Blacksmithing Workshops and Classes:

Peters Valley Craft Education Center
19 Kuhn Rd., Layton, NJ 07851 (973)948-5200
pv@warwick.net www.pvcrafts.org

Academy of Traditional Arts
Carrol County Farm Museum
500 South Center St. Westminster, MD 21157
(410)848-7775 (410)876-2667

Touchstone Center for Crafts
R.D.#1, Box 60, Farmington, PA 15437
(724)329-1370 Fax: (724)329-1371

John C Campbell Folk School
One Folk School Rd.
Brasstown, NC 28902
1-800-365-5724 www.folkschool.com

Brookfield Craft Center
286 Whisconier Road
P. O. Box 122
Brookfield, CT 06804-0122
203.775.4526

Open Forges

If any members have a forge at home and work in the evenings or weekends and want to open it up to help a few local guys, let me know, Larry Brown, editor, as we get requests from members who have a hard time traveling to some of the open forge locations.
Please contact, Larry Brown, Editor.
We want to encourage all to join us at:

Monday Night Open Forge in N.J.

Marshall Bienstock is hosting an open forge in his shop at 7 pm almost every Monday night (Please call ahead on holidays to make sure , (732)780-0871)

Open Forge in Long Island

Sunday from 10:00 am to 6pm.
Starting the 1st Sunday in November until the end of April. Please call ahead to confirm and get directions. Ron Grabowski, 110 Burlington Blvd. Smithtown, NY (631) 265-1564 Ronsforge@aol.com

Business Members

We would like to thank those who joined with our new Business Membership category .
Business dues are $40
Please show them our support

John Chobrda, Dragon Run Forge
P.O. Box 315 Delaware City, DE, 19706
302-838-1960 jchob@verizon.net

Grant Clark, GWC Forge
PO Box 158 Perrineville NJ 08535
732 446-2638, 732 446-2638

Eric Cuper Artist Blacksmith
109 Lehman Lane, Neshanic Station, NJ 08853
908 642-6420 ericuper@msn.com

Bruce Hay, Jr.
50 Pine St., Lincroft, NJ 07738

Jayesh Shah, Architectural Iron Design
950 S. 2nd St., Plainfield, NJ 07063
jay@archirondesign.com

Louise Pezzi, Blacksmith
1241 Carpenter St
Philadelphia, PA 19147
215 336 6023 pezziandjr@gmail.com

Mark Balzarette, Blue Sun Customs LLC
124 Greenwood Ave. STE.C Suite C
Midland Park, NJ 07432

There are two more open forges now, see page 7. Thanks to the members who are doing this.

First Aid Tip
Heat Related Illnesses

By Albin Drzewianowski

I am not a doctor, and I don't play one on TV. The following information has been pulled from a number of health related web sites and for the most part is common sense. Albin

Soon it will be summer and summertime in Maryland mean HEAT and HUMIDITY. Blacksmithing is a vigorous activity and if you are not careful you can find yourself experiencing the unpleasant side effects of dehydration.

Technically dehydration means that the amount of water in your body has dropped below the proper level. When it is hot and you are working hard your body can produce a half gallon of sweat every hour. Unless you are drinking water at the same rate, you will dehydrate and then stop sweating, at which point your body starts to overheat. Remember, sweating is the body's natural mechanism for cooling off.

The initial signs of dehydration are:

- Thirst
- Less-frequent urination
- Dry skin
- Fatigue
- Light-headedness
- Dizziness
- Confusion
- Dry mouth and mucous membranes
- Increased heart rate and breathing

As the dehydration continues you will start to experience the progressively more dangerous conditions of: heat cramps, heat exhaustion, and finally heat stroke.

WARNING: Heat stroke can be fatal!!

Heat cramps are muscle pains or spasms - usually in the abdomen, arms, or legs - that may occur in association with strenuous activity. People who sweat a lot during strenuous activity are prone to heat cramps. This sweating depletes the body's salts and moisture. The low salt level in the muscles causes painful cramps. Heat cramps may also be a symptom of heat exhaustion. If you have heart problems or are on a low-sodium diet, seek medical attention for heat cramps.

What should you do if you experience heat cramps?

If medical attention is not necessary, take the following steps:

- Stop all activity and sit quietly in a cool place.
- Drink clear juice or a sports beverage.
- Do not return to strenuous activity for a few hours after the cramps subside because further exertion may lead to heat exhaustion or heat stroke.
- Seek medical attention for heat cramps if they do not subside in 1 hour.

Heat exhaustion is a milder form of heat related illness that can develop after exposure to high temperatures and inadequate or unbalanced replacement of fluids.

The warning signs of heat exhaustion include the following:

- Heavy sweating
- Paleness
- Muscle cramps
- Tiredness
- Weakness
- Dizziness
- Headache
- Nausea or vomiting
- Fainting

The skin may be cool and moist. The pulse rate will be fast and weak, and breathing will be fast and shallow. If heat exhaustion is untreated, it may progress to heat stroke. Seek medical attention if symptoms worsen or last longer than one hour.

What steps can be taken to cool the body during heat exhaustion?

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- Drink cool, nonalcoholic beverages.
- Rest.
- Take a cool shower, bath, or sponge bath.
- Seek an air-conditioned environment.

Heat stroke is the most serious heat-related illness. It occurs when the body becomes unable to control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down.

Body temperature may rise to 106°F or higher within 10 to 15 minutes.

Heat stroke can cause death or permanent disability if emergency treatment is not provided.

Warning signs of heat stroke vary but may include the following:

- An extremely high body temperature (above 103°F)
- Red, hot, and dry skin (no sweating)
- Rapid, strong pulse
- Throbbing headache
- Dizziness
- Nausea
- Confusion
- Unconsciousness

If you start to experience these symptoms or see any of these signs in someone else, you may be dealing with a life threatening emergency. Have someone call for immediate medical assistance while you begin cooling the victim. Do the following:

- Get the victim to a shady area.
- Cool the victim rapidly, using whatever methods you can. For example, immerse the victim in a tub of cool water; place the person in a cool shower; spray the victim with cool water from a garden hose; sponge the person with cool water; or if the humidity is low, wrap the victim in a cool, wet sheet and fan him or her vigorously.
- Monitor body temperature and continue cooling efforts until the body temperature drops to 101-102°F.
- If emergency medical personnel are delayed, call the hospital emergency room for further instructions.
- Do not give the victim alcohol to drink.
- Get medical assistance as soon as possible

If not treated, heat stroke can be fatal in less than an hour.

The smart thing is to avoid getting into any of the situations above in the first place. Start drinking liquids before you begin blacksmithing, continue while working and drink some more after you stop. Many authorities maintain that water is the single best way to combat heat related illnesses. Many sports drinks on the market effectively restore body fluids, electrolytes, and salt balance. Don't drink liquids that contain caffeine, alcohol, or large amounts of sugar. These actually cause you to lose more body fluid. Also, avoid very cold drinks, because they can cause stomach cramps. Do not take salt tablets unless directed by your doctor.

Pace yourself. If you are not accustomed to working or exercising in a hot environment, start slowly and pick up the pace gradually. If exertion in the heat makes your heart pound and leaves you gasping for breath, STOP all activity. Get into a cool area or at least in the shade, and rest, especially if you become light-headed, confused, weak, or faint.

Be especially careful since one of the early side effects is confusion and light-headedness. As the condition gets worse you will be less likely to think rationally. The symptoms described here can really sneak up on you and catch you unaware. Since many of do our blacksmithing alone, there may not be someone to notice that we are going into a state of heat exhaustion or worse, heat stroke.

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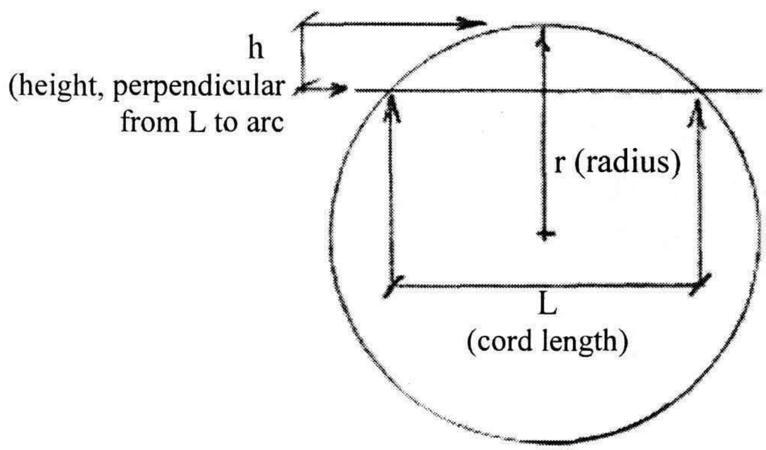
This article appeared in the Summer 2005 issue of the Rocky Mountain Smith's newsletter Forge Facts

THE RADIUS OF AN ARC

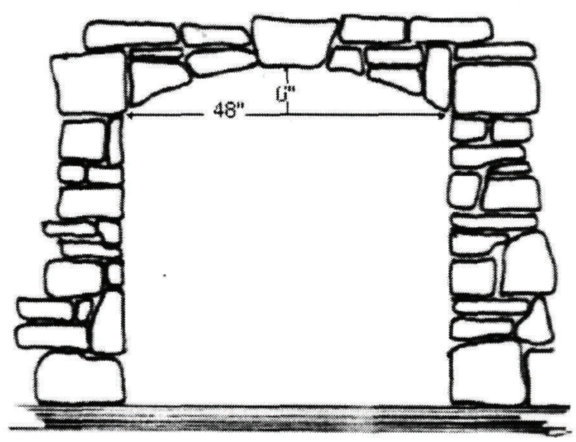
by Julie Pickett, Durango, CO

I'll be the first to admit that my math skills have declined over the years. The old saying "Use it or lose it" is very true with regards to higher math skills. However, I can still perform algebra and basic trig well enough to help Rod in the business.
Finding the radius of an arc is something we do quite frequently. We need this information whenever we lay out fireplace doors or build bending jigs.



I'll do a sample problem to help you apply the formula. Let's say you measure an existing opening of an arched fireplace. The distance from side to side at the point where the straight sides of the fireplace start curving to make the arch (the cord length) is 48" ("L "in our formula).

The height from that cord length to the highest point in the arch is 6" ("h" in our formula).



Drawings by Rod Pickett

This is the formula that you must use to find the radius of an arc:

$$r = \frac{4h2 + L2}{8h}$$

Here is the formula with our sample problem numbers plugged into it:

$$r = \frac{4(62)+482}{8(6)}$$

Whenever you solve a math problem you must follow what is called "the order of operations" or your answer will not be correct.

The first thing we must do is simplify anything inside of parenthesis. In this case that would be the (62), which we know is 36 and will make our problem look like this:

$$r = \frac{4(36)+482}{8(6)}$$

Next we must simplify anything with an exponent. In this sample it is the 482, which equals 2304. Now our sample problem looks like this:

$$r = \frac{4(36)+2304}{8(6)}$$

Next we must do any multiplication both above and below the division bar. Always work from left to right. Remember that a parenthesis () means multiplication. So first we multiply 4 x 36 which equals 144. Next we go below the bar and multiply 8 x 6 which equals 48. Now our sample problem looks like this:

$$r = \frac{144+2304}{48}$$

Next in the order of operations is the addition. In this case we must simply add 144 + 2304 which equals 2448. Now the problem is starting to look easy, like this:

$$r = \frac{2448}{48}$$

All that is left to do is to divide the numerator of 2448 by the denominator of 48, which gives us our radius of 51 ".

$$r= 51$$

BRIEF HISTORY of IRON

Wrought Iron dates back to the ancient Egyptian Empire. Very small blooms of iron were produced in forges using charcoal. In 500 BC, the Etruscans were producing 10,000 pounds of iron per year on the western shore of Italy using short cupolas with bellows made from animal skins to produce the air source. Once the burn was complete, the short furnaces made of stone were disassembled and the resulting mass of iron and impurities were removed and further refined by heating and hammering. The charcoal making process deforested most of western Italy. The iron ore was brought to the furnaces on sailing ships. The extraction method that the Etruscans used was so poor that the tailings were mined during both world wars to produce steel. Wrought iron was produced throughout Europe in late BC to early AD. In the magnificent buildings of the Greeks and Romans, the stones were held together with butterfly-shaped pieces of iron coated with lead.

The first steel was produced by the Celts, ca. AD 200. They cut wrought iron into small strips and stacked the strips in a wrought iron container with burnt bone and carbon and then heated the iron in a charcoal-fired furnace for 10-12 hours at high heat. In the process, carbon was absorbed into the surface of the metal. They then forge welded the pieces together and produced blades. This was the forerunner of pattern-welded blades as we know them and which we erroneously call "Damascus." Damascus steel was produced in Pakistan about the same time in the form of Wootz billets and sent to Syria to be made into Damascus blades. As near as we can tell (since the exact process is unknown), pure iron ore and carbon were placed in a ceramic crucible and actually melted, producing carbon steel containing about 1.5% carbon. The steel was very difficult to forge since it had to be worked at a red heat. Any hotter and it would shatter. The Celt's steel process was copied by the Vikings and Germans to produce pattern-welded steel blades through about 1050. From then until about 1400, both countries produced steel blades by family-protected, secret processes.

During that time period, they started making their furnaces taller and taller. At this point they were no longer producing wrought iron. The iron finally melted, and as it ran down through the charcoal, it dissolved some of the carbon into the iron. The resulting iron contained 3-4% carbon, was not forgeable, and was very brittle. It could only be used for casted items and was not useful for blades or wagon parts. Also during this time period, most of the forests in England and Europe were disappearing because of building and charcoal making. The King of England ruled at one point that the forests could no longer be cut for making charcoal. This forced the steel makers to come up with a process to make coke out of coal by driving out the volatile oils.

To get wrought iron in quantity, the English developed a puddling process; they mixed molten cast iron with molten iron silicate and iron oxide. Iron silicate is a component of wrought iron. They called this coal-fired furnace a "finery." When a worker (the rabbler) stirred this mixture, the iron oxide would combine with the carbon forming iron and carbon dioxide. The resulting iron had a much higher melting point and would float to the top of the puddle. The

rabbler would move the pieces into larger lumps weighing 200-300 pounds. Another worker, using a pair of large tongs and an overhead track, would grab the pieces (called "blooms") and place them in a press to squeeze out some of the iron silicate. The pressed blooms would then be run through a rolling mill and turned into muck bars. The muck bars were cut into short pieces, wired together, and placed in a coal-fired soak pit where they were heated to a welding heat. The muck bars were run through the rolling mill again and turned into a merchant bar. This process was used not only throughout Europe but in the eastern United States as well.
To make steel, thin rolled merchant bars were placed in a coal-fired soak pit, covered with carbon and burnt bone, and heated at a high temperature for several days. The carbon would be absorbed into the iron forming blister steel. The name "blister" comes from the appearance of the bars when they were removed from the pit-they were covered with "blisters." The bars were then folded over and rewelded together to be used as steel. None of the steel was of very good quality as it had iron silicate inclusions.

England needed good quality steel to make springs for timepieces so that their fleet could navigate the oceans. One enterprising Englishman noticed that glassmakers were able to get very high temperatures in their glass furnaces. He took pieces of blister steel, placed them in ceramic crucibles, and set them in a glass furnace. When the steel melted, iron silicate floated out and the carbon remained, making a good quality steel. Unfortunately for him, too many people observed the process and he was unable to keep it secret and thereby profit from the discovery. This process was further developed and produced quality steel called "cast steel" or "crucible steel." It is still used today to produce small quantities of differing steels. Many old tools made in the USA are marked "cast steel". Some mistakenly believe that these tools were "cast" as the name implies.

Steel making got its greatest boost when the Bessemer process was developed. There is a great argument as to whether it was invented in England or the United States.

Wrought Iron was produced in quantity by Beyers Steel through 1950 and was used in large construction projects such as the Grand Coulee Dam because wrought iron is impervious to rusting. It will only rust down to the iron silicate and then stop.

Mixing of alloys with iron occurred in the early 1900's when manganese, chrome, nickel, etc. were added in gas-fired open hearth furnaces. The progress of alloying was very slow since it is a hit-or miss experimental process. The real push for alloying metal occurred during WWII when greater strength alloys were required for the weapons of war. Since then, great strides have been made in developing different steels.

IRON & STEEL:

Wrought Iron: Wrought Iron is pure iron mixed with iron silicate. When rolled through the mills a few times, its structure takes on the characteristics of wood, having a definite grain structure. It is forged at a yellow heat. Lower heats will result in the metal shattering like a wood board unless it has been refined several times. If it does split, it is easily welded together at a yellow heat. Iron silicate acts a flux in this process. Holes drilled through wrought iron will split out lengthwise under load. Therefore, the end where the hole is drilled should be folded across the grain and forge welded. Since there is no carbon in wrought iron, it will not burn like carbon steel, even at a yellow heat. Wrought iron is no longer commercially produced. It can still be found in structures built a century or more ago. Old bridges have been a good source of wrought iron.

Carbon steels: Most carbon steels contain less than 1.5% carbon. Mild steel, as we once knew it, was labeled 1018-1020 and contained .18% and .20% carbon respectively. Today this is only true for steels smaller than 1/4" thick and over 4" in width. Most of the hot-rolled steel today is made from scrap and is categorized as A-36, having a guaranteed tensile strength of 65,000 psi. Since it contains numerous other alloys, the carbon content can vary up to .29% at which level it is not very suitable for forging. Metal with that carbon content develops black hardness which results in cracking and breaking. A-36 is also made in a continuous pour process. As a result, it contains inclusions which will cause it to split when you work with it. Sulfur or Lead is added to low carbon steel to improve machineability. This is usually found in colddrawn mild steels and is no good for forging at all as it has a tendency to crumble at forging temperatures. It is usually designated as 1118 or 11L18.

The more carbon added to the iron, the stronger the tensile strength until it becomes brittle. The optimum strength is achieved at .40% to .45% carbon. In order to achieve hardness, the steel has to be heated to a cherry red, quenched in warm salt brine, and then tempered. Carbon steels with a carbon content of .60% to 1.4% are designated as W-1, W-2, etc. The "W" indicates that they can be hardened in water. This is somewhat misleading as only small pieces such as chisels and punches can be safely hardened in water. When water boils, it causes steam bubbles which result in uneven cooling, causing cracking on larger pieces of carbon steel. Most of the time, the coolant used is warm salt brine. With the best quench, the depth of the hardness goes in less that 1/4" leaving the core soft. The cherry red color of the core can be observed in a dark area with no outside lighting. Blacksmiths of old used a blackened bucket to find this red color. For people who are colorblind, this temperature occurs when the steel is no longer magnetic.

Tempering: Once the steel is quenched, it has to be tempered using heat. This is done by first cleaning the piece down to bright metal and then slowly heating it, watching for the color of the metal to change. The proper temper is reached according to the chart below and then the metal is further cooled in water.

STRAW YELLOW	LATHE TOOLS, MILLING CUTTERS
BRONZE TO DARK PURPLE	CHISELS AND PUNCHES
BLUE	WOODWORKING TOOLS
DARK BLUE	SPRINGS

Alloy steels: Since carbon steels can only be hardened to a depth of 1/4", large pieces of hardened steel were not available to industry. The most important alloying metal is chrome. Chrome does two things: It allows for deeper hardening and for increased resistance to deforming at elevated temperatures. Other metals that improve strength and deep hardening are molybdenum, vanadium, nickel, and tungsten. Since we now have deep hardening during quenching, we can no longer use water or brine because the cooling is too fast and high stresses in the metal cause cracking or breakage. We must now quench with oil or air. Quenching oils are organic and specifically developed for quenching. Motor oil can be used but fumes from the oil are toxic and results are not predictable since quenching rates are unknown.
Some useful steels that blacksmiths can find at the local junkyard:

Car & Truck springs--flat, round, coiled	Referred to as 5160 which is a chrome steel with 0.5% carbon, 1.0% manganese, 0.3% silicon, 0.6% chrome
Large truck axles (for good hammer heads)	Referred to as 4140 which is steel with 0.4% carbon, 1.0% manganese, 0.2% silicon, 1.0% chrome, 0.2% molybdenum

Bessemer Process (for Sir Henry Bessemer): Industrial process for the manufacture of steel from molten pig iron. The principle involved is that of oxidation of the impurities in the iron by the oxygen of air that is blown through the molten iron; the heat of oxidation raises the temperature of the mass and keeps it molten during operation. The process is carried on in a large container called the Bessemer converter, which is made of steel and has a lining of silica and clay or of dolomite. The capacity is from 8 to 30 tons of molten iron; the usual charge is 15 or 18 tons. The converter is egg-shaped. At its narrow upper end it has an opening through which the iron to be treated is introduced and the finished product is poured out. The wide end, or bottom, has a number of perforations (tuyeres) through which the air is forced upward into the converter during operation. The container is set on pivots (trunnions) so that it can be tilted at an angle to receive the charge, turned upright during the "blow," and inclined for pouring the molten steel after the operation is complete. As the air passes upward through the molten pig iron, impurities such as silicon, manganese, and carbon unite with the oxygen in the air to form oxides; the carbon monoxide burns off with a blue flame and the other impurities form slag. Dolomite is used as the converter lining when the phosphorus content is high; the process is then called basic Bessemer. The silica and clay lining is used in the acid Bessemer, in which phosphorus is not removed. In order to provide the elements necessary to give the steel the desired properties, another substance (often spiegeleisen, an iron-carbon-manganese alloy) is usually added to the molten metal after the oxidation is completed. The converter is then emptied into ladles from which the steel is poured into molds; the slag is left behind. The whole process is completed in 15 to 20 min. The Bessemer process was superseded by the open hearth process. Columbia Encyclopedia, 6th edition, 2001Encyl. information did not appear in the SOFA article but is added for the reader's convenience

Editor's apology; I really don't remember where I found this information. Apparently it started with SOFA (Southern Ohio Forge and Anvil)