Chapter One 1

Ancient Metals

Metals such as iron, lead, and tin were important to ancient people. They made tools, spears, shields, dinnerware, and even mirrors from metals. Iron is one of the metals used for centuries. Some ancient civilizations had tools made of iron although they did not have the skill to extract iron from its ore. Where did they get the iron?

One clue to the answer came when Europeans settled in the New World. They discovered that a few tribes of Aztec Indians of South America had tools and knives made of iron. The Aztecs, like the ancient civilizations, did not know how to smelt iron. Where did the iron come from? The Aztecs explained that rocks

ACTION

1. **Ancient people had iron tools.**
2. **Iron resisted efforts to remove it from its ore.**
3. **The Scott expedition to the South Pole perished in a blizzard when their fuel cans were found empty.**

Can You Predict the Reactions?

containing pure iron fell from the sky. They prized the metal more than gold.

The French Academy, a powerful and respected group of scientists, completely discounted the report of falling rocks. Antoine Lavoisier, a famous French scientist, insisted, "The fall of stones from the sky is physically impossible."

Once, an old French clergyman came to the Paris Museum with a stone that he described as having fallen from the sky.

"No," the museum curator said. "You must be mistaken. You should know better. Rocks can't fall from the sky because there are none up there to fall."

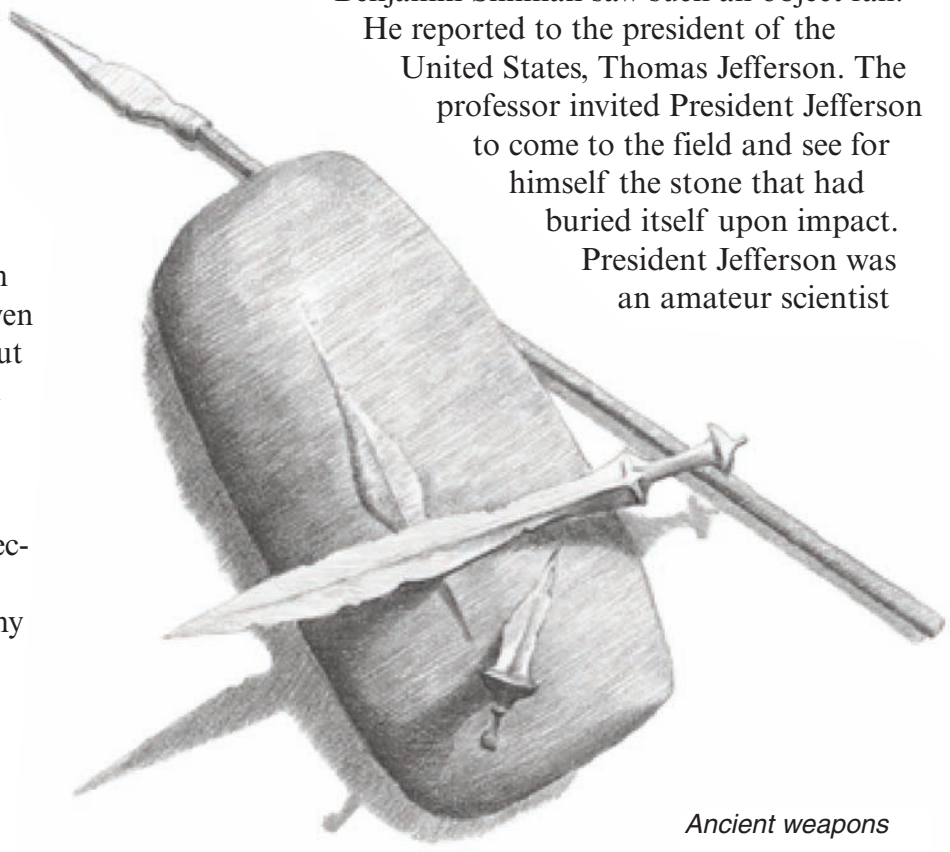
The clergyman asked the academy to investigate anyway. A committee of several respected chemists and geologists studied the rocks. They replied, "We regret that in our enlightened age there still are people so superstitious as to believe stones fall from the sky. This peculiar-looking stone is nothing more than soil which has been struck by lightning."

In 1790, the French Academy of Sciences even passed a resolution about the subject. They would no longer investigate reports of objects falling from the sky.

Many museum directors read the academy's report. Did they have any of the stones? People claimed to have seen objects streak through the sky like a flash of lightning. Sometimes the object fell to earth with an ear-shattering bang. They donated the stones to the museums. Museum directors searched through their geology displays for the blackened stones. They found the rocks and hid them from sight.

Leonid Fire Ball

In 1807 the American chemist Benjamin Silliman saw such an object fall. He reported to the president of the United States, Thomas Jefferson. The professor invited President Jefferson to come to the field and see for himself the stone that had buried itself upon impact. President Jefferson was an amateur scientist



Ancient weapons

How Egyptians Made Iron

The Egyptians became desperate for iron. One of the rulers of Egypt offered the Hittites an exchange of gold for iron. The Hittites refused, so the Egyptians had to learn to smelt iron themselves.

Coaching iron from its ore is not easy because it is so tightly bound. The Egyptian metal workers believed the ore would release the iron in a hot furnace, the hotter the better. First, they baked wood in closed ovens. Charcoal was formed when wood was heated without oxygen. Charcoal was rich in carbon and burned even hotter than wood. Next, they made a small blast furnace by tipping hollow reeds with clay. They blew through the reeds, sending oxygen through a charcoal and iron ore mixture.

The Egyptian blast furnace worked. They got iron from iron ore.

Chemists know now that charcoal does more than merely generate heat. It takes part in the chemical reaction that releases iron from its ore. Iron ore contains iron combined with oxygen. During smelting, carbon from charcoal frees iron from oxygen's grip by combining with the oxygen.

Iron produced in this way is cast iron. It has impurities, including carbon from the charcoal. Cast iron is hard, but brittle. A sudden blow can shatter it.

The Egyptians learned to remove the impurities by heating cast iron with more iron ore and limestone. The result was wrought iron, a pure form of the metal. It is soft and easily hammered into shape, but is much too soft for most purposes.

Modern steel mill

and a very knowledgeable individual. He declined the invitation. "I find it easier to believe that a Yankee professor would lie than that stones would fall from heaven."

Benjamin Silliman investigated further. He discovered many honest and dependable people who backed him up. The people claimed they had found rocks that were still hot enough to blister their fingers. Finally, Benjamin Silliman wrote a book describing the fiery objects. Most American scientists did not believe him.

Rocks did fall from the sky. They still do! The objects come from space and are called meteorites by today's scientists. We call them shooting stars.

Meteorites are from outer space. Most burn up in the earth's atmosphere. A few survive their fiery trip and plunge to earth. A shooting star is the glowing track in the sky left as a meteor streaks into the earth's atmosphere. Some meteorites are made of rocks, but many are made almost entirely of iron.

Ancient people found these iron meteorites and hammered the pure iron into useful tools. Long before metal workers learned to extract iron from its ores, they found meteorites made of almost pure iron. The image of Diana at Ephesus that "fell down from heaven" in Acts 19:35 may possibly be an iron meteorite.

The Hittites are believed to have been the first to discover the secret of extracting iron from its ore. Until late in the 1800s, the Bible was the only record of the Hittites (Joshua 1:4, for example.) They,

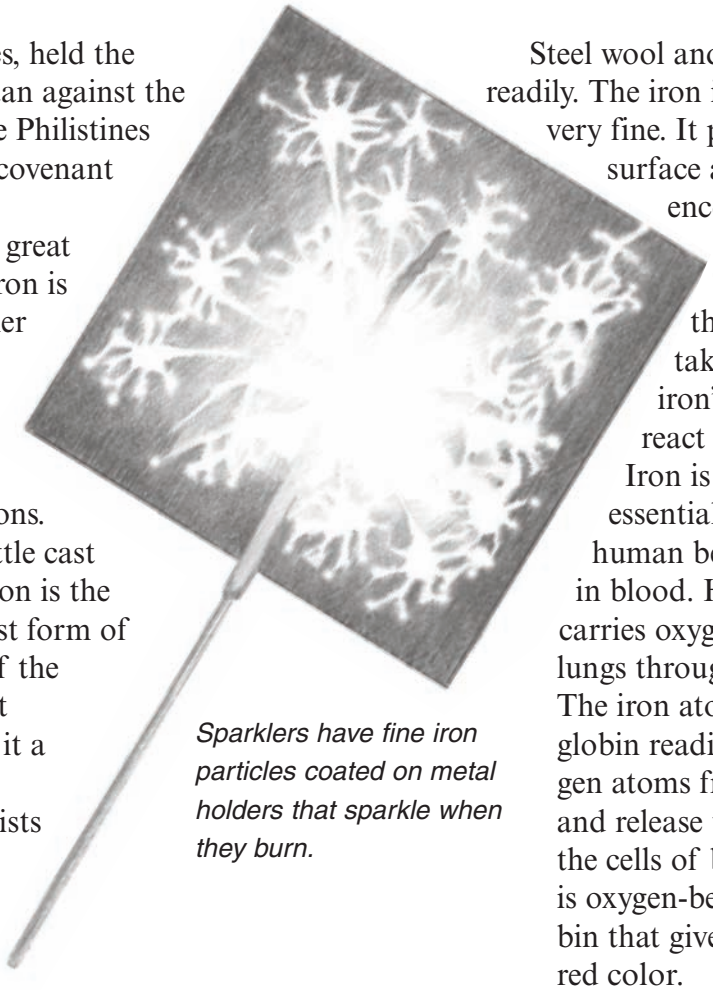
along with the Philistines, held the Promised Land of Canaan against the Israelites. For a time, the Philistines captured the ark of the covenant (1 Samuel 4:10–17).

The Hittites built a great empire in Asia Minor. Iron is harder than bronze. Other nations outfitted their armies with bronze knives, swords, and shields. They could not stand against iron weapons. Somewhere between brittle cast iron and soft wrought iron is the most useful and strongest form of iron — steel. The iron of the Egyptians contained just enough carbon to make it a good grade of steel.

Egyptian metallurgists improved upon it even more by quenching it. They heated the iron until red-hot and then suddenly thrust it in cold water. Steel treated in this way is even stronger and harder than regular steel.

Cast iron, steel, and wrought iron differ only in the amount of carbon they contain. Today, structural steel is the most common use of iron. When steel is used as reinforcing rods in concrete, the combination is both rigid and strong.

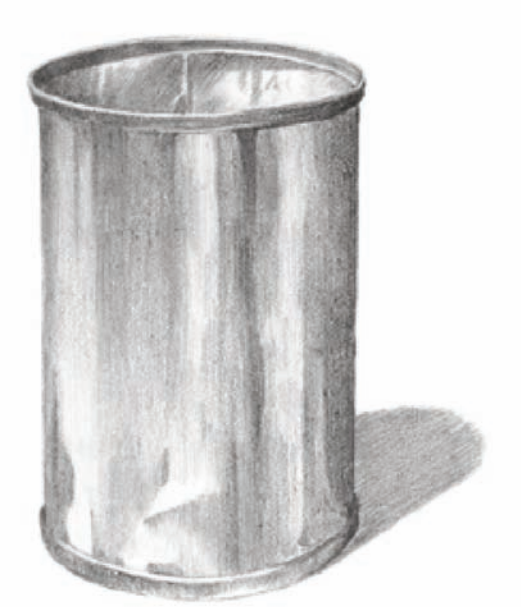
Iron is cheap and strong, but combines readily with oxygen. The chemical combination of oxygen with a metal or other element is oxidation. Burning is rapid oxidation. Iron itself will burn under certain conditions. For instance, holding a lighted match to fine steel wool causes the steel to burst into flames. Independence Day sparklers have fine iron particles coated on a metal holder. The tiny iron particles sparkle as they burn.



Sparklers have fine iron particles coated on metal holders that sparkle when they burn.

Steel wool and sparklers burn readily. The iron in them is spun very fine. It presents a huge surface area to the air, encouraging rapid oxidation.

The design of the human body takes advantage of iron's ability to react with oxygen. Iron is one of the essential elements in human beings, especially in blood. Hemoglobin carries oxygen from the lungs throughout the body. The iron atoms in hemoglobin readily accept oxygen atoms from the lungs, and release the oxygen to the cells of body tissues. It is oxygen-bearing hemoglobin that gives blood its red color.



Although commonly knows as a "tin" can, this popular food container is actually a thin layer of tin plated over steel.

Larger pieces of iron do not burst into flames, but they react to oxygen nonetheless. Rust is a form of slow oxidation. Although many other metals rust, the oxide coating often protects the metal underneath. This is not the case with iron rust. It flakes away to expose a new layer to the air. Rust continues to do its damage.

Painting prevents rust, or iron can be coated with another metal such as tin to protect it. An Englishman, Peter Durand, patented the tin can in 1810. Tin is nontoxic and does not discolor food. A thin layer of tin is plated over steel. A tin can is a steel can coated with a layer of tin only 1/250 of an inch thick. A tin can is mostly steel, not tin.

Tin is another of the seven ancient metals. During early Bible times people used tin in alloys with copper and lead. Bronze is an alloy of copper with tin. Another important alloy is pewter, a bright and shiny combination of tin with lead. People once used pewter to make cheap kitchen utensils and tableware as a look-alike substitute for expensive silver dishes.

The common name for ordinary metallic tin is white tin. As pure tin gets cold, it undergoes a dramatic change in its physical properties. It turns gray in color. Gray tin is brittle.

British explorer Robert F. Scott led a tragic expedition in 1912 in an effort to be the first to reach the South Pole.

Once, in Russia, tin buttons vanished from soldiers' uniforms. When the quartermaster opened boxes of spare buttons, he found nothing but gray powder. During the long Siberian winter, bitterly cold weather had changed white tin to gray tin.

One of the great tragedies of Antarctic exploration came about because of tin used to solder the seams of kerosene cans. Captain Robert Scott, a British explorer, organized an expedition to try to be the first to reach the South Pole. He led his party across 1,800 miles of ice and snow. At regular intervals, they stored fuel and food for their return. They reached the South Pole on January 18, 1912. Standing on the spot was a marker left there one month earlier by Roald Amundsen, a Norwegian explorer.

Disheartened, the men began their return journey into the face of a blizzard. When the weary men arrived at food and fuel, the tin had turned to powder. The kerosene leaked through the seams. The desperate men raced to the next cache. The cans there were empty, too. The entire Scott party perished in the frozen wilderness, partly because of the little-known fact that tin becomes brittle at cold temperatures.

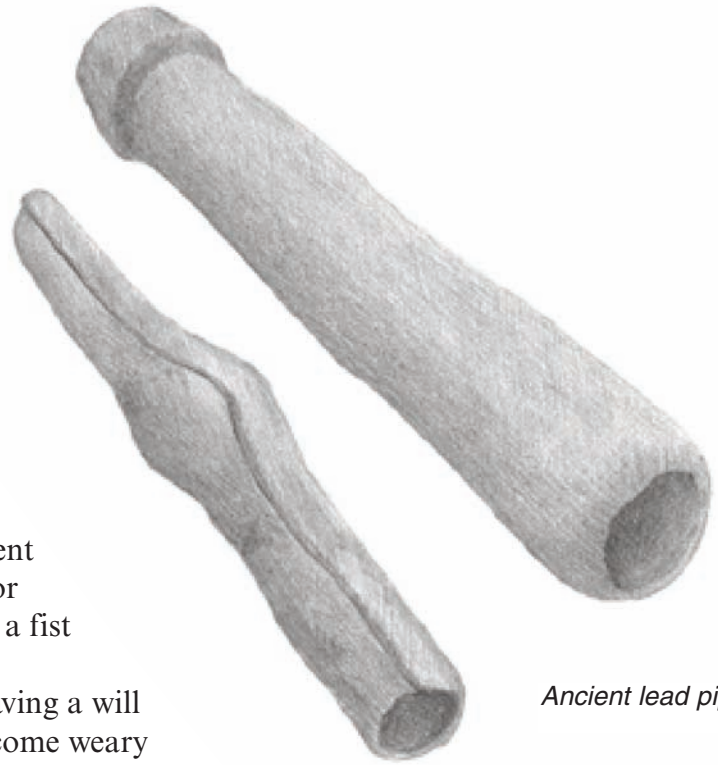
Tin can be beaten into thin sheets and used as tin foil to wrap foods, especially chocolate candy. However,

aluminum will do as well, and the cheaper aluminum has replaced tin. Some people still use the term "tin foil" when actually they mean aluminum foil.

For some reason, people think of tin as a cheap metal, although it is not cheap. They called the first automobiles tin lizzies. People say that cheap radios with poor quality speakers have a tinny sound.

People often use the ancient metals as figures of speech. For instance, a king may rule with a fist of iron. A determined person may be described as having a will of iron. A runner who has become weary is said to have leaden feet. Lead is a heavy metal. When we grow sleepy, we have leaden eyelids because we barely can keep them open. Lead is easily worked into sheets, and rolled into pipes. People of ancient times used lead for water pipes. The Roman name for lead is *plumbum*, the word from which plumber gets its name.

Lead, tin, and iron are three of the seven ancient metals. They are known as the working metals because of their everyday uses.



Ancient lead pipe

REACTION

1. **Some meteorites that fell to earth contained pure iron.**
2. **In a blast furnace, carbon in charcoal combined with oxygen in iron ore to free the pure metal.**
3. **In the extremely cold weather, cans sealed with tin leaked their precious heating fuel.**

Questions

Ancient Metals

Answer T or F for true or false; select A, B, C, or D; or fill in the blank for the phrase that best completes the sentence.

1. Ancient people hammered the soft, pure iron from _____ into useful tools.

A–D 2. Charcoal is (A. a meteorite that fell from the heavens; B. a type of coal found in the earth; C. made of almost pure oxygen; D. wood that has been heated without oxygen).

T F 3. The only purpose of carbon in smelting iron from its ore is so it will burn and supply heat.

A–D 4. Which of these forms of iron is the purest? (A. cast iron; B. charcoal; C. steel; D. wrought iron).

A–B 5. Cast iron is (A. brittle and will shatter if struck; B. soft and easily hammered into shape).

A–D 6. Steel is quenched by (A. burying it in the earth; B. heating it in an oven for several days; C. heating it white hot and thrusting it into cold water; D. raising it overhead for lightning to strike).

7. Cast iron, steel, and wrought iron differ only in the amount of _____ they contain.

A–B 8. Rusting is a (A. slow; B. rapid) oxidation.

A–B 9. A tin can is made mostly of (A. tin; B. steel).

A–D 10. The one that looks more like silver is (A. brass; B. bronze; C. gold; D. pewter).

T F 11. Metals maintain their properties regardless of temperature.

A–B 12. The more expensive metal is (A. aluminum; B. tin).