

**Priestley's Burning Lens for the Film "The Mystery of Matter: Search for the Elements"**

By Jim and Rhoda Morris \*

In 2011 when we were researching the work of Joseph Priestley for the PBS film "The Mystery of Matter: Search for the Elements" we visited the Priestley House on a mission for information to replicate the experiment by which Priestley discovered oxygen.

Priestley was one of the first of several scientists with interesting discovery stories to be covered in the film and since he was the earliest of these, it was not surprising to find that his home was often his laboratory – a very familiar setting for us since we also work out of our home. The volunteer docent at Priestley House was very welcoming, professional and knowledgeable. Our visit was very enlightening. The house gave great insight to the breadth of Priestley's interests

and how his scientific work blended with his domestic life. It further helped define Priestley's uniqueness for us, a citizen of the world who left his mark as a minister, an educator, a political activist and most importantly for us, as a scientist.

It is well known that Priestley was an obsessive experimenter. He loved to see what would happen if he mixed things together or "burned" them. Candles, wood, kerosene, oil, etc. were readily available fuels back then, but in "dephlogistisizing" substances called calxes (known today as oxides) he needed a cleaner convenient source that could burn the substance inside glassware, and allow him to collect evolved gases. So he used a more sophisticated source of heat, called the burning lens. The principle behind this device was well known and scientific glass houses made these available to natural



Replica of Priestley's burning lens in a display case in the lab at Priestley House set up to use sunlight to generate oxygen.

philosophers (as scientists were called in those days) who could afford them. They consisted of large convex lenses mounted in an adjustable framework for directly focusing the sun's rays onto the substance to be burned.

When Priestley focused his burning lens on the calx of mercury (mercuric oxide) and collected a new gas which turned out to be oxygen little did he know the importance of this element and that in fact, it is our survival gas! Actually he was not the first to discover oxygen, but he was the

first to publicize it and did an excellent job characterizing it (as did the actor in the film). As is mostly the case in discoveries, it's a team of people responsible for the state of our knowledge. When we were asked to reconstruct the experiments that resulted in the discovery of the elements portrayed in the film, Priestley's experiment was one of many experiments we had to build and test. It was one of the more important and exciting but also quite dangerous to run because it also produces toxic elemental mercury. Period equipment needed to convert the mercuric oxide to oxygen were a stand-mounted burning lens, a glass retort to hold the mercuric oxide, which was connected by tubing to a glass jar filled with water and inverted in a trough of water. As the Mercuric Oxide "burned" (decomposed), it generated oxygen which flowed through the tube into an upside down jar full of water. The gas forced the water out of the jar; eventually filling the jar with pure oxygen

These items were mostly available or buildable but finding a lens within cost and large enough to collect the required sunlight to decompose a reasonable sized sample of mercury calx was a challenge. Our contact with Amateur Telescope Makers of Boston led us to Dr. Jeffrey Baumgardner, with the Center for Space Physics at Boston University. He graciously offered a 10 inch lens, large enough to do the job! We constructed a frame for it and an adjustable stand to produce a period type burning lens! Of course we tested it in our backyard as described in the reference below to see whether we could actually generate oxygen from real mercuric oxide with our replicated burning lens.\*\* In running the experiment it became very obvious that toxic elemental mercury forms quite readily and at the high solar heat the more hazardous vapor fills the reaction flask. It's important that these condense out to prevent contamination of the oxygen collection flask and water in the trough.

So for the actor to demonstrate the dramatic properties of the new gas we used a tank of pure oxygen behind the scene so he could effectively make the candle burn brighter, burst a glowing ember into flame, and show its unusual effect on living creatures.

In the last couple of years we have enjoyed owning and displaying the replica of Priestley's burning lens, but we realized that a larger audience for it would help more people understand the all-important lesson on how science works and moves forward. Since we were very impressed with the Priestley House, especially in its demonstration of how Priestley blended his interest in the natural world with his everyday life, we thought the best home for the lens would be Priestley's home. In January 2017 we loaned the lens to the Bloomsburg Theatre Ensemble as a prop for the play about Joseph Priestley titled, "Gunpowder Joe". After the play the lens was donated to Priestley House.

\*The Morris family team -Jim is a physicist and Rhoda is a chemist, and joining in our more recent ventures is our daughter Kathleen, a mechanical engineer. We own a large inventory of antique and vintage scientific instruments that we make available for technical documentaries. If not available, we build them. Our background enables us to provide technical consulting; we design and set up the experiments; and teach the actors how to run them. Experiments not safe for actors to carry out on location, we run at our home site and provide close up photography.

\*\*A very exhaustive, technical discussion, including pictures, safety cautions, factors that influence the effectiveness of the sun's radiation, image distortion, etc. is provided on our web site. It gives detailed explanations of all the critical factors Priestly faced and had to control, some of which he probably did not understand at the time. <http://www.scitechantiques.com/priestley-lens/>.