

## Smelting Metal Lesson Summary

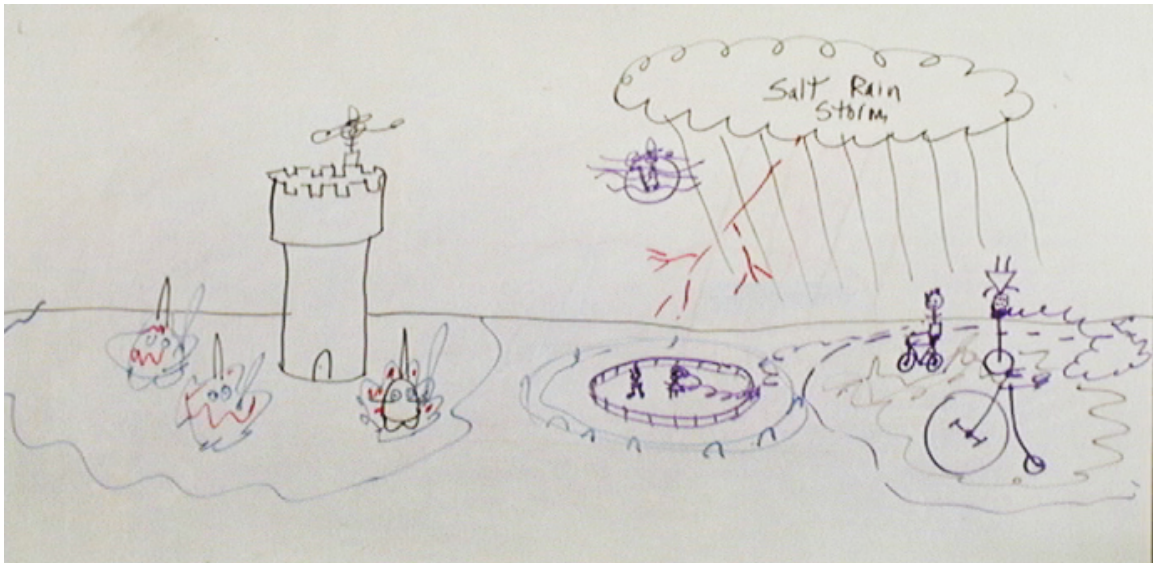


### Intro:

- Two cavemen – Og (big dumb guy) and Doofus (little smart guy).
- Doofus caught a saber tooth tiger and is cooking it. Knows Og will steal it and put out his fire so Doofus will be cold and hungry.
- Doofus makes a fake tiger, fills the skin with dirt, pretends to cook it.
- Og comes, steals tiger, throws dirt on Doofus' fire, runs away. Doofus cooks and eats the real tiger before Og finds out.
- Doofus puts green sticks above the fire so when Og throws dirt on it, the sticks will fall, but the fire won't go out completely.
- Og comes back and does this every day, and the level of the fire keeps getting higher and higher.
- Doofus cut a channel in the cliff face to make a chimney, which makes the fire burn better when the wind blows.
- This makes alternating layers of charcoal and dirt.
- One day all the layers started to burn, like a chimney fire. After it goes out and Doofus cleans out the ashes, he finds a glob of hard stuff.
- He heats it and hammers it to make a sword so he can fight Og. This is iron.

- Dirt was rich in iron ( $\text{Fe}_2\text{O}_3$  – rust). If you heat layers of rust and charcoal, you get pure iron (Fe).
- Easier way to do it. Charcoal is just carbon. You can steal the Oxygen away from the rust better with Aluminum. When you heat them up together, aluminum becomes an aluminum oxide and the iron becomes pure. This is called Thermite.
- MythBusters mixed this in a bathtub, put it in bags, and set it on top of a car to see if it would cut the car in half. Today we'll find out how hot thermite is and whether they were successful.

### Story:



- EMF ordered suits of armor and put them on his minions to make them look scary, but it was so heavy they couldn't move, so he took it off.
- He ordered armor made of aluminum foil, put it on a thousand minions, and painted them black and red to look scary.
- J&J are having a bike rally with about ten thousand people. They saw the minion attacking, so they ordered evasive maneuvers. The riders started swerving all over the place, and the minions couldn't see very well through their helmets, so they couldn't catch the riders.
- EMF ordered a storm to make mud and trap the riders. But it turned out to be a saltwater storm. The bikes rusted and turned into piles of dust. Minions attacked

the riders with bats. After the fight, there was a big pile of aluminum armor and bike parts.

- Now it was night and people were vulnerable. Riders formed a protective circle with their bodies.
- EMF flew over on vacuum. Whenever there was a lightning flash, he could see what was going on, so he could direct the minions. Minions circled around, throwing stuff at the riders.

### **Experiment:**

- Instructor demonstrates entire process before students do it.
- Show aluminum powder, rust, and magnesium (shaved into small filings, with activated charcoal added to prevent corrosion).
- Need to mix this to make thermite and change iron oxide into iron.
- Need 1 part aluminum to 3 parts iron. For this lesson, we'll use 5 grams of aluminum and 15 grams of iron.
- Use 2-oz plastic soufflé cups to weigh ingredients on the digital scale. Zero out the weight of the cup, then scoop out the aluminum and iron with spoons and weigh them in separate cups.



- Put aluminum into the cup with the iron and mix with a wooden craft stick. Tell about how inventors of nitroglycerin learned not to mix it with a steel tool. It blows up, and one brother died.
- Nitro was invented as a safer alternative to black powder in mines, which often went off unexpectedly. Nitro could be ignited with electricity or a long fuse, so people could be at a safe distance.



- Show firebrick with a hole drilled through it.



- Put a single layer of aluminum foil into the hole so the powder doesn't fall through. Push it down toward the bottom so the heat will melt the foil and let the metal drip out the bottom.
- Fill the hole with the thermite mixture. Either leave it like that or compress it with a finger. (Compressed seemed to melt better during the experiment.)
- Thermite is very hard to light. Can't use a match or torch. Requires magnesium.



- Put some magnesium filings into the hole on top of the thermite, then add a thin layer of thermite on top of the magnesium, so just a little of the magnesium shows. If this thin layer can be ignited, the rest will usually burn.



- Place firebrick on a ceramic tile, with ceramic risers between them to allow room for the molten metal to drop through.
- Put on welder's goggles, because thermite gives off UV light when it burns.



- Put ceramic plate and firebrick on the ground and light the magnesium with a propane torch. There will be some smoke, and iron sparks will fly out as it starts to burn.
- Let students look into the hole in the brick to see it burning.

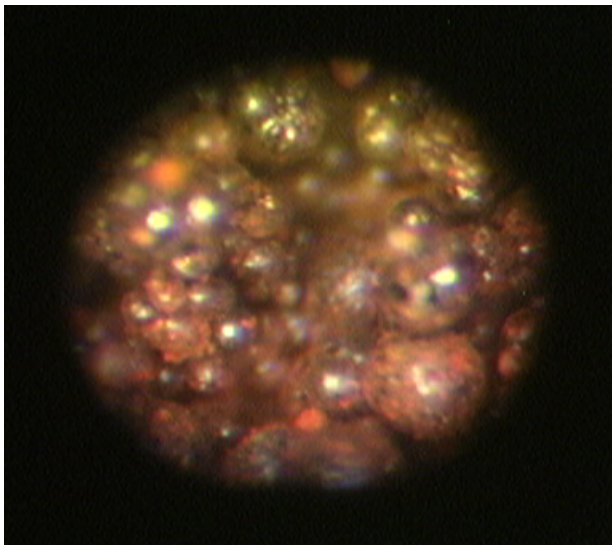


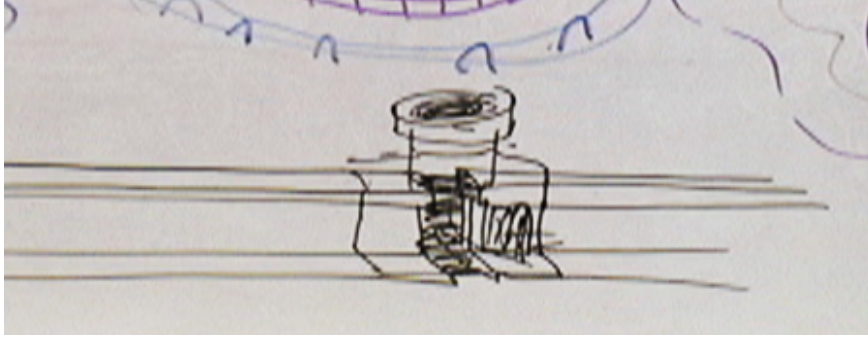
- Remove firebrick from risers to reveal blob of pure iron on the ceramic tile. Afterwards, a magnet can be used to clean up the excess powder.
- Students work in pairs. As each student finishes setting up their thermite, they set their bricks and tiles on the ground and light them under the instructor's supervision.
- When all have finished, students pick up their tiles and bricks, return to their stations, and use tweezers to remove the material from the hole in the firebrick. They can break the brick if necessary.

- They use small disk magnets to gather up the magnetic fragments on their tiles and bricks. Then they use the magnets to clean up the floor where the thermite was burned.



- Instructor sets up a firebrick under a microscope. Students place their magnets on it so they can view the iron bits.





- Thermite was used to join railroad tracks. A mold was placed on each section of the track, then a pot of thermite was placed above the gap and burned. The molten iron filled in the mold, then filled in the gap between the tracks.

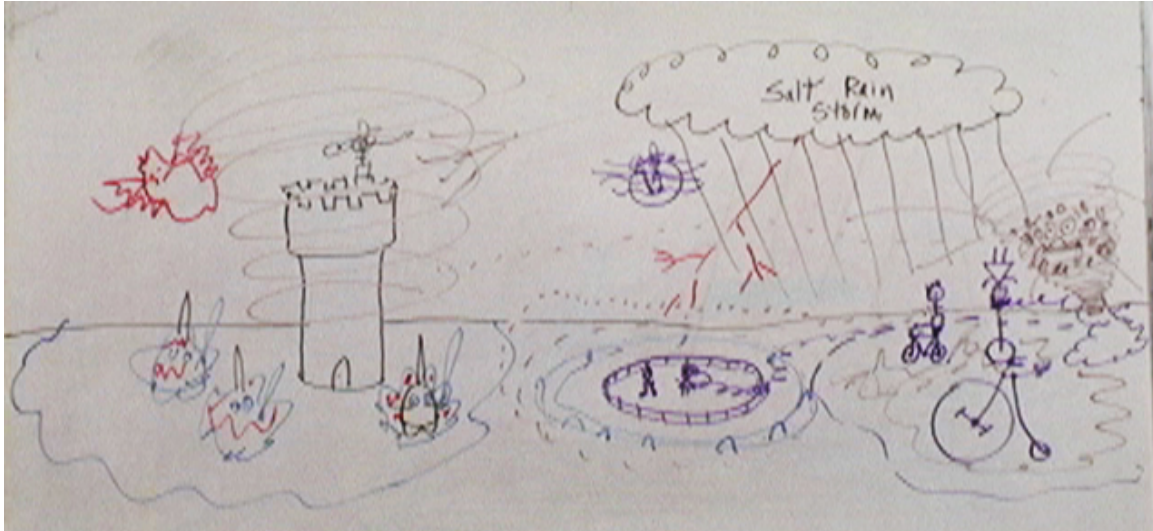


- Show a fragment of thermite left over from a track join, with iron oxide crystals in the middle.



**Story End:**

- There is iron oxide from the rusted bicycles, aluminum from the suits of armor, and lightning at 15,000 degrees.



- Jack calls ASOE and orders a class 5 tornado. It scoops up all the rusted bicycles and grinds them into powder, which is now swirling in the tornado.
- Then it bypasses the riders, scoops up the minions, grinds their armor into powder, and tosses out the minions.
- EMF ducks down inside his castle as the tornado approaches. The tornado encircles the castle so EMF is inside the eye of the tornado. He thinks he's safe so he sticks his head out. Then a lightning bolt hits the tornado and the powders explode.