnesium atoms and 2 oxygen atoms on each side of the equation. The balanced equation now reads 2 moles of magnesium combine with 1 mole of oxygen to produce 2 moles of magnesium oxide. The following expression shows how the weights of each of the substances in the balanced equation may be indicated:

2 Mg [2 x 24.31] + O2 [2 x 16] -----|> 2 MgO [2 x (24.31 + 16)].

So, 48.62 units of weight of magnesium combine with 32 units of weight of oxygen to form 80.62 units of weight of magnesium oxide. These units of weight may be grams, kilograms, ounces, pounds, grains, tons, tonnes, etc., just so long as all three weights are expressed in the same units. This weight relationship also tells us that magnesium and oxygen combine in a ratio of 48.62 parts by weight of magnesium to 32 parts by weight of oxygen. Similarly, 80.62 parts by weight of magnesium oxide are formed for every 32 parts of oxygen or every 48.62 parts of magnesium. It is quite easy to convert this into percentage ratios (read on..).

Let's look at yet another example. Naphthalene (formula C10H8) is a substance commonly used to produce large orange fireball effects in movies. It burns with oxygen under optimum conditions to form carbon dioxide and hydrogen monoxide (water). The skeleton equation is:

C10H8 + O2 -----|> CO2 + H2O.

Let us balance this skeleton equation using the "even numbers" technique described in the previous examples.

1. First, we balance the equation for the carbon and hydrogen. Since there is 10 carbons on the left side, there must therefore be 10 carbons on the right side (of course, combined with O2). Also, there is 8 hydrogens on the left side, so therefore there must be 8 on the right side. The equation, with the coefficients placed, becomes this:

w C10H8 + x O2 -----|> 10 CO2 + 4 H2O.

This gives us an equal number of carbon and hydrogen on both sides. Now, we must

balance the equation to work O_2-wise.
2. First, we must determine how many oxygen atoms are needed by the hydrogen to completely oxidize to H_2O. This number is 4 oxygen atoms, or 2 O_2s. For complete combustion of the C into CO_2, 20 oxygen atoms, or 10 O_2s are needed. Therefore, the equation needs a total of 12 O_2s (2 O_2 for the hydrogen + 10 O_2 for the carbon). Thus, the equation becomes so:
1 $C_{10}H_8$ + 12 O_2 -----|> 10 CO_2 + 4 H_2O.
This equation reads: 1 mole of naphthalene combine with 12 moles of diatomic oxygen to produce 10 moles of carbon dioxide and 4 moles of hydrogen monoxide (water). The weight proportions involved are:
Reactants: (Naphthalene: 120 + 8 = 128; Oxygen: 12(32) = 384); 128 + 384 = 512.
Products: (Carbon Dioxide: 10(12 + 32) = 440; Water: 4(2 + 16) = 72); 440 + 72 = 512.
The charactaristics of a balanced equation may be summarized as follows:
1: It obeys the Law of Conservation of Matter.
2: It obeys the Law of Definite Proportions.
3: Its coefficients give the molar proportions of reactants and products involved in the reaction.
Symbols, formulas, and equations all have definite quantitative meanings. We are now ready to look at some numerical applications based upon these ideas.

Lesson 4

Converting Balanced Equations into Percentage Ratios

By Andy
Stoichiometric pyrotechnic compositions are basically balanced equations that are converted into percent ratios from the use of the substance's molecular weights (moles). An example is that of ordinary flash powder:
3 $KClO_4$ + 8 Al -----|> 3 KCl + 4 Al_2O_3
As you can see, a ratio of 3 moles of potassium perchlorate to 8 moles of aluminium powder are needed for a complete, balanced reaction. To convert this into a percentage ratio, you need to do some math with the molecular weights:
1 mole of $KClO_4$ = 138.55
138.55 x 3 = 415.65
Therefore, 3 moles of $KClO_4$ = 415.65
1 mole of Al = 26.98
26.98 x 8 = 215.84
Therefore, 8 moles of Al = 215.84
Next, you add the two numbers you obtained together:
415.65 [3 moles of $KClO_4$] + 215.84 [8 moles of Al] = 631.49.

Then, you do this, to obtain the percentage:
(X times 100) divided by Y = percentage for comp, [where X equals either the 3 moles of the Al or the 8 moles of KClO4, and the Y equals the sum of both moles added together (see examples below). I hope you know some algebra!]
Here is an example of this equation in action. This will determine how much Al must be present.
First, we substitute our values:
(215.84 times 100) divided by 631.49 = ?%
Then, we finish the equation:
(215.84 times 100 = 21584) divided by 631.49 = ?%; 21584 divided by 631.49 = 34.17948%
The percentage thus obtained (34.17948%) can be used to extrapolate the percentage of KClO4 that must be present, by simply subtracting it from 100:
100 minus 34.17948 = 65.82052%
Thus, the composition, stoichiometrically, would be ~65.8% KClO4, ~34.2% Al. As you can see, the traditional 70/30 flash is a little overoxidized.
You can use this equation to easily determine a basis for most of your pyrotechnic compositions.
I hope this helps. If you have any questions, feel free to ask.

Combustion, Deflagration, and Detonation

By Boris

Combustion is a chemical reaction between oxygen and a substance. The reaction is highly exothermic and a flame is usually produced. When the reaction is initiated the heat produced will increase the temperature of the unreacted material and thus the rate of reaction will increase. An example of a combustible material would be wood & petrol.
Deflagration is a highly exothermic, self-propagating reaction once initiated by flame, electrostatic spark, friction, shock or high temperatures. Those conditions produce hotspots within the substance. These hotspots are where the reaction begins. The reaction begins and the hot gases produced in turn heat the surrounding particles that also begin decompose. The rate of reaction of deflagration increases with confinement. If the deflagrating explosive is encased in a gas proof container, the exhaust gases produced by the composition will pressurise the container, this will also increase the rate of reaction. Once the pressure becomes too great for the container it will split and the expansion of the compressed gases will produce a "bang". Deflagrating Explosives do not require a outside source for oxygen as combustible materials do, instead the composition contains the oxygen required (i.e., an oxidising substance like KNO3 or Saltpetre will decompose producing oxygen)

The speed of explosion is subsonic in deflagrating explosives. .

Detonation In Detonating explosives a shockwave propagates through the decomposition, whilst deflagrating explosives react due to a thermal mechanism. The velocity of the shockwave varies between 1500-9000m/s depending on the compound and its density.

Rate of Deflagration of 1000-1800m/s is a "low order" detonation

Rate of Deflagration >5000m/s "high Order" detonation

Detonation can be initiated in two ways:

Deflagration to Detonation

Primary explosives (ie, Acetone/Propanone Peroxide) undergoe a deflagration to detonation transition. The explosive begins with a deflagration that is so fast that the pressure caused by the reaction will be high enough to increase the rate of deflagration to above the speed of sound. This is called detonation. Primary explosives are very sensitive explosives that are able to produce a shockwave that will initiate an insensitive explosive that cannot produce the deflagration to detonation transition.

Detonation by shock

Explosives that require a shockwave to detonate are called secondary explosives. These will only burn with a flame but they will not explode. A shockwave produced by a primary explosive or otherwise will compress the crystals of the explosive causing them to heat above their decomposition temperature. This exothermic decomposition will accelerate the shockwave

Chapter 3 **Low Explosives**

Lesson 1

Definition of Low Explosives

By Boris

Definition : an EXPLOSIVE is a mixture or chemical compound, which, when subjected to sufficient heat, shock, or friction, undergoes a sudden chemical change with the liberation of energy and the development of high gas pressure . Explosives are classified as high or low explosives, depending upon the rate at which this reaction takes place .

Low Explosives : Low Explosives (such as black, flash powder and smokeless powder) are those which change relatively slowly from a solid to a gaseous state . The particles of such explosives burn in rapid succession, the heat from burning particles, igniting adjacent particles until all of the explosive is consumed . This process of progressive burning is called deflagration . The transfer of heat takes place so slowly that, when the explosive is set off in the open, the gases push aside the air without making appreciable disturbances . In confinement, the speed of the reaction is somewhat increased . However, the explosion has a pushing and rending, rather than a shattering effect . Therefore, the principal military uses for low explosives are as propelling charges (for projectiles) and powder trains (in time fuses) .

Lesson 2

Safety for Low Explosives

By Boris

Starting out

When starting out one should begin with Low Explosives (blackpowder, flashpowder etc). With Low Explosives one stands a much larger chance of survival when something goes wrong. Instead of the composition detonating it will only deflagrate, meaning that it will not send bits of shrapnel flying towards you at supersonic speeds. Much more skill is required to use low explosives to produce high quality compositions. This allows the beginner to learn methods of producing powders, drying, mixing, and pressing and grinding with a much larger margin for error, however the risk is still great. Using Low Explosives will also increase the pyrotechnicians ability to manufacture casings. This skill is not so important with High Explosives as the compositions do not rely upon the container to achieve high pressures in order to make a loud sound, or burst an aerial shell.

Low Explosive:

The first thing you should do is acquire proper safety equipment that should be at hands reach. These should include:

Safety Goggles
Dust Mask
Gloves
Fire extinguisher
Bucket of water
Apron

The second thing you should do when you start is, provided you have the chemicals, to begin experimenting with burn tests of different compositions. This will teach you what the speed of the burn depends on. Of course this can be learnt through research, but if it is learnt through experimentation your practical skills will improve, these skills are vital for any explosives manufacture. Simple steps such as closing the lids of containers after you have taken out the required amount of chemical will improve safety and performance of your powders (in black powder, 2% moisture content will reduce the burn rate by half of maximum).

This is the stage that you will have to learn to do this safely. When you are just experimenting with different powders you should not make batches of more than 10g. 10g does a lot less damage then 100g. The power of the powder increases exponentially with its mass. There are chemicals that are incompatible with each other, that means that if they come into contact they will explode or burn spontaneously. Chemicals such as chlorates, sulphur, and phosphorous are examples of these. Under no circumstances should you mix these chemicals, as it will probably result in burns for you and property.

Never grind oxidisers and fuel in the same mortar and pestle or ball mill jar. Once the chemicals have been ground down they will be moist due to air moisture (In the UK this is especially bad during anytime that is not summer). They should be dried to achieve good results. To do this you may use several methods. Silica Gel is very useful although will take a long time to dry powders, but it does not rely on heating the powder to evaporate the water. The silica gel can be dried and then reused by heating it in an oven. Bear in mind that dry silica gel will heat as it absorbs water, so having a wet, sensitive composition, drying directly (on top of paper towel or filter paper) on the silica gel will cause heat to be produced. Another method for drying is the use of heat. This can be provided in an oven, by infrared lamps, or sunlight. You should never use an oven to dry mixtures of fuel and oxidiser even when the mixture is a very concentrated solution, as crystals will form soon and they can combust. An oven on low heat can be used to dry just fuel or just oxidiser. The sun is your friend when you need to dry powders or explosive compounds. Not only is it a free way of getting your powders to dry, it also is more safe because the powder will be drying outside, thus if it does combust, it will not cause any harm, provided you placed it away from wood, clothes lines etc. The disadvantage in places like England is that the sun does not always pop out when you need it, so this method is only useful in the summer. Once you have the powders dry and fine you will need to mix them, the safest way to do this is called diapering. Place the powders in a pile on top of a large piece of paper. Then lift the edges or the paper to move the powder around until it is a uniform mixture.

Once you have experimented with powders and achieved desired burn rates consistently, you can begin to work on ways of using these powders in order to do something creative. Pyrotechnic compositions are able to produce very impressive sounds and lights, as you should be well aware. To make these sounds and lights you must be skilled at the manufacture of casings and procedures to fill them. Making salutes (bangers) is a very satisfying act. However to make salutes you will need an gas tight container that is able to contain high pressures for a small amount of time. This means either making or finding some tubing that will do the job. Never should metal or plastic be used for this job, these are the lazy and stupid option, these will cause flying pointy shards to fly in your and other peoples' general direction (even worse). For Salutes there is simply no need for the containment that metal or plastic provides. Rolling tubes takes skill and patience, but the end product is worth the wait. You can read on rolling in the Casings section

There are lots of sites that specifically concentrate on pyrotechnics and their manufacture. You will find them some of them in the Links section. Pyrotechnic compositions are extremely versatile and are used in every type of firework, you can find information on making any type of firework you wish. Remember that whatever you do the most important thing is SAFETY Damage to you and others will also damage the reputation of this hobby and cause more things to be banned and restricted.

Lesson 3

Flash Powder Safety

By Bob Lazar

While it is assumed that the individual who is dispensing these materials is responsible and knowledgeable as to their use, the following pointers will prove helpful:

1. Always use electrical ignition, either a commercial squib or Nichrome hot wire. The use of a squib is preferred because it provides a more positive ignition.
2. Always use an approved flash pot, made from transite or other similar material.
3. Always use the minimum amount of powder required to achieve the desired effect. In general, one quarter of a teaspoon will be sufficient.
4. Always have only one person who is responsible for dispensing and storing the flash powders.
5. Never pour the powder directly from the bottle into the flash pot. Measure the correct amount using a non-sparking metal, not plastic, spoon.
6. Never confine or compact the powder in any way. To do so may lead to a violent explosion.
7. Never return unused powder to the original bottle.
8. Never mix two different colors of flash powder. In many cases, the chemicals in the two materials are incompatible with each other.
9. Never pour flash powder from its plastic bottle onto plastic film or into another plastic container. The material is packed in plastic to reduce the danger of serious injury in case the powder should ignite in the bottle.
10. Be extra careful on dry or low humidity days, when the chance of ignition by static electricity is high.

Lesson 4

Flash Powder Compositions

By Boris

If you see any mistakes please contact me….

Flash Powder is an explosive used in all firecrackers & larger salutes such as M-80s & Aerial Bombs. Although there are many different formulas for Flash Powder, the safest, (and the industry standard) is made just from Potassium Perchlorate & German Aluminum. It is far superior to any other Flash Powder formula in many respects.

Flash powder is the term for almost any unstable and fast burning metal/oxidizer mixture. It’s aptly named- it burns or explodes with a bright flash. Flash powder is useful as an explosive, special effect, or additive. This is a recipe for just one kind of flash powder- there are many other mixtures that work as well.

Flash #1

Comments: The sulfur can be replaced by antimony trisulfide and the sound of a salute made with this composition will change very little.

Preparation:

potassium perchlorate.............................50
Aluminum...23
sulfur...27

Flash #2

Comments:

Preparation:

potassium perchlorate.............................70
Aluminum (dark german)..............................30

Flash #3

Comments: Larger percentage of aluminum results in a stronger flash. This composition is slightly less sensitive than the usual perchlorate mixtures which also contain sulfur.

Preparation:

Potassium perchlorate.............................65...70%
Aluminum powder...................................rest (up to 100%)

Flash #4

Comments:

Preparation:

Potassium perchlorate.............................3
Aluminum, 400 mesh................................3
Sulfur...1

Flash #5.

Comments: This is a relatively safe flash composition. Burns with a brilliant white light in an open tube, or when unconfined. When well confined, it produces a loud, low pitched report and a short but intense flash.

Preparation:

Potassium nitrate.................................50%

Sulfur..30%
Aluminum..20%

Flash #6

Comments: Can be ignited by a fairly low temperature flame, and produces a greenish flash when magnesium is used. Burns very fast, and produces a loud report even in an open container.

Preparation:

Magnesium or Aluminum.............................1
Barium sulfate....................................1

Flash #7

Comments: Relatively insensitive.

Preparation:

Barium nitrate....................................4
Alumium (fine mesh)..............................2
sulfur...1

Flash #8

Comments:

Preparation: Dampen the mix lightly with water and mix thoroughly such that the material is crumbly but then packs tightly into a ball. If it is at all greasy feeling or mushy, there is way too much water. Save some dry mix on the side just in case it becomes too wet during the dampening. Granulate the damp comp by rubbing the packed ball over a 20 mesh screen. Do not use any screens larger than 20 mesh. If the screen plugs, the comp is too damp. Add more dry comp and thoughly mix in. After drying the granulated powder, it can be used in flash bags. About 3 to 5 grams works well in a 3 inch shell. Experimentation is needed to adjust the amount of burst for good results with different stars and shell construction. This powder can also be used ungranulated, in a central flash bag, in larger shells.

Potassium nitrate.................................3
Potassium perchlorate............................3
Dark aluminum (USB 809)...........................3
Barium nitrate....................................1
Antimony sulfide (CN)............................1
Sulfur...1
Dextrin...1/2

Flash #9

Comments: The use of permanganate in pyrotechnic compositions is not recommended, since it is unstable and will decompose over time. Also, like all flash mixtures, this mixture is quite sensitive and powerfull. Great care should be taken when handling this mixture.

Preparation:

Potassium permanganate............................12
Aluminum...7
Sulfur...10
Flash #10
Comments: Listed as a report formulation.
Preparation:
Potassium perchlorate.............................80%
Aluminum...27%
Sulfur...3%
Flash #11
Comments: Listed as a report formulation. Shimizu states that this composition produces the loudest report obtainable with a pottasium perchlorate/aluminum/sulfur composition.
Preparation:
Potassium perchlorate.............................64%
Aluminum...23%
Sulfur...13%
Flash #12
Comments: Listed as a report formulation. This composition produces slightly less noise than "Flash #11", but is safer to handle than similar compositions containing sulfur.
Preparation:
Potassium perchlorate.............................72%
Aluminum...28%
Flash #13
Comments: Listed as a report formulation
Preparation:
Barium nitrate...................................68%
aluminum, dark German..............................23%
Sulfur...9%
Flash Powder

Flash powder is the term for almost any unstable and fast burning metal/oxidizer mixture. It’s aptly named- it burns or explodes with a bright flash. **Flash powder is useful as an explosive,** special effect, or additive. This is a recipe for just one kind of flash powder- there are many other mixtures that work as well.

Materials:
Potassium Nitrate• (KNO3), powdered.
Magnesium, powdered. (Aluminum works,• too.)

Equipment:
Storage container.•
Mixing• implement.

Procedure:
1. Mix 40% KNO_3, 60% magnesium or aluminum in your container. Do this slowly, and carefully. Flash powder is often very sensitive. Don’t scrape or crush the powder when you mix it.

Flash powder ignites with a bright flash, and releases smoke. It burns faster than black powder, and generally produces more hot gas. Flash powder is sensitive to heat and excessive friction. Never grind the KNO_3 and magnesium in the same container. Don’t shake the flash powder or expose it to heat, flame, or sparks. Store it in a safe, dry place.

Modification:
There are literally dozens of flash mixtures. Other popular mixtures include the following:

2 parts potassium nitrate 1 part aluminum powder
2 parts potassium perchlorate 1 part aluminum powder
1 part potassium chlorate 1 part sugar
2 parts potassium permanganate 1 part sulfur
2 parts ammonium perchlorate 1 part aluminum powder
2 parts sodium perchlorate 1 part magnesium powder

As a general rule the **finer the ingredients the faster burning and more powerful the flash powder will be**. Flake shaped metal particles are better than spherical particles, as well. You can order both sphere and flake type aluminum powder from many pyrotechnics suppliers.
1.
Potassium Perchlorate 2 oz.
Aluminum Powder 600 Mesh 1 oz.
2.
Potassium Perchlorate 2 oz.
Aluminum Powder 400 Mesh 1 oz.
3.
Barium Peroxide 9 oz.
50%/50% Magnesium aluminum

powder 200 Mesh 1 oz.
4.
Barium Nitrate 3 oz.
Potassium Perchlorate 3 oz.
Aluminum Powder 400 Mesh 4 oz.
5.
Potassium Perchlorate 2 oz.
Sulfur 1 oz.
Aluminum Powder 400 Mesh 1 oz.

6.
Sodium Chlorate 2 oz.
Sulfur 1 oz.
Aluminum Powder 400 Mesh 1 oz.
7.
Potassium Chlorate 2 oz.
Sulfur 1 oz.
Aluminum Powder 1 oz.
8..
Potassium Chlorate 6.7 oz.
Red Phosphorus 2.7 oz.
Sulfur 0.3 oz.
Calcium Carbonate 0.3 oz.
9.
Potassium Permanganate 2 oz.
Sulfur 1 oz.
Aluminum Powder 1 oz.

10.
Potassium Chlorate 7.5 oz.
Charcoal dust 1.5 oz.
Sulfur 1.0 oz.
11.
Potassium Chlorate 6 oz.
Antimony Sulfide 3 oz.
Sulfur 1 oz.
12.
Sodium Chlorate 7.5 oz.
Charcoal dust 1.5 oz.
Sulfur 1.0 oz.

13.
Potassium Chlorate 7.5 oz.
Gallic acid 2.2 oz.
Red gum 0.3 oz.

Other Flash Powder Formulas

The following are special purpose Flash Powder formulas that find use in some magic tricks (when lit as a loose powder),
but most do not perform well in salutes (exploding fireworks).

Potassium Nitrate Flash Powder
Potassium Nitrate 40 %
Magnesium Powder 60 %

Barium Nitrate Flash Powder
Barium Nitrate 68 %
German Aluminum Powder 23 %
Sulfur 9 %

Red Magnesium Flash Powder
Strontium Nitrate 50 %
Magnesium Powder 50 %

Green Magnesium Flash Powder
Barium Nitrate 50 %
Magnesium Powder 50 %

!CAUTION!

The mixture of any chlorate with phosphorus or sulfur is extremely sensitive to friction and percussion and explodes with great violence.
Chlorate explosives must not be stored together with ammonium nitrate explosives, since ammonium chlorate which is formed when these two substances are brought in contact, explodes.
When mixing chlorate explosives, crush all of the chemicals separately

Lesson 5

Black Powder

By Bob Lazar and Boris

Black Powder is the backbone of pyrotechnics.
After all, it's Black Powder that gives fireworks the smell we all love so much.

Black Powder Basics

Black Powder is also known by a couple of other names. The most common, is Gun Powder. Black powder is produced in large quantities commercially, and sold in small 1 pound containers, mainly for use in antique Black Powder guns. It is also normally sold in different granulations, and they indicate how fine the Black Powder is granulated by how many "F's" they put on the container. Coarse granulations are called "FG or FFG" (aka "1Fg" and "2Fg"). Finer granulations are "FFFg and "FFFFg" (aka 3Fg and 4Fg).

The more "F's", the finer the Black Powder... and the finer the Black Powder is, the faster it burns.

Small (fine) granulations burn faster and are used in small bore guns, where larger (coarser) granulations, are used for larger bore guns & cannons... and for launching Aerial Shells out of mortars. Using a finer granulation for these jobs puts too much strain on the gun (or shell or mortar) because the powder burns much faster and creates a fast pressure increase that could damage whatever you're trying to launch, or the gun/mortar itself.

Coarser, granulated Black Powder that is used in mortars to launch shells, or in Roman Candles to shoot out stars, is sometimes called "Lift Powder".

When Black Powder isn't granulated, and is in a super fine powder state (similar to that of Talcum Powder) it is called "Meal Powder".

Just to confuse things even more, any granulated Black Powder is also sometimes called "Grain Powder".

Smokeless Powder (Pyrodex, etc.) is not to be confused with Black Powder. It is actually Nitrocellulose, and cannot be used in place of Black Powder.

Now, why they needed 5 names to describe one substance is beyond me, but just keep in mind that Black Powder, Gun Powder, Lift Powder, Grain Powder, and Meal Powder are really all the same material. 20 years ago (when I was 13), I sat picking the raisins out of Oatmeal because I thought Meal Powder was just finely powdered Oatmeal. Needless to say, the rocket engine I was building didn't work, as Oatmeal doesn't have quite the kick that Black Powder does. On the other hand, Black Powder makes a terrible breakfast.

Anyway, as far as fireworks are concerned, Black Powder is used both in its finely powdered form (Meal Powder) for coating starts and for mixing in other pyrotechnic formulas, and in its granulated form (Lift Powder) for launching shells out of a mortar, or stars out of a Roman Candle.

However, unlike many pyrotechnic formulas, you just can't mix these chemicals together and expect to have Black Powder. The mixing process for Black Powder is just as important as the formula. Black Powder MUST be made in a Ball Mill to work properly.

A Ball Mill is a rotating drum with dozens of lead balls inside. The 3 chemicals are loaded into the Ball Mill, along with the lead balls, sealed shut and allowed to rotate for anywhere between 1 hour and 24 hours. As the Ball Mill rotates, the lead balls will crush the chemicals together, forcing some of the Potassium Nitrate into the pores of the Charcoal and Sulfur. At the same time, the entire mass will be reduced to a super fine powder. **The longer the Ball Mill runs, the stronger the Black Powder will be.** A general rule of thumb for all pyrotechnic mixtures is " the finer the powder is, the faster it will burn ".

ONLY lead balls can be used in a Ball Mill as they are completely non-sparking.

ONLY Black Powder can be mixed in a Ball Mill. Other pyrotechnic mixtures such as Flash Powder, etc. CAN NOT, as they are too sensitive and will explode.

Individual chemicals however, can also be Ball Milled into a fine powder, but the mill must be cleaned before this is done.

Once the mill has run for a while, it can be opened and the lead balls separated from the fine Meal Powder.

As we'll show you below, this Meal Powder can now be used to make all the other forms of Black Powder for use in fireworks

Black Powder vs. Flash Powder

A lot of people ask which is stronger, Black Powder or Flash Powder... or if Black Powder can be used in Salutes (exploding fireworks).

In short, there is no comparison. Flash Powder is a high explosive, a shattering explosive. It converts to a gas so fast, that objects near it, and containers that hold it cannot move out of they way (or vent) fast enough to release this gas, so they are destroyed into fragments.

Black Powder is a low explosive, a heaving explosive. It converts to gas much more slowly than Flash Powder, and generally pushes things as opposed to fragmenting them. If Black Powder is used in a small Salute like an M-80, it will just make a loud "pop", and push out the end plugs.

Flash Powder in an M-80 will make a loud explosion and fragment the tube into small pieces. Flash Powder burns so much faster than Black Powder that in larger Salutes, it doesn't even matter if you've got end plugs on the tube at all, it will still detonate and fragment the Salute, even with 2 open ends.

You can NEVER substitute Flash Powder for Black Powder or vice-versa. If you were to use Flash Powder to launch a shell out of a tube, or a bullet out of a gun, it would barely move the shell or bullet, and completely destroy the mortar or gun, most probably injuring the operator.

Black Powder is a substance you cannot do without. It is used in mortars to launch Aerial Shells ,in Aerial Shells to ignite and disperse stars and so on, the list is endless. There is also an awful lot of different compositions for Bp.The most common being **Potassium Nitrate (KNO3) 75% ,Sulphur 10% ,Charcoal 15% , all parts are by weight** (If you do not yet know this get it into your head now ,all parts are by weight). Just mixing the ingredients, potassium nitrate, charcoal and sulphur, does not result in real black powder. That mixture is commonly called "green powder". It burns relatively slowly**. "Real" Bp however burns very quickly, leaving almost no residue.** Its properties are very different from "green powder". Making black powder at home is possible, although it probably will require the use of a ball mill. The black powder produced by either of the two methods described below is suitable for most common purposes.

How To

The two main methods to make BP: The ball mill method and the precipitation (or CIA) method. A ball mill will be an advantage in any case, the CIA method does not demand a mill, however a mill will greatly improve the Bp's quality. The main disadvantage of the ball mill method is that it is essential that you have a safe place to let your mill do it's work. You need a place with no buildings, people or animals in the area and you need to be able to turn it on and off remotely it is also safer to have a "bunker" of some sort or another to shield explosions. The advantage of the ball mill method is that it is very much less laborous. You can simply put your ingredients in the "mill jar" , turn it on, come back a few hours later and your done. The CIA Method is much more work I'm told (I never tried it), but I found out how to do it and boy does it look hard.

The ball mill method

1. Take your charcoal and crush it with a hammer between two sheets of paper. This is very messy (Wear a dust mask). Sieve the charcoal through a coarse sieve (about 30 mesh).
2. Weigh the charcoal. To every 100 grams of charcoal, add 67 grams of sulphur, and put some in your ball mill. Put the media(balls) in and let the mill run for 1 hour (Time varies depending on the Motors Rpm).
3. When you open your mill, you should find a fine black/greyish powder. Sieve this to get the media of the mill out, and weigh it. In a separate container, place 75 grams of potassium nitrate for every 25 grams of charcoal/sulphur powder you have. Put the potassium nitrate in your ball mill, and mill it for 1 hour (Time varies depending on the Motors Rpm). You should have a very fine white/greyish powder.

4. Now mix the charcoal/sulphur mix with the potassium nitrate. Don't bother to mix it very thoroughly, since that will happen in the mill soon enough. To this mixture, add 6% of water. I spray it over the powder that I spread out on a sheet of paper to make sure all of it becomes wet. Put the wet powder in your mill and let it run for 2-3 hours (Time varies depending on the Motors Rpm). Every hour or so, check to see if the powder is still wet. If it dries out the risk of ignition greatly increases.

5. Sieve the powder to get the media out, spread it out on a large sheet of paper and let it dry. If possible in the sun. Needless to say you shouldn't heat it in order to dry it more quickly, just be patient.

6. When dry, sieve the black powder through a few sieves to get several fractions for different purposes.

The precipitation method

1. Take your charcoal and crush it with a hammer between two sheets of paper. This is very messy (Wear a dust mask). Sieve the charcoal through a coarse sieve (about 30 mesh).

2. Weigh the charcoal. To every 100 grams of charcoal, add 67 grams of sulphur, and put some in your ball mill. Put the media in and let the mill run for 3 hours (Time varies depending on the Motors Rpm).

3. While the mill is running, place 600 ml isopropyl alcohol in a large container for every 100 grams of charcoal/sulphur mix you have, and place it in the fridge.

3. When you open your mill, you should find a fine black/greyish powder. Sieve this to get the media of the mill out, and weigh it. In a separate container, place 75 grams of potassium nitrate for every 25 grams of charcoal/sulphur powder you have. Put the potassium nitrate in an old pan, and add 40 ml tap water for every 100 grams of potassium nitrate.

5. Place the pan on the stove and bring it to a boil while continuously stirring. When the solution starts boiling, start adding small amounts of water while stirring all the time until all the potassium nitrate has dissolved.

6. Add an extra 10 ml tap water and the charcoal/sulfur mixture to the boiling potassium nitrate solution. Stir the charcoal/sulfur mixture in the solution. Make sure there are no dry clumps left.

7. By now, your isopropyl alcohol should have cooled to at least 0 deg C or colder. Take the isopropyl alcohol outside, and pour the potassium nitrate solution/charcoal/sulfur into the cold isopropyl alcohol. Make sure there are no sources of ignition nearby! Stir for a few seconds.

8. Cool the mixture again to 0 deg C at the fastest rate you can. The faster the better.

9. Filter the mixture through an old cloth, and squeeze to get all the liquid out. Discard the black liquid.

10. Spread the black mush out on a sheet of paper, and dry it in the sun. Don't try to dry it inside since it will produce a lot of flammable vapors from the isopropyl

alcohol. When it is still slightly wet to the touch, press it through a sieve to corn it. Then dry it further.
11. When dry, sieve the black powder through a few sieves to get several fractions for different purposes.

Lesson 6

Thermite

By Boris

Background
The thermite reaction was discovered by Hans Goldschmidt in 1895. When it burns it leaves behind very pure iron and so was used in the welding of steel and in the production of carbon free metals.
This is an extremely dangerous reaction where the aluminium burns, using the iron oxide as an oxidizer. It burns at between 2000 and > 3000º C, spits and should not be looked at directly because of the brightness and UV light emited. Magnesium is the only thing you can light this with because it burns at higher temperatures…
Composition
Ingredient Formula Proportion
iron (III) oxide (rust) Fe2O3 8
aluminium powder Al 3
Thermite would work using any non-reactive metal oxide and any reactive metal, with varying degrees of efficency.
Equations
2Al(s) + Fe2O3(s) => Al2O3(g) + 2Fe(l)
Ignition
Thermite is extremely difficult to ignite because a very high temperature is required and the two powders are separate. **It may ignite more easily if the two powders were melted together to achieve an alloy**, similar to the one which can be bought as rods in welding stores.
When the military uses thermite as an incendiary device it is held in a magnesium casing which is ignited, causing its contents to be ignited.
As a laboratory experiment, it is often ignited with magnesium ribbon or a common party sparkler. **Another method which I have seen suggested is to place some potassium chlorate on the thermite and then add a small amount of sulfuric acid.** This method should not, however, be used as what happens is chloric acid is formed which explodes spontaneously, which may or may not ignite the rest of the chlorate mix.
Other Information

Thermite is not classified as an explosive and is not really used as a firework either. It is used by the military as an incendiary weapon.

.... Thermite Incendiaries and Formulas ....
DISCLAIMER : The making and possesion of the following devices and mixtures is probably illegal in most communities. The incendiaries are capable of burning in **excess of 5400 degrees F.** and are next to impossible to extinguish. If you make them you accept all responsibility for their possesion and use. You also accept all responsibility for your own stupidity and carelessness. This information is intended solely to educate.
All Formulas are by Weight
Thermites are a group of pyrotechnics mixtures in which a reactive metal reduces oxygen from a metallic oxide. This produces a lot of heat, slag and pure metal. The most common themite is ferroaluminum thermite, made from aluminum (reactive metal) and iron oxide (metal oxide). When it burns it produces aluminum oxide (slag) and pure iron. Thermite is usually used to cut or weld metal. As an experiment, a 3lb. brick of thermite was placed on an aluminum engine block. After the thermite was done burning, only a small portion of block was melted. However, the block was very warped out of shape plus there were cracks all through the block. Ferro-thermite produces about 930 calories per gram The usual proportions of ferro-thermite are 25% aluminum and 75% iron oxide The iron oxide usually used is not rust (Fe_2O_3) but iron scale (Fe_3O_4).Rust will work but you may want to adjust the mixture to about 77% rust. The aluminum is usually coarse powder to help slow down the burning rate. The chemicals are mixed together thoroughly and compressed into a suitable container. A first fire mix is poured on top and ignited.
NOTE: Thermites are generally very safe to mix and store. They are not shock or friction sensitive and ignite at about 2000 degrees F. Thermites can only be ignited with magnesium.
A first fire mix is a mixture that ignites easier than thermite and burns hot enough to light the thermite reliably. A very good one is :
Potassium Nitrate 4 parts
Magnesium 6 parts

Mix the above thoroughly and combine 2 parts of it with 1 part of finely powdered ferro-thermite. The resulting mixture can be light by safety fuse and burns intensely. One problem with thermites is the difference in weight between the aluminum and the oxide. This causes them to separate out rendering the thermite useless. One way to fix this is to use a binder to hold the chemicals to each other. Sulfur is good for this. Called Diasite, this formula uses sulfur to bind all the chemicals together. It's drawback is the thermite must be heated to melt the sulfur.

Iron Oxide 70 %
Aluminum 23 %
Sulfur 7 %

Mix the oxide and aluminum together and put them in an oven at 325 degrees F. and let the mix heat for a while. When the mixture is hot sprinkle the sulfur over it and mix well. Put this back in the oven for a few minutes to melt all the sulfur. Pull it back out and mix it again. While it is still hot, load into containers for use. When it cools, drill out the diasite to hold about 10 - 15 grams of first fire mix. When diasite burns it forms sulfide compounds that release hydrogen sulfide when in contact with water. This rotten egg odor can hamper fire fighting efforts. Thermite can be made not to separate by compressing it under a couple of tons pressure. The resulting pellet is strong and burns slower than thermite powder.

CAST THERMITE: This formula can be cast into molds or containers and hardens into a solid mass. It does not produce as much iron as regular ferro-thermite , but it makes a slag which stays liquid a lot longer. Make a mixtures as follows.

Plaster of Paris 2 parts look at chemical sources .
Fine and Coarse ((خشن Mixed Aluminum 2 parts
Iron Oxide 3 parts

Mix together well and and enough water to wet down plaster. Pour it into a mold and let it sit for 1/2 hour. Pour off any extra water that seperates out on top. Let this dry in the sun for at least a week. Or dry in the sun for one day and put in a 250 degree F. oven for a couple of hours. Drill it out for a first fire mix when dry.

THERMITE BOMB: Thermite can be made to explode by taking the cast thermite formula and substituting **fine powdered aluminum for the coarse/fine mix.** Take 15 grams of first fire mix and put in the center of a piece of aluminum foil. Insert a waterproof fuse into the mix and gather up the foil around the fuse. Waterproof the foil/fuse with a thin coat of wax. Obtain a two-piece spherical mold with a diameter of about 4-5 inches. Wax or oil the inside of the mold to help release the thermite. Now, fill one half of the mold with the cast thermite. Put the first fire/fuse package into the center of the filled mold. Fill the other half of the mold with the thermite and assemble mold. The mold will have to have a hole in it for the fuse to stick out. In about an hour, carefully separate the mold. You should have a ball of thermite with the first fire mix in the center of it, and the fuse sticking out of the ball. Dry the ball in the sun for about a week. DO NOT DRY IT IN AN OVEN ! The fuse ignites the first fire mix(has magnesium) which in turn ignites the thermite. Since the thermite is ignited from the center out, the heat builds up in the thermite and it burns faster than normal. The result is a small explosion. The thermite ball burns in a split second and throws molten iron and slag around. Use this carefully !

THERMITE WELL: To cut metal with thermite, take a refractory crucible and drill a 1/4 in. hole in the bottom. Epoxy a thin (20 ga.) sheet of mild steel over the hole.

fuel-air mix. The result is obvious. Try about 1 1/2 lbs of thermite to a gallon of fuel. For the pressure vessel, try an old pressure cooker. Because the fuel may dissolve the epoxy don't keep this device around for very long. But ask yourself, do you really want to make this?

EXOTIC THERMITES: Thermites can also be made from teflon-magnesium or metal flourides-magnesium or aluminum. If there is an excess of flouride compound in the mixture, flourine gas can be released. Flourine is extremely corrosive and reactive. The gas can cause organic material to burst into flames by mere contact. For teflon-magnesium use 67% teflon and 33% magnesium A strong first fire igniter should be used to ignite this mixture. Both the teflon and the magnesium should be in powdered form. Do not inhale any smoke from the burning mixture.

If you use metal-florides instead of teflon, use flourides of low energy metals. Lead flouride is a good example. Try using 90% lead flouride and 10% aluminum.

Warning: Flouride compounds can be very poisonous. They are approximately equal to cyanide compounds.

Another exotic mix is tricalcium orthophosphate and aluminum. When this burns,it forms calcium phosphide which when contacts water releases hydrogen phosphide which can ignite spontaneously in air. Tricalcium orthophosphate has the formula Ca3(PO4)2 and is known as white-lockite. Use about 75% orthophosphate and 25% aluminum. This ratio may have to be altered for better burning as I have not experimented with it much and don't know if more aluminum may reduce the calcium better. It does work but it is a hard to ignite mixture. A first fire mix containing a few percent of magnesium works well.

Fighting thermite fires: Two ways to fight thermite fires are either smothering the thermite with sand. This doesn't put out the thermite but it does help contain it and block some of the heat. The other way is to flood the thermite with a great amount of water. This helps to break the thermite apart and stop the reaction. If you use a small amount of water, an explosion may result as the thermite may reduce the water and release hydrogen gas.

Thermite can start fires from the heat radiating from the reaction. Nearby flammable substances can catch fire even though no sparks or flame touch them.

Thermite is an incendiary that consists of iron oxide (rust) and aluminium mixed together in granular form. This incendiary produces molten iron and aluminium oxide when it burns. This molten slag iron, with a temperature in excess of 4,000 degrees farenhieght, it can be used to melt, weld and cut holes in metal. Machines or apparatus containing large numbers of small, complicated parts are hopelessly ruined by the melting and flowing action of the hot steel slag.

MATERIALS REQUIRED:

Iron oxide (black granules)

Aluminium granules

PROCEDURE:

NOTE: Thermite is comercially available already mixed. It is used in shipyards and on railroads for welding and repairing. If it cannot be obtained from comercial sources, it can be prepared by mixing filings from an aluminium bar with with iron oxide in the following manner:

1. Obtain aluminium by filing an aluminium rod or tube witha metal file. The particles must be small as coarse ground coffee or smaller.
2. Using a window screen as a filter, place several handfuls of filed aluminium particles on the screen and shake back and forth. Collect the aluminium particles that pass through the screen and fill a canning jar 1/3 full.
3. The iron oxide may be either red iron oxide commonly called jeweler's rouge or black iron oxide commonly called hammerscale or magnetic iron oxide. The black iron oxide can be found around forges, steel mills and foundries.
4. Whichever iron oxide is used, place several handfuls of it on a window screen and shake back and forth. Collect the iron oxide particles that pass through the screen and add them to mixing container containing the aluminium particles until it is 2/3 full.
5. Place lid on the mixing container and shake and tumble it for at least two minutes to blend the mixture together. It is now ready for use and can be stored for months in the closed container without losing effectiveness.

NOTE: To use thermite effectively against steel targets, it has to be enclosed in a special dispensing container.

Safety. This is a hazardous procedure, but is a safe demonstration in experienced hands. However, there must always be a first time, and it is to those persons that we offer the following advice. Read the safety recommendations of say reference 7 below.

First perform this experiment outdoors a couple of times, preferably use a table as you would indoors. There are very few demonstrations that can safely be performed for the first time in front of an audience and, in this case, we recommend that you practice at least twice more indoors before regarding yourself as sufficiently experienced and competent. It is always a good idea to get someone else to work with you as an equal partner, in that you should both be equally familiar with the procedure, and both sense the burden of responsibility. In these circumstances the partners should assume individual and collective responsibility and so will ‘watch out for each other’. For example a teacher might involve his technician in this way.

It is important that the Thermite mixture is perfectly dry otherwise extremely hot material might be violently ejected from the crucible. Dry the components separately at ca. 125C. Do not use heat to dry the mixture use a desiccant.

Metallic iron is produced at a temperature significantly above its melting point at 1535C. Once the reaction has started it is almost impossible to stop it. A CO2 fire extinguisher should to hand; water should not be used because potentially explosive hydrogen can be produced. No one should be closer to the reaction than two metres.

Eliteforum
October 2nd, 2002, 08:18 PM
Why is it called the "KGB Files"?

Boris
October 2nd, 2002, 10:30 PM
What kind of system is the exact opposite of anarchy? Well the most logical answer is communism...Ok,There is no real point to the name....I just didn't want something too stupid.Heh it was gonna be Pierre and Pedros guide....But that was a little too...yeah...Well the kgb files is good enough for now...

THErAPIST
October 2nd, 2002, 10:49 PM
looks good to me. do you plan on having small pictures of each substance? granted final products always seem to differ a little in appearance (in my experimentations anyways) but a picture is sometimes a good thing. doesnt really matter to me but some people might prefer it. im siure with everyone on the forum and/or by yourself you can get the pictures needed. but yea the name is kinda out there :D

Boris
October 3rd, 2002, 05:18 AM
I am working on a bunch of shit now with flash powder,BP, and thermite....I am calculating the burn rate of different compositions and then what happens when I change the ratios a little....I will maybe put pictures, If my camera will work and what not....But I really want to get it done before I start updating....

Korfaction
October 6th, 2002, 05:34 AM
I was wondering why you are doing this. For me it may sound like Big Book of Mischief, or any Anarchist cookbook. I'm wondering why the hell you try to make a file that looks like another crap book... Hell, NBK has made a PDF and you could simply ask to add a few more articles instead of writing a big book for kewls... "The KGB File" sounds bad, since no particular reason to be such called.

==> So you should contribute to a global work instead of trying to be Mr JollyRoger.

بالله الدعاء يا اخوان

جمادي الأول-1429