Fire making by concentrating solar energy.

The thermal radiation from the sun at the distance of Earth's orbit contains about one kilowatt of energy per square meter (1 sq. yd) of area. This energy can be concentrated by various means to where it is sufficient to raise the temperature of a suitable tinder above its ignition point. The two principle means for doing this are refraction using lenses and reflection using shiny surfaces.

Lenses: A properly shaped lens of sufficient size, made of glass, plastic – including flat Fresnel lenses, ice, or even water can be used to concentrate radiation from the sun onto a tinder in such a way as to cause the tinder to ignite. Actually, any clear material that has an index of refraction different from air and that can be shaped to focus the suns rays can be used as a fire-starting lens.

The important requirements for the lens include the area (which determines the amount of solar radiation captured), and the focal length (which determines the degree of concentration of the captured energy). The optical accuracy of the lens's surfaces also plays an important roll. Any distortion of the surface (both in shape and smoothness) will result in a less focused solar image, which means that the captured energy will be distributed over a bigger area on the tinder and the peak temperature on the tinder will be proportionately lower. A larger capture area (i.e.: bigger lens) can make up for this effect, so, for example, a crude ice lens will have to be larger than an optically perfect glass lens of the same focal length.

Note that only a "positive" lens will work for starting fires. Such a lens will act as a magnifying glass making objects appear larger when seen through the lens. Corrective lenses worn to correct near-sightedness will not work because they spread rather than concentrate the captured energy.

The reason focal length is important is because it determines the size of the solar image and ultimately the amount of solar concentration possible. The shorter the focal length the smaller will be the focused image of the sun, and thus the hotter will be the spot on the tinder. Again, a larger lens area can make up for a longer focal length.

Another consideration is the optical color of the tinder. Because this method depends on heating the tinder with radiation we want the tinder to absorb, rather than reflect, the incident radiation. An optically black body is the most efficient for absorbing radiation while a white body will reflect much or most of it away. Thus a darker tinder (charcloth is excellent) will work much better than a light colored tinder (white paper is very poor for this application). A tinder like *Inonotus obliquus* (tinder fungus) is generally tan in color and can be difficult to ignite until it has been heated long enough to darken in color.

The general method of igniting tinder with a lens is to hold the lens so that its area will capture or intercept the maximum amount of solar radiation. For most lenses this will point the lens directly at the sun. While maintaining that orientation the lens is then moved back and forth near the tinder until an image of the sun is formed on the surface of the tinder. Slight adjustments towards or away from the tinder will then bring the image into the sharpest possible focus. Remember to keep the lens itself positioned directly towards the sun. With an appropriate lens and tinder ignition of a coal should take place within a few seconds. The glowing coal can then be transferred to a tinder bundle and blown into a flame in the usual way.

Other refracting devices I have successfully used include a water filled ZipLock sandwich bag, and a piece of foodwrap film formed into a pocket and filled with water. These two methods require that the water-filled "bag" be manipulated with two hands to concentrate as much sunlight as possible on the smallest spot. Because the "lens" is quite large it can work despite a great deal of distortion. An easier water-filled device can be made from an ordinary household incandescent light bulb. The bottom is carefully broken off and the innards removed. The white powder used to diffuse the light is then cleaned from the inner surface of the glass bulb (it comes out quite easily). The bulb is then filled about halfway with water – thus forming a plano-convex lens. If the sun is reasonably high in the sky (from about 10 am to 2 pm local solar time) this horizontal lens can be used to quickly ignite various tinders.

Reflectors: In much the same way that a lens concentrates captured solar energy into a smaller spot on the tinder a properly shaped reflective surface can do the same thing. The required shape is concave so that reflected solar rays are directed towards a common focus. Such a concave surface also has a focal length, and again, the shorter the focal length the greater will be the temperature of the focused image of the sun on the tinder.

And as with the lens, the accuracy of the shape of the surface and the degree of polish will affect the size of the focused image, and again, the smaller the better. To work best the surface should look mirror-like. But, as with the lens, increased capture area can make up for distortion or lack of polish.

Good candidates for reflectors for this method of fire starting include the reflector from a flashlight or automobile headlight, a "flying saucer" type snow sled, or any other concave shiny object with sufficient capture area and degree of polish.

Two rather interesting and unusual devices include a compound mirror first made by PSG member Glen Monaghan from small pieces of mirror cut or broken from a larger plane mirror arranged so that all of the small mirrors reflected light from the sun to a common target.   Glen's working device needed about 35 mirror pieces to get sufficient heating to light his tinder.

The other unusual device, which I believe I was the first to make work, uses the concave bottom of an aluminum beverage can to ignite the tinder. Because can bottoms provide a limited capture area the shape and polish need to be quite good. Aluminum cans from different manufacturers will have somewhat different degrees of smoothness and distortions such as embossed markings or stretch marks from the manufacturing process. Many can bottoms will be free of such distortions and make the best reflectors for fire starting.

There are a number of ways to polish the aluminum surface, but the quickest I've found is to rub the surface with 0000 steel wool and then finish with some buffing compound applied to a rag wrapped over your index finger or thumb. Approximately five minutes of polishing with the steel wool and about ten minutes rubbing with the buffing compound should provide sufficient polish. In the field natural polishing compounds can be found such as the silicate containing Horsetail Rush or Scouring Rush (Equesitum hyemale).

The polished can is then held so that the bottom is pointed directly at the sun and a suitable tinder is held at the focus, which will be about 1.5 cm (3/4 inch) above the center of the bottom of the can. A good way to find the focal point is to use a narrow strip of white paper held where the tinder would be placed. The bright focused image of the sun will be easily visible through the paper, and you can then move it slightly towards or away from the can bottom until the image is as small and sharp as possible. If the image formed is no larger than about 2 mm (1/12 inch) the can should be sufficiently polished. If the image is much larger (due to distortion or from lack of polish) it will probably not get the tinder hot enough.

An ideal tinder for this method is a rolled up square of charcloth. Rolling it into a tube is helpful in two ways; it stiffens the charcloth so you can position it more easily at the focus, and it blocks less of the incident solar energy. With everything positioned correctly the charcloth should ignite in about two or three seconds in fairly bright sun.

Positioning the can to maximize the amount of captured energy and to minimize distortion of the solar image is easily accomplished with a few tricks I've discovered. First of all, when the can is pointing directly at the sun its shadow will be a perfect circle. Any tipping of the can will result in the can's shadow becoming elliptical. As the can approaches the correct position a bright circular arc of reflected sunlight resembling a halo (from the sides of the can) will be seen near the can's shadow. As the can is brought into correct alignment the bright halo will decrease in size and approach the can's shadow. Just as the can reaches the exact position the halo will disappear. This is a very sensitive alignment indicator and is easy to learn.

If I can help with more details about any of the above please contact me at usscod@en.com John Fakan (Primitive Skills Group - PSG)